GLO0937

(1)

WASHINGTON STATE DEPARTMENT OF
Natural Resources

BRIAN BOYLE
Commissioner of Public Lands

OLYMPIA, WA 98504

October 7, 1987

Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 Department of Energy Place
Idaho Falls, ID 83402

Dear Ms. Thorne:

I have enclosed a modification to our proposal regarding PRDA No. DE-PR07-87ID12662 for the State Geothermal Research and Development Program. In brief, the modification eliminates the drilling of two shallow holes, shifts funding for age dates to U.U.R.I., and cuts the total funding request by $34,727. The deliverables will remain the same, and as far as we know at this point, the schedule is unaffected.

Please contact us if there are additional questions concerning the modification.

Sincerely,

Michael A. Korosec

Michael A. Korosec
Program Manager
Geothermal Exploration
Division of Geology and Earth Resources
Department of Natural Resources
State of Washington
(206) 459-6372

MAK:wb

Modification to Proposal in Response to
PRDA No. DE-PR07-87ID12662

by

Division of Geology and Earth Resources
Department of Natural Resources
State of Washington

Part I Technical Proposal

I Statement of work
Page 2: change "six 150m holes" to "four 150m holes"

II Discussion of statement of work
Pages 3-4: eliminate holes no. (1) and no. (8)

Part II Business Proposal
Title page: change Total Project Cost to $214,751

I Program Financial Plan

Page 2: change total cost to $214,751
change U.S. DOE cost to $165,162
change direct drilling cost to $106,000
change cost of K-Ar age dates to $0
change overhead charge to $27,240

Page 3: replace Table 1 with Revised Table 1. Note that the per foot cost of the 500 footholes increases to $25 per foot.

Signature *Michael A. Korosec* date *10/7/87*

Michael A. Korosec
Program Manager
Division of Geology and
Earth Resources
Department of Natural Resources
State of Washington

Revised

Table 1

1987-1988 Geothermal Program Budget

From

U.S. Department of Energy Funds

Salaries:		
Geologist 2 - 10 months at $2,128/month		$ 21,280
Benefits:		
24% of salaries		5,107
Travel:		
Per diem 70 days at $50/day	$ 3,500	
Mileage, 4,500 miles at $0.23/mile	~~1,035~~	
Air fare and professional meeting fee	1,000	
Total Travel Costs		5,535
Age Date Analyses:		
12 analyses at $700/analysis	$ 8,400	
4 analyses at $400/analysis	1,600	
Total cost of analyses paid by U.U.R.I.		0
Drilling:		
2 1,000 foot holes at $28/foot	56,000	
4 500 foot holes at $25/foot	50,000	
Total Drilling Costs		106,000
Total Direct Costs (without overhead)		137,922
Overhead at 19.75%		27,240
Total		$165,162

Response OK
HPR 10/19/87

#3

THE UNIVERSITY OF WYOMING
DEPARTMENT OF GEOLOGY AND GEOPHYSICS
P.O. BOX 3006
LARAMIE, WYOMING 82071
(307) 766-3386

September 14, 1987

Trudy A. Thorne
Contracts Management Division
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

Dear Ms. Thorne:

This letter is in response to the September 8th letter from Brent Clark requesting clarification on my geothermal proposal submitted in response to PRDA No. DE-PR07-87ID12662.

Clarification #1. The model we propose to develop will not be site specific to either the Cody or Thermopolis areas. The model will be in a format that will allow its use in other hydrothermal areas.

Clarification #2. The software which will be incorporated into the model will be newly developed by the researchers.

will software be avail to the public?

Clarification #3. A financial statement for the University of Wyoming is attached.

Clarification #4. A cost breakdown by task is listed below. Note that the cost estimate includes fringe (.20 of salaries) and overhead (.39 of direct costs).

Task	Description	Approximate Cost DOE	Approximate Cost UW
1	Develop algorithm for conjugate gradient solver.	4934.78	2585.40
2	Develop algorithms for heat transfer due to forced convection (second order difference representation).	7298.33	3753.00
3	Develop algorithms for heat transfer due to Newton's law of cooling.	2363.56	3753.00

Task	Description	Approximate Cost DOE	UW
4	Develop algorithms for three dimensional heat transfer using operator splitting or alternating direction iterative methods.	8897.11	
5	Apply grid refinement methods to improve precision of solution in areas of large gradient change.	7715.33	
6	Gather additional temperature data from wells in either the Cody or Thermopolis hydrothermal systems.	3406.06	
7	Apply developed finite difference to either the Cody or Thermopolis hydrothermal systems to test the improved computational scheme.	4796.33	3753.00
8	Complete final report.	6199.96	3753.00
	TOTAL COSTS	45611.46	17597.40

~28% total

If you have additional questions, please contact me.

Sincerely,

Henry Heasler

Henry P. Heasler
Temporary Assistant
Professor

October 26, 1987

Trudy Thorne
Contracts Management Division
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83042

Dear Ms. Thorne:

We are submitting the enclosed revised technical and business proposals requested in your letter of Sept. 8, 1987. The DGGS budget is unchanged from our original submission. The Geophysical Institute budget amount requested from DOE has been reduced from $128,000 to $55,593.

Please note that Dr. Eugene Wescott will no longer be associated with the proposed project due to the elimination of all previously proposed field geophysics tasks by DOE. Please send future correspondence to me at at this address.

Sincerely,

Donald L. Turner

cc:
Roman Motyka
Chris Nye
Neta Stilkey
Robert Forbes

Geophysical Institute, University of Alaska
Fairbanks, Alaska 99775-0800

PHONE: 907-474-7558 TELEX: 35414 GEOPH INST FBK
FAX: 907-474-7290 TELEMAIL: GEOPH.INST.FBK

Established by Act of Congress, dedicated to the maintenance of geophysical research concerning the Arctic regions.

(4 rev)

PART I - TECHNICAL PROPOSAL SUBMITTED TO THE U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
STATE GEOTHERMAL RESEARCH AND DEVELOPMENT
PRDA NO. DE-PRO7-87ID12662

Date of Submission: **October 28, 1987**

Name of Proposers: **Geophysical Institute, University of Alaska and Alaska Division of Geological and Geophysical Surveys.**

Address of Proposers:

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99775-0800

Alaska Division of Geological and Geophysical Surveys
794 University Ave. Basement
Fairbanks, Alaska 99709

Title of Proposal: **GEOTHERMAL RESOURCE ASSESSMENT IN THE ALEUTIAN ISLANDS AND ALASKA PENINSULA**

Type of Research: **Resource Assessment**

Location of Work: **Geyser Bight, Umnak Island, Aleutian Islands, Alaska; and Aleutian Islands-Alaska Peninsula Region.**

Proposed Start Date: **December 1, 1987**

Proposed Project Duration: **24 months**

Proposed Project Managers: **Donald L. Turner (907) 474-7198 (Task 1); Roman J. Motyka, (907) 465-2520 (Task 2).**

Permission for Outside Evaluation: **Yes**

Donald L. Turner
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Geophysical Institute
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Syun-I. Akasofu
Director
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for Roman J. Motyka
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Robert B. Forbes
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Tel. (907) 479-7629

TABLE OF CONTENTS

ABSTRACT

The Geophysical Institute of the University of Alaska and the Alaska Division of Geological and Geophysical Surveys propose to cost-share in a cooperative program of Alaskan geothermal resource assessment. The program consists of two major, interrelated tasks. As Task 1, we propose to prepare a detailed, 1:25,000-scale geologic map of a part of the Geyser Bight KGRA on Umnak Island. Geyser Bight is the hottest and most extensive area of thermal springs in Alaska. Reservoir temperatures are estimated at 180-264^{o}C. Preliminary estimates have indicated about 25 megawatts being dissipated by these springs. The area is readily accessible to the sea coast and volcanic hazards are slight.

We also propose the collection of additional water samples from critical springs, re-measurement of thermal spring flow rates and temperatures, estimation of present heat loss, analysis of new water samples for major, minor and selected trace elements (including As and Cs) and stable isotopes, chloride-enthalpy and fluid-mineral equilibria analyses, re-evaluation and expansion of previous geothermometry studies and isotope analyses, estimates of reservoir temperatures via geothermometry and an estimate of the source of reservoir recharge waters.

As Task 2, we propose to prepare and publish a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region with accompanying circular. The color-coded map will show locations of all known geothermal sites lying between Buldir Island on the West and Becharof Lake on the east (Figure 1). Map information for each site will include maximum surface temperatures, estimated convective heat discharge, estimated reservoir temperatures, total dissolved solids, and land status. The map will also include larger scale, more detailed insets of three to five of the most promising geothermal prospects in this region including the Makushin geothermal area on Unalaska Island, Hot Springs Bay Valley on Akutan Island, and Geyser Bight KGRA on Umnak Island.

The accompanying circular will contain brief descriptions of each geothermal site located on the resource map with the more important sites receiving greater emphasis. The narratives will include summaries of any site-specific investigations that have been conducted plus relevant references. The circular will also contain comprehensive tables and brief discussions of pertinent geochemical data and of the accessible heat energy base stored in the Aleutian arc volcanic systems.

The Geophysical Institute and the Alaska Division of Geological and Geophysical Surveys will provide a combined cost-sharing of $57,049, and request $127,593 from DOE to make a total budget of $184,642 for the proposed two-year project.

STATEMENT OF WORK

Overview of Nature, Objectives, and Benefits of the Proposed Research

The proposed research consists entirely of geothermal resource assessment in the Aleutian Islands-Alaska Peninsula region, one of the largest geothermal energy resource areas of the U.S., and is divided into two tasks.

As Task 1, we propose to conduct a site-specific geological and geochemical resource assessment study at Geyser Bight KGRA (known geothermal resource area) on Umnak Island (Figures 1, 2). Geyser Bight KGRA is the hottest and most extensive area of thermal springs in Alaska.

As Task 2, we propose to prepare a 1:1,000,000-scale geothermal resource map for the Aleutian Islands-Alaskan Peninsula area (Figure 1). This map will be a significant expansion of the statewide geothermal resource map in that it will contain all available published and unpublished data on all spring systems and expanded descriptions of all sites and their reservoir characteristics.

Task 1 - Geyser Bight KGRA Site-Specific Study

Nature

We propose to conduct an integrated geological and geochemical study of the Geyser Bight KGRA. This study will include investigations of fluid geochemistry (including additional sampling to complete the previous study of Motyka et al., 1981), and detailed geologic mapping augmented by K-Ar dating, petrography and rock chemistry. The proposed K-Ar dating will be done at no cost to DOE. The only study that has been made of the Geyser Bight KGRA is a preliminary Alaska Division of Geological and Geophysical Surveys (DGGS) study of hot-spring geochemistry (Motyka et al., 1981). There have been no geophysical or detailed geological investigations of the resource.

Objectives

Our study will produce a detailed chemical model of fluid chemistry which will constrain deep reservoir temperatures, origins of fluids, and mixing between different

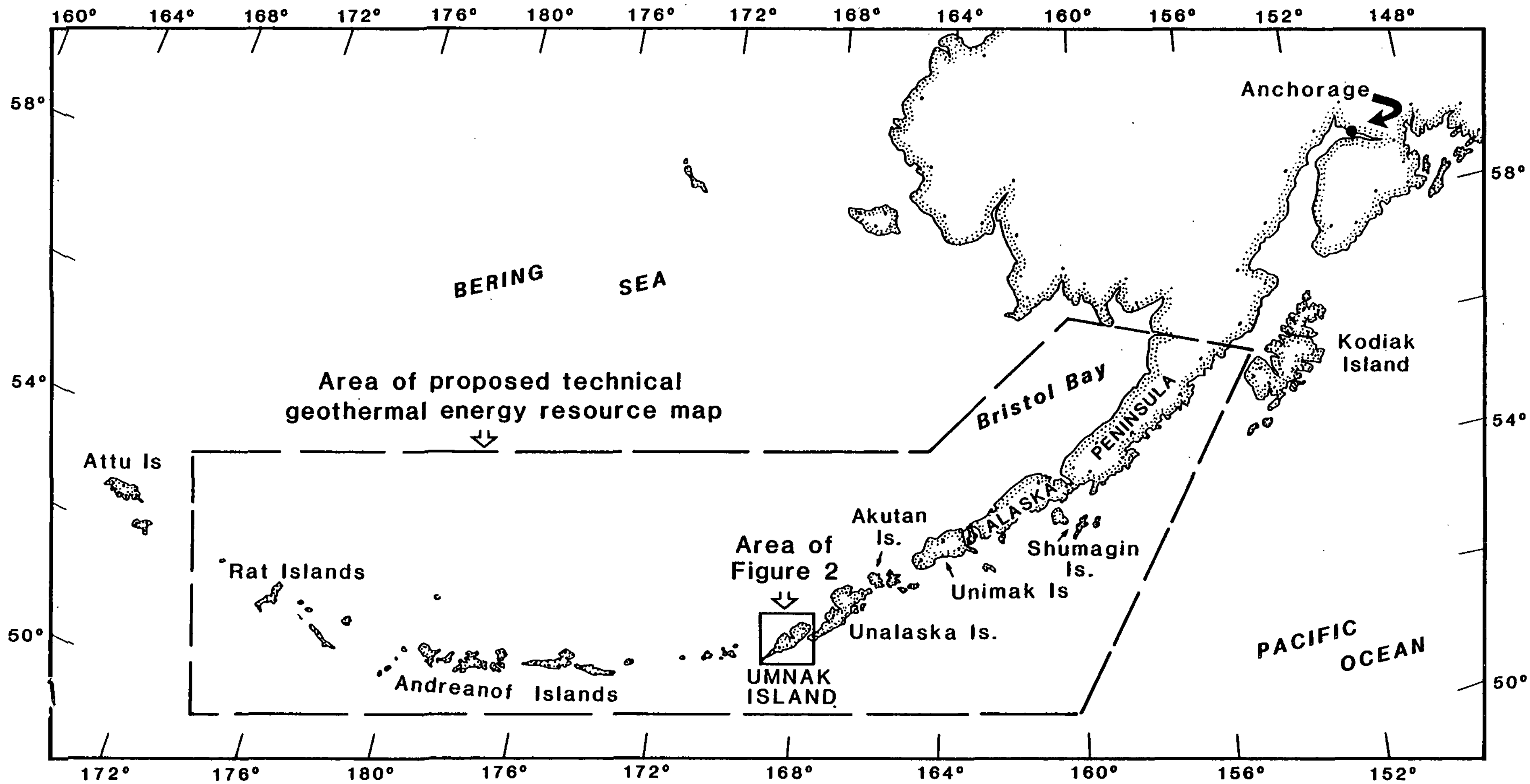

Figure 1. Location map showing area of proposed technical geothermal energy resource map and Umnak Island.

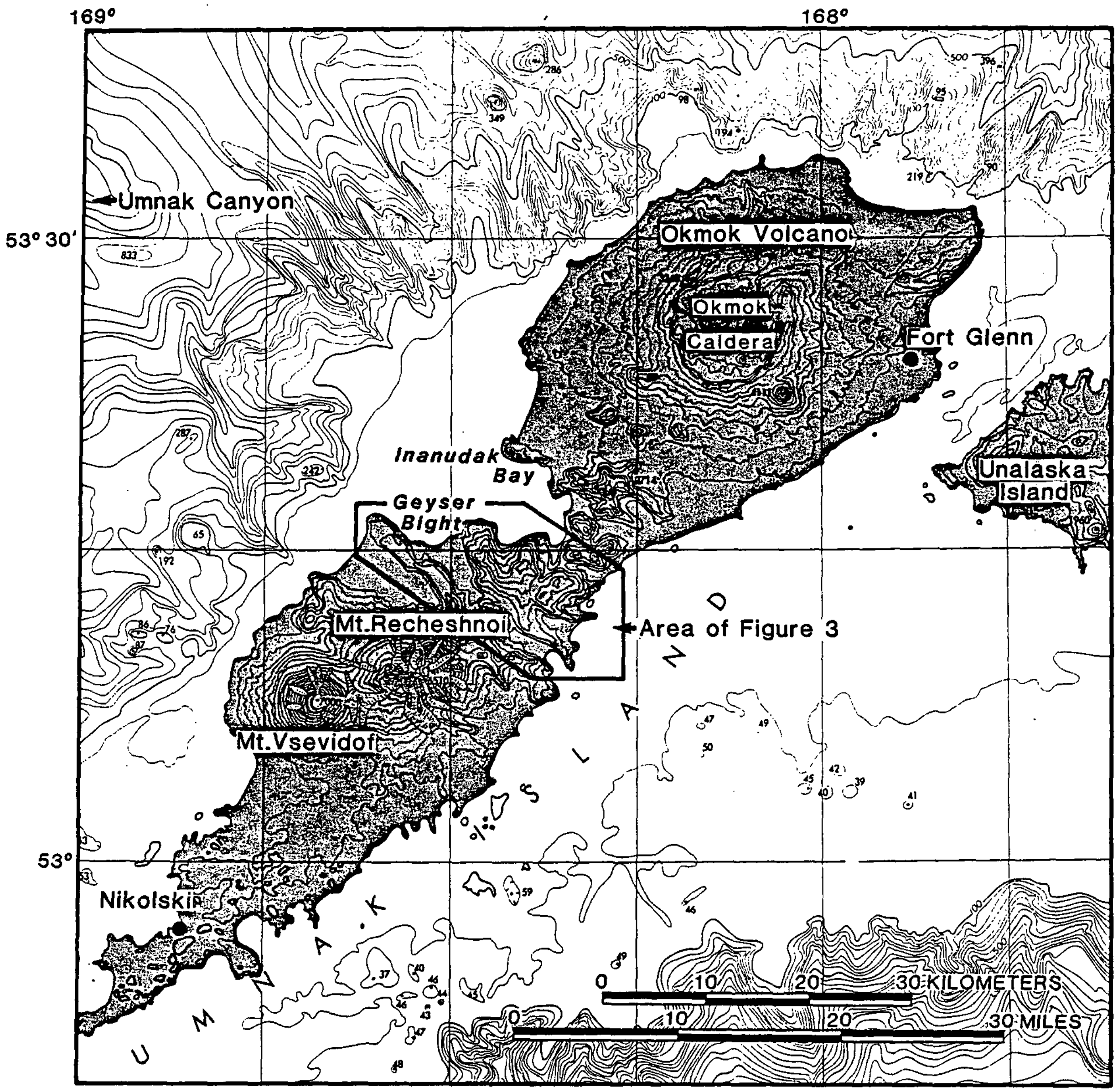

Figure 2. Umnak Island and the western part of Unalaska Island. Topographic contours on land (shaded areas) are at 300 foot intervals. Submarine contour interval is 50 fathoms.

fluids. We will also produce a detailed (1:25,000-scale) geologic map of the Geyser Bight area (Figure 3) which will provide a framework for any future geophysical work and will also help to constrain possible sources for the heat that drives the geothermal system.

Benefits

The proposed study will provide a solid base of geologic and geochemical information for future development of the Geyser Bight resource. It will also provide an estimate of total available power and an understanding of those aspects of fluid chemistry applicable to power plant design.

As fossil fuels become scarce, industry may be forced to locate in regions with readily-available energy. Thus the Geyser Bight KGRA may become attractive for processing ore, producing hydrogen by electrolysis of water (for later use in fuel cells at other locations), seafood irradiation, or other energy-intensive industries.

The central Aleutians are currently sparsely populated and remote. However, rapid growth of the American bottom-fish industry in the Bering Sea and northern Pacific Ocean, as well as increased oil and gas exploration in the Bering Sea, are generating an increased need for power in the region. This industrial growth may well make development of high-quality geothermal resources attractive, even if they are not near current population centers. Economic feasibility studies at Dutch Harbor, 85 miles to the east on Unalaska Island (Figure 1), show that production of electricity using the Makushin geothermal resource will be cost-efficient compared to diesel-fired generators, hydropower, or wind power, even though current community power usage is less than 10 megawatts. The Makushin resource is currently being developed by the state.

We believe that it is particularly important to do the proposed study of the Geyser Bight KGRA for the following reasons:

1) Geyser Bight has the hottest and most extensive geothermal system in all of Alaska (Motyka et al., 1981). *Minimum* estimates of temperature and available energy for the Geyser Bight KGRA (Motyka et al., 1981; Muffler, 1978) are larger than maximum estimates of the energy available at the Makushin geothermal field (Republic Geothermal, 1985). Thus development of Geyser Bight may become attractive if the Makushin field proves insufficient for industrial development in the central Aleutians. See Appendix 4 for a discussion of estimated available energy.

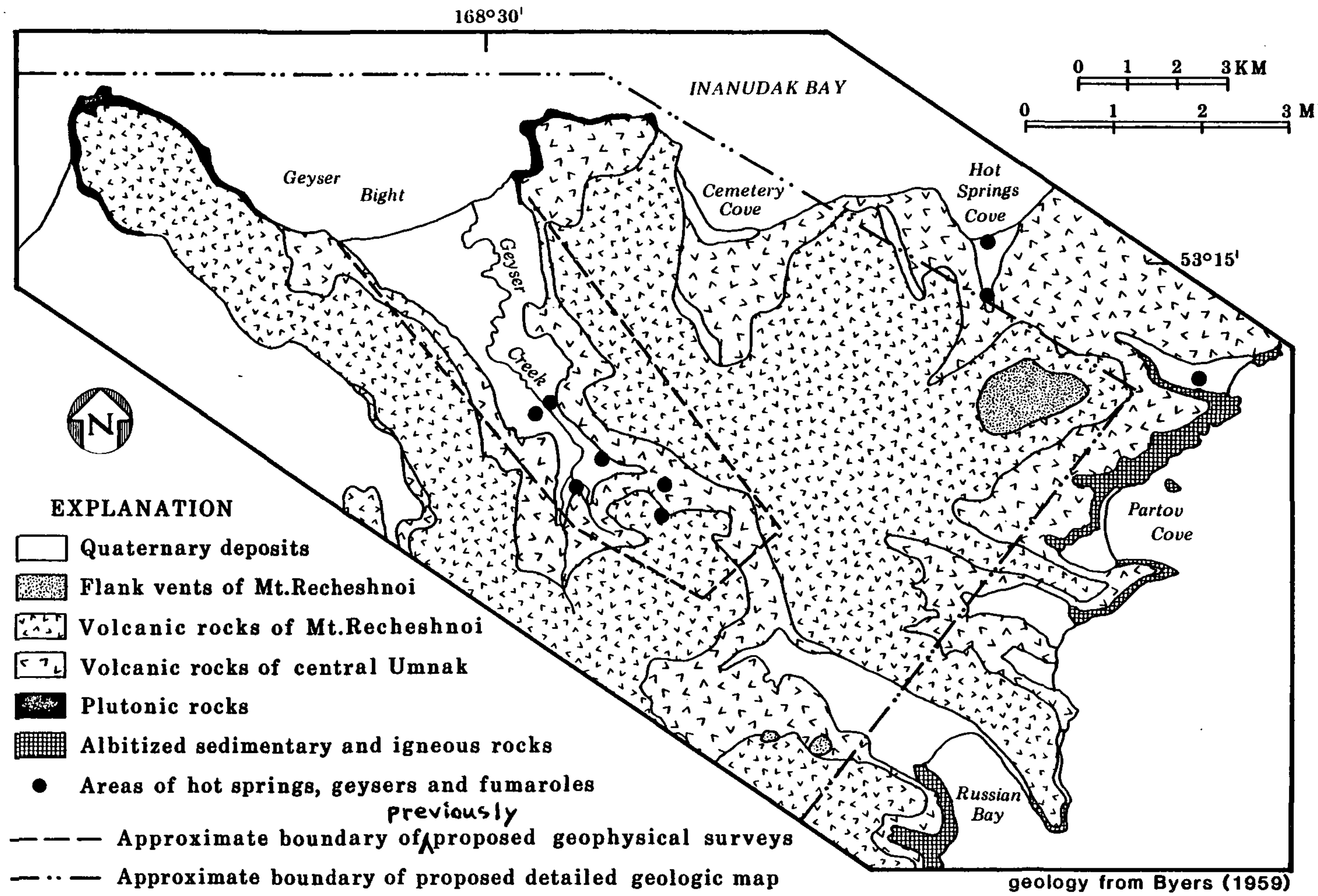

Figure 3. Generalized geologic map of Geyser Creek valley and adjacent areas from Byers (1959).

2) Although a reconnaissance geochemical study has been done (Motyka et al., 1981), there has been no detailed geologic mapping or geothermally related geophysical work.

3) There are several semi-protected bays near the Geyser Bight resource, such as Hot Springs Cove and Russian Bay (Figure 3). With some improvements such as breakwater construction and/or dredging, a suitable deep-water harbor could possibly be constructed at one or more of these sites.

4) We have a well-qualified team of investigators who have a long and productive record of DOE-sponsored, cooperative Alaskan geothermal work using all of the methods proposed here. Two of our three co-investigators have recently worked together on a geothermal assessment study of Hot Springs Bay valley on Akutan Island (Figure 1; Motyka et al., 1985b). The Akutan geothermal resource is nearly identical (although smaller) to the Geyser Bight resource in terms of its geologic and geographic setting.

5) Given the declining trend of federal funding for geothermal assessment studies, this may well be our last opportunity to do an integrated geochemical and geological study of Alaska's most significant geothermal resource.

Location and Description of Field Site

The Geyser Bight Hot Springs site is the hottest and most extensive area of thermal springs in Alaska. Minimum and maximum reservoir temperatures have been estimated at 180 and 264^{o} C (Motyka, et al., 1981). Preliminary estimates have indicated about 25 megawatts being dissipated by the springs alone (Byers and Brannock, 1949). The site is located at latitude 53 degrees 13 min. N, longitude 168 degrees 28 min. W, at the approximate center of the north side of Umnak Island (Figure 2). The thermal area consists of five zones of numerous thermal springs and small geysers dispersed over an area of about 4 km^2 in the upper reaches of a broad glacial valley, which has excellent access to the Bering Sea (Figures 3 and 4). The hot springs occur mostly along Geyser Creek and its tributaries, and emerge in the valley floor and at the base of steep valley walls. Two small fumarole fields are located at elevations of 140 and 300 m in a small tributary valley at the headwaters of Geyser Creek. The surface expression of thermal springs, geysers, and fumaroles suggest that the subsurface reservoir is large. Based on the geochemistry of the spring waters, Motyka et al. (1981) suggested that "the striking similarity in chemistry of springs G_8 and J_1 (Figure 4) indicate these springs are being fed directly from a common reservoir." He also suggested that three intermediate reservoirs may underlie three

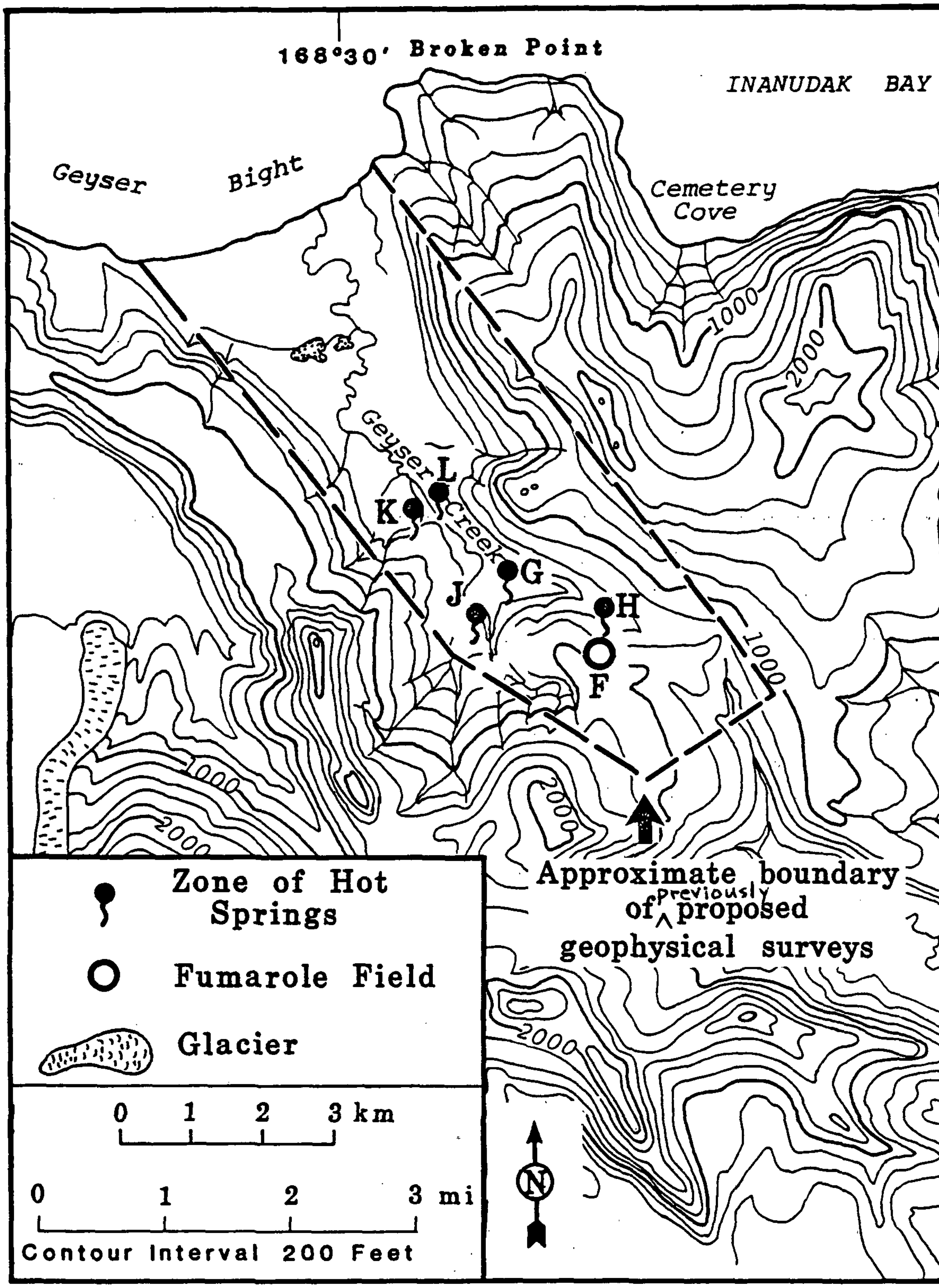

Figure 4. Detailed topography of Geyser Creek valley and immediately adjacent areas.

geographically separate groups of springs: H, G and J, K and L (Figure 4) with temperatures of 155, 185, and 165°C, respectively.

Lithologic units of the Geyser Bight area consist of albitized Oligocene sedimentary and hypabyssal volcanic rocks, Oligocene or Miocene plutonic rocks, and Plio-Pleistocene-through-Holocene intermediate and silicic volcanic rocks (Byers, 1959; McLean and Hein, 1984). The presence of small rhyolite domes of probable Holocene age in the upper portion of the valley immediately southeast of Geyser Creek valley (the southeastern "flank vents of Mt. Recheshnoi" in Figure 3) suggests that there may be a shallow, silicic magma chamber which is providing heat to the geothermal system. Appendix 1 contains a detailed description of the geologic setting and a volcanic hazards assessment of the area.

The Geyser Bight resource could be used for large-scale, flash-steam electric power generation and for a variety of other applications. The flat floor and gentle slope of Geyser Creek valley would allow relatively inexpensive road building from the beach to the thermal area, a distance of only 3 miles (Figure 4). There is a large airfield in good condition at Fort Glenn (WW II, abandoned) located at the east end of the island, about 30 miles from Geyser Creek valley (Figure 2). An unimproved road leads from Fort Glenn to within 10 miles of Geyser Bight. Volcanic hazards to power plant construction and other development are relatively slight (see Appendix 1).

Land Status and Environmental Concerns

The Geyser Bight KGRA is on federal land under the jurisdiction of the U.S. Bureau of Land Management. BLM would be involved in any lease sale, permitting for drilling, etc., in the development phase of the resource. The state has also tentatively selected some land in the area. One of the village corporations has overfiled for part of the area in the name of the Shumagin Corporation, under the Alaska Native Land Claims Settlement Act. We have been informed by BLM that it is unlikely that the land will be conveyed to the village corporation. BLM has an agreement that the U.S. Fish and Wildlife Service will issue permits for exploration in the study area. We have obtained a special use permit for our proposed project, and a letter of non-objection from the Shumagin Corporation, which are included in Appendix 5.

There are no anticipated environmental problems involving the work proposed here. The permit we have obtained (Appendix 5) allows us to carry out all operations specified in the List of Key Tasks. Before eventual development could proceed, appropriate environmental impact studies would have to be carried out and necessary additional permits obtained.

Task 2 - Technical Geothermal Resource Map

Nature and Objectives

We propose to prepare and publish a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region with accompanying circular. The color-coded map will show locations of all known geothermal sites lying between Buldir Island on the West and Becharof Lake on the east (Figure 1). Map information for each site will include maximum surface temperatures, estimated convective heat discharge, estimated reservoir temperatures, total dissolved solids, and land status. The map will also include larger scale, more detailed insets of three to five of the most promising geothermal prospects in this region including the Makushin geothermal area on Unalaska Island, Hot Springs Bay Valley on Akutan Island, and Geyser Bight KGRA on Umnak Island.

The accompanying circular will contain brief descriptions of each geothermal site located on the resource map with the more important sites receiving greater emphasis. The narratives will include summaries of any site-specific investigations that have been conducted plus relevant references. The circular will also contain comprehensive tables and brief discussions of the following pertinent geochemical data collected by DGGS:

- Water chemistry of thermal springs and geothermal wells
- Gas chemistry of fumaroles, thermal springs, and geothermal wells
- Stable isotope compositions of thermal waters and selected, locally-derived meteoric waters
- Available isotopic compositions of gases including del ^{13}C-CO_2, del ^{13}C-CH_4, del D-H_2, and $^3He/^4He$
- Thermal water geothermometry including silica, Na-K, Na-Ca-K, del ^{18}O H_2O-SO_4, K-Mg (Giggenbach et al., 1983)

- Gas geothermometry including the geothermometers proposed by D'Amore and Panichi (1980) and by Arnorsson and Gunnlaugsson (1985).

The circular will also include a brief discussion of the accessible heat energy base stored in the Aleutian arc volcanic systems.

Background

Since the inception of the DOE-sponsored, state-coupled geothermal resource assessment program in 1979, DGGS has investigated over 100 geothermal sites and has acquired a wealth of data on water and gas chemistries of these hydrothermal systems. A prime objective of this program was met in 1983 with the publication of a state-wide geothermal resources map that was oriented towards the general public. An additional goal of the DGGS geothermal program has been to publish geotechnically-oriented geothermal resource maps, such as described above, at a scale of 1:1,000,000 for four different regions of the state: southeast Alaska, Aleutian Islands-Alaska Peninsula, northern and interior, and southcentral. Four maps were deemed necessary because of the large number of geothermal sites and the vastness of the state (approximately one-fifth the land area of the contiguous 48 states). The first of these maps, "Geothermal resources of southeast Alaska" (Motyka and Moorman, 1987) is scheduled for publication this December.

However, the recent rapid decline in state oil revenues has led to severe budget cuts in DGGS (as well as in other state agencies). State funding for the DGGS geothermal program has been drastically reduced, resulting in a temporary suspension of work on the geothermal resource maps. The level of funding being requested from DOE would allow completion and publication of the next map in the series which is scheduled to be the Aleutian Islands-Alaska Peninsula region.

Work on this map is about 30% completed. The map and accompanying circular will be built on the foundation of our earlier reconnaissance investigations of the region published as an open-file report (Motyka et al., 1981). Since then, we have acquired much additional information on the hydrothermal systems both through site-specific investigations and by continued reconnaissance of the region. These data will be presented and summarized in a readily accessible format in the proposed map and circular.

Benefits

The proposed map and accompanying circular will provide geochemical and other technical information plus brief discussions of geothermal sites in a readily accessible format which can be quickly referenced and used by anyone interested in the region's geothermal resource base. Potential users include private industry, government agencies, Alaska native corporations, and other geothermal scientists and engineers. Although sparsely populated, the Aleutian Islands-Alaska Peninsula region has become increasingly important as a result of the increasing American participation in the rich Northern Pacific and Bering Sea bottom fisheries, increased oil and gas exploration, and strategic national defense location. With the increased emphasis being placed on shore-based fish processing facilities and the need for service facilities for the expanding fishing fleet and oil and gas exploration vessels, power derived from geothermal resources can play an important role in the region's economy.

Description and Significance of the Resource Area

There are over 33 hydrothermal systems identified in the region extending from Buldir Island to Becharof Lake (Motyka et al., 1981). At least thirteen of these systems are thought to house high-temperature reservoirs ($>150^{\circ}C$) (Motyka, 1983). Thus the Aleutian Islands-Alaska Peninsula region is one of the most significant geothermal districts in the world. Although many of these sites lie in remote locations, several sites are close to population and industrial centers with good natural harbors and thus have good-to-excellent potential for eventual development. These communities presently rely almost solely on imported fossil fuels for heat and electric power generation.

List of Key Tasks, and Responsible Personnel and Agencies

1A. Construct a detailed geologic map of Geyser Creek valley and the surrounding area (Nye, Turner, DGGS and GI).

1B. Investigation of the fluid geochemistry of the Geyser Bight KGRA (Motyka, DGGS).

1C. Analysis and interpretation of all the available data for the Geyser Bight KGRA study area and preparation of a final report on the geology and geochemistry of the area and their relationship to hidden geothermal reservoirs and the geothermal resource (Turner, Nye, Motyka, GI and DGGS).

2A. Preparation of 1:1,000,000-scale Technical Geothermal Energy Resource Map for The Aleutian Islands-Alaska Peninsula Region (Motyka, DGGS).

2B. Preparation of tables of all known fluid geochemistry from the Aleutian Islands-Alaska Peninsula Region (Motyka, DGGS).

2C. Preparation of circular describing all known geothermal sites of the Aleutian Islands-Alaska Peninsula Region (Motyka, DGGS).

Detailed Description of Key Tasks

Task 1A: Construct a detailed 1:25,000-scale geologic map of Geyser Creek valley and the surrounding area (see Appendix 1 for additional geologic information).

The map will cover the area shown in Figure 3, and include contacts between lithologies, bedding attitudes, attitudes of joints, fractures and folds, and descriptions of the composition (including alteration) of each unit. We will subdivide the stratigraphy of Byers (1959) where appropriate. Our mapping will be supported by petrographic and geochemical studies and K-Ar dating of key rock units. The K-Ar dating will be done at no cost to DOE. The map will provide a framework within which to interpret geochemical and future geophysical data.

By virtue of mapping at a larger scale than Byers (1959) and by spending 4 weeks mapping a restricted area we anticipate the following improvements on Byers' map:

1) Additional detail about the structure of Geyser Creek valley. We will search for any indication of fractures or faults which may be controlling the position of the valley and localizing geothermal fluids. This will be a test of the hypothesis that the location and orientation of the valley, as well as the location of the resource, are structurally controlled by the interaction of the Pacific and North American plates, as discussed in Geologic Setting (Appendix 1).

2) Additional detail about Quaternary valley-filling deposits. We will search for evidence of valley-filling deposits other than alluvium (e.g. lahars) and interpret all valley-filling deposits in terms of the geologic history of the valley.

3) Additional information about alteration. We will interpret alteration in terms of the regional alteration of older rocks and search for sites of older hot springs and fumaroles. This will provide information about the history of the geothermal system.

4) Information about the nature of the plutonic rocks. At Makushin Volcano on adjacent Unalaska Island, a shallow gabbronorite pluton hosts the geothermal system while adjacent tuffaceous sediments do not. This probably reflects the ability of the gabbronorite to maintain open fractures. Makushin is presently being developed by the state as a geothermal electricity generation facility. We will carefully map joint orientation and density in the Umnak pluton. If possible, we will collect additional information about the lateral extent and continuity of the pluton, in order to test the hypothesis of Byers (1959) that the scattered outcrops of pluton that are exposed belong to a single plutonic body which underlies much of southwestern Umnak.

5) Information about major contacts, such as the contact between intrusive rock and overlying lavas. This information will help constrain the timing of emplacement of the rock units and the geologic history of the area.

6) Additional information about the rhyolite and quartz-andesite domes and flows. We will collect field evidence concerning the relative age and method of emplacement of these units. These units are the prime indicator that there is, or has once been, a shallow silicic magma chamber under the valley, and it is important to know their age. Field investigation of these units is an important addition to the K-Ar dating program because the domes may be Holocene, and therefore too young to date reliably (Byers, 1959).

7) Information about volcanic hazards. The presently available data indicate that volcanic hazards at Geyser Bight valley are slight (Appendix 1), but we will search for volcanically-generated mass flows and tephra falls at the site. This will help to better quantify possible hazards to future development.

Task 1B: Investigation of the Fluid Geochemistry of the Geyser Bight KGRA

The objectives of the fluid geochemistry study are 1) to determine whether or not multiple reservoirs underlie Geyser Basin and what, if any, inter-relationships may exist between these reservoirs; 2) to estimate the geochemical, isotopic and temperature characteristics of these reservoirs; 3) to examine whether fluid-mineral equilibrium exists within the reservoirs; 4) to determine the source of waters charging the reservoirs; and 5) to estimate heat loss by surface and near-surface thermal water discharge.

To meet these objectives we propose to do the following.

1) Perform preliminary chloride-enthalpy and fluid-mineral equilibria analyses. During our 1980 reconnaissance investigation of the Geyser Bight KGRA, we collected water samples from six thermal springs which were representative of the four different groups of thermal springs present in the valley. The results of the geochemical analyses of these samples suggested that the springs were fed by three different intermediate reservoirs which were ultimately all related to a deeper parent reservoir (Motyka et al., 1981). Using these analyses and previous U. S. Geological Survey analyses, we propose to perform preliminary chloride-enthalpy analyses following techniques described in Fournier (1979) to find further supporting evidence for the existence of multiple reservoirs and their geochemical and thermal characteristics. We also propose to do a preliminary study of fluid-mineral equilibria using techniques described in Reed and Spycher (1984), Giggenbach (1984), and Henley et al. (1984).

2) Examine and evaluate results of chemical and isotopic geothermometers. We will re-examine application of chemical and isotopic geothermometers to the Geyser Basin spring waters and will include the K-Mg geothermometer proposed by Giggenbach et al. (1983). In addition, we will also analyze the results of sulfate-water oxygen isotope geothermometry. Isotopic analyses on three different spring waters were made subsequent to publication of our 1981 report but lack of time and funding has thus far prevented any detailed examination of the results.

3) Examine the results of analyses of stable isotope compositions. Subsequent to publication of our 1981 report we obtained analyses of the stable isotope composition of several of the thermal spring waters and also locally-derived meteoric waters. Lack of time and funding has thus far prevented any detailed examination of the results. We therefore propose to examine the available data (including previous data from the U. S. Geological Survey) to obtain preliminary estimates of the source of reservoir recharge waters, isotopic shifts that are potentially attributable to water-rock interactions, and evidence of any mixing of cold and hot waters.

4) Collect additional water samples during the 1988 field season for geochemical and isotopic analyses. Based on the results of our preliminary analyses we propose to collect whatever additional water samples are needed to help further our understanding of the

hydrothermal system. We estimate collecting on the order of 12 additional samples, four from previously sampled spring sites to check for any long term changes in water chemistry and up to 8 samples from previously unsampled sites. Additional samples of locally-derived meteoric waters will also be obtained for isotopic analyses. Wherever possible, samples of gases associated with the thermal springs will also be collected. Gas flow from fumarole vents at the head of the valley is too diffuse for acquisition of reliable samples and, unless flow rates have significantly changed since 1981, we do not anticipate collecting gas samples from this site in 1988.

5) Re-measure thermal spring flow rates and temperatures. Measurements of flow rates made in 1980 were significantly lower than the estimates of spring discharge made by Byers and Brannock (1949) in 1947. We propose to re-measure the flow rates to see whether there has been any further decline in discharge. If so, the decline could signify blockage of conduits due to silica deposition.

6) Estimate heat loss due to surface and near-surface discharge of thermal waters. All the major thermal spring systems drain into Geyser Creek. Additional thermal water may seep directly into the creek. In addition to measuring thermal spring discharge we propose to obtain estimates of heat loss through thermal water discharge by measuring stream flow in Geyser Creek above and below each major spring system, and using conservative elements such as Cl and B, to estimate the hot water fraction entering the stream.

7) Analyze water samples for major and minor and selected trace element constituents and for stable isotope composition. The geochemical analyses will be performed at the DGGS water laboratory. Analyses of stable isotopes will be performed by contract with the Stable Isotope Laboratory at Southern Methodist University. Analysis of arsenic will be done because high concentrations (10 ppm) were found in geothermal well waters at the Makushin geothermal area located on the neighboring island of Unalaska (Motyka et al., 1985a) and because the source of arsenic in hydrothermal waters is still unclear (cf. Stauffer and Thompson, 1984).

Using the enlarged geochemical data base we propose to refine a) the chloride-enthalpy model, b) the analyses of fluid mineral equilibria, c) estimates of reservoir temperatures via geothermometry, and d) the estimate of the source of reservoir recharge waters.

Task 1C: Analysis and interpretation of all the available data and production of a final report.

The suite of data which we will collect at the Geyser Bight KGRA will consist of detailed geological mapping with supporting rock chemistry, K-Ar dating and petrographic studies; follow-on studies of the spring, geyser, and fumarole temperatures, flow rates, and chemistry; and geothermometry of the reservoir temperatures.

Individual investigators will be responsible for analysis and interpretation of their data. The investigators will cooperate, consult with each other and produce an integrated final report on the Geyser Bight geothermal study area, to include improved estimates of reservoir temperature and of the magnitude of the energy available for development.

Task 2A: Preparation of 1:1,000,000-scale Technical Geothermal Energy Resource Map for Aleutian Islands-Alaska Peninsula Region.

We propose to prepare and publish a four-color, geotechnically-oriented geothermal resource map of the Aleutian Islands and the Alaska Peninsula region with accompanying circular. The color-coded map will show locations of all known geothermal sites lying between Buldir Island on the west and Becharof Lake on the east (Figure 1). Map information for each site will include maximum surface temperatures, estimated convective heat discharge, estimated reservoir temperatures, total dissolved solids, and land status. The map will also include larger-scale, more-detailed insets of three to five of the most promising geothermal prospects in this region including the Makushin geothermal area on Unalaska Island, Hot Springs Bay valley on Akutan Island, and Geyser Bight Basin KGRA on Umnak Island.

Task 2B: Preparation of tables of fluid geochemistry

We propose to compile tables of all previously published and unpublished geochemical data on geothermal fluids. None of these data are widely available, and much of the published data are contained in DGGS Reports of Investigations which are out of print or in very short supply.

These tables will contain:

- Water chemistry of thermal springs and geothermal wells

- Gas chemistry of fumaroles, thermal springs, and geothermal wells

- Stable isotope compositions of thermal waters and selected, locally-derived meteoric waters

- Isotopic compositions of gases including del ^{13}C-CO_2, del ^{13}C-CH_4, del D-H_2, and $^3He/^4He$

- Estimates of temperatures of thermal water based on chemical equilibria, including silica, Na-K, Na-Ca-K, del ^{18}O H_2O-SO_4,and K-Mg geothermometry (Giggenbach et al., 1983),

- Estimates of temperatures of geothermal gases based on the geothermometers proposed by D'Amore and Panichi (1980) and by Arnorsson and Gunnlaugsson (1985).

<u>Task 2C: Preparation of circular describing geothermal sites</u>

A circular accompanying the final map will contain brief descriptions of each geothermal site located on the resource map with the more important sites receiving greater emphasis. The narratives will include summaries of any site-specific investigations that have been conducted plus relevant references. The circular will also contain comprehensive tables and brief discussions of the following pertinent geochemical data collected by DGGS:

Schedule of Completion of Project

Task 1

1. Receipt of requested funding December 1, 1987. <u>Critical Date: no later than January 5, 1988</u>, to allow adequate lead time for scheduled items listed below. Logistical planning for the proposed operation is complex and requires considerable lead time to avoid problems.

2. Preparation of Requests for Bids for necessary boat transportation services (Jan. 5-15).

3. Selection and hiring of field assistant (Jan. 25-Mar. 1).

4. Opening of bids (Feb. 5).

5. Completion of boat charter arrangements (Feb. 10).

6. Purchasing of necessary equipment and supplies (Feb. 5-May 30).

7. Completion of preliminary chloride-enthalpy analyses and examination of geothermometry (Feb. 5-Mar. 15).

8. Completion of examination of available thermal water stable isotope data (Mar. 31).

9. Completion of preliminary fluid-mineral equilibria study (April 30).

10. Design of geochemical sampling program for field season (May 15).

11. Packing of equipment and supplies in Fairbanks (May 20-June 2).

12. Nye, Turner, and assistant take commercial flight (Reeve Aleutian Airways) to Dutch Harbor, Unalaska Island (June 8). Equipment and supplies are transported as air freight.

13. Above personnel pick up perishable food supplies in Dutch Harbor ordered in advance (June 8-9).

14. Crew loads equipment and supplies into chartered boat - a converted Navy landing craft (LCM)-June 9.

15. LCM leaves Dutch Harbor with crew and equipment June 10 for 10-hour trip to Geyser Bight, lands on beach and drops bow ramp for direct unloading of gear. LCM departs for Dutch Harbor; base camp is set up (June 10-11). NOTE: Surf conditions at Geyser Bight make direct unloading onto beach from LCM preferable to ferrying gear by small boat from an anchored, larger boat. The relatively small additional cost of the LCM will insure that the field party and their equipment can be landed safely, even in marginal weather conditions.

16. Four weeks of field work as specified in Key Tasks. Motyka visits for one week during this period to do the geochemical sampling, using a chartered amphibious plane or helicopter (if available) from Dutch Harbor (June 12-July 8).

17. Completion of all field work and packing for return trip (July 8).

18. LCM arrives at Geyser Bight approximately July 9 and takes crew and equipment back to Dutch Harbor.

19. Crew and equipment return to Fairbanks by air, approximately July 11.

20. Lab work and data analysis (July 15, 1988-Jan. 30, 1989).

21. Final report preparation (Feb. 1- March 30, 1989).

22. Submission of first draft of report 90 days prior to final submittal (April 2, 1989).

23. Revision of first draft based on DOE reviewers' comments (May 1-June 30, 1989).

24. Submission of Final Geyser Bight Report (July 1, 1989).

<u>Task 2</u>

All work on the technical geothermal resource map will be conducted by DGGS under the supervision of Dr. Motyka. A junior-level geologist and a cartographer will aid with map preparation and production. Base maps for the Aleutian Islands-Alaska Peninsula region have already been purchased and preparatory work is estimated to be about 30% completed. The following schedule is based on anticipated receipt of federal funds by November 1, 1987:

1. Review and redesign of map layout and preliminary drafting of locations, land status, geotechnical information, and map insets. (December 1 - January 31, 1987).

2. Update and synthesis of water and gas data. Preparation of chemistry tables. (December 1, 1987 - February 28, 1988)

3. Computation of water and gas geothermometers, selection of applicable temperature estimates, and preparation of tables. (March 1 - March 31, 1988)

4. Update and synthesis of available stable isotope data on waters and gases. Preparation of tables. (December 1, 1987 - February 28, 1988)

5. Preparation and calculation of estimates of stored heat energy in volcanic systems. (January 1 - March 31, 1988).

6. Preparation and preliminary drafting of figures for circular. (January 1 - March 31, 1988).

7. Preparation and update of all site descriptions, and technical discussions, (December 1, 1987 - March 31, 1988).

8. Proofing of all tables and text. Final preparation for review copy. (April 1 - April 30, 1988).

9. Final drafting of map and circular figures for review copy. (April 1 - April 30, 1988).

10. External scientific and DOE review of map and circular. (May 1 - July 31, 1988).

11. Incorporation of reviewers comments and map changes. Final editorial review. (August 1 - September 30, 1988). 12 mo.

12. Final production and publication of four-color map and circular. (October 1 - October 31, 1988).

QUALIFICATIONS AND CAPABILITIES OF INVESTIGATORS AND PROPOSING ORGANIZATIONS

Our DOE-sponsored, cooperative, Geophysical Institute-Division of Geological and Geophysical Surveys program of Alaskan geothermal energy resource assessment began in 1978 and has continued (with a few breaks in funding) up to the present time. The maps, reports, and publications of our Alaskan geothermal team are listed in a following section.

Key Personnel

Dr. Donald L. Turner, co-principal investigator, will be responsible for field logistics, coordination and planning. He will also do detailed geologic mapping with Nye and will be responsible for the K-Ar dating (at no cost to DOE) and, together with Nye and Motyka, will produce the final report for the Geyser Bight study. He will devote at least three months (full time equivalent) to the project.

Dr. Turner received his A.B. and PhD. degrees in geology from the University of California at Berkeley in 1960 and 1968. He established the Geochronology Laboratory at the Geophysical Institute in 1970 after spending two years with the U.S. Geological Survey Branch of Isotope Geology. His background includes geochronology, stratigraphy, general geology, and tectonics. He established the Geophysical Institute's part of the DOE-sponsored Alaskan Geothermal Energy Resource Assessment Program (a cooperative with DGGS) in 1978, and has authored numerous Alaskan geothermal reports and publications.

Dr. Roman J. Motyka, co-principal investigator, will spend 4 months overseeing and/or participating in the collection and analysis of additional fluid samples from Geyser Creek valley and synthesizing all available data into a comprehensive fluid-geochemical model of the resource. He will supervise a Geologist I (3 months) who will aid in accomplishing these tasks. He will spend an additional 4 months synthesizing all available information on the geothermal resources of the Aleutians and the Alaska Peninsula for inclusion in the regional geothermal resource map and will have overall responsibility for the production of the map. He will supervise a Geologist I (5 months) and a cartographer (1.5 months) who will aid in map preparation and production.

Dr. Motyka has been head of the DGGS Geothermal Resource Assessment Program since its inception and has conducted state-wide, regional, and site-specific studies of Alaska's geothermal resources. Products of this work include regional and statewide resource maps, and detailed reports on the fluid geochemistry of many of Alaska's most significant geothermal resources. He has an extensive background in the geochemistry of geothermal fluids, and has conducted the overwhelming majority of geothermal fluid investigations in Alaska. Dr. Motyka also has extensive experience in the synthesis of fluid chemistry as well as in the detailed modeling of the origin of geothermal fluids; experience which will be valuable for this study.

Dr. Motyka received his B.S. and M.S. in Physics from St. Mary's College and Michigan State University in 1964 and 1966, respectively, and his Ph.D. in Geology and Geophysics from the University of Alaska, Fairbanks in 1983.

Dr. Christopher J. Nye, co-principal investigator, will spend one month doing the detailed geologic mapping with Turner and two months analysing the samples obtained for pertinent petrographic and geochemical information, and producing the 1:25,000 scale map of the Geyser Creek valley area together with the accompanying final report.

Dr. Nye worked with the DGGS Geothermal Resource Assessment Program from 1983 to 1986. During that time his principal tasks were to produce a detailed geologic map of the Makushin geothermal area, to compile preexisting petrochemical data from young lavas of the Makushin volcanic field, and to continue the analytical program on the Makushin ejecta. In 1986 he initiated a program of geologic mapping, sampling, and analyzing young ejecta from the Spurr volcanic field in conjunction with the geophysical and geochemical geothermal prospecting studies conducted by the Geophysical Institute. In late 1986 he moved the Spurr geology and geochemistry program to the Geophysical Institute, where he is currently employed. He will take a temporary position with DGGS to produce the proposed Umnak geologic map.

Dr. Nye received his B.S. and M.S. degrees in geology from the University of Alaska, Fairbanks in 1976 and 1978; and his Ph.D. in geology from the University of California at Santa Cruz in 1983. He has worked exclusively on the petrology and geochemistry of Alaskan arc volcanoes for the last 8 years.

A list of principal geothermal reports and publications of the co-principal investigators follows:

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Motyka, R. J., and Moorman, M. A., 1981, Reconnaissance of thermal spring sites in the Aleutian Arc, Atka Island to Becherof Lake: Geothermal Resources Council Transactions, v. 5, p. 111-114.

Motyka, R. J., and Moorman, M. A., 1987, Geothermal resources of southeast Alaska: Fairbanks, Alaska Division of Geological and Geophysical Surveys, Professional Report (in press).

Motyka, R. J., Moorman, M. A., and Liss, S. A., 1981, Assessment of thermal spring sites, Aleutian arc, Atka Island to Becherof Lake--preliminary results and evaluation: Fairbanks, Alaska Division of Geological and Geophysical Surveys Open-file Report 144, 173 p.

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Our Alaskan geothermal assessment team has had considerable success in stimulating geothermal exploration in Alaska, as evidenced by successful state-funded, follow-on exploration and production drilling at Pilgrim Springs and Makushin Volcano and by a second state geothermal lease sale at Mt. Spurr with exploratory drilling planned by one of the lease holders.

Our team has recently completed a DOE-funded resource assessment study of Akutan Island (Motyka et al., 1985b). This makes us well qualified for the proposed Umnak Island study, because the geology, geographic setting, and nature of the geothermal resource occurrence are very similar for both islands.

Resources and Capabilities of the Proposing Organizations

The Geophysical Institute

Since its establishment by an act of Congress in 1946, the Geophysical Institute has earned an international reputation in the study of the earth and its physical environment at high latitudes, and in the training of students in related disciplines. It is one of the few institutions in the country where scientific expertise covers the whole spectrum of geophysical disciplines, ranging from outer space to the earth's inner core, and where scientists from these diverse disciplines work in close proximity to each other.

The Institute is housed in the eight-story C.T. Elvey Building on the West Ridge of the University of Alaska, Fairbanks campus. Turner has an office of 185 sq. ft., and a laboratory of 2300 sq. ft. Nye also has an office of 185 sq. ft. Besides staff offices and laboratories, the Elvey Building accommodates supporting services that are essential to the research program--machine and carpentry shops, electronics design and construction, instrument calibration, photography, drafting, stenography, computing, data processing, library, archives (including aircraft and satellite imagery, conference facilities, and business functions.

The Institute's linked VAX 11/780 and 11/785 computers add a powerful capability for scientific research. With arithmetic operations in the microsecond range, an internal memory of 16 megabytes for each CPU, 7 Winchester and 3 tape drives and 80 terminals distributed throughout the building, this computer system is admirably suited to large-scale data analysis and modeling of processes which are not amenable to analytical solution.

The staff of the Geophysical Institute currently numbers 188, of whom 41 are members of the faculty. Others are professional engineers, research associates, graduate assistants, supervisory personnel, technicians and other specialists, secretaries, data handling assistants, etc.

<u>**Equipment to be provided by the Geophysical Institute at no cost to proposal budget:**</u>

Spillsbury SBX-11a HFSSB radio and antenna for outside communications (via phone patches from Trident Communications Co., Anchorage, Ak.)

Zodiac 16 ft. inflatable boat.

25 HP outboard motor.

12x20 ft. weatherport tent, several small backpacking tents.

<u>**Alaska Division of Geological and Geophysical Surveys (DGGS)**</u>

Alaska Statute 41.08 states that DGGS shall "conduct geological and geophysical surveys to determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources; the locations and supplies of groundwater and construction materials; the potential geologic hazards to buildings, roads, bridges and other installations and structures; and shall conduct such other surveys and investigations as will advance knowledge of the geology of Alaska." In addition, "The state geologist shall print and publish an annual report and such other special and topical reports and maps as may be desirable for the benefit of the state, ...".

DGGS is composed of about 45 professional and 15 support staff who have collective expertise spanning virtually all aspects of the applied geosciences.

Of specific relevance to this proposal are the geothermal-fluid laboratory and the cartographic unit. The DGGS water laboratory contains a Perkin Elmer model 4000 atomic absorption spectrometer with HGA-400 graphite furnaces, a Dionex 2010i ion chromatograph, and a wet chemistry lab with which we routinely analyze Na, K, Ca, Mg, Li, Fe, Al, As, HCO_3, SO_4, Cl, F, Br, I, B, SiO_2, pH, and TDS.

The DGGS cartographic unit routinely produces high-quality color maps which are frequent award winners in cartographic competitions.

<u>Equipment to be provided by Alaska Division of Geological and Geophysical Surveys at no cost to proposal budget:</u>

4- Motorola MX360 FMVHF hand-held radios with mercury batteries.

1- Radio Specialties Repeater station with 12V car battery for extending the range of above FMVHF radios.

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APPENDIX 1 - GEOLOGIC SETTING AND VOLCANIC HAZARDS OF THE GEYSER BIGHT KGRA

Geologic Setting

The geothermal area we propose to study is located in the upper portion of a broad, NW-trending, alluvium-filled glacial valley on central Umnak Island. The valley is cut in Tertiary volcanic, plutonic and, perhaps, sedimentary rocks and in volcanic rocks of two or more late Tertiary-to-Holocene stratovolcanoes (Byers, 1959).

The following description of local stratigraphy is, unless otherwise noted, taken from Byers (1959). The oldest rocks are argillite, tuff, keratophyre, and gabbroic and diabasic sills, dikes and hypabyssal intrusive bodies, termed albitized sedimentary and igneous rocks by Byers (1959). Paleontological and isotopic data suggest a Late Eocene-to-Early Oligocene age for these rocks in the Nikolski area (McLean and Hein, 1984).

The albitized sedimentary and igneous rocks are intruded by diorite, quartz diorite, quartz monzonite and granophyre. These intrusive rocks outcrop in scattered locations at low altitudes around the base of Mt. Recheshnoi and Mt. Vsevidof (Figure 2), but Byers (1959) suggests that these outcrops may indicate a single large plutonic body 200 to 300 km^2 in area. He correlates this pluton with the large plutons of Unalaska Island because of similarities in texture and composition and assigns a probable Miocene age based on this correlation. An alternative he does not discuss is that the pluton may be the same age as the large stocks of southwestern Umnak, which have been dated at about 30 Ma (McLean and Hein, 1984). Our proposed K-Ar dating program should resolve this question.

The pluton and the albitized sedimentary and volcanic rocks are truncated by a smooth (presumably wave-cut) erosional surface that is now about 150 m above sea level. The volcanic rocks of central Umnak are deposited on this platform, and consist of altered and unaltered lava flows, vent breccias, and hypabyssal intrusive bodies. The total areal extent of these rocks is unknown because they are covered by younger volcanic rocks to the northeast and southwest. Flows and pyroclastic rocks were erupted from several centers, chiefly in central Umnak. The largest exposed center is located just north of the narrowest portion of Umnak. The age of these rocks is not precisely known. Unaltered lavas unconformably overlie the plutonic rocks of presumed Miocene age. Other lavas, however, have undergone extensive hydrothermal alteration and Byers (1959) believes that these may be older than the pluton. We believe, however, that the presence of sinuous, flat-to-nearly-vertical contacts between the unaltered and altered lavas argues for a single unit of volcanic rocks that has undergone variable hydrothermal alteration. Poor exposure of contacts between the altered and unaltered lavas makes it difficult to determine if there is any temporal discordance between the two lava types.

The volcanic rocks of central Umnak are overlain in the study area by andesitic lava flows derived from Mt. Recheshnoi, a deeply dissected volcano (Figure 2). The extent of glacial dissection of Mt. Recheshnoi suggests that the major cone-building stage was completed by the mid-Pleistocene. There are flank vents of diverse composition, including basalt, quartz olivine andesite, hypersthene andesite, and rhyolite. The uneroded nature of some of these flank vents suggest that the youngest may possibly be Holocene in age.

The three rhyolite domes 7 km southeast of the geothermal field, and the quartz-bearing olivine andesite plug and flow 8 km to the east are of particular relevance to the geothermal resource,. Silicic magmas are extremely rare in the Aleutians, and the presence of these rocks suggests the existence of a high-level silicic chamber which could be providing the heat to the geothermal field. Byers (1959, 1961) interpreted extreme mineral disequilibrium in Mt. Recheshnoi lavas, as well as certain aspects of the major element chemistry, as indicative of shallow crustal fusion. Thus it may be that central Umnak has been a site of unusually great heat input to the crust during most of the Pleistocene.

Younger constructional volcanic features on Umnak, but relatively far from the proposed study site, include Mt. Vsevidof and Okmok Volcano, both active in historic time, and several parasitic basaltic vents, mostly associated with Okmok.

Only the oldest rocks on central Umnak have been deformed, and these only weakly. Beds usually have gentle dips, folds are open, and faults, although numerous, do not have large displacements. Folds trend northwest, and fractures large enough to have been mapped by Byers (1959) trend northeast. Rocks younger than the albitized sedimentary and igneous rocks are not deformed.

Motyka et al. (1981) have noted that Geyser Creek valley trends northwest at the same azimuth that Nakamura et al. (1980) suggest is the azimuth of principal compressive stress due to the subduction of the Pacific plate. The upper part of Umnak Canyon is on trend with this lineament (Figure 2) and could possibly represent an extension of a NW-trending fracture system, although other explanations are also possible. The Nakamura et al. stress trajectory is based on the alignment of parasitic and flank volcanic vents of Aleutian and other Alaskan volcanoes, as well as on Quaternary fault orientations. These authors suggest that dilational fractures should occur parallel to the axis of principal compression, allowing magma to rise to the surface. It is possible that such fractures could also provide a conduit system for a geothermal resource. In our geologic mapping we will search carefully for any such fractures. The mapping of Byers (1959), however, does not show a pattern of northwest-trending fractures.

Volcanic Hazards

The entire Aleutian arc is the locus of intense volcanism, and volcanic hazards are to be expected anywhere within the arc. However, at Geyser Bight and in Geyser Creek valley the volcanic hazards are surprisingly slight, despite the fact that there are two active volcanoes on the island. Mt. Vsevidof, which is unglaciated and therefore has had numerous Holocene eruptions, is 18 km southwest of Geyser Creek valley, but the bulk of Mt. Recheshnoi and the 300 m high ridge southwest of Geyser Creek protect Geyser Creek from flowage hazards. Historic activity at Mt. Vsevidof has been restricted to minor explosions and steaming, and, if that pattern of continues, future activity is expected to only deposit minor amounts of ash on Geyser Creek valley.

Okmok Volcano is 30 km to the northeast and is the most active volcano on the island. Following a mid-Holocene, caldera-forming eruption, activity has been restricted to steaming, minor ash emissions, and the emplacement of basaltic lava flows on the caldera floor. Activity in the future is expected to continue in the same pattern, with quiet, effusive, flows accompanied by minor ash eruptions. The caldera wall is about 300 m high, and breached only to the northeast. If lava should erupt in sufficient volume to leave the caldera, it would most likely exit through the northeast breach. There is not enough information available to judge the probability of explosive eruptions, or eruptions from centers outside Okmok Caldera. Geyser Creek valley is separated from Okmok Volcano by Inanudak Bay and a ridge about 600 m tall, and is thus well protected from volcanic activity originating at Okmok (Figure 2).

Mt. Recheshnoi is only 10 km southwest of Geyser Creek valley, and is the closest volcano to the geothermal area. The central cone is highly eroded and is thus probably entirely Pleistocene. There have been a few Holocene or late Pleistocene flank eruptions, including dacite flows on the east and west flanks and possibly the rhyolite and quartz-andesite domes mentioned above. Alternatively, the rhyolite and quartz olivine andesite may be genetically unrelated to Mt. Recheshnoi. There is no evidence that any of the flank flows ever entered Geyser Creek valley. There is not enough information to estimate the recurrence interval of Holocene eruptions, but the probability of volcanic flows entering Geyser Creek valley seems small. Geyser Creek valley is protected from flowage hazards by a high ridge between the valley and Mt. Recheshnoi.

The possibility of future eruptions associated with the young rhyolites cannot be evaluated because we do not know if the rhyolites signal the presence of a shallow magma chamber. The recurrence interval of rhyolitic volcanism is long, and thus hazards are probably slight.

The most likely hazard is ash fall, which would probably only be a hazard to machinery operation. Debris flows, avalanches, lahars, lava flows, or glacier outburst floods are unlikely to enter the valley from any of the volcanoes.

APPENDIX 2 - LETTER OF AUTHORIZATION FROM ALASKA STATE GEOLOGIST

(Attached to original version of proposal)

APPENDIX 3 - AREA OF PROPOSED RESEARCH

The major area of the proposed research is resource assessment in the Aleutian Islands-Alaska Peninsula region. Specially, we propose to do a site-specific resource assessment study at the Geyser Bight Known Geothermal Resource Area (KGRA) on Umnak Island and to prepare a 1:1,000,000-scale geothermal resource map for the Aleutian Islands-Alaska Peninsula region.

APPENDIX 4 - RELATION OF PROPOSED RESEARCH TO HYDROTHERMAL RESOURCES

The proposed research is on hydrothermal resources in the Aleutian Islands-Alaska Peninsula region, which has one of the major hydrothermal resource bases described in U.S. Geological Survey Circular 790 (Muffler, 1978), and in several recent studies by the Alaska Division of Geological and Geophysical Surveys, the Geophysical Institute of the University of Alaska, and the Alaska Power Authority. Muffler (1978) estimates that 136 megawatts of electrical energy are available over 30 years at Geyser Bight KGRA, a resource comparable in size to Soda Lake, Beowawe Hot Springs and Brady Hot Springs in Nevada.

There are over 33 hydrothermal systems identified in the region extending from Buldir Island to Becharof Lake (Motyka et al., 1981). At least thirteen of these systems are thought to house high-temperature reservoirs ($>150^{o}C$) (Motyka, 1983). Thus the Aleutian Islands-Alaska Peninsula region is one of the richest geothermal districts in the world. Although many of these sites lie in remote locations, several sites are close to population and industrial centers with good natural harbors and thus have good-to-excellent potential for eventual development. These communities presently rely almost solely on imported fossil fuels for heat and electric power generation.

APPENDIX 5 - LAND USE PERMITS FOR PROPOSED STUDY SITE

The proposed site-specific study area is the Geyser Bight KGRA on the north side of Umnak Island, Alaska. The land is under the control of the the United States Bureau of Land Management. Some of the area has been overfiled under the Alaska Native Land Claims Settlement Act by one of the native villages under the general umbrella of Shumagin Corporation, Sand Point, Alaska.

Under inter-departmental agreement, the U.S. Bureau of Land Management has given the management of special land use permits to the U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, even though only small portions of Umnak Island are part of the refuge.

We have obtained a special land use permit for the geological, geophysical, and geochemical research field program proposed, and a letter of non-objection from the Shumagin Corporation which are attached to the original version of this proposal.

4 rev

PART II - BUSINESS PROPOSAL SUBMITTED TO THE U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
STATE GEOTHERMAL RESEARCH AND DEVELOPMENT
PRDA NO. DE-PRO7-87ID12662

Date of Submission: **October 28, 1987**

Name of Proposers: **Geophysical Institute, University of Alaska and Alaska Division of Geological and Geophysical Surveys.**

Address of Proposers:

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99775-0800

Alaska Division of Geological and Geophysical Surveys
794 University Ave. Basement
Fairbanks, Alaska 99709

Title of Proposal: **GEOTHERMAL RESOURCE ASSESSMENT IN THE ALEUTIAN ISLANDS AND ALASKA PENINSULA**

Location of Work: **Geyser Bight, Umnak Island, Aleutian Islands, Alaska; and Aleutian Islands-Alaska Peninsula Region.**

Proposed Start Date: **December 1, 1987**

Proposed Project Duration: **24 months**

Proposed Project Managers: **Donald L. Turner, (907) 474-7198 (Task 1); Roman J. Motyka, (907) 465-2520 (Task 2).**

Permission for Outside Evaluation: **Yes**

Donald L. Turner
Co-Principal Investigator
Geophysical Institute
Tel. (907) 474-7198

Syun-I. Akasofu
Director
Geophysical Institute
Tel. (907) 474-7282

Christopher J. Nye
Co-Principal Investigator
Geophysical Institute
Tel. (907) 474-7430

Neta J. Stilkey
Business Manager
Geophysical Institute
Tel. (907) 474-7644

for Roman J. Motyka
Co-Principal Investigator
Division of Geological and
Geophysical Surveys
Tel. (907) 465-2520

Robert B. Forbes
State Geologist
Division of Geological and
Geophysical Surveys
Tel. (907) 479-7629

Please Check: University X ; State Government X

TABLE OF CONTENTS

OMB Approval No. 0348-0006

FEDERAL ASSISTANCE

1. TYPE OF SUBMISSION *(Mark appropriate box)*
- ☐ NOTICE OF INTENT (OPTIONAL)
- ☐ PREAPPLICATION
- ☒ APPLICATION

2. APPLICANT'S APPLICATION IDENTIFIER
a. NUMBER: GI 87-87a
b. DATE (Year month day): 19 87 10 20

3. STATE APPLICATION IDENTIFIER (NOTE: TO BE ASSIGNED BY STATE)
a. NUMBER:
b. DATE ASSIGNED (Year month day): 19

Leave Blank

4. LEGAL APPLICANT/RECIPIENT
- a. Applicant Name: Geophysical Institute
- b. Organization Unit: University of Alaska-Fairbanks
- c. Street/P.O. Box:
- d. City: Fairbanks
- e. County: Fbks.No.Star Borough
- f. State: Alaska
- g. ZIP Code: 99775-0800
- h. Contact Person (Name & Telephone No.): Neta Stilkey, (907)474-7644

5. EMPLOYER IDENTIFICATION NUMBER (EIN): 87-0282770

6. PROGRAM (From CFDA)
a. NUMBER: ☐☐.☐☐☐ MULTIPLE ☐
b. TITLE: Basic Energy Research

7. TITLE OF APPLICANT'S PROJECT (Use section IV of this form to provide a summary description of the project.)
Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula

8. TYPE OF APPLICANT/RECIPIENT
A—State; B—Interstate; C—Substate Organization; D—County; E—City; F—School District; G—Special Purpose District; H—Community Action Agency; I—Higher Educational Institution; J—Indian Tribe; K—Other (Specify):
Enter appropriate letter: I

9. AREA OF PROJECT IMPACT (Names of cities, counties, states, etc.)
Fairbanks, Fairbanks North Star Borough

10. ESTIMATED NUMBER OF PERSONS BENEFITING: N/A

11. TYPE OF ASSISTANCE
A—Basic Grant; B—Supplemental Grant; C—Loan; D—Insurance; E—Other
Enter appropriate letter(s): A

12. PROPOSED FUNDING

a. FEDERAL	$ 127,593	.00
b. APPLICANT	57,049	.00
c. STATE		.00
d. LOCAL		.00
e. OTHER		.00
f. Total	$ 184,642	.00

13. CONGRESSIONAL DISTRICTS OF: Alaska
a. APPLICANT:
b. PROJECT:

14. TYPE OF APPLICATION
A—New; B—Renewal; C—Revision; D—Continuation; E—Augmentation
Enter appropriate letter: ☐

15. PROJECT START DATE (Year month day): 19 87 11 01

16. PROJECT DURATION: 24 Months

17. TYPE OF CHANGE (For 14c or 14e)
A—Increase Dollars; B—Decrease Dollars; C—Increase Duration; D—Decrease Duration; E—Cancellation; F—Other (Specify):
Enter appropriate letter(s): ☐☐☐

18. DATE DUE TO FEDERAL AGENCY ► (Year month day): 19

19. FEDERAL AGENCY TO RECEIVE REQUEST: U. S. Department of Energy
a. ORGANIZATIONAL UNIT (IF APPROPRIATE): Idaho Operations Office
b. ADMINISTRATIVE CONTACT (IF KNOWN):
c. ADDRESS:

20. EXISTING FEDERAL GRANT IDENTIFICATION NUMBER:

21. REMARKS ADDED: ☐ Yes ☒ No

22. THE APPLICANT CERTIFIES THAT► To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

a. YES, THIS NOTICE OF INTENT/PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
DATE ____________

b. NO, PROGRAM IS NOT COVERED BY E.O. 12372 ☐
OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW ☒

23. CERTIFYING REPRESENTATIVE
a. TYPED NAME AND TITLE: Vice Chancellor for Research
b. SIGNATURE:

24. APPLICATION RECEIVED (Year month day): 19

25. FEDERAL APPLICATION IDENTIFICATION NUMBER:

26. FEDERAL GRANT IDENTIFICATION:

27. ACTION TAKEN
- ☐ a. AWARDED
- ☐ b. REJECTED
- ☐ c. RETURNED FOR AMENDMENT
- ☐ d. RETURNED FOR E.O. 12372 SUBMISSION BY APPLICANT TO STATE
- ☐ e. DEFERRED
- ☐ f. WITHDRAWN

28. FUNDING

a. FEDERAL	$	.00
b. APPLICANT		.00
c. STATE		.00
d. LOCAL		.00
e. OTHER		.00
f. TOTAL	$	.00

29. ACTION DATE► (Year month day): 19

30. STARTING DATE (Year month date): 19

31. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

32. ENDING DATE (Year month date): 19

33. REMARKS ADDED: ☐ Yes ☐ No

N 7540-01-008-8162
PREVIOUS EDITION NOT USABLE

424-103

STANDARD FORM 424 PAGE 1 (Rev. 4-84)
Prescribed by OMB Circular A-102

OMB Approval No. 0348-0006

FEDERAL ASSISTANCE

1. TYPE OF SUBMISSION *(Mark appropriate box)*
- [ ] NOTICE OF INTENT (OPTIONAL)
- [ ] PREAPPLICATION
- [X] APPLICATION

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a. NUMBER: GI 87-87a
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b. DATE ASSIGNED (Year month day): 19

Leave Blank

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a. Applicant Name: Geophysical Institute
b. Organization Unit: University of Alaska-Fairbanks
c. Street/P.O. Box:
d. City: Fairbanks — e. County: Fbks.No.Star Borough
f. State: Alaska — g. ZIP Code: 99775-0800
h. Contact Person *(Name & Telephone No.)*: Neta Stilkey, (907)474-7644

5. EMPLOYER IDENTIFICATION NUMBER (EIN): 87-0282770

6. PROGRAM *(From CFDA)*
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Enter appropriate letter: I

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10. ESTIMATED NUMBER OF PERSONS BENEFITING: N/A

11. TYPE OF ASSISTANCE
A—Basic Grant; B—Supplemental Grant; C—Loan; D—Insurance; E—Other
Enter appropriate letter(s): A

12. PROPOSED FUNDING

a. FEDERAL	$ 55,593	.00
b. APPLICANT	16,580	.00
c. STATE		.00
d. LOCAL		.00
e. OTHER		.00
f. Total	$ 72,173	.00

13. CONGRESSIONAL DISTRICTS OF: Alaska
a. APPLICANT:
b. PROJECT:

14. TYPE OF APPLICATION
A—New; B—Renewal; C—Revision; D—Continuation; E—Augmentation
Enter appropriate letter: [ ]

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Enter appropriate letter(s): [ ][ ][ ]

18. DATE DUE TO FEDERAL AGENCY ► (Year month day): 19

19. FEDERAL AGENCY TO RECEIVE REQUEST: U. S. Department of Energy
a. ORGANIZATIONAL UNIT (IF APPROPRIATE): Idaho Operations Office
b. ADMINISTRATIVE CONTACT (IF KNOWN):
c. ADDRESS:

20. EXISTING FEDERAL GRANT IDENTIFICATION NUMBER:

21. REMARKS ADDED: [ ] Yes [X] No

22. THE APPLICANT CERTIFIES THAT ► To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

a. YES, THIS NOTICE OF INTENT/PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
DATE ____________

b. NO, PROGRAM IS NOT COVERED BY E.O. 12372 [ ]
OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW [X]

23. CERTIFYING REPRESENTATIVE
a. TYPED NAME AND TITLE: Vice Chancellor for Research
b. SIGNATURE:

24. APPLICATION RECEIVED (Year month day): 19

25. FEDERAL APPLICATION IDENTIFICATION NUMBER:

26. FEDERAL GRANT IDENTIFICATION:

27. ACTION TAKEN
- [ ] a. AWARDED
- [ ] b. REJECTED
- [ ] c. RETURNED FOR AMENDMENT
- [ ] d. RETURNED FOR E.O. 12372 SUBMISSION BY APPLICANT TO STATE
- [ ] e. DEFERRED
- [ ] f. WITHDRAWN

28. FUNDING

a. FEDERAL	$	.00
b. APPLICANT		.00
c. STATE		.00
d. LOCAL		.00
e. OTHER		.00
f. TOTAL	$	.00

29. ACTION DATE ► (Year month day): 19

30. STARTING DATE (Year month date): 19

31. CONTACT FOR ADDITIONAL INFORMATION *(Name and telephone number)*:

32. ENDING DATE (Year month date): 19

33. REMARKS ADDED: [ ] Yes [ ] No

OMB Approval No. 0348-0006

FEDERAL ASSISTANCE

1. TYPE OF SUBMISSION (*Mark appropriate box*)
- ☐ NOTICE OF INTENT (OPTIONAL)
- ☐ PREAPPLICATION
- ☒ APPLICATION

2. APPLICANT'S APPLICATION IDENTIFIER
- a. NUMBER: GI 87-87a
- b. DATE (Year month day): 19 87 10 20

3. STATE APPLICATION IDENTIFIER (*NOTE: TO BE ASSIGNED BY STATE*)
- a. NUMBER:
- b. DATE ASSIGNED (Year month day): 19

Leave Blank

4. LEGAL APPLICANT/RECIPIENT
- a. Applicant Name: Geophysical Institute
- b. Organization Unit: University of Alaska-Fairbanks
- c. Street/P.O. Box:
- d. City: Fairbanks
- e. County: Fbks.No.Star Borough
- f. State: Alaska
- g. ZIP Code: 99775-0800
- h. Contact Person (*Name & Telephone No.*): Neta Stilkey, (907)474-7644

5. EMPLOYER IDENTIFICATION NUMBER (EIN): 87-0282770

6. PROGRAM (*From CFDA*)
- a. NUMBER: __ __ . __ __ __ MULTIPLE ☐
- b. TITLE: Basic Energy Research

7. TITLE OF APPLICANT'S PROJECT (Use section IV of this form to provide a summary description of the project.) Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula

8. TYPE OF APPLICANT/RECIPIENT
A—State; B—Interstate; C—Substate Organization; D—County; E—City; F—School District; G—Special Purpose District; H—Community Action Agency; I—Higher Educational Institution; J—Indian Tribe; K—Other (*Specify*):
Enter appropriate letter [I]

9. AREA OF PROJECT IMPACT (*Names of cities, counties, states, etc.*) Fairbanks, Fairbanks North Star Borough

10. ESTIMATED NUMBER OF PERSONS BENEFITING: N/A

11. TYPE OF ASSISTANCE
A—Basic Grant; B—Supplemental Grant; C—Loan; D—Insurance; E—Other
Enter appropriate letter(s) [A]

12. PROPOSED FUNDING

a. FEDERAL	$ 72,000 .00
b. APPLICANT	40,469 .00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. Total	$ 112,469 .00

13. CONGRESSIONAL DISTRICTS OF: Alaska
- a. APPLICANT
- b. PROJECT

14. TYPE OF APPLICATION
A—New; B—Renewal; C—Revision; D—Continuation; E—Augmentation
Enter appropriate letter [ ]

15. PROJECT START DATE (Year month day): 19 87 11 01

16. PROJECT DURATION: 24 Months

17. TYPE OF CHANGE (*For 14c or 14e*)
A—Increase Dollars; B—Decrease Dollars; C—Increase Duration; D—Decrease Duration; E—Cancellation; F—Other (*Specify*):
Enter appropriate letter(s) [ ]

18. DATE DUE TO FEDERAL AGENCY ► (Year month day) 19

19. FEDERAL AGENCY TO RECEIVE REQUEST: U. S. Department of Energy
- a. ORGANIZATIONAL UNIT (IF APPROPRIATE): Idaho Operations Office
- b. ADMINISTRATIVE CONTACT (IF KNOWN):
- c. ADDRESS:

20. EXISTING FEDERAL GRANT IDENTIFICATION NUMBER

21. REMARKS ADDED ☐ Yes ☒ No

22. THE APPLICANT CERTIFIES THAT► To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.
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- b. NO, PROGRAM IS NOT COVERED BY E.O. 12372 ☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW ☒

23. CERTIFYING REPRESENTATIVE
- a. TYPED NAME AND TITLE: Vice Chancellor for Research
- b. SIGNATURE

24. APPLICATION RECEIVED (Year month day) 19

25. FEDERAL APPLICATION IDENTIFICATION NUMBER

26. FEDERAL GRANT IDENTIFICATION

27. ACTION TAKEN
- ☐ a. AWARDED
- ☐ b. REJECTED
- ☐ c. RETURNED FOR AMENDMENT
- ☐ d. RETURNED FOR E.O. 12372 SUBMISSION BY APPLICANT TO STATE
- ☐ e. DEFERRED
- ☐ f. WITHDRAWN

28. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

29. ACTION DATE► (Year month day) 19

30. STARTING DATE (Year month date) 19

31. CONTACT FOR ADDITIONAL INFORMATION (*Name and telephone number*)

32. ENDING DATE (Year month date) 19

33. REMARKS ADDED ☐ Yes ☐ No

GI 87-87a

ER F 4620.1
(7-85)

U.S. Department of Energy
Grant Application Budget Period Summary
(See Reverse for Definitions and Instructions)

OMB Approval
No. 1910-1400

Please Print or Type

Organization: Geophysical Institute, University of Alaska Fairbanks	Period Covering: From: 11/01/87	FOR DOE USE ONLY — Proposal No:
Principal Investigator (P.I.)/Project Director (P.D.): D. Turner	To: 10/31/89	Award No.:

A. SENIOR PERSONNEL PI/PD Co PIs, Faculty and Other Senior Associates (List each separately with title, A.6 show number in brackets. Attach separate sheet, if required.)	DOE Funded Person-Mos. Cal.	Acad.	Sumr.	Funds Requested By Applicant $
1. Co-P.I., D. Turner			3	19,209
2. Co-P.I., R. Motyka			8	34,736
3. Co-P.I., C. Nye			3	11,436
4.				
5.				
6. (3) TOTAL SENIOR PERSONNEL			14	65,381
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)				
1. ( ) POST DOCTORAL ASSOCIATES				
2. ( ) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)				
3. (1) GRADUATE STUDENTS			3	4,800
4. ( ) UNDERGRADUATE STUDENTS				
5. ( ) SECRETARIAL-CLERICAL				
6. (2) OTHER				27,666
TOTAL SALARIES AND WAGES (A + B)				97,847
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				22,151
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				119,998
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM)				
TOTAL EQUIPMENT				
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)				9,053
2. FOREIGN				
F. OTHER DIRECT COSTS				
1. MATERIALS AND SUPPLIES				5,520
2. PUBLICATION COSTS/PAGE CHARGES				
3. CONSULTANT SERVICES				
4. COMPUTER (ADPE) SERVICES				
5. CONTRACTS AND SUBGRANTS				
6. OTHER				29,450
TOTAL OTHER DIRECT COSTS				
G. TOTAL DIRECT COSTS (A THROUGH F)				164,021
H. INDIRECT COSTS (SPECIFY RATE AND BASE) TOTAL INDIRECT COSTS 40% TMDC ($51,552)				20,621
I. TOTAL DIRECT AND INDIRECT COSTS (G & H)				184,642
J. APPLICANT'S COST SHARING (IF ANY)				(57,049)
K. TOTAL AMOUNT OF THIS REQUEST (ITEM I LESS ITEM J)				127,593

PI/PD TYPED NAME & SIGNATURE: D. Turner [signature]	DATE: 10/20/87
INST. REP. TYPED NAME & SIGNATURE: Neta Stilkey [signature]	DATE: 10/20/87

GI 87-87a

ER F 4620.1A
(7-85)

U.S. Department of Energy

GRANT APPLICATION
PROJECT PERIOD SUMMARY

(Must be completed for all new and renewal applications.)

Please Print or Type

OMB Approval
No. 1910-1400

Categories	01 Budget Period	02 Budget Period	03 Budget Period	04 Budget Period	05 Budget Period
A. Senior Personnel Totals	65,381				
B. Other Personnel Totals	32,466				
C. Fringe Benefit Totals	22,151				
Total of A, B & C	119,998				
D. Equipment					
E. Travel 1. Domestic	9,053				
2. Foreign					
F. Other Direct Costs	34,970				
G. Total Direct Costs	164,021				
H. Total Indirect Costs	20,621				
I. Total Direct & Indirect Costs	184,642				
J. Applicant's Cost-Sharing (If any)	(57,049)				
K. Total Amount of Request (Item I. Less Item J.)	(1)* 127,593	(2)	(3)	(4)	(5)

*This should equal Item K on Budget Period Summary (ER/F/4620.1)

ESTIMATE

TOTAL COST OF PROJECT

$ 127,593

(add K(1) thru (5))

Budget 11/1/87 - 10/31/89	DOE	GI	Total
Salaries			
Co-Principal Investigator, D. Turner, 3 mo.	12,806	6,403	
Graduate Student, 3 mo. @$1,600/mo. (GI will cost share 30%)	3,360	1,440	
Total Salaries	16,166	7,843	24,009
Travel			3,693
3 round trip airfares, Fairbanks-Dutch Harbor	2,814		
Motel accommodations: 3 nights for 4 persons, (2 rooms/night) @$200 total per night	600		
Per diem to & from field site, 9 person days @$31/day	279		
Materials & Supplies			3,800
Expendable field supplies	1,000		
Food, propane, fuel and miscellaneous supplies for 4-person crew, 28 days @$25/day/person	2,800		
Other Direct Costs			20,050
8 K-Ar dates @$500 each		4,000	
Round trip air shipment of field equipment & supplies, Fairbanks-Dutch Harbor	3,000		
Landing craft (LCM) charter for moving personnel & supplies from Dutch Harbor to & from Geyser Bight field site, 2 round trips @$3500, with fuel & crew	7,000		
Radio communications contract with Trident Communications, Anchorage, 2 month minimum required @$200/mo.	400		
Outboard motor repair	250		
Shipping	500		
Steno services, 40 hours @$26.75/hr.	1,070		
Photo/Graphics services, 40 hr. @$37/hr.	1,480		
Communications	350		
Rock thin sections, 75 @$8	600		
Rock analyses by X-ray fluorescence, 30 @$30	900		
Logistics support at Dutch Harbor from Aleutian Logistics Co.	500		
Total Direct Costs	39,709	11,843	51,552
Indirect Costs			
40% of total modified direct costs	15,884	4,737	20,621
Total Budget	55,593	16,580	72,173

DGGS Budget	DOE	DGGS	Total
Salaries			
Co-Principal Investigator, R.Motyka, 8 mo. @$4,342	21,710	13,026	
Co-Principal Investigator, C.Nye, 3 mo. @$3,812		11,436	
Geologist I, 8 mo. @$2,895	20,265	2,895	
Cartographer II, 1.5 mo. @$3,004	1,502	3,004	
Total Salaries	43,477	30,361	73,838
Staff Benefits			
Medical Insurance, Social Security			
Retirement, Leave, etc., 30% of salaries	13,043	9,108	22,151
Travel			
1 RT Juneau-Dutch Harbor	1,300		
1 RT Fairbanks-Dutch Harbor	1,000		
Helicopter charter, Dutch Harbor-Geysers Bight	1,500		
Per Diem, 3 day x 2 x $80 (town)	480		
Per Diem, 8 day x $30 (field, RJM)	240		
Per Diem, 28 days x $30 (field, Geol I)	840		
Total Travel	5,360		5,360
Materials and Supplies			
Field supplies	500		
Computer supplies	500		
Fluid sampling equipment	200		
Drafting supplies	520		
Total Materials & Supplies	1,720		1,720
Other Direct Costs			
Polished thin sections, 15 @$20	300		
Postage, xerox, telephone	500		
Preparation of topographic base map for detailed geologic mapping	2,500		
4-color map production costs	4,000	1,000	
Analytical expenses	1,100		
Total Other Direct Costs	8,400	1,000	9400
Total Direct Costs	72,000	40,469	112,469
Indirect Costs			
The State of Alaska does not charge overhead	0	0	0
Total Requested from DOE	72,000		
Total Cost Sharing by DGGS		40,469	
Total Budget			112,469

BUDGET EXPLANATION

Source of cost-sharing funds

The Geophysical Institute and the Alaska Division of Geological and Geophysical Surveys will cost-share funds from their respective State of Alaska appropriations.

Request for the award of two contracts

This proposal is for a cooperative program involving two agencies - the Geophysical Institute of the University of Alaska (GI) and the Alaska Division of Geological and Geophysical Surveys (DGGS). One portion of the proposed work is to be managed by GI personnel and the other portion by DGGS personnel, although there will be extensive cooperation on the site-specific work at Geyser Bight.

We have submitted individual budgets for each agency, together with a combined budget summary. We request that DOE award two separate contracts - one to GI and one to DGGS. The enclosed form E1A459C (Federal Assistance Budget Information Form) contains a breakdown of the separate proposed budgets. The GI budget covers most of the site-specific study of Geyser Bight KGRA (Task 1), and the DGGS budget covers the compilation of material for, and production of, the 1:1,000,000 scale technical geothermal resource map (Task 2). In addition, the DGGS budget contains expenses for the participation of DGGS personnel in Task 1.

Efficiency of completion of each task will be enhanced by the award of two contracts because task management and fiscal control will reside with the appropriate individual investigator. In addition, the award of two contracts will relieve either institution of the burden of overseeing a subcontract.

If it is not possible to award a separate contract to each agency we ask that the Geophysical Institute be awarded a single contract for the amount of the combined GI and DGGS budget request to DOE ($127,593). The GI will then subcontract the amount of the DGGS budget request ($72,000) to DGGS.

U.S. Department of Energy

Assurance of Compliance

Nondiscrimination in Federally Assisted Programs

Geophysical Institute
University of Alaska-Fairbanks (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or handicap, in its employment practices. Such employment practices may include, but are not limited to, recruitment, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether

any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age and handicap; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age and handicap, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicant by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

20 October 1987
(Date)

Geophysical Institute
University of Alaska-Fairbanks
(Name of Applicant)

903 Koyukuk Ave. No.
Fairbanks, Alaska 99775-0800
(Address)

Neta Stilkey, Business Manager
(Authorized Official)

( ) 907-474-7644
(Applicant's Telephone Number)

DOE F 1600.5
(5-85)

OMB NO. 1900-0400

U.S. Department of Energy

Assurance of Compliance

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Alaska Division of Geological and Geophysical Surveys (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

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Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

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The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such data of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and the the United States shall have the right to seek judicial enforcement of this assurance. This assurance in binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

June 9, 1987
(Date)

Division of Geological and Geophysical Surv.
Alaska Divsion of Natural Resources
(Name of Applicant)

794 University Ave. Basement
Fairbanks, Alaska, 99709
(Address)

Robert B. Forbes by CN
Robert B. Forbes, State Geologist
(Authorized Official)

( ) 907- 479-7629
(Applicant's Telephone Number)

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10/80)

FORM APPROVED
OMB No. 1900 0127

1. Program/Project Identification No.	2. Program/Project Title Geothermal Resource Assessment in the Aleutian Islands and Alaska Peninsula
3. Name and Address Geophysical Institute University of Alaska Fairbanks, AK 99775-0800	4. Program/Project Start Date 11/1/87 5. Completion Date 10/31/89

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Geophysical Institute		$	$	$ 55,593	$	$ 55,593
2. State of AK				72,000		72,000
3.						
4.						
5. TOTALS		$	$	$127,593	$	$ 127,593

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity				Total (5)
	(1)	(2)	(3)	(4)	
a. Personnel	$ 16,166	$ 43,477	$	$	$ 59,643
b. Fringe Benefits	0	13,043			13,043
c. Travel	3,693	5,360			9,053
d. Equipment					
e. Supplies	3,800	1,720			5,520
f. Contractual					
g. Construction					
h. Other	16,050	8,400			24,450
i. Total Direct Charges	39,709	72,000			111,709
j. Indirect Charges	15,884	0			15,884
k. TOTALS	$ 55,593	$ 72,000	$	$	$ 127,593
7. Program Income	$	$	$	$	$

PART III

AMENDMENTS TO

TECHNICAL AND BUSINESS PROPOSALS

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 45 of 4

Date of Submission October 16, 1987

Name of Proposer University of Nevada, Las Vegas

Address of Proposer Division of Earth Sciences, 255 Bell St.
Suite 200, Reno, Nevada 89503

Title of Proposal Geothermal Fluid Genesis in the Great Basin

Type of Research/Project Resource Assessment /x/ Resource Development / /
Technical Assistance / /

Location of Work Nevada

Proposed Start Date December 1, 1987 Proposed Project Duration 12 (in months)

Proposed Project Manager Thomas Flynn Phone No. (702) 784-6151

Permission for Outside Evaluation Yes X No

AUTHORIZED OFFICIAL: Signature Dennis T. Trexler

Name Typed Dennis T. Trexler

Title Director

Date October 2, 1987

INTRODUCTION

I have completed my review of the Clarifications/Information sheet which was attached to your September 8, 1987 communication. On the basis of my understanding of the ATTACHMENT and subsequent telephone conversations with Ms. Trudy Thorne (9/11/87) and Ms. Peggy Brookshire (9/15/87), I have modified the scale of the proposal. I should point out that the original intentions, which are endorsed by US DOE Headquarters, US DOE stated policy, the Nevada Geothermal Industry, and the State Regulatory Agencies, and other research beneficiaries, remain intact.

The enclosed revision consists of specific answers to questions raised on the ATTACHMENT, a revised statement of work, and a revised cost estimate. In reviewing the ATTACHMENT I found what appeared to be several internal inconsistencies, which were eventually explained by Ms. Brookshire. I appreciate her assistance with these questions and I would strongly recommend that any additional requests for information be conducted via telephone with an immediate follow-up by written communication. I think this would expedite what would otherwise be a time-consuming effort for both parties.

I. ANSWERS TO QUESTIONS ON ATTACHMENT - CLARIFICATIONS/INFORMATION NEEDED

1. How will geochemical data be disseminated?

This question is addressed in Tasks 2, 7 and 8 of the original proposal. Task 2 provides that the data be encoded and added to the Nevada GEOTHERM computer data file. In Task 7 the wording was "Provide geothermal utilities, developers, and State Legislative committees and regulatory agencies with timely progress reports." Task 8 reads, "Prepare progress reports on a quarterly and annual basis including appropriate data in tabular and graphical format, models, and large-scale maps depicting detailed geochemical sampling data on geothermal systems and development." In short, at least three ways of data dissemination were discussed. This kind of information is also appropriate for publication in the Geothermal Resources Council Bulletin and Transactions, and, since the Division of Earth Sciences regularly publishes data in this format, this tradition will continue.

2. What data currently exist concerning age of Ice in Great Basin ice fields?

Very little quantitative data of this nature are available, which accounts for the exclusion of "glacial" field work in the revised proposal. Glaciers are present at Palisades, near Bishop, California, in Lamoille Canyon, Ruby Mountains, Nevada and at Wheeler Peak National Park, also in Nevada. Systematic analysis of oxygen-isotope ratios have been completed at sites in Greenland, Antarctica, Canada, and the United States. The ice-sheet volumes (thickness mainly) at these sites are much greater than those available in the Great Basin. This suggests that, although this technique may be feasible, it may not provide a reliable data set. That is, one that can be successfully duplicated to substantiate the scientific claims. Therefore, efforts associated with the glacial data have been restricted to compilation of existing information in three areas; ice-core, radiocarbon and oxygen-isotope data from glacial till, and volcanic tephra deposits in till and lake sediments. These efforts have been incorporated into Task 1C.

3. Can efforts be narrowed to only 1 or 2 selected geothermal systems to test the hypothesis?

No. The proposal was developed as a regional-scale project for several reasons. The principal reason is that the recharge mechanisms occur on a regional scale. As the proposal says, there are more than 900 hot springs and wells in Nevada. The odds of correctly choosing a hot spring or two that adequately represents all of Nevada's geothermal systems is, in my opinion, quite small. In addition, the development of Nevada's geothermal resources is occurring on a state-wide, (regional) scale. This development has accelerated in the last decade and there is no consensus among scientists that any one or two systems properly represent all systems. Specific parameters such as temperature, chemical composition, depth, reservoir rock, application, and duration of use vary from site to site. Reduction of these data sets will require substantial use of statistics and other mathematical methods. Limiting the population to 1 or 2 areas would deny any statistical analysis and would prevent any meaningful comparisons and conclusions. Another reason is that the PRDA encourages "resource assessment efforts that would enhance the knowledge base of geothermal systems or regions and would provide important information that would not otherwise be available to encourage the development of geothermal resources."

Finally, the proposal was not designed to simply "test a hypothesis." One of the most clearly stated goals was to sample geothermal fluids from large-scale developments to assess the long-term effects on the geothermal reservoir. This is similar to the data generated at Cerro Prieto, Mexico. There have been no corresponding programs in the United States and it is the stated policy of the United States Department of Energy to pursue this kind of research. It should be noted that the sampling program has been reduced from 20 sites to 12 sites.

4. The amount of actual cost sharing of State Funds and equipment is in question. How much of the equipment has been purchased previously by DOE?

The cost share in the proposal consisted of state-funded salary and fringe, which amounted to $20,136. In addition, 25 proprietary Carbon-14 age determinations, completed with non-Federal funds, were also included bringing the total to $23,261 (10.5% cost share). This is consistent with 48 CFR Ch. 9 section 917.7003 (10-1-86 edition):

Amount of cost participation.

(a) Cost participation may be in various forms or combinations, which includes but is not limited to cash outlays, real property, or interest therein, needed for the project, personal property or services, cost matching, foregone fee, or other in-kind participation.

This is a moot point however, the Carbon-14 dates have been removed as a cost-share item and will not be available to the project.

There was no equipment included in the cost share. The only equipment charge was for vehicles at a rate of $.30/mile for gas, oil, tires, batteries, and general maintenance. This was explained on page 1 of the business proposal.

The only remaining cost share item is salary and fringe benefits for the Senior Geologist for a period of 4 months, which amounts to about 11 percent of the total revised budget.

(NOTE: PRDA Attachment No. 7, SOURCES OF REFERENCED DOCUMENTS, lists DOE Acquisition Regulations (Code of Federal Regulations, Title 41, Chapter 9). I suspect that there is a typographical error in the above sentence. The code now in effect is 48 CFR Ch. 9 (10-1-86 Edition), not 41 CFR Ch. 9.)

4. Are new air photos and imagery really required?

A minimal number of air photos are required to complete the coverage now available in the UNLV and UNR libraries. The photos required are available through Federal agencies in Salt Lake City, Utah and Sioux Falls. South Dakota. This budget item does not imply new photo-missions, only the purchase of existing photos.

II. RECOMMENDATIONS AND REVISIONS

On the basis of the recommendations and the scope of the project, the efforts in the original proposal have been modified. The modifications consist of a reduction of effort, a consolidation of tasks, and a budget reduction of $35,000 for the DOE share alone. The Statement of Work now consists of the following tasks:

TASK 1. Collect and evaluate existing data.

An extensive literature search will focus on, but not be limited to the following areas:

A. Collect fluid chemistry data for thermal and non-thermal fluids throughout the Great Basin with emphasis on isotopic ratios, apparent ages, and tritium values. These data will serve as the baseline for subsequent work. Potential data sources include published reports, maps, and related documents in geothermal energy; data from the Nevada Test Site and High-Level Nuclear Waste Isolation Program; and the National Uranium Resource Evaluation program (NURE).

B. Collect corresponding data for major geothermal reservoir rocks or rock-types with emphasis on stable light isotope ratios. Rock-water interactions alter isotope ratios at elevated temperatures. These data are essential for establishing model resolution limits.

C. Collect existing glacial ice data from sites in western North America, Greenland and Antarctic and compare to snow/ice packs in the Sierra Nevada, White Mountains, Wheeler Peak, and Ruby Mountains. Existing ice core data, tephra deposits, and glacial till material with corresponding stable isotope ratios will be used to reconstruct paleoclimatic conditions within the Great Basin.

D. Acquire and describe preserved organic archaeological material from prehistoric habitation sites and material from packrat middens and other natural organic deposits throughout the Great Basin. Native Americans of the Washoe, Paiute and other Tribes have occupied sites in the Great Basin since about 10,000 BP. These sites contain preserved organic material that can be analyzed for stable light isotopes as well as dated using radiometric carbon-dating techniques. Both data sets, location and elevation, are required to reconstruct paleoclimatic conditions on a local scale. These data will be compared to present isotope ratios in geothermal fluids and represent the best available proxy data set for the successful completion of the proposal. These data will also form the basis for projecting the isotopic composition of paleo-fluids precipitated at various elevations throughout the Great Basin.

TASK 2. Format data base.

Preliminary maps and tables will be produced that differentiate data sources, establish spatial, temporal, and elevation relationships for principal geothermal systems. Identify and mitigate data voids. Determine preliminary model parameters for chemical data, temporal and spatial constraints, and regional geologic setting. A properly formatted data base is important to scientists, geothermal developers, and state regulatory agencies. Technical resource data will be tabulated and submitted to GEOTHERM for archiving.

TASK 3. Sampling and analysis

A. Systematically sample, record, and submit for chemical analysis (including major, minor, and trace elements, stable light isotopes, Tritium, and Carbon-14) geothermal fluids from the following sources:

a) selected large geothermal springs with a history of continuous flow and established geochemical sampling record (Table R1, Figure R1).

b) large geothermal systems presently under development (Table R1, Figure R1).

Data from these two sources will be integrated with baseline data collected in Task 1. Graphs will be produced that illustrate various parameters with respect to time at both idle hot springs and geothermal developments.

B. Arrange for precision isotopic analyses of selected archaeological material including plant material from caves, charcoal, reed baskets, coprolites, middens, and food cache items, from representative sites throughout the Great Basin. Data will be incorporated into maps developed in Task 2.

(NOTE: This proposal depends heavily on accurate paleoclimatic reconstruction in the Great Basin. Since weather records extend only to the turn of the century, proxies or fossil climate records, are used to

TABLE R1.

Description of hydrothermal resources selected for sampling

Hydrothermal resource	Description and comments
1. Steamboat Hot Springs	Steamboat was selected because of the extensive data base and large scale development underway. These include an operating 10 MWe binary power plant, a 25 MWe power plant that is scheduled for construction, (four wells have already been drilled to support the plant), and the springs that continue to flow from the large sinter terrace. Temperatures in wells 3,300 feet deep exceed 460° F.
2. Desert Peak	In 1976 Phillips Petroleum completed a three-year exploration program with the discovery of a geothermal field at Desert Peak in Churchill County. Geothermal fluids are produced from wells at temperatures approaching 400° F. Chevron now operates a 10 MWe power plant using fluid from two wells.
3. Beowawe	Chevron presently produces 16 MWe from this plant, the largest in Nevada. Hot water at a temperature of 420° F is tapped from two wells. In addition, flowing springs from the terrace are available to sample.
4. Wabuska	Tad's enterprises built the first geothermal electric power plant in Nevada a Wabuska. Hot water at a temperature of 226° F is pumped from a well at 700 gpm. The plant is a binary unit that produces about .5MWe and is presently being expanded by 100%.
5. Moana	The Moana geothermal area in southwest Reno is one of the largest geothermal developments in Nevada. Temperatures range from 95° to 220° F and more than 250 home use geothermal fluids from shallow wells for space heating. Several district space heating projects are on-line including the Warren Estates, which provides heat and hot water from a single well to more than 50 homes.

6. Elko

Two large district space heating operations are currently in use in Elko.

The Elko Heat Company supplies hot water (180° F) to 2 banks, a hotel, and a laundry.

The Elko Co. School District completed a well that heats the Junior and Senior High Schools, the Hospital, municipal pool, court house, and several other public buildings.

7. Brady's

This is the site of the first vegetable (onions) dehydration plant that uses geothermal energy as the heat source. Well temperatures approach 400° F. A geothermal power plant is under construction just north of the onion plant.

8. Big Smoky Valley

Two sites are available. Spencer's Hot Spring, at the north end of the valley, produces approximately 49 l/m at a temperature of 72° C. Darrough's hot spring produces several hundred l/m at 98° C. Temperatures measured in exploration wells exceed 125° C.

9. Gerlach

The Great Boiling Spring was discovered by explorer John Fremont in 1845. The area has been extensively explored and is suitable for binary electric power generation. Geothermal fluids at a temperature of 98° C discharge from the springs at several hundred l/m.

10. Golconda

Approximately ten hot springs discharge from a area of about 1 square km. Temperature range from 42° to 72° C and the combined flow is estimated to be about 750 l/m.

11. Warm Springs

Two springs issue from a prominent range-front fault located along the west side of Hot Creek Valley. The geothermal fluids flow at several hundred l/m at a temperature of 63° C.

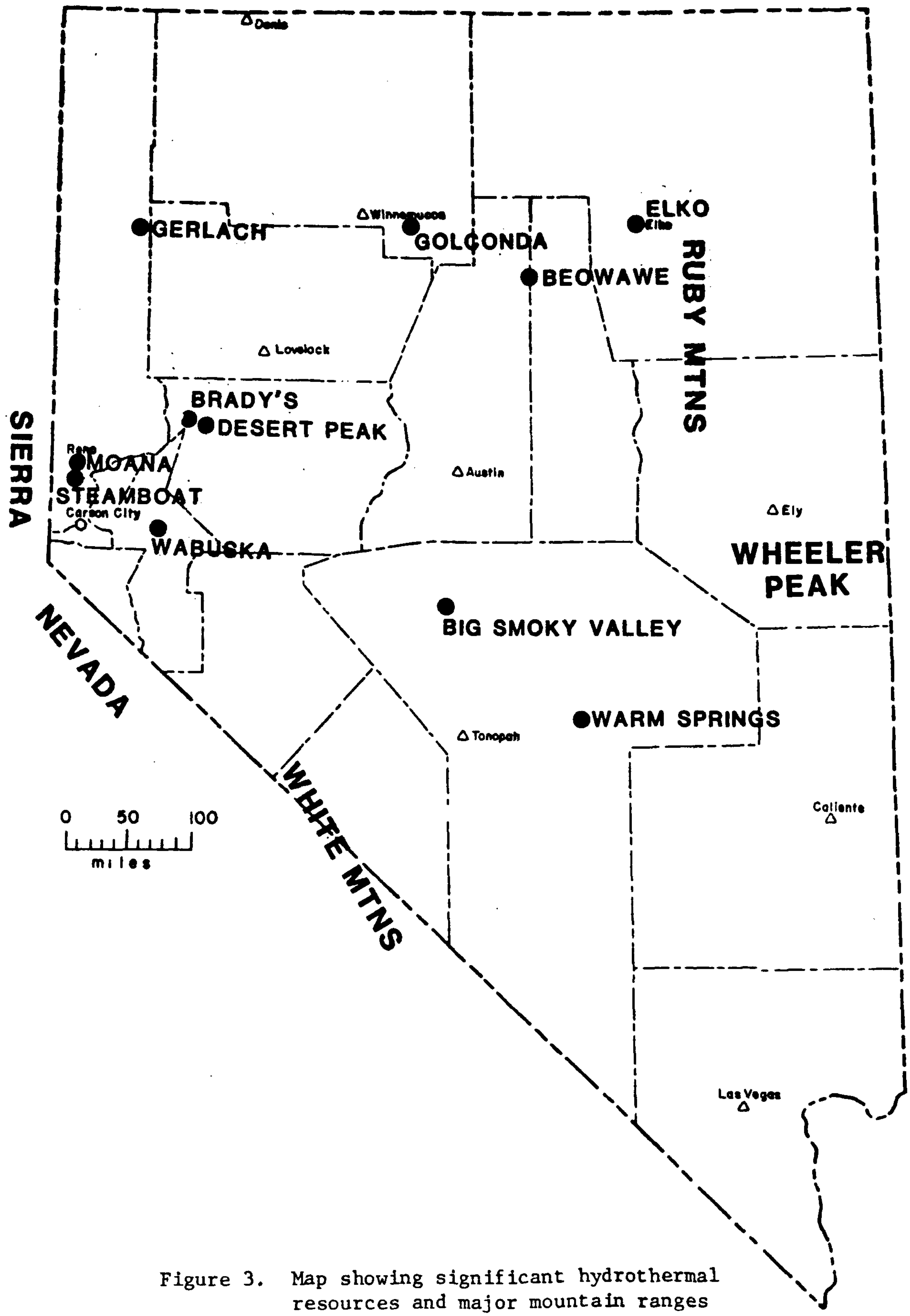

Figure 3. Map showing significant hydrothermal resources and major mountain ranges in the Great Basin.

determine atmospheric conditions for periods up to 50,000 years BP. In the original proposal two proxies were considered: ice-core data from glaciers and archaeological/paleontological data from culture sites and packrat middens found in caves throughout the Great Basin. After a review of the data sets available, a comparative determination of the ultimate success of these methods within the structure of the proposal and the limits of the budget, a decision was made to eliminate the ice-core field work and retain the acquisition of archaeological/paleontologic data that was originally described in TASK 4. These efforts are considered vital to the successful completion of the program and are now assigned to TASK 3B.)

TASK 4. Data interpretation, integration and synthesis.

Develop conceptual geothermal fluid genesis and recharge models based on geology, inferred paleoclimatic conditions, geothermal fluid chemical and isotopic composition. Compare to existing regional paleoclimatic models. Determine those data supporting the contemporary fluid recharge model and those supporting the paleo recharge model. Identify areas of conflicting data sets and determine factors that influence the models (ie. geologic structure, heat source, reservoir rock, etc.). Integrate detailed geochemical data with overall reservoir performance where appropriate data are available (flow rates, pressure declines/buildups, temperature variations, energy output). Provide geothermal utilities, developers, and State legislative committees and regulatory agencies with timely progress reports. Consider performance characteristics with respect to geothermal provinces (ie. fluid chemistry and isotope signatures, reservoir rock, etc.)

TASK 5. Prepare progress reports.

Reports will be prepared on a quarterly and annual basis and will include appropriate data in tabular and graphical format, models, and large-scale maps depicting detailed geochemical sampling data on geothermal systems and developments. Recommendations for further geothermal research will be included in the final report.

SUMMARY

These tasks are keyed to the schedule of research activities shown in Figure R2. There are no known environmental or institutional problems associated with this proposal. All contacts with both the geothermal industry and the regulatory agencies have been positive and supportive. Developers of large-scale facilities have allowed access to fluid sampling ports of high-pressure geothermal fluids.

The U. S. Department of Energy recognizes the importance of long-term geothermal resource monitoring programs as a means of establishing the longevity of the resource and has supported programs like this in Mexico. This program is one of the first of its kind in the United States and the information is vital to the geothermal industry and the state agencies in Nevada charged with geothermal regulation. This program addresses regional-scale assessment, diversity of development, and long-term temporal dynamics that will provide clues to the genesis of geothermal fluids in the Great Basin.

Sampling protocol have been modified to accommodate the reduction in effort described above.

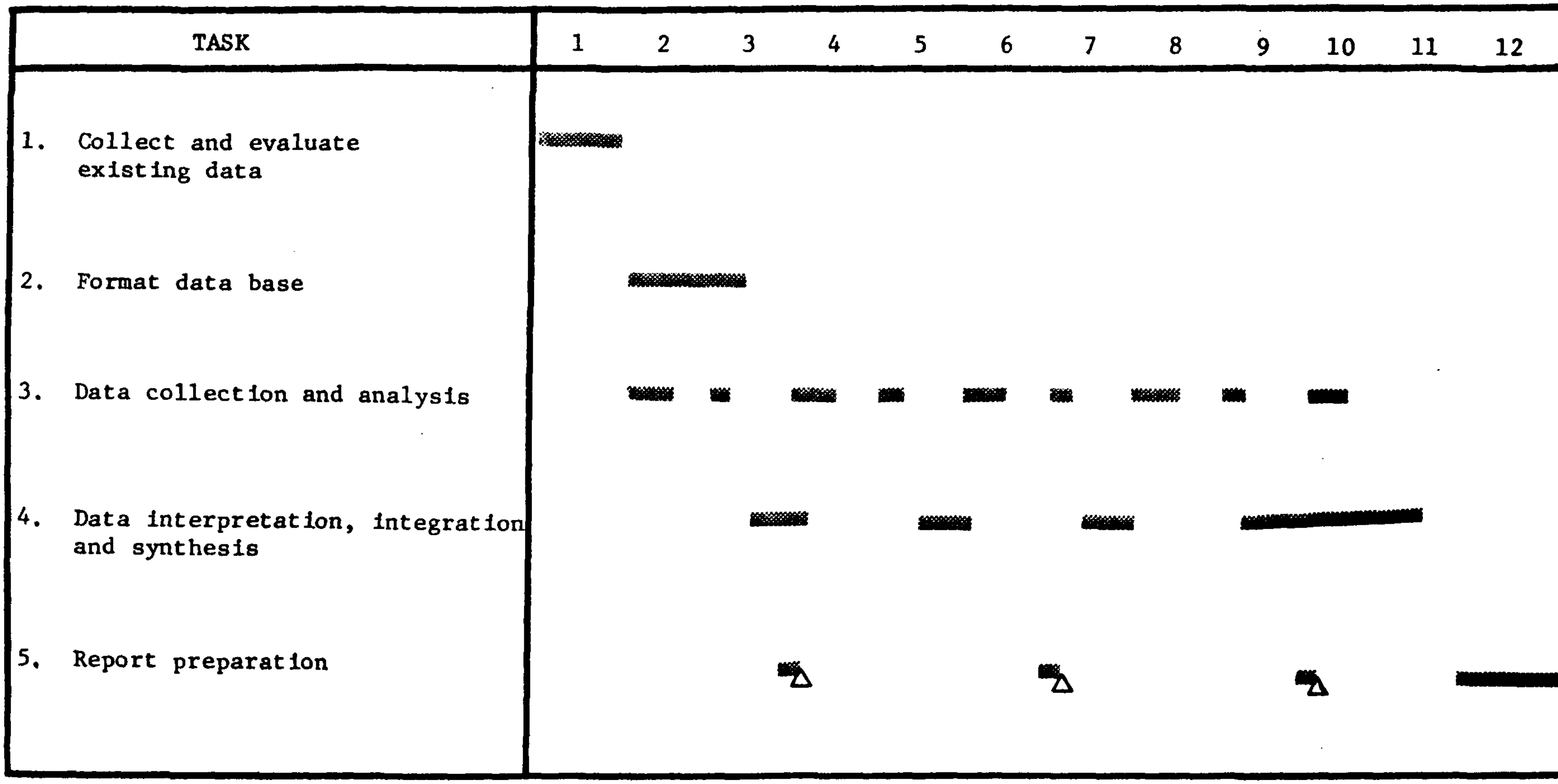

Figure R2. Schedule of research activities.

III. REVISED BUDGET

Budget amendments are shown in the attached FEDERAL ASSISTANCE BUDGET INFORMATION FORM (FABIF) as well as the attached spread sheet. It should be noted that, due to arithmetic rounding differences between the software that generated the spread sheet and the calculator that generated the numbers on the FABIF, there is a $6.00 difference between the two. The FABIF is the operational budget. The spread sheet is included to show detail costs and line items.

A new STANDARD FORM 424 has been completed and is attached with the modified proposal.

PRDA No. DE-PR07-87ID12662
Attachment No. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 4587 (10-80)

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No.	2. Program/Project Title: GEOTHERMAL FLUID GENESIS IN THE GREAT BASIN
3. Name and Address: University of Nevada, Las Vegas Division of Earth Sciences 255 Bell St., Suite 200, Reno, NV 89503	4. Program/Project Start Date: December 1, 1987 5. Completion Date: November 31, 1988

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
TASK 1		$	$	$ 12,492	$ 5,185	$ 17,677
TASK 2				16,111	2,578	18,689
TASK 3				65,414	2,578	67,992
TASK 4				47,122	7,734	54,856
TOTALS see page 2		$	$	$	$	$

SECTION B - BUDGET CATEGORIES

Object Class Categories	(1) TASK 1	(2) TASK 2	(3) TASK 3	(4) TASK 4	Total (5) page 2
Personnel	$ 6,044	$ 8,429	$ 21,768	$ 24,158	$
Fringe Benefits	948	1,621	4,757	5,099	
Travel	572		5,250		
Equipment					
Supplies	852	202	1,277	808	
Rental					
Consultant					
Analyses			16,898		
Total Direct	8,416	10,252	49,950	30,065	
Indirect Charges	4,076	5,859	15,464	17,057	
Total	$ 12,492	$ 16,111	$ 65,414	$ 47,122	$
Cost Share	$ 5,185	$ 2,578	$ 2,578	$ 7,734	$

PRDA No. DE-PR07-87ID12662
Attachment No. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM FORM APPROVED

1. Program Project Identification No.	2. Program Project Title GEOTHERMAL FLUID GENESIS IN THE GREAT BASIN
3. Name and Address University of Nevada, Las Vegas Division of Earth Sciences 255 Bell St. , Suite 200, Reno, NV 89503	4. Program Project Start Date December 1, 1987 5. Completion Date November 31, 1988

SECTION A · BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	New or Revised Budget: Total (g)
1. TASK 5		$	$	$ 20, 920	$ 2,578	$ 23,498
2.						
3.						
4.						
5. TOTALS		$	$	$ 162,059	$ 20,653	$ 182,712

SECTION B · BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity: (1) TASK 5	(2)	(3)	(4)	Total (5) Page 1&2
Personnel	$ 9,986	$	$	$	$ 70,385
Fringe Benefits	1,853				14,278
Travel	1,450				7,272
Equipment					
Supplies	729				3,868
Rental					
Consultants					
Analyses					16,898
Total Direct	14,018				112,701
Indirect Charges	6,902				49,358
Total	$ 20,920	$	$	$	$ 162,059
Cost Share	$ 2,578	$	$	$	$ 20,653

PRDA REVISED BUDGET OCTOBER 2, 1987

	TASK 1		TASK 2		TASK 3		TASK 4		TASK 5	
LABOR	MONTHS	AMOUNT	MONTHS	AMOUNT	MONTHS	AMOUNT	MONTHS	AMOUNT	MONTHS	AMOUNT
Principal Investigator	1.0	3114	1.5	4671	3.5	10899	4.0	12456	2.0	6228
Senior Geologist	0.0	0	0.5	2092	2.0	8370	2.0	8370	0.5	2092
Geologic Assistant	0.5	833	1.0	1666	1.5	2499	2.0	3332	1.0	1666
Archaeologist	1.0	2097	0.0	0	0.0	0	0.0	0	0.0	0
Cost Share	1.0	4185	0.5	2092	0.5	2092	1.5	6277	0.5	2092
Total Labor	3.5	10229	3.5	10522	7.5	23860	9.5	30435	4.0	12079
Cost Share Labor	1.0	4185	0.5	2092	0.5	2092	1.5	6277	0.5	2092
Subtotal Charge	2.5	6044	3.0	8429	7.0	21768	8.0	24158	3.5	9986
FRINGE BENEFITS										
Health Insurance	2.0	272	2.0	294	5.5	808	6.0	882	2.5	367
Retirement (TC)	2.0	646	1.5	859	3.5	2220	4.0	2464	2.0	1018
Retirement (NV)	0.0	0	0.5	412	2.0	1648	2.0	1648	0.5	412
Cost Share Retire (NV)	1.0	864	0.5	412	0.5	412	1.5	1236	0.5	412
Cost Share Health	1.0	136	0.5	73	0.5	73	1.5	220	0.5	73
LOA Fringe	0.5	29	1.0	54	1.5	79	2.0	104	1.0	54
Total Fringe	3.5	1948	4.0	2106	9.5	5243	11.5	6557	4.5	2339
Cost Share Fringe	1.0	1000	0.5	485	0.5	485	1.5	1457	0.5	485
Subtotal Charge	2.5	948	3.5	1621	9.0	4757	10.0	5099	4.0	1853
LABOR PLUS FRINGE		6992		10050		26525		29257		11839
INDIRECT COST		4076		5859		15464		17057		6902
TRAVEL	MILES/DAYS	AMOUNT	MILES/DAYS	AMOUNT	MILES/DAYS	AMOUNT	MILES/DAYS	AMOUNT	MILES/DAYS	AMOUNT
Airfares	900.0	150								1000
Milage	300.0	90			8000.0	2400				
Per Dium	7.0	332			60.0	2850				450
Total Travel		572				5250				1450
MISCELLANEOUS SUPPLIES										
Telephones	1.0	140	1.0	140	3.5	490	4.0	560	2.0	280
Postage	1.0	12	1.0	12	3.5	42	4.0	48	2.0	24
Maps		150								
Reproductions		50	1.0	50		100				200
Air Photos		500								
Graphics								150		150
Office Material						40		50		75
Sample Bottles						105				
Fabrications						500				
Total Supplies		852		202		1277		808		729
CHEMICAL ANALYSES					Number	Cost				
Geothermal Fluids										
Major/Minor/Trace					48.0	3048				
Stable Isotopes					48.0	3600				
Tritium					15.0	2250				
Carbon-14					10.0	3000				
Archaeology										
Stable Isotopes					20.0	5000				
Total Chemical Analyses						16898				
DOE TOTAL		12493		16111		65415		47123		20921
COST SHARE		5185		2578		2578		7734		2578
TASK TOTAL		17679		18690		67993		54858		23499

GRAND TOTALS	
DOE Share	162065
Cost Share	20654
Total Project Cost	182720
Percent Cost Share	11

OMB Approval No. 29-RO218

FEDERAL ASSISTANCE

1. TYPE OF ACTION (Mark appropriate box)
- [ ] PREAPPLICATION
- [X] APPLICATION
- [ ] NOTIFICATION OF INTENT (OpL)
- [ ] REPORT OF FEDERAL ACTION

2. APPLICANT'S APPLICATION a. NUMBER: — b. DATE (Year month day): 1987 10 2

3. STATE APPLICATION IDENTIFIER a. NUMBER: — b. DATE ASSIGNED (Year month day): 19

Leave Blank

SECTION I—APPLICANT/RECIPIENT DATA

4. LEGAL APPLICANT/RECIPIENT
- a. Applicant Name : University of Nevada, Las Vegas
- b. Organization Unit : Division of Earth Sciences
- c. Street/P.O. Box : 255 Bell St., Suite 200
- d. City : Reno — e. County : Washoe
- f. State : Nevada — g. ZIP Code: 89503
- h. Contact Person (Name & telephone No.) : Dennis T. Trexler (702) 784-6151

5. FEDERAL EMPLOYER IDENTIFICATION NO. 88-6000024

6. PROGRAM (From Federal Catalog) a. NUMBER: — b. TITLE: P. L. 93-410

7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT

GEOTHERMAL FLUID GENESIS IN THE GREAT BASIN

8. TYPE OF APPLICANT/RECIPIENT
A–State, B–Interstate, C–Substate District, D–County, E–City, F–School District, G–Special Purpose District, H–Community Action Agency, I–Higher Educational Institution, J–Indian Tribe, K–Other (Specify):
Enter appropriate letter: I

9. TYPE OF ASSISTANCE
A–Basic Grant, B–Supplemental Grant, C–Loan, D–Insurance, E–Other
Enter appropriate letter(s): A

10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.): Nevada

11. ESTIMATED NUMBER OF PERSONS BENEFITING: 1 million

12. TYPE OF APPLICATION
A–New, B–Renewal, C–Revision, D–Continuation, E–Augmentation
Enter appropriate letter:

13. PROPOSED FUNDING

a. FEDERAL	$ 162,059.00
b. APPLICANT	20,653.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ 182,712.00

14. CONGRESSIONAL DISTRICTS OF: a. APPLICANT: 2 — b. PROJECT: State-wide

15. TYPE OF CHANGE (For 12c or 12e)
A–Increase Dollars, B–Decrease Dollars, C–Increase Duration, D–Decrease Duration, E–Cancellation, F–Other (Specify):
Enter appropriate letter(s):

16. PROJECT START DATE (Year month day): 1987 12 1

17. PROJECT DURATION: 12 Months

18. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY (Year month day): 1987 10 2

19. EXISTING FEDERAL IDENTIFICATION NUMBER: N/A

20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code): Dept. of Energy, Idaho Operations Office, Idaho Falls, ID 83402

21. REMARKS ADDED [X] Yes [ ] No

SECTION II—CERTIFICATION

22. THE APPLICANT CERTIFIES THAT ▶

a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached:

	No response	Response attached
(1)	[ ]	[ ]
(2)	[ ]	[ ]
(3)	[ ]	[ ]

23. CERTIFYING REPRESENTATIVE
- a. TYPED NAME AND TITLE: Dennis T. Trexler, Director
- b. SIGNATURE: Dennis T. Trexler
- c. DATE SIGNED (Year month day): 1987 10 2

SECTION III—FEDERAL AGENCY ACTION

24. AGENCY NAME

25. APPLICATION RECEIVED (Year month day): 19

26. ORGANIZATIONAL UNIT

27. ADMINISTRATIVE OFFICE

28. FEDERAL APPLICATION IDENTIFICATION

29. ADDRESS

30. FEDERAL GRANT IDENTIFICATION

31. ACTION TAKEN
- [ ] a. AWARDED
- [ ] b. REJECTED
- [ ] c. RETURNED FOR AMENDMENT
- [ ] d. DEFERRED
- [ ] e. WITHDRAWN

32. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

33. ACTION DATE ▶ (Year month day): 19

34. STARTING DATE (Year month day): 19

35. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

36. ENDING DATE (Year month day): 19

37. REMARKS ADDED [ ] Yes [ ] No

38. FEDERAL AGENCY A-95 ACTION

a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.

b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)

SECTION IV-REMARKS *(Please reference the proper item number from Sections I, II or III, if applicable)*

ABSTRACT

The Division of Earth Sciences proposes to conduct a detailed, interdisciplinary, geochemical assessment of Nevada's geothermal resources. The principal objectives of this program are to determine recharge areas, flow rates and paths, and provinces of geothermal fluids that occur at the surface today. For example, did recharge occur during historic or pre-historic time? Are recharge areas, flow paths and rates constant throughout the different geothermal provinces in the Great Basin? The principal objectives will be accomplished by integrating data sets from a variety of sources. One source is the stable light-isotope compositions of geothermal fluids from large-scale geothermal developments (power plants, industrial processes, etc.), and non-producing (but flowing) hot spring areas. These data will be collected through a systematic geochemical sampling program on a state-wide basis. This information will be augmented with isotope ratio data from organic archaeological material and associated paleontological data collected from caves and other habitation sites in the Great Basin. In addition, major, minor and trace element data from these locations and the historical record will be an essential component of the program. Enriched tritium analyses and Carbon-13/14 will be performed at selected sites to determine minimum isotopic ages of the fluids. The ultimate goal is to develop a model of geothermal fluid genesis within the Great Basin which will provide benefits to the scientific community, the geothermal industry, and the state agencies responsible for regulating geothermal energy and water rights issues.

JOHN WAIHEE
GOVERNOR
ROGER A. ULVELING
DIRECTOR
MURRAY E. TOWILL
DEPUTY DIRECTOR
BARBARA KIM STANTON
DEPUTY DIRECTOR

7

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING, 250 SOUTH KING ST., HONOLULU, HAWAII
MAILING ADDRESS: P.O. BOX 2359, HONOLULU, HAWAII 96804 TELEX: 7430250 HIDPED

Ref. No. 2848

October 28, 1987

Ms. Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

Dear Ms. Thorne:

In response to H. Brent Clark's letter of September 8, 1987, attached are an original and two copies of a revised proposal in response to PRDA No. DE-PR07-87ID12622.

This submittal includes a revised statement of work and a revised cost estimate for only Subproject 1, which relates to geothermal brine, of our original submittal. We understand that you have not favorably considered Subprojects 2 and 3 of our original proposal.

Other elements of our initial proposal remain effective. These elements are: Assurance of Compliance; financial statements; permission for outside evaluation; location of work; local contacts; purpose of research; objectives of research; resource and location; schedule and reports; environmental and institutional considerations; qualifications and capabilities; statements required by PRDA Section IV, Part I.e; resumes of key personnels; and map.

Dr. Harry J. Olson of the University of Hawaii was recently advised by Ms. Peggy Brookshire of the Idaho Operations Office that we could also resubmit a revised Task 3 proposal. An original and two copies of "EAST RIFT OPTIMIZATION STUDY" are also attached.

Please contact Dr. Takeshi Yoshihara at (808) 548-4150, or in his absence, Gerald O. Lesperance at (808) 548-4020, if you have further questions.

Very truly yours,

Barbara Kim Stanton
for Roger A. Ulveling

RAU/GOL:stk
Attachments

SILICA CONTROL AND RECOVERY IN HAWAIIAN GEOTHERMAL FLUIDS

We propose to investigate methods of controlling silica deposition from Hawaiian geothermal fluids in two phases. The first phase will consist of the brine subproject outlined in the original proposal submitted under PRDA No. DE-PR07-87ID12662 that was returned to us for revision. The second phase, although initially planned as part of our silica research program, was deleted from the original proposal because the added costs would have exceeded those allowable by the PRDA. Because of the deletion of the gas injection and reservoir optimization subprojects in our original response to the PRDA and consequent deletion of their anticipated costs, we believe that the work originally planned for the brine subproject second phase would be appropriate for inclusion in the revised plan of work.

The original scope of the investigation of silica deposition included the following subtasks:

1.1 Polymerization studies;

1.2 Low temperature brine treatment;

1.3 High temperature brine treatment;

1.4 Fluid characteristics determination;

1.5 Preliminary design of a larger pilot scale system; and

1.6 Byproduct recovery analysis.

A detailed description of the work plan for each of these subtasks is as follows:

1.1 Polymerization studies: This investigation will consist of an analysis of the rate of polymerization of the dissolved silica from the geothermal brine at temperatures ranging from 100°C down to 30°C in temperature decrements of 20°C. The analyses will be conducted as follows: a side stream of brine will be chilled and stored at a constant temperature in an insulated container; aliquots of the brine will be drawn off at intervals over a period of hours and the free silica concentration will be analyzed using an auto-analyzer. The analysis technique employs the spectroscopic "molybdate blue" method that is sensitive only to non-polymerized silica. These analyses will be conducted, as noted above, at a variety of temperatures, and after the addition of the following reagents: acid and caustic (for pH control), iron sulfate, and potassium aluminum sulfate. We believe that the results of this work will allow us to determine the natural rate of polymerization and deposition of silica at low temperatures and, by extrapolation, at the temperatures of reinjection. Polymerization at various pH levels will allow us to investigate the rate controlling steps (dehydration of the silica/water cages or cross linking of the monomers) in the polymerization reaction. The addition of iron and aluminum salts, which have been shown to accelerate the rate of polymerization and coagulation of dissolved silica, will allow us to determine retention times and efficiencies of these particular reagents. Efforts will also be undertaken to investigate other commercially available reagents for scale/polymerization control to determine whether it will be possible to either better accelerate or to retard the rate of silica polymerization. These investigations will follow the procedures outlined above.

1.2 Low Temperature Brine Treatment: In this experiment, a continuous side stream of brine, cooled to temperatures of less than 100°C, will be treated with pH control and metal ion reagents at the optimum levels determined in the polymerization studies. The depositional characteristics of the brine will be analyzed for settling efficiency, recovery rates, and fouling rates at temperatures of less than 100°C. Although the final (small-scale) design will be the objective of this investigation, the preliminary design will consist of raw brine stream, a heat exchanger to cool the brine to below boiling temperatures, injectors for pH control and reagent addition followed by static mixers, a retention spool, and a second heat exchanger. We will analyze the effect of reagent addition and retention times on the rate of silica deposition inside the treatment system and downstream heat exchanger as well as the deposition and settling rates in a small retention volume at the outlet of the treatment system. We will also be testing the efficiency of removal of silica from the low temperature fluids. The results of this investigation will be used in the design of a high-temperature pressurized system that will be constructed for use in the next subtask.

1.3 High-temperature Brine Treatment: This subtask will consist of the fabrication of a pilot scale treatment system based on the results of the prior subtask. After the system is fabricated it will be operated for a period of weeks with pH control and reagent addition to determine the effects of the brine treatment on the deposition rate of silica in the piping system and in the heat exchanger. If time and funding permit, we will also attempt to conduct extended tests using this system at a range of reagent addition rates, pH conditions, and heat exchanger temperatures.

1.4 Fluid Characterization: The discharge fluid from the above testing will be analyzed for solids settling rates and residual silica concentrations. This investigation will consist of separation of suspended solids by centrifugation, gravimetric determination of suspended solids, and atomic absorption analysis of residual dissolved silica. We will also conduct a particle size/fouling experiment in which fouling rates of filters having varying pore sizes will be determined.

1.5 Preliminary Design of Pilot Scale System: The data generated by the above investigations will be used to prepare a preliminary design for a larger silica treatment system that would be capable of handling the full brine load from the HGP-A geothermal generator. This design will be generic in nature and will provide pipe diameters, reagent addition rates, mixer sizes, retention times, and temperature recommendations. Detailed fabrication design is beyond the capabilities of the current staff and will not be attempted.

1.6 Byproduct Characterization: The precipitated silica recovered during the long-term operation of the small scale treatment system will be retained and analyzed for its physical and chemical characteristics that are relevant to possible commercial use. The parameters that will be analyzed include particle sizes, specific surface areas, overall purity, and concentrations of key coloration elements such as iron, zinc, and manganese. A brief investigation of potential uses for the silica will be conducted and, based on the probable uses of the silica, an attempt will be made to determine the silica removal and treatment conditions that will optimize the most valuable characteristics of the recovered byproduct. Prior research indicates that both purity and particle size (or specific surface areas) are critical characteristics for its use as a chemical feedstock. However, other potential uses (and characteristics) will also be investigated.

PHASE II INVESTIGATION: REINJECTION EVALUATION

The second phase of the proposed investigation is to evaluate the probable effects of the treated and untreated geothermal fluid on a reinjection well. This investigation will consist of the fabrication and operation of a bench scale "reinjection bed" that will be designed to accept treated and untreated brine under a range of temperatures and pressures. The reinjection beds will consist of flow-through canisters of crushed and sieved basalt that will be sized to a scale that will yield pore volumes and aperture diameters equivalent to those present in the reinjection zone of the geothermal reservoir. Test beds will be exposed to the effluent from the silica treatment system under the following conditions: 1) high temperatures without chemical modification and with treatments that attempt to retard silica polymerization; or 2) to treated brine that has been allowed to settle its precipitated silica load. This flow-through system will be operated for extended periods of time and monitored for back-pressure build-up and associated plugging. Upon completion of the individual runs, the contents of the canisters will be analyzed using optical and electron microscopy to determine the mode of plugging (whether particulate or depositional), and the rates of scale deposition in the flow porosity.

We believe that this experiment will be able to give a much better indication of the "reinjectivity" of the raw and treated geothermal fluids than would be obtainable by the other analyses performed during the Phase I investigations. This inference is based on the observations of the characteristics of silica deposition that have occurred in the HGP-A generator facility during the last six years of operation. These observations have shown that silica deposition is a progressive process that depends upon the chemical character of the substrate, the surface charge characteristics of the substrate, the surface charge conditions of the silica polymers, and the degree of turbulence in the fluid flow paths. Because silica deposition rates are sensitive to these conditions, we believe that the best way to determine deposition and plugging characteristics of the brine in the reservoir rock is to perform this test using samples of the rock itself. As time and funding permits, a computer modelling attempt can also be made to scale up the results of this experiment to the reinjection of the raw and treated fluids under power production conditions in an effort to determine the probable costs of fluid reinjection as well as the cost-effectiveness of the treatment methods developed during the Phase I investigation.

The proposed flow-through experiments would be conducted in conjunction with Subtask 1.4 above and would be anticipated to extend the completion date of that work by an additional two months. The subsequent microscopic analysis of the fill material in the flow-through canisters is expected to take an additional two months to complete and, therefore, completion of the proposed Phase II work would increase the term of this investigation by an additional four months. The increased costs associated with this investigation are as detailed in the attached budget.

FEDERAL ASSISTANCE

1. TYPE OF SUBMISSION (Mark appropriate box)
- ☐ NOTICE OF INTENT (OPTIONAL)
- ☐ PREAPPLICATION
- ☒ APPLICATION

2. APPLICANT'S APPLICATION IDENTIFIER
a. NUMBER:
b. DATE (Year month day): 19 87 10 28

3. STATE APPLICATION IDENTIFIER (NOTE: TO BE ASSIGNED BY STATE)
a. NUMBER:
b. DATE ASSIGNED (Year month day): 19

Leave Blank

4. LEGAL APPLICANT/RECIPIENT
- a. Applicant Name: State of Hawaii
- b. Organization Unit: Dept. of Business & Economic Development
- c. Street/P.O. Box: P.O. Box 2359
- d. City: Honolulu — e. County: Honolulu
- f. State: Hawaii — g. ZIP Code: 96804
- h. Contact Person (Name & Telephone No.): Takeshi Yoshihara (808) 548-4150

5. EMPLOYER IDENTIFICATION NUMBER (EIN): 99-6001081

6. PROGRAM (From CFDA)
a. NUMBER: [ ][ ].[ ][ ][ ]
MULTIPLE ☐
b. TITLE: Geothermal Energy Research, Development & Demonstration Act of 1974

7. TITLE OF APPLICANT'S PROJECT (Use section IV of this form to provide a summary description of the project.)
Silica Control and Recovery in Hawaiian Geothermal Fluids (in response to SCAP No. DE-PR-07-87-ID12622)

8. TYPE OF APPLICANT/RECIPIENT
A—State; B—Interstate; C—Substate Organization; D—County; E—City; F—School District; G—Special Purpose District; H—Community Action Agency; I—Higher Educational Institution; J—Indian Tribe; K—Other (Specify):
Enter appropriate letter: A

9. AREA OF PROJECT IMPACT (Names of cities, counties, states, etc.): State of Hawaii

10. ESTIMATED NUMBER OF PERSONS BENEFITING: 1,141,300

11. TYPE OF ASSISTANCE
A—Basic Grant; B—Supplemental Grant; C—Loan; D—Insurance; E—Other
Enter appropriate letter(s): A

12. PROPOSED FUNDING

a. FEDERAL	$ 119,950 .00
b. APPLICANT	75,643 .00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. Total	$ 195,593 .00

13. CONGRESSIONAL DISTRICTS OF:
a. APPLICANT: State-wide
b. PROJECT: State-wide

14. TYPE OF APPLICATION
A—New; B—Renewal; C—Revision; D—Continuation; E—Augmentation
Enter appropriate letter: A

15. PROJECT START DATE (Year month day): 19 87 12 01

16. PROJECT DURATION: 22 Months

17. TYPE OF CHANGE (For 14c or 14e)
A—Increase Dollars; B—Decrease Dollars; C—Increase Duration; D—Decrease Duration; E—Cancellation; F—Other (Specify):
Enter appropriate letter(s): [ ][ ][ ]

18. DATE DUE TO FEDERAL AGENCY (Year month day): 19 87 11 02

19. FEDERAL AGENCY TO RECEIVE REQUEST: U.S. Department of Energy
- a. ORGANIZATIONAL UNIT (IF APPROPRIATE): Idaho Operations Office
- b. ADMINISTRATIVE CONTACT (IF KNOWN): Ms. Trudy Thorne
- c. ADDRESS: 785 DOE Place, Idaho Falls, Idaho 83402

20. EXISTING FEDERAL GRANT IDENTIFICATION NUMBER:

21. REMARKS ADDED ☐ Yes ☐ No

22. THE APPLICANT CERTIFIES THAT▶ To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

a. YES, THIS NOTICE OF INTENT/PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON:
DATE ________ NA

b. NO, PROGRAM IS NOT COVERED BY E.O. 12372 ☐
OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW ☐

23. CERTIFYING REPRESENTATIVE
a. TYPED NAME AND TITLE: for Roger A. Ulveling, Director, Department of Business & Economic Development
b. SIGNATURE: Barbara Kim Stanton

24. APPLICATION RECEIVED (Year month day): 19

25. FEDERAL APPLICATION IDENTIFICATION NUMBER:

26. FEDERAL GRANT IDENTIFICATION:

27. ACTION TAKEN
- ☐ a. AWARDED
- ☐ b. REJECTED
- ☐ c. RETURNED FOR AMENDMENT
- ☐ d. RETURNED FOR E.O. 12372 SUBMISSION BY APPLICANT TO STATE
- ☐ e. DEFERRED
- ☐ f. WITHDRAWN

28. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

29. ACTION DATE▶ (Year month day): 19

30. STARTING DATE (Year month day): 19

31. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number):

32. ENDING DATE (Year month day): 19

33. REMARKS ADDED ☐ Yes ☐ No

NSN 7540-01-008-8162
PREVIOUS EDITION IS NOT USABLE

424-103

STANDARD FORM 424 PAGE 1 (Rev. 4-84)
Prescribed by OMB Circular A-102

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA-459C (10-80)

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No. SCAP DE-PR07-87ID12622	2. Program/Project Title Silica Control & Recovery in Hawaiian Geothermal Fluids
3. Name and Address State of Hawaii Department of Business & Economic Development P.O. Box 2359, Honolulu, Hawaii 96804	4. Program/Project Start Date December 1, 1987 5. Completion Date July 31, 1989

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Phase I		$	$	$ 91,858	$ 67,842	$ 159,700
2. Phase II				28,092	7,801	35,893
3						
4						
5. TOTALS		$	$	$ 119,950	$ 75,643	$ 195,593

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity				Total (5)
	(1) Phase I Federal	(2) Phase I Non-Federal	(3) Phase II Federal	(4) Phase II Non-Federal	
a. Personnel	$ 48,436	$ 6,681	$ 15,550	$ 2,359	$ 73,026
b. Fringe Benefits Fed 30% Non-Fed 42.07%	14,531	2,811	4,665	992	22,999
c. Travel	9,270	1,350	1,040	450	12,110
d. Equipment		45,000			45,000
e. Supplies	400	12,000	1,000	4,000	17,400
f. Contractual					
g. Construction					
h. Other	1,442		400		1,842
i. Total Direct Charges	74,079	67,842	22,655	7,801	172,377
j. Indirect Charges Fed 24% Non-Fed 0	17,779	0	5,437	0	23,216
k. TOTALS	$ 91,858	$ 67,842	$ 28,092	$ 7,801	$ 195,593
7. Program Income	$	$	$	$	$

EXPLANATION OF FEDERAL FUNDS

Line 6.a. Personnel

Dr. Donald Thomas, Principal Investigator: two months @ $3,735 and two months @ $3,959 during Phase I; and two months @ $3,959 during Phase II.

University of Hawaii technician: 12 months @ $1,800 and six months @ $1,908 during Phase I; and four months @ $1,908 during Phase II.

Line 6.b. Fringe Benefits

Thirty percent of direct labor for University personnel.

Line 6.c. Travel

Phase I: ten inter-island trips ($90 for round trip airfare, three days of car rental @ $25,and five days of per diem @ $50) = $4,150; three inter-island trips ($90 for round trip airfare, 6-2/3 days of car rental @ $25, and ten days of per diem @ $55) = $2,420; two Mainland trips for conferences ($600 for round trip airfare, five days of car rental @ $45 and five days per diem @ $105) = $2,700.

Phase II: two inter-island trips ($90 for round trip airfare, four days of car rental @ $25, and six days per diem @ $55) = $1,040.

Line 6.e. Supplies

Phase I: $400
Phase II: $1,000

Line 6.h. Other

Phase I: Publication Costs $1,000; Engineering Support $442
Phase II: Analytical Service Charge $400

Line 6.j. Indirect Charges

Phases I and II: The University of Hawaii applies 24 percent to all direct charges.

EXPLANATION OF NON-FEDERAL FUNDS

Line 6.a. Personnel	Rate	PHASE I MH	PHASE I Amount	PHASE II MH	PHASE II Amount	TOTAL MH	TOTAL Amount
Program Manager	25	60	1,500	20	500	80	2,000
DBED Professional	18	100	1,800	30	540	130	2,340
DLNR Professional	18	40	720	15	270	55	990
HECO Professional	25	40	1,000	15	375	55	1,375
PGV Professional	25	23	575	10	250	33	825
Mid-Pac Professional	22	23	506	10	220	33	726
DBED Clerical	7	60	420	20	140	80	560
Private Clerical	8	20	160	8	64	28	224
Subtotal-Personnel		366	6,681	128	2,359	494	9,040

	PHASE I	PHASE II	TOTAL
Line 6.b. Fringe Benefits @ 42.07%	2,811	992	3,803
Line 6.c. Travel	1,350	450	1,800
Line 6.d. Equipment	45,000*	0	45,000
Line 6.e. Supplies	12,000*	4,000*	16,000
Line 6.i. Total Direct Charges	67,842	7,801	75,643
Line 6.j. Indirect Charges	0	0	0
Line 6.k. TOTALS	67,842	7,801	75,643

*Cash contributions are $45,000 to construct and install a reagent mixing system at the Puna Research Center and $10,000 for supplies in Phase I; and $2,000 for supplies in Phase II.

EAST RIFT OPTIMIZATION STUDY

During the past years much progress has been made by Hawaiian research teams at the Puna Research Center in direct application utilization, and in the understanding of the chemistry and behavior of the geothermal fluids in the reservoir and the HGP-A well. With the initiation of construction of facilities leading to the building of a 12.5 MW power plant adjacent to the Puna Research Center by the private sector in 1989, it is now more important than ever to continue research on the trace element and isotope content of the geothermal fluids and on the production capabilities and limitations of the Puna reservoir. These studies should provide answers to questions relating to meteoric water contributions, reservoir wallrock - geothermal interactions, seawater incursions, and reservoir flow rates and fracture permeability interconnections.

As far as reservoir optimization is concerned the most important factor over the life of the field, is that with run-down of the field under exploitation, the terminal wellhead pressure is attained sooner at a higher designed initial setting. For the unique conditions prevailing in a given field, it is essential that an optimum value be determined to ensure that the maximum power-life is obtained for original design conditions imposed on a declining resource.

Optimizing the vacuum pressure is an equally important exercise, and it is becoming increasingly recognized that geothermal power plants should operate with a value which is significantly different from that of a conventional fossil fuel plant. Optimal vacuum pressures for geothermal power plants are necessary to keep costs to the minimum when financial interest rates are factored into the power-life equation. It is timely to make a determined effort to reduce the costs, so that geothermally generated electricity can be produced at costs which are lower than or competitive with other alternate energy sources.

As the result of a visit sponsored by HNEI to the UH, the University of Hawaii has a unique opportunity to bring Russell James to Hawaii for six months during the next year and a half to study reservoir chemistry and production optimization at the Puna Research Center. Russell James is with the New Zealand Department of Scientific and Industrial Research, and is a world-renowned geothermal research engineer and the developer of the "James" tubes and method for geothermal reservoir analysis. His work is noted for being timely, innovative, practical, and empirical. The results of his study should produce considerable financial economies in future plant capital costs, and an increase in reservoir life. Such economies could save millions of dollars over the life of a 25 MW plant with pro-rata savings for larger or smaller developments, as well as conserving valuable energy resources.

It is estimated that it would cost $60,975 to bring Russell James to the Puna Research Center to complete this geothermal reservoir optimization study. However, as the University of Hawaii and the State of Hawaii feel that this work is so vital to the timely and efficient development of the geothermal resources of the Kilauea East Rift Zone, the University will contribute $8,175 in cost sharing salary expenses and a cash contribution of $25,000. If the DOE funds this proposal, the DOE's cost would be $27,800.

PRELIMINARY PROPOSED BUDGET

East Rift Reservoir Optimization Study

Direct Costs			
Management			
Salary* - FREE Staff (Cost Share)	6,540		
Fringe* - FREE Staff (Cost Share)	1,635		$ 8,175
Inter-island Travel (FREE Program staff)			
Per Diem - 3 days/mo. @$50	900		
Air - 2 round trips/mo. @$100	1,200		
Car - 3 days/mo. @$25	450		$ 2,550
Supplies			$ 250
Sub-Total			$10,975
Consultant (Russell James)			
Fees** - 6 mos. @$5500/mo.		33,000	
Per Diem - 10 days/mo. @$50	3,000		
Air - 2 round trips/mo. @$100	1,200		
Car - 10 days/mo. @$25	1,500		
Publication costs	300	6,000	
Total - Direct Costs			$39,000
Indirect Costs			$11,000
TOTAL			$60,975
Less Cost Share (Salary)		8,175	
Cash Contribution		25,000	
			($33,175)
TOTAL (DOE)			$27,800

* Salary and Fringe at 25% - 20% FTE for 6 months to be provided by UHM-HNEI.

** Includes fees, travel to and from New Zealand, Housing in Honolulu.

New Mexico Research and Development Institute

DIRECTOR
Larry Icerman

October 16, 1987

Ms. Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83402

Re: Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift (PRDA No. DE-PR07-87ID12662)

Dear Ms. Thorne:

Please find enclosed the original and five (5) copies of revisions to the statement of work and associated budgets for the above proposal as requested in the September 8, 1987, letter from Mr. H. Brent Clark and in accordance with our subsequent telephone conversation. The enclosed materials consist of three complete and distinct responses to the recommendations provided by the Department of Energy (DOE) review process. These responses are identified as Options 1 through 3 for reference purposes. In all three options, the in-kind cost-sharing pledged by the New Mexico Research and Development Institute (NMRDI) remains essentially unchanged from that in the original proposal. The NMRDI and its major subcontractor, the New Mexico State University Energy Institute, are prepared to conduct the work in whichever option is selected by DOE in accordance with the original proposed schedule.

Option 1 consists of the original proposed work with Tasks 4 and 7 deleted in their entirety. Corresponding budget adjustments are made resulting in a total budget of $152,000, consisting of a request of $124,960 from DOE and matching funds of $12,440 (in-kind) and $14,600 (direct monetary) from NMRDI. Although Option 1 addresses the modifications requested by DOE, the technical merit and cost-effectiveness of the work plan are, in comparison to that of the original proposal, seriously compromised in my opinion.

Option 2 consists of the original proposed work with Tasks 5 and 7 deleted in their entirety and Task 4 work being conducted at a reduced level. Corresponding budget adjustments are made

Piñon Building, Suite 358, 1220 South St. Francis Drive, Santa Fe, NM 87501 • (505) 827-5886

resulting in a total budget of $157,307, consisting of a request of $129,267 from DOE and matching funds of $12,440 (in-kind) and $15,600 (direct monetary) from NMRDI. The technical merit and cost-effectiveness of the work plan in Option 2, as compared to that in Option 1, are improved significantly because the Task 4 area (Rincon) is a much more promising resource and commercialization area than Task 5 (Picacho). The incremental cost of Option 2 over Option 1 is only $5,307, of which NMRDI will contribute $1,000 or about 20%.

Option 3 consists of the original proposed work with Task 7 deleted in its entirety and the work proposed in both Tasks 4 and 5 being conducted at a reduced level. Option 3 is preferred strongly because this approach allows all of the objectives of the original proposal to be achieved at reduced costs, albeit with less supporting field data being collected and analyzed. Corresponding budget adjustments are made resulting in a total budget of $199,785, consisting of a request of $157,085 from DOE and matching funds of $12,500 (in-kind) and $30,200 (direct monetary) from NMRDI. The incremental cost of Option 3 over Option 1 is $47,785, of which NMRDI will contribute $15,600 or about 33%. In my opinion, the technical merit and cost-effectiveness of the work plan in Option 3, as compared to that in either Option 1 or Option 2, is so superior that NMRDI will commit the full amount of matching funds contained in the original proposal to this overall lower cost option to achieve the original research objectives and to build the technical foundation for subsequent successful geothermal energy commercialization.

Thank you for the opportunity to submit revisions to the above proposal. If you would like to discuss the suggested modifications to the original work plan or budget in greater detail, please do not hesitate to contact me.

Sincerely yours,

Larry Icerman

LARRY ICERMAN
Director

OPTION 1

PROPOSAL REVISIONS

submitted to
U.S. Department of Energy
Idaho Operations Office

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA No. DE-PR07-87ID12662

Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift

submitted by

New Mexico Research and Development Institute

Authorized Signature: Larry Iceerman
Larry Icerman, Director

October 16, 1987

PRDA No. DE-PR07-87ID12662
Option 1

Evaluation of Time-Integrated Radon Soil Gas Surveys in the Southern Rio Grande Rift

REVISED STATEMENT OF WORK, Option 1

1. Soil-Depth Profiles (Task 1)

Two soil-depth, radon gas surveys will be performed. One survey will profile radon soil gas over a young geomorphic surface with little or no caliche development. The other depth profile will detail radon soil gas over an old geomorphic surface with well-developed caliche. A total of 15 soil background concentration measurements and 15 time-integrated field measurements will be made.

2. Tortugas Mountain Survey (Task 2)

The Tortugas Mountain survey will consist of one reconnaissance radon soil-gas profile eight miles in length and two detailed radon profiles with a total length of 9 miles. The reconnaissance profile will include 40 pairs of soil background and time-integrated field measurements. The detailed profiles will include 270 pairs of soil background and time-integrated field measurements.

3. Radium Springs Survey (Task 3)

The Radium Springs survey will consist of one radon soil-gas grid survey of seven square miles, three detailed radon profiles with a total length of two miles, and two temperature-gradient holes. The radon grid survey will include 175 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements.

4. Rincon Survey (Task 4)

This task is deleted.

5. Picacho Survey (Task 5)

The Picacho survey will consist of two reconnaissance radon soil-gas profiles with a total length of eight miles, one detailed radon profile one mile in length, and two temperature-gradient holes. The reconnaissance profiles will include 40 pairs of soil background and time-integrated field measurements. The detailed profile will include 30 pairs of soil background and time-integrated field measurements.

6. Discussion, Interpretation, and Final Report (Task 6)

The final report will include a description of the proposed model for shallow geothermal resource areas in the study area, a description of the research methodology, radon survey and the temperature-gradient data summaries, qualitative and quantitative discussions and interpretation of the research results, evaluations of the use of radon soil-gas surveys for low-to-moderate temperature geothermal resource exploration, and recommendations for future work. The field data collected will be tabulated in appendices.

7. Work Schedule

In preparation for the field studies, land status for each survey will be inventoried, base maps and permits obtained, and survey equipment and supplies procured. A detailed schedule of the proposed work is given in Table 1 in the proposal.

8. Deliverables

The results of all of the proposed work will be reported on in the form of a comprehensive final report (Task 6). This report will be edited by the Project Manager. Public dissemination of the information will be provided through the established NMRDI information dissemination program. This effort distributes approximately 5,000 copies of technical reports annually.

Option 1

Cost-Sharing Summary

	DOE	NMRDI	TOTAL
Administration			
Personnel Services, Benefits Travel, Supplies, Telephone, Copying, Mailing	-	$ 10,440	$10,440
Report Editing and Publication	-	2,000	2,000
Contractual Programs			
Radon Soil-Gas Surveys	$124,960	14,600	139,560
Total Program Cost	$124,960	$ 27,040	$152,000

Cost-Sharing Summary	Amount	Percentage
State of New Mexico		
direct monetary	$ 14,600	9.6%
in-kind	12,440	8.2
U.S. Department of Energy	124,960	82.2
Total	$152,000	100.0%

Option 1

PRDA No. DE-PR07-87ID12662
ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10 80)

FORM APPROVED OMB No 1900 0127

1 Program Project Identification No	2 Program Project Title
DE-PR07-87ID12662	State Geothermal Research and Development

3 Name and Address	4 Program Project Start Date / 5 Completion Date
New Mexico Research and Development Inst. 1220 South St. Francis Drive, Suite 358 Santa Fe, NM 87501	4 Program Project Start Date: December 1987 5 Completion Date: May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non Federal (d)	Federal (e)	Non Federal (f)	Total (g)
1 Task 1-6		$	$	$ 124,960	$ 27,040	$ 152,000
2						
3						
4						
5 TOTALS		$	$	$ 124,960	$ 27,040	$ 152,000

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity				Total (5)
	(1)	(2)	(3)	(4)	
a Personnel	$ 8,018	$	$	$	$ 8,018
b Fringe Benefits	1,522				1,522
c Travel	500				500
d Equipment	--				--
e Supplies	400				400
f Contractual *	139,560				139,650
g Construction					
h Other	2,000				2,000
i Total Direct Charges	152,000				152,000
j Indirect Charges					
k TOTALS	$ 152,000	$	$	$	$ 152,000
7 Program Income	$	$	$	$	$

*See attached Federal Assistance Budget Information
Forms for details on major subcontract.

Option 1

PRDA No. DE-PR07-87ID12662
ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10 80)

FORM APPROVED OMB No 1900 0127

1. Program/Project Identification No. DE-PR07-87ID12662	2. Program/Project Title State Geothermal Research and Development	
3. Name and Address NMSU Energy Institute Box 3 EI Las Cruces, NM 88003		4. Program/Project Start Date December 1987 5. Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	Total (g)
1. Task 1		$	$	$ 2,370	$ 300	$ 2,670
2. Task 2				37,360	4,500	41,860
3. Task 3				41,820	4,800	46,620
4. Task 4				--	--	--
5. TOTALS		$	$	$ Continued	$ on next page	

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program Function or Activity: (1) Task 1	(2) Task 2	(3) Task 3	(4) Task 4	Total (5)
a. Personnel	$ 1,100	$ 13,900	$ 13,200	$ --	$ Continued
b. Fringe Benefits	220	2,780	2,640	--	on next
c. Travel	150	1,200	1,100	--	page.
d. Equipment	--	--	--	--	
e. Supplies	200	2,000	2,000	--	
f. Contractual *	750	15,500	20,750	--	
g. Construction	--	--	--	--	
h. Other	--	2,500	2,500	--	
i. Total Direct Charges	2,420	37,880	42,190	--	
j. Indirect Charges	250	3,980	4,430	--	
k. TOTALS	$ 2,670	$ 41,860	$ 46,620	$ --	$
7. Program Income	$	$	$	$	$

* Radon Detectors, Analyses, and Temperature Gradient Drilling.

Option 1

PRDA No. DE-PR07-87ID12662
ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10 80)

FORM APPROVED
OMB No 1900 0127

1 Program/Project Identification No DE-PR07-87ID12662	2 Program/Project Title State Geothermal Research and Development		
3 Name and Address	NMSU Energy Institute Box 3 EI Las Cruces, NM 88003	4 Program/Project Start Date December 1987	5 Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non Federal (d)	Federal (e)	Non Federal (f)	Total (g)
1 Task 5		$	$	$ 24,650	$ 3,000	$ 27,650
2 Task 6				18,760	2,000	20,760
3						
4						
5 TOTALS		$	$	$ 124,960	$ 14,600	$ 139,560

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity				Total (5)
	(1) Task 5	(2) Task 6	(3)	(4)	
a Personnel	$ 7,600	$ 14,200	$	$	$ 50,000
b Fringe Benefits	1,520	2,840			10,000
c Travel	600	250			3,300
d Equipment	—	—			—
e Supplies	1,300	1,500			7,000
f Contractual *	12,500	—			49,500
g Construction	—	—			—
h Other	1,500	—			6,500
i Total Direct Charges	25,020	18,790			126,300
j Indirect Charges	2,630	1,970			13,260
k TOTALS	$ 27,650	$ 20,760	$	$	$ 139,560
7 Program Income	$	$	$	$	$

*Radon Detectors, Analyses, and Temperature Gradient Drilling.

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OPTION 2

PROPOSAL REVISIONS

submitted to
U.S. Department of Energy
Idaho Operations Office

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA No. DE-PR07-87ID12662

Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift

submitted by

New Mexico Research and Development Institute

Authorized Signature: Larry Iceman
Larry Icerman, Director

October 16, 1987

Evaluation of Time-Integrated Radon Soil Gas Surveys in the Southern Rio Grande Rift

REVISED STATEMENT OF WORK, Option 2

1. Soil-Depth Profiles (Task 1)

Two soil-depth, radon gas surveys will be performed. One survey will profile radon soil gas over a young geomorphic surface with little or no caliche development. The other depth profile will detail radon soil gas over an old geomorphic surface with well-developed caliche. A total of 15 soil background concentration measurements and 15 time-integrated field measurements will be made.

2. Tortugas Mountain Survey (Task 2)

The Tortugas Mountain survey will consist of one reconnaissance radon soil-gas profile eight miles in length and two detailed radon profiles with a total length of 9 miles. The reconnaissance profile will include 40 pairs of soil background and time-integrated field measurements. The detailed profiles will include 270 pairs of soil background and time-integrated field measurements.

3. Radium Springs Survey (Task 3)

The Radium Springs survey will consist of one radon soil-gas grid survey of seven square miles, three detailed radon profiles with a total length of two miles, and two temperature-gradient holes. The radon grid survey will include 175 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements.

4. Rincon Survey (Task 4)

The Rincon survey will consist of one radon soil-gas grid survey, two and one-half square miles in area, one detailed radon profile totaling one mile in length, and two temperature-gradient holes. The grid survey will include 60 pairs of soil background and time-integrated field measurements. The detailed profiles will include 30 pairs of soil background and time-integrated field measurements.

5. Picacho Survey (Task 5)

This task is deleted.

6. Discussion, Interpretation, and Final Report (Task 6)

The final report will include a description of the proposed model for shallow geothermal resource areas in the study area, a description of the research methodology, radon survey and the temperature-gradient data summaries, qualitative and quantitative discussions and interpretation of the research results, evaluations of the use of radon soil-gas surveys for low-to-moderate temperature geothermal resource exploration, and recommendations for future work. The field data collected will be tabulated in appendices.

7. Work Schedule

In preparation for the field studies, land status for each survey will be inventoried, base maps and permits obtained, and survey equipment and supplies procured. A detailed schedule of the proposed work is given in Table 1 in the proposal.

8. Deliverables

The results of all of the proposed work will be reported on in the form of a comprehensive final report (Task 6). This report will be edited by the Project Manager. Public dissemination of the information will be provided through the established NMRDI information dissemination program. This effort distributes approximately 5,000 copies of technical reports annually.

Option 2

Cost-Sharing Summary

	DOE	NMRDI	TOTAL
Administration			
Personnel Services, Benefits Travel, Supplies, Telephone, Copying, Mailing	-	$ 10,440	$10,440
Report Editing and Publication	-	2,000	2,000
Contractual Programs			
Radon Soil-Gas Surveys	$129,267	15,600	144,867
Total Program Cost	$129,267	$ 28,040	$157,307

Cost-Sharing Summary	Amount	Percentage
State of New Mexico		
direct monetary	$ 15,600	9.9%
in-kind	12,440	7.9
U.S. Department of Energy	129,267	82.2
Total	$157,307	100.0%

Option 2

PRDA No. DE-PR07-87ID12662
ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10 80)

FORM APPROVED OMB No 1900 0127

1 Program Project Identification No	2 Program Project Title	
DE-PR07-87ID12662	State Geothermal Research and Development	
3 Name and Address	New Mexico Research and Development Inst. 1220 South St. Francis Drive, Suite 358 Santa Fe, NM 87501	4 Program Project Start Date: December 1987 5 Completion Date: May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	New or Revised Budget: Total (g)
1 Task 1-6		$	$	$ 129,267	$ 28,040	$ 157,307
2						
3						
4						
5 TOTALS		$	$	$ 129,267	$ 28,040	$ 157,307

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity: (1) Task 1-6	(2)	(3)	(4)	Total (5)
a Personnel	$ 8,018	$	$	$	$ 8,018
b Fringe Benefits	1,522				1,522
c Travel	500				500
d Equipment	—				—
e Supplies	400				400
f Contractual *	144,867				144,867
g Construction	—				—
h Other	2,000				2,000
i Total Direct Charges	157,307				157,307
j Indirect Charges	—				—
k TOTALS	$ 157,307	$	$	$	$ 157,307
7 Program Income	$	$	$	$	$

*See attached Federal Assistance Budget Information Forms for details on major subcontract.

Option 2

PRDA No. DE-PR07-87ID12662

ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10 80)

FORM APPROVED OMB No 1900 0127

1 Program/Project Identification No DE-PR07-87ID12662	2 Program/Project Title State Geothermal Research and Development
3 Name and Address NMSU Energy Institute, Box 3 EI, Las Cruces, NM 88003	4 Program/Project Start Date December 1987
	5 Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	New or Revised Budget: Total (g)
1 Task 1		$	$	$ 2,370	$ 300	$ 2,670
2 Task 2				37,360	4,500	41,860
3 Task 3				41,820	4,800	46,620
4 Task 4				28,957	4,000	32,957
5 TOTALS		$	$	$ Continued	$ on next page	

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	(1) Task 1	(2) Task 2	(3) Task 3	(4) Task 4	Total (5)
a Personnel	$ 1,100	$ 13,900	$ 13,200	$ 10,000	$ Continued
b Fringe Benefits	220	2,780	2,640	2,000	on next
c Travel	150	1,200	1,100	1,000	page.
d Equipment	--	--	--	--	
e Supplies	200	2,000	2,000	1,500	
f Contractual *	750	15,500	20,750	13,625	
g Construction	--	--	--	--	
h Other	--	2,500	2,500	1,700	
i Total Direct Charges	2,420	37,880	42,190	29,825	
j Indirect Charges	250	3,980	4,430	3,132	
k TOTALS	$ 2,670	$ 41,860	$ 46,620	$ 32,957	$
7 Program Income	$	$	$	$	$

* Radon Detectors, Analyses, and Temperature Gradient Drilling.

Option 2

PRDA No. DE-PR07-87ID12662
ATTACHMENT NO. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10-80)

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No. DE-PR07-87ID12662	2. Program/Project Title State Geothermal Research and Development	
3. Name and Address NMSU Energy Institute Box 3 EI Las Cruces, NM 88003		4. Program/Project Start Date December 1987 5. Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. Task 5		$	$	$ 18,760	$ 2,000	$ 20,760
2. Task 6						
3.						
4.						
5. TOTALS		$	$	$ 129,267	$ 15,600	$ 144,867

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity: (1) Task 5	(2) Task 6	(3)	(4)	Total (5)
a. Personnel	$ —	$ 14,200	$	$	$ 52,400
b. Fringe Benefits	—	2,840			10,480
c. Travel	—	250			3,700
d. Equipment	—	—			—
e. Supplies	—	1,500			7,200
f. Contractual *	—	—			50,625
g. Construction	—	—			—
h. Other	—	—			6,700
i. Total Direct Charges	—	18,790			131,105
j. Indirect Charges	—	1,970			13,762
k. TOTALS	$ —	$ 20,760	$	$	$ 144,867
7. Program Income	$	$	$	$	$

*Radon Detectors, Analyses, and Temperature Gradient Drilling.

OPTION 3

PROPOSAL REVISIONS

submitted to
U.S. Department of Energy
Idaho Operations Office

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA No. DE-PR07-87ID12662

Evaluation of Time-Integrated Radon Soil-Gas Surveys in the Southern Rio Grande Rift

submitted by

New Mexico Research and Development Institute

Authorized Signature: ______________________
Larry Icerman, Director

October 16, 1987

PRDA No. DE-PR07-87ID12662
Option 3

Evaluation of Time-Integrated Radon Soil Gas Surveys in the Southern Rio Grande Rift

REVISED STATEMENT OF WORK, Option 3

1. Soil-Depth Profiles (Task 1)

Two soil-depth, radon gas surveys will be performed. One survey will profile radon soil gas over a young geomorphic surface with little or no caliche development. The other depth profile will detail radon soil gas over an old geomorphic surface with well-developed caliche. A total of 15 soil background concentration measurements and 15 time-integrated field measurements will be made.

2. Tortugas Mountain Survey (Task 2)

The Tortugas Mountain survey will consist of one reconnaissance radon soil-gas profile eight miles in length and two detailed radon profiles with a total length of 9 miles. The reconnaissance profile will include 40 pairs of soil background and time-integrated field measurements. The detailed profiles will include 270 pairs of soil background and time-integrated field measurements.

3. Radium Springs Survey (Task 3)

The Radium Springs survey will consist of one radon soil-gas grid survey of seven square miles, three detailed radon profiles with a total length of two miles, and two temperature-gradient holes. The radon grid survey will include 175 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements.

4. Rincon Survey (Task 4)

The Rincon survey will consist of one radon soil-gas grid survey, five square miles in area, two detailed radon profiles totaling two miles in length, and three temperature-gradient holes. The grid survey will include 125 pairs of soil background and time-integrated field measurements. The detailed profiles will include 60 pairs of soil background and time-integrated field measurements.

5. Picacho Survey (Task 5)

The Picacho survey will consist of one reconnaissance radon soil-gas profile with a total length of four miles, one detailed radon profile one mile in length, and one temperature-gradient hole. The reconnaissance profile will include 20 pairs of soil background and time-integrated field measurements. The detailed profile will include 30 pairs of soil background and time-integrated field measurements.

6. Discussion, Interpretation, and Final Report (Task 6)

The final report will include a description of the proposed model for shallow geothermal resource areas in the study area, a description of the research methodology, radon survey and the temperature-gradient data summaries, qualitative and quantitative discussions and interpretation of the research results, evaluations of the use of radon soil-gas surveys for low-to-moderate temperature geothermal resource exploration, and recommendations for future work. The field data collected will be tabulated in appendices.

7. Work Schedule

In preparation for the field studies, land status for each survey will be inventoried, base maps and permits obtained, and survey equipment and supplies procured. A detailed schedule of the proposed work is given in Table 1 in the proposal.

8. Deliverables

The results of all of the proposed work will be reported on in the form of a comprehensive final report (Task 6). This report will be edited by the Project Manager. Public dissemination of the information will be provided through the established NMRDI information dissemination program. This effort distributes approximately 5,000 copies of technical reports annually.

Option 3

Cost-Sharing Summary

	DOE	NMRDI	TOTAL
Administration			
Personnel Services, Benefits Travel, Supplies, Telephone, Copying, Mailing	-	$ 10,500	$10,500
Report Editing and Publication	-	2,000	2,000
Contractual Programs			
Radon Soil-Gas Surveys	$157,085	30,200	187,285
Total Program Cost	$157,085	$ 42,700	$199,785

Cost-Sharing Summary	Amount	Percentage
State of New Mexico		
direct monetary	$ 30,200	15.1%
in-kind	12,500	6.3
U.S. Department of Energy	157,085	78.6
Total	$199,785	100.0%

Option 3

PRDA No. DE-PR07-87ID12662
Attachment No. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10-80)

FORM APPROVED
OMB No. 1900-0127

1. Program/Project Identification No. DE-PR07-87ID12662	2. Program/Project Title State Geothermal Research and Development
3. Name and Address New Mexico Research and Development Institute 1220 South St. Francis Drive, Suite 358 Santa Fe, New Mexico 87501	4. Program/Project Start Date December 1987 5. Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Task 1-6		$	$	$ 157,085	$ 42,700	$ 199,785
2.						
3.						
4.						
5. TOTALS		$	$	$ 157,085	$ 42,700	$ 199,785

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program Function or Activity				Total (5)
	(1) Task 1-6	(2)	(3)	(4)	
a. Personnel	$ 8,018	$	$	$	$ 8,018
b. Fringe Benefits	1,523				1,523
c. Travel	559				559
d. Equipment					
e. Supplies	400				400
f. Contractual *	187,285				187,285
g. Construction					
h. Other	2,000				2,000
i. Total Direct Charges	199,785				199,785
j. Indirect Charges					
k. TOTALS	$ 199,785	$	$	$	$ 199,785
7. Program Income	$	$	$	$	$

* See attached Federal Assistance Budget Information Forms for details on major subcontract.

Option 3

PRDA No. DE-PR07-87ID12662
Attachment No. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10-80)

FORM APPROVED OMB No. 1900-0127

1. Program/Project Identification No. DE-PR07-87ID12662	2. Program/Project Title State Geothermal Research and Development
3. Name and Address: NMSU Energy Institute, Box 3 EI, Las Cruces, New Mexico 88003	4. Program/Project Start Date December 1987 5. Completion Date May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. Task 1		$	$	$ 2,370	$ 300	$ 2,670
2. Task 2				37,360	4,500	41,860
3. Task 3				41,820	4,800	46,620
4. Task 4				43,905	11,625	55,530
5. TOTALS		$	$	$ Continued	on next page	$

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity: (1) Task 1	(2) Task 2	(3) Task 3	(4) Task 4	Total (5)
a. Personnel	$ 1,100	$ 13,900	$ 13,200	$ 17,000	$ continued
b. Fringe Benefits	220	2,780	2,640	3,400	on next
c. Travel	150	1,200	1,100	1,600	page
d. Equipment	-	-	-	-	
e. Supplies	200	2,000	2,000	2,500	
f. Contractual *	750	15,500	20,750	22,750	
g. Construction	-	-	-	-	
h. Other	-	2,500	2,500	3,000	
i. Total Direct Charges	2,420	37,880	42,190	50,250	
j. Indirect Charges	250	3,980	4,430	5,280	
k. TOTALS	$ 2,670	$ 41,860	$ 46,620	$ 55,530	$
7. Program Income	$	$	$	$	$

* Radon Detectors, Analyses, and Temperature Gradient Drilling.

Option 3

PRDA No. DE-PR07-87ID12662
Attachment No. 5

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM [illegible] (10-80)

FORM APPROVED
OMB No. 1900-0177

1. Program/Project Identification No.	2. Program/Project Title	
DE-PR07-87ID12662	State Geothermal Research and Development	
3. Name and Address	NMSU Energy Institute Box 3 EI Las Cruces, New Mexico 88003	4. Program/Project Start Date: December 1987 5. Completion Date: May 1989

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. Task 5		$	$	$ 12,870	$ 6,975	$ 19,845
2. Task 6				18,760	2,000	20,760
3.						
4.						
5. TOTALS		$	$	$ 157,085	$ 30,200	$ 187,285

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program, Function or Activity: (1) Task 5	(2) Task 6	(3)	(4)	Total (5)
a. Personnel	$ 7,000	$ 14,200	$	$	$ 66,400
b. Fringe Benefits	1,400	2,840			13,280
c. Travel	660	250			4,960
d. Equipment	-	-			-
e. Supplies	900	1,500			9,100
f. Contractual *	7,000	-			66,750
g. Construction	-	-			-
h. Other	1,000	-			9,000
i. Total Direct Charges	17,960	18,790			169,490
j. Indirect Charges	1,885	1,970			17,795
k. TOTALS	$ 19,845	$ 20,760	$	$	$ 187,285
7. Program Income	$	$	$	$	$

* Radon Detectors, Analyses, and Temperature Gradient Drilling.

RICHARD H. WATSON
Director

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STATE OF WASHINGTON

WASHINGTON STATE ENERGY OFFICE

#11

809 Legion Way S.E., FA-11   Olympia, Washington 98504-1211

September 15, 1987

Ms. Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls ID 83402

Re: Clarification/Information Regarding Proposal Submitted in Response to PRDA No. DE-PR07-87ID12662

Dear Ms. Thorne:

The enclosed clarification is provided in response to the September 8, 1987 letter, also enclosed.

Please feel free to call if you need further clarification or additional information. I can be reached at (206) 586-5052 or contact Gordon Bloomquist at (206) 586-5074.

Sincerely,

Stuart Simpson
Stuart Simpson
Hydrothermal Resource Specialist

SS/cjm
C-L1-66

Enclosures

CLARIFICATION OF THE PROPOSAL:

DEVELOPMENT AND FIELD TESTING OF THE
GEOTHERMAL OPTIMIZATION COMPUTER PROGRAM
GEODIM

In its current state, the GEODIM program is able to support all phases of the design of a geothermal direct use system, with the exception of heat transfer calculations. The requirements to complete the computer code include the following:

1. Addition of heat transfer calculations.

2. Addition of a report generator to provide a greater variety of printed output as would be required for use of the program in the field.

3. Addition of routines to optimize the operation of existing systems against actual heat production needs by finding the working point for heat pumps and guidelines for regulating the production pumps.

In addition to completion of the computer code, the following work is essential to achieve the goal of providing a truly useful and trustworthy tool:

1. The software must be tested against working geothermal systems to ensure that the results produced by the program are reasonable and reproducible.

2. A complete user manual be produced. This document must contain detailed instruction in both the use of the program, and in the interpretation and application of the results produced by the software.

The time needed to complete, test and modify the program will be 12 months as proposed with an additional one month for publishing of the user manual.

DEVELOPMENT AND FIELD TESTING OF THE GEOTHERMAL OPTIMIZATION COMPUTER PROGRAM GEODIM

Revised Budget Breakdown by Task:

Task 1

Salaries		DOE	GRANTEE
Geologist 4	35% for 1 month @ $3,306/month	1,157.10	
Energy Resource Specialist	35% for 1 month @ $2,714/month	474.95	474.95
Computer Analyst	30% for 1 month @ $2,781/month	834.30	
		2,466.35	474.95
Fringe Benefits	23.8% of Salaries	586.99	113.04
Equipment	Computer (to be used in all tasks)		2,132.00
Administrative Fee	67.35% of Sal,Fringe,Travel	2,056.42	396.01
	Subtotal	5,109.76	3,116.00

Task 2

Salaries		DOE	GRANTEE
Geologist 4	20% for .5 month @ $3,306/month	330.60	
Energy Resource Specialist	20% for .5 month @ $2,714/month	135.70	135.70
		466.30	135.70
Fringe Benefits	23.8% of Salaries	110.98	32.30
Administrative Fee	67.35% of Sal,Fringe,Travel	388.80	113.15
	Subtotal	966.08	281.15

Task 3

Salaries		DOE	GRANTEE
Geologist 4	20% for 1 month @ $3,306/month	661.20	
Energy Resource Specialist	20% for 1 month @ $2,714/month	271.40	271.40
		932.60	271.40
Fringe Benefits	23.8% of Salaries	221.96	64.59
Administrative Fee	67.35% of Sal,Fringe,Travel	777.60	226.29
Consultant		2,165.00	390.00
	Subtotal	4,097.16	952.28

Task 4

Salaries		DOE	GRANTEE
Computer Analyst	10% for 4 months @ $2,781/month	1,112.40	
		1,112.40	0.00
Fringe Benefits	23.8% of Salaries	264.75	0.00
Consultant		10,820.00	1,945.00
Administrative Fee	67.35% of Sal,Fringe,Travel	927.51	0.00
	Subtotal	13,124.66	1,945.00

Task 5

Salaries		DOE	GRANTEE
Consultant		4,320.00	770.00
	Subtotal	4,320.00	770.00

Task 6

Salaries		DOE	GRANTEE
Geologist 4	40% for 1.5 month @ $3,306/month	1,983.60	
Energy Resource Specialist	40% for 1.5 month @ $2,714/month	814.20	814.20
		2,797.80	814.20
Fringe Benefits	23.8% of Salaries	665.88	193.78
Travel			
1 trip to Eastern Wash/2 People		150.00	
1 trip to Klamath Falls, Oregon/2 People		365.00	
1 trip to Boise, Idaho/2 People		440.00	
		955.00	
Administrative Fee	67.35% of Sal,Fringe,Travel	2,975.98	678.87
	Subtotal	7,394.66	1.686.85

Task 7

Salaries		DOE	GRANTEE
Geologist 4	10% for 3.5 months @ $3,306/month	1,157.10	
Energy Resource Specialist	20% for 3.5 months @ $2,714/month	474.95	474.95
Computer Analyst	6% for 3.5 months @ 2,781/month	584.01	
		2,216.06	474.95
Fringe Benefits	23.8% of Salaries	527.42	113.04
Travel			
1 Trip to Lund, Sweden/1 Person			1,125.00
Administrative Fee	67.35% of Sal,Fringe,Travel	1,847.73	1,153.70
	Subtotal	4,591.21	2,866.69

Task 8

Salaries		DOE	GRANTEE
Consultant		4,320.00	770.00
	Subtotal	4,320.00	770.00

Task 9

Salaries		DOE	GRANTEE
Geologist 4	10% for 3 months @ 3,306/month	991.80	
Energy Resource Specialist	10% for 3 months @ $2,714/month	407.10	407.10
		1,398.90	407.10
Fringe Benefits	23.8% of Salaries	332.94	96.89
Travel			
1 trip to Eastern Washington/2 People		150.00	
1 trip to Klamath Falls, Oregon/2 People		365.00	
1 trip to Boise, Idaho/2 People		440.00	
		955.00	
Administrative Fee	67.35% of Sal,Fringe,Travel	1,809.59	339.44
	Subtotal	4,496.43	843.43

Task 10

Salaries		DOE	GRANTEE
Geologist 4	10% for 1 month @ $3,306/month	165.30	
Energy Resource Specialist	10% for 1 month @ $2,714/month	67.85	67.85
Computer Analyst	9% for 1 month @ $2,781/month	250.29	
		483.44	67.85
Fringe Benefits	23.8% of Salaries	115.06	16.15
Other-Printing & Miscellaneous		2,000.00	
Administrative Fee	67.35% of Sal,Fringe,Travel	403.09	56.57
	Subtotal	3,001.59	140.57
	GRAND TOTAL	**51,721.55**	**13,371.97**

PART I - TECHNICAL PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 6 of 7

Date of Submission June 18, 1987 (resubmitted: 10-26-87)

Name of Proposer Desert Research Institute, University of Nevada System

Address of Proposer P. O. Box 60220

Reno, NV 89506-0220

Title of Proposal Quantitative Evaluation and Numerical Simulation of the Moana Geothermal System

Type of Research/Project Resource Assessment / / Resource Development / / Technical Assistance /X/

Location of Work Washoe County, Nevada

Proposed Start Date December 1, 1987 Proposed Project Duration 22 (in months)

Proposed Project Manager Michael E. Campana Phone No. (702) ~~673-7~~392

Permission for Outside Evaluation Yes X No

AUTHORIZED OFFICIAL: Signature

Name Typed James V. Taranik

Title President, Desert Research Institute

Date 10-26-87

K2a-0850K

CONTENTS

NOTE: Appendices are unchanged from the original proposal and are not included.

ABSTRACT

The Moana geothermal system, a moderate-temperature hydrothermal reservoir located in Reno, Nevada, is used extensively for space heating by over 200 residences and numerous commercial establishments. Additional development is currently underway, although it is occurring in an uncoordinated fashion as there is no overall development plan. Three state agencies have regulatory responsibility over various aspects of geothermal development. Lack of resources prevents the agencies from developing a quantitative model of the system, one that could be used to predict reservoir performance or the consequences of development under a variety of scenarios. The piecemeal, individual land parcel-type of development with many private developers also mitigates strongly against the development of a predictive model of the system, a complicated and expensive task. It is obvious that to insure sound development with minimum environmental impact, an accurate reservoir model must be developed.

The research proposed herein will construct, calibrate and verify a numerical model of the Moana system. The model will be capable of simulating fluid, heat and solute transport and will be used to assess the effects of development on groundwater levels, temperatures and chemistry under a variety of different scenarios. A user's guide to the model will be developed to facilitate model use by developers and regulators, each of whom will benefit from the research.

RESEARCH AREA

The major emphasis of this proposal falls within the area of "Technical Assistance". The specific geothermal area to be studied is the Moana geothermal system, a moderate-temperature hydrothermal system (U.S. Geological Survey Circular 790, pp. 76–77) located in Reno, Nevada (see Figures 1 and 2).

GEOLOGIC FRAMEWORK

The Moana geothermal area is located in a structural trough bounded on the west by the Carson Range, a spar of the Sierra Nevada, and on the east by the Virginia Range (Figure 1). The oldest lithologic unit in the area is the lower–Pliocene Kate Peak Formation, which consists of volcanic flows, flow and mudflow breccias, agglomerates, and interbedded rhyolitic tuffs; volcanic flows are usually andesitic in composition. Blue clays associated with geothermal fluids appear to be a hydrothermal alteration product of a vitrophytic member of the Kate Peak andesite (Flynn and Ghusn, 1984).

Pliocene sedimentary rock of the Hunter Creek Formation unconformably overlies the Kate Peak andesite. Sedimentary units include a lower greywacke member, a thick sequence of diatomaceous siltstone, and an upper member of well–rounded sandstone. Sandstone of Hunter Creek attains a thickness of approximately 2000 feet in the Moana geothermal area.

Major unconformities separate Tertiary volcanics and sandstones from Quaternary deposits. Quaternary deposits consist of glacial stream gravels and alluvial fan deposits ranging in age from early Quaternary to Holocene.

Two systems of Pleistocene normal faults penetrate and displace Tertiary units; one set trends approximately 20 degrees northeast and the second trends 10 degrees northwest. The faults are considered inactive, and are obscured in most areas by younger Holocene alluvium.

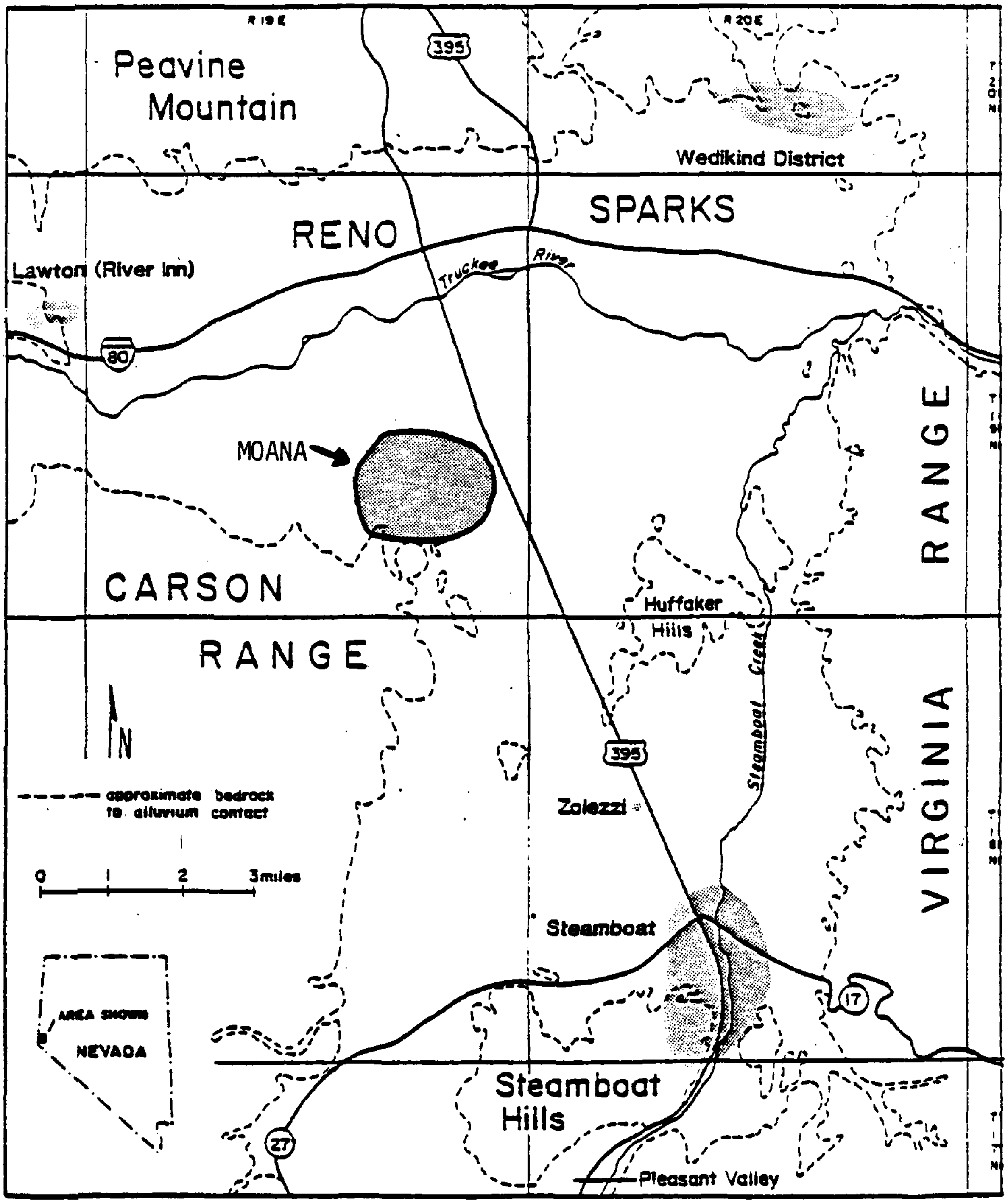

Figure 1. Location of the Moana geothermal resource.
(from Flynn and Ghusn, 1984)

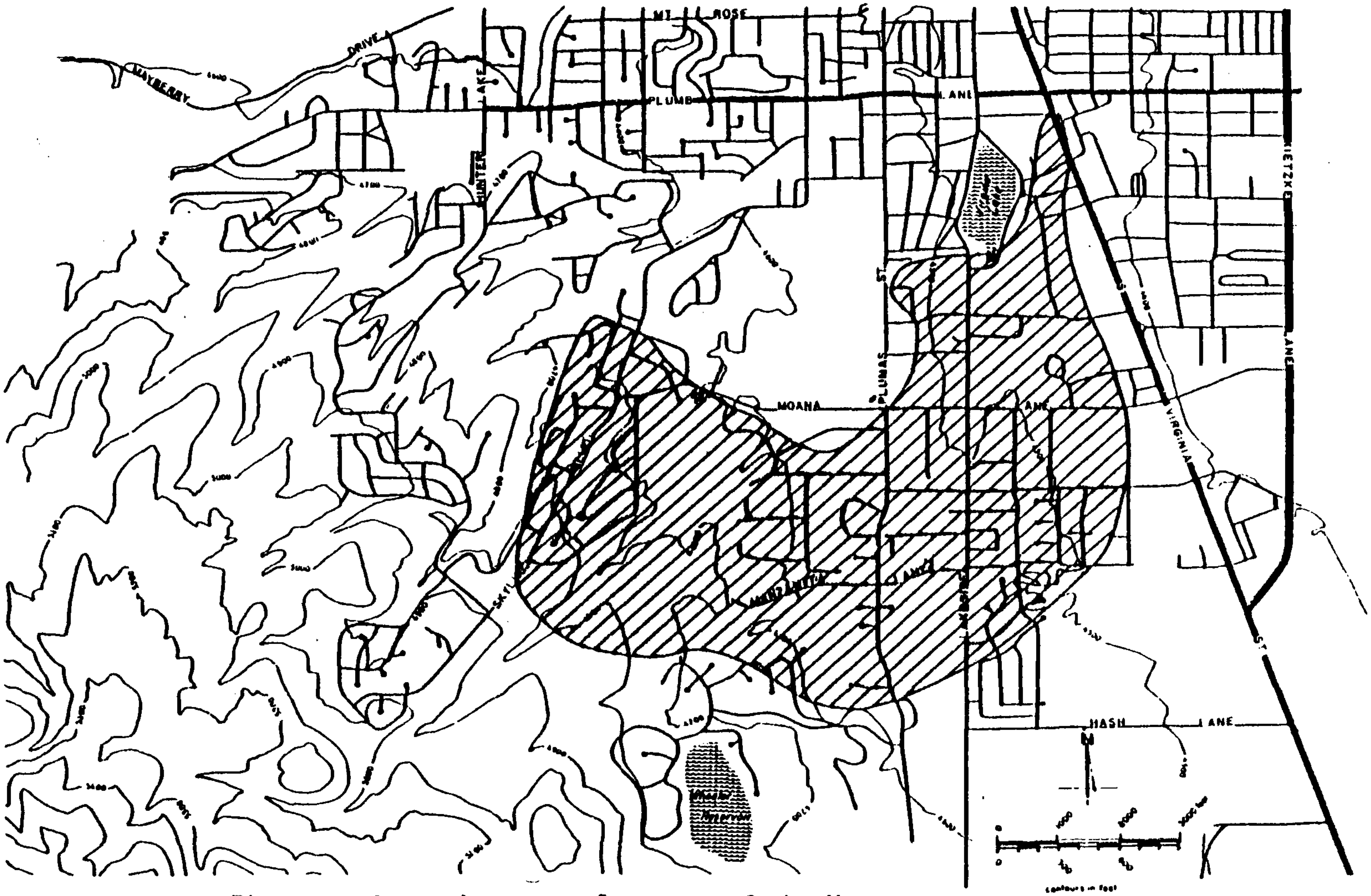

Figure 2. Approximate areal extent of the Moana geothermal resource. (from Flynn and Ghusn, 1984)

The Moana geothermal system is structurally separated from a second, high-temperature reservoir (Steamboat Hot Springs geothermal area) located 13 kilometers south-southeast of Reno by a northeast trending block of Kate Peak andesite. The two principle conduits for thermal fluid migration in the reservoir are fault planes, and the contact between the Kate Peak and Hunter Creek Formations (Flynn and Ghusn, 1984).

SIGNIFICANCE OF THE RESOURCE

In its Circular 790, the U. S. Geological Survey estimated that the Moana system had a mean reservoir volume of 8.8 $\pm$ 1.8 cubic kilometers, a mean thermal energy of 2.4 $\pm$ 0.6 x 10^{18} Joules and a mean reservoir temperature of 116 $\pm$ 14 degrees Celsius (pp. 76–77). Flynn and Ghusn (1984) reported usable temperatures from 50 to 99 degrees Celsius.

The Moana system is used extensively for space heating and, to a lesser extent, hot water, by residences and businesses. At the present time, the geothermal waters heat over 200 single-family residences as well as several churches, a few small businesses, the Mark Twain Motel, the Peppermill Hotel-Casino and a municipal pool. The Peppermill currently pumps about 750 gpm (gallons per minute) in winter and 185 gpm in summer, while the Mark Twain uses about 250 gpm in winter and 150 gpm in the summer; neither establishment injects the fluid back into the reservoir. In addition, three residential developments -- Warren Estates, the Virginia Lake Townhouses and the Salem Plaza Condominiums -- utilize the reservoir for space heating. Each of these pumps/injects an average of 350 gpm. Two planned residential developments by Farahi and Associates and the Hydrothermal Energy Corporation will also eventually use the resource for space heating, with each extracting/injecting an average of about 750 gpm. A private firm, Sierra Geothermal, Inc., has recently started to sell hot water for space heating; about 10 residences are now on-line. The development of the resource is proceeding at a rapid pace and will continue as heating costs rise. Flynn and Ghusn (1984) indicated that two to three geothermal wells come on-line each month.

THE PROBLEM

Development of the Moana resource is proceeding without any overall plan; neither the regulators nor the developers are capable of predicting future reservoir temperatures, groundwater levels, land surface elevations and groundwater quality. No one, developer or regulator, has examined the entire resource and quantitatively evaluated it with respect to a system-wide development scenario. The resource is utilized on individual parcels of property with essentially no consideration given to adjacent landowners regarding production/injection impacts. Developers are unsure of the limits and capabilities of the resource or potential interference effects with other developments. The hydraulic, chemical and thermal effects of injection wells may be difficult to assess.

Three Nevada state agencies have regulatory responsibility over various aspects of development: the Department of Minerals, which issues permits for geothermal production and injection wells and has regulatory responsibility for the mineral resource (heat); the Division of Water Resources (State Engineer), which is concerned with water rights questions, groundwater availability, water level declines and the water mining of the geothermal aquifer; and the Division of Environmental Protection (DEP), which is concerned with ground-water quality impacts resulting from injection. The objectives of these agencies sometimes conflict. For example, the DEP is especially concerned that the increased use of injection wells could lead to unacceptably high levels of arsenic, fluoride, boron and sulfate in drinking water supplies, particularly if poor-quality water withdrawn at one locale is injected and mixed with good-quality water at another locale. This is a potential problem because the Moana geothermal aquifer is part of a larger groundwater system that is used for water supply. However, from the State Engineer's viewpoint, injection wells might be considered favorable as they would tend to mitigate water–level declines and land subsidence. It is worth noting that the Department of Minerals also advocates geothermal development, as one of its charges is to promote and develop geothermal resources in the State of Nevada.

It is clear that to develop and regulate the Moana resource efficiently, a quantitative model of the geothermal reservoir is needed. This model could then be used by both developers and regulators to predict reservoir performance and environmental impacts under a variety of different development scenarios.

OBJECTIVES

With the aforementioned discussion as a prelude, the objectives of the proposed research are as follows:

1) Construct, calibrate and verify a numerical model of the Moana geothermal reservoir. The model will be capable of simulating fluid, heat and contaminant transport under steady or transient conditions.
2) Use the model to simulate the behavior of the reservoir under a variety of different and realistic development scenarios. The scenarios will include but not be limited to ones depicting: the current condition of uncoordinated development with increasing density of development; and an area–wide development plan with perhaps community/regional injection wells. With regard to simulation/investigation of reservoir performance, the following items are of interest: a) decline of reservoir temperatures; b) lowering of ground–water levels; c) land subsidence; d) groundwater quality changes induced by injection operations; and e) adverse chemical reactions (precipitation, dis-

solution, etc.) caused by the mixing of injected and native groundwaters.

3) Development of a user's guide to the model so that it can easily be used by developer and regulator. The Division of Environmental Protection, which has encouraged this proposal, has tentatively agreed to keep the model and run it for the state agencies involved; developers can run it either on their own hardware or the Water Resources Center's system.

The scenarios referred to in Item (2) will not be developed in a vacuum; state agencies, as well as developers, will be solicited for input. The Division of Environmental Protection has already indicated several appropriate scenarios. In fact, we will coordinate our efforts with the aforementioned state agencies as well as the Division of Earth Sciences of the University of Nevada–Las Vegas.

No agency or private developer is currently in a position to undertake a quantitative evaluation of the Moana geothermal system. The model we will produce will be state-of-the-art; its calibration and verification will be neither routine nor inexpensive. Such a task is beyond the capabilities and resources of the developers and their consultants; in addition, the piecemeal development of the resource and the many individual users tend to preclude the funding of an undertaking of this magnitude by the private sector. Likewise, the state agencies, each of which has missions other than geothermal energy, do not have the time, money and human resources to undertake such a project. In these respects, the proposed research involves work not being done by private industry, yet which will produce results and benefits to both the private and public sector, and is entirely consistent with the objectives of this PRDA.

BENEFITS

The proposed research will benefit both regulator and developer, whether the developer is a private entity or the Department of Minerals. Specific benefits are listed below.

Developers

The scenarios we propose to simulate will be useful to any developer interested in the size and development limitations of the reservoir.

The model will enable any developer to assess the characteristics of the Moana hydrothermal reservoir as it relates to a specific development. For example, the model will be able to answer the following: will the reservoir be able to produce enough heat to supply a particular development for the desired amount of time? Will unacceptable fluid and thermal drawdowns result? Will neighboring developments be adversely affected? What will be the most efficient engineering approach to extract the thermal energy? Should the fluid be reinjected? If so, where should injection wells be placed so as not to quench the resource or cause adverse reactions? The existence of an accurate predictive model may provide the impetus for a "space heating" or "geothermal heating" district that can develop a rational, area-wide management and development plan. The Department of Minerals will be able to use the model to decide whether to require injection wells in certain locations or to restrict well permits so as to prevent overdevelopment.

Regulators

The State Engineer will be able to determine whether water mining is imminent or under what set of conditions it will occur in the future. Injection wells could be properly located so as to minimize water level declines and land subsidence. Minimization of water level declines is also important to protect those who use downhole heat exchangers. The Division of Environmental Protection would use the model to predict the effects of injection on water quality. Again, the presence of a reliable model might provide the impetus for a rational, united regulatory approach among the three agencies involved.

STATEMENT OF WORK

The three objectives mentioned will be accomplished in 5 tasks, listed below along with the anticipated starting date and duration of each. Note that since the Moana geothermal area is located in residential southwestern Reno about 10 miles from our offices, field work will be quite convenient and not subject to the usual problems of travel time, inaccessibility, adverse weather conditions, etc. The total project duration is 22 months. Figure 3 graphically shows the project schedule.

Task I: Inventory/Assessment of Existing Data (2 months, 12/1/87 - 1/31/88)

Task II: Data Collection (13 months, 1/15/88 - 2/15/89)

Task III: Model Calibration/Verification (12 months, 3/15/88 - 3/15/89)

Task IV: Reservoir Simulation: Development Scenarios (3.5 months, 2/15 - 5/31/89)

Task V: Report Preparation: Draft and Final (4 months, 6/1 - 9/30/89)

Detailed descriptions of the tasks follow.

TASK I: Inventory/Assessment of Existing Data

This will entail collecting and assessing the quality of all relevant data. Data gaps will be identified. Data requirements are essentially dictated by the numerical models, which will be described later. The following is a list of the type of information that must be inventoried and assessed:

1) hydraulic data (heads, reservoir storage and transmissive properties);
2) thermal data (water temperatures, thermal properties of the reservoir);

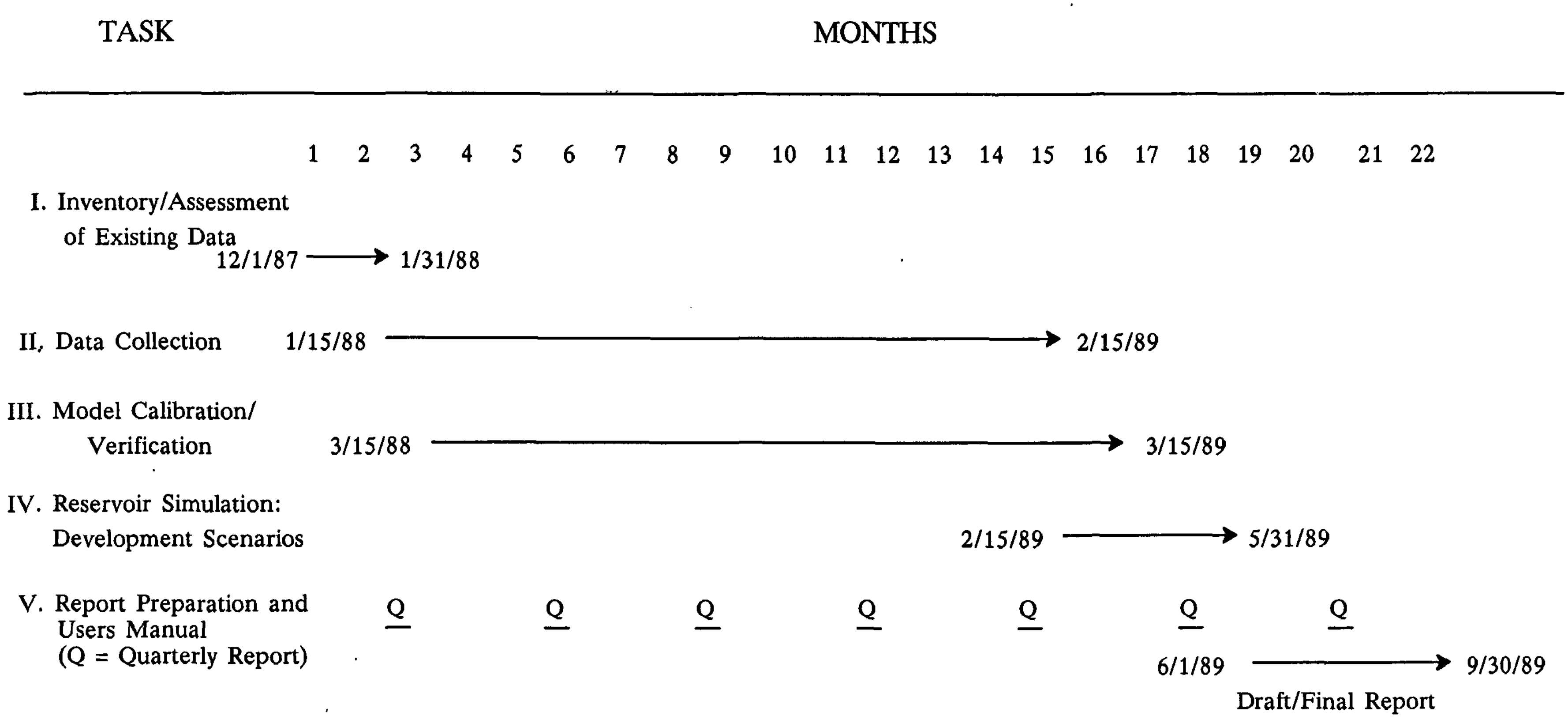

FIGURE 3. Project Schedule.

3) well data (number of wells, construction details, type of well, discharges and injection rates);
4) geologic data (reservoir geometry, lithologies of reservoir and adjacent formations, reservoir mineralogy);
5) hydrochemical data (water chemistry); and
6) hydrologic data (recharge rates and areas, precipitation, evapotranspiration, etc.).

These data can be found in a variety of places, including a number of reports: Bateman and Scheibach (1975); Bingler (1975); Ghusn (1982); and Flynn and Ghusn (1984). The latter is a very good summary and interpretation of the fluid chemistry, geology and hydrologic aspects of the Moana area and will be invaluable in our efforts.

In addition to the aforementioned reports, information will be obtained from our own files, those of the State Engineer, the Department of Minerals, the U. S. Geological Survey, the Utility Division and Department of Comprehensive Planning of Washoe County, local consultants/geothermal developers and drillers. The DEP will also be an excellent source of data, as it has the results of a number of aquifer tests and water level/water chemistry monitoring programs, some of which are ongoing.

The length of Task 1 is dictated by the extensive amount and variability of data that must be collated, the numerous agencies and private individuals that must be consulted, and the need to assess the quality of data collected. Based on this assessment, a monitoring system (Task II) will be designed to rectify deficiencies in data requirements, as well as to establish a data baseline with which to calibrate and verify a model of the geothermal system (Task III). Efficient inventory at this stage will prevent the collection of unnecessary information and potentially decrease the costs of Task II.

TASK II: Data Collection

This task will involve rectifying data deficiencies identified in Task I. Task II lasts for 13 months and will obtain time series information necessary to conduct transient simulations of the geothermal system. Initially, we expect that weekly measurements of water levels and temperatures will be made in selected wells. Until a comprehensive data inventory is completed, it is difficult to say how many wells will be measured and how often they will be measured. Aquifer tests will be designed and conducted in order to characterize the storage and fluid conductive properties of the reservoir as well as the natures of the boundaries. Thermal gradients in wells will be measured, not only to characterize the fluid thermal regime but also to estimate reservoir thermal properties by data inversion techniques. If necessary, laboratory tests may be conducted to obtain thermal characteristics of the porous medium. Reservoir chemical data will also be acquired.

Prior to utilizing a model to simulate potential geothermal development scenarios (Task IV) under transient conditions, it is essential to calibrate and verify the model using the time-series data described above. Obviously, continuous measurements of aquifer parameters over an extensive time period will result in the best agreement between model simulations and actual field responses; 12 months will provide the minimum amount of transient data on the response of the reservoir under one complete cold-season – warm-season operating cycle. Therefore, allowing one month as a "cushion", a 13-month time period has been allocated for Task II data collection.

TASK III: Model Calibration/Verification

Data assimilated in Task I will be used to calibrate a numerical model simulating the physical flow system of the Moana geothermal reservoir. After the model has been calibrated under steady-state conditions, data collected in Task II will be utilized to verify accuracy of the model under transient, or time-dependent, conditions. Additionally, ongoing data collection is necessary to refine parameter estimates used in the model; accurate time-dependent simulations of the geothermal system based on these parameters are necessary prior to utilizing the model as a predictive tool for future development scenarios.

The numerical model that will be used to simulate fluid, heat, and solute transport in the Moana flow system is SUTRA, a finite-element model developed by the USGS (Voss, 1984). SUTRA is well-documented and tested, and is capable of modeling:

1) two-dimensional areal simulations with variable thicknesses in the third (vertical) dimension;
2) two-dimensional cross-sectional simulations;
3) complex physical geometries;
4) spatially variable physical parameters (matrix hydraulic and thermal properties, etc.);
5) constant or time-dependent boundary, source, and sink nodes;
6) solute transport in groundwater; and
7) transport of thermal energy in the solid matrix and groundwater.

Solute species may be conservative, or may undergo sorption, production, or decay.

Because SUTRA was developed by the USGS, the source code is in the public domain and is therefore available at no cost to DRI personnel. Additionally, the model is well-documented and well-benchmarked, indicating that the code has been successfully applied to previous field simulations. At the conclusion of the geothermal study, the calibrated and verified SUTRA model will be utilized by state agencies and private individuals, many of whom will have little or no programming experience; therefore, the importance of a well-documented, user-friendly model must be stressed.

Based on the financial constraints specified for the geothermal study, cost for the computer time necessary to calibrate and verify a three-dimensional model of the Moana geothermal system is prohibitive. In addition, though the data available from Tasks I and II will result in a viable two-dimensional model of the system, the data would not be sufficient to calibrate a three-dimensional model; at best, the result would be an inaccurate or incomplete representation of the geothermal reservoir. Alternatively, the SUTRA code is capable of modeling variable thicknesses in the third dimension (pseudo three-dimensional), which closely approximates the spatial capabilities of a three-dimensional model, while at the same time incorporating the cost and time efficiency of a two-dimensional model.

Based on prior geologic and geophysical (gravity) surveys (Flynn and Ghusn, 1984), initial estimates of the areal extent and distribution of the Moana geothermal reservoir have been delineated. Using SUTRA, the reservoir will be simulated by a two-dimensional areal grid which will incorporate variable thicknesses in the vertical dimension. Historical water levels, temperatures, and chemistry data from the approximately 250 residential and commercial wells tapping the Moana system will then be used to calibrate a steady-state model. Time-dependent data collected from 1/88 to 2/89 will be used to refine parameter estimations and verify the ability and accuracy of the model to simulate actual transient conditions in the aquifer. To maximize the accuracy of the two-dimensional areal simulation, the Moana system will also be modeled using a two-dimensional cross-sectional grid.

Future development of the Moana geothermal reservoir may impact current domestic and commercial users, as well as influence the fluid, thermal, and chemical gradients currently established in the aquifer. In order to predict effects of future geothermal development on the resource, it is essential to first determine existing (baseline) water level, water quality, and heat distributions. Results from the SUTRA simulations will include areal distributions under steady-state and transient conditions of water levels, temperature gradients, and solute concentrations. Areas of high, intermediate, and low temperatures will be delineated, and concentration distributions of potentially problem solutes (for example, arsenic, fluoride, boron, sodium, and sulfate) will be defined.

The numerical model will be run on the Sun Microsystems 280, a sophisticated, state-of-the-art workstation computer with 8 megabytes of main memory and 575 megabytes of disk storage. In addition, the Sun employs a floating-point accelerator, which significantly increases the solution rate of the model simulations. Color graphics and advanced publishing capabilities supported under the Unix operating system will enhance and facilitate report preparation (Task V).

TASK IV: Reservoir Simulation: Development Scenarios

Evaluation of the entire Moana geothermal reservoir using a numerical model will enable the three Nevada state regulatory agencies (Department of Minerals, Division of Water Resources, Division of Environmental Protection) to create a comprehensive management plan for future domestic and industrial development of the resource. Overdevelopment or inadequate regulation of the system could result in:

1) quenched temperatures due to reinjection of lower temperature waste waters;
2) decreased water levels due to withdrawal of geothermal fluids without reinjection;
3) degraded water quality as a result of injection of poorer quality water into higher quality native groundwater; and

4) clogging of the aquifer due to groundwater mixing and subsequent mineral precipitation.

Potential development scenarios will be designed based on DEP recommendations, as well as recommendations from the two additional state agencies and developers. Using the calibrated and verified SUTRA model, simulations will show:

1) the effects on temperature distributions due to forced convection (pumping/injection);
2) plumes of lower temperature waters due to reinjection of cooled waste waters and effects on current users;
3) solute concentrations and distributions due to pumping;
4) high solute concentration plumes due to reinjection of poorer quality waters; and
5) areas of decreased water levels due to groundwater withdrawal.

Injection of waters from one part of the Moana flow system to another (for example, piping of hotter waters to areas of lower temperature waters to meet heat requirements of specific industries) will result in a new equilibrium between host rock and groundwater, with subsequent mineral dissolution or precipitation. Mineral precipitation could potentially decrease well-efficiency and affect near-well flow fields, while mineral dissolution could possibly result in degradation of groundwater quality. Therefore, in addition to the numerical model, thermodynamic and mass balance models will be used to determine mineral stability relationships in mixing scenarios. Three such geochemical models are available on the DRI system, PHREEQE (Parkhurst, Thorstenson, and Plummer, 1980), MIX2 (Plummer, Parkhurst, and Kosiur, 1976), and WATEQ DR (Bohm and Jacobson, 1981). PHREEQE incorporates the capabilities of both the latter models, but also requires complex input files. WATEQ DR and MIX2 require relatively simple input data;

results from the two models are equivalent to those calculated by PHREEQE, but operator time is reduced. Therefore, WATEQ DR and MIX2 will be used to predict geothermal reactions in development scenarios. Results from WATEQ DR will indicate mineral stability in a given scenario, whereas MIX2 will be utilized to determine precipitation/dissolution reactions occurring due to injection and mixing of waters from different areas of the reservoir. MIX2 has the additional capability of allowing variable and increasing amounts of waters to mix; in this way, injection of waste waters can be controlled to minimize adverse geochemical reactions in any given area of the geothermal system.

It must be noted that all geochemical models in existence are validated for groundwater temperatures of less than 100°C. Geochemical reactions calculated for temperatures exceeding 100°C are extrapolated from the lower temperature results; therefore, a degree of uncertainty is introduced into geochemical modeling of moderate and high temperature geothermal systems. However, these models proffer the best estimate of geochemical reactions occurring in the system and should enhance results calculated from the numerical model.

Use of the calibrated and verified transient numerical model will benefit future developers by delineating depths to water, water quality, thermal capacities, etc. At the same time, the regulating agencies will be able to maximize utilization of the geothermal resource and minimize adverse impacts on current users and on the resource potential itself.

TASK V: Report Preparation: Draft and Final

This task entails writing the draft final report, which will be submitted 90 days prior to the final submission, and the final report, which will be submitted by 9/30/89. Quarterly technical reports will also be submitted. In addition, a user's manual to the model will be developed and presented to the three state regulatory agencies and interested parties.

KEY PERSONNEL

Michael E. Campana. Dr. Campana will serve as Project Manager and have overall responsibility for the project. He has had extensive experience in managing projects of this scale. His experience in Basin and Range hydrogeology and geothermal hydrogeology is substantial. In addition to overall project management, Dr. Campana will heavily involve himself in aquifer test analysis and subsurface flow system analysis in general, will assist Dr. Wheatcraft in the model calibration/verification effort, supervise the reservoir simulation scenarios (Task IV) and do the bulk of the report writing (quarterly and final reports). Dr. Campana teaches classes in Groundwater Hydraulics, Groundwater Hydrology and Hydrologic Fluid Dynamics at the University of Nevada-Reno in addition to his DRI research. Total time commitment: 470 hours.

Stephen W. Wheatcraft. Dr. Wheatcraft's forte is the numerical modeling of transport phenomena in subsurface flow systems. In addition to developing his own models, he is intimately familiar with the ones to be used in this study. Dr. Wheatcraft will be primarily responsible for supervising Task III, which consists of model calibration/verification. This task will be the most difficult of the two modeling tasks; Task IV, involving the simulations, will not require very much of Dr. Wheatcraft's time, although he will be available for advice and trouble-shooting. Dr. Wheatcraft teaches classes in Groundwater Modeling and Contaminant Transport in Groundwater Flow Systems at the University of Nevada-Reno in addition to his DRI research. Total time commitment: 140 hours.

W. Alan McKay. Mr. McKay has had a great deal of experience with the geology and hydrology of the Basin and Range. He has also organized, designed, supervised and participated in numerous field investigations while at the Institute. Field work and data analyses are his strengths, and he will essentially supervise Tasks I and II as well as participate in all 5 tasks. Total time commitment: 600 hours.

Biographies of Key Personnel are included as Appendix II.

OTHER PERSONNEL

Dennis Ghiglieri. Mr. Ghiglieri is in charge of the computer facilities in DRI's Water Resources Center. His skills encompass both hardware and software installation, maintenance and trouble-shooting. Since the Center's computer system will be used heavily, his talents will be very useful. Total time commitment: 40 hours.

Graduate Research Fellows - TBN. Two graduate research fellows have been budgeted for this project. Two Hydrology/Hydrogeology M.S. candidates from the University of Nevada, Reno will be used for field work, computer runs and assistance with the data analyses. As is customary with our projects, these students will obtain M.S. theses from their work and valuable experience as well. Total time commitment: 1360 hours for #1 and 1080 hours for #2.

INSTITUTIONAL CAPABILITIES

The Water Resources Center of the Desert Research Institute is well-qualified to conduct the proposed research. For over 25 years, the Center has had an outstanding record of research into all aspects of research on the groundwater flow systems of the Basin and Range region and the arid West. Detailed descriptions of the Center's expertise and facilities are in Appendix III, and descriptions of some of the Center's geothermal work are in Appendix IV.

REFERENCES

Bateman, Richard L. and R. Bruce Scheibach, 1975. "Evaluation of Geothermal Activity in the Truckee Meadows, Washoe County, Nevada"; Nevada Bureau of Mines and Geology, Report 25, p. 38.

Bingler, E.C., 1975. Guidebook to the Quaternary Geology Along the Western Flank of the Truckee Meadows, Washoe County, Nevada; Nevada Bureau of Mines and Geology, Report 22, p. 14.

Bohm, Burkhard and Roger L. Jacobson, 1981. "WATEQ DR, an Updated Version of WATEQ QF - A Computerized Chemical Model of Natural Waters"; Water Resources Center, Desert Research Institute, Reno, NV, 55 pp.

Flynn, Thomas and George Ghusn Jr., 1984. Geologic and Hydrologic Research on the Moana Geothermal System, Washoe County, Nevada. Work performed under contract No. AC03-82RA50075 to U.S. Department of Energy, by Division of Earth Sciences, UNLV.

Ghusn, George Jr., 1982. Baseline Data for Moana Geothermal Area: in Low- to Moderate-Temperature Geothermal Resources Assessment for Nevada: Area Specific Studies, Pumpernickel Valley, Carlin, and Moana: Trexler, Flynn, Koenig, Bell, and Ghusn: Work performed under contract No. DE-AC08-81NV10220 to U.S. Dept. of Energy, by Division of Earth Sciences, UNLV.

Parkhurst, D.L., D.C. Thorstenson and L.N. Plummer, 1980. "PHREEQE - a Computer Program for Geochemical Calculations"; U.S.G.S. Water Resources Investigations 80-96, p. 210.

Plummer, L. Niel, David L. Parkhurst, and David R. Kosiur, 1976. "MIX2: A Computer Program for Modeling Chemical Reactions in Natural Waters"; U.S.G.S. Water Resources Investigations 75-61, 68 pp.

U.S. Geological Survey Circular 790, 1979. Assessment of Geothermal Resources of the United States - 1978, L.J.P. Muffler, Editor, p. 163.

Voss, Clifford I., 1984. "A Finite-Element Simulation Model for Saturated-Unsaturated, Fluid-Density-Dependent Groundwater Flow with Energy Transport or Chemically-Reactive Single-Species Solute Transport"; U.S.G.S. Water Resources Investigations, Report 84-4369, p. 409.

12 B

PART II - BUSINESS PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 6 of 7

Date of Submission June 18, 1987 (resubmitted: 10-26-87)

Name of Proposer Desert Research Institute, University of Nevada System

Address of Proposer P. O. Box 60220

Reno, NV 89506-0220

Title of Proposal Quantitative Evaluation and Numerical Simulation of the Moana Geothermal System

Location of Work Washoe County, Nevada

Proposed Total Project Cost $162,987 DOE Funding Requested $146,687

Proposed Start Date December 1, 1987 Proposed Project Duration 22 (in months)

Official Contact for Negotiations Dale F. Schulke Phone No. (702) 673-7315

Permission for Outside Evaluation Yes X No ___

Effective Period of Proposal 180 days

AUTHORIZED OFFICIAL: Signature [signature]

Name Typed James V. Taranik

Title President, Desert Research Institute

Date 10-26-87

Please Check Small Business ___ Disadvantaged Business ___ Other Profit ___
Women-Owned ___ Nonprofit X
University X State or Local Government ___

K2a-0850K

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C
(10 80)

FORM APPROVED
OMB No 1900 0127

1 Program Project Identification No	2 Program Project Title
DE-PR07-87ID12662	State Geothermal R. & D.

3 Name and Address	4 Program Project Start Date / 5 Completion Date
Desert Research Institute University of Nevada System P.O. Box 60220, Reno, Nevada 89506	4: 12/1/87 5: 9/30/87

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	New or Revised Budget: Total (g)
1 R&D	N/A	$ 146,687	$ 16,300	$	$	$ 162,987
2						
3						
4						
5 TOTALS		$ 146,687	$ 16,300	$	$	$ 162,987

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity: Task I	Task II	Task III	Task IV	Task V	Total (5)
a Personnel	$ 4,047	$19,553	$15,208	$ 7,184	$ 4,276	$ 50,268
b Fringe Benefits	867	2,932	2,651	1,526	1,370	9,346
c Travel	300	1,800	300	300	300	3,000
d Equipment	-0-	-0-	-0-	-0-	-0-	-0-
e Supplies	60	2,145	720	140	200	3,265
f Contractual	-0-	-0-	-0-	-0-	-0-	-0-
g Construction	-0-	-0-	-0-	-0-	-0-	-0-
h Other	708	7,918	11,784	3,150	3,696	27,256
i Total Direct Charges	5,982	34,348	30,663	12,300	9,842	93,135
j Indirect Charges	4,487	25,761	22,997	9,225	7,382	69,852
k TOTALS	10,469	60,109	53,660	21,525	17,224	$162,987
7 Program Income	-0-	-0-	-0-	-0-	-0-	$ -0-

PAGE NO.	NO. OF PAGES

NAME OF OFFEROR Desert Research Institute University of Nevada System	SUPPLIES AND/OR SERVICES TO BE FURNISHED State Geothermal Research and Development - Task I - Inventory 12-1-87/1-31-88 (8 weeks)
HOME OFFICE ADDRESS P.O. Box 60220 Reno, Nevada 89506	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Reno, Nevada	TOTAL AMOUNT OF PROPOSAL $ 10,469 / GOV'T SOLICITATION NO.

DETAIL DESCRIPTION OF COST ELEMENTS

1. DIRECT MATERIAL (Itemize on Exhibit A)			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL				-0-	
2. MATERIAL OVERHEAD[3] (Rate %X$ base=)				-0-	
3. DIRECT LABOR (Specify)	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
M.E. Campana - Project Manager	50	25.15	1,258		
W.A. McKay - Hydrogeologist	80	14.86	1,189		
T.B.N. - Graduate Research Fellow #1	160	8.75	1,400		
T.B.N. - Secretary	20	10.00	200		
TOTAL DIRECT LABOR				4,047	
4. LABOR OVERHEAD (Specify Department or Cost Center)[3]	O.H. RATE	X BASE =	EST COST ($)		
EB - Professional	32.2%	2447	788		
EB - Classified	31.1%	200	62		
EB - Graduate Research Fellow	1.2%	1400	17		
TOTAL LABOR OVERHEAD				867	
5. SPECIAL TESTING (Including field work at Government installations)			EST COST ($)		
TOTAL SPECIAL TESTING				-0-	
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)				-0-	
7. TRAVEL (If direct charge) (Give details on attached Schedule)			EST COST ($)		
a. TRANSPORTATION Project mileage 1,000 miles @$0.30/mile			300		
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				300	
8. CONSULTANTS (Identify—purpose—rate)			EST COST ($)		
TOTAL CONSULTANTS				-0-	
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				768	p.3
10. TOTAL DIRECT COST AND OVERHEAD				5,982	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate 75 % of cost element Nos. 3,4,7&9)[3]				4,487	
12. ROYALTIES[4]				-0-	
13. TOTAL ESTIMATED COST				10,469	
14. FEE OR PROFIT				-0-	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				10,469	

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*		
COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Computer - 10 hrs. @$58.80/hr.	588
9	Office supplies	60
9	Postage and communication	120

PAGE NO.	NO. OF PAGES

NAME OF OFFEROR	SUPPLIES AND/OR SERVICES TO BE FURNISHED
Desert Research Institute University of Nevada System	State Geothermal Research and Development - Task II - Data Collection 1-15-88/2-15-89 (56 weeks)
HOME OFFICE ADDRESS P.O. Box 60220 Reno, Nevada 89506	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Reno, Nevada	TOTAL AMOUNT OF PROPOSAL: $ 60,109 GOV'T SOLICITATION NO.:

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				-0-	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*				-0-	
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/ HOUR	EST COST ($)		
M.E. Campana - Project Manager	120	25.88	3,106		
W.A. McKay - Hydrogeologist	340	15.29	5,199		
T.B.N. - Graduate Research Fellow #1	1200	9.03	10,836		
T.B.N. - Secretary	40	10.29	412		
TOTAL DIRECT LABOR				19,553	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
EB - Professional	32.2%	8,305	2,674		
EB - Classified	31.1%	412	128		
EB - Graduate Research Fellow	1.2%	10,836	130		
TOTAL LABOR OVERHEAD				2,932	
5. SPECIAL TESTING *(Including field work at Government installations)*			EST COST ($)		
TOTAL SPECIAL TESTING				-0-	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*				-0-	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST ($)		
a. TRANSPORTATION Project Mileage 6,000 miles @$0.30/mile			1,800		
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				1,800	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS				-0-	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*				10,063	p.5
10. *TOTAL DIRECT COST AND OVERHEAD*				34,348	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 75 % of cost element Nos. 2,4,7(6))*[3]				25,761	
12. ROYALTIES[4]				-0-	
13. *TOTAL ESTIMATED COST*				60,109	
14. FEE OR PROFIT				-0-	
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*				60,109	

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*		
COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Computer - 60 hrs. @$58.80/hr.	3,528
9	Chemical Analysis - 40 @$100	4,000
9	Miscellaneous field supplies - 13 mo. @$125/mo.	1,625
9	Miscellaneous office supplies - 13 mo. @$40/mo.	520
9	Postage and communication - 13 mo. @$30/mo.	390

PAGE NO.	NO. OF PAGES

NAME OF OFFEROR	SUPPLIES AND/OR SERVICES TO BE FURNISHED	
Desert Research Institute ~~University of Nevada System~~	State Geothermal Research and Development - Task III - Model Calibration/Verification 3/15/88 - 3/15/89 (52 weeks)	
HOME OFFICE ADDRESS P.O. Box 60220 Reno, Nevada 89506		
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Reno, Nevada	TOTAL AMOUNT OF PROPOSAL $ 53,660	GOV'T SOLICITATION NO.

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL (Itemize on Exhibit A)					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL				-0-	
2. MATERIAL OVERHEAD[3] (Rate %X$ base=)				-0-	
3. DIRECT LABOR (Specify)	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
M.E. Campana - Project Manager	100	25.88	2,588		
W.A. McKay - Hydrogeologist	40	15.29	612		
S.W. Wheatcraft - Hydrogeologist/Modeler	120	26.82	3,218		
D.L. Ghiglieri - Computer Programmer	40	23.73	949		
T.B.N. - Graduate Research Fellow #2	800	9.03	7,224		
T.B.N. - Secretary	60	10.29	617		
TOTAL DIRECT LABOR				15,208	
4. LABOR OVERHEAD (Specify Department or Cost Center)[3]	O.H. RATE	X BASE =	EST COST ($)		
EB - Professional	32.2%	7367	2,372		
EB - Classified	31.1%	617	192		
EB - Graduate Research Fellow	1.2%	7224	87		
TOTAL LABOR OVERHEAD				2,651	
5. SPECIAL TESTING (Including field work at Government installations)			EST COST ($)		
TOTAL SPECIAL TESTING				-0-	
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)				-0-	
7. TRAVEL (If direct charge) (Give details on attached Schedule)			EST COST ($)		
a. TRANSPORTATION Project Mileage 1,000 miles @$0.30/mile			300		
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				300	
8. CONSULTANTS (Identify—purpose—rate)			EST COST ($)		
TOTAL CONSULTANTS				-0-	
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				12,504	p.7
10. TOTAL DIRECT COST AND OVERHEAD				30,663	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate 75 % of cost element Nos. 3,4,7&9)[3]				22,997	
12. ROYALTIES[4]				-0-	
13. TOTAL ESTIMATED COST				53,660	
14. FEE OR PROFIT				-0-	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				53,660	

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*		
COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
9	Computer - 180 hrs. @$58.80	10,584
9	Miscellaneous office supplies - 12 mo. @$60/mo.	720
9	Postage and communication - 12 mo. @$100/mo.	1,200

2

PAGE NO.	NO. OF PAGES

NAME OF OFFEROR Desert Research Institute University of Nevada System	SUPPLIES AND/OR SERVICES TO BE FURNISHED State Geothermal Research and Development - Task IV - Reservoir Simulation: Development Scenarios 2/15/89-5/31/89 (14 weeks)
HOME OFFICE ADDRESS P.O. Box 60220 Reno, Nevada 89506	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Reno, Nevada	TOTAL AMOUNT OF PROPOSAL $ 21,525
	GOV'T SOLICITATION NO.

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—*(1)* RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				-0-	
2. MATERIAL OVERHEAD[1] *(Rate %X$ base=)*				-0-	
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
M.E. Campana - Project Manager	100	25.88	2,588		
W.A. McKay - Hydrogeologist	80	15.29	1,223		
S.W. Wheatcraft - Hydrogeologist/Modeler	20	26.82	536		
T.B.N. - Graduate Research Fellow #2	280	9.03	2,528		
T.B.N. - Secretary	30	10.29	309		
TOTAL DIRECT LABOR				7,184	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[1]	O.H. RATE	X BASE =	EST COST ($)		
EB - Professional	32.2%	4347	1,400		
EB - Classified	31.1%	309	96		
EB - Graduate Research Fellow	1.2%	2528	30		
TOTAL LABOR OVERHEAD				1,526	
5. SPECIAL TESTING *(Including field work at Government installations)*			EST COST ($)		
TOTAL SPECIAL TESTING				-0-	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*				-0-	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST ($)		
a. TRANSPORTATION Project Mileage 1000 miles @ $0.30/mile			300		
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				300	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS				-0-	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*				3,290	p.9
10. *TOTAL DIRECT COST AND OVERHEAD*				12,300	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 75 *% of cost element Nos.* 3,4,7&9 *)*[1]				9,225	
12. ROYALTIES[1]					
13. *TOTAL ESTIMATED COST*				21,525	
14. FEE OR PROFIT				-0-	
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*				21,525	

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*		
COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Computer - 50 hrs. @$58.80/hr	2,940
9	Miscellaneous office supplies - 3.5 mo. @$40/mo.	140
9	Postage and communication - 3.5 mo. @$60/mo.	210

2

PAGE NO.	NO. OF PAGES

NAME OF OFFEROR Desert Research Institute University of Nevada System	SUPPLIES AND/OR SERVICES TO BE FURNISHED State Geothermal Research and Development - Task V - Report Preparation 6/1/89 - 9/30/89 (16 weeks)
HOME OFFICE ADDRESS P.O. Box 60220 Reno, Nevada 89506	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Reno, Nevada	TOTAL AMOUNT OF PROPOSAL $ 17,224 — GOV'T SOLICITATION NO.

DETAIL DESCRIPTION OF COST ELEMENTS

1. DIRECT MATERIAL (*Itemize on Exhibit A*)			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (*At other than cost*)					
TOTAL DIRECT MATERIAL				-0-	
2. MATERIAL OVERHEAD[3] (*Rate* %X$ *base=*)				-0-	
3. DIRECT LABOR (*Specify*)	ESTIMATED HOURS	RATE/ HOUR	EST COST ($)		
M.E. Campana - Project Manager	100	26.84	2,684		
W.A. McKay - Hydrogeologist	60	15.86	952		
T.B.N. - Secretary	60	10.67	640		
TOTAL DIRECT LABOR				4,276	
4. LABOR OVERHEAD (*Specify Department or Cost Center*)[3]	O.H. RATE	X BASE =	EST COST ($)		
EB - Professional	32.2%	3636	1,171		
EB - Classified	31.1%	640	199		
TOTAL LABOR OVERHEAD				1,370	
5. SPECIAL TESTING (*Including field work at Government installations*)			EST COST ($)		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT (*If direct charge*) (*Itemize on Exhibit A*)					
7. TRAVEL (*If direct charge*) (*Give details on attached Schedule*)			EST COST ($)		
a. TRANSPORTATION Project Mileage 1000 miles @ $0.30/mile			300		
b. PER DIEM OR SUBSISTENCE					
TOTAL TRAVEL				300	
8. CONSULTANTS (*Identify—purpose—rate*)			EST COST ($)		
TOTAL CONSULTANTS				-0-	
9. OTHER DIRECT COSTS (*Itemize on Exhibit A*)				3,896	p.11
10. *TOTAL DIRECT COST AND OVERHEAD*				9,842	
11. GENERAL AND ADMINISTRATIVE EXPENSE (*Rate* 75 *% of cost element Nos.* 3,4,7&9)[3]				7,382	
12. ROYALTIES[4]				-0-	
13. *TOTAL ESTIMATED COST*				17,224	
14. FEE OR PROFIT				-0-	
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*				17,224	

EXHIBIT A—SUPPORTING SCHEDULE *(Specify. If more space is needed, use reverse)*

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
9	Computer - 20 hr. @ $58.80/hr.	1,176
9	Report preparation/graphics	2,200
9	Miscellaneous office supplies - 4 mo. @ $50/mo.	200
9	Postage and communication - 4 mo. @ $80/mo.	320

2

BUDGET JUSTIFICATIONS

COMPUTER TIME. A total of 320 hours of computer time @$58.80 per hour has been budgeted. The hourly charge covers the following: software and hardware maintenance, computer supplies (manuals, paper, etc.), lease of the computer and peripherals, and the various communication lines required by the system. The actual amount of time was estimated based on our experience with numerical modeling, the SUTRA code and the fact that we will be simulating transient conditions in a geothermal reservoir, a non-trivial problem. In addition, some of the computer time will be allocated for data storage, manipulation and retrieval, and word processing.

MILEAGE. A total of 10,000 miles has been allocated for mileage. The study area is a 20-mile round trip from our offices, and Carson City, where the state agencies are located, is about a 70-mile round trip. Although the mileage may seem high, it amounts to only 450 miles per month over the life of the project, with 60 percent of the mileage allocated for the data collection. Even if we sample only weekly (and we may decide to do so more often), the 6,000 miles for Task II would permit about 100 60-mile round trips, which is not unreasonable considering the entire sampling circuit and the fact that we will use two sampling teams. The additional mileage will cover the numerous trips we expect to make to Carson City and other areas during the life of the project. The per mile charge is our standard rate for the 2WD truck, and covers such things as routine and non-routine maintenance and gasoline.

MAN-HOURS. The amount of time that we have charged is an estimate, as one cannot know exactly how many hours it will take to complete a project such as the one proposed herein. However, the budget was prepared by the project manager in consultation with others involved in the project as well as Desert Research Institute administrators, all of whom have had substantial experience in the budgeting and conduction of research projects. It should be remembered that the proposed research deals with a transient system, a fact that demands a lot of data, most of which will have to be collected. Data collection is a very labor-intensive task for which there is no alternative. Similarly, the numerical simulation of a time-dependent system involving fluid, mass and energy transport is another labor-intensive task; even though a computer will be used, many man-hours of skilled labor will be required to ensure success. Again, we have had a great deal of experience with studies involving transient numerical simulation and the collection and manipulation of the necessary time-dependent data. Finally, the User's Manual, a document we will write in addition to the various reports required by the Department of Energy, will require a fair amount of time to produce.

COST SHARING

A total of $16,300 will be cost-shared by the Desert Research Institute. The funds for the cost share are available in the administrative funds appropriated for the Desert Research Institute by the Nevada State Legislature. These funds have been set aside and will be forthcoming upon the award of the grant. Cost share funds will be set aside in fund accounts per the regulations in OMB Circular A-122. Of the total cost share, $9,378 will be in salaries and benefits and $6,922 will be indirect cost.

Anne L. Audrain
Controller
Desert Research Institute

James V. Taranik
President
Desert Research Institute

Peggy -> HPR

(13)

State of Idaho
DEPARTMENT OF WATER RESOURCES
STATE OFFICE, 450 W. State Street, Boise, Idaho

CECIL D. ANDRUS
Governor

R. KEITH HIGGINSON
Director

Mailing address:
Statehouse
Boise, Idaho 83720
(208) 334-4440

September 22, 1987

Ms. Trudy A. Thorne
Contracts Management Division
U. S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

RE: Geothermal Proposal to Program Research and Development Announcement No. DE-PR07-87ID12662

Dear Ms. Thorne:

In response to your letter dated September 8, 1987, we are providing you the following information and clarification concerning the above-mentioned proposal:

a) Revised Workhour Data
b) Task 2: Clarification of the Boise Geothermal Aquifer Study
c) Senate Bill No. 1225 (including copy of FY 1988 Appropriation for Resource Analysis Division, Idaho Department of Water Resources)
d) FY 1986 Annual Report of the State Treasurer to the Governor of Idaho

The revised workhour data and appropriation information should clarify your questions concerning cost-share and manhour data. As far as our equipment input is concerned, we do have all of the equipment available for use during the course of the proposed study.

We hope that this information satisfies your needs and that we can start as soon as possible on our studies since the heating season is rapidly approaching. By delaying too much, valuable background information will not be collected, thus limiting our results.

If you have any questions, please contact Leah Street at 734-3578.

Sincerely,

Wayne T. Haas

Wayne T. Haas
Administrator
Resource Analysis Division

WTH:LS:db

Revised Workhour Data
September 21, 1987

	D. O. E. Funds		
Task #1 Budget:	FY '88	FY '89	Total
Salaries	$20,250 (.75FTE)	$16,200 (.60 FTE)	$36,450
Fringe (23%)	4,658	3,726	8,384
Task #2 Budget:			
Salaries	4,050 (~~.75~~ .15 FTE)	4,050 (.15 FTE)	8,100
Fringe (23%)	931	931	1,862
Task #3 Budget:			
Salaries	2,700 (.10 FTE)	6,750 (.25 FTE)	9,450
Fringe (23%)	621	1,553	2,174
Total Budget (Salaries & Fringe)			
Salaries	27,000	27,000	54,000
Fringe	6,210	6,210	12,420
Total	$33,210	$33,210	$66,420

Task 2: Clarification of the Boise Geothermal Aquifer Study

It is envisioned that the data collection will continue for one year and will be subcontracted to Boise State University. The principal investigator of the data collection phase will be a staff Hydrogeologist from the Geology and Geophysics Department at Boise State University. At the end of this data collection year, all available data would be released to an outside, independent consultant who would analyze it in terms of defining relationships of the wells, effects of development, and make recommendations regarding aquifer testing and management of the resource. This independent contractor will be selected based upon the guidelines set forth by state procurement. The Request-for-Proposals (RFP) will be sent to DOE for approval as well as a representative from DOE will be on the review committee to insure the independence of the contractor. All reports (including drafts) will be sent directly to DOE.

IN THE SENATE

SENATE BILL NO. 1225

BY FINANCE COMMITTEE

AN ACT

EXPRESSING LEGISLATIVE INTENT; APPROPRIATING MONEYS TO THE DEPARTMENT OF WATER RESOURCES FOR FISCAL YEAR 1988 AND DESIGNATING PROGRAM LIMITS.

Be It Enacted by the Legislature of the State of Idaho:

SECTION 1. It is legislative intent that the expenditures for the Department of Water Resources not exceed the following amount for the designated expense classes from the listed accounts for the period July 1, 1987, through June 30, 1988:

FOR:	
Personnel Costs	$4,605,700
Operating Expenditures	2,233,600
Capital Outlay	466,500
Trustee and Benefit Payments	1,269,700
TOTAL	$8,575,500
FROM:	
General Account	$4,403,800
Water Conservation and Development Account	10,000
Watermaster Service Account	136,800
Miscellaneous Federal Account	610,000
Federal Energy Account	1,369,900
Water Pollution Control Account	200,000
Water Resources Adjudication Account	1,845,000
TOTAL	$8,575,500

SECTION 2. There is hereby appropriated to the Department of Water Resources the following amounts, to be expended for designated programs according to designated expense classes from the listed accounts for the period July 1, 1987, through June 30, 1988:

	FOR PERSONNEL COSTS	FOR OPERATING EXPENDITURES	FOR CAPITAL OUTLAY	FOR TRUSTEE AND BENEFIT PAYMENTS	TOTAL
I. MANAGEMENT & SUPPORT SERVICES:					
FROM:					
General Account	$ 307,400	$ 243,600	$ 25,000		$ 576,000
Water Conservation and Development Account		10,000			10,000
Miscellaneous Federal Account	173,400	83,800			257,200
TOTAL	$ 480,800	$ 337,400	$ 25,000		$ 843,200
II. RESOURCES ANALYSIS:					
FROM:					
General Account	$ 749,400	$ 164,300	$ 70,000	$ 160,700	$1,144,400
Miscellaneous Federal Account	287,900	64,900			352,800

	FOR PERSONNEL COSTS	FOR OPERATING EXPENDITURES	FOR CAPITAL OUTLAY	FOR TRUSTEE AND BENEFIT PAYMENTS	TOTAL
Water Pollution Control Account		200,000			200,000
TOTAL	$1,037,300	$ 429,200	$ 70,000	$ 160,700	$1,697,200
III. ENERGY RESOURCES:					
FROM:					
General Account	$ 92,200	$ 25,500			$ 117,700
Federal Energy Account	654,700	715,200			1,369,900
TOTAL	$ 746,900	$ 740,700			$1,487,600
IV. SNAKE BASIN ADJUDICATIONS:					
FROM:					
General Account	$ 155,000	$ 87,700		$ 409,000	$ 651,700
Water Resources Adjudication Account	663,000	249,100	232,900	700,000	1,845,000
TOTAL	$ 818,000	$ 336,800	$232,900	$1,109,000	$2,496,700
V. REGIONAL OFFICES:					
FROM:					
General Account	$ 787,600	$ 228,000	$120,000		$1,135,600
Watermaster Services Account	112,900	23,900			136,800
TOTAL	$ 900,500	$ 251,900	$120,000		$1,272,400
VI. OPERATIONS BUREAU:					
FROM:					
General Account	$ 622,200	$ 137,600	$ 18,600		$ 778,400
GRAND TOTAL	$4,605,700	$2,233,600	$466,500	$1,269,700	$8,575,500

19.00.00

II. RESOURCE ANALYSIS: SB 1225.

PROGRAM DESCRIPTION: Conduct objective analysis of water resource projects and problems, and seek implementation of the most desirable resource developments. Conduct detailed hydrologic, economic and environmental studies to evaluate water resource problems.

TWO-YEAR COMPARISON:

Fund Source	FY 1987 Approp.	FY 1987 Est. Exp.	FY 1988 Base	FY 1988 Approp.	% Change over FY 1988 Base
General	1,005,600	1,005,600	1,005,600	1,144,400	13.8%
Dedicated	0	0	0	200,000	0.0%
Federal	340,600	340,600	340,600	352,800	3.6%
Total	1,346,200	1,346,200	1,346,200	1,697,200	26.1%
Standard Class					
Personnel Costs	964,000	964,000	964,000	1,037,300	7.6%
Operating Expenses	224,700	224,700	224,700	429,200	91.0%
Capital Outlay	0	0	0	70,000	0.0%
T/B Payments	157,500	157,500	157,500	160,700	2.0%
Total	1,346,200	1,346,200	1,346,200	1,697,200	26.1%

FY 1988 APPROPRIATION:

Fund	Acct.	FTE	Personnel Costs	Operating Expend.	Capital Outlay	T/B Payments	TOTAL
General	1101	16.90	749,400	164,300	70,000	160,700	1,144,400
Dedicated	3822	0.00	0	200,000	0	0	200,000
Federal	1332	9.60	287,900	64,900	0	0	352,800
TOTAL		26.50	1,037,300	429,200	70,000	160,700	1,697,200

TOTAL APPROPRIATION CONSISTS OF:

Gen. Fund	All Funds	
1,005,600	1,346,200	FY 1988 Base, and...
77,900	80,200	Inflationary: fixed personnel costs, a 2% operating expense increase, and $70,000 for replacement capital outlay.
10,900	20,800	CEC.
50,000	50,000	Funds beginning study phase of the Smith Fork project with Wyoming.
0	200,000	Provides Water Pollution Control funds for a groundwater inventory study of hot and cold artesian wells to correct deficiencies.
1,144,400	1,697,200	TOTAL APPROPRIATION

10,000

III. ENERGY RESOURCES: SB 1225.

PROGRAM DESCRIPTION: Provides Idaho industry, business, agriculture, government and citizens with energy related information and assistance.

TWO-YEAR COMPARISON:

Fund Source	FY 1987 Approp.	FY 1987 Est. Exp.	FY 1988 Base	FY 1988 Approp.	% Change over FY 1988 Base
General	117,200	117,200	117,200	117,700	0.4%
Dedicated	0	192,400	0	0	0.0%
Federal	1,334,600	1,334,600	1,334,600	1,369,900	2.6%
Total	1,451,800	1,644,200	1,451,800	1,487,600	2.5%
Standard Class					
Personnel Costs	725,600	730,500	725,600	746,900	2.9%
Operating Expenses	726,200	913,700	726,200	740,700	2.0%
Total	1,451,800	1,644,200	1,451,800	1,487,600	2.5%

FY 1988 APPROPRIATION:

Fund	Acct.	FTE	Personnel Costs	Operating Expend.	Capital Outlay	T/B Payments	TOTAL
General	1101	3.00	92,200	25,500	0	0	117,700
Federal	1392	24.00	654,700	715,200	0	0	1,369,900
TOTAL		27.00	746,900	740,700	0	0	1,487,600

TOTAL APPROPRIATION CONSISTS OF:

Gen. Fund	All Funds	
117,200	1,451,800	FY 1988 BASE, and...
500	16,100	Inflationary: fixed personnel costs, and a 2% operating expense increase.
0	19,700	CEC.
117,700	1,487,600	TOTAL APPROPRIATION

NORTH DAKOTA MINING AND MINERAL RESOURCES RESEARCH INSTITUTE

- COAL BY-PRODUCTS UTILIZATION LABORATORY
- FUELS ANALYSIS LABORATORY
- NATURAL MATERIALS ANALYTICAL LABORATORY

BOX 8103, UNIVERSITY STATION, GRAND FORKS, NORTH DAKOTA 58202 PHONE: (701) 777-3132

Response OK
NPR
10/19/87
#14

September 14, 1987

Ms. Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy - Idaho
Operations Office
785 DOE Place
Idaho Falls, ID 83402

Dear Ms. Thorne:

RE: Proposal submitted in response to Program Research and Development Announcement No. DE-PR07-87ID12662 for State Geothermal Research and Development.

We thank you for consideration of our proposal, and we submit the following responses to your questions:

1. Will the CICSCO wells be available in time for this study?

   Yes, as far as we know at this time. The proposal to DOSSECC from CICSCO is in review. If it is funded, two sites in South Dakota would be drilled in May and June of 1988, and a third site would be drilled in early 1989. At this time, we anticipate three of the CICSCO wells will be available during the duration of our study.

2. Are there any computer costs?

   No. Computer work done by the North Dakota Geological Survey will be fully supported by the NDGS. Computer work done by Gosnold, LeFever, and Chu will be supported by the Department of Geology and Geological Engineering and the School of Engineering and Mines. Although this part of our proposal could have been considered as cost share, we did not do so.

3. Cost breakdown by tasks and justification of drilling costs.

   Personnel assigned to specific tasks were allotted a certain percentage of their effort to those tasks, and their salaries were distributed accordingly. Costs for travel, supplies, etc. were distributed according to their planned proportions. The cost breakdown by task is provided on an attached sheet.

Drilling costs are based on an estimated drilling rate of $3.00 per foot and casing costs of $1.09 per foot. The drilling rates are currently very low due to lack of activity. The quote was provided by MMRRI personnel who have recently contracted for drilling in western North Dakota, and by a driller who drilled five heat flow holes for UND in 1982. We have allowed for about 18 hours of standby time at $50/hour according to the driller's quote. The pipe is 1 1/4" Sch. 40 blk iron pipe, threaded and coupled. The price per foot for threaded pipe with couplings was provided by the Chicago Tube & Iron Co. of Minnesota in St. Paul. As listed in the proposal, each hole will cost about $4000.

4. Provide financial statements.

The financial statements for the University of North Dakota for the last three years are enclosed.

Please contact me if any further response or clarification is needed.

Sincerely,

W.D. Gosnold Jr.

William D. Gosnold, Jr.
Associate Professor
Department of Geology and Geological
Engineering

WDG/clh

Enclosures

COST BREAKDOWN BY TASKS (DOE AMOUNT)

SALARY	1	2	3	4	5	6	7	8	9
GOSNOLD	1/8	1/8	1/8	1/16	1/16	1/16	1/16	1/4	1/8
	3564	3564	3564	1782	1782	1782	1782	7129	3564
LEFEVER							3/4	1/8	1/8
							9234	1539	1539
CHU						3/4		1/8	1/8
						9810		1635	1635
R.A'S	1/4	1/8	1/4	1/16	1/16	1/8	1/8		
	15923	7647	15923	3823	3823	7647	7647		
SUBTOT.	19487	11211	19487	5605	5605	19239	18663	10303	6738
TRAVEL	8800			2200	2200			1150	3962
DRILLING				16000	16000				
TOTAL	28287	11211	19487	23805	23805	19239	18663	11453	10700

COST BREAKDOWN BY TASKS (TOTAL AMOUNT DOE + COST SHARE)

SALARY	1	2	3	4	5	6	7	8	9
GOSNOLD	1/8	1/8	1/8	1/16	1/16	1/16	1/16	1/4	1/8
	6092	6092	6092	3046	3046	3046	3046	12185	6092
LEFEVER							3/4	1/8	1/8
							9234	1539	1539
CHU						3/4		1/8	1/8
						9810		1635	1635
ANDERSON	1/8	1/8	1/8	1/8		1/16	1/16	1/8	1/4
	659	659	659	659		329	329	659	1316
BREKKE	1/8	1/8	1/8	1/4		1/16	1/16	1/8	1/8
	888	888	888	1778		444	444	888	888
TIPTON	1/8				1/4	1/8	1/8	1/8	1/4
	527				1054	527	527	527	1054
SCHOON	1/4				1/4	1/8	1/8	1/8	1/8
	1845				1845	922	922	922	922
R.A'S	1/4	1/8	1/4	1/16	1/16	1/8	1/8		
SUBTOT.	15923	7647	15923	3823	3823	7647	7647		
OTHER	8800			18200	18200			1150	3962
TOTAL	34734	15286	23562	27506	27506	22725	22149	18355	13446

Salaries include benefits, escalation factors, research and indirect costs.

Budget
October 1, 1987 - September 30, 1989

	Year 1 10/1/87 - 6/30/88		Year 2 7/1/88 - 6/30/89		Year 3 7/1/89 - 9/30/89		TOTAL	
	Cost Share	DOE	Cost Share	DOE	Cost Share	DOE	Cost Share	DOE
Personnel:								
William Gosnold, Principal Investigator								
2.25 mo. @ $3,478/mo.	3,478		7,823		4,348		15,649	
2 mo. @ $3,478/mo		3,478		6,956		3,478		13,912
Min Chu, Co-Principal Investigator								
1 mo. @ $3,222/mo		3,222		3,222				6,444
Richard LeFever, Geologist								
1 mo. @ $3,033/mo.		3,033		3,033				6,066
Clerical/Drafting								
267 hrs. @ $7.50/hr.		2,003		2,003				4,006
2 Student Assistants								
3 mo. in summer @ $1,000/mo. & 9 mo. during AY @ $500/mo.		11,500		15,000		3,500		30,000
Total Salaries and Wages	3,478	23,236	7,823	30,214	4,348	6,978	15,649	60,428
Escalation Factor (2)			313	1,209	348	558	661	1,767
Fringe Benefits @ 24% (1)	835	5,577	1,953	7,541	1,127	1,809	3,914	14,927
Research Support @ 75% (3)		17,427		23,567		5,652		46,646
Total Salaries, Wages, Fringe Benefits and Research Support	4,313	46,240	10,089	62,531	5,823	14,997	20,224	123,768
Travel (4)		4,142		7,606		3,464		15,212
Office Supplies		300		300				600
Communications		750		750				1,500
Supplies		200		200				400
Drilling (5)				32,000				32,000
Cost Share Agreement With SD Geol. Survey (6)	5,684		5,912				11,596	
Cost Share Agreement with ND Geol. Survey (7)	6,066		6,309				12,375	
Total Direct Costs	16,063	51,632	22,309	103,387	5,823	18,461	44,195	173,480
Indirect Costs (6)		6,351		12,717		2,271		21,338
Total Costs	16,063	57,982	22,309	116,103	5,823	20,732	44,195	194,818

STATE OF UTAH
NATURAL RESOURCES
Utah Geological & Mineral Survey

Norman H. Bangerter, Governor
Dee C. Hansen, Executive Director
Genevieve Atwood, State Geologist

606 Black Hawk Way · Salt Lake City, UT 84108-1280 · 801-581-6831

17

October 21, 1987

Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, Idaho 83401

Attention: Trudy A. Thorne

Enclosed are six copies and one signed original of our revised proposal submitted in response to DOE's Program Research and Development Announcement No. DE-PR07-87ID12662 for state geothermal research and development. We have made considerable revisions from the original proposal and have reduced the level of effort in accordance with DOE's request of 9/8/87. In addition, more of an effort has been made to better justify the individual cost elements within the proposed work plan. As a result of the revisions and new costing information, estimated costs on a task by task basis are, although similar, not the same as those contained within the original proposal.

In this newly revised version, more emphasis has been placed upon addressing the areas where reviewers had expressed concern in the original proposal. A summary of the clarifications is attached to this correspondence.

Thank you for allowing us the opportunity to cooperate in this very important research program. If you require additional information or need clarifications to individual points within the proposal, please contact either Archie Smith or Robert Blackett at (801) 581-6831.

Sincerely,

Genevieve Atwood
Director

GA/rb
enc.

ATTACHMENT

Points requiring clarifications from the original proposal

- "Will the mercury studies proposed work on a lower temperature area?"

  - A review of published work on mercury studies in moderate-temperature geothermal areas suggests that a mercury survey at Newcastle would be very useful for better outlining the extent and configuration of the geothermal anomaly, and help determine the locations of faults. See the discussion of "Soil-Mercury Investigations" begining on page 5 of Part I - Technical Proposal.

- "Could new low altitude aeromagnetic data be substituted for ground magnetic data at similar or reduced costs?"

  - In fact, the UGMS has recently arranged for the acquisition of both low and high altitude aeromagnetic coverage across the study area at a nominal cost. These data will be purchased by the UGMS as part of the state cooperative share. See the discussion under "Task 4: Detailed Gravity and Magnetic Studies" on page 10, Part I - Technical Proposal.

  - Because it will be necessary to occupy and to tie in ground stations for the proposed gravity survey, we feel that it would be prudent to take ground magnetic readings at gravity stations as well. These ground magnetic readings can then be used to correlate to and possibly refine the aeromag data. Moreover, the costs of obtaining these data, as described in the discussion on page 10 (Part I - Technical Proposal), will only be the cost of renting the magnetometers.

- "Will Dr. David Chapman be available for study? If not, who will replace him?"

  - Because of the timing of the proposal and because of prior commitments by Dr. Chapman, it was not the intent to suggest that Dr. Chapman would be available to actively participate in this study. However, Dr. Chapman has returned to the University of Utah as of Autumn Quarter and has reaffirmed his interest in working with the UGMS in an advisory role on the project. See the discussion under section 5.4 on page 29 of Part I - Technical Proposal. Dr. Chapman would like to become actively involved in follow-on state cooperative geothermal programs. His resume, along with others, is included only to give the reader a perspective of the geothermal expertise and facilities available at the University of Utah.

- "Will the proposer have right of access to the resource?"
  - We do not forsee any problems with gaining access to perform surface and subsurface investigations. See the discussion under "Task 6: Thermal Gradient Drilling" on page 12, Part I - Technical Proposal.
- "Provide financial statements"
  - A funding profile for FY 1983-84 and FY 1984-85 has been provided on page 12, Part II - Business Proposal.

PART II - BUSINESS PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 6 of 7

Date of Submission October 21, 1987

Name of Proposer Utah Geological and Mineral Survey (UGMS)

Address of Proposer 606 Black Hawk Way
Salt Lake City, Utah 84108-1280

Title of Proposal Geothermal Resource Assessment at Newcastle
Iron County, Utah

Location of Work Newcastle Area, Iron County, Utah

Proposed Total Project Cost $78,488 DOE Funding Requested $63,147

Proposed Start Date 11-01-87 Proposed Project Duration 13 mos.

Contact for Negotiations Archie D. Smith Phone (801)581-6831

Permission for Outside Evaluation Yes X No ___

Effective Period of Proposal 180 days

AUTHORIZED OFFICIAL: Signature [signature]

Name Genevieve Atwood

Title Director - UGMS

Date October 21, 1987

Type of Organization State Government Agency

TABLE OF CONTENTS - PART II

2.0 BUSINESS EVALUATION CRITERIA

The following section presents the overall proposed project costs. Itemized costs are broken out into the various listed categories. The unit costs of each task element are presented later under section 2.2.1 -- "Budget Summary by Key Tasks."

2.1 TOTAL PROJECT COSTS AND COST-SHARE SUMMARY

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	596/16.29	$ 0	$ 9,709	$ 9,709
M.A. Shubat	320/14.48	0	4,632	4,632
G.E. Christenson	120/19.97	2,396	0	2,396
A.D. Smith	96/22.53	2,162	0	2,162
Geotechnician	770/ 8.84	6,807	0	6,807
Indirect Costs (31.7%)		3,602	0	3,602
TOTAL LABOR		14,967	14,341	29,308
Equipment Rental		1,640	0	1,640
Supplies and Purchases		4,695	1,000	5,695
Testing and Analyses		3,988	0	3,988
Mileage		1,771	0	1,771
Per Diem and Subsistence		6,826	0	6,826
Subcontractor		29,260	0	29,260
TOTAL COSTS		$63,147	$15,341	$78,488

Cost-Share Contributions

U.S. Department of Energy...............80.5%
Utah Geological and Mineral Survey......19.5%

2.2 PROJECT FINANCIAL PLAN

2.2.1 Budget Summary by Key Tasks

The following section presents a task by task breakdown of proposed project costs. Houly rates and total costs are presented for both DOE and UGMS contributions.

TASK 1: LITERATURE REVIEW AND BACKGROUND DATA COMPILATION

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	40/16.29	$ 0	$ 652	$ 652
M.A. Shubat	40/14.48	0	579	579
A.D. Smith	8/22.53	180	0	180
Geotechnician	80/ 8.84	707	0	707
Indirect Costs (31.7%)		281	0	281
TOTAL LABOR		$1,168	$1,231	$2,399
TOTAL COST		$1,168	$1,231	$2,399

TASK 2: MAPPING SURFICIAL DEPOSITS AND QUATERNARY STRUCTURE

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	40/16.29	$ 0	$ 652	$ 652
G.E. Christenson	120/19.97	2,396	0	2,396
A.D. Smith	8/22.53	180	0	180
Geotechnician	40/8.84	354	0	354
Indirect Costs (31.7%)		929	0	929
TOTAL LABOR		3,859	652	4,511
Travel				
Mileage (estimated 850 mi. at $0.21/mi.)		179	0	179
Per Diem (estimated 10 man-days at $23/day for meals and $35/day for motel)		580	0	580
TOTAL COSTS		$4,618	$ 652	$5,270

TASK 3: BEDROCK GEOLOGIC MAPPING

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	80/16.29	0	$1,303	$1,303
M.A. Shubat	80/14.48	0	1,158	1,158
A.D. Smith	16/22.53	360	0	360
Geotechnician	40/ 8.84	354	0	354
Indirect Costs (31.7%)		226	0	226
TOTAL LABOR		$ 940	$2,461	$3,401
Travel				
Mileage (estimated 1,700 vehicle miles* at $0.21 per mile)		357	0	357
Per Diem (estimated 15 man-days in the field at $23 per day for meals and $35 per day for motel)		870	0	870
TOTAL COST		$2,167	$2,461	$4,628

TASK 4: GRAVITY AND MAGNETIC STUDIES

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	56/16.29	$ 0	$ 912	$ 912
C.M. Schlinger	no charge to this project task			
J.B. Hollis	no charge to this project task			
4-Univ. Utah students	no charge to this project task			
Indirect Cost (31.7%)		0	0	0
TOTAL LABOR		$ 0	$ 912	$ 912
Equipment Rental				
- prisms for EDM		100	0	100
- magnetometers (includes base station @ $44 per day, 2 roving units @ $48 per day, instrument set up fees @ $50 per magnetometer).		990	0	990
- Romberg & LaCoste gravimeters (supplied by Univ. of Utah at no cost to this task)				
Supplies and Purchases				
- batteries, stakes, notebooks, flagging, etc.		75	0	75
- Low-altitude & high-altitude aero-mag data from USX Corp.		0	1,000	1,000
Travel				
- mileage for UGMS 4WD vehicle @ $0.21 per mi for estimated 1,000 miles		210	0	210
- mileage for Univ. Utah 4WD carry-all van @ $0.50 per mi for estimated 1,000 miles		500	0	500
- subsistence for Univ. Utah personnel				
- motel (3 rooms for 2 @ $40 per day for 6 days)		720	0	720
- meals (for crew of 6 @ $23 per day for 6 days)		828	0	828
- Per Diem for UGMS person ($23 per day for meals and $35 per day for motel)		348	0	348
TOTAL COST		$3,771	$1,912	$5,683

TASK 5: GEOCHEMICAL STUDIES

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	80/16.29	$ 0	$1,303	$1,303
M.A. Shubat	80/14.48	0	1,158	1,158
Geotechnician	160/ 8.84	1,414	0	1,414
Indirect Cost (31.7%)		448	0	448
TOTAL LABOR		$1,862	$2,461	$4,323
Supplies				
- sample bottles, stakes, flagging, sieves, etc.		200	0	200
Testing and Analysis				
- mercury analyses (estimated 200 soil samples at $7.75 per sample, plus $2.75 preparation per sample)		2,100	0	2,100
- chemical analyses of water samples (estimated 25 samples at $63.50 per sample)		1,588	0	1,588
- analysis for hydrogen and oxygen isotopes (estimated 5 samples at $60 per sample		300	0	300
Travel				
- mileage (estimated 1,000 miles at $0.21 per mile)		210	0	210
- Per Diem (estimated 40 man-days at $23 per day for meals and $35 per day for motel)		2,320	0	2,320
TOTAL COST		$8,580	$2,461	$11,041

TASK 6: THERMAL GRADIENT DRILLING

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	60/16.29	$ 0	$ 977	$ 977
M.A. Shubat	40/14.48	0	579	579
Geotechnician	40/ 8.84	354	0	354
Indirect Cost (31.7%)		112	0	112
TOTAL LABOR		$ 466	$1,556	$2,022
Equipment Rental				
- Thermistor probes (rental from Univ. of Utah)		250	0	250
- Backhoe or bulldozer for site leveling and mud pits (estimated at $60 per hour for 5 hours)		300	0	300
Supplies				
- 2,100 ft of 1.5 or 2.0 inch pipe with threaded connectors estimated at $1.15 per foot		2,415	0	2,415
- cement and other miscellaneous expenses		1,600	0	1,600
- surface casing (60 ft of six-inch casing at $6.75 per foot		405	0	405
Travel				
- mileage (estimated 1,500 miles at $0.21 per mi)		315	0	315
- Per Diem (estimated 20 man days at $23 per day for meals and $35 per day for motel)		1,160	0	1,160
Subcontractor*				
- Drilling and hole completion		$29,260	0	$29,260
TOTAL COST		$36,171	$1,556	$37,727

* Total estimated drilling costs are based upon (1) mobilization charges at $2,000; (2) rig-time for setting surface casing, cementing, and setting temperature gradient and hydrologic monitoring pipes at $200 per hour for 15 hours; (3) standby time for waiting on cement and other unforseen problems at $160 per hour for 10 hours; (4) footage and mud charges estimated at $20 per foot for 1,000 feet; and (5) a contingency of 10 percent.

TASK 7: DATA EVALUATION

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	120/16.29	$ 0	$1,955	$1,955
M.A. Shubat	40/14.48	0	579	579
A.D. Smith	40/22.53	901	0	901
Geotechnician	330/ 8.84	2,917	0	2,917
Indirect Cost (31.7%)		1,210	0	1,210
TOTAL LABOR		$5,028	$2,534	$7,562
TOTAL COST		$5,028	$2,534	$7,562

TASK 8: FINAL REPORT PREPARATION

Labor	Hours/ Rate	DOE Funded	UGMS Funded	Total
R.E. Blackett	120/16.29	$ 0	$1,955	$1,955
M.A. Shubat	40/14.48	0	579	579
A.D. Smith	24/22.53	541	0	541
Geotechnician	80/ 8.84	707	0	707
Indirect Cost (31.7%)		396	0	396
TOTAL LABOR		$1,644	$2,534	$4,178
TOTAL COST		$1,644	$2,534	$4,178

2.2.2 UGMS FUNDING PROFILE

Being a state-operating entity, the UGMS does not prepare an annual financial statement. In place of this proposal requirement, excerpts from the Utah Department of Natural Resources annual reports (FY 1983-1984 and FY 1985-1986) are presented here.

FY 1983-1984

REVENUE		EXPENDITURES	
General Fund	$ 407,315	Administration	$ 298,598
Mineral Lease	789,845	Information	414,516
Federal Contracts	368,873	Economic	630,522
Collections	31,910	Applied	290,611
Transfers from other Agencies	160,937	Mapping	324,784
TOTALS	$1,758,880		$1,959,031
		Net Revenue Shortfall	$ 200,150

FY 1985-1986

REVENUE		EXPENDITURES	
General Fund	$ 584,597	Administration	$ 336,233
Mineral Lease	1,117,000	Support	456,943
Federal Contracts	377,767	Economic	619,700
Collections	36,352	Applied	455,844
Transfers from other Agencies	115,000	Mapping	354,679
Pass Through	126,454	Pass Through	133,130
TOTALS	$2,357,170		$2,356,529
		Excess of Revenue	$ 641

3.0 OTHER REQUIRED FORMS

DOE F 1600.5
(5-85)

OMB NO. 1900-0400

U.S. Department of Energy

Assurance of Compliance

Nondiscrimination in Federally Assisted Programs

Utah Geological and Mineral Survey (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or handicap, in its employment practices. Such employment practices may include, but are not limited to, recruitment, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs; or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to,the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age and handicap; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English, (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecesarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age and handicap, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such data of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and the the United States shall have the right to seek judicial enforcement of this assurance. This assurance in binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

10-20-87
(Date)

Utah Geological and Mineral Survey
(Name of Applicant)

606 Black Hawk Way
Salt Lake City, Utah 84108
(Address)

[signature]
(Authorized Official) Genevieve Atwood

( ) 801/581-6831
(Applicant's Telephone Number)

OMB Approval No. 29-R0218

FEDERAL ASSISTANCE

2. APPLICANT'S APPLICATION — a. NUMBER: ; b. DATE: 19 Year month day

3. STATE APPLICATION IDENTIFIER — a. NUMBER: UT870616-010; b. DATE ASSIGNED: 19 Year month day

Leave Blank

1. TYPE OF ACTION (Mark appropriate box)
- ☐ PREAPPLICATION
- ☒ APPLICATION
- ☐ NOTIFICATION OF INTENT (Opt.)
- ☐ REPORT OF FEDERAL ACTION

4. LEGAL APPLICANT/RECIPIENT

a. Applicant Name	:Dept. Natural Resources - Utah
b. Organization Unit	:Utah Geological and Mineral Survey
c. Street/P.O. Box	:606 Black Hawk Way
d. City	:Salt Lake City
e. County	: Salt Lake
f. State	:Utah
g. ZIP Code:	84108
h. Contact Person (Name & telephone No.)	Genevieve Atwood :801/581-6831

5. FEDERAL EMPLOYER IDENTIFICATION NO. 87-6000545W

6. PROGRAM (From Federal Catalog) — a. NUMBER: ; b. TITLE:

7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT

Geothermal Resources Assessment at Newcastle, Iron County, Utah

8. TYPE OF APPLICANT/RECIPIENT
A-State; B-Interstate; C-Substate District; D-County; E-City; F-School District; G-Special Purpose District; H-Community Action Agency; I-Higher Educational Institution; J-Indian Tribe; K-Other (Specify):
Enter appropriate letter ☐

9. TYPE OF ASSISTANCE
A-Basic Grant; B-Supplemental Grant; C-Loan; D-Insurance; E-Other
Enter appropriate letter(s) ☐☐

10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.)

11. ESTIMATED NUMBER OF PERSONS BENEFITING

12. TYPE OF APPLICATION
A-New; B-Renewal; C-Revision; D-Continuation; E-Augmentation
Enter appropriate letter ☐

13. PROPOSED FUNDING

a. FEDERAL	$ 63,147 .00
b. APPLICANT	.00
c. STATE	15,341 .00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ 78,488 .00

14. CONGRESSIONAL DISTRICTS OF: a. APPLICANT: #2; b. PROJECT: #1

15. TYPE OF CHANGE (For 12c or 12e)
A-Increase Dollars; B-Decrease Dollars; C-Increase Duration; D-Decrease Duration; E-Cancellation; F-Other (Specify):
Enter appropriate letter(s) ☐☐☐

16. PROJECT START DATE Year month day: 19 87-11-1

17. PROJECT DURATION: 13 Months

18. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY Year month day: 19 88-12-1

19. EXISTING FEDERAL IDENTIFICATION NUMBER

20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code)
U.S. Department of Energy, 785 DOE Place, Idaho Falls, Idaho

21. REMARKS ADDED ☐ Yes ☒ No

SECTION I—APPLICANT/RECIPIENT DATA

22. THE APPLICANT CERTIFIES THAT ▶

a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached: No response / Response attached
(1) ☐ ☐
(2) ☐ ☐
(3) ☐ ☐

23. CERTIFYING REPRESENTATIVE — a. TYPED NAME AND TITLE: Genevieve Atwood, Director; b. SIGNATURE: [signature]; c. DATE SIGNED Year month day: 19 87-10-20

SECTION II—CERTIFICATION

24. AGENCY NAME

25. APPLICATION RECEIVED 19 Year month day

26. ORGANIZATIONAL UNIT

27. ADMINISTRATIVE OFFICE

28. FEDERAL APPLICATION IDENTIFICATION

29. ADDRESS

30. FEDERAL GRANT IDENTIFICATION

31. ACTION TAKEN
- ☐ a. AWARDED
- ☐ b. REJECTED
- ☐ c. RETURNED FOR AMENDMENT
- ☐ d. DEFERRED
- ☐ e. WITHDRAWN

32. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

33. ACTION DATE ▶ 19 Year month day

34. STARTING DATE 19 Year month day

35. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

36. ENDING DATE 19 Year month day

37. REMARKS ADDED ☐ Yes ☐ No

38. FEDERAL AGENCY A-95 ACTION

a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.

b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)

SECTION III—FEDERAL AGENCY ACTION

424-101

STANDARD FORM 424 PAGE 1 (10-75)
Prescribed by GSA, Federal Management Circular 74-7

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

FORM EIA 459C (10 80)

FORM APPROVED OMB No 1900 0127

1 Program Project Identification No: DE-PR07-87ID12662	2 Program Project Title: Geothermal Resource Assessment at Newcastle, Utah
3 Name and Address: Utah Geological and Mineral Survey 606 Black Hawk Way, Salt Lake City, Utah 84108	4 Program Project Start Date: 11-1-87 5 Completion Date: 12-1-88

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non Federal (f)	New or Revised Budget: Total (g)
1		$ 63,147	$ 15,341	$	$	$ 78,488
2						
3						
4						
5 TOTALS		$	$	$	$	$

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity (1)	(2)	(3)	(4)	Total (5)
a Personnel	$ 21,325	$	$	$	$ 21,325
b Fringe Benefits	4,381				4,381
c Travel	8,597				8,597
d Equipment	1,640				1,640
e Supplies	5,695				5,695
f Contractual	29,260				29,260
g Construction					
h Other	3,988				3,988
i Total Direct Charges	74,886				74,886
j Indirect Charges	3,602				3,602
k TOTALS	$ 78,488	$	$	$	$ 78,488
7 Program Income	$ -0-	$	$	$	$ -0-

PART I - TECHNICAL PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 6 of 7

Date of Submission October 21, 1987

Name of Proposer Utah Geological and Mineral Survey (UGMS)

Address of Proposer 606 Black Hawk Way
Salt Lake City, Utah 84108-1280

Title of Proposal Geothermal Resource Assessment at Newcastle Iron County, Utah

Type of Research Resource Assessment

Location of Work Newcastle Area, Iron County, Utah

Proposed Start Date November 1, 1987 Proposed Duration 13 mos.

Proposed Project Manager Robert E. Blackett Phone (801)581-6831

Permission for Outside Evaluation Yes X No ___

AUTHORIZED OFFICIAL: Signature [signature]

Name Genevieve Atwood

Title Director - UGMS

Date October 21, 1987

1.0 ABSTRACT

Undiscovered hydrothermal systems represent a significant portion of the total hydrothermal accessible resource base in the United States, estimated to be between 3 and 5 times that of identified hydrothermal systems. Many of these undiscovered systems are so-called "blind" systems where no surface expression of hydrothermal activity, such as thermal springs, sinter mounds, alteration minerals, etc., exists. The proposed work effort here will investigate the nature of one such blind system located in southwestern Utah, discovered by accident, near the community of Newcastle.

This study will help establish a basis for developing an exploration methodology for investigation of other blind hydrothermal systems in the Basin and Range Province by providing a better picture of the geologic controls to fluid movement. In addition, the study will help to define the extent of thermal resources available at Newcastle. Three commercial greenhouse operations, employing a work force of 40 people, currently exploit the Newcastle system. The success of recent drilling by greenhouse owners and the history of production from existing wells, suggest that the thermal resources at Newcastle are larger than previously estimated.

Proposed here, is a multidisciplinary study of the Newcastle geothermal area, situated in Iron County, Utah, the broad objective being to construct a refined, conceptual geologic model. A major component to the determination of a correct geologic/geo-hydrologic model will be to define the geometry of the controlling geologic structures, and the stratigraphy and configuration of enclosing basin fill deposits. The studies will consist of several coordinated activities including: (1) mapping of Quaternary structure and stratigraphy; (2) geologic mapping of bedrock in adjacent hills; (3) acquisition and analysis of detailed gravity, aero-magnetic, and ground magnetic data; (4) a geochemical study including investigations of soil mercury concentrations, and water analyses; and (5) thermal gradient and hydrologic monitoring within a shallow, exploratory drill hole.

The combined studies will be used to refine an earlier proposed geohydrologic model. Follow-on investigations will, hopefully, result in the creation of definitive regional guides for the detection of undiscovered hydrothermal systems.

2.0 TABLE OF CONTENTS - PART I
TECHNICAL PROPOSAL

3.0 STATEMENT OF WORK

3.1 Background and Regional Setting

The geothermal resources of Utah are primarily hydrothermal systems occurring within the Basin and Range province where a favorable geologic setting is present. Extensional tectonism, active over the past 21 million years, has produced numerous high-angle normal faults, low-angle detachment faults, and widespread volcanic rocks. Brook (and others, 1979) estimated the thermal content of high-temperature (>150°C) hydrothermal systems in Utah to be approximately 48 x 10^{18} Joules (1 Quad = 10^{18} Joules), and intermediate or moderate-temperature (90-150°C) hydrothermal systems to contain approximately 8 x 10^{18} Joules. Mariner and others (1983) estimated the energy content of low-temperature systems in Utah at about 19 x 10^{18} Joules. Combined, the total identified hydrothermal "accessible resource base" in Utah is approximately 75 Quads of thermal energy. If one applies the criteria presented by Muffler (1979) and assumes that the energy in undiscovered hydrothermal systems probably accounts for 3 to 5 times that in identified systems, the total accessible hydrothermal resource base in Utah may be as much as 200 to 400 Quads of thermal energy. Considering that total annual U.S. energy consumption is about 70 Quads, Utah's hydrothermal resources appear to be very significant.

The Newcastle KGRA, in a recent summary of the geothermal resources of Utah (Mabey and Budding, 1987), was identified as being a virtually unexplored, moderate- to high-temperature resource with a potentially sufficient volume to justify development. A review of the literature also points out that the Newcastle KGRA is the least studied of Utah's systems. This general lack of knowledge of the Newcastle hydrothermal system is likely the result of the relatively recent discovery of the system and the "blind" nature of the resource. No surface expressions of geothermal activity, such as hot springs or sinter deposits, occur in the area.

Thermal water was discovered in the Newcastle area in 1975 during test pumping of an irrigation well owned by the Christensen Brothers of Newcastle (Rush, 1983). The discovery well encountered a hot-water aquifer with a maximum temperature of 107.8°C between depths of 85 to 95 meters. Denton (1976) conducted a helium-gas survey across the area and detected a broad helium anomaly around the discovery well and along the nearby range-front fault. Denton reported a maximum value of 170 ppb above atmosphere at a sample site approximately 300 m (650 ft) east of the discovery well. Galyardt (1977) performed reconnaissance mapping of the Newcastle KGRA. Brook and others (1979) calculated a reservoir temperature of 130°C (266°F) and estimated the volume, depth, and energy content of the Newcastle system. Pe and Cook (1980) conducted a gravity survey in the region and defined a large, northeast-trending gravity low centered northwest of the town of Newcastle, which they interpreted as representing a deep graben. Clement and Chapman (1981), using data supplied by Rush (1983), calculated the thermal power loss from an area of 9.4 km^2 as 13 megawatts, assuming a water temperature of 110°C (230°F) and a discharge rate of 32 l/s. They also calculated the energy content of a reservoir extending from 75 m (246 ft) to 2 km (6,560 ft with an area of 1.2 km^2 (0.5 mi^2). Rush (1983) estimated a reservoir temperature of 140°C to 170°C (284°F to 338°F) for the Newcastle system. Rush also published a chemical analysis of the Newcastle Thermal water, temperature profile of the Christensen Brother's well, potentiometric map to the KGRA, temperature map at a depth of 100 m (328 ft), and a heat flow map of the principal hot water aquifer. Hoover (1987) reported the results of eight audio-magnetotelluric soundings in the Newcastle area. The lowest resistivity values were measured at a station east of the Christensen Brother's well and near the range-front fault. Mabey and Budding (1987) compiled available data on the Newcastle system and presented a geothermal model. In their model, Mabey and Budding suggest that hot water rising along a fault zone near the base of the hills southeast of Newcastle discharges into an aquifer in unconsolidated Quaternary sediments. Shubat and Siders (1987) mapped the adjacent Silver Peak quadrangle and suggested that Quaternary offset has occurred along the range-front fault separating the Escalante Valley from the Antelope Range and that the fault extends into the Newcastle KGRA.

3.2 Proposed Research Area, Objectives, and Benefits

Resource Assessment is the area of proposed research.

The program plan proposed here will coordinate several separate investigations that, combined, will help generate a conceptual geologic model of the Newcastle geothermal system. Emphasis will be placed upon identifying structural and stratigraphic controls to thermal fluid movement.

This research is expected to aid in the understanding of Basin and Range hydrothermal resources, and will likely assist in development of exploration methodologies for blind geothermal systems. By developing a better approach to assessing the likelihood of occurrence of undiscovered or "buried" geothermal systems, prospectively valuable regions can be more accurately assessed with respect to resource potential. This could enable government agencies to make better informed decisions concerning indigenous geothermal resources, and provide industry and individual developers with a useful means of evaluation.

3.3 Project Location and Significance of the System

The location of the proposed project is in Iron County, Utah near the southeastern edge of a physiographic region known as the Escalante Desert. The small community of Newcastle, Utah lies within the project area (figure 1).

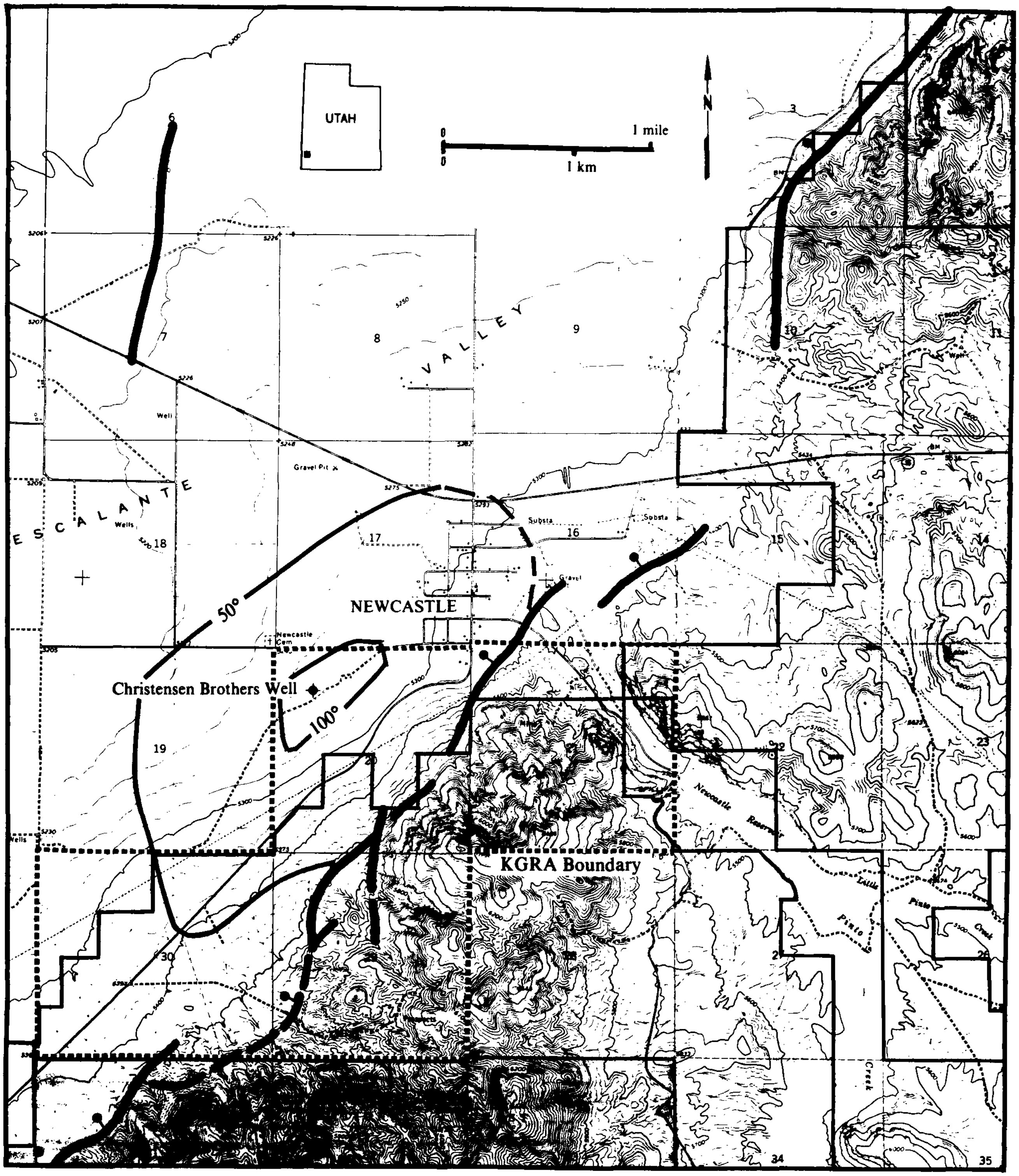

Figure 1. Map of proposed study area showing outline of Newcastle KGRA, scarps marking range-front (heavy lines), and contours of temperature (50° and 100° C) at 100 m depth (from Rush, 1983).

NATIONAL FOREST

BUREAU OF LAND MANAGEMENT

STATE OF UTAH

PRIVATE

The Escalante Desert is an elliptical depression extending over an area measuring approximately 44 x 28 mi (70 x 45 km) and is surrounded by mountain ranges and hills composed dominantly of Tertiary ash-flow tuffs erupted between 32 and 19 million years ago, and younger (13 to 8.5 m.y. old) rhyolite and dacite domes.

The significance of the Newcastle hydrothermal system and the performing of detailed site investigations there lies within the nature of the system itself. Because the Newcastle system was discovered by accident a relatively short time ago (1975), investigations to date have been primarily regional reconnaissance studies, although Chapman and others (1981), as part of a regional study of the Escalante Desert, performed detailed heat flow investigations in the Newcastle area. The investigations proposed here would provide a more detailed view, and reveal further insights into one of the few "blind" hydrothermal systems discovered in the Basin and Range.

3.4 Project Task Summary -- Rationale and Objectives

Literature Search and Background Data Compilation

A compilation of relevant literature and other data including records from existing oil and gas and water wells will be an essential first step in the proposed study. Background data will be used to aid in the designing of the individual field tasks, and in the final evaluation of the project. The compilation will include data on geology, geochemistry, geophysics, and hydrology of the study area. An effort will also be made to obtain proprietary data from geothermal companies who have done exploration at Newcastle.

Mapping Surficial Deposits and Quaternary Structures

Controls on the subsurface discharge of thermal fluids at Newcastle are both stratigraphic and structural. Because sediments in the discharge zone and associated faults are Pleistocene to Holocene in age, documenting the neotectonic history of the area is vital to understanding the geothermal system. Mapping surficial deposits, locating and profiling fault scarps, and geomorphic studies can shed light on the structural history of the area and its effect on the depositional system.

Geologic Mapping of Bedrock

The distribution of faults and fractures in bedrock flanking the Newcastle area is important in two regards. First, bedrock faults may serve as fluid conduits in the recharge zone of the hydrologic system. Second, bedrock faults in the footwall of the range-front fault, possibly reactivated during uplift of the range, may provide enhanced permeability where thermal fluids discharge in the subsurface. These considerations suggest that bedrock geologic mapping can provide valuable insights regarding the geohydrologic setting of the Newcastle system. Preliminary geologic mapping revealed the presence of many bedrock faults in the area including a major northwest striking fault that intersects the range-front near Newcastle. The relatively thin and distinctive ash-flow tuffs present in the bedrock allow for the identification (by stratigraphic separation) of most faults with offsets greater than 30 m (100 ft). Bedrock geologic mapping will be integrated with Quaternary fault mapping in an effort to determine if the Newcastle system lies near a segment boundary of the modern range-front fault.

Detailed Gravity and Magnetic Studies

Regional gravity studies performed by Pe and Cook (1980) defined a northeast-trending gravity low in the southern Escalante Desert that they interpreted as a deep, concealed graben. The southeastern margin of the graben coincides with the range-front fault at Newcastle, and the northwestern margin may coincide with a east-facing scarp located in the Escalante Desert.

Published aero-magnetic data (Zeitz and others, 1976) exists only on a regional scale and does not permit a detailed interpretation in the Newcastle area. Many of the bedrock units mapped in the adjacent mountains are Tertiary ash flows; some bearing distinct magnetic signatures. One example is the Swett tuff of the Condor Canyon Formation, which reportedly has reverse polarity (Proctor, P., 1987, personal communication). It can be expected that these volcanic rock units underlie portions of the Escalante Desert and thereby would be recognizable in a detailed magnetic study.

Building on these data, the objective of the detailed gravity and magnetic studies will be to determine more accurately, the distribution of consolidated versus unconsolidated lithologies, thus helping to map the deeper structures in the Newcastle area.

Geochemical Studies

Soil-Mercury investigations

A soil mercury geochemical study will be performed as part of this project to assist in identifying the location of the fault or fracture system that may be controlling the movement of fluid. A discussion of soil-mercury surveys follows.

Evidence of a linkage between mercury occurrences and hot spring activity has been well documented. Areas of economic mercury occurrences, although not usually located near present day hot springs, exhibit evidence of past geothermal activity. Areas of present geothermal activity that have been mined for mercury in the past include Ngawha, New Zealand; Skaggs Springs, Sulfur Bank, Wilbur Springs and Coso Hot Springs, California; and Steamboat Springs, Nevada. In addition, mercury minerals (cinnabar and metacinnabar) have been noted to be depositing in some hot springs such as at Sulfur Bank and Amedee Springs, California; Steamboat Springs, Nevada; and Boiling Springs, Idaho (Weissberg et al., 1979, p. 757).

During the process of hydrothermal alteration of sulfides and other minerals containing Hg in trace amounts, Hg is released in the 2+ valence state. Hg^{+2} can then be reduced by Fe^{+2} or by organic material to Hg^{+} or Hg^{o}. The result is a net production of Hg^{o} (Klusman and Landress, 1978). The high vapor pressure of Hg^{o} makes it an extremely mobile, volatile component in a gas-water system. Elevated temperatures encountered in and near a geothermal system serve to increase this mobility resulting in the exolution and migration of Hg upward and away from a geothermal reservoir. The overall result is that soils in geothermal areas tend to become Hg-enriched by trapping vapor phase Hg onto clay surfaces and within organic materials.

To test the application of soil-Hg geochemistry to geothermal exploration, Matlick and Buseck (1975) performed soil-Hg studies in four geothermal areas in the western U.S. Areas studied included two high-temperature systems -- Long Valley and East Mesa, California -- and two moderate-temperature systems -- Klamath Falls and Summer Lake, Oregon. All areas except the East Mesa system showed continuous Hg anomalies. At East Mesa, the depth to the geothermal system and the thickness of overlying fine-grained Colorado River deltaic sediments probably contributed to the absence of continuous soil-Hg anomalies. As anticipated, the well-defined Klamath Falls and Long Valley geothermal areas showed the presence of continuous soil-Hg anomalies spatially coincident with thermal and geophysical anomalies. At the little-explored and lower temperature Summer Lake geothermal area, soil-Hg anomalies enclosed all thermal springs and wells, located mineralization over the Brattain Mining district, and identified a previously undiscovered thermal area.

Summer Lake is a large, shallow lake in the Basin and Range province where geothermal activity is limited to a few thermal springs and wells. The highest surface temperature is 51°C (124°F) at Summer Lake Hot Springs. The highest recorded subsurface temperature is 111°C (232°F) at a depth of 228 m (748 ft). All of the thermal springs and wells are situated near Basin and Range normal faults. The soil-Hg survey sampled approximately 360 sites within the Summer Lake basin and delineated six Hg anomalies. Five of the anomalies were determined to relate to geothermal activity, <u>one of which had no surface indication of geothermal activity</u>. The sixth anomaly was attributed to hydrothermal mineralization.

Another example of a successful use of soil-Hg surveys in a moderate-temperature geothermal system was at Wendel-Amedee Hot Springs, California where as part of a geothermal case study, Hg analyses of soils were used to help in determining the location of faults transmitting thermal fluids (Zeisloft, et al., 1984). Measured subsurface temperatures at Wendel-Amedee Hot Springs are between 120 and 130°C (248 and 266°F), similar to projected equilibration temperatures at Newcastle.

Soil-Hg geochemical studies were also shown to be useful by Capuano and Bamford (1978) for locating major structures and for siting geothermal wells at Roosevelt Hot Springs, Utah.

Soil-Hg studies in the Newcastle geothermal area could prove useful in delimiting the geothermal system and locating structures associated with the range front fault. Similar surveys performed in other moderate-temperature geothermal areas such as at Summer Lake, Oregon and Wendel-Amedee Hot Springs, California have proven useful for locating geothermal anomalies and helping to better evaluate the geothermal resources in those areas.

Analysis of Fluid Samples

Chemical analysis of water samples from wells is important for deriving equilibration temperatures using chemical geothermometry and for inferring ground water movement. Thermal water ascending toward the surface from a geothermal reservoir, may cool due to a variety of mechanisms including conduction to surrounding rock formations, mixing with cool shallow ground water, boiling, or a combination of these conditions. When considering chemical analyes of thermal fluid, it is important to use other geologic and geophysical data in the construction of a hydrothermal model for a system. At Newcastle, analysis of thermal water from newly drilled wells will be an important part of the overall study and the development of a system model.

Oxygen and hydrogen isotopic analyses of thermal and non-thermal water from the Newcastle area will be used to determine the recharge area for the hydrothermal system and to estimate the residence time of the fluid in the geothermal reservoir. Isotopic analyses of Newcastle waters will also be used to estimate the degree of mixing between thermal waters and cool ground water.

Thermal Gradient Drilling

Also proposed is the drilling and completion of one intermediate depth, temperature-gradient drill hole. The test hole will be sited somewhere between the Christensen Brothers, well and the adjacent range-front to the southeast, and drilled to a depth of about 1,000 ft (305 m). The objective will be to gather temperature and lithologic information from zones deeper than those penetrated by previous wells, collect samples for thermal conductivity measurements, and provide a means for hydrologic monitoring of thermal fluids over time.

3.5 Project Schedule

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N   D    J    F    M    A    M    J    J    A    S    O    N   D
----------------------------------------------------------------
1:-| Literature and Background Data Review
2:  |-------| Quaternary Mapping
3:  |-------| Bedrock Mapping
4: |-------------------| Gravity and Magnetic Studies
5:                 |---------| Geochemistry
6:                           |----| Thermal Gradient Drilling
7:                           |---------| Data Evaluation
8:                           Reporting |----*****************----|
----------------------------------------------------------------
N   D    J    F    M    A    M    J    J    A    S    O    N   D
    1987 | 1988
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*********** DOE Commment Period

3.6 Deliverables

Monthly activity summaries, quarterly progress reports, and draft and final reports will be submitted to the DOE, Idaho Operations Office, contracts manager in compliance with DOE guidelines. The draft final report will be submitted for review and comment 90 days prior to the final report.

4.0 DISCUSSION OF STATEMENT OF WORK

4.1 Benefits to Geothermal Development

This proposed effort is designed to promote industrial geothermal development within the Basin and Range of Utah, in addition to benefiting certain DOE-sponsored geothermal R & D initiatives. It is anticipated that the results of the work proposed -- plus follow-on studies -- will be of significant value to geothermal operators in the context of exploration for "blind" or concealed hydrothermal systems. The proposed effort is also expected to add considerably to the body of basic data regarding geothermal systems. The eventual development of a methodology to locate these types of systems could result in (1) the identification of previously undiscovered hydrothermal systems, thereby increasing the identified "accessible" hydrothermal resource base, and (2) advancement in the state-of the-art of technology to exploit hydrothermal systems.

4.2 Project Overview

The project plan has been designed to better determine the resource potential at Newcastle by creating a better understanding of the system and to assist in the development of an exploration methodology for blind hydrothermal systems. The general approach will be to identify all available regional and area-specific information and design a correct area investigation program to more fully understand the system. This plan will thereby create an opportunity to assess the geothermal resource potential and to refine the conceptual geologic model.

As previously presented, the overall goals of geothermal studies in Utah are to provide government and industry with a basis for eventually realizing the full resource potential within the state. Presently, the economic climate will not permit industry to pursue the higher-risk activities that are typical of exploration programs. Moreover, the methods used to explore for new sources of geothermal energy are still evolving and will require continued research and refinement.

To address the goals, the proposed project will serve to (1) increase the body of knowledge of hydrothermal systems in the Basin and Range by focusing on Newcastle, and (2) provide parameters that will be needed to develop and exploration methodology for undiscovered Basin and Range hydrothermal systems. Follow-on studies should continue to build upon these objectives, and eventually incorporate the acquisition of hydrologic data as well as additional heat flow and other geophysical data. Ultimately, these combined efforts could result in the development of a refined regional understanding of Basin and Range hydrothermal systems in Utah and how these systems are controlled by geology, hydrology, and regional heat flow.

4.3 Project Task Descriptions -- Approach

Task 1: Literature Search and Background Data Compilation

A comprehensive examination and compilation of all available background data will be performed. Data that are anticipated to be of primary value are lithologic and hydrologic records from water wells, oil and gas wells, and shallow temperature gradient holes. These data will be derived from records on file with the State Division of Water Rights, the Division of Oil & Gas and Mining, and from published sources. An effort will also be made to acquire data from companies that have performed geothermal exploration near Newcastle in the past. Task 1 will be performed prior to all other activities to ensure that all existing public data are available for use in the remaining tasks.

Task 2: Mapping of Surficial Deposits and Quaternary Structure

Investigations of Quaternary deposits in the study area are of prime importance to determining possible stratigraphic and structural controls to the hydrothermal system. Quaternary fault scarps and surficial deposits will be mapped by a combination of air-photo interpretation and field studies. Geomorphic studies, includign scarp profiling and stream terrace profiling (if possible) will be used to document the Late Quaternary tectonic history. This activity will optimally be performed early-on in the investigations (late fall). Depending upon weather conditions and the scheduling of other UGMS activities, however, the activity may necessarily be postponed until early spring (1988). It is intended that the work-effort proposed here will utilize the UGMS staff experience gained through the ongoing geological quadrangle mapping programs.

Task 3: Geologic Mapping of Bedrock Units

The UGMS is preparing a number of 7.5 minute geologic quadrangle maps of Utah. The Newcastle area is located within one of the quadrangles recently mapped as a joint U.S. Geological Survey - UGMS project. As a result of this, much geologic data is presently available and will be used in the third proposed task. It is anticipated that only a small amount of additional field work will be required to verify structural relationships in complex fault intersection zones. Additional fault slip-vector data will be collected to supplement the existing database and will be used in a structural analysis of the area. Again, this work will ideally be performed early-on in the investigation, but may need to be re-scheduled to the Spring of 1988.

Task 4: Detailed Gravity and Magnetic Studies

Ground based gravity and magnetic studies will be performed in an effort to supplement (1) existing regional gravity data, which is considered to be inadequate for the purposes of this study, and (2) existing low-altitude aeromagnetic data, which will be purchased from a private source. The field portion of the task is primarily for the purpose gathering detailed gravity data. Since individual ground stations must be occupied and tied to a coordinate system, ground magnetic readings will also be taken to support the to-be-acquired aero-magnetic data (see discussion below).

Low-altitude aero-magnetic data covering the study area will be purchased at a nominal cost from a private source, thereby negating the need for new low-altitude aero-magnetic coverage. The raw data, by agreement with USX Corporation, the supplier, cannot be released to the public. However, interpretations in a reduced format such as in detailed contour maps or models, by agreement, can be disclosed to the public. The aero-magnetic coverage consists fo both high- and low-altitude surveys at 0.25 mi (0.4 km) flight line spacings and covers approximately 250 mi^2 (650 km^2) of the southern Escalante Desert and adjoining mountain ranges.

The field crew, for ground-based geophysical studies, will be comprised of a total of seven people directed by Dr. Charles M. Schlinger and Mr. James B. Hollis of the Department of Geology and Geophysics, University of Utah. The remainder of the crew will include four University of Utah students and a geologist from the UGMS. The resumes of Dr. Schlinger and Mr. Hollis are included in section 5.4 -- Available Facilities and Personnel of the Department of Geology and Geophysics, University of Utah.

The field portion of the task will be carried out in early to mid November and will require 5 to 6 days for completion. Within a project area of about 25 square miles, gravity stations will be located on 0.5 mile to 1.0 mile grid spacings while ground magnetic readings will be taken on 0.25 mile to 0.5 mile spacings. Station locations will be established absolutely using a Pentax electronic theodolite/EDM (electronic distance meter), and tied to established bench marks, section corners, and spot elevations. Geophysical instruments will include two La Coste & Romberg model G gravimeters and three Scintrex total field magnetometers (one base station and two roving units). Gravity observations will be tied to the regional base station in Cedar City (or Enterprise), Utah. A Compac-286 portable computer will be used in the field for part of the data reduction. Dr. Schlinger and his students will be responsible for compiling and reducing all of the data with the exception of terrain corrections, which will be the responsibility of the UGMS using the assistance of Mr. Hollis.

Task 5: Soil-Mercury Investigations and Water Analyses

A soil-Hg geochemical survey is proposed across the area of the Newcastle thermal anomaly to try to better outline the zone of "upwelling" of hydrothermal fluid. As discussed previously, soil-mercury surveys can be extremely useful for locating and outlining subsurface hydrothermal activity, including moderate-temperature systems such as at Newcastle. We propose to collect approximately 200 soil samples from a sample grid across the area of suspected thermal activity, and analyze the samples for mercury using gold film detection methods. The positioning and spacing of the sample grid will be determined largely upon the results of surface mapping and geophysical studies, but will likely be on the order of 1,000 ft x 1,000 ft and cover about eight square miles.

Several new wells, drilled for irrigation and for direct-application geothermal, have recently (over the past few years) been completed in and around Newcastle. Because of this, we propose to collect water samples from available wells for analyses. Multiple samples (2 to 4) will be collected from each water well and analyzed for total dissolved solids (TDS), SO_4, Cl, F, pH, and alkalinity. It is anticipated that no more than 25 wells will be sampled. The analytical work will likely be performed by the Earth Science Laboratory / University of Utah Research Institute in Salt Lake City. The analyses will be used to prepare tri-linear plots to study the grouping of samples from various wells, and to apply geothermometry for better determining reservoir equilibration temperature.

Also proposed is the sampling of wells for the determination of oxygen and hydrogen isotopic composition. We anticipate that no more than five water samples will be collected for the determination of $^{16}O/^{18}O$ and H/D ratios, and that the analytical work will be carried out at the laboratory facilities of Mr. James Borthwick at Southern Methodist University.

Task 6: Thermal Gradient Drilling

One temperature gradient test hole is proposed to be drilled near Newcastle, somewhere between the Christensen Brothers' discovery well and the range-front fault to the southeast. The test hole will be sited based upon the results of the previous tasks, but will preferably be located on Federal land near the range front.

The Bureau of Land Management (BLM) State Office in Salt Lake City and District Office in Cedar City both report that no Federal geothermal leases are in effect within the Newcastle KGRA. Union Geothermal, a subsidiary of UNOCAL, obtained a geothermal Federal lease at Newcastle in 1977, performed a limited amount of exploration, and relinquished their lease in 1983. In this case, with regard to Federal land within the KGRA, the BLM will issue a permit to drill an exploratory hole after the UGMS files a "notice of intent," or NOI with the District Office. The BLM then performs a quick evaluation of potential environmental conflicts that could be caused by the proposed operations and either issues a permit to drill or rejects the application. BLM officials in the State and District offices have indicated that there would be little or no problem in approving an NOI at Newcastle. A permit is normally issued by the BLM within about one month of receipt of the NOI.

A permit to drill a geothermal test hole is also required by the Utah Division of Water Rights (DWR), the regulatory agency for geothermal resources in the state. Similarly, the DWR can normally issue a permit for geothermal exploratory drilling within about one month of receipt of an application.

If it becomes necessary to drill on privately owned land, then arrangements will need to be made with the land owner to do so. In this case, a drilling permit will still be required by the Utah DWR. Again, it is anticipated that the test hole will be located on Federal land.

Tasks 7 and 8: Data Compilation, Reporting

Following field studies and analyses, will be a period for compiling and evaluating all acquired data sets. During this period, information will be collated, interpreted and formatted for presentation in a final report. A draft final report will then be submitted to the DOE Idaho Operations Office for a required 90 day comment period. After the comment period, changes will be incorporated into the report and the report will be finalized.

5.0 QUALIFICATIONS AND CAPABILITIES

5.1 Functions and Responsibilities of Key UGMS Personnel

Key personnel for the project have been selected from the UGMS staff based upon their respective skills and experience. A listing of key personnel and their respective responsibilities is described below, followed by resumes.

Robert E. Blackett - Project Manager / Geologist

- Provides overall responsibility for management and technical decisions
- Performs technical work on all project tasks
- Assures implementation of activities for the overall statement of work
- Monitors the progress of the project and approves reports to DOE
- Interacts with other project personnel on all tasks
- Provides main direction for thermal gradient drilling, geochemical sampling, and preparation of final report

Michael A. Shubat - Mining District Geologist

- Performs technical work on nearly all project tasks
- Primary responsibilities include field geologic mapping, structural analysis, assisting with implementation of geophysical studies, designing geochemical sampling programs, and assisting with drilling and data evaluation
- Reviews the results of each project activity for completeness
- Provides technical guidance to other project personnel and assures level of quality

Gary E. Christenson - Engineering Geologist

- Responsible for implementing and directing geologic mapping and determination of Quaternary structure and stratigraphy
- Assists the Project Manager with preparation of final report

Archie D. Smith - Senior Geologist

- Serves as project reviewer and provides the Project Manager with recommendations on all aspects of the work plan

5.2 <u>Resumes of Key Personnel</u>

RESUME

NAME: ROBERT E. BLACKETT
TITLE: Geologist III - Energy Section

EDUCATION:

1971	B.S. Geology, Weber State College
1979	M.S. Geological Engineering, University of Utah

EMPLOYMENT HISTORY:

Present	Geologist, Utah Geological and Mineral Survey
1984-1987	Technical Analyst, Meridian Corporation, Washington, D.C.
1983-1984	Associate Geologist, Norwest Resource Consultants, Inc.
1980-1983	Geologist, University of Utah Research Institute
1978-1980	Senior Geologist, Utah Power & Light Company
1972-1978	Geologist, Sanders Exploration, Ltd.

MEMBERSHIP/CERTIFICATION:

Member, Geological Society of America
Certified Professional Geologist, State of Virginia (#667)

PUBLICATIONS:

Mr. Blackett has authored and co-authored articles relating to the use of low-temperature geothermal resources in the United States and an assessment of U.S. Department of Energy geothermal data bases. He has also authored one paper and a U.S. DOE report concerning the geothermal systems at Raft River, Idaho and Stillwater, Nevada respectively. Most recently, he co-authored a paper presenting the U.S. DOE's Geothermal Reservoir Technology Program.

EXPERIENCE:

Before joining the Utah Geological and Mineral Survey's Economic Program, Mr. Blackett was most recently employed at Meridian Corporation, a Washington, D.C.-based consulting firm, where he was responsible for providing technical and analytical support to the U.S. Department of Energy's Geothermal Technology Division. Through his work at Meridian, Mr. Blackett obtained a broad knowledge of DOE's geothermal programs and provided support in the program areas of Reservoir Technology, Magma Energy, and the Salton Sea Scientific Drilling Program.

While employed at the University of Utah Research Institute, Earth Science Laboratory, Mr. Blackett assisted with various geothermal studies in Utah, Idaho and Nevada. His principal geothermal experience was in studying moderate-temperature resource areas located in the Basin and Range and low-temperature areas of the Snake River Plain and along the southeast margin of the Idaho Batholith.

He was responsible for managing an on-going uranium exploration program in southeastern Utah while employed by Utah Power & Light Company. Over the course of this work, data were compiled from more than 1,000 shallow exploratory holes into an assessment of uranium resources.

Mr. Blackett assisted with resource evaluations on large tracts of coal-resource lands located throughout Utah and Colorado while employed by Sanders Exploration Ltd. His responsibilities included field supervision of exploration and development drilling programs, and collection of geologic and geotechnical data.

REPORTS AND PUBLICATIONS

Blackett, R. E., 1979, Landslide Hazards in the Weber River Delta, Near Ogden, Utah: University of Utah unpublished masters thesis, 72 p.

Blackett, R. E., 1981, Preliminary Investigation of the Geology and Geothermal Resources at Guyer Hot Springs and Vicinity, Blaine County, Idaho: Earth Science Laboratory, University of Utah Research Institute, ID/GHS/ESL-1

Blackett, R.E., 1985, Regulatory, Land Ownership, and Water Availability Factors for a Magma Well -- Long Valley Caldera and Coso Hot Springs, California: Meridian Corporation Working Paper prepared for Sandia National Laboratories, 35p.

Blackett, R.E., 1986, Assessment of Geothermal Related Data Bases: Oregon Institute of Technology, Geo-Heat Center Quarterly Bulletin, V. 9, No. 4, pp. 8-11.

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Blackett, R. E. and Kolesar, P. T., Geology and Alteration of the Raft River Geothermal System, Idaho: Geothermal Resources Council Transactions, V. 7, pp. 123 -127.

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Lunis, B.C., Blackett, R.E., and Foley, D., 1982, Geothermal Energy -- a brief assessment: U.S. Department of Energy, Western Area Power Administration report, 16 p., appendices.

Mock, J.E., and Blackett, R.E., 1987, The U.S. Department of Energy's Geothermal Reservoir Technology Program: Stanford University Twelfth Workshop on Geothermal Reservoir Engineering, Proceedings (in press).

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Sibbett, B. S. and Blackett, R. E., 1982, Lithology and Alteration of Rosewood Corporation Geothermal Wells #52-14 and #72-23, Elevenmile Canyon area, Churchill County, Nevada: Earth Science Laboratory, University of Utah Research Institute unpublished report

Sibbett, B.S., Blackett R.E., and Cole, D.R., 1982, Geology of the Minersville Geothermal Prospect, Beaver County, Utah: Earth Science Laboratory / University of Utah Research Institute unpublished report, 33p.

RESUME

NAME: MICHAEL A. SHUBAT
TITLE: Geologist

EDUCATION:

M.S. degree in geology, 5/79, Washington State University: Major fields of study included igneous and metamorphic petrology. Thesis topic was the structure, stratigraphy, and petrochemistry of the Columbia River Basalt Group in the Wallowa Mountains of northeastern Oregon.

B.S. degree in geology, 6/76, University of Minnesota.

EXPERIENCE:

Geologist, Utah Geological and Mineral Survey, 2-84-Present: Responsible for designing and producing research projects leading to publications on the economic geology of the mining districts of Utah. Specific responsibilities include (1) writing research proposals, (2) conducting projects within budgetary constraints and in a timely manner, (3) writing reports suitable for publication as UGMS Special Studies, UGMS Bulletins, UGMS Maps, or outside publications, and (4) drafting geologic maps and text figures. Studies are oriented toward the minerals exploration industry. Mining district studies typically include geologic and hydrothermal alteration mapping, petrographic and x-ray analysis, geochemical and geophysical studies, and detailed mine mapping. Data generated during the studies are interpreted in terms of modern genetic models of ore deposits. Target areas for specific types of ore deposits are outlined.

Geologist, U.S. Steel Corporation, 4/81 to 12/83: Evaluated epithermal, volcanic-hosted, Tertiary, disseminated and vein-type precious-metals deposits located in the western Great Basin. Responsibilities included design and execution of exploration programs, interpretion of geological and geochemical data, and preparation of reports. Methods used in prospect evaluation included detailed geologic mapping, detailed hydrothermal alteration mapping, exploration geochemistry, whole rock and trace element geochemistry, mineralogical and petrographic studies, and remote sensing techniques.

Geologist, Houston Oil and Minerals Corporation, 1/80 to 2/81: Primary responsibility was to conduct an exploration program on a Precambrian exhalative volcanogenic massive sulfide prospect located on the Seward Peninsula, Alaska. Duties included geologic mapping, drill hole site selection, core logging, geochemical sampling, compliation of data, and report preparation.

Seasonal employment; Houston Oil and Minerals Corporation (1979), Getty Oil Company (1978), and AMAX Exploration Incorporated (1976):

Participated in exploration programs located in Alaska and Minnesota. Targets included volcanogenic massive sulfide deposits and magmatic copper-nickel deposits. Duties included mapping, geochemical sampling, and core logging.

PUBLICATIONS:

Shubat, M.A., and Siders, M.A., 1986, Strike-slip and normal faulting in the Silver Peak quadrangle, Iron County, Utah, related to extensional tectonics: A shear zone in southwestern Utah?: Geological Society of America Abstracts with programs, v. 18, no. 5.

Siders, M.A., and Shubat, M.A., 1986, Stratigraphy and structure of the northern Bull Valley Mountains and Antelope Range, Iron County, Utah; in Griffen, D.T., and Phillips, W.R., eds., Thrusting and extensional structures and mineralization in the Beaver Dam Mountains, southwestern Utah: Utah Geological Association Publication 15, p. 87-102.

Shubat, M.A., 1987, The Antelope Range mining district study: Survey Notes (Utah Geological and Mineral Survey), v. 20, no. 3, p. 3-6.

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Shubat, M.A., Geology and Mineral Occurrences of Northern Keg Mountain, Juab County, Utah: in Utah Geological Association Publication 16 (1987 Guidebook in press).

RESUME
GARY E. CHRISTENSON
GEOLOGIST

EDUCATION

1969-1973 Montana State University, Bozeman, Montana
B.S., Earth Sciences, Geology

1973-1976 Arizona State University, Tempe, Arizona
M.S., Geology, Geomorphology, Engineering and Quaternary Geology
Theses topic: Environmental Geology of the McDowell Mountains, Maricopa County, Arizona

Post-graduate
1977 Technical writing short course
1978 Pedology workshop
1979 Remote sensing short course
1980 Mined land reclamation workshop
1981 Quaternary geology of the Great Basin (University of Utah)
1983 Seminar on Lake Bonneville (University of Utah)
1985 Managing for Productivity, ODI workshop

EXPERIENCE

1981-present Utah Geological and Mineral Survey, Salt Lake City, Utah
Perform engineering geologic and hydrologic investigations for public facility siting and land-use planning, including: 1) preparation of maps depicting geologic hazards and constraints on development for use by planners, 2) aid to state health authorities regarding existing and potential ground-water and surface water contamination problems, and 3) evaluation of sites for schools, water systems, waste disposal facilities, and other public works. Detailed Quaternary stratigraphic, geomorphic, and geochronologic studies related to siting of a nuclear waste repository. Proposal preparation, representation of UGMS on various state environmental health and natural resources committees, review and preparation of regulations regarding geotechnical aspects of waste disposal, review of geotechnical reports submitted by developers for approval by local and state government, administration of federal grants, and supervision/management of hazards compilation and mapping programs.

1976-1980 Fugro, Inc., Consulting Engineers and Geologists, Long Beach, California (presently Earth Technology Corporation Western, Inc.)
Progressed from staff to project geologist. Performed regional geologic and geomorphic investigations involving interpretation of small and large-scale aerial photography and remote sensing imagery, trenching, drilling, and soil testing to evaluate and predict engineering properties of Quaternary deposits. Detailed mapping of geomorphic surfaces and Quaternary deposits to reconstruct Quaternary history and evaluate erosional and depositional trends in arid and semiarid regions. Regional and site-specific fault investigations involving subsurface exploration and mapping of surficial deposits to determine

seismotectonic setting and detailed history of faulting. Major project involvement included: 1) screening and siting investigations for the MX missile and various nuclear power plants in the western U.S., 2) fault investigations and seismotectonic evaluations for the U.S.G.S. Earthquake Hazards Reduction Program and for U.S. Bureau of Reclamation dams in California and Arizona, and 3) preparation of mine permit applications for Wyoming coal mines.
Coauthor of in-house geologic standards manual and director of in-house research and development projects on the use of aerial photography and remote sensing imagery in geotechnical studies. Prepared proposals and organized technical seminars for Fugro, Inc. staff.

1977 California State University, Long Beach, Department of Geology Instructor, geomorphology and air photo interpretation.

1973-1976 Arizona State University, Tempe, Department of Geology Graduate teaching and research assistant. Aided in faculty research in geomorphology, stratigraphy, and Quaternary geology in Arizona, Montana, and Wyoming.

1974-1975 City of Scottsdale, Long Range Planning Department, Scottsdale, Arizona Environmental geologist. Performed investigations to aid in land-use planning related to geologic hazards and construction in the city and surrounding areas.

1973 U.S. Geological Survey, Boston, Massachusetts Geologic field assistant. Mapping of Paleozoic metamorphic rocks and Quaternary surficial deposits, South Coventry, Connecticut.

PROFESSIONAL SOCIETIES AND REGISTRATIONS

Association of Engineering Geologists
International Association of Engineering Geologists
American Quaternary Association
Utah Geological Association
Registered Professional Geologist #3614 (California)
Certified Engineering Geologist #1069 (California)

PUBLICATIONS

Christenson, G.E., Welsch, D.G., and Pe'we', T.L., 1975, Environmental geology in arid regions - an application in urban planning, Scottsdale, Arizona: Geological Society of America Abstracts with Programs, v. 7, no. 7, p. 1026.

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Christenson, G.E., LaViolette, J.W., and Stepp, J.C., 1980, Holocene displacement on the western Garlock fault: Geological Society of America Abstracts with Programs, v. 12, no. 7, p. 402.

Stepp, J.C., LaViolette, J.W., and Christenson, G.E., 1980, Seismic hazard study of the western portion of the Garlock fault: U.S. Geological Survey Open-File Report 80-1172, 56 p.

LaViolette, J.W., Christenson, G.E., and Stepp, J.C., 1980, Quaternary displacement on the western Garlock fault, southern California, in Fife, D.L., and Brown, A.R., eds., Geology and mineral wealth of the California desert: South Coast Geological Society, Dibblee Volume, p. 449-456.

Christenson, G.E., 1981, Engineering geology for land-use planning, Ballard, Utah: Utah Geological and Mineral Survey Report of Investigation 167, 12 p.

Christenson, G.E., 1981, Preliminary feasibility study for proposed oil field wastewater disposal sites east of Coalville, Summit County, Utah: Utah Geological and Mineral Survey Report of Investigation 164, 8 p.

Christenson, G.E., Miller, J.R., and Pieratti, D.D., 1982, Prediction of engineering properties and construction conditions from geomorphic mapping in regional siting studies, in Craig, R.G., and Craft, J.L., eds., Applied geomorphology: London, George Allen and Unwin, The Binghamton Symposia in Geomorphology: International Series No. 11, p. 94-107.

Schell, B.A., Wilson, K.L., Christenson, G.E., and Scott, S.L., 1982, Regional neotectonic analysis of the Sonoran Desert: U.S. Geological Survey Open-File Report 82-57, 28 p.

Christenson, G.E., and Purcell, C.W., 1982, Correlation and age of Quaternary alluvial sequences, Basin and Range: Geological Society of America Abstracts with Programs, v. 14, no. 4, p. 155.

Lund, W.R., Christenson, G.E., and Gill, H.G., 1982, Engineering geologic aspects of liquid waste disposal problems in Utah: Geological Society of America Abstracts with Programs, v. 14, no. 6, p. 320.

Christenson, G.E., 1983, Quaternary geology of the Montezuma Creek-lower Recapture Creek area, southeastern Utah: Geological Society of America Abstracts with Programs, v. 15, p. 328.

Christenson, G.E., 1983, Field trip guide to the engineering geology of southwestern Utah: Association of Engineering Geologists, Utah Section, 18 p.

Christenson, G.E., and Deen, R.D., 1983, Engineering geology of the St. George area, Washington County, Utah: Utah Geological and Mineral Survey Special Studies 58, 32 p.

Christenson, G.E., 1983, Engineering geology of the St. George area, south-western Utah: Geological Society of America Abstracts with Programs, v. 16, no. 4, p. 217-218.

Christenson, G.E., 1984, Sediment source study, Little Cottonwood, Big Cottonwood, and Mill Creeks, Salt Lake County, Utah: Utah Geological and Mineral Survey Report of Investigation 189, 22 p.

Christenson, G.E., and Purcell, C.W., 1985, Correlation and age of Quaternary alluvial-fan sequences, Basin and Range province, southwestern United States, in Weide, D.L., ed., Soils and Quaternary geology of the southwestern United States: Geological Society of America Special Paper 203, p. 115-122.

Christenson, G.E., 1985, Quaternary geology of the Montezuma Creek-lower Recapture Creek area, San Juan County, Utah, in Christenson, G.E., and others, Contributions to Quaternary geology of the Colorado Plateau: Utah Geological and Mineral Survey Special Studies 64, p. 2-31.

Christenson, G.E., 1985, Causes of basement flooding in South Jordan and Riverton near Kennecott evaporation ponds, Salt Lake County: Utah Geological and Mineral Survey Report of Investigation 195, 29 p.

Christenson, G.E., and Bishop, Charles, 1985, Preliminary geologic hazards and resource assessment of state lands in Washington County, Utah: Utah Geological and Mineral Survey Report of Investigation 199, 15 p.

Christenson, G.E., 1986, Engineering geology for land-use planning, Smithfield, Utah, in Lund, W.R., ed., Engineering geologic case studies in Utah: Utah Geological and Mineral Survey Special Studies 68, p. 37-58.

Christenson, G.E., 1987, Suggested approach to geologic hazards ordinances in Utah: Utah Geological and Mineral Survey Circular 79, 16 p.

Christenson, G.E., Lowe, Mike, Nelson, C.V., and Robison, R.M., 1987, Geologic hazards and land-use planning, Wasatch Front, Utah: Geological Society of America Abstracts with Program, v. 19, no. 5, p. 265.

Nelson, C.V., Christenson, G.E., Lowe, M.V., and Robison, R.M., 1987, The review process and adequacy of engineering geologic reports, Wasatch Front, Utah, in McCalpin, James, ed., Proceedings of the 23rd Symposium on Engineering Geology and Soils Engineering: Utah State University, Logan, Utah, p. 83-86.

Robison, R.M., Christenson, G.E., Knight, R.V., Dewsnup, Wes, and Johnson, Mike, 1987, Earthquake and slope failure hazards, Utah County Comprehensive Hazard Mitigation Project, Utah, in McCalpin, James, ed., Proceedings of the 23rd Symposium on Engineering Geology and Soils Engineering: Utah State University, Logan, Utah, p. 499-521.

RESUME

NAME: ARCHIE D. SMITH
TITLE: Senior Geologist, Economic Program

EDUCATION:

1957	B.S.	Geology, Mathematics, Brigham Young University
1983	MPA	Public Administration, Brigham Young University

EMPLOYMENT HISTORY:

1983-Present	Senior Geologist, Utah Geological and Mineral Survey
1981-1983	Chief Geologist, Utah Geological and Mineral Survey
1977-1981	Staff Geologist, Utah Geological and Mineral Survey
1976-1977	Certification Secondary Education, Brigham Young University
1975	Well Site Geologist, Mudlogger, Tooke Engineering
1959-1975	Surface Warfare Officer, U.S. Navy
1958-1959	Geophysical Computer, Shell Oil Company
1957	Geological Sampler/Drillers Helper, Anaconda Copper Company, E.J. Longyear

MEMBERSHIPS:

Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers
American Association of Petroleum Geologists
Utah Geological Association
The Society for Organic Petrology
American Society for Public Administration

PUBLICATIONS:

Authored two Special Studies and an Open File Report Co-authored two Special Studies

EXPERIENCE:

As Senior Geologist for the Economic Program, Utah Geological and Mineral Survey, Mr. Smith is responsible for a major state-wide geological program involving public and industrial contacts at top administrative levels. The program compiles, interprets, maintains, publishes, and disseminates information on the energy and mineral resources of the state of Utah.

Mr. Smith's professional emphasis has been in coal exploration and mine geology. He is knowledgeble in exploration management, coal bed methane determination, coal petrography, and exploratory drilling. As a principal investigator, his coal work includes successful completion of a $1.5 million drilling and resource evaluation program. Also, collection of numerous coal cores for methane desorption, chemical analysis, and selected petrographic evaluation. He has orginated proposals for coal work including authoring operations and work statements; estimating costs and preparing budgets; conducting pre-award surveys; and negotiating contracts and subcontracts. Mr. Smith has 16 years administrative and management experience as a U.S. Naval Officer including command experience. His naval work involved sustained periods of concentrated and analytical thinking and mental application to resolve complex technical problems and to develop formal written plans. Also, his work involved contacts at all levels affecting fundamental relationships with other services and foreign government officials and personnel. He holds several personal awards and top secret security clearance.

PUBLICATIONS

Smith, A.D., 1981a, Coal drilling, North Horn Mountain, East Mountain areas, Wasatch Plateau, Utah, in Utah Coal Studies II: Utah Geol. Miner. Surv. Spec. Studies, No. 54, p. 1-31.

________, 1981b, Methane content of Utah coals - progress report 1979-1980: Utah Geol. Miner. Surv. Open-File Report 28, 8 p.

________, 1981c, Muddy Creek coal drilling project, Wasatch Plateau: Utah Geol. Miner. Surv. Spec. Studies 55, 57 p.

Foster, D.A. and Smith, A.D., 1983, Bibliography of Utah geology: Utah Geol. Miner. Surv. Bull. 120, in press.

5.3 Summary of the Utah Geological and Mineral Survey Programs and Facilities

The Utah Geological and Mineral Survey (UGMS) is one of eight divisions in the Utah Department of Natural Resources. The UGMS inventories the geologic resources of Utah; identifies the state's geologic and topographic hazards; maps geology and studies the rock formations and their structural habitat; and provides information to decision makers at local, state and Federal levels.

The UGMS is organized into five programs. Administration provides support to the programs. The Economic Geology Program undertakes studies to map mining districts, to monitor the brines of the Great Salt Lake, to identify coal, geothermal, uranium, petroleum and industrial minerals resources, and to develop computerized resource databases. The Applied Geology Program responds to requests from local and state governmental entities for site investigations of critical facilities, documents, responds to and seeks to understand geologic hazards, and compiles geologic hazards information. The Geologic Mapping Program maps the bedrock and surficial geology of the state at a regional scale by county and a more detailed scale by 7.5 minute quadrangle.

The Information Program distributes publications, answers inquiries form the public, and manages the UGMS Library. The UGMS Library is open to the public and contains many reference works on Utah geology by UGMS staff and others. The UGMS has begun several computer data bases with information of mineral and energy resources, geologic hazards, and bibliographic references. Most files are not available by direct access but can be obtained through the library.

The UGMS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public.

5.4 Available Facilities and Personnel of the Department of Geology and Geophysics, University of Utah

The UGMS cooperates informally with the Department of Geology and Geophysics at the University of Utah on geothermal related studies. Although a direct subcontract to the Department of Geology and Geophysics will not be required as part of this work effort, the Department will provide (1) access to their geothermics laboratory, (2) field geophysical equipment at a nominal rental cost, and (3) technical advise and support on the tasks involving geophysical studies -- Task 4: Gravity and Magnetic Studies; and Task 6: Thermal Gradient Drilling.

Dr. David S. Chapman and Mr. William G. Powell have agreed to act as informal advisors to thermal gradient and hydrologic monitoring studies to be performed as part of Task 6. Their assistance will, because of other commitments, necessarily be limited to lending advise on test hole completion techniques and on obtaining temperature gradient information. Cutting samples may eventually be used by students of Dr. Chapman for determination of thermal conductivities. Resumes of Dr. Chapman and Mr. Powell have been inserted following this section.

(NOTE: Dr. Chapman was recently on a leave of absence from the University of Utah while teaching at the University of British Columbia. He has returned to the University of Utah as of Fall Quarter, 1987 and will continue as a professor in the Department of Geology and Geophysics.)

As previously described, the gravity and magnetic studies will be carried out with the help of Dr. Charles M. Schlinger, Assistant Professor of Geophysics at the University of Utah. Dr. Schlinger will be assisted by Mr. James Hollis, a graduate student of geophysics, and several undergraduate students as part of a field geophysical methods course. Dr. Schlinger has very kindly agreed to conduct the field gravity and magnetic studies for this project in return for only reimbursement of the field expense. Dr. Schlinger's and Mr. Hollis's resumes also follow this section.

Following is a description of the University of Utah Department of Geology and Geophysics' Geothermics Laboratory.

Temperature Logging Equipment

- Precision thermistor temperature probes with 4-conductor logging cable, mounted on portable reels. Digital ohmmeters with 4 and 5 digit precision. Thermistors calibrated to a digital quartz thermometer.

Accuracy:	0.1°C
Precision:	0.01°C
Maximum logging depth:	600 M (2,000 ft)
Minimum well casing diameter:	2.5 cm (1 in)
Logging speed:	500 ft / hr

- Portable data acquisition system (Hewlett-Packard 3421A Data Acquisition Control Unit) for monitoring temperature changes through time

Rock Properties Apparatus

- Dual divided bar apparatus and microprocessor-controlled data acquisition electronics for measurement of thermal conductivity and thermal diffusivity on rock samples. Capability to measure disks of core or drill cuttings.

Analysis and modeling facilities

- A Hewlett-Packard Model 300 computer with color graphics terminal, 4 pen plotter, laser printer, HP 9874A digitizer and various user terminals. Data link with College of Mines Gould supermini computer facility

- Software for numerical modeling of thermal, hydrologic and mechanical processes in geologic systems of all scales, including finite element and bouldary integral solutions to geothermal and hydrothermal problems

DAVID S. CHAPMAN

BORN: August 31, 1942, Comox, British Columbia, Canada

ACADEMIC POSITION: Associate Professor
Department of Geology and Geophysics
College of Mines and Mineral Industries
University of Utah

EDUCATION:

University of British Columbia	1964	B.S. (Physics, Mathematics)
University of British Columbia	1966	M.S. (Physics)
University of Michigan	1976	Ph.D. (Geophysics)

EXPERIENCE: Teaching

1966 to 1969 — Physics and mathematics teacher, Canisius College, Republic of Zambia.

1969 to 1972 — Lecturer in physics, University of Zambia.

1972 to 1975 — Teaching assistant in geology and geophysics, University of Michigan.

1975 to 1976 — Assistant Professor of Physics, University of Michigan - Dearborn.

1976 to 1979 — Assistant Professor, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah.

1979 to 1985 — Associate Professor, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah.

1985 to present — Full Professor, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah.

Research

1964 to 1966 — University of British Columbia, experimental low temperature physics, vortex rings in liquid helium.

1969 to 1972 — University of Zambia, general applied physics: thermal and acoustic properties of lecture halls at the University, dynamic strain measurements on railway bridges.

1970 to 1972 — University of Zambia, geophysical fieldwork; heat flow measurements, subsurface temperature measurements in mines; reconnaissance gravity surveys; micro earthquake monitoring; integrated geophysical study of hot springs.

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1972 to 1975	University of Michigan, geophysical analysis: heat flow data reduction and analysis; thermal and rheological structure of the lithosphere; thermal perturbations in the lithosphere; spherical harmonic analysis of global heat flow data; regional and local gravity analysis; experimental rock deformation under intermediate crustal conditions.
1976 to present	University of Utah. Regional heat flow studies; thermal state of the lithosphere; heat flow and mid-plate volcanism; geophysical characterization of geothermal systems; thermal aspects of plate interactions; thermal aspects of groundwater flow; influence of lithospheric thermal state on its mechanical behavior; thermal histories of sedimentary basins.

PUBLICATIONS

Chapman, D. S. and P. R. Critchlow, "Formation of vortex rings from falling drops", J. Fluid Mechanics, 29, 1, 177-185, 1967.

Chapman, D. S. "Science and mathematics teaching in Zambia", Bull. Zambia Assn. Science Education, 1, 1, 21-23, 1970.

Chapman, D. S., "The moon and its wives", Bull. Zambia Assn. Science Education, 2, 2, 9-11, 1971.

Chapman, D. S. and H. N. Pollack, "Cold spot in West Africa: anchoring the African plate", Nature, 250, 477-478, 1974.

Chapman, D. S., J. Vise and H. N. Pollack, "Geothermal investigations in Zambia:, J. Engineering Inst. of Zambia, 19, no. 3, 33-37, 1975.

Chapman, D. S. and H. N. Pollack, "Heat flow and incipient rifting in the Central African plateau", Nature, 256, 28-30, 1975.

Chapman, D. S. and H. N. Pollack, "Global heat flow: a new look", Earth Planet. Sci. Lett., 28, 23-32, 1975.

Chapman, D. S., "Heat flow and heat production in ~~Zambia"~~, Ph.D. Thesis, The University of Michigan, 1976.

Pollack, H. N. and D. S. Chapman, "On the regional variation of heat flow. geotherms, and lithospheric thickness:, Tectonophysics, 38, 279-296, 1976.

Pollack, H. N., and D. S. Chapman, "Mantle heat flow", Earth Planet Sci. Lett., 34, 174-184, 1977.

Chapman, D. S., and H. N. Pollack, "Regional geotherms and lithospheric thickness", Geology, 5, 265-268, 1977.

Pollack, H. N. and D. S. Chapman, "The flow of heat from the Earth's interior", Scientific American, August, 1977, 60-76, 1977. (translated into Japanese Sci. Am., Nov. 1977).

Chapman, D. S. and H. N. Pollack, "Heat flow and heat production in Zambia: evidence for lithospheric thinning in Central Africa", Tectonophysics, 41, 79-100, 1977.

Gass, I. G., D. S. Chapman, H. N. Pollack and R. S. Thorpe, "Geological and geophysical parameters for mid-plate volcanism". Phil. Trans. Roy. Soc. A288, 581-597, 1978.

Furlong, K. P. and D. S. Chapman, "Roll cell mantle convection under the Pacific plate", Nature, 274, 145-147, 1978.

Ward, S. H., Parry, W. T., Nash, W. P., Cook, K. L., Smith, R. B., Chapman, D. S., Brown, F. H., Whelan, J. A., and Bowman, J. R., "A summary of the geology, geochemistry and geophysics of the Roosevelt Hot Springs thermal area, Utah," Geophysics, 43, 1515-1542, 1978.

Chapman, D. S., Pollack, H. N., and Cermak, V., "Global heat flow with special reference to the European region of the globe," in European Heat Flow, ed. by V. Cermak and L. Rybach, p. 41-48, 1979.

Kilty, K., D. S. Chapman and C. W. Mase, "Forced convective heat transfer in the Monroe Hot Springs geothermal system: J. Volcanol. Geothermal Res., 6, p. 257-277, 1979.

Chapman, D. S., "Lithosphere", 1980 McGraw-Hill Yearbook of Science and Technology, 261-263, 1980.

Kilty, K., D. S. Chapman, "Convective heat transfer in selected geologic situations" Groundwater, 18, n. 4, 1980.

Chapman, D. S., "Terrestrial heat flux", Nature - News and Views, 287, 190-191, 1980.

Sass, J. H., D. D. Blackwell, D. S. Chapman, J. K. Costain, E. R. Decker, A. H. Lachenbruch, L. A. Lawver, B. V. Marshall and R. J. Munroe, "Heat flow from the crust of the United States", Chapter 13, McGraw-Hill/CINDAS Data Series on Material Properties, V. 11-2, Physical Properties of Rocks and Minerals, eds. Y. S. Touloukian, W. R. Judd, and R. F. Roy, 503-548, 1981.

Pollack, H. N., I. G. Gass, R. S. Thorpe, and D. S. Chapman, "On the vulnerability of lithospheric plates to mid-plate volcanism": reply to comments by P. Vogt., J. Geophys. Res., 86, 961-966, 1981.

Carrier, D. L. and D. S. Chapman, "Gravity and thermal models for the Twin Peaks silicic volcanic center, southwestern Utah," J. Geophys. Res., 86, 10287-10302, 1981.

Chapman, D. S., M. D. Clement and C. W. Mase, "Thermal regime of the Escalante Desert, Utah with an analysis of the Newcastle geothermal system," J. Geophys. Res., 86, 11735-11746, 1981.

Bodell, J. M., and D. S. Chapman, Heat flow in the north-central Colorado Plateau, J. Geophys. Res., 87, p. 2869-2884, 1982.

Furlong, K. P., D. S. Chapman, and P. W. Alfeld, Thermal modeling of the geometry of subduction with implications for the tectonics of the overriding plate, J. Geophys. Res., 87, p. 1786-1802, 1982.

Hyndman, R. D., T. J. Lewis, J. A. Wright, M. Burgess, D. S. Chapman and M. Yamano, Queen Charlotte fault zone: heat flow measurements, Canadian J. Earth Sci., 19, p. 1657-1669, 1982.

Smith, L. and D. S. Chapman, On the thermal aspects of groundwater Flow 1. Regional scale systems, J. Geophys. Res., 88, p. 593-608, 1983.

Chapman, D. S., Thermal regime of the Luanshya Mine, Republic of Zambia, Geoexploration, 21, p. 265-281, 1983.

Pollack, H. N., I. G. Gass, R. S. Thorpe and D. S. Chapman, Reply to "Comments on 'On the Vulnerability of lithospheric plates to mid-plate to mid-plate volcanism': Reply to comments by P.R. Vogt, H.N. Pollack et al," by M.A. Summerfield, Jour. Geophys. Res., 88, 1251-1254, 1983.

Chapman, D. S., J. Howell, and J. H. Sass, A note on drillhole depths required for reliable heat flow determinations, Tectonophysics, 103, 11-18, 1984.

Chapman, D. S., T. H. Keho, M. S. Bauer and M. D. Picard, Heat flow in the Uinta Basin determined from bottom hole temperature (BHT) data, Geophysics, 49, 453-466, 1984.

Cermak, V., L. Rybach and D. S. Chapman, (Editors) Special Issue - Terrestrial Heat Flow Studies and the Structure of the Lithosphere, v. 103, 356 p., 1984.

Chapman, Inga M. and D. S. Chapman (Translators), Geothermics by G. Buntebarth, Springer Verlag, Heidelberg, 144 p., 1984 (Original text in German).

Willett, S. D., D. S. Chapman and H. J. Neugebauer, Mechanical response of the continental lithosphere to surface loading: effect of thermal regimes, Annales Geophys'cae, 2, 679-688, 1984.

Smith, L. and D. S. Chapman, The influence of water table configuration on the near surface thermal regime, J. Geodynamics, 4, 1985.

Chapman, D. S., Continental heat flow data, in Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series vol. 2b, edited by K. Fuchs and H. Soffel, Springer Verlag, Berlin, 1-19, 1985.

Willett, S. D., D. S. Chapman, and H. J. Neugebauer, A thermo-mechanical model of continental lithosphere, Nature, 314, 520-523, 1985.

Chapman, D. S., and L. Rybach, Heat flow anomalies and their interpretation, J. Geodynamics, 4, 1-25, 1985.

Chapman, D. S., Thermal gradients in the continental crust, J. Geol. Soc. Lond. (in press, 1985).

Bauer, M. S., and D. S. Chapman, Thermal regime of the Upper Stillwater dam site, Uinta Mountains, Utah: implications for microclimate, terrain and structural corrections in heat flow studies, Tectonophysics (in press 1986).

William G. Powell

Education

University of Utah, Salt Lake (1980-87) Ph.D., geophysics (expected Fall 1988).
Thesis: Thermal State of the Lithosphere in the Colorado Plateau-Basin & Range Transition Zone.
ASARCO and Mobil Research and Development Corp. Fellowships.
Departmental distinguished PhD research award, 1986.
University of California, Riverside (1977-80) B.S., geophysics.
Thesis: DC Resistivity Survey at a Low-temperature Geothermal Reservoir.
California Institute of Technology, Pasadena (1973-76).

Teaching Experience

ASSOCIATE INSTRUCTOR, University of Utah, Salt Lake City, 1986-7. Graduate level courses in 1) global geophysics and 2) diffusion in geologic systems. Introductory courses in physical geology for liberal education program.
TEACHING ASSISTANT, University of Utah, Salt Lake City, 1981, 82, 85 Prepared and presented classroom lectures, directed laboratory sessions, wrote exams and exercises for courses in global geophysics and gravity/magnetic exploration methods. Designed field exercise for grav/mag class.
TUTOR (Volunteer position), California Institute of Technology, 1973-75. Weekly geology class in science enrichment program for junior high and senior high students.

Research Experience

RESEARCH ASSISTANT, University of Utah, Salt Lake City, 1983-86. Thermotectonic studies of Colorado Plateau-Basin & Range transition. Heat flow survey of southern Utah. Near-surface effects and geothermics in rugged terrains. Gravity and magnetic evidence for crustal structure.
RESEARCH ASSISTANT, Well Logging Group, Mobil Research & Devel. Corp., Dallas, TX, 1981. Inversion and modeling of magnetic and VLF data in study of exploration strategies.

Other Experience

TECHNICAL ASSISTANT, Energy Systems Analysis Group, Jet Propulsion Laboratory, Pasadena, CA, 1979. Directed contractors on study of potential for development of direct-heat application of geothermal energy in AZ, CA, NV, HI, for U.S. Dept. of Energy.
TECHNICAL ASSISTANT, Guidance and Control Section, Jet Propulsion Laboratory, Pasadena, CA, 1973-77. Engineering analyses of spacecraft control systems and software testing. Responsible for design, documentation and delivery of software used to operate Voyager spacecraft.

Professional Societies

Society of Exploration Geophysicists, American Geophysical Union, Sigma Xi.
Cofounder and former President of UCR Geophysical Society.

William G. Powell

Abstracts

Powell, W.G., D.S. Chapman, and J.M. Bodell. Heat flow in the Colorado Plateau of southern Utah. EOS Trans. Am. Geophys. Union, 64: 837, 1983.

Powell, W.G. and D.S. Chapman. Terrain corrections for heat flow in rugged topography: a comparison. IASPEI Regional Assembly Abstracts Volume, Nat. Geophys. Res. Inst., Hyderabad, India, 153, 1984.

Powell, W.G. and D.S. Chapman. Geophysical characteristics of the Colorado Plateau – Basin and Range Transition in Utah. Abstracts with Programs, Geol. Soc. Am. Rocky Mountain Section, 18: 403, 1986.

Papers in preparation

Powell, W.G., D.S. Chapman, N. Balling, and A.E. Beck. Continental heat flow density: methods and corrections. In: R. Haenel, L. Stegena and L. Rybach (eds.), Heat Flow Density Determination and Representation, International Heat Flow Committee Monograph, 1987 (in press).

Powell, W.G. and D. S. Chapman. Heat flow in the Colorado Plateau of southern Utah. (for submission to Geophys. Res. Lett.)

Powell, W.G. and D. S. Chapman. Geothermal terrain correction in rugged regions: an example from the Wasatch Mountains, Utah. (for submission to Tectonophysics).

Reports

Powell, W.G. and K. Tang, 1979. Geothermal Direct Heat Use: Market Potential/Penetration Analysis for Federal Region IX. Jet Propulsion Laboratory Publication, prepared for U.S. Department of Energy.

Research Proposals Funded

1. A High Resolution Heat Flow Study: Jordanelle Dam Site.
   NSF no. EAR 8609952, 1987. (prepared 90% of proposal).

2. Thermal Aspects of the Basin and Range – Colorado Plateau Transition.
   NSF no. EAR 8219136, 1983-85. (assisted with final preparation).

3. DC Resistivity Survey in Desert Hot Springs.
   UCR Undergraduate Research Minigrant, 1979. (wrote 100% of proposal)

CHARLES M. SCHLINGER

UNIVERSITY DEGREES

Ph.D., Geophysics, The Johns Hopkins University, 1983
M.A., Geology, The Johns Hopkins University, 1979
B.S., Physical Geography, The University of Michigan, Flint, Michigan, 1977

PAST AND PRESENT EMPLOYMENT

1983-Present	Assistant Professor, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112
1979	Teaching Assistant, The Johns Hopkins University
1978	Research Seismologist, Amoco Production Company, Tulsa, Oklahoma, Modelling of 3D seismic data acquisition and processing
1975-1977	Teaching, Research, Laboratory and Field Assistant, The University of Michigan, Flint, Michigan
1973-1984	Photography (published)

RELATED EXPERIENCE

1984,'86,'87	Precision gravity surveys, Yellowstone National Park

MEMBERSHIP IN SCIENTIFIC AND PROFESSIONAL SOCIETIES

American Geophysical Union
Australian Society of Exploration Geophysicists

HONORS AND AWARDS

Michigan Competitive Scholarship - '73-'77
Gilman Fellowship, The Johns Hopkins University - '77-'79
Carnegie Institution Pre-Doctoral Fellowship (Geophysical Laboratory) '81 & '82

PUBLICATIONS AND EXTENDED ABSTRACTS

Schlinger, C.M., Griscom, D., Papaefthymiou, G., Veblen, D.R. and Smith, R.M., Volcanic glasses of the KBS tuff: transmission electron microscopy, magnetism, electron spin resonance, Mössbauer and optical spectroscopy, in review, J. Geophys. Res..

Schlinger, C.M., Rosenbaum, J.G. and Veblen, D.R., Fe-oxide microcrystals in volcanic glasses from Yucca Mountain, Nevada: Evidence for a relationship between glass microstructure and paleomagnetism, to be submitted, Geology.

Schlinger, C.M. and Veblen, D.R., Magnetism and transmission electron microscopy of Fe-Ti oxide inclusions in granulitic augites from Lofoten, Norway, to be submitted.

Schlinger, C.M., Magnetic and optical evidence for microstructure at the 5 to 100 Å scale in volcanic glasses, Proc. 2nd Inter. Conf. Natural Glasses, Prague, 1987.

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INVITED LECTURES

Institute Laue-Langevin, Grenoble, France, October 8, 1986.

CURRENT AND PENDING EXTERNAL RESEARCH SUPPORT

Mineralogy, magnetism and geologic origin of fine-grained Fe-Ti oxides in glassy and devitrified rhyolitic rocks, National Science Foundation Grant EAR-8708004, $20,000 (Continuation proposal is in review).

Rock magnetic study of the Kohistan complex, Pakistan, Smithsonian Institution; $19,100.

ABSTRACTS

Wasilewski, P., Schlinger, C.M. and Stoddard, S., Amphibolite-granulite metamorphic transition - magnetic petrology, Proc. Intern. U. Geod. Geophys., Vancouver, British Columbia, 1987.

Schlinger, C.M. and Veblen, D.R., 1986, Magnetism and transmission electron microscopy of Fe-Ti oxide inclusions in granulitic augites from Lofoten, Norway, EOS, 67, 928.

Schlinger, C.M. and Smith, R.M., 1985, Superparamagnetic precipitates in volcanic glasses of the KBS tuff, EOS, 66, 869.

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Schlinger, C.M. and Marsh, B.D., 1982, Magnetic mineralogy of the deep crust and regional magnetic anomalies: rocks from Lofoten and Vesterålen, North Norway, Geol. Soc. Am. Bull., 14, 610.

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JAMES RICHARD HOLLIS

Present Address:
1533 Emerson Ave.
Salt Lake City, Utah 84105
(801) 484-8436

Permanent Address:
1233 Eureka Avenue
Los Altos, California 94022
(415) 961-4754

PROFESSIONAL OBJECTIVE: Entry level position as an exploration oriented Geophysicist.

EDUCATION: University of Utah - Master of Science degree in Geophysics, expected in March, 1988. Attending at present.

University of California, Santa Barbara - Bachelor of Science degree in Geophysics, August, 1984.

Scholastic Awards: Fellowship in Geophysics, University of Utah, 1985-1986 academic year.

THESIS: Precision temporal gravity variations at Yellowstone National Park. Data reduction and forward/inverse modeling code development.

RELEVANT EMPLOYMENT:

Present — Research Assistant. University of Utah, Salt Lake City, Utah. Reducing and modeling temporal gravity data.

Summer 1987 — Researcher. Designed and conducted a precision temporal gravity survey in Yellowstone National Park.

1986-1987 — Teaching Assistant. University of Utah, Salt Lake City, Utah. Aiding in teaching courses and laboratories in exploration geophysics and potential theory.

Summer 1986 — Research Assistant. University of Utah, Salt Lake City, Utah. Collected precise temporal gravity measurements for thesis research at Yellowstone National Park.

Summer 1985 — Teaching Assistant. Los Alamos National Labs/IGPP, Los Alamos, New Mexico. Aided in instruction geophysics summer field course (SAGE) in the Rio Grande Rift area of New Mexico.

1984-1985 Geophysicist. U.S. Geological Survey, Menlo Park, California. Participated in crustal strain project related to earthquake prediction studies along the San Andreas fault zone and active volcanic areas.

1982-1984 Research Assistant. Marine Science Institute, Santa Barbara, California. Participated in vertical crustal strain studies utilizing precision leveling techniques.

Winter 1984 Assistant Hydrologist. U.S. Geological Survey, Santa Barbara, California. Aided in stream gauging and sediment run-off study.

COMPUTER EXPERIENCE:

Operating systems:	Languages:
Unix	Fortran
DOS	(Pascal)
Sperry/Univac	(C)
VMS	

PROFESSIONAL ASSOCIATIONS:

Society of Exploration Geophysicist
American Geophysical Union
American Association of Petroleum Geologists

PUBLICATIONS:

Hollis, J.R., 1984, Analysis of Apparent Tilt by Thermoelastically-induced Bedrock Motion, Appendix of final technical report to USGS by A.G. Sylvester, Crustal Tilt in Long Valley Caldera, California, U.S. Geological Survey Contract PO 94247.

PERSONAL INFORMATION:

Born March 10, 1961. Single. U.S. Citizen. Excellent health. Hobbies include skiing, sailing, and swimming.

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Weissberg, B.G., Browne, R.L., and Seward, T.M., 1979, Ore metals in active geothermal systems in Geochemistry of hydrothermal ore deposits, Barnes, H.L. ed., John Wiley and Sons, New York, pp. 738-780

Zeisloft, J.A., Sibbett, B.S., and Adams, M.C., 1984, Case study of the Wendel-Amedee exploration drilling project, Lassen County, California -- User Coupled Confirmation Drilling Program: Earth Science Laboratory / University of Utah Research Institute Report, no. ESL-162, 97 p.

APPENDIX A: LEGISLATIVE AUTHORIZATION

The Utah Geological and Mineral Survey is authorized by sections 53-36-1 through 12, UCA, 1953 as amended:

The composition of the governing board is covered by 53-36-3 which is quoted in part as follows:

(1) "...The board shall be comprised of seven members appointed by the governor, with the advice and consent of the senate. Of the members so appointed, all of whom shall possess the knowledge, skill, and experience to fit them for the position, one shall be knowledgeable in the field of geology as applied to the practice of civil engineering, four shall be representative of various segments of the mineral industry throughout the State (such as hydrocarbons, solid fuels, metals, and industrial minerals), one shall reflect the economic or scientific interests of the mineral industry in the State, and one, interested in the goals of the survey, shall be from the public at large.

(2) The director of the division of State Lands shall be an ex-officio member of the board but without any voting privilege.

53-36-6. The Survey shall have as its objectives:

(1) To assist and advise State and local governmental agencies and State educational institutions on geologic and mineralogic subjects;

(2) to collect and distribute reliable information regarding the mineral industry and mineral resources, topography, and geology of the State;

(3) to survey the geology and the mineral occurrences of the State (including, but not limited to, the ores of the various metals, all energy resources including geothermal, industrial raw materials, all mineral-bearing waters and other surface and underground water supplies), with special reference to their economic contents, values, uses, kind and availability in order to facilitate their economic utilization;

(4) to investigate the kind, amount and availability of the various mineral substances contained in State lands, so as to contribute to the most effective and beneficial administration of these lands for the State;

(5) to determine and investigate areas of geology and topographic hazards that could affect the safety of, or cause economic loss to, the citizens of Utah;

(6) to assist local and State government agencies in their planning, zoning, and building regulation functions by publishing maps delineating appropriately wide special earthquake risk areas

and, at the request of State agencies, review the siting of critical facilities;

(7) to cooperate with State agencies, political subdivisions of the State, quasi-governmental and Federal agencies, schools of higher education, and others in fields of mutual concern including field investigations and preparation, publication and distribution of reports, maps, and publications embodying the results of the work. The survey in accordance with the authority granted the department is authorized to enter cooperative agreements with these agencies, as may be approved by the board, and to accept or commit allocated or budgeted funds in connection with same, and, on approval of the board, to undertake joint projects with private entities if these projects are not inconsistent with the State's objectives and the results of them are open-filed;

(8) to collect and preserve data pertaining to mineral resource exploration and development programs and to construction activities, such as claim maps, location of drill holes and of surface and underground workings, geologic plans and sections, drill logs, and assay and sample maps; and the maintenance of the sample library of cores and cuttings;

(9) to study and analyze such other scientific, economic or aesthetic problems as, in the judgment of the board, should be undertaken by the Survey to serve the needs of the State and to support the development of natural resources and utilization of lands within the State;

(10) to prepare, publish, distribute, and sell maps, reports, and bulletins embodying the work accomplished by the Survey, directly or in collaboration with others; to collect and prepare exhibits of the geological and mineral resources of Utah and to interpret their significance; and

(11) upon approval of the board to undertake other activities consistent with the above."

APPENDIX B: MAJOR AREA OF PROPOSED RESEARCH

The area of proposed research is Resource Assessment. Resource Assessment is considered to be scientific studies or activities aimed at quantifying the volume, tonnage, or energy content of any naturally-occurring commodity, without regard to economic factors. Within the context of this proposal, all activities are directed at determining the controls and boundaries of the Newcastle hydrothermal system. In this manner, the study may allow for the estimation of the volume and energy content of the system.

APPENDIX C: HYDROTHERMAL RESOURCES IN UTAH

Following is a tabulation of identified hydrothermal systems in Utah reported in U.S. Geological Survey Circulars 790 and 892.

Area	Mean Reservoir Temperature (C)	Mean Reservoir Thermal Energy 10^{18}J	
Cove Fort/Sulphurdale	167	16	
Roosevelt Hot Springs	265	32	
SUBTOTAL -- HIGH-TEMPERATURE SYSTEMS			48
Abraham (Crater) H.S.	97	1.36	
Monroe-Red Hill H.S.	101	1.09	
Joseph Hot Springs	107	0.83	
Thermo Hot Springs	142	2.8	
Newcastle	130	1.9	
SUBTOTAL--INTERMEDIATE-TEMPERATURE SYSTEMS			7.98
Central Bear Valley	38	0.11	
Saratoga Hot Springs	43	0.26	
Crystal Hot Springs	55	0.14	
Delta	25	4.1	
Deseret Livestock	23	0.03	
Goshen Valley	50	0.26	
Granger-Mud Flats	25	0.65	
Kaysville-Farmington	23	0.10	
Kennecott-Asarco Wells	30	0.06	
Meadow-Hatton H.S.	48	0.32	
Milford	33	0.58	
North Salt Lake City	37	0.75	
Ogden Flats	30	3.4	
Southern Cache Valley	27	2.0	
Tule Valley	30	0.28	
Wendover	28	0.13	
Ashley Valley	45	0.36	
Midway	52	0.24	
SUBTOTAL--LOW-TEMPERATURE SYSTEMS			13.77
TOTAL--ALL SYSTEMS			69.75

STATE OF CALIFORNIA—THE RESOURCES AGENCY GEORGE DEUKMEJIAN, *Governor*

CALIFORNIA ENERGY COMMISSION
1516 NINTH STREET
SACRAMENTO, CA 95814

Ms. Trudy A. Thorne
Contracts Management Division
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

Dear Ms. Thorne:

Attached are copies of our revised Wilbur Hot Springs resource assessment proposal. Please note that we have prepared two separate proposals based on your suggestion. In the first proposal we have eliminated the temperature-gradient well drilling task, as recommended in your September 9, 1987 letter, and replaced it with a brief geochemical survey. The second proposal, however, includes a more thorough explanation of the need for the well drilling program and addresses the concerns and questions that were raised by the technical committee reviewing the applications. We, of course, favor this second proposal, but feel that our knowledge of the resource at Wilbur will still be enhanced by the work outlined in the first proposal.

In addition to the six copies of each proposal, I have attached a "Clarification Sheet" which directly answers the questions outlined in the attachment to your letter of September 9, 1987.

We welcome the opportunity to work with the Department of Energy on a project we feel will have a significant impact on the development of moderate-temperature geothermal resources in Northern California.

Thank you for your consideration.

Sincerely,

KENT SMITH
Deputy Executive Director

Attachments

cc: Michael Smith
Sheri Guzman

Attachment

Answers and clarification of questions and concerns raised by the technical review committee.

1. Question: Only partial rights are indicated as being able to be obtained, can all necessary access rights be obtained.

   Clarification: The property in question, located approximately 1-1/2 km south of Wilbur Hot Springs is being held in trust by Wells Fargo Bank, Agricultural Trust Department. The bank has extended to the Energy Commission complete access to the property in exchange for a final copy of any subsequent technical evaluation.

2. Question: Give reasons for the need of a new thermal gradient hole. Why will this hole permit all further analyses especially when no well production data will be obtained.

   Clarification: As more thoroughly explained in our revised proposal, previously drilled TG wells were located outside of the negative gravity anomaly and away from the known surface manifestations of thermal activity. We strongly feel that this is the reason that these earlier holes reached maximum temperatures of only 140°F. Originally our intent was to keep drilling costs down and to merely verify that moderate temperatures do exist. In light of your questions, however, we agree with your concern have revised our drilling proposal to include testing of the well.

3. Question: Why is the Atlas only going to be delivered as a draft?

   Clarification: A draft copy of the Atlas was proposed based on projections of how long it would take to produce a final "publishable" version. Both of our proposals have been modified to include a final version of the Atlas.

4. Question: Would wellhead power development conflict with other resource/land usage.

   Clarification: Quite to the contrary, wellhead power development would complement, perhaps even accelerate currently planned mining activities on the property.

5. Question: Where could the well be drilled, with respect to known hot springs.

   Clarification: As shown on Figure 2 of the revised proposals the well, whether an exploratory well, or eventual production well, would be drilled approximately 1-1/2 km south of the known occurrence of the Hot Springs at Wilbur.

6. Question: Geologic nature of the resource is not understood. Any specific relationship to the Geysers area?

   Clarification: We believe that there is a genetic relationship between the thermal activity at Wilbur Hot Springs and the Geysers. Volcanic activity in the vicinity of Wilbur has been related to the Clear Lake volcanics, and the current hydrothermal system at the Geysers. Please refer to the revised proposals for a more adequate explanation of this relationship.

7. Question: Why are salary figures listed more than once for some individuals in the same task?

   Clarification: The letter designations, A. B. C. etc. for each salary task were inadvertently left off the original proposal. Please review the revised business proposals for clarification.

PART I - TECHNICAL PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No.______ of 8 ORIGINAL COPY

Date of Submission June 19, 1987 revised October 7, 1987

Name of Proposer California Energy Commission

Address of Proposer 1516 Ninth Street

Sacramento, California 95814

Title of Proposal Resource Assessment of the Wilbur Hot Springs Area

Type of Research/Project Resource Assessment /X/ Resource Development / / Technical Assistance / /

Location of Work Northeastern Lake County, California

Proposed Start Date December 15, 1987 Proposed Project Duration 12 (in months)

Proposed Project Manager Dr. Kent Murray Phone No. (916) 324-3474

Permission for Outside Evaluation Yes XXX No____

AUTHORIZED OFFICIAL: Signature [signature]

Name Typed Kent Smith

Title Deputy Director

Date June 19, 1987

ABSTRACT

A geothermal resource assessment project is proposed to study the suitability of moderate-temperature geothermal resources in Northern California for well-head generation. A thermal anomaly in the Wilbur Hot Springs area of the north Central Coast Ranges of California will be used as a model to test the applicability of several well-head generation technologies. Resource characteristics obtained from the Wilbur Hot Springs area will be used to evaluate optimum power generation cycles from a consideration of capital costs, O&M costs, efficiency, reliability, and historical operating experience. The site-specific information obtained from the Wilbur Hot Springs assessment study will then be used to develop an Atlas of matrix or resource characteristics versus well head generation technology on other moderate-temperature geothermal resources in northern California. The results of this analysis is expected to benefit utilities, energy planners and small power producers by demonstrating geothermal resource availability, resource characteristics and the associated geothermal power cycles suitable at each site. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared showing economical geothermal capacity in Megawatts as a function of system power costs in dollars per kilowatt-hour.

Wilbur Hot Springs was selected as a model for this proposal due to its potential of achieving the moderate temperatures suitable for well head generation, and because a substantial amount of geologic and geophysical data already exists on the Wilbur Hot Springs area. This data, which includes shallow temperature gradient holes and geophysical information, will be supplemented in this study by extensive surface water and soil geochemistry. The results of this study should broadly define the thermal anomaly at Wilbur Hot Springs, facilitating the siting of an eventual production well.

TABLE OF CONTENTS

Part I - Technical Proposal

STATEMENT OF WORK

I. Introduction

The California Energy Commission (CEC), in conjunction with the Pacific Gas and Electric Company (PGandE), proposes a two-fold research project in the area of resource assessment. The objective of this proposal is to 1.) Determine the geographical extent and chemical character of the moderate-temperature resource at Wilbur Hot Springs and 2.) to evaluate the various geothermal wellhead power generation systems (e.g. flash steam, binary cycle, etc) that could be used, given the resource characteristics, to optimize power cycle based on capital cost, O&M costs, efficiency, reliability, and historical operating experience. Once completed, this site specific analysis will be applied to other moderate-temperature geothermal resource areas in Northern California to develop a Geothermal Atlas. The atlas will show the availability of geothermal resources, resource characteristics, and the most appropriate types of geothermal power generation systems for these sites.

Wilbur Hot Springs, an area of abundant thermal springs and quicksilver deposits, is located approximately 18 km east of Clear Lake in the north-central Coast Ranges of California. (Figure 1). The area, characterized by rugged relief and heavily wooded slopes, was the center of an extensive mercury mining industry around the turn of the century. Today the land is being used in a limited capacity as pasture for the grazing of cattle. Preliminary geothermal exploration began in the mid-1960's and soon confirmed the existence of a pronounced thermal anomaly in the Wilbur Hot Springs area. A series of shallow holes drilled to a maximum depth of 100 m indicated thermal gradients as high as $0.3^{o}C/m$, and two deep holes drilled to depth of 400m (Magma Power Co.) and 1200 m (Cordero Mining Co.) reached maximum bottom temperatures of $120^{o}C$ and $140^{o}C$, respectively. Although these holes yielded bottom hole temperatures too low for wellhead power generation, both wells were believed to be drilled outside of the main thermal anomaly, and southwest of Wilbur Hot Springs. An extensive study of the economic geology of the area (Moisseeff, 1966) has demonstrated that the hot springs, the occurrence of cinnabar, and quicksilver deposits are all related and are probably associated with recent volcanic activity near Clear Lake. Further support for this association was recently obtained with the mapping of a dike of 1.6 my andesitic basalt in the vicinity of Wilbur Hot Springs (Thompson, 1979). The andesitic basalt has been related to the 1.3 to 2.0 m.y. basaltic lavas of the Clear Lake Volcanic Field by Hearn and others (1981). While the andesitic basalt is undoubtedly too old to be the present day heat source for the hot springs at Wilbur, Hearn and others (1981) believe that the Clear Lake Volcanics, including the

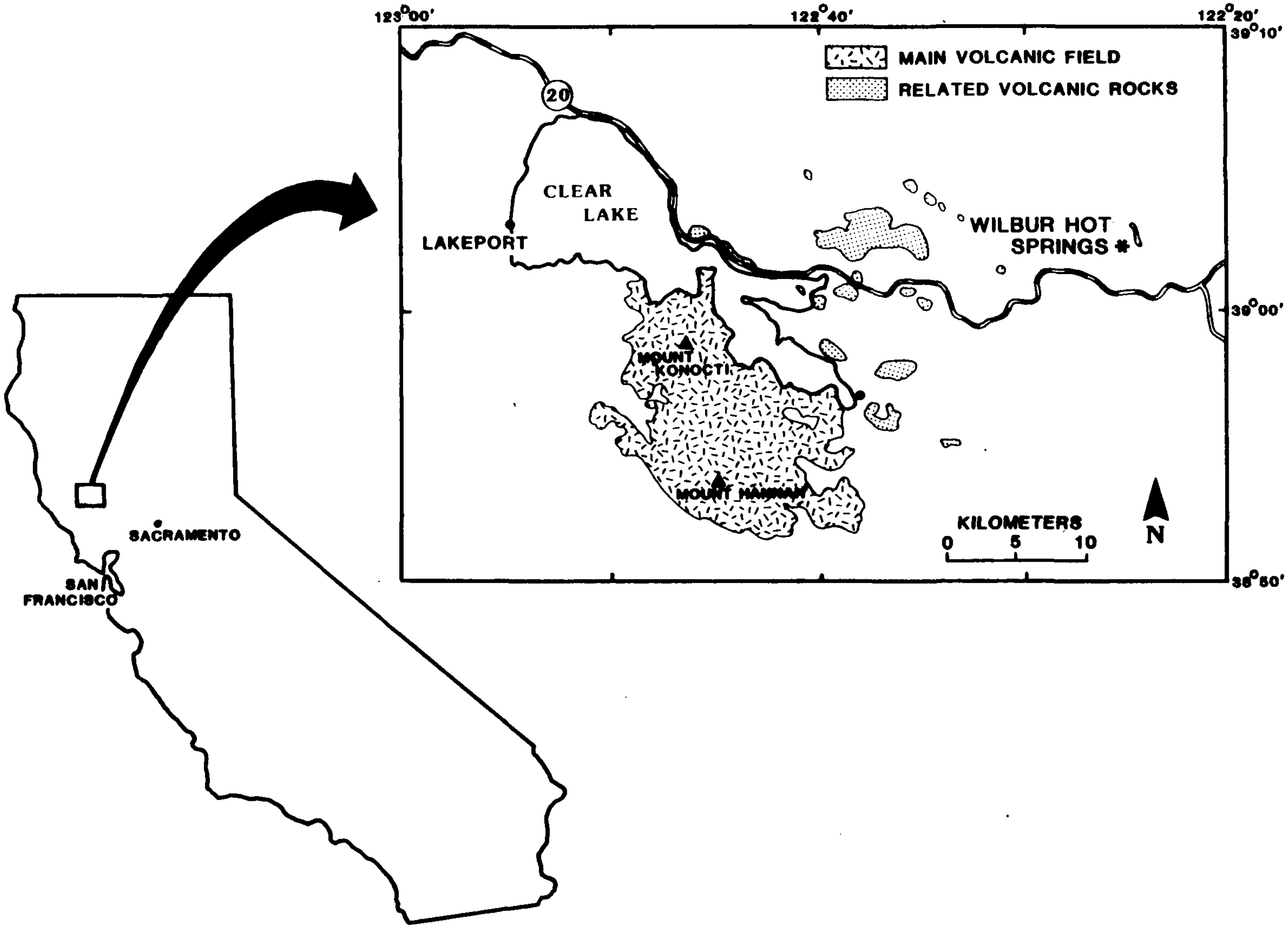


Figure 1. Generalized map showing the location of the Clear Lake volcanic field.

intrusion at Wilbur, maybe the surface manifestation of a mantle hot spot that has left a tract of Tertiary and Quaternary volcanic centers throughout the northern California Coast Ranges. A magma chamber currently located south of Clear Lake, is the likely source of heat for the vapor-dominated geothermal system at The Geysers and the inferred hot-water geothermal system beneath the volcanic field. It is thus also probable that a small magma chamber or cooling pluton may still exist at depth beneath the Wilbur Hot Springs area. Regional and detailed gravity surveys, conducted between 1977 and 1981, were initiated to explore this possibility (Harrington and Verosub, 1981). These surveys were designed to determine the nature of the thermal anomaly, its precise location and depth below the surface. The geophysical investigations confirmed that a negative gravity anomaly is associated with the hot springs and quicksilver deposits and that the feature likely arises from a shallow geothermal reservoir 1.5 km to the south of Wilbur Hot Springs proper.

Defining the geographical extent and understanding the character of this moderate-temperature resource near Wilbur Hot Springs would likely facilitate the resurgence of mineral mining in this part of Colusa County. Homestake Mining Company (HMC), owner of the Mclaughlin Gold Mine located 15 km to the south, has already explored the property encompassed by the negative gravity anomaly and has, indicated that they "fully intend to develop a small mine in the vicinity of Wilbur Hot Springs within the next decade". Recent discussions with HMC's regional office in Reno have further suggested that if a developable geothermal resource exists on or adjacent to the property leased by HMC, that they may move up their timetable for development (Gustafson, oral communication, 1987).

To determine the extent and character of the presumed moderate-temperature geothermal resource near Wilbur Hot Springs, the CEC proposes to supplement existing temperature gradient and geophysical data with an extensive geochemical survey in the area defined by the negative gravity anomaly, located approximately 1.5 km south of Wilbur Hot Springs (Figure 2). The geochemical survey will include a soil radon and trace metal investigation as well as sampling of all surface and hot spring waters located. The results of this investigation will be used to site an eventual production well to support a wellhead power generation system. A modular system, with capacities in the range of 1/2 to 10 megawatts, is currently being considered. Modular systems offer the advantage of low financial risk, which is particularly important when developing new resources whose characteristics are not completely known. Modular systems also can be installed on a relatively short schedule and increments as justified by historical geothermal reservoir performance and the demand for electricity.

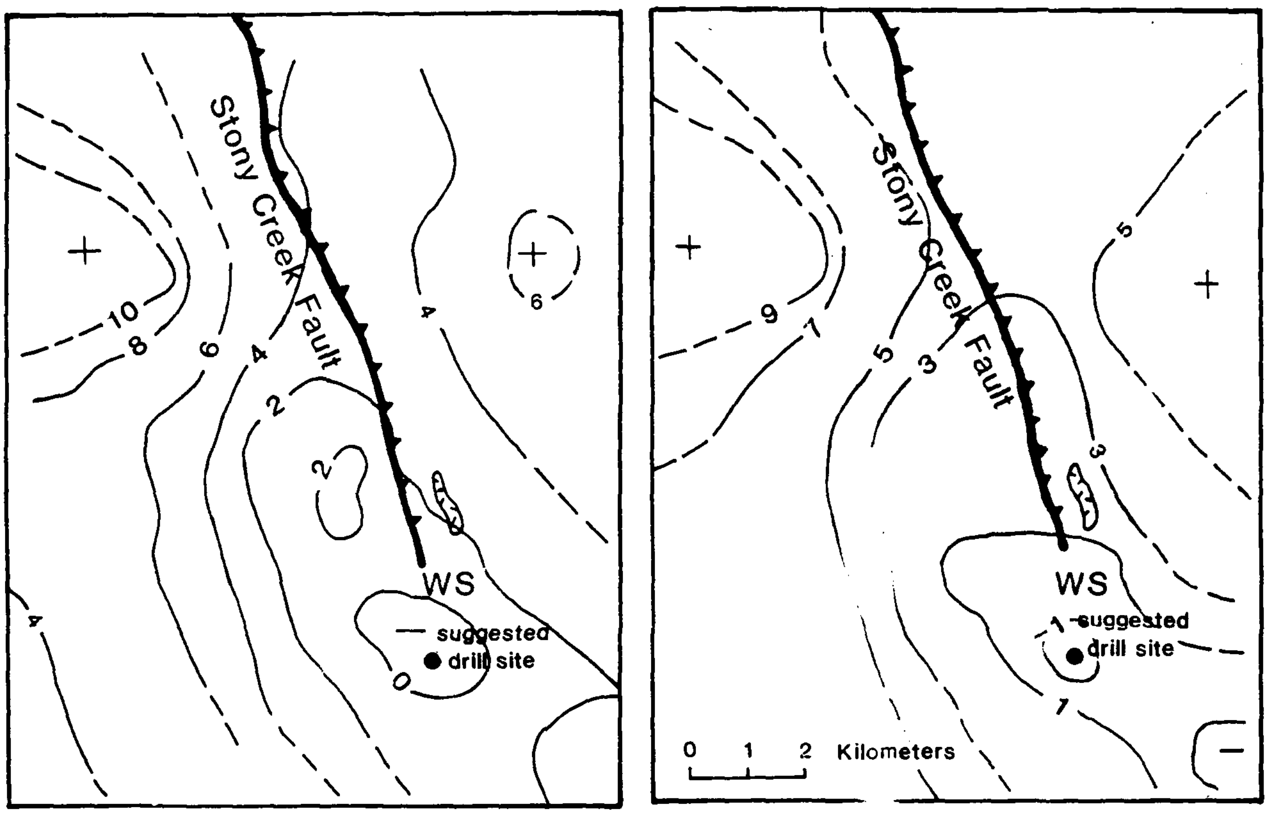


Figure 2. Map showing the location of the proposed exploratory well, relative to the negative gravity anomaly of Harrington and Verosub (1981). Note that the southern projection of the Stony Creek fault aligns with Wilbur Hot Springs (WS) and the center of the gravity anomaly. Figures A and B are even and odd integral contour intervals for a reduction density of 2.50 g/cm^3.

The types of geothermal power cycles to be considered will include single and double flash, binary cycle, and rotary separator turbine. Single flash is the simpliest hot water geothermal power cycle. A simplified schematic of such a cycle is shown in Figure 1 of Appendix A. Hot brine from geothermal production wells is directed to a flash vessel, where the brine is flash boiled by reducing its pressure. The resulting steam is expanded through a turbine to generate power, and then condensed in a surface condenser. The steam condensate is combined with spent brine from the flash vessel, and the resulting mixture is returned to the geothermal reservoir. The main advantages of the single flash cycle are its relatively low cost and simplicity. The major disadvantage of flash cycles in general is low efficiency; however, this disadvantage may be offset by lower cost, particularly at high reservoir temperatures.

The dual flash cycle is similar to single flash, except that hot brine from geothermal production wells is flash boiled in two stages rather than one. A simplified dual flash cycle schematic is shown in Figure 2 of Appendix A. Steam produced in the first flash vessel is expanded through a high-pressure turbine to generate power. The spent brine is routed to a second, lower pressure flash vessel, where additional steam is produced. This steam is combined with the high-pressure turbine exhaust, then expanded through a low-pressure turbine to generate additional power output. To complete the cycle, condensed low-pressure turbine exhaust steam and spent brine from the low-pressure flash vessel are mixed and returned to the geothermal reservoir. Dual flash cycles are more costly than comparable single flash cycles, but the cost is often outweighted by the possible gains in efficiency.

A typical binary cycle for geothermal power production is shown in Figure 3 of Appendix A. In a binary cycle, hot geothermal brine is used to preheat and then boil a working fluid such as ammonia, freon or isobutane/isopentane. The brine is returned directly to the geothermal reservoir, without coming in direct contact with the working fluid. After boiling, the working fluid expands through a turbine to generate power. The turbine exhaust fluid is condensed and then pumped back to the brine heat exchangers to complete the cycle. Binary cycles can be designed to deliver fluid to the turbine at multiple pressures, similar to flash cycles. The principal advantage of binary cycles is relatively high efficiency, which often outweighs the high cost and complexity. Many of the low-temperature geothermal resources in California could be developed economically only through the use of binary cycles.

Total-flow rotary separator turbine (RST) systems are similar to flash cycles, but substitute an RST for the flash vessel. Figure 4 of Appendix A shows a typical total-flow RST cycle.

Hot geothermal brine is routed directly to an RST and the brine is expanded through the RST as steam/water mixture in order to produce power. Steam available at the RST exhaust may then be expanded through a steam turbine to produce additional power. Exhaust steam and spent brine from the RST are returned to the geothermal reservior in the same manner as for the single flash cycle. RST's offer the advantage of direct utilization of geothermal brine and relatively low costs; however RST's must be extremely rugged to withstand the corrosive and erosive effects of the flashing geothermal brine.

Based on the information derived from the CEC assessment of the Wilbur Hot Springs area, other potential moderate-temperature geothermal areas in Northern California will be evaluated in terms of resource characteristics to determine the optimum geothermal power generation systems for these sites. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared to show economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. These curves can be combined with projections of future power costs to answer the following questions:

- When will development of wellhead geothermal resources be economical?
- Which areas in Northern California should be given the highest priority for future development?
- What type of geothermal power cycles should be constructed, and what are their associated costs and performance?
- How much economical geothermal capacity exist in Northern California for utility-scale power generation?

The development of the Geothermal Atlas for the Northern California area will be of enormous benefit to energy planners, utilities, small power producers, and regulatory agencies. The ultimate goal of such a plan is the development of California's indigenous geothermal resources. This development is necessary to meet the increasing demand for energy at a point in time when existing large-scale electrical generation development at the Geysers in Northern California is expected to level off and possibly even decline.

2. Key Tasks

Task 1A. Literature Search. Conduct a research of all pertinent geologic and geothermal information concerning the Wilbur Hot Springs area including:

a. Published literature, geologic maps, geophysical data and geothermal information.

b. Unpublished reports, dissertations, theses, and well logs and open file reports by the U.S. Geological Survey, California Division of Mines and Geology and the California department of Water Resources.

c. Existing water information, both thermal and cold wells and springs, including chemistry, temperature, depth to groundwater, and subsurface logs.

Task 1B. Geologic Field Reconnaissance. Based on an analysis of the data obtained in Task 1A, supplemented by an evaluation of aerial photography, a brief field reconnaissance of the area will be undertaken to 1) develop a grid system for the soil geochemical survey, and 2) to locate all thermal and cold springs in the vicinity of the negative gravity anomaly.

a. Acquire stereo air photo coverage of the area encompassing the negative gravity anomaly. Conduct an evaluation of the aerial photography searching primarily for fault intersections, lineaments, and surface manisfetations of hot spring activity, leaching, mineralization etc.

b. Complete reconnaissance-level field mapping to provide documentation of structual features, hot and cold springs identified from air photos and to establish a grid system for the soil geochemical survey.

Task 1C. Geochemical Surveys. Soil geochemistry and the sampling of all surface and spring waters in the area bounded by the negative gravity anomaly.

a. Obtain radon detectors from Terra-Tech. Radon, like soil mercury, is found in anomalous concentrations in geothermal areas. Also like mercury, radon is a vapor that is trapped at the base of the A horizon of a soil profile. A radon detector is placed in an augered hole approximately 15 cm below the surface, and the hole is covered. The detector is retrieved in 48 hours, and taken to the terra-tech lab for anaysis. In this region of mercury enrichment it is believed that radon will provide a more definitive interpretation of the geographical extent of the resource.

b. Analyze soil samples. Soil samples, derived from the augering of holes for the radon detectors, will be evaluated for trace metals characteristic of the gold-mercury-geothermal association.

c. Analysis of surface waters and hot springs. All surface and spring waters, both thermal and cold will be sampled and analyzed to determine chemical characteristics and subsurface temperatures.

d. Draft report summarizing the results of task 3a-3c, and recommending a location for the drilling of a production well.

Task 2A. Technical Data Collection. Much of the data required to determine optimum geothermal power cycles is readily available from sources such as the Electric Power Research Institute (EPRI), Geothermal Resources Council (GRC), and equipment manufacturers. The United Technologies Research Center of east Hartford, Connecticut has prepared a report for EPRI that provides a database and preliminary guidelines for selecting geothermal power cycles of the types described above (Reference: EPRI AP-4070, Analysis of Power cycles for Geothermal Wellhead Conversion Systems, June 1985). United Technologies Research Center and Elliott Company of Jeannette, Pennsylvania have also prepared a design guide for wellhead binary cycles (Reference: EPRI Research Project 2195-4, Modular Wellhead Binary Power ystems Design Guide, September 1985). The Heber binary Cycle Demonstration Plant in California's Imperial Valley, which has operated since June 1985 and produced as much as 25 megawatts gross of electrical output, is another possible source of data. Barber-Nichols and Ormat are equipment manufacturers on the list for inquiry.

Task 2B. Technical Data Validation and Assessment. The technical data collected under Task 2A. will be checked for consistency and completeness. Available data on costs and performance will be compiled. Cost data will be updated to present day, checked for completeness of scope, and checked for reasonableness, i.e., whether the specified equipment can be procured at the costs indicated. Because some potential wellhead sites might not have sufficient water available for evaporative cooling, both wet and dry cooling cycles will be evaluated. Effort will be made to contact operators of existing wellhead power plants to obtain operating experience data, discuss plant performance, and identify any operating problems on specific equipment. The results of field visit with plant operators will be factore into the cost and performance data, as appropriate.

Task 2C. Technology Database Development. In this Task the validated technical data from Task 2B. will be assessed to develop accurate technology database on:

- capital costs including equipment costs, construction costs, labor costs, plant startup costs, engineering and project management costs, allowance for funds used during construction (AFUDC),

- operating and maintenance costs including operating labor, operating consumables, maintenance labor, maintenance materials, overhead, taxes and insurance,

- performance and operating characteristics including plant efficiency, operating temperature range, geothermal flow requirement.

Task 3. Site-Specific Geothermal Technology Characterization for Potential Resource Areas in Northern California. Based upon the results from Tasks 1A through 1C and 2C, the appropriate geothermal generation technology for Wilbur Hot Springs and for potential resources in Northern California will be characterized.

A. Wilbur Hot Springs Technology Characterization. Wilbur Hot Springs is located within 15 miles to the northeast of the Geysers dry-steam geothermal field. At the Geysers, PGandE operates 19 power plants with a total generation capacity exceeding 1300 megawatts. Both the CEC and PGandhave a particular interest in this site. From previous geological work the Wilbur Hot Springs site shows great potential and further developmental work is desired. From PGandE's power generating aspect, the site is close to existing power transmission lines lowering the cost of constructing transmission line. In addition, its close proximity to the Geysers would also reduce operating and maintenance costs,

With the detailed resource development and characterization work outlined in Tasks 1B. and 1C., the technology characterization work of this task will provide accurate information on the costs of constructing utility-scale power plant at Wilbur Hot Springs and assist CEC and PGandE to evaluate the potentials of the wellhead modular systems.

B. Geothermal Atlas in Northern California. In this task a geothermal atlas for the Northern California area will be developed to show the potentials of geothermal resource availability, resource characteristics, and the associated types of geothermal power cycles for these sites. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared showing economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. These curves can be combined with projections of future power costs to answer the following questions:

- o When will development of wellhead geothermal resources be economical?
- o Which areas in Northern California should be given the highest priority for future development?
- o What type of geothermal power cycles should be constructed, and what are their associated costs and performance?
- o How much economical geothermal capacity exist in Northern California for utility-scale power generation?

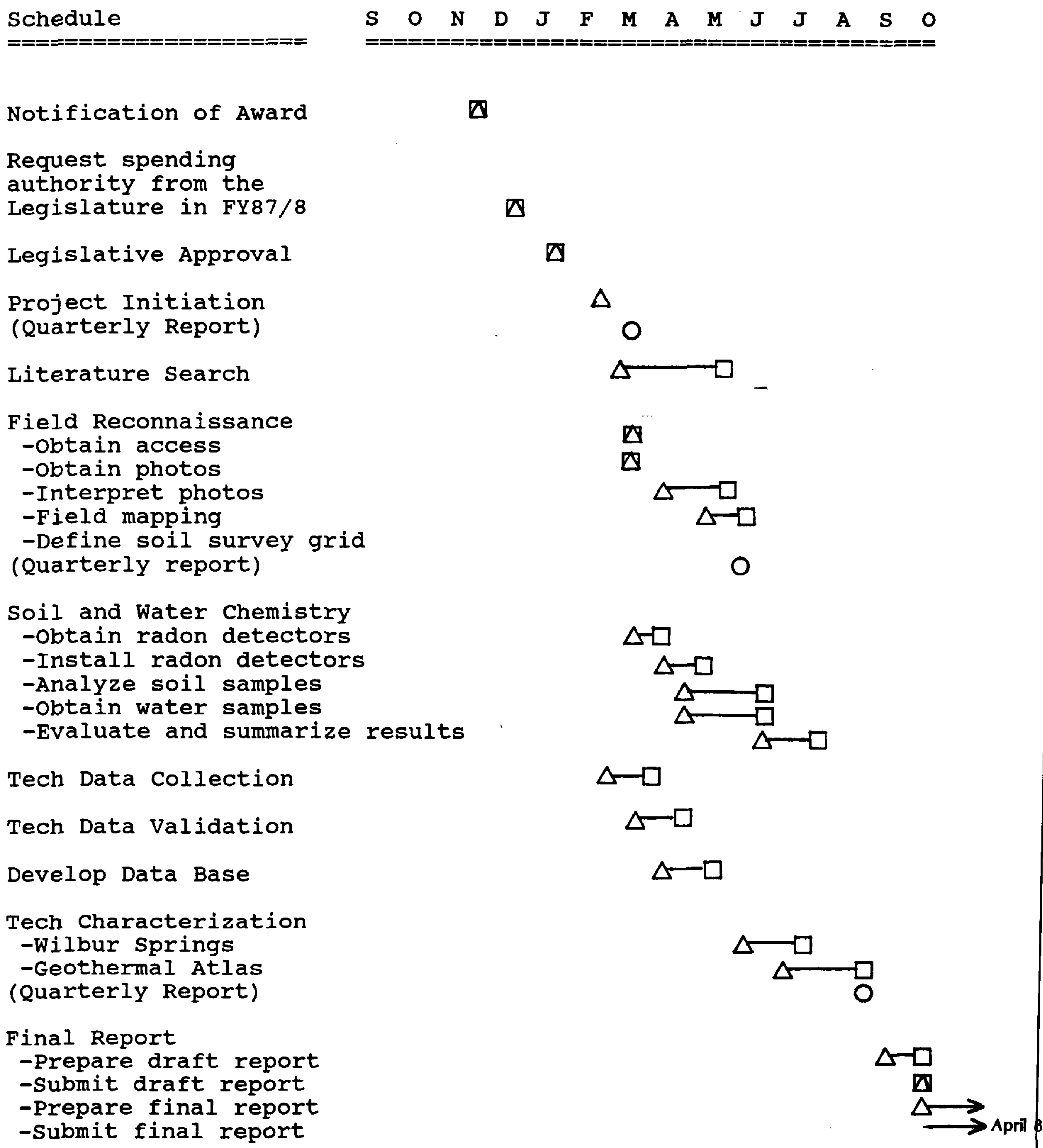
Specific tasks to be completed include:

- o Integrate newly developed resource assessment data with the listing of moderate temperature KGRA's as indicated on the Technical Map of the geothermal Resources of California (Majmundar, 1983)
- o Develop location map of KGRA, being evaluated, and complete atlas by preparing a matrix of all resource data.
- o Integrate resource data with wellhead technology data to complete the atlas.

Task 4. Final Report Preparation. A final report will be prepared summarizing the results of the Wilbur Springs Assessment, the integration of the site specific Wilbur Springs resource data with the PGandE technology assessment data and a draft of the Geothermal Atlas.

3. Schedule

A tentative work schedule is presented on the next page. However, there is a major administrative consideration. If the CEC receives funding for this project, the California Legislature will have to approve the spending authority by amending the CEC's FY1987/88 budget. This will require four to eight weeks to obtain.



KEY: Task initiation △ , Task completion □ , Quarterly Report ○

QUALIFICATIONS AND CAPABILITIES

1. Description of Proposing Organization

The CEC proposes to undertake the work at Wilbur Hot Springs using CEC staff resources and technical support from the Berkeley Group Incorporated (BGI). BGI is currently under contract to the CEC. BGI will provide geotechnical support to the CEC staff in Task 1C (Exploratory Well Drilling). The CEC will pay for these services with state contract funds separate from any that may be awarded by DOE. DOE will not be required to enter into a contract with either of these firms. Therefore, the estimated cost of their services are presented in the Business Proposal as match contribution. The CEC will contract with a drilling company to drill the TG well drilling in Task 1C. The CEC maintains lists of highly qualified drilling contractors which we will use as a basis for a competitive bid selection process. We also would welcome any recommendations of qualified contractors that DOE staff may wish to provide should we receive funding.

The following descriptions depict the general capabilities of the CEC, BGI, and Chemwest. The biographies of the key personnel of each organization are provided as an appendix.

<u>California Energy Commission</u>

The CEC is the only state agency with a comprehensive program of research and development in low- and moderate-temperature geothermal energy. The responsibility for administering the CEC's Geothermal Program rests with the Office of Research and Development within the Development Division. The Program's objective is to provide technical and financial assistance to both public and private organizations in California. The goal is to achieve wider development of California's plentiful low- and moderate-temperature geothermal resources.

The Program is comprised of staff with expertise in geology, hydrology, geochemistry, mechanical engineering, economics, and project management. Direct technical assistance offerred through the Program includes geologic evaluation and resource assessment, economic and engineering feasibility analyses, and project planning and review. The CEC also maintains a geothermal library which includes market assessment studies, feasibility studies, regional and site-specific resource data, geothermal technology reports, and environmental data and planning documents.

In addition, local governments may apply for financial assistance through the CEC's Geothermal Grant and Loan Program. Funding may be used for planning studies related to geothermal power plants; to assess and develop geothermal resources, and to mitigate the impacts of existing geothermal development.

Berkeley Group Incorporated

BGI has been proving geotechnical consulting services to the geothermal industry since 1980. The main office is in Berkeley, California. BGI consists of six professional staff members and several staff associates. The BGI staff includes expertise in geology, hydrology, reservoir engineering, well engineering, mechanical engineering, project management, and equipment engineering. Their primary expertise includes all aspects of geothermal electric generating projects, except turbines and power lines, and wellfield and resource engineering. They also have experience in financial analysis and evaluation of energy conversion technologies.

BGI provides high-technology data acquisition equipment for geothermal measurements through its subsidiary, BG Technologies. The BGI equipment manufactured for wellfield use includes: high-resolution microcomputer loggers; downhole and surface tools for measuring pressure, temperature and flowrate; and production sampling equipment for real-time gas monitoring. BGI equipment is used in many applications worldwide. BGI also provides resource and wellfield engineering software for use with microcomputers and mainframes through its subsidiary BGI Software. This working knowledge of geothermal equipment makes BGI well suited to assist in the proposed Brockway Hot Springs project.

Pacific Gas and Electric Company

PGandE is the largest investor-owned public utility in the United States, with a wide variety of experience in the management and operation of oil- and gas-fired power plants,electric transmission facilities, and natural gas distribution facilities. PGandE is also actively involved in renewable energy projects including hydroelectric power plants, and has the world's largest combined generating capacities form geothermal power plants (the Geysers) and from wind turbines (Altamont Pass wind farms). Within PGandE, the Department of Engineering Research guides and focuses research, development, and demonstration activities for new and emerging energy technologies. The Mechanical Systems Group for geothermal projects in the Department of Mechanical and Nuclear Engineering has expertise in the design, project management of the construction of dry-steam geothemal power plants. The two departments have a common goal in developing hot-water geothermal resources in Northern

California for utility-scale power generating application.

2. Function of Key Personnel

Personnel	Function
Kent S. Murray Ph.D.	CEC geologist responsible for overall project supervision, report preparation, and will participate directly in Tasks 1A, 1B, 1C, 3B and 4.
Cheryl A. Closson	CEC geologist responsible primarily for implementing Tasks 1B, 1C, and 3B.
Paul O. Petersen	PGandE Supervising Mechanical Engineer, responsible for overall project supervision and report review. Will participate in tasks 2C and 4.
Charles R. Hicklin	PGandE Senior Mechanical Engineer, responsible for data collection and analysis. Will participate in Task 2A, 2B, 3A and 4.
Peter Y. Lee	PGandE/RD&D Program element Manager, responsible for project coordination for the PG&E team and report review. Will participate in Task 3B.
Staff Engineers	PGandE Staff Engineers not identified yet, responsible for Task 2A, 2B and 2C.

Function of Key Personnel

Staff Member	Field Data Acquisition	Data Analysis	Report/Atlas Preparation	Report Review	Staff Mgmt.
Murray	X	X	X	X	X
Closson	X		X		
Peterson				X	X
Hicklin	X	X	X		
Lee				X	X
Staff Engineers	X	X			

3. Biographies of Key Personnel

The resumes of the key personnel appear on the following pages.

K. S. Murray

EDUCATION: Ph.D. Degree in Geology, 1981
University of California

M.S. Degree in Geology, 1974
Northern Arizona University

B.S. Degree in Geologoy, 1970
Western Michigan University

PROFESSIONAL HISTORY

1981 - Present
California Energy Commission

Geothermal specialist with expertise in reservoir/ resource evaluation. Provide geologic, geochemical and geohydrologic expertise to a wide variety of geothermal end-users including local governments and private industry. Responsibilities include resource assessment and confirmation studies, well engineering, groundwater modeling, site feasibility studies, and contract/project management.

1982 - Present
California State University - Sacramento

Adjunct Professor of Engineering and Environmental Geology with teaching and research responsibilities primarily in the fields of engineering geology, environmental geology, hydrology, geothermal energy, and oceanography (coastal erosion studies). Other responsibilities include thesis supervision, advising students in engineering and environmental geology, and faculty advisor to the student chapter of the Association of Engineering Geologists.

1983 - Present
Consultant

Geotechnical consultant providing services in the field of geothermal resource assessment, toxic waste disposal, engineering geology, and geohydrology to a wide range of clients including local governments and other consulting firms.

1981
Oregon State University

Visiting Professor of Engineering Geology teaching graduate and under-graduate courses in engineering geology.

1977 - 1981
California Energy Commission

Geologist responsible for review and analysis of geotechnical and seismic considerations for proposed power plant sites and related facilities. Assisted in the preparation and editing of comprehensive reports on the geological aspects of power plant siting, design, and operation. Supervised, conducted, and contracted commission-sponsored research in geothermal resource evaluation, and reservoir modeling studies, including both single-phase and two-phase reservoirs.

1974 - 1977
Fugro Inc. Consulting Engineers and Geologists

Geologist responsible for site selection studies for critical facilities in the Western United States, Puerto Rico, Japan, and the Middle East. Supervised a team of geologists and engineers conducting regional and site feasibility investigations. Conducted field investigations for fault-risk analysis for proposed nuclear power plant sites.

1972 - 1974
U.S. Geological Survey, Center of Astrogeology

Geologist responsible for the preparation of geologic maps of proposed Moss landing sites for Viking program. Utilized satellite imagery and volcanic analog studies in a supervised program of lunar research and terrain mapping.

PROFESSIONAL SOCIETIES

Association of Engineering Geologists, Member
Geological Society of America, Member
American Association for the Advancement of Science, Member
Arizona Academy of Science, Member
Geothermal Resources Council, Member

AWARDS AND ACTIVITIES

Dean's list scholar - U.C. Davis
Registered Geologist, State of California (No. 3264)
Registered Geologist, State of Oregon (No. 210)
Certified Engineering Geologist, State of Oregon (No. E210)

RECENT PUBLICATIONS IN THE FIELD OF GEOTHERMAL RESEARCH

Low- to Moderate-Temperature Geothermal Resource Assessment - A Methodical Approach, California Energy Commission, Staff Report, 1984.

Geochemical Exploration of the Calistoga Resource Area, Napa Valley, California, co-author with Mark Jonas and Carlos Lopez: Geothermal Resources Council, Transaction, V.8, p. 339-344, 1985.

Geochemical Modeling of the Calistoga Geothermal Field, Napa Valley, California, co-author with Mark Jonas: Geothermal Resources Council, Transactions, V.9, p. 139-144, 1986.

Geothermal Resource Assessment Study, City of Calistoga, California Energy Commission, Staff Report, 82 p. 1986.

C. A. Closson

EDUCATION: B. A. Degree in Earth Science, 1982
University of California, Berkeley

PROFESSIONAL HISTORY

1987 - Present
California Energy Commission

Geologist responsible for providing in-field technical assistance for resource assessment and development aspects of low-temperature geothermal projects. Manage projects funded under the Geothermal Grant and Loan Program for Local Jurisdictions.

1986 - 1987
I-Chem Research, Inc.

Geologist/Water Quality Technician responsible for conducting field sampling and monitoring of surface and groundwater, air, and soil. Performed chemical and physical tests on sampler in the field and in the lab including pH, EC, alkalinity, and anion/cation/trace metal determination.

1985 - 1986
United States Bureau of Reclamation

Geologist responsible for field sampling and lab testing of water, soil, and rock for engineering geologic and geochemical studies. Lab tests included wet screening/mechanical analysis, sample extract preparation, atomic absorption analysis for trace metals, pH, EC, and alkalinity. Constructed and drafted geologic maps and diagrams, compiled data, edited and proofed reports and papers for publication.

PROFESSIONAL SOCIETIES

Geologic Society of America, Member

P. O. Petersen

EDUCATION : B.S. Degree in Mechanical Engineering, 1960
Iowa State University

OCCUPATIONAL HISTORY

1969 - Present
Pacific Gas & Electric Company, San Francisco, CA

Supervising Mechanical Engineer: Supervise the Mechanical Systems Group for geothermal projects being designed and constructed at the Geysers Power Plants. The projects range from pollution abatement retrofits facilities to new power plant additions. Responsible for the overall technical direction of the Geothermal Mechanical Systems Group and for the compliance with project objectives, schedules and budgets.

Senior Mechanical Engineer: Responsibilities included designs and project management on various PG&E projects such as fossil fuel power generation, direct steam heating facilities, gas turbines and combined cycle power plants, wind and geothermal power generation.

1960-1969
Bechtel Power Corporation, San Francisco, CA

Mechanical Engineer: Responsibilities included designing mechanical systems for petroleum nd chemical refineries.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M021529)

C. R. Hicklin

EDUCATION: B.S. in Mechanical Engineering, 1972
University of California, Berkeley

OCCUPATIONAL HISTORY

1979 to Present
Pacific Gas and Electric Company, San Francisco, CA

Senior Mechanical Engineer: Serve as Mechanical Systems Group Leader for five geothermal power project being designed or constructed at the Geysers Power Plant, Sonoma and Lake Counties, California. The projects range in size from 110 to 140 megawatts, and four of them have attained commercial operation to date. Responsible for supervision and technical direction of Mechanical Engineers assigned to the projects, coordination of design and construction activities with operations and construction personnel, power cycle optimization studies, and project licensing through the California Energy Commission.

Mechanical Engineer: Responsible for various power plant efficiency improvement, reliability improvement and pollution abatement retrofit projects at the Geysers Power Plant. Activities included conceptual design studies, preparation of design criteria and calculations, equipment procurement, and construction and operations support.

1972 - 1979
Bechtel Power Corporation, San Francisco, California and Ann Arbor, MI

Mechanical Engineer: Responsibilities included supervision and technical direction of Mechanical Engineers, power cycle optimization, system reliability studies, preparation of design criteria and calculations, equipment procurement, and supervision of drawing preparation. Developed nuclear safety-related system designs in compliance with Nuclear Regulatory Commission and ASME Section III requirements, and responsible for preparation and coordination of a project Environmental Report.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M016733)

P. Y. Lee

EDUCATION: MBA Degree in Finance, 1983
University of California, Berkeley

M.S. Degree in Mechanical Engineering, 1971
University of California, Berkeley

B.S. Degree in Mechanical Engineering, 1969
University of California, Berkeley

OCCUPATIONAL HISTORY

1979 - Present
Pacific Gas and Electric Company, San Ramon, CA
Research, Development and Demonstration (RD&D) Program Element Manager: Responsible for PG&E's research planning and implementation in areas of coal conversion, biomass/MSW conversion, solar thermal technology, and geothermal technology and development. Represent PG&E as a member of the technical and management committee on the Heber Binary Project.

Mechanical Engineer: Conducted noise and vibration testing and control for PG&E companywide facilities. Provided noise impact evaluation for several PG&E dry-steam geothermal power plants at the Geysers.

1971 - 1979
Wilson, Ihrig & Associates, Inc., Oakland CA

Acoustical Consultant: Provided consulting services in acoustics in various areas including rapid transit systems, chemical plants, refineries, mechanical systems, and building acoustics. Responsibilities included performing noise and vibration testing, recommending mitigation designs, and conducting business promotion and client contact.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M018149)

APPENDIX A

Diagrams of Wellhead Generation Systems

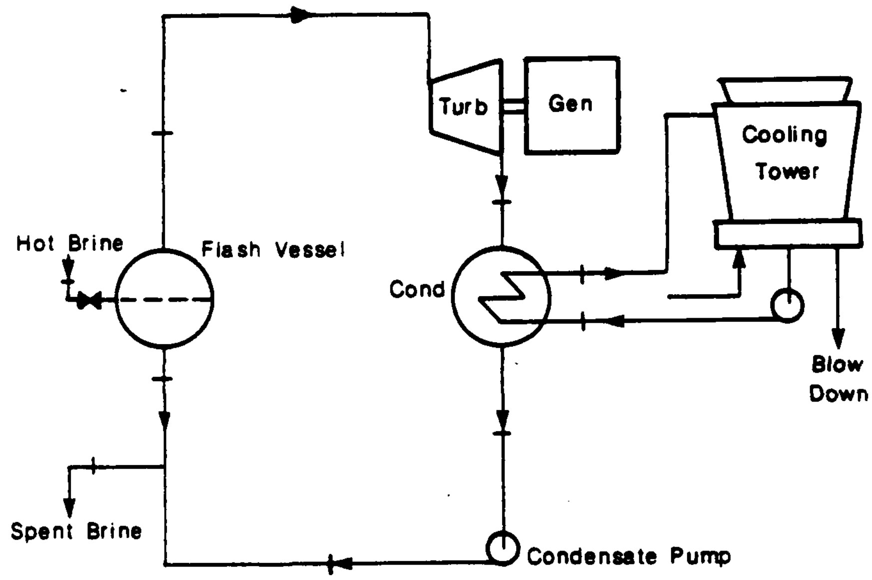


FIGURE 1. Flow Diagram of a Single-Flash System

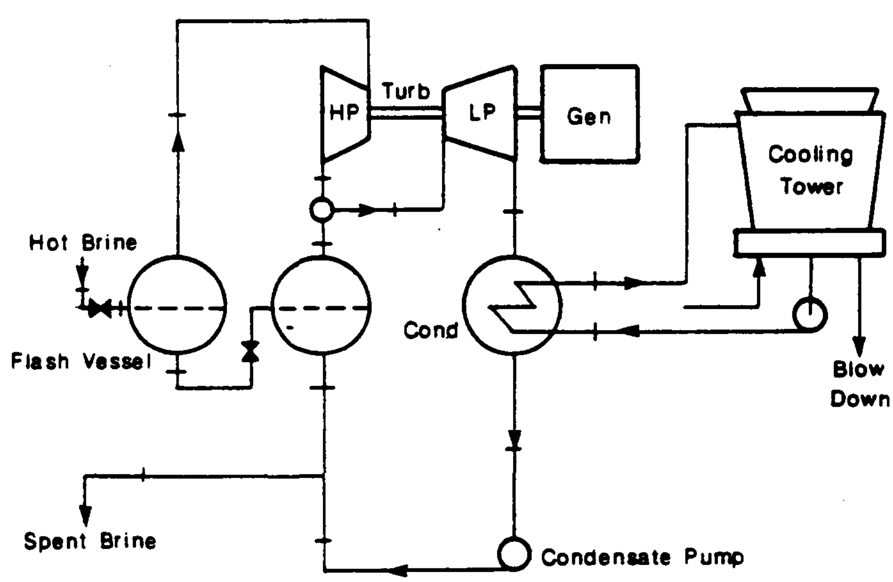


FIGURE 2. Flow Diagram of a Double-Flash System

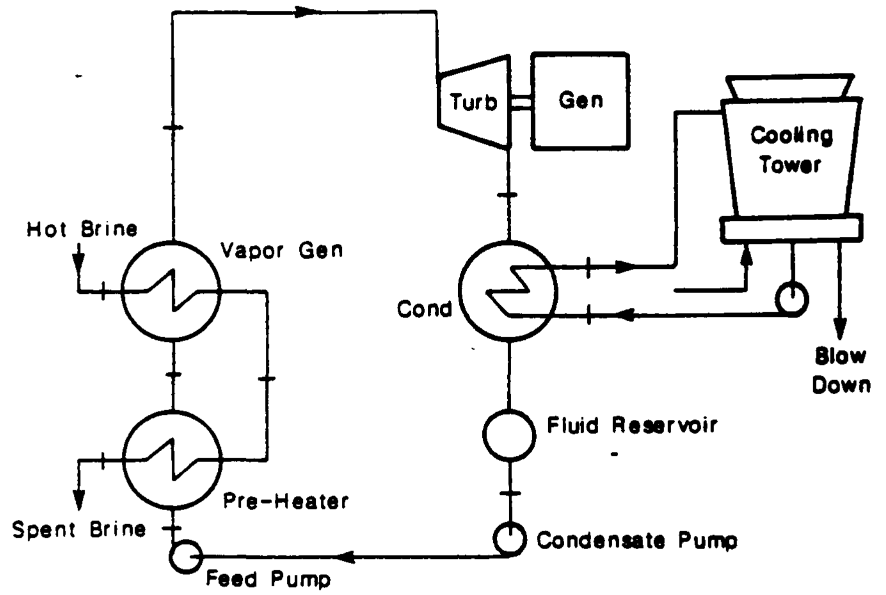


FIGURE 3. Flow Diagram of a Binary-Cycle System

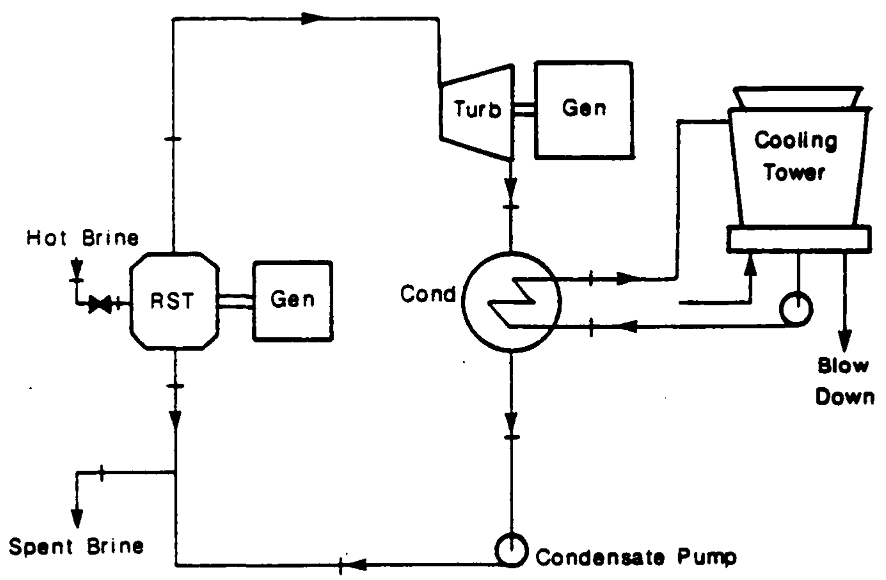


FIGURE 4. Flow Diagram of a Total-Flow RST System

REFERENCES CITED

Harrington, J. M. and Verosub, k., 1981, A detailed gravity survey of the Wilbur Springs area, California: in Research in The Geysers-Clear Lake geothermal area, northern California: U.S. Geol. Survey Prof. Paper 1141, 259p.

Hearn, B.C., Donnelly-Nolan, J.M., and Goff, F.E., 1981, The Clear Lake Volcanics: Tectonic setting and magma sources: in Research in The Geysers-Clear Lake geothermal area, northern California: U.S. Geol. Survey Prof. Paper 1141, 259p.

Moisseeff, A. N., 1966, The geology and geochemistry of the Wilbur Springs quicksilver district, Colusa and Lake Counties, California: Ph.D. Thesis, Stanford University, 214p.

Thompson, J. M., 1979, A reevaluation of geothermal potential of the Wilbur Hot Springs area, California: Geothermal Resources Council, Transactions, v.3, p729-731.

PART II - BUSINESS PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 1 of 8 ORIGINAL COPY

Date of Submission June 19, 1987 revised October 7, 1987

Name of Proposer California Energy Commission

Address of Proposer 1516 Ninth Street

Sacramento, California 95814

Title of Proposal Resource Assessment of the Wilbur Hot Springs Area

Location of Work Northeastern Lake County, California

Proposed Total Project Cost ______ DOE Funding Requested ______

Proposed Start Date December 15, 1987 Proposed Project Duration 12 (in months)

Official Contact for Negotiations Dr. Kent Murray Phone No. (916) 324-3474

Permission for Outside Evaluation Yes XXX No ___

Effective Period of Proposal 180 days

AUTHORIZED OFFICIAL: Signature [signature]

Name Typed ~~Kent Smith~~

Title Deputy Director

Date June 19, 1987

Please Check

Small Business ___	Disadvantaged Business ___	Other Profit ___
Women-Owned ___	Nonprofit ___	
University ___	State or Local Government XXX	

TABLE OF CONTENTS

Part II - Business Proposal

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

1. Program/Project Identification No.	2. Program/Project Title Resource Assessment of the Wilbur Hot Springs Area

3. Name and Address: California Energy Commission 1516 Ninth Street, MS-1 Sacramento, CA 95814	4. Program/Project Start Date December 15, 1987 5. Completion Date

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1.		$ 55,721.38	$ 35,142.45	$	$	$ 90,863.83
2.						
3.						
4.						
5. TOTALS		$	$	$	$	$

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program Function or Activity (1)	(2)	(3)	(4)	(5) TOTAL
a. Personnel	$	$	$	$	$ 36,080
b. Fringe Benefits					20,644.92
c. Travel					6,650
d. Equipment					500
e. Supplies					0
f. Contractual					15,000
g. Construction					0
h. Other					5,300
i. Total Direct Charges					84,174.92
j. Indirect Charges					6,688.91
k. TOTALS	$	$	$	$	90,863.83
7. Program Income	$	$	$	$	$

(4/14/87) G-7 (G/L)

Detailed Project Financial Plan

	Total Hours	Hourly Wage	Total Wages	Fringe Benefit 69%	Ind. Charge 6%	Total Budget	Federal	Non-Federal
I. Personnel Service								
Task 1A								
K. Murray	80	20.8	1664	500.86	779.35	2944.21		2944.21
C. Closson	80	9.8	784	235.98	367.19	1387.17		1387.17
Task 1B								
K. Murray	40	20.8	832	250.43	389.67	1472.10		1472.10
C. Closson	40	9.8	392	117.99	183.60	693.59		693.59
Task 1C								
K. Murray	80	20.8	1664	500.86	779.35	2944.21	2944.21	
C. Closson	80	9.8	784	235.98	367.17	1387.17	1387.17	
Task 2A								
C. Hicklin	80	27.00	2160.00	1490.40	129.50	3779.90		3779.90
Staff Engineers	160	23.00	3680.00	2539.20	220.80	6440.00		6440.00
Task 2B								
C. Hicklin	120	27.00	3240.00	2235.60	194.40	5670.00	5670.00	
Staff Engineers	240	23.00	5520.00	3808.80	331.20	9660.00		9660.00
Task 2C								
P. Petersen	40	29.00	1160.00	800.40	69.60	2030.00	2030.00	
C. Hicklin	100	27.00	2700.00	1863.00	162.00	4725.00	4725.00	
Staff Engineers	100	23.00	2300.00	1587.00	138.00	4025.00	4025.00	

Detailed Project Financial Plan

	Total Hours	Hourly Wage	Total Wages	Fringe Benefit	Ind. Charge	Total Budget	Federal	Non-Federal
I. Personnel Services (Cont.)								
Task 3A								
C. Hicklin	40	27.00	1080.00	745.20	64.80	1890.00	1890.00	
Task 3B								
P. Lee	40	25.00	1000.00	690.00	60.00	1750.00	1750.00	
K. Murray	120	20.8	2496.00	773.76	1177.11	4446.87		4446.87
C. Closson	120	9.8	1176.00	364.56	554.60	2095.16		2095.16
Task 4								
K. Murray	60	20.80	1248.00	386.88	588.57	2223.43		2223.45
P. Petersen	20	29.00	580.00	400.20	34.80	1015.00	1015.00	
C. Hicklin	60	27.00	1620.00	1117.80	97.20	2835.00	2835.00	
Total Personnel Services			36,080.00	20,644.90	6688.91	63,413.83	28,271.38	35,142.45

2. Detailed Budget Form (Cont'd)

	Total Budget	Federal	Non-Federal
II. Operating Expenses			
Task 1.A.			
Travel	500	500	0
Equipment	0	0	0
Other*	100	100	0
Task 1.B.			
Travel	3000	3000	0
Equipment	0	0	0
Other**	2000	2000	0
Task 1.C.			
Travel	1500	1500	0
Equipment	500	500	0
Contractual	15000	15000	0
Other	0	0	0
Task 2.A.			
Travel	0	0	0
Equipment	0	0	0
Other*	0	0	0
Task 2.B.			
Travel	1500	1500	0
Equipment	0	0	0
Other*	200	200	0
Task 2.C.			
Travel	0	0	0
Equipment	0	0	0
Other*	0	0	0
Task 3.			
Travel	150	150	0
Other++	3000	3000	0

	TOTAL BUDGET	FEDERAL	NON-FEDERAL
Task 4			
Travel	0	0	0
Other	0	0	0
SUBTOTAL	27,450	27,450	0
TOTAL BUDGET (I + II)	95373.45	55721.38	35142.45

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*printing, postage, phone, etc.
**purchase of airphotos
++graphics, printing

U.S. Department of Energy

Assurance of Compliance

Nondiscrimination in Federally Assisted Programs

California Energy Commission (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or handicap, in its employment practices. Such employment practices may include, but are not limited to, recruitment, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether

any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age and handicap; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age and handicap, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicant by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

June 19, 1987
(Date)

California Energy Commission

(Name of Applicant)

1516 Ninth Street, MS-1

Sacramento, CA 95814
(Address)

[signature]
(Authorized Official)

( ) (916) 324-3080
(Applicant's Telephone Number)

Attachment No. 4

OMB Approval No. 29-R0218

FEDERAL ASSISTANCE

1. TYPE OF ACTION (Mark appropriate box)	[ ] PREAPPLICATION [X] APPLICATION [ ] NOTIFICATION OF INTENT (Opt.) [ ] REPORT OF FEDERAL ACTION
2. APPLICANT'S APPLICATION	a. NUMBER: 912 b. DATE (Year month day): 19 87 06 19
3. STATE APPLICATION IDENTIFIER	a. NUMBER: NA b. DATE ASSIGNED (Year month day): 19
Leave Blank	

4. LEGAL APPLICANT/RECIPIENT

- a. Applicant Name : State of California
- b. Organization Unit : California Energy Commission
- c. Street/P.O. Box : 1516 Ninth Street, MS-1
- d. City : Sacramento, e. County : Sacramento
- f. State : California g. ZIP Code: 95814
- h. Contact Person (Name & telephone No.) :

5. FEDERAL EMPLOYER IDENTIFICATION NO. 94-60013476

6. PROGRAM (From Federal Catalog)
- a. NUMBER: 81.087
- b. TITLE: Renewable Energy Research & Development (Renewable Energy)

7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT

State Geothermal Research and Development--
Resource Assessment of the Wilbur Hot Springs Area

8. TYPE OF APPLICANT/RECIPIENT
A–State, B–Interstate, C–Substate District, D–County, E–City, F–School District, G–Special Purpose District, H–Community Action Agency, I–Higher Educational Institution, J–Indian Tribe, K–Other (Specify):
Enter appropriate letter: A

9. TYPE OF ASSISTANCE
A–Basic Grant, B–Supplemental Grant, C–Loan, D–Insurance, E–Other
Enter appropriate letter(s): A

10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.): Lake County

11. ESTIMATED NUMBER OF PERSONS BENEFITING: Unknown

12. TYPE OF APPLICATION
A–New, B–Renewal, C–Revision, D–Continuation, E–Augmentation
Enter appropriate letter: A

13. PROPOSED FUNDING	
a. FEDERAL	$ 81,690 .00
b. APPLICANT	43,984 .00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ 125,674 .00

14. CONGRESSIONAL DISTRICTS OF: a. APPLICANT: Statewide; b. PROJECT: District 1

15. TYPE OF CHANGE (For 12c or 12e)
A–Increase Dollars, B–Decrease Dollars, C–Increase Duration, D–Decrease Duration, E–Cancellation, F–Other (Specify):
Enter appropriate letter(s):

16. PROJECT START DATE (Year month day): 19 87 12 15

17. PROJECT DURATION: 12 Months

18. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY (Year month day): 19 87 06 19

19. EXISTING FEDERAL IDENTIFICATION NUMBER: N/A

20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code): DOE Idaho Operations Office, Idaho Falls, ID 83402

21. REMARKS ADDED [ ] Yes [X] No

SECTION II—CERTIFICATION

22. THE APPLICANT CERTIFIES THAT ▶

a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached:

	No response	Response attached
(1)	[ ]	[ ]
(2)	[ ]	[ ]
(3)	[ ]	[ ]

23. CERTIFYING REPRESENTATIVE
- a. TYPED NAME AND TITLE: Kent Smith, Deputy Director
- b. SIGNATURE: Don Wallace
- c. DATE SIGNED (Year month day): 19 87 06 19

SECTION III—FEDERAL AGENCY ACTION

24. AGENCY NAME: State of California

25. APPLICATION RECEIVED (Year month day): 19

26. ORGANIZATIONAL UNIT: California Energy Commission

27. ADMINISTRATIVE OFFICE: Grants & Loans (916)324-3060

28. FEDERAL APPLICATION IDENTIFICATION

29. ADDRESS: 1 516 Ninth Street, MS-1, Sacramento, CA 95814

30. FEDERAL GRANT IDENTIFICATION

31. ACTION TAKEN	32. FUNDING	
[ ] a. AWARDED	a. FEDERAL	$ .00
[ ] b. REJECTED	b. APPLICANT	.00
[ ] c. RETURNED FOR AMENDMENT	c. STATE	.00
[ ] d. DEFERRED	d. LOCAL	.00
[ ] e. WITHDRAWN	e. OTHER	.00
	f. TOTAL	$ .00

33. ACTION DATE ▶ (Year month day) 19

34. STARTING DATE (Year month day) 19

35. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

36. ENDING DATE (Year month day) 19

37. REMARKS ADDED [ ] Yes [ ] No

38. FEDERAL AGENCY A-95 ACTION

a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.

b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)

424-101

STANDARD FORM 424 PAGE 1 (10-75)
Prescribed by GSA, Federal Management Circular 74-7

APPENDIX A

CEC Indirect Cost Rate Proposal for FY 1987/88

ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

INDIRECT COST RATE PROPOSAL

FISCAL YEAR 1987-88

PURPOSE

This proposal outlines methods used to determine the Indirect Cost Rate which should be applied to all grant projects. This will allocate costs to those projects which are not otherwise identified or accounted for at the Energy Resources Conservation and Development Commission (ERCDC).

EFFECTIVE DATES

This rate is applicable to all projects for fiscal year 1987-88.

PROPOSAL

Our Proposed Indirect Cost Rate is 36% to be applied to Personal Services based on:

* Expected expenditures for FY 1987-88
* Plus the Approved Statewide Cost Allocation Plan (SWCAP) for FY 1987-88
* Plus an adjustment for actual expenditures for FY 1985-86

RATIONALE

The methods outlined are based upon the accounting system of the ERCDC. Our total State allotment is distributed among our divisions and offices. In addition to our divisions and offices, we also account separately for each grant project.

Each individual budget is broken down into line items for Personal Services, Operating Expenses and Equipment, and Research and Development contracts. The Executive Office, the Office of Governmental Affairs and the Public Information Office have been included with the indirect offices due to their increasing involvement in grant-related efforts, especially in the areas of developing new legislation, regulations, standards, etc. The fact that the involvement of these offices is mainly through the all-encompassing area of Commission meetings, hearings, and legislative sessions effectively precludes them from being able to charge grants directly. All other costs were determined to be direct costs.

Dividing total Indirect Costs (ERCDC indirect, plus SWCAP, plus adjustment) by total Direct Personal Services resulted in a rate of 36%. This rate will allow allocation of those grant costs which belong to, but are otherwise not charged to grant projects. The rate would be applied to Personal Services.

In accordance with page 15 of OACS 10, this is a Fixed with Carry-forward Rate applicable to all 1987-88 grants. Any difference between the estimated 36% Indirect Cost Rate and the actual rate will be included as an adjustment in our 1989-90 Indirect Cost Rate Proposal.

CALIFORNIA ENERGY COMMI TON
Indirect Cost Rate Proposal
1985 - 86 ACTUAL

	6/30/86 AEL	LESS ASD	LESS EXECUTIVE	LESS O E & E	TOTAL INDIRECT	TOTAL DIRECT
PERSONAL SERVICES						
Salaries & Wages	16,297,833	2,019,021	914,310		2,933,331	13,364,[illegible]
Less Overtime	-273,909	-32,814	-3,859		-36,673	-237,[illegible]
TOTAL, PERSONAL SERVICES	16,023,924	1,986,207	910,451		2,896,658	13,127,[illegible]
OPERATING EXPENSE						
General Expense	572,044	314,169	98,752		412,921	159,[illegible]
Printing	272,217	124,578	50,709		175,287	96,[illegible]
Communications	316,058			50,176	50,176	265,8[illegible]
Travel In State	344,438	26,899	12,039		38,938	305,[illegible]
Travel Out Of State	50,396		4,176		4,176	46,[illegible]
Consult/Profess Svcs	9,116,633		47,295		47,295	9,069,[illegible]
Data Processing	742,712	267,952	1,729		269,681	473,[illegible]
Facilities Operations	951,933			311,282	311,282	640,[illegible]
Training	47,852	14,514	1,845		16,359	31,[illegible]
Vehicle Operations	3,137	3,137			3,137	[illegible]
Postage	347,571			182,810	182,810	164,[illegible]
Equipmt Use Allowance	121,194			121,194	121,194	[illegible]
TOTAL, OPERATING EXP.	12,886,185	751,249	216,545	665,462	1,633,256	11,252,[illegible]
GRAND TOTAL	28,910,109	2,737,456	1,126,996	665,462	4,529,914	24,380,1[illegible]

Indirect	4,529,914	4,431,300	
SWCAP	677,240	-----------	= 33.76%
Less Adjustment	-775,854	13,127,266	
	4,431,300		

Executive Branch includes Executive Office, Public Information Office and Office of Governmental Affairs.

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CALIFORNIA ENERGY COMMISSION

Indirect Cost Proposal

Carry-Forward Computation

	83/84	85/86	87/88
1. FIXED RATE	43%	31%	35%
Direct Rate (Personal Svcs)	$8,742,756	$13,017,705	15,797,498
Indirect Cost Pool:			
Departmental	$3,318,069	$4,164,170	4,509,026
SWCAP	700,944	677,240	690,835
Carry Forward	-223,295	-775,854	396,276
TOTAL POOL	$3,795,718	$4,065,556	$5,596,137
2. ACTUAL COSTS			
Direct Base	$11,291,633	$13,127,266	
Indirect Cost Pool:			
Departmental	$3,601,899	$4,529,914	
SWCAP	700,944	677,240	
Carry Forward	-223,295	-775,854	
	$4,079,548	$4,431,300	
3. CARRY FORWARD COMPUTATION			
Recovered:			
83/84 (43% of $11,291,633)	$4,855,402		
85/86 (31% of $13,017,705)		$4,035,489	
Should have recovered:			
Actual Indirect			
83/84 (36.13%)	$4,079,548		
85/86 (33.76%)		$4,431,765	
Under Recoverey	$775,854	$396,276	
Over Recovery			

CALIFORNIA ENERGY COMMISSION
Indirect Cost Rate Proposal
1987 - 88 PROPOSED
Revised

	PROPOSED GOV BUD	LESS ASD	LESS EXECUTIVE	LESS O E & E	TOTAL INDIRECT	TOTAL DIRECT
PERSONAL SERVICES						
Salaries & Wages	18,782,000	1,889,391	945,111		2,834,502	15,797,4[illegible]
Less Overtime	-150,000					
TOTAL, PERSONAL SERVICES	18,632,000	1,889,391	945,111		2,834,502	15,797,4[illegible]
OPERATING EXPENSE						
General Expense	524,000	314,924	69,168		384,092	139,[illegible]
Printing	387,000	202,014	14,319		216,333	170,[illegible]
Communications	366,000			58,194	58,194	307,[illegible]
Travel In State	343,000	17,150	13,720		30,870	312,1[illegible]
Travel Out Of State	70,000		4,900		4,900	65,1[illegible]
Consult/Profess Svcs	8,300,000		47,295		47,295	8,252,7[illegible]
Data Processing	752,000	242,896	1,504		244,400	507,6[illegible]
Facilities Operations	1,236,000			415,296	415,296	820,7[illegible]
Training	47,000	9,964	3,337		13,301	33,[illegible]
Vehicle Operations	5,000			5,000	5,000	
Postage	344,000			180,944	180,944	163,[illegible]
Equipmt Use Allowance	121,194			121,194	121,194	
TOTAL, OPERATING EXP.	12,495,194	786,948	154,243	780,628	1,721,819	10,773,[illegible]
GRAND TOTAL	31,127,194	2,676,339	1,099,354	780,628	4,556,321	26,570,8[illegible]

Indirect	4,556,321	5,643,432 / 15,797,498	= 35.7% (36%)
SWCAP	690,835		
Less Adjustment	396,276		
	5,643,432		

Executive Branch includes Executive Office, Public Information Office and Office of Governmental Affairs.

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CALIFORN[illegible] ENERGY COMMISSION
ESTIMATED/ACTUAL IDC
1985-86 FISCAL YEAR

GRANT #	TITLE	PERSONNEL DIRECT CHARGES	ESTIMATED IDC 31%	ACTUAL IDC 33.76%	DIFF[illegible]
940	SECP - Buildings	$428,304	$132,774	$144,595	$11,[illegible]
941	SECP - Conservation & Load Management	320,894	99,477	108,334	$[illegible]
942	SECP - Local/Retrofit (no carryover)	181,076	56,134	61,131	$4,[illegible]
943	SECP - Management & Support	105,562	32,724	35,638	$[illegible]
944	SECP - Local/Retrofit (carryover)	0			
968	ICP - Schools & Hospitals, Phase II, Cycle 3	218,526	67,743	73,774	$[illegible]
969	ICP - Local Govt/Public Care, Phase II, Cycle 3	0			
976	ICP - Local Govt/Public Care, Phase II, Cycle 2	0			
978	ICP - Local Govt/Public Care, Phase I	0			
999	ICP - Schools & Hospitals, Phase I	0			
		1,254,362	388,852	423,472	34,[illegible]

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APPENDIX B

CEC Budget Summary

3340 CALIFORNIA CONSERVATION CORPS—*Continued*

STATE BUILDING PROGRAM EXPENDITURES	Actual 1985–86*	Estimated 1986–87*	Proposed 1987–88*

RECONCILIATION WITH APPROPRIATIONS

3 CAPITAL OUTLAY

036 Special Account for Capital Outlay [f]

APPROPRIATIONS			
301 Budget Act appropriation	$5,584	-	$966
Allocation for emergencies or contingencies	-	$760	-
Prior year balance available:			
Item 3340-301-036, Budget Act of 1984	306	276	-
Item 3340-301-036, Budget Act of 1985	-	52	-
Totals Available	$5,890	$1,088	$966
Balance available in subsequent years	−328	-	-
Unexpended balance, estimated savings	−4,978	-	-
TOTALS, EXPENDITURES	$584	$1,088	$966

890 Federal Trust Fund [f]

APPROPRIATIONS			
301 Budget Act appropriation (expenditures)	-	$91	-
TOTALS, EXPENDITURES, ALL FUNDS (*Capital Outlay*)	$584	$1,179	$966

3360 ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION

The Energy Resources Conservation and Development Commission is working to ensure the continuance of a reliable supply of energy at a level consistent with California's needs, while complying with environmental, safety, and land use goals. The Commission's programs are aimed at processing applications for siting new power facilities, encouraging measures to reduce wasteful and inefficient use of energy, and monitoring alternative ways to conserve, generate, and supply energy.

SUMMARY OF PROGRAM REQUIREMENTS	1985–86*	1986–87*	1987–88*
10 Regulatory and Planning	$17,760	$19,305	$19,725
20 Energy Resources Conservation	17,747	71,683	15,717
30 Development	12,471	32,338	111,285
40 Policy, Management and Administration:			
Distributed to other programs	(7,033)	(7,310)	(6,534)
TOTALS, PROGRAMS	$47,978	$123,326	$146,727
Reimbursements	-	*−10*	*−108*
NET TOTALS, PROGRAMS	$47,978	$123,316	$146,619
99 Loan Repayments	−5,557	−1,800	−75
TOTALS, ADJUSTED PROGRAMS	$42,421	$121,516	$146,544
General Fund	*45*	-	-
Agricultural and Forestry Residue Utilization Account	-	*1,500*	-
Less Loan Repayments to the Agricultural and Forestry Residue Utilization Account	*−458*	*−1,800*	*−75*
State Energy Conservation and Assistance Account	*10,052*	*5,890*	-
Less Loan Repayments to the Energy Conservation and Assistance Account	*−4,493*	-	-
Geothermal Resources Development Account	*1,875*	*2,452*	*3,272*
Motor Vehicle Account, State Transportation Fund	*90*	*90*	*91*
Energy Account, Energy and Resources Fund (State Operations)	*1,678*	-	-
Less Loan Repayments to the Energy Account, Energy and Resources Fund (Local Assistance)	*−606*	-	-
Clean Fuels Account, General Fund	-	*−21*	*21*
Local Jurisdiction Energy Assistance Account, General Fund	-	*−118*	*118*
Energy Resources Programs Account, General Fund	*26,815*	*31,406*	*30,224*
Energy Technologies Research, Development and Demonstration Account, General Fund	*1,613*	*6,587*	*545*
Petroleum Violation Escrow Account [f]	-	*72,841*	*110,659*
Federal Trust Fund [f]	*5,810*	*2,689*	*1,689*
Personnel years	348.6	363.5	392.1

For the list of standard (lettered) footnotes, see the end of the Governor's Budget.
* Dollars in thousands

APPENDIX C

CEC Fringe Benefits Computations

BILLING FOR SERVICES OF EMPLOYEES PAID ON MONTHLY BASIS (Revised 1/87) — 8740

Below is the formula for determining hourly rates when departments bill for services of employees paid on a monthly basis on or after January 1, 1987. The formula provides an amount for holidays, vacations, sick leave, informal time off, bereavement, jury duty leave, military leave, and State contribution for staff benefits; therefore, departments will bill only for those hours actually worked.[1] However, the formula does not include an amount for such costs as identifiable operating expenses incurred in rendering the service, charges for other than incidental use of equipment, overhead, and other costs. Such costs will be included in billing for services in accordance with SAM Sections 8752.1 and 8758.

TOTAL TIME FOR CALENDAR YEAR	365 days x 8 hours	2,920	hrs.
DEDUCTIONS			
Sundays	52 x 8 hrs.	416	hrs.
Saturdays	52 x 8 hrs.	416	hrs.
Holidays:			

January 1	1	2nd Monday in October	1
3rd Monday in January	1	November 11	1
February 12	1	Thanksgiving Day	1
3rd Monday in February	1	November 27	1
Last Monday in May	1	December 25	1
July 4	1	Floating Holiday	1
1st Monday in September	1		

	13.0 x 8 =	104	hrs.
Vacation Earned (average)	16.25 x 8 =	130.0	hrs.
Sick Leave Taken (average)[2]	8.4 x 8 =	67.2	hrs.
Bereavement (average)		2.0	hrs.
Informal Time Off	0.5 x 8 =	4.0	hrs.
Jury Duty Taken (average)		3.1	hrs.
Military Leave Taken (average)		1.4	hrs.
TOTAL DEDUCTIONS		1,143.7	hrs.
Total Actual Working Time Per Year		1,776.3	hrs.
Total Actual Working Time Per Month		148.03	hrs.[3]

STATE PERCENTAGE CONTRIBUTIONS FOR STAFF BENEFITS[1]
(EFFECTIVE JANUARY 1, 1987)

Employees' Retirement	15.45
OASDI	4.52
Health, Vision, and Dental Benefits	7.16
Total Percent	27.13

FORMULA:

$$\frac{\text{Monthly Salary Rate} \times 1.2713}{148.03} = \text{Hourly Rate}$$ [4]

or

$$\frac{1.2713}{148.03} = .00858812 \times \text{Monthly Salary Rate} = \text{Hourly Rate}$$

ILLUSTRATION: Assume work was performed by an employee who is earning $2,073 per month. The hourly billing rate, performed after January 1, 1987, would be computed as follows:

.00858812 x $2,073 = $17.80 per hour

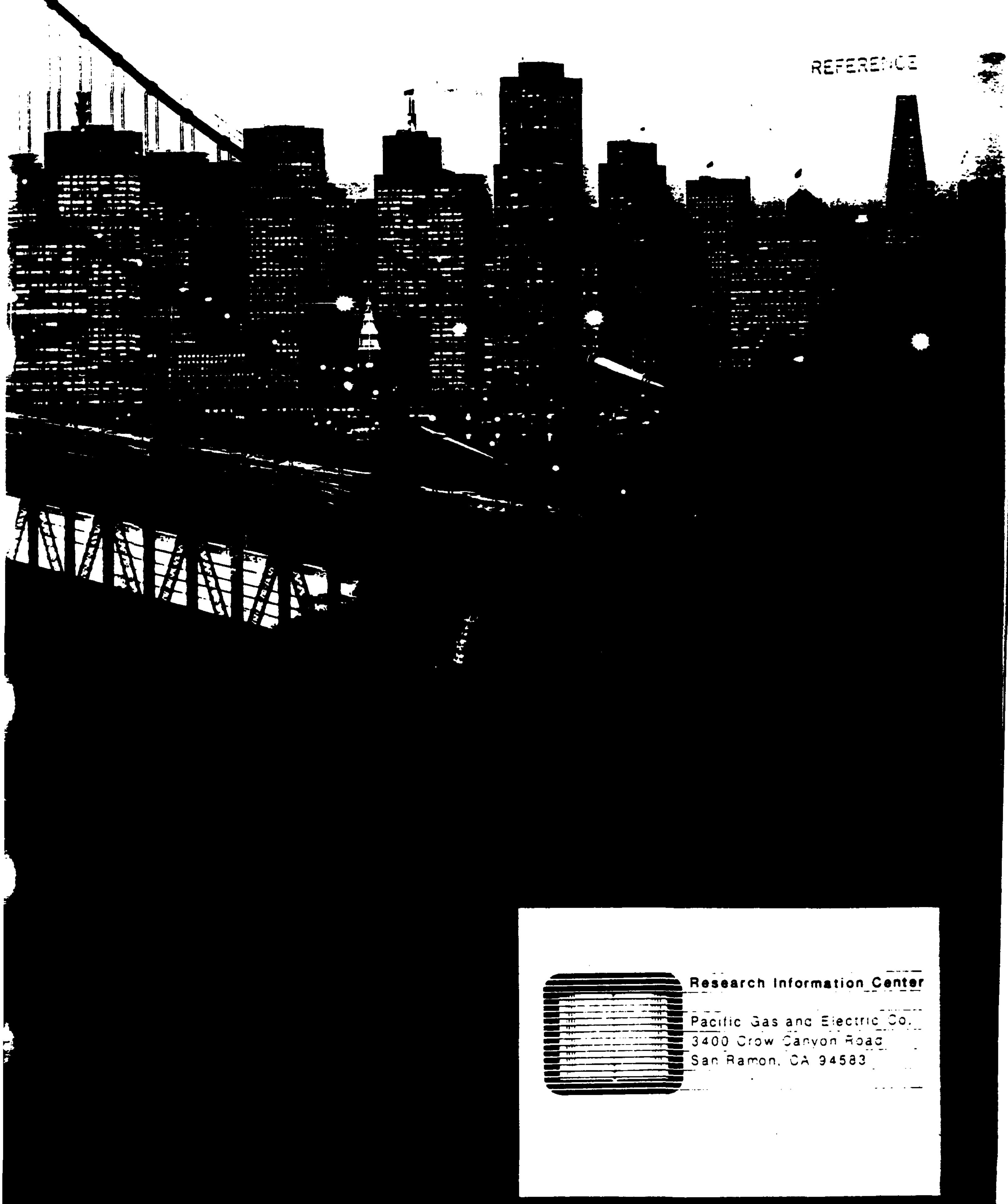
(Continued)

APPENDIX D

PGandE Financial Statements

PACIFIC GAS AND ELECTRIC COMPANY

REFERENCE



Research Information Center
Pacific Gas and Electric Co.
3400 Crow Canyon Road
San Ramon, CA 94583

1986 ANNUAL REPORT

STATEMENT OF CONSOLIDATED INCOME

Years Ended December 31	1986	1985	1984
	In Thousands (except per share amounts)		
Operating Revenues			
Electric	$5,567,438	$5,819,983	$5,158,165
Gas	2,249,223	2,610,998	2,671,538
Total Operating Revenues	7,816,661	8,430,981	7,829,703
Operating Expenses			
Operation			
Cost of Electric Energy	1,252,414	2,072,548	2,098,473
Cost of Gas Sold	1,074,392	1,749,207	1,823,218
Transmission	148,788	148,479	130,340
Distribution	188,499	173,081	171,907
Customer Accounts and Services	339,583	357,189	317,125
Administrative and General	635,792	591,926	510,015
Other	276,091	257,025	118,000
Total Operation	3,915,559	5,349,455	5,169,078
Maintenance	352,230	312,531	287,882
Depreciation	693,675	535,654	445,690
Gas Exploration	56,947	45,301	48,977
Income Taxes	927,647	652,669	637,674
Property and Other Taxes	216,978	166,012	137,014
Total Operating Expenses	6,163,036	7,061,622	6,726,315
Operating Income	1,653,625	1,369,359	1,103,388
Other Income and (Income Deductions)			
Allowance for Equity Funds Used During Construction	69,164	247,367	365,625
Interest Income	120,431	132,985	59,771
Minority Interest in Net Income of Subsidiary Companies	(2,364)	(13,525)	(14,123)
Reserve-Construction Projects	(7,125)	(6,712)	(59,137)
Disallowed Project Costs	–	(58,882)	(16,653)
Other-Net	(28,271)	32,000	101,446
Total Other Income and (Income Deductions)	151,835	333,233	436,929
Income Before Interest Expense	1,805,460	1,702,592	1,540,317
Interest Expense			
Interest on Long-term Debt	707,975	709,258	609,086
Other Interest Charges	58,802	55,588	70,960
Allowance for Borrowed Funds Used During Construction	(42,540)	(93,059)	(114,621)
Total Interest Expense	724,237	671,787	565,425
Net Income	1,081,223	1,030,805	974,892
Preferred Dividend Requirements	156,190	164,230	164,316
Earnings Available for Common Stock	$ 925,033	$ 866,575	$ 810,576
Weighted Average Common Shares Outstanding	355,937	326,838	309,367
Earnings Per Common Share	$2.60	$2.65	$2.62
Dividends Declared Per Common Share	$1.90	$1.81	$1.69

The accompanying notes to consolidated financial statements are an integral part of this statement.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS Cont.

PG&E's maximum public liability for claims resulting from any nuclear incident is limited to $700 million under provisions of the Price-Anderson Act. In the event there is a nuclear incident involving any of the nation's licensed reactors, PG&E is subject to a retrospective assessment of up to $5 million per incident for each of its two licensed reactors with an aggregate assessment per calendar year of $10 million per reactor with payments in excess deferred to the next calendar year.

Capacity Payments to SMUD
PG&E has a contract with Sacramento Municipal Utility District (SMUD) to purchase surplus energy and capacity from the Rancho Seco Nuclear Power Plant (Rancho Seco), which shut down in December 1985.

As a result of the shutdown, PG&E stopped accruing a liability and making payments to SMUD for capacity in December 1985. The total unpaid amount through December 1986 is $35.9 million. PG&E has also filed a claim requesting that SMUD return $27.5 million in capacity payments made during 1985 for capacity that was not received during the months of January through November 1985 when Rancho Seco was inoperative.

SMUD in turn, has withheld payment for PG&E energy deliveries, estimated to be $44.4 million through the December 1986 billing. This receivable is included in current assets.

The dispute is in litigation and the case has been stayed indefinitely pending resolution of the dispute at the Federal Energy Regulatory Commission. The Company believes that it will recover substantially all of these amounts.

Litigation – Geothermal Steam Contracts
In January 1987, two lawsuits were filed against the Company relating to the sale of geothermal steam to the Company for use in the generation of electricity at the Company's The Geysers Geothermal Power Plant (The Geysers). In total, the lawsuits claim damages in excess of $120 million for breach of contract, improper calculation of the steam price and inadequate operation of The Geysers.

The Company plans to vigorously defend these lawsuits and believes that the ultimate outcome of this matter will not have a significant impact on its financial position or results of operations.

Put in service in mi[illegible] 1925 the three turbine-generators of Pi[illegible] Powerhouse added about 90,000 kilowatts to the company's capa-city — and with periodic overhauls are still making this contribution six decades later.

REPORT OF INDEPENDENT PUBLIC ACCOUNTANTS

To the Stockholders and the Board of Directors of Pacific Gas and Electric Company

We have examined the consolidated balance sheet and statement of consolidated capitalization of Pacific Gas and Electric Company (a California corporation) and subsidiaries as of December 31, 1986 and 1985, and the related statements of consolidated income, funds used for construction, common stock equity and preferred stock, and the schedule of consolidated segment information for each of the three years in the period ended December 31, 1986. Our examinations were made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As discussed more fully in Note 10 to the financial statements, the Diablo Canyon Nuclear Power Plant experienced significant delays and substantial cost increases. In connection with the California Public Utilities Commission (CPUC) review of interim rates for Unit 1 and a stipulation for Unit 2, the Company has recorded the revenues for operating expenses and a return on rate base and recognized as a deferred asset the amounts not allowed in current rates. The allowed interim rates, accrued revenues and deferred asset are subject to adjustment pending the CPUC reasonableness review of plant costs. In view of the events discussed in Note 10, the Company believes it appears reasonable to expect that the CPUC will disallow rate recovery of some portion of the Diablo Canyon plant costs and the related balancing account revenues. The Company is currently unable to estimate the amount of such disallowance or predict whether such disallowance of the Diablo Canyon plant costs and related revenues and deferred asset would have a significant adverse impact on its financial position and results of operations.

In our opinion, subject to the effects of such adjustments as might have been required had the outcome of the uncertainties referred to in the preceeding paragraph been known, the consolidated financial statements and schedule of consolidated segment information referred to above present fairly the financial position of Pacific Gas and Electric Company and subsidiaries as of December 31, 1986 and 1985, and the results of its operations and funds used for construction for each of the three years in the period ended December 31, 1986 in conformity with generally accepted accounting principles applied on a consistent basis.

ARTHUR ANDERSEN & CO.

San Francisco, California
February 6, 1987

RESPONSIBILITY FOR FINANCIAL STATEMENTS

The responsibility for the integrity of the financial information included in this annual report rests with management. Such information has been prepared in accordance with generally accepted accounting principles appropriate in the circumstances, and is based on the Company's best estimates and judgements after giving consideration to materiality.

Pacific Gas and Electric Company maintains systems of internal accounting controls supported by formal policies and procedures which are communicated throughout the Company. These controls are adequate to provide reasonable assurance that assets are safeguarded from loss or unauthorized use and to produce the records necessary for the preparation of financial information. There are limits inherent in all systems of internal control, based on the recognition that the costs of such systems should not exceed the benefits to be derived. The Company believes its systems provide this appropriate balance. In addition, the Company's internal auditors perform audits and evaluate the adequacy of and the adherence to these controls, policies and procedures.

Arthur Andersen & Co., the Company's independent public accountants, review and evaluate the Company's internal accounting control systems to the extent they consider necessary in order to support their opinion on the consolidated financial statements. Their auditors' report, above, contains an independent informed judgement as to the fairness of the Company's reported results of operations and financial position.

In a further attempt to assure objectivity and remove bias, the financial data contained in this report have been reviewed by the audit committee of the board of directors. The audit committee is composed of five outside directors who meet regularly with management, the corporate internal auditors and Arthur Andersen & Co., jointly and separately, to review internal accounting controls and auditing and financial reporting matters.

The Company maintains high standards in selecting, training and developing personnel to ensure that management's objectives of maintaining strong, effective internal controls and unbiased, uniform reporting standards are attained. The Company believes its policies and procedures provide reasonable assurance that operations are conducted in conformity with applicable laws and with its commitment to a high standard of business conduct.

QUARTERLY CONSOLIDATED FINANCIAL DATA (Unaudited)

Quarterly financial data for the four quarters of 1986 and 1985 are shown in the table below. Due to the seasonal nature of the utility business, operating revenues, operating income, and net income are not generated evenly by quarter during the year.

The Company's common stock is traded on the New York, Pacific, London, Amsterdam, Basel and Zürich Stock Exchanges. The approximate number of common stockholders of record as of December 31, 1986 was 298,000. Dividends are paid on a quarterly basis, and there are no material restrictions on the present or future ability of the Company to pay dividends.

	4th	3rd	2nd	1st
	In Thousands (except per share amounts)			
1986				
Operating Revenues	$1,927,405	$2,000,896	$1,876,724	$2,011,636
Operating Income	$ 396,699	$ 461,897	$ 419,415	$ 375,614
Net Income	$ 235,998	$ 299,578	$ 265,339	$ 280,308
Earnings Per Common Share	$ .54	$ .73	$ .63	$ .70
Dividends Declared Per Common Share	$ .48	$ .48	$ .48	$ .46
Common Stock Price Per Share				
High	$ 26⅛	$ 27½	$ 23⅜	$ 23⅝
Low	$ 23⅜	$ 22¼	$ 21	$ 18¾
1985				
Operating Revenues	$ 2,066,862	$ 2,167,401	$ 2,024,196	$ 2,172,522
Operating Income	$ 345,438	$ 415,543	$ 334,253	$ 274,125
Net Income	$ 234,284	$ 278,175	$ 266,146	$ 252,200
Earnings Per Common Share	$ .58	$ .72	$ .70	$ .66
Dividends Declared Per Common Share	$ .46	$ .46	$ .46	$ .43
Common Stock Price Per Share				
High	$ 20⅜	$ 20	$ 20¼	$ 17⅞
Low	$ 17⅞	$ 17¼	$ 17⅜	$ 16

PART I - TECHNICAL PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No.__________ of 8 ORIGINAL COPY

Date of Submission June 19, 1987 revised October 7, 1987

Name of Proposer California Energy Commission

Address of Proposer 1516 Ninth Street

Sacramento, California 95814

Title of Proposal Resource Assessment of the Wilbur Hot Springs Area

Type of Research/Project Resource Assessment /X/ Resource Development / /
Technical Assistance / /

Location of Work Northeastern Lake County, California

Proposed Start Date December 15, 1987 Proposed Project Duration 12 (in months)

Proposed Project Manager Dr. Kent Murray Phone No. (916) 324-3474

Permission for Outside Evaluation Yes XXX No___

AUTHORIZED OFFICIAL: Signature [signature]

Name Typed Kent Smith

Title Deputy Director

Date June 19, 1987

ABSTRACT

A geothermal resource assessment project is proposed to study the suitability of moderate-temperature geothermal resources in Northern California for well-head generation. A thermal anomaly in the Wilbur Hot Springs area of the north Central Coast Ranges of California will be used as a model to test the applicability of several well-head generation technologies. Resource characteristics obtained from the Wilbur Hot Springs area will be used to evaluate optimum power generation cycles from a consideration of capital costs, O&M costs, efficiency, reliability, and historical operating experience. The site-specific information obtained from the Wilbur Hot Springs assessment study will then be used to develop an Atlas of matrix or resource characteristics versus well head generation technology on other moderate-temperature geothermal resources in northern California. The results of this analysis is expected to benefit utilities, energy planners and small power producers by demonstrating geothermal resource availability, resource characteristics and the associated geothermal power cycles suitable at each site. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared showing economical geothermal capacity in Megawatts as a function of system power costs in dollars per kilowatt-hour.

Wilbur Hot Springs was selected as a model for this proposal due to the potential of achieving the moderate temperatures suitable for well head generation, and because a substantial amount of geologic and geophysical data already exists on the Wilbur Hot Springs area. This data, which includes shallow temperature gradient holes and subsurface geophysical information, will facilitate the siting and drilling of a deeper exploratory well within the thermal anomaly. The exploratory well will be designed to obtain reservoir data necessary to complete the site-specific technology assessment.

TABLE OF CONTENTS

Part I - Technical Proposal

STATEMENT OF WORK

I. Introduction

The California Energy Commission (CEC), in conjunction with the Pacific Gas and Electric Company (PGandE), proposes a two-fold research project in the area of resource assessment. The objective of this proposal is to 1.) verify the presence of the moderate-temperature resource at Wilbur Hot Springs and 2.) to evaluate the various geothermal wellhead power generation systems (e.g. flash steam, binary cycle, etc) that could be used, given the resource characteristics, to optimize power cycle based on capital cost, O&M costs, efficiency, reliability, and historical operating experience. Once completed, this site specific analysis will be applied to other moderate-temperature geothermal resource areas in Northern California to develop a Geothermal Atlas. The atlas will show the availability of geothermal resources, resource characteristics, and the most appropriate types of geothermal power generation systems for these sites.

Wilbur Hot Springs, an area of abundant thermal springs and quicksilver deposits, is located approximately 18 km east of Clear Lake in the north-central Coast Ranges of California. (Figure 1). The area, characterized by rugged relief and heavily wooded slopes, was the center of an extensive mercury mining industry around the turn of the century. Today the land is being used in a limited capacity as pasture for the grazing of cattle. Preliminary geothermal exploration began in the mid-1960's and soon confirmed the existence of a pronounced thermal anomaly in the Wilbur Hot Springs area. A series of shallow holes drilled to a maximum depth of 100 m indicated thermal gradients as high as $0.3^{o}C/m$, and two deep holes drilled to depth of 400m (Magma Power Co.) and 1200 m (Cordero Mining Co.) reached maximum bottom temperatures of $120^{o}C$ and $140^{o}C$, respectively. Although these holes yielded bottom hole temperatures too low for wellhead power generation, both wells were drilled outside of the mapped thermal anomaly, and southwest of Wilbur Hot Springs. An extensive study of the geology and geochemistry of the area (Moisseeff, 1966) has demonstrated that the hot springs, the occurrence of cinnabar, and quicksilver deposits are all related and are probably associated with recent volcanic activity near Clear Lake. Further support for this association was recently obtained with the mapping of a dike of 1.6 my andesitic basalt in the vicinity of Wilbur Hot Springs (Thompson, 1979). The andesitic basalt has been related to the 1.3 to 2.0 m.y. basaltic lavas of the Clear Lake Volcanic Field by Hearn and others (1981). While the andesitic basalt is undoubtedly too old to be the present day heat source for the hot springs at Wilbur, Hearn and others (1981) believe that the Clear Lake Volcanics, including the intrusion at Wilbur, may be the surface manifestation of a

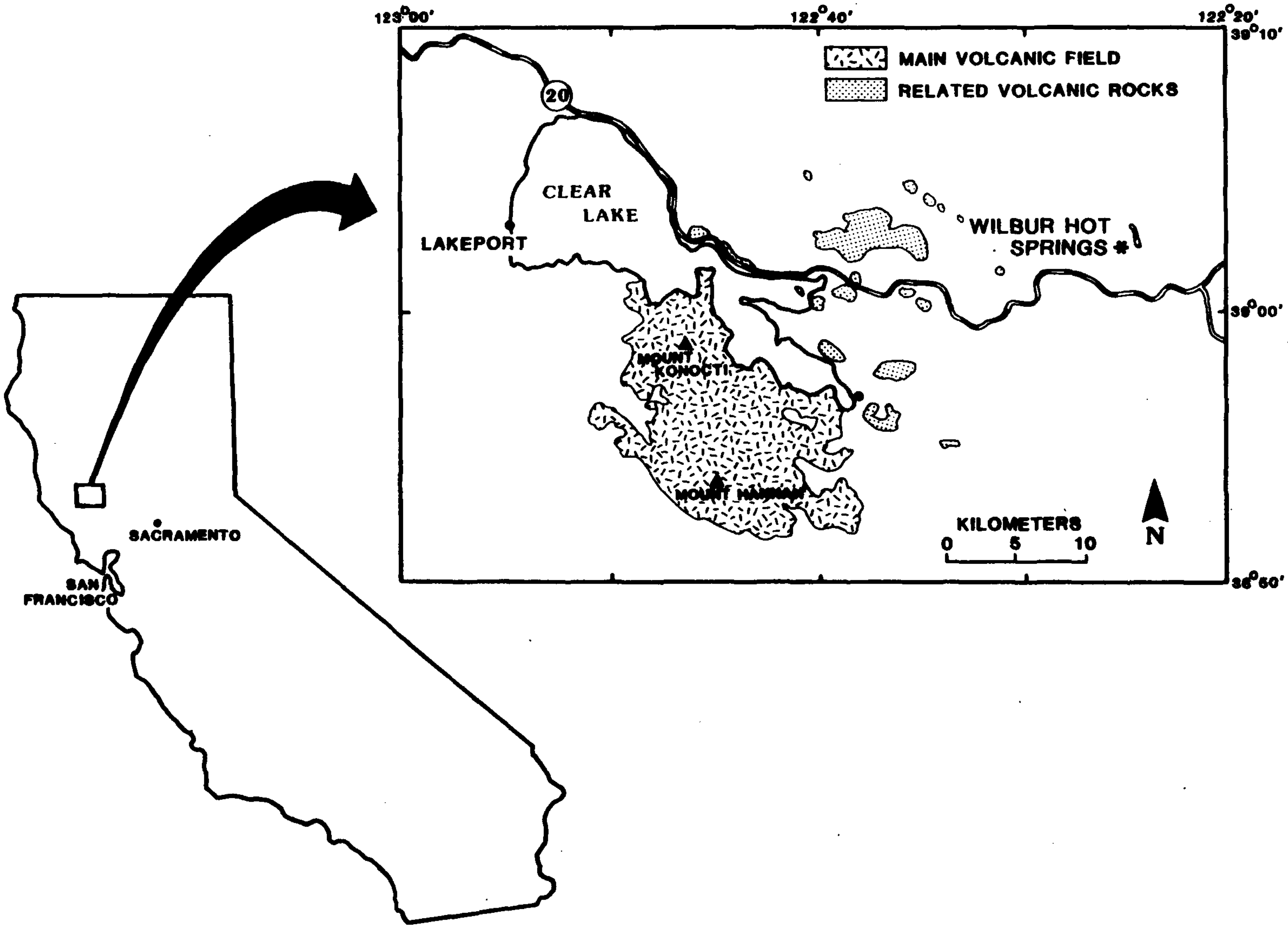


Figure 1. Generalized map showing the location of the Clear Lake volcanic field.

mantle hot spot that has left a tract of Tertiary and Quaternary volcanic centers throughout the northern California Coast Ranges. A magma chamber currently located south of Clear Lake, is the likely source of heat for the vapor-dominated geothermal system at The Geysers and the inferred hot-water geothermal system beneath the volcanic field. It is thus also probable that a small magma chamber or cooling pluton may still exist at depth beneath the Wilbur Hot Springs area. Regional and detailed gravity surveys, conducted between 1977 and 1981, were initiated to explore this possibility (Harrington and Verosub, 1981). These surveys were designed to determine the nature of the thermal anomaly, its precise location and depth below the surface. The geophysical investigations confirmed that a negative gravity anomaly is associated with the hot springs and quicksilver deposits and that the feature likely arises from a shallow geothermal reservoir 1.5 km to the south of Wilbur Hot Springs proper.

Verifying the existence of a moderate-temperature resource near Wilbur Hot Springs would likely facilitate the resurgence of mineral mining in this part of Colusa County. Homestake Mining Company (HMC), owner of the Mclaughlin Gold Mine located 15 km to the south, have already explored the property encompassed by the negative gravity anomaly and have indicated that they "fully intend to develop a small mine in the vicinity of Wilbur Hot Springs within the next decade". Recent discussions with HMC's regional office in Reno however, have hinted that if a developable geothermal resource exists on or adjacent to the property, that they may step up their timing for development (Gustafson, oral communication, 1987).

To verify the existence of a moderate-temperature geothermal resource near Wilbur Hot Springs, the CEC proposes to site and drill a 700 m exploratory well into the shallow geothermal reservoir as defined by the negative gravity anomaly (Figure 2). The exploratory well, to be located approximately 1.5 km south of the hot springs at Wilbur, will enable a maximum temperature to be obtained or projected and a flow rate to be calculated. This information will in turn allow a determination of optimum geothermal wellhead power generation cycles to be made. If successful, the exploratory well will be turned over to the current property owners for possible conversion to a wellhead power generation system. Only modular systems, with capacities in the range of 1/2 to 10 megawatts, will be considered. Modular systems offer the advantage of low financial risk, which is particularly important when developing new resources whose characteristics are not completely known. Modular systems also can be installed on a relatively short schedule and increments as justified by historical geothermal reservoir performance and the demand for electricity.

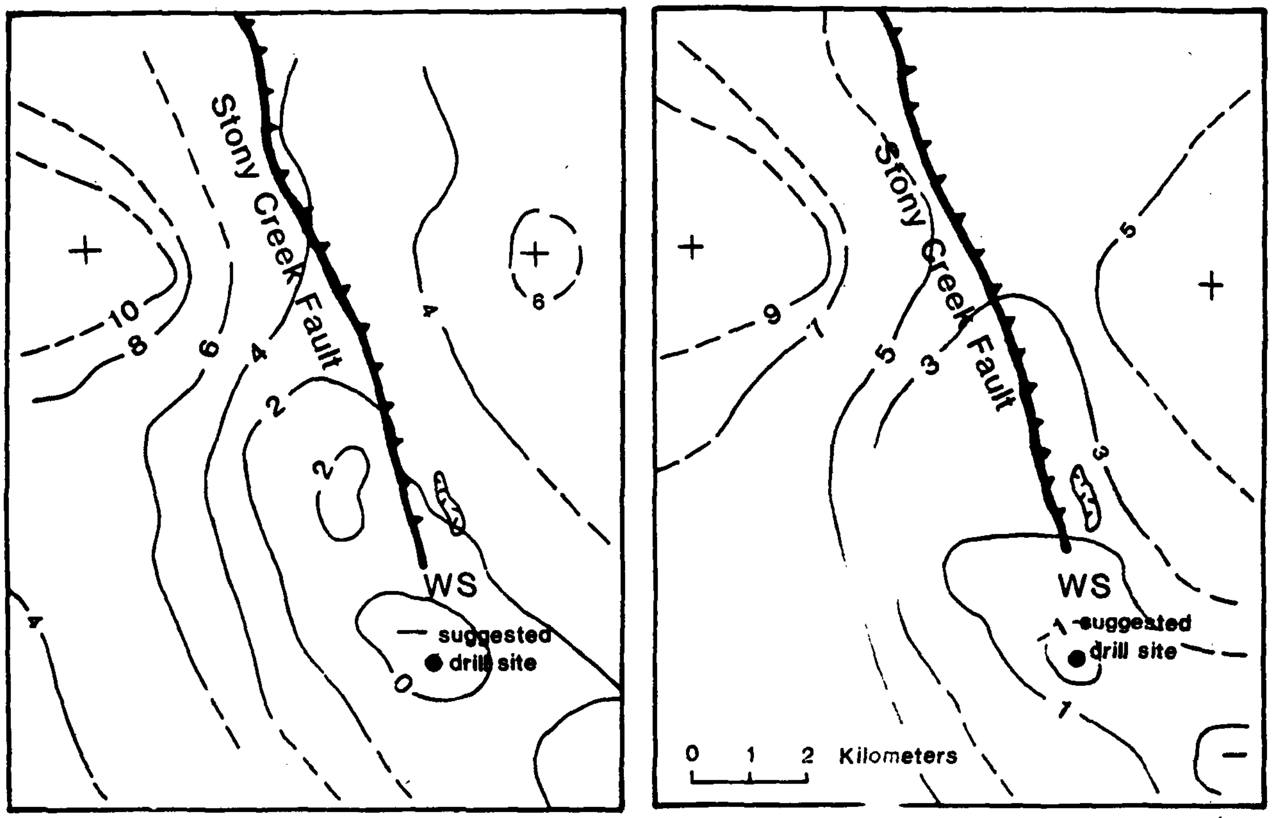


Figure 2. Map showing the location of the proposed exploratory well, relative to the negative gravity anomaly of Harrington and Verosub (1981). Note that the southern projection of the Stony Creek fault aligns with Wilbur Hot Springs (WS) and the center of the gravity anomaly. Figures A and B are even and odd integral contour intervals for a reduction density of 2.50 g/cm^3.

The types of geothermal power cycles to be considered will include single and double flash, binary cycle, and rotary separator turbine. Single flash is the simpliest hot water geothermal power cycle. A simplified schematic of such a cycle is shown in Figure 1 of Appendix A. Hot brine from geothermal production wells is directed to a flash vessel, where the brine is flash boiled by reducing its pressure. The resulting steam is expanded through a turbine to generate power, and then condensed in a surface condenser. The steam condensate is combined with spent brine from the flash vessel, and the resulting mixture is returned to the geothermal reservoir. The main advantages of the single flash cycle are its relatively low cost and simplicity. The major disadvantage of flash cycles in general is low efficiency; however, this disadvantage may be offset by lower cost, particularly at high reservoir temperatures.

The dual flash cycle is similar to single flash, except that hot brine from geothermal production wells is flash boiled in two stages rather than one. A simplified dual flash cycle schematic is shown in Figure 2 of Appendix A. Steam produced in the first flash vessel is expanded through a high-pressure turbine to generate power. The spent brine is routed to a second, lower pressure flash vessel, where additional steam is produced. This steam is combined with the high-pressure turbine exhaust, then expanded through a low-pressure turbine to generate additional power output. To complete the cycle, condensed low-pressure turbine exhaust steam and spent brine from the low-pressure flash vessel are mixed and returned to the geothermal reservoir. Dual flash cycles are more costly than comparable single flash cycles, but the cost is often outweighted by the possible gains in efficiency.

A typical binary cycle for geothermal power production is shown in Figure 3 of Appendix A. In a binary cycle, hot geothermal brine is used to preheat and then boil a working fluid such as ammonia, freon or isobutane/isopentane. The brine is returned directly to the geothermal reservoir, without coming in direct contact with the working fluid. After boiling, the working fluid expands through a turbine to generate power. The turbine exhaust fluid is condensed and then pumped back to the brine heat exchangers to complete the cycle. Binary cycles can be designed to deliver fluid to the turbine at multiple pressures, similar to flash cycles. The principal advantage of binary cycles is relatively high efficiency, which often outweighs the high cost and complexity. Many of the low-temperature geothermal resources in California could be developed economically only through the use of binary cycles.

Total-flow rotary separator turbine (RST) systems are similar to flash cycles, but substitute an RST for the flash vessel. Figure 4 of Appendix A shows a typical total-flow RST cycle. Hot geothermal brine is routed directly to an RST and the brine is expanded through the RST as steam/water mixture in order to produce power. Steam available at the RST exhaust may then be expanded through a steam turbine to produce additional power. Exhaust steam and spent brine from the RST are returned to the geothermal reservior in the same manner as for the single flash cycle. RST's offer the advantage of direct utilization of geothermal brine and relatively low costs; however RST's must be extremely rugged to withstand the corrosive and erosive effects of the flashing geothermal brine.

Based on the reservoir temperature and depth information derived from the CEC assessment of the Wilbur Hot Springs area, other potential moderate-temperature geothermal areas in Northern California will be evaluated in terms of resource characteristics to determine the optimum geothermal power generation systems for these sites. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared to show economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. These curves can be combined with projections of future power costs to answer the following questions:

o When will development of wellhead geothermal resources be economical?

o Which areas in Northern California should be given the highest priority for future development?

o What type of geothermal power cycles should be constructed, and what are their associated costs and performance?

o How much economical geothermal capacity exist in Northern California for utility-scale power generation?

The development of the Geothermal Atlas for the Northern California area will be of enormous benefit to energy planners, utilities, small power producers, and regulatory agencies. The ultimate goal of such a plan is the development of California's indigenous geothermal resources. This development is necessary to meet the increasing demand for energy at a point in time when existing large-scale electrical generation development at the Geysers in Northern California is expected to level off and possibly even decline.

2. Key Tasks

Task 1A. Literature Search. Conduct a research of all pertinent geologic and geothermal information concerning the Wilbur Hot Springs area including:

a. Published literature, geologic maps, geophysical data and geothermal information.

b. Unpublished reports, dissertations, theses, and well logs and open file reports by the U.S. Geological Survey, California Division of Mines and Geology and the California department of Water Resources.

c. Existing water information, both thermal and cold wells and springs, including chemistry, temperature, depth to groundwater, and subsurface logs.

Task 1B. Geologic Field Reconnaissance. Based on an analysis of the data obtained in Task 1A, supplemented by an evaluation of aerial photography and a brief field reconnaissance, an appropriate site will be selected for the proposed temperature-gradient well drilling.

a. Acquire stereo air photo coverage of the area encompassing the negative gravity anomaly. Conduct an evaluation of the aerial photography searching primarily for fault intersections, lineaments, and surface manisfestations of hot spring activity, leaching etc.

b. Complete reconnaissance-level field mapping to provide documentation of structual features identified from air photos and to select a drill site location.

Task 1C. Temperature-Gradient Well Drilling. The drilling of a small-diameter, exploratory well will allow an evaluation to be made of the resource potential and characteristics. The well will be drilled to a depth of 700 m or until temperatures of 200°C are reached, whichever is less.

a. Prepare RFP to solicit bids for a drilling contractor.
b. Supervise and log the drilling of the TG well.
c. Determine temperature gradient.
d. Obtain water sample for chemical analysis.
e. Evaluate water chemistry for water quality analysis, and geothermometry.
f. Flow or pump well briefly to determine possible flow rates

Task 2A. Technical Data Collection. Much of the data required to determine optimum geothermal power cycles is readily available from sources such as the Electric Power Research Institute (EPRI), Geothermal Resources Council (GRC), and equipment manufacturers. The United Technologies Research Center of east Hartford, Connecticut has prepared a report for EPRI that provides a database and preliminary guidelines for selecting geothermal power cycles of the types described above (Reference: EPRI AP-4070, Analysis of Power cycles for Geothermal Wellhead Conversion Systems, June 1985). United Technologies Research Center and Elliott Company of Jeannette, Pennsylvania have also prepared a design guide for wellhead binary cycles (Reference: EPRI Research Project 2195-4, Modular Wellhead Binary Power ystems Design Guide, September 1985). The Heber binary Cycle Demonstration Plant in California's Imperial Valley, which has operated since June 1985 and produced as much as 25 megawatts gross of electrical output, is another possible source of data. Barber-Nichols and Ormat are equipment manufacturers on the list for inquiry.

Task 2B. Technical Data Validation and Assessment. The technical data collected under Task 2A. will be checked for consistency and completeness. Available data on costs and performance will be compiled. Cost data will be updated to present day, checked for completeness of scope, and checked for reasonableness, i.e., whether the specified equipment can be procured at the costs indicated. Because some potential wellhead sites might not have sufficient water available for evaporative cooling, both wet and dry cooling cycles will be evaluated. Effort will be made to contact operators of existing wellhead power plants to obtain operating experience data, discuss plant performance, and identify any operating problems on specific equipment. The results of field visit with plant operators will be factored into the cost and performance data, as appropriate.

Task 2C. Technology Database Development. In this Task the validated technical data from Task 2B. will be assessed to develop accurate technology database on:

- capital costs including equipment costs, construction costs, labor costs, plant startup costs, engineering and project management costs, allowance for funds used during construction (AFUDC),

- operating and maintenance costs including operating labor, operating consumables, maintenance labor, maintenance materials, overhead, taxes and insurance,

- performance and operating characteristics including plant efficiency, operating temperature range, geothermal flow requirement.

Task 3. <u>Site-Specific Geothermal Technology Characterization for Potential Resource Areas in Northern California.</u> Based upon the results from Tasks 1A., 1B. and 2C, the appropriate geothermal generation technology for Wilbur Hot Springs and for potential resources in Northern California will be characterized.

A. <u>Wilbur Hot Springs Technology Characterization.</u> Wilbur Hot Springs is located within 15 miles to the northeast of the Geysers dry-steam geothermal field. At the Geysers, PGandE operates 19 power plants with a total generation capacity exceeding 1300 megawatts. Both the CEC and PGandhave a particular interest in this site. From previous geological work the Wilbur Hot Springs site shows great potential and further developmental work is desired. From PGandE's power generating aspect, the site is close to existing power transmission lines lowering the cost of constructing transmission line. In addition, its close proximity to the Geysers would also reduce operating and maintenance costs.

With the detailed resource development and characterization work outlined in Tasks 1B. and 1C., the technology characterization work of this task will provide accurate information on the costs of constructing utility-scale power plant at Wilbur Hot Springs and assist CEC and PGandE to evaluate the potentials of the wellhead modular systems.

B. <u>Geothermal Atlas in Northern California.</u> In this task a geothermal atlas for the Northern California area will be developed to show the potentials of geothermal resource availability, resource characteristics, and the associated types of geothermal power cycles for these sites. In addition, using estimated temperatures and production rates of individual geothermal resources, curves will be prepared showing economical geothermal capacity in megawatts as a function of system power costs in dollars per kilowatt-hour. These curves can be combined with projections of future power costs to answer the following questions:

o When will development of wellhead geothermal resources be economical?

o Which areas in Northern California should be given the highest priority for future development?

- o What type of geothermal power cycles should be constructed, and what are their associated costs and performance?

- o How much economical geothermal capacity exist in Northern California for utility-scale power generation?

Specific tasks to be completed include:

- o Integrate newly developed resource assessment data with the listing of moderate temperature KGRA's as indicated on the Technical Map of the geothermal Resources of California (Majmundar, 1983)

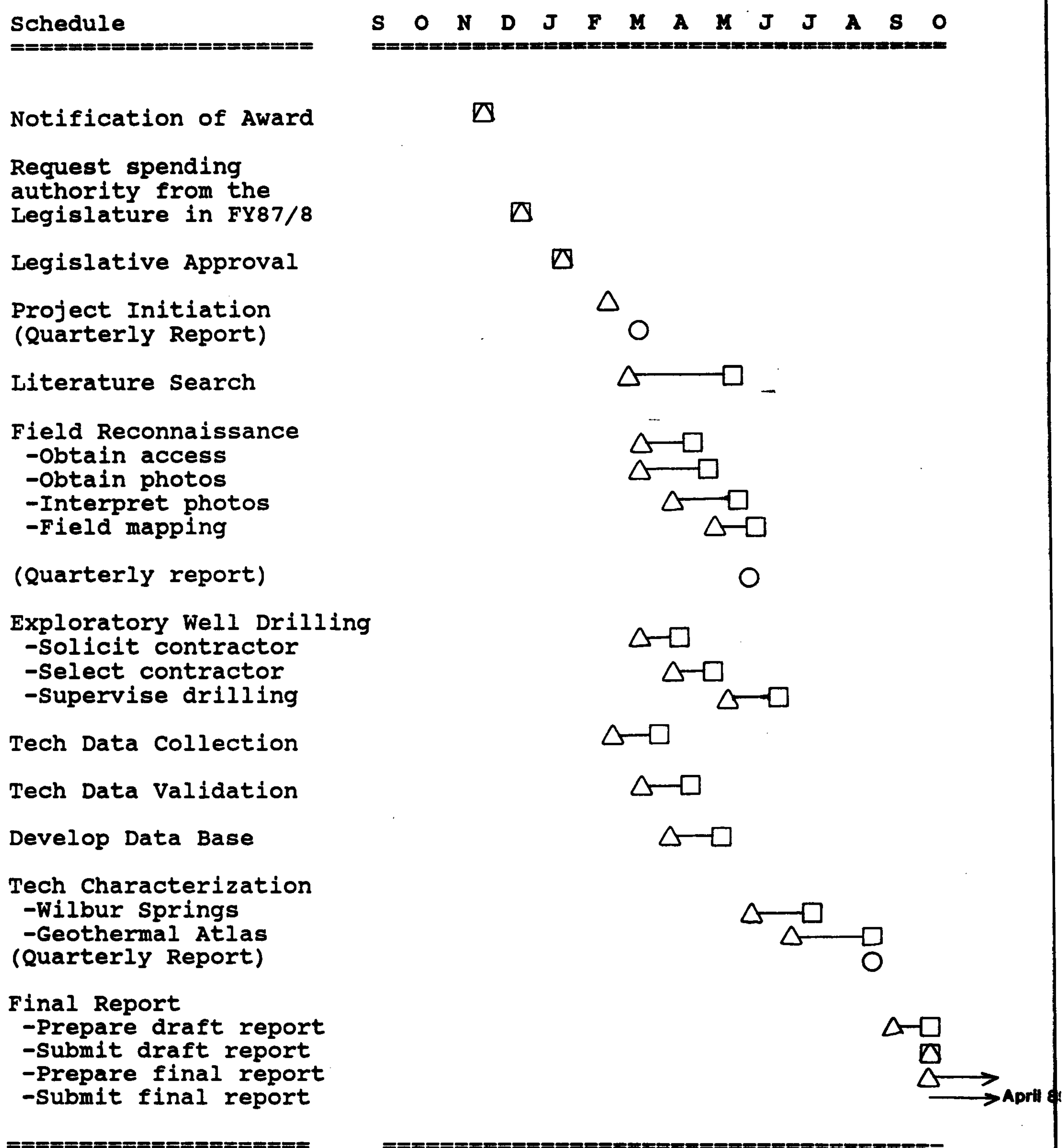
- o Develop location map of KGRA, being evaluated, and complete atlas by preparing a matrix of all resource data.

- o Integrate resource data with wellhead technology data to complete the atlas.

Task 4. <u>Final Report Preparation.</u> A final report will be prepared summarizing the results of the Wilbur Springs Assessment, the integration of the site specific Wilbur Springs resource data with the PGandE technology assessment data and a draft of the Geothermal Atlas.

3. Schedule

A tentative work schedule is presented on the next page. However, there is a major administrative consideration. If the CEC receives funding for this project, the California Legislature will have to approve the spending authority by amending the CEC's FY1987/88 budget. This will require four to eight weeks to obtain.



KEY: Task initiation △ , Task completion □ , Quarterly Report ○

QUALIFICATIONS AND CAPABILITIES

1. Description of Proposing Organization

The CEC proposes to undertake the work at Wilbur Hot Springs using CEC staff resources and technical support from the Berkeley Group Incorporated (BGI). BGI is currently under contract to the CEC. BGI will provide geotechnical support to the CEC staff in Task 1C (Exploratory Well Drilling). The CEC will pay for these services with state contract funds separate from any that may be awarded by DOE. DOE will not be required to enter into a contract with either of these firms. Therefore, the estimated cost of their services are presented in the Business Proposal as match contribution. The CEC will contract with a drilling company to drill the TG well drilling in Task 1C. The CEC maintains lists of highly qualified drilling contractors which we will use as a basis for a competitive bid selection process. We also would welcome any recommendations of qualified contractors that DOE staff may wish to provide should we receive funding.

The following descriptions depict the general capabilities of the CEC, BGI, and Chemwest. The biographies of the key personnel of each organization are provided as an appendix.

California Energy Commission

The CEC is the only state agency with a comprehensive program of research and development in low- and moderate-temperature geothermal energy. The responsibility for administering the CEC's Geothermal Program rests with the Office of Research and Development within the Development Division. The Program's objective is to provide technical and financial assistance to both public and private organizations in California. The goal is to achieve wider development of California's plentiful low- and moderate-temperature geothermal resources.

The Program is comprised of staff with expertise in geology, hydrology, geochemistry, mechanical engineering, economics, and project management. Direct technical assistance offerred through the Program includes geologic evaluation and resource assessment, economic and engineering feasibility analyses, and project planning and review. The CEC also maintains a geothermal library which includes market assessment studies, feasibility studies, regional and site-specific resource data, geothermal technology reports, and environmental data and planning documents.

In addition, local governments may apply for financial assistance through the CEC's Geothermal Grant and Loan Program. Funding may be used for planning studies related to geothermal power plants; to assess and develop geothermal resources, and to mitigate the impacts of existing geothermal development.

Berkeley Group Incorporated

BGI has been proving geotechnical consulting services to the geothermal industry since 1980. The main office is in Berkeley, California. BGI consists of six professional staff members and several staff associates. The BGI staff includes expertise in geology, hydrology, reservoir engineering, well engineering, mechanical engineering, project management, and equipment engineering. Their primary expertise includes all aspects of geothermal electric generating projects, except turbines and power lines, and wellfield and resource engineering. They also have experience in financial analysis and evaluation of energy conversion technologies.

BGI provides high-technology data acquisition equipment for geothermal measurements through its subsidiary, BG Technologies. The BGI equipment manufactured for wellfield use includes: high-resolution microcomputer loggers; downhole and surface tools for measuring pressure, temperature and flowrate; and production sampling equipment for real-time gas monitoring. BGI equipment is used in many applications worldwide. BGI also provides resource and wellfield engineering software for use with microcomputers and mainframes through its subsidiary BGI Software. This working knowledge of geothermal equipment makes BGI well suited to assist in the proposed Brockway Hot Springs project.

Pacific Gas and Electric Company

PGandE is the largest investor-owned public utility in the United States, with a wide variety of experience in the management and operation of oil- and gas-fired power plants,electric transmission facilities, and natural gas distribution facilities. PGandE is also actively involved in renewable energy projects including hydroelectric power plants, and has the world's largest combined generating capacities form geothermal power plants (the Geysers) and from wind turbines (Altamont Pass wind farms). Within PGandE, the Department of Engineering Research guides and focuses research, development, and demonstration activities for new and emerging energy technologies. The Mechanical Systems Group for geothermal projects in the Department of Mechanical and Nuclear Engineering has expertise in the design, project management of the construction of dry-steam geothemal power plants. The two departments have a common goal in developing hot-water geothermal resources in Northern California for utility-scale power generating application.

2. Function of Key Personnel

Personnel	Function
Kent S. Murray Ph.D.	CEC geologist responsible for overall project supervision, report preparation, and will participate directly in Tasks 1A, 1B, 3B and 4.
Cheryl A. Closson	CEC geologist responsible primarily for implementing Tasks 1B, 1C, and 3B.
Ron Schroeder	President of BGI responsible for administration of Task 1C.
Peter Pyle	BGI geologist responsible primarily for Task 1C.
Paul O. Petersen	PGandE Supervising Mechanical Engineer, responsible for overall project supervision and report review. Will participate in tasks 2C and 4.
Charles R. Hicklin	PGandE Senior Mechanical Engineer, responsible for data collection and analysis. Will participate in Task 2A, 2B, 3A and 4.
Peter Y. Lee	PGandE/RD&D Program element Manager, responsible for project coordination for the PG&E team and report review. Will participate in Task 3B.
Staff Engineers	PGandE Staff Engineers not identified yet, responsible for Task 2A, 2B and 2C.

Function of Key Personnel

Staff Member	Field Data Acquisition	Data Analysis	Report/Atlas Preparation	Report Review	Staff Mgmt.
Murray	X	X	X	X	X
Closson	X		X		
Schroeder		X	X	X	
Pyle	X		X		
Peterson				X	X
Hicklin	X	X	X		
Lee				X	X
Staff Engineers	X	X			

3. Biographies of Key Personnel

The resumes of the key personnel appear on the following pages.

K. S. Murray

EDUCATION: Ph.D. Degree in Geology, 1981
University of California

M.S. Degree in Geology, 1974
Northern Arizona University

B.S. Degree in Geologoy, 1970
Western Michigan University

PROFESSIONAL HISTORY

1981 - Present
California Energy Commission

Geothermal specialist with expertise in reservoir/ resource evaluation. Provide geologic, geochemical and geohydrologic expertise to a wide variety of geothermal end-users including local governments and private industry. Responsibilities include resource assessment and confirmation studies, well engineering, groundwater modeling, site feasibility studies, and contract/project management.

1982 - Present
California State University - Sacramento

Adjunct Professor of Engineering and Environmental Geology with teaching and research responsibilities primarily in the fields of engineering geology, environmental geology, hydrology, geothermal energy, and oceanography (coastal erosion studies). Other responsibilities include thesis supervision, advising students in engineering and environmental geology, and faculty advisor to the student chapter of the Association of Engineering Geologists.

1983 - Present
Consultant

Geotechnical consultant providing services in the field of geothermal resource assessment, toxic waste disposal, engineering geology, and geohydrology to a wide range of clients including local governments and other consulting firms.

1981
Oregon State University

Visiting Professor of Engineering Geology teaching graduate and under-graduate courses in engineering geology.

1977 - 1981
California Energy Commission

Geologist responsible for review and analysis of geotechnical and seismic considerations for proposed power plant sites and related facilities. Assisted in the preparation and editing of comprehensive reports on the geological aspects of power plant siting, design, and operation. Supervised, conducted, and contracted commission-sponsored research in geothermal resource evaluation, and reservoir modeling studies, including both single-phase and two-phase reservoirs.

1974 - 1977
Fugro Inc. Consulting Engineers and Geologists

Geologist responsible for site selection studies for critical facilities in the Western United States, Puerto Rico, Japan, and the Middle East. Supervised a team of geologists and engineers conducting regional and site feasibility investigations. Conducted field investigations for fault-risk analysis for proposed nuclear power plant sites.

1972 - 1974
U.S. Geological Survey, Center of Astrogeology

Geologist responsible for the preparation of geologic maps of proposed Moss landing sites for Viking program. Utilized satellite imagery and volcanic analog studies in a supervised program of lunar research and terrain mapping.

PROFESSIONAL SOCIETIES

Association of Engineering Geologists, Member
Geological Society of America, Member
American Association for the Advancement of Science, Member
Arizona Academy of Science, Member
Geothermal Resources Council, Member

AWARDS AND ACTIVITIES

Dean's list scholar - U.C. Davis
Registered Geologist, State of California (No. 3264)
Registered Geologist, State of Oregon (No. 210)
Certified Engineering Geologist, State of Oregon (No. E210)

RECENT PUBLICATIONS IN THE FIELD OF GEOTHERMAL RESEARCH

Low- to Moderate-Temperature Geothermal Resource Assessment - A Methodical Approach, California Energy Commission, Staff Report, 1984.

Geochemical Exploration of the Calistoga Resource Area, Napa Valley, California, co-author with Mark Jonas and Carlos Lopez: Geothermal Resources Council, Transaction, V.8, p. 339-344, 1985.

Geochemical Modeling of the Calistoga Geothermal Field, Napa Valley, California, co-author with Mark Jonas: Geothermal Resources Council, Transactions, V.9, p. 139-144, 1986.

Geothermal Resource Assessment Study, City of Calistoga, California Energy Commission, Staff Report, 82 p. 1986.

C. A. Closson

EDUCATION: B. A. Degree in Earth Science, 1982
University of California, Berkeley

PROFESSIONAL HISTORY

1987 - Present
California Energy Commission

Geologist responsible for providing in-field technical assistance for resource assessment and development aspects of low-temperature geothermal projects. Manage projects funded under the Geothermal Grant and Loan Program for Local Jurisdictions.

1986 - 1987
I-Chem Research, Inc.

Geologist/Water Quality Technician responsible for conducting field sampling and monitoring of surface and groundwater, air, and soil. Performed chemical and physical tests on sampler in the field and in the lab including pH, EC, alkalinity, and anion/cation/trace metal determination.

1985 - 1986
United States Bureau of Reclamation

Geologist responsible for field sampling and lab testing of water, soil, and rock for engineering geologic and geochemical studies. Lab tests included wet screening/mechanical analysis, sample extract preparation, atomic absorption analysis for trace metals, pH, EC, and alkalinity. Constructed and drafted geologic maps and diagrams, compiled data, edited and proofed reports and papers for publication.

PROFESSIONAL SOCIETIES

Geologic Society of America, Member

P. M. Pyle

EDUCATION: M.S. Degree in Engineering Geoscience, 1982
University of California, Berkeley

B.A. Degree in Geology, 1979,
University of California, Santa Barbara

PROFESSIONAL HISTORY

1984 - present
Berkeley Group Inc.

Reservoir engineer responsible for flow testing geothermal wells, including: flowrate measurements, pressure, temperature and spinner surveys, gas and fluid sampling and measurements, and interference monitoring systems. Interpret data from testing methods listed aboveleading to the development of reservoir models. Extensive field equipment procurement, operation, and maintenance experience. Familiar with numerous analytical methods and computer modeling programs.

1979 - 1981
Harding-Lawson Associates

Geologist responsible for field management, and project geologist for aquifer thermal energy storage test in Alaska. Performed engineering geology field studies for groundwater monitoring projects in California. Supplied well design, well drilling, water sampling, and field testing services for groundwater studies. Geologic hazard studies included investigation of landslides, fault movement, soil conditions, and slope stability.

PROFESSIONAL SOCIETIES

Society of Petroleum Engineers of AIME
Geothermal Resources Council

AWARDS AND ACTIVITIES

Honor Students Society - U. C. Berkeley
Dean's List Scholar - U. C. Santa Barbara

R. C. Schroeder

EDUCATION: B.S. in Mathematics, 1962
San Jose State University

Graduate School, 1963 (Applied Mathematics), UCLA

PROFESSIONAL HISTORY

1980 - present
Berkeley Group Inc.

Engineering and exploration consultant for geothermal and other alternative energy projects for both private and government clients. Leader of data acquisition equipment development team engineering software development team.

1975 - 1980
Lawrence Berkeley Laboratory

Leader of the LBL reservoir engineering group responsible for research in a wide range of earth science-related resource problems. Supervised scientists, engineers, and technicians in many aspects of well testing, numerical simulation, computer program development, and well test instrumentation development.

1963 - 1975
Lawrence Livermore Laboratory

Physicist in the Nuclear Weapons Test Division and the Earth Sciences Division. Conducted research in theoretical physics of x-ray, gamma ray, and neutron interactions with matter and electromagnetic pulse generation; hydrodynamics; and stresswave propagation. Developed equation for the state of matter under high temperatures and pressures. Developed theory of shock wave melting for rocks and all elements of the periodic table. Conducted X-ray and neutron experiments of the Nevada test Site. Prepared geopressure and geothermal feasibility studies, and reservoir analyses of the Salton Sea geothermal field in the Imperial Valley, California.

1962 - 1963
Information Science Center

Conducted theoretical and calculational studies of computerized information storage and networking, active and passive circuit analysis, and computer aided design methodology.

1959 - 1962
Sylvania Electric Products

Assisted in measurements and computer designs of microwave and electron optics for use in prototype microwave tubes.

PROFESSIONAL SOCIETIES

American Association for the Advancement of Science
Society of Petroleum Engineers of AIME
National Water Well Association
Geothermal Resources Council

RECENT PUBLICATIONS IN THE FIELD OF GEOTHERMAL RESEARCH

In Situ Leaching and Solution Mining: State-of-the-Art Fluid Flow Management (with S.E. Follin, L.W. Lake, S. Sanyal, D. Sharima and P.M. Wright), University of Utah Research Institute, January 1983.

Geothermal Exploration and Field Management, Invited Report, United Nations Workshop on Development and Exploration of Geothermal Energy in Developing Countries, September 1986.

P. O. Petersen

EDUCATION : B.S. Degree in Mechanical Engineering, 1960
Iowa State University

OCCUPATIONAL HISTORY

1969 - Present
Pacific Gas & Electric Company, San Francisco, CA

Supervising Mechanical Engineer: Supervise the Mechanical Systems Group for geothermal projects being designed and constructed at the Geysers Power Plants. The projects range from pollution abatement retrofits facilities to new power plant additions. Responsible for the overall technical direction of the Geothermal Mechanical Systems Group and for the compliance with project objectives, schedules and budgets.

Senior Mechanical Engineer: Responsibilities included designs and project management on various PG&E projects such as fossil fuel power generation, direct steam heating facilities, gas turbines and combined cycle power plants, wind and geothermal power generation.

1960-1969
Bechtel Power Corporation, San Francisco, CA

Mechanical Engineer: Responsibilities included designing mechanical systems for petroleum nd chemical refineries.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M021529)

C. R. Hicklin

EDUCATION: B.S. in Mechanical Engineering, 1972
University of California, Berkeley

OCCUPATIONAL HISTORY

1979 to Present
Pacific Gas and Electric Company, San Francisco, CA

Senior Mechanical Engineer: Serve as Mechanical Systems Group Leader for five geothermal power project being designed or constructed at the Geysers Power Plant, Sonoma and Lake Counties, California. The projects range in size from 110 to 140 megawatts, and four of them have attained commercial operation to date. Responsible for supervision and technical direction of Mechanical Engineers assigned to the projects, coordination of design and construction activities with operations and construction personnel, power cycle optimization studies, and project licensing through the California Energy Commission.

Mechanical Engineer: Responsible for various power plant efficiency improvement, reliability improvement and pollution abatement retrofit projects at the Geysers Power Plant. Activities included conceptual design studies, preparation of design criteria and calculations, equipment procurement, and construction and operations support.

1972 - 1979
Bechtel Power Corporation, San Francisco, California and Ann Arbor, MI

Mechanical Engineer: Responsibilities included supervision and technical direction of Mechanical Engineers, power cycle optimization, system reliability studies, preparation of design criteria and calculations, equipment procurement, and supervision of drawing preparation. Developed nuclear safety-related system designs in compliance with Nuclear Regulatory Commission and ASME Section III requirements, and responsible for preparation and coordination of a project Environmental Report.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M016733)

P. Y. Lee

EDUCATION: MBA Degree in Finance, 1983
University of California, Berkeley

M.S. Degree in Mechanical Engineering, 1971
University of California, Berkeley

B.S. Degree in Mechanical Engineering, 1969
University of California, Berkeley

OCCUPATIONAL HISTORY

1979 - Present
Pacific Gas and Electric Company, San Ramon, CA
Research, Development and Demonstration (RD&D) Program Element Manager: Responsible for PG&E's research planning and implementation in areas of coal conversion, biomass/MSW conversion, solar thermal technology, and geothermal technology and development. Represent PG&E as a member of the technical and management committee on the Heber Binary Project.

Mechanical Engineer: Conducted noise and vibration testing and control for PG&E companywide facilities. Provided noise impact evaluation for several PG&E dry-steam geothermal power plants at the Geysers.

1971 - 1979
Wilson, Ihrig & Associates, Inc., Oakland CA

Acoustical Consultant: Provided consulting services in acoustics in various areas including rapid transit systems, chemical plants, refineries, mechanical systems, and building acoustics. Responsibilities included performing noise and vibration testing, recommending mitigation designs, and conducting business promotion and client contact.

PROFESSIONAL SOCIETIES

Registered Professional Engineer, State of California
(No. M018149)

APPENDIX A

Diagrams of Wellhead Generation Systems

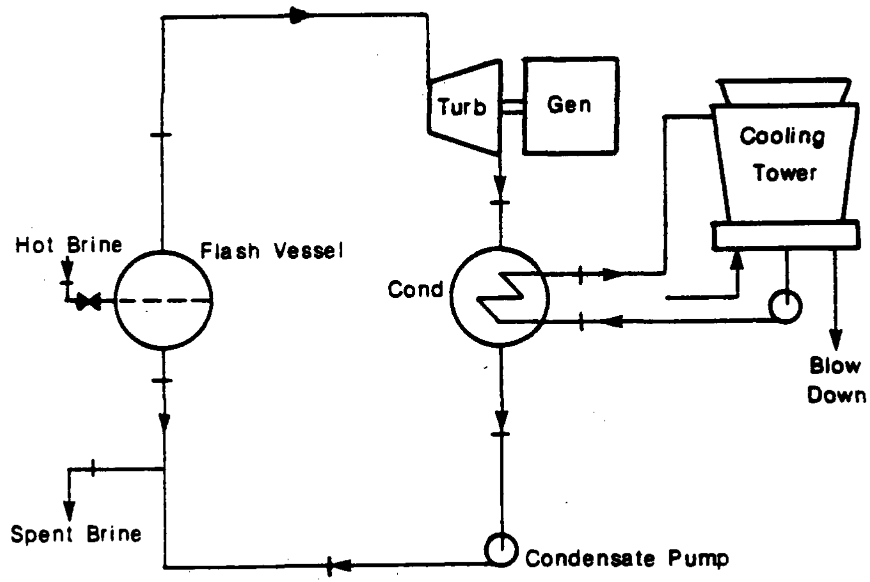


FIGURE 1. Flow Diagram of a Single-Flash System

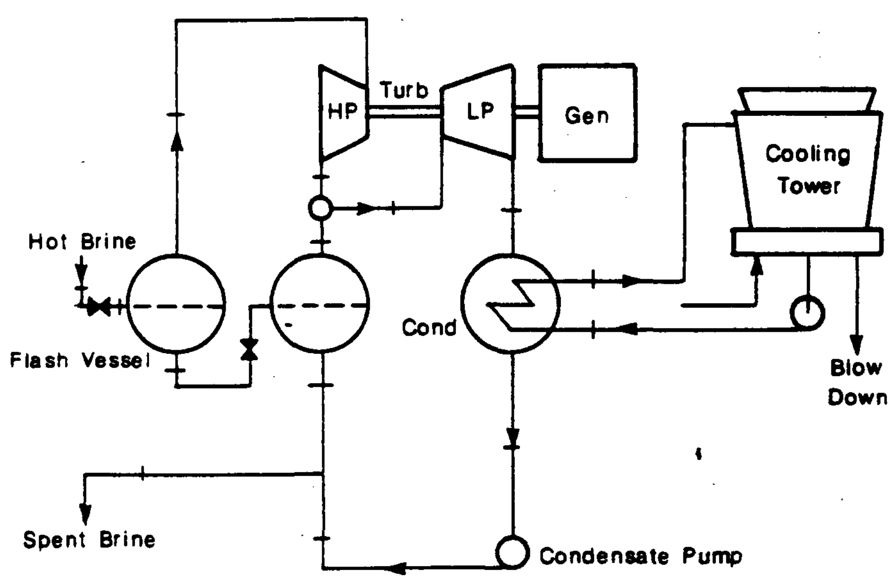


FIGURE 2. Flow Diagram of a Double-Flash System

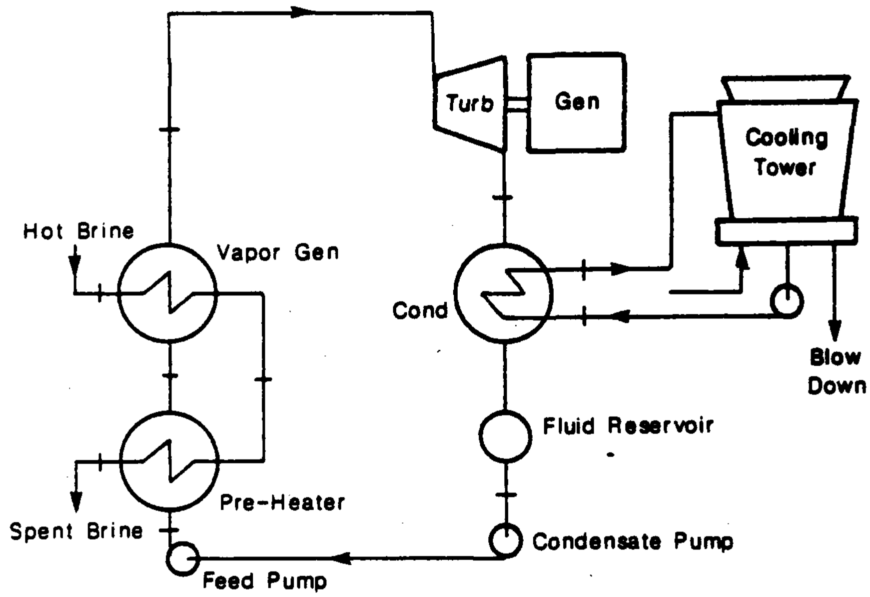


FIGURE 3. Flow Diagram of a Binary-Cycle System

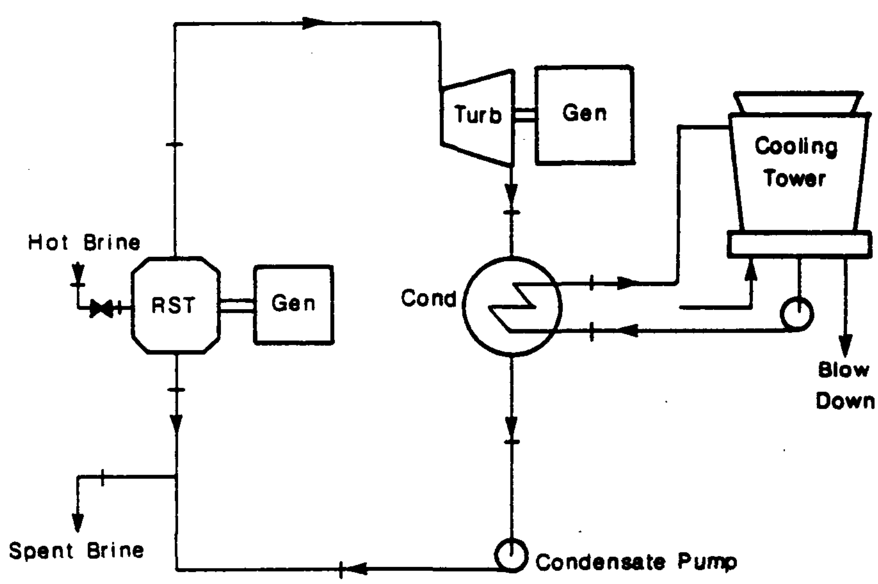


FIGURE 4. Flow Diagram of a Total-Flow RST System

REFERENCES CITED

Harrington, J. M. and Verosub, k., 1981, A detailed gravity survey of the Wilbur Springs area, California: in Research in The Geysers-Clear Lake geothermal area, northern California: U.S. Geol. Survey Prof. Paper 1141, 259p.

Hearn, B.C., Donnelly-Nolan, J.M., and Goff, F.E., 1981, The Clear Lake Volcanics: Tectonic setting and magma sources: in Research in The Geysers-Clear Lake geothermal area, northern California: U.S. Geol. Survey Prof. Paper 1141, 259p.

Moisseeff, A. N., 1966, The geology and geochemistry of the Wilbur Springs quicksilver district, Colusa and Lake Counties, California: Ph.D. Thesis, Stanford University, 214p.

Thompson, J. M., 1979, A reevaluation of geothermal potential of the Wilbur Hot Springs area, California: Geothermal Resources Council, Transactions, v.3, p729-731.

PART II - BUSINESS PROPOSAL

SUBMITTED TO THE

DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

STATE GEOTHERMAL RESEARCH AND DEVELOPMENT

PRDA NO. DE-PR07-87ID12662

Copy No. 1 of 8 ORIGINAL COPY

Date of Submission June 19, 1987 revised October 7, 1987

Name of Proposer California Energy Commission

Address of Proposer 1516 Ninth Street
Sacramento, California 95814

Title of Proposal Resource Assessment of the Wilbur Hot Springs Area

Location of Work Northeastern Lake County, California

Proposed Total Project Cost ________ DOE Funding Requested ________

Proposed Start Date December 15, 1987 Proposed Project Duration 12 (in months)

Official Contact for Negotiations Dr. Kent Murray Phone No. (916) 324-3474

Permission for Outside Evaluation Yes XXX No ___

Effective Period of Proposal 180 days

AUTHORIZED OFFICIAL: Signature [signature]

Name Typed for Kent Smith

Title Deputy Director

Date June 19, 1987

Please Check Small Business ___ Disadvantaged Business ___ Other Profit ___
Women-Owned ___ Nonprofit ___
University ___ State or Local Government XXX

TABLE OF CONTENTS

Part II - Business Proposal

FEDERAL ASSISTANCE BUDGET INFORMATION FORM

1. Program/Project Identification No.	2. Program/Project Title Resource Assessment of the Wilbur Hot Springs Area

3. Name and Address: California Energy Commission 1516 Ninth Street, MS-1 Sacramento, CA 95814	4. Program/Project Start Date December 15, 1987 5. Completion Date

SECTION A - BUDGET SUMMARY

Grant Program, Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1.		$ 136,390	$ 43,983.45	$	$	$180,373.45
2.						
3.						
4.						
5. TOTALS		$	$	$	$	$

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	Grant Program Function or Activity				
	(1)	(2)	(3)	(4)	(5) TOTAL
a. Personnel	$	$	$	$	$ 42,473
b. Fringe Benefits					19,908
c. Travel					5,450
d. Equipment					500
e. Supplies					0
f. Contractual					100,000
g. Construction					0
h. Other					2,300
i. Total Direct Charges					149,831
j. Indirect Charges					5,542.45
k. TOTALS	$	$	$	$	180,373.45
7. Program Income	$	$	$	$	$

(4/14/87) G-7 (G/L)

Detailed Project Financial Plan

	Total Hours	Hourly Wage	Total Wages	Fringe Benefit 69%	Ind. Charge 6%	Total Budget	Federal	Non-Federal
I. Personnel Services								
Task 1A								
K. Murray	80	20.8	1664	500.86	779.35	2944.21		2944.21
C. Closson	80	9.8	784	235.98	367.19	1387.17		1387.17
Task 1B								
K. Murray	40	20.8	832	250.43	389.67	1472.10		1472.10
C. Closson	40	9.8	392	117.99	183.60	693.59		693.59
Task 1C								
R. Schroeder	40	67.9	2716			2716.00		2716.00
P. Pyle	140	43.75	6125			6125.00		6125.00
Task 2A								
C. Hicklin	80	27.00	2160.00	1490.40	129.50	3779.90		3779.90
Staff Engineers	160	23.00	3680.00	2539.20	220.80	6440.00		6440.00
Task 2B								
C. Hicklin	120	27.00	3240.00	2235.60	194.40	5670.00	5670.00	
Staff Engineers	240	23.00	5520.00	3808.80	331.20	9660.00		9660.00
Task 2C								
P. Petersen	40	29.00	1160.00	800.40	69.60	2030.00	2030.00	
C. Hicklin	100	27.00	2700.00	1863.00	162.00	4725.00	4725.00	
Staff Engineers	100	23.00	2300.00	1587.00	138.00	4025.00	4025.00	

Detailed Project Financial Plan

	Total Hours	Hourly Wage	Total Wages	Fringe Benefit	Ind. Charge	Total Budget	Federal	Non-Federal
I. Personnel Services cont.								
Task 3A.								
C. Hicklin	40	27.00	1080.00	745.20	64.80	1890.00	1890.00	
Task 3B.								
P. Lee	40	25.00	1000.00	690.00	60.00	1750.00	1750.00	
K. Murray	120	20.8	2496.00	773.76	1177.11	4446.87		4446.87
C. Closson	120	9.8	1176.00	364.56	554.60	2095.16		2095.16
Task 4.								
K. Murray	60	20.80	1248.00	386.88	588.57	2223.43		2223.45
P. Petersen	20	29.00	580.00	400.20	34.80	1015.00	1015.00	
C. Hicklin	60	27.00	1620.00	1117.80	97.20	2835.00	2835.00	
Total Personnel Services						67,923.45	23,940.00	43,983.45

Detailed Project Financial Plan

2. Detailed Budget Form (Cont'd)

	Total Budget	Federal	Non-Federal
II. Operating Expenses			
Task 1.A.			
Travel	500	500	0
Equipment	0	0	0
Other*	100	100	0
Task 1.B.			
Travel	3000	3000	0
Equipment	0	0	0
Other**	2000	2000	0
Task 1.C.			
Travel	1500	1500	0
Equipment	500	500	0
Contractual	100,000	100,000	0
Other	0	0	0
Task 2.A.			
Travel	0	0	0
Equipment	0	0	0
Other*	0	0	0
Task 2.B.			
Travel	1500	1500	0
Equipment	0	0	0
Other*	200	200	0
Task 2.C.			
Travel	0	0	0
Equipment	0	0	0
Other*	0	0	0
Task 3.			
Travel	150	150	0
Other++	3000	3000	0

	TOTAL BUDGET	FEDERAL	NON-FEDERAL
Task 4			
Travel	0	0	0
Other	0	0	0
SUBTOTAL	87,450	87,450	0
TOTAL BUDGET (I + II)	180,373.45	136,390.00	43,983.45

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*printing, postage, phone, etc.
**purchase of airphotos
++graphics, printing

U.S. Department of Energy

Assurance of Compliance

Nondiscrimination in Federally Assisted Programs

California Energy Commission (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended, (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1975 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), and the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385). In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or handicap, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, age, or handicap, in its employment practices. Such employment practices may include, but are not limited to, recruitment, recruitment advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form, however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to, the following: (1) the manner in which services are or will be provided and related data necessary for determining whether

MA-647R (5/83)

any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population eligible to be served by race, color, national origin, sex, age and handicap; (3) data regarding covered employment including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, age and handicap, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to its obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal assistance funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours on request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Equal Opportunity, U.S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicant by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

June 19, 1987
(Date)

California Energy Commission

(Name of Applicant)

1516 Ninth Street, MS-1

Sacramento, CA 95814
(Address)

[signature]
(Authorized Official)

( ) (916) 324-3080
(Applicant's Telephone Number)

Attachment No. 4

OMB Approval No. 29-R0218

FEDERAL ASSISTANCE

1. TYPE OF ACTION (Mark appropriate box)
- [ ] PREAPPLICATION
- [X] APPLICATION
- [ ] NOTIFICATION OF INTENT (Opt.)
- [ ] REPORT OF FEDERAL ACTION

2. APPLICANT'S APPLICATION
- a. NUMBER: 912
- b. DATE (Year month day): 19 87 06 19

3. STATE APPLICATION IDENTIFIER
- a. NUMBER: NA
- b. DATE ASSIGNED (Year month day): 19

Leave Blank

4. LEGAL APPLICANT/RECIPIENT
- a. Applicant Name : State of California
- b. Organization Unit : California Energy Commission
- c. Street/P.O. Box : 1516 Ninth Street, MS-1
- d. City : Sacramento, e. County : Sacramento
- f. State : California g. ZIP Code: 95814
- h. Contact Person (Name & telephone No.) :

5. FEDERAL EMPLOYER IDENTIFICATION NO. 94-60013476

6. PROGRAM (From Federal Catalog)
- a. NUMBER: 81.087
- b. TITLE: Renewable Energy Research & Development (Renewable Energy)

SECTION I—APPLICANT/RECIPIENT DATA

7. TITLE AND DESCRIPTION OF APPLICANT'S PROJECT

State Geothermal Research and Development--
Resource Assessment of the Wilbur Hot Springs Area

8. TYPE OF APPLICANT/RECIPIENT
A-State, B-Interstate, C-Substate District, D-County, E-City, F-School District, G-Special Purpose District, H-Community Action Agency, I-Higher Educational Institution, J-Indian Tribe, K-Other (Specify):

Enter appropriate letter: A

9. TYPE OF ASSISTANCE
A-Basic Grant, B-Supplemental Grant, C-Loan, D-Insurance, E-Other

Enter appropriate letter(s): A

10. AREA OF PROJECT IMPACT (Names of cities, counties, States, etc.)
Lake County

11. ESTIMATED NUMBER OF PERSONS BENEFITING
Unknown

12. TYPE OF APPLICATION
A-New, B-Renewal, C-Revision, D-Continuation, E-Augmentation

Enter appropriate letter: A

13. PROPOSED FUNDING

a. FEDERAL	$ 81,690 .00
b. APPLICANT	43,984 .00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ 125,674 .00

14. CONGRESSIONAL DISTRICTS OF:
- a. APPLICANT: Statewide
- b. PROJECT: District 1

15. TYPE OF CHANGE (For 12c or 12e)
A-Increase Dollars, B-Decrease Dollars, C-Increase Duration, D-Decrease Duration, E-Cancellation, F-Other (Specify):

Enter appropriate letter(s):

16. PROJECT START DATE (Year month day): 19 87 12 15

17. PROJECT DURATION: 12 Months

18. ESTIMATED DATE TO BE SUBMITTED TO FEDERAL AGENCY (Year month day): 19 87 06 19

19. EXISTING FEDERAL IDENTIFICATION NUMBER: N/A

20. FEDERAL AGENCY TO RECEIVE REQUEST (Name, City, State, ZIP code)
DOE Idaho Operations Office, Idaho Falls, ID 83402

21. REMARKS ADDED: [ ] Yes [X] No

SECTION II—CERTIFICATION

22. THE APPLICANT CERTIFIES THAT ▶
a. To the best of my knowledge and belief, data in this preapplication/application are true and correct, the document has been duly authorized by the governing body of the applicant and the applicant will comply with the attached assurances if the assistance is approved.

b. If required by OMB Circular A-95 this application was submitted, pursuant to instructions therein, to appropriate clearinghouses and all responses are attached:

	No response	Response attached
(1)	[ ]	[ ]
(2)	[ ]	[ ]
(3)	[ ]	[ ]

23. CERTIFYING REPRESENTATIVE
- a. TYPED NAME AND TITLE: Kent Smith, Deputy Director
- b. SIGNATURE: Don Wallace
- c. DATE SIGNED (Year month day): 19 87 06 19

SECTION III—FEDERAL AGENCY ACTION

24. AGENCY NAME: State of California

25. APPLICATION RECEIVED (Year month day): 19

26. ORGANIZATIONAL UNIT: California Energy Commission

27. ADMINISTRATIVE OFFICE: Grants & Loans (916)324-3080

28. FEDERAL APPLICATION IDENTIFICATION

29. ADDRESS: 1 516 Ninth Street, MS-1, Sacramento, CA 95814

30. FEDERAL GRANT IDENTIFICATION

31. ACTION TAKEN
- [ ] a. AWARDED
- [ ] b. REJECTED
- [ ] c. RETURNED FOR AMENDMENT
- [ ] d. DEFERRED
- [ ] e. WITHDRAWN

32. FUNDING

a. FEDERAL	$ .00
b. APPLICANT	.00
c. STATE	.00
d. LOCAL	.00
e. OTHER	.00
f. TOTAL	$ .00

33. ACTION DATE ▶ (Year month day) 19

34. STARTING DATE (Year month day) 19

35. CONTACT FOR ADDITIONAL INFORMATION (Name and telephone number)

36. ENDING DATE (Year month day) 19

37. REMARKS ADDED: [ ] Yes [ ] No

38. FEDERAL AGENCY A-95 ACTION
a. In taking above action, any comments received from clearinghouses were considered. If agency response is due under provisions of Part 1, OMB Circular A-95, it has been or is being made.

b. FEDERAL AGENCY A-95 OFFICIAL (Name and telephone no.)

424-101

STANDARD FORM 424 PAGE 1 (10-75)
Prescribed by GSA, Federal Management Circular 74-7

APPENDIX A

CEC Indirect Cost Rate Proposal for FY 1987/88

ENERGY RESOURCES
CONSERVATION AND DEVELOPMENT COMMISSION

INDIRECT COST RATE PROPOSAL

FISCAL YEAR 1987-88

PURPOSE

This proposal outlines methods used to determine the Indirect Cost Rate which should be applied to all grant projects. This will allocate costs to those projects which are not otherwise identified or accounted for at the Energy Resources Conservation and Development Commission (ERCDC).

EFFECTIVE DATES

This rate is applicable to all projects for fiscal year 1987-88.

PROPOSAL

Our Proposed Indirect Cost Rate is 36% to be applied to Personal Services based on:

* Expected expenditures for FY 1987-88
* Plus the Approved Statewide Cost Allocation Plan (SWCAP) for FY 1987-88
* Plus an adjustment for actual expenditures for FY 1985-86

RATIONALE

The methods outlined are based upon the accounting system of the ERCDC. Our total State allotment is distributed among our divisions and offices. In addition to our divisions and offices, we also account separately for each grant project.

Each individual budget is broken down into line items for Personal Services, Operating Expenses and Equipment, and Research and Development contracts. The Executive Office, the Office of Governmental Affairs and the Public Information Office have been included with the indirect offices due to their increasing involvement in grant-related efforts, especially in the areas of developing new legislation, regulations, standards, etc. The fact that the involvement of these offices is mainly through the all-encompassing area of Commission meetings, hearings, and legislative sessions effectively precludes them from being able to charge grants directly. All other costs were determined to be direct costs.

Dividing total Indirect Costs (ERCDC indirect, plus SWCAP, plus adjustment) by total Direct Personal Services resulted in a rate of 36%. This rate will allow allocation of those grant costs which belong to, but are otherwise not charged to grant projects. The rate would be applied to Personal Services.

In accordance with page 15 of OACS 10, this is a Fixed with Carry-forward Rate applicable to all 1987-88 grants. Any difference between the estimated 36% Indirect Cost Rate and the actual rate will be included as an adjustment in our 1989-90 Indirect Cost Rate Proposal.

CALIFORNIA ENERGY COMMI TON
Indirect Cost Rate Propo al
1985 - 86 ACTUAL

	6/30/86 AEL	LESS ASD	LESS EXECUTIVE	LESS O E & E	TOTAL INDIRECT	TOTAL DIRECT
PERSONAL SERVICES						
Salaries & Wages	16,297,833	2,019,021	914,310		2,933,331	13,364,[illegible]
Less Overtime	-273,909	-32,814	-3,859		-36,673	-237,[illegible]
TOTAL, PERSONAL SERVICES	16,023,924	1,986,207	910,451		2,896,658	13,127,[illegible]
OPERATING EXPENSE						
General Expense	572,044	314,169	98,752		412,921	159,[illegible]
Printing	272,217	124,578	50,709		175,287	96,[illegible]
Communications	316,058			50,176	50,176	265,8[illegible]
Travel In State	344,438	26,899	12,039		38,938	305,[illegible]
Travel Out Of State	50,396		4,176		4,176	46,[illegible]
Consult/Profess Svcs	9,116,633		47,295		47,295	9,069,[illegible]
Data Processing	742,712	267,952	1,729		269,681	473,[illegible]
Facilities Operations	951,933			311,282	311,282	640,[illegible]
Training	47,852	14,514	1,845		16,359	31,[illegible]
Vehicle Operations	3,137	3,137			3,137	[illegible]
Postage	347,571			182,810	182,810	164,[illegible]
Equipmt Use Allowance	121,194			121,194	121,194	[illegible]
TOTAL, OPERATING EXP.	12,886,185	751,249	216,545	665,462	1,633,256	11,252,9[illegible]
GRAND TOTAL	28,910,109	2,737,456	1,126,996	665,462	4,529,914	24,380,1[illegible]

Indirect	4,529,914	
SWCAP	677,240	4,431,300 / 13,127,266 = 33.76%
Less Adjustment	-775,854	
	4,431,300	

Executive Branch includes Executive Office, Public Information Office and Office of Governmental Affairs.

icrp

CALIFORNIA ENERGY COMMISSION
Indirect Cost Proposal
Carry-Forward Computation

	83/84	85/86	87/88
1. FIXED RATE	43%	31%	35%
Direct Rate (Personal Svcs)	$8,742,756	$13,017,705	15,797,498
Indirect Cost Pool:			
Departmental	$3,318,069	$4,164,170	4,509,026
SWCAP	700,944	677,240	690,835
Carry Forward	-223,295	-775,854	396,276
TOTAL POOL	$3,795,718	$4,065,556	$5,596,137
2. ACTUAL COSTS			
Direct Base	$11,291,633	$13,127,266	
Indirect Cost Pool:			
Departmental	$3,601,899	$4,529,914	
SWCAP	700,944	677,240	
Carry Forward	-223,295	-775,854	
	$4,079,548	$4,431,300	
3. CARRY FORWARD COMPUTATION			
Recovered:			
83/84 (43% of $11,291,633)	$4,855,402		
85/86 (31% of $13,017,705)		$4,035,489	
Should have recovered:			
Actual Indirect			
83/84 (36.13%)	$4,079,548		
85/86 (33.76%)		$4,431,765	
Under Recoverey	$775,854	$396,276	
Over Recovery			

CALIFORNIA ENERGY COMMISSION
Indirect Cost Rate Proposal
1987 - 88 PROPOSED
Revised

	PROPOSED GOV BUD	LESS ASD	LESS EXECUTIVE	LESS O E & E	TOTAL INDIRECT	TOTAL DIRECT
PERSONAL SERVICES						
Salaries & Wages	18,782,000	1,889,391	945,111		2,834,502	15,797,4[illegible]
Less Overtime	-150,000					
TOTAL, PERSONAL SERVICES	18,632,000	1,889,391	945,111		2,834,502	15,797,4[illegible]
OPERATING EXPENSE						
General Expense	524,000	314,924	69,168		384,092	139,9[illegible]
Printing	387,000	202,014	14,319		216,333	170,6[illegible]
Communications	366,000			58,194	58,194	307,8[illegible]
Travel In State	343,000	17,150	13,720		30,870	312,1[illegible]
Travel Out Of State	70,000		4,900		4,900	65,10[illegible]
Consult/Profess Svcs	8,300,000		47,295		47,295	8,252,70[illegible]
Data Processing	752,000	242,896	1,504		244,400	507,60[illegible]
Facilities Operations	1,236,000			415,296	415,296	820,70[illegible]
Training	47,000	9,964	3,337		13,301	33,6[illegible]
Vehicle Operations	5,000			5,000	5,000	
Postage	344,000			180,944	180,944	163,0[illegible]
Equipmt Use Allowance	121,194			121,194	121,194	
TOTAL, OPERATING EXP.	12,495,194	786,948	154,243	780,628	1,721,819	10,773,1[illegible]
GRAND TOTAL	31,127,194	2,676,339	1,099,354	780,628	4,556,321	26,570,8[illegible]

Indirect	4,556,321	5,643,432	
SWCAP	690,835	-----------	= 35.7% (3~~7~~6%)
Less Adjustment	396,276	15,797,498	
	5,643,432		

Executive Branch includes Executive Office, Public Information Office and Office of Governmental Affairs.

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CALIFORN ENERGY COMMISSION
ESTIMATED/ACTUAL IDC
1985-86 FISCAL YEAR

GRANT #	TITLE	PERSONNEL DIRECT CHARGES	ESTIMATED IDC 31%	ACTUAL IDC 33.76%	DIFFE[illegible]
940	SECP - Buildings	$428,304	$132,774	$144,595	$11,[illegible]
941	SECP - Conservation & Load Management	320,894	99,477	108,334	$[illegible],[illegible]
942	SECP - Local/Retrofit (no carryover)	181,076	56,134	61,131	$4,[illegible]
943	SECP - Management & Support	105,562	32,724	35,638	$[illegible],[illegible]
944	SECP - Local/Retrofit (carryover)	0			
968	ICP - Schools & Hospitals, Phase II, Cycle 3	218,526	67,743	73,774	$6,[illegible]
969	ICP - Local Govt/Public Care, Phase II, Cycle 3	0			
976	ICP - Local Govt/Public Care, Phase II, Cycle 2	0			
978	ICP - Local Govt/Public Care, Phase I	0			
999	ICP - Schools & Hospitals, Phase I	0			
		1,254,362	388,852	423,472	34,[illegible]

icrp6

APPENDIX B

CEC Budget Summary

3340 CALIFORNIA CONSERVATION CORPS—*Continued*

STATE BUILDING PROGRAM EXPENDITURES	Actual 1985–86*	Estimated 1986–87*	Proposed 1987–88*
RECONCILIATION WITH APPROPRIATIONS			
3 CAPITAL OUTLAY			
036 Special Account for Capital Outlay '			
APPROPRIATIONS			
301 Budget Act appropriation	$5,584	-	$966
Allocation for emergencies or contingencies	-	$760	-
Prior year balance available:			
Item 3340-301-036, Budget Act of 1984	306	276	-
Item 3340-301-036, Budget Act of 1985	-	52	-
Totals Available	$5,890	$1,088	$966
Balance available in subsequent years	−328	-	-
Unexpended balance, estimated savings	−4,978	-	-
TOTALS, EXPENDITURES	$584	$1,088	$966
890 Federal Trust Fund '			
APPROPRIATIONS			
301 Budget Act appropriation (expenditures)	-	$91	-
TOTALS, EXPENDITURES, ALL FUNDS (*Capital Outlay*)	$584	$1,179	$966

3360 ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION

The Energy Resources Conservation and Development Commission is working to ensure the continuance of a reliable supply of energy at a level consistent with California's needs, while complying with environmental, safety, and land use goals. The Commission's programs are aimed at processing applications for siting new power facilities, encouraging measures to reduce wasteful and inefficient use of energy, and monitoring alternative ways to conserve, generate, and supply energy.

SUMMARY OF PROGRAM REQUIREMENTS	*1985–86**	*1986–87**	*1987–88**
10 Regulatory and Planning	$17,760	$19,305	$19,725
20 Energy Resources Conservation	17,747	71,683	15,717
30 Development	12,471	32,338	111,285
40 Policy, Management and Administration:			
Distributed to other programs	(7,033)	(7,310)	(6,534)
TOTALS, PROGRAMS	$47,978	$123,326	$146,727
Reimbursements	-	*−10*	*−108*
NET TOTALS, PROGRAMS	$47,978	$123,316	$146,619
99 Loan Repayments	−5,557	−1,800	−75
TOTALS, ADJUSTED PROGRAMS	$42,421	$121,516	$146,544
General Fund	*45*	-	-
Agricultural and Forestry Residue Utilization Account	-	*1,500*	-
Less Loan Repayments to the Agricultural and Forestry Residue Utilization Account	*−458*	*−1,800*	*−75*
State Energy Conservation and Assistance Account	*10,052*	*5,890*	-
Less Loan Repayments to the Energy Conservation and Assistance Account	*−4,493*	-	-
Geothermal Resources Development Account	*1,875*	*2,452*	*3,272*
Motor Vehicle Account, State Transportation Fund	*90*	*90*	*91*
Energy Account, Energy and Resources Fund (State Operations)	*1,678*	-	-
Less Loan Repayments to the Energy Account, Energy and Resources Fund (Local Assistance)	*−606*	-	-
Clean Fuels Account, General Fund	-	*−21*	*21*
Local Jurisdiction Energy Assistance Account, General Fund	-	*−118*	*118*
Energy Resources Programs Account, General Fund	*26,815*	*31,406*	*30,224*
Energy Technologies Research, Development and Demonstration Account, General Fund	*1,613*	*6,587*	*545*
Petroleum Violation Escrow Account [f]	-	*72,841*	*110,659*
Federal Trust Fund [f]	*5,810*	*2,689*	*1,689*
Personnel years	348.6	363.5	392.1

For the list of standard (lettered) footnotes, see the end of the Governor's Budget.
* Dollars in thousands

APPENDIX C

CEC Fringe Benefits Computations

BILLING FOR SERVICES OF EMPLOYEES PAID ON MONTHLY BASIS (Revised 1/87) 8740

Below is the formula for determining hourly rates when departments bill for services of employees paid on a monthly basis on or after January 1, 1987. The formula provides an amount for holidays, vacations, sick leave, informal time off, bereavement, jury duty leave, military leave, and State contribution for staff benefits; therefore, departments will bill only for those hours actually worked.[1] However, the formula does not include an amount for such costs as identifiable operating expenses incurred in rendering the service, charges for other than incidental use of equipment, overhead, and other costs. Such costs will be included in billing for services in accordance with SAM Sections 8752.1 and 8756.

TOTAL TIME FOR CALENDAR YEAR		365 days x 8 hours	2,920	hrs.
DEDUCTIONS				
Sundays		52 x 8 hrs.	416	hrs.
Saturdays		52 x 8 hrs.	416	hrs.
Holidays:				

January 1	1	2nd Monday in October	1
3rd Monday in January	1	November 11	1
February 12	1	Thanksgiving Day	1
3rd Monday in February	1	November 27	1
Last Monday in May	1	December 25	1
July 4	1	Floating Holiday	1
1st Monday in September	1		

	13.0 x 8 =	104	hrs.
Vacation Earned (average)	16.25 x 8 =	130.0	hrs.
Sick Leave Taken (average)[2]	8.4 x 8 =	67.2	hrs.
Bereavement (average)		2.0	hrs.
Informal Time Off	0.5 x 8 =	4.0	hrs.
Jury Duty Taken (average)		3.1	hrs.
Military Leave Taken (average)		1.4	hrs.
TOTAL DEDUCTIONS		1,143.7	hrs.
Total Actual Working Time Per Year		1,776.3	hrs.
Total Actual Working Time Per Month		148.03	hrs.[3]

STATE PERCENTAGE CONTRIBUTIONS FOR STAFF BENEFITS[1]
(EFFECTIVE JANUARY 1, 1987)

Employees' Retirement	15.45
OASDI	4.52
Health, Vision, and Dental Benefits	7.16
Total Percent	27.13

FORMULA:

$$\frac{\text{Monthly Salary Rate} \times 1.2713}{148.03} \text{ [4]} = \text{Hourly Rate}$$

or

$$\frac{1.2713}{148.03} = .00858812 \times \text{Monthly Salary Rate} = \text{Hourly Rate}$$

ILLUSTRATION: Assume work was performed by an employee who is earning $2,073 per month. The hourly billing rate, performed after January 1, 1987, would be computed as follows:

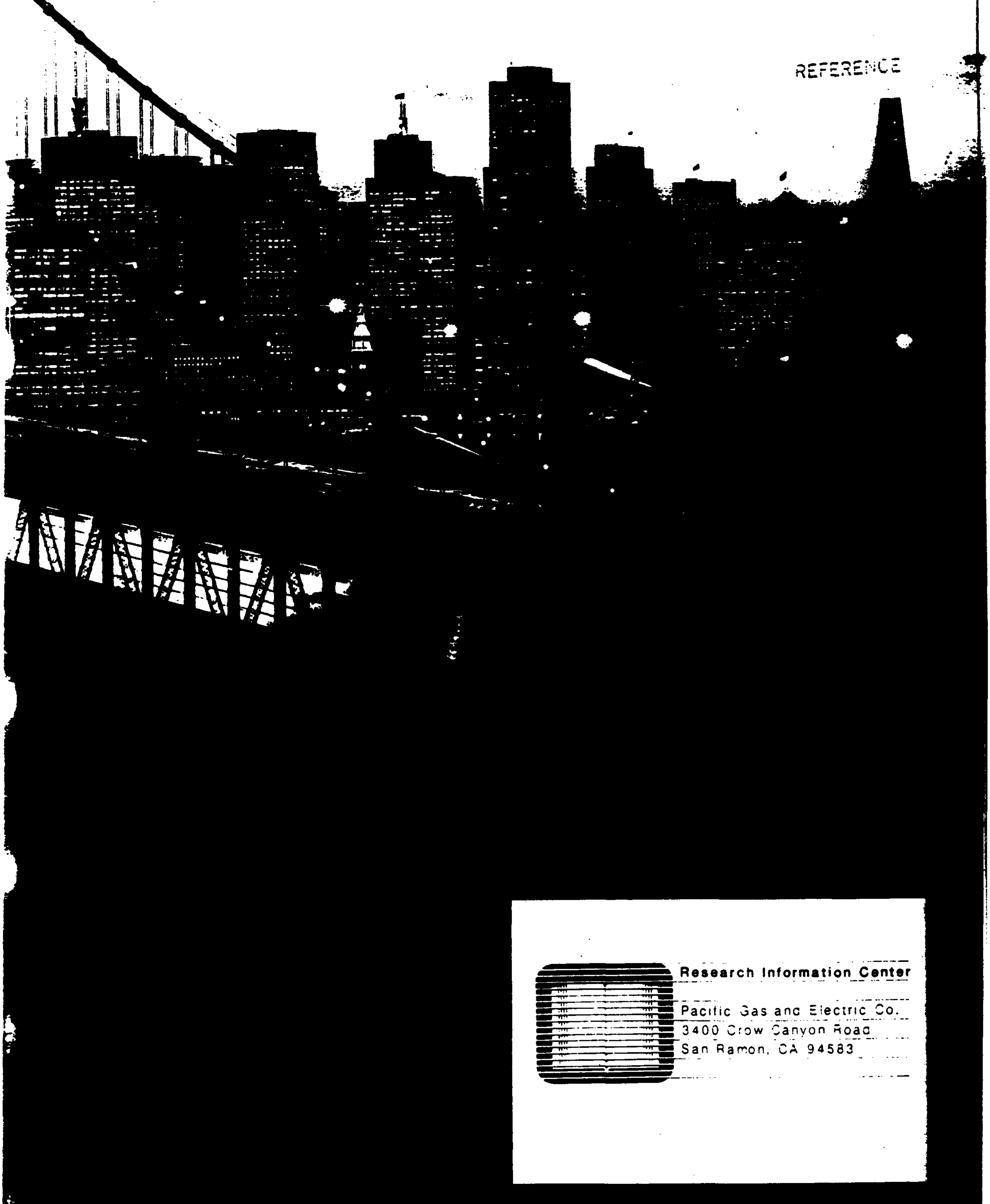
.00858812 x $2,073 = $17.80 per hour

(Continued)

APPENDIX D

PGandE Financial Statements

PACIFIC GAS AND ELECTRIC COMPANY



REFERENCE

Research Information Center
Pacific Gas and Electric Co.
3400 Crow Canyon Road
San Ramon, CA 94583

1986 ANNUAL REPORT

STATEMENT OF CONSOLIDATED INCOME

Years Ended December 31	1986	1985	1984
	In Thousands (except per share amounts)		
Operating Revenues			
Electric	$5,567,438	$5,819,983	$5,158,165
Gas	2,249,223	2,610,998	2,671,538
Total Operating Revenues	7,816,661	8,430,981	7,829,703
Operating Expenses			
Operation			
Cost of Electric Energy	1,252,414	2,072,548	2,098,473
Cost of Gas Sold	1,074,392	1,749,207	1,823,218
Transmission	148,788	148,479	130,340
Distribution	188,499	173,081	171,907
Customer Accounts and Services	339,583	357,189	317,125
Administrative and General	635,792	591,926	510,015
Other	276,091	257,025	118,000
Total Operation	3,915,559	5,349,455	5,169,078
Maintenance	352,230	312,531	287,882
Depreciation	693,675	535,654	445,690
Gas Exploration	56,947	45,301	48,977
Income Taxes	927,647	652,669	637,674
Property and Other Taxes	216,978	166,012	137,014
Total Operating Expenses	6,163,036	7,061,622	6,726,315
Operating Income	1,653,625	1,369,359	1,103,388
Other Income and (Income Deductions)			
Allowance for Equity Funds Used During Construction	69,164	247,367	365,625
Interest Income	120,431	132,985	59,771
Minority Interest in Net Income of Subsidiary Companies	(2,364)	(13,525)	(14,123)
Reserve-Construction Projects	(7,125)	(6,712)	(59,137)
Disallowed Project Costs	-	(58,882)	(16,653)
Other-Net	(28,271)	32,000	101,446
Total Other Income and (Income Deductions)	151,835	333,233	436,929
Income Before Interest Expense	1,805,460	1,702,592	1,540,317
Interest Expense			
Interest on Long-term Debt	707,975	709,258	609,086
Other Interest Charges	58,802	55,588	70,960
Allowance for Borrowed Funds Used During Construction	(42,540)	(93,059)	(114,621)
Total Interest Expense	724,237	671,787	565,425
Net Income	1,081,223	1,030,805	974,892
Preferred Dividend Requirements	156,190	164,230	164,316
Earnings Available for Common Stock	$ 925,033	$ 866,575	$ 810,576
Weighted Average Common Shares Outstanding	355,937	326,838	309,367
Earnings Per Common Share	$2.60	$2.65	$2.62
Dividends Declared Per Common Share	$1.90	$1.81	$1.69

The accompanying notes to consolidated financial statements are an integral part of this statement.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS Cont.

PG&E's maximum public liability for claims resulting from any nuclear incident is limited to $700 million under provisions of the Price-Anderson Act. In the event there is a nuclear incident involving any of the nation's licensed reactors, PG&E is subject to a retrospective assessment of up to $5 million per incident for each of its two licensed reactors with an aggregate assessment per calendar year of $10 million per reactor with payments in excess deferred to the next calendar year.

Put in service in mid-1925 the three turbine-generators of Pit [illegible] Powerhouse added about 90,000 kilowatts to the company's capacity — and with periodic overhauls are still making this contribution six decades later.

Capacity Payments to SMUD

PG&E has a contract with Sacramento Municipal Utility District (SMUD) to purchase surplus energy and capacity from the Rancho Seco Nuclear Power Plant (Rancho Seco), which shut down in December 1985.

As a result of the shutdown, PG&E stopped accruing a liability and making payments to SMUD for capacity in December 1985. The total unpaid amount through December 1986 is $35.9 million. PG&E has also filed a claim requesting that SMUD return $27.5 million in capacity payments made during 1985 for capacity that was not received during the months of January through November 1985 when Rancho Seco was inoperative.

SMUD in turn, has withheld payment for PG&E energy deliveries, estimated to be $44.4 million through the December 1986 billing. This receivable is included in current assets.

The dispute is in litigation and the case has been stayed indefinitely pending resolution of the dispute at the Federal Energy Regulatory Commission. The Company believes that it will recover substantially all of these amounts.

Litigation – Geothermal Steam Contracts

In January 1987, two lawsuits were filed against the Company relating to the sale of geothermal steam to the Company for use in the generation of electricity at the Company's The Geysers Geothermal Power Plant (The Geysers). In total, the lawsuits claim damages in excess of $120 million for breach of contract, improper calculation of the steam price and inadequate operation of The Geysers.

The Company plans to vigorously defend these lawsuits and believes that the ultimate outcome of this matter will not have a significant impact on its financial position or results of operations.

REPORT OF INDEPENDENT PUBLIC ACCOUNTANTS

To the Stockholders and the Board of Directors of Pacific Gas and Electric Company

We have examined the consolidated balance sheet and statement of consolidated capitalization of Pacific Gas and Electric Company (a California corporation) and subsidiaries as of December 31, 1986 and 1985, and the related statements of consolidated income, funds used for construction, common stock equity and preferred stock, and the schedule of consolidated segment information for each of the three years in the period ended December 31, 1986. Our examinations were made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As discussed more fully in Note 10 to the financial statements, the Diablo Canyon Nuclear Power Plant experienced significant delays and substantial cost increases. In connection with the California Public Utilities Commission (CPUC) review of interim rates for Unit 1 and a stipulation for Unit 2, the Company has recorded the revenues for operating expenses and a return on rate base and recognized as a deferred asset the amounts not allowed in current rates. The allowed interim rates, accrued revenues and deferred asset are subject to adjustment pending the CPUC reasonableness review of plant costs. In view of the events discussed in Note 10, the Company believes it appears reasonable to expect that the CPUC will disallow rate recovery of some portion of the Diablo Canyon plant costs and the related balancing account revenues. The Company is currently unable to estimate the amount of such disallowance or predict whether such disallowance of the Diablo Canyon plant costs and related revenues and deferred asset would have a significant adverse impact on its financial position and results of operations.

In our opinion, subject to the effects of such adjustments as might have been required had the outcome of the uncertainties referred to in the preceeding paragraph been known, the consolidated financial statements and schedule of consolidated segment information referred to above present fairly the financial position of Pacific Gas and Electric Company and subsidiaries as of December 31, 1986 and 1985, and the results of its operations and funds used for construction for each of the three years in the period ended December 31, 1986 in conformity with generally accepted accounting principles applied on a consistent basis.

ARTHUR ANDERSEN & CO.

San Francisco, California
February 6, 1987

RESPONSIBILITY FOR FINANCIAL STATEMENTS

The responsibility for the integrity of the financial information included in this annual report rests with management. Such information has been prepared in accordance with generally accepted accounting principles appropriate in the circumstances, and is based on the Company's best estimates and judgements after giving consideration to materiality.

Pacific Gas and Electric Company maintains systems of internal accounting controls supported by formal policies and procedures which are communicated throughout the Company. These controls are adequate to provide reasonable assurance that assets are safeguarded from loss or unauthorized use and to produce the records necessary for the preparation of financial information. There are limits inherent in all systems of internal control, based on the recognition that the costs of such systems should not exceed the benefits to be derived. The Company believes its systems provide this appropriate balance. In addition, the Company's internal auditors perform audits and evaluate the adequacy of and the adherence to these controls, policies and procedures.

Arthur Andersen & Co., the Company's independent public accountants, review and evaluate the Company's internal accounting control systems to the extent they consider necessary in order to support their opinion on the consolidated financial statements. Their auditors' report, above, contains an independent informed judgement as to the fairness of the Company's reported results of operations and financial position.

In a further attempt to assure objectivity and remove bias, the financial data contained in this report have been reviewed by the audit committee of the board of directors. The audit committee is composed of five outside directors who meet regularly with management, the corporate internal auditors and Arthur Andersen & Co., jointly and separately, to review internal accounting controls and auditing and financial reporting matters.

The Company maintains high standards in selecting, training and developing personnel to ensure that management's objectives of maintaining strong, effective internal controls and unbiased, uniform reporting standards are attained. The Company believes its policies and procedures provide reasonable assurance that operations are conducted in conformity with applicable laws and with its commitment to a high standard of business conduct.

QUARTERLY CONSOLIDATED FINANCIAL DATA (Unaudited)

Quarterly financial data for the four quarters of 1986 and 1985 are shown in the table below. Due to the seasonal nature of the utility business, operating revenues, operating income, and net income are not generated evenly by quarter during the year.

The Company's common stock is traded on the New York, Pacific, London, Amsterdam, Basel and Zürich Stock Exchanges. The approximate number of common stockholders of record as of December 31, 1986 was 298,000. Dividends are paid on a quarterly basis, and there are no material restrictions on the present or future ability of the Company to pay dividends.

	4th	3rd	2nd	1st
	In Thousands (except per share amounts)			
1986				
Operating Revenues	$1,927,405	$2,000,896	$1,876,724	$2,011,636
Operating Income	$ 396,699	$ 461,897	$ 419,415	$ 375,614
Net Income	$ 235,998	$ 299,578	$ 265,339	$ 280,308
Earnings Per Common Share	$ .54	$ .73	$ .63	$ .70
Dividends Declared Per Common Share	$ .48	$ .48	$ .48	$ .46
Common Stock Price Per Share				
High	$ 26⅛	$ 27½	$ 23⅝	$ 23⅝
Low	$ 23⅜	$ 22¼	$ 21	$ 18¾
1985				
Operating Revenues	$ 2,066,862	$ 2,167,401	$ 2,024,196	$ 2,172,522
Operating Income	$ 345,438	$ 415,543	$ 334,253	$ 274,125
Net Income	$ 234,284	$ 278,175	$ 266,146	$ 252,200
Earnings Per Common Share	$ .58	$ .72	$ .70	$ .66
Dividends Declared Per Common Share	$ .46	$ .46	$ .46	$ .43
Common Stock Price Per Share				
High	$ 20⅜	$ 20	$ 20¼	$ 17⅞
Low	$ 17⅜	$ 17¼	$ 17⅜	$ 16