GL00989

PROPOSAL FOR SUPPORT FOR SCIENTIFIC RESEARCH

SUBMITTED TO:	U. S. Department of Energy Division of Geothermal Energy
INSTITUTION:	Board of Regents University of Nevada System Nevada Bureau of Mines and Geology University of Nevada - Reno Reno, Nevada 89557
PRINCIPAL INVESTIGATOR:	Dennis T. Trexler Nevada Bureau of Mines and Geology
TITLE OF RESEARCH:	LOW- TO MODERATE-TEMPERATURE GEOTHERMAL RESOURCE ASSESSMENT FOR NEVADA - SITE SPECIFIC STUDIES
SUPPORT REQUESTED FOR PERIOD:	May 1, 1979 to April 30, 1981

SUPPORT REQUESTED:

	Year 1	Year 2
Option I	$140,630	$136,469
Option II	$205,585	$208,704

Dennis T. Trexler
Research Associate/Geologist
(702) 784-6691

APPROVED:

John H. Schilling, Director
Nevada Bureau of Mines and Geology

John E. Nellor
Graduate Dean,
Research Coordinator

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INTRODUCTION

The Nevada Bureau of Mines and Geology (NBMG) proposes to extend its investigation of low- to moderate-temperature geothermal resources by examining four sites, over a two year period, where geothermal resource development has been favorably assessed. These areas include the northern Big Smoky Valley, the Carson City area, and two areas from the following list of possibilities: Carlin, Moana, Wells, Gerlach, Wabuska, Smith Creek Valley, Crescent Valley, Golconda, and Hawthorne. All of these areas contain a significant number of hot springs and wells and were recently designated as high potential areas for geothermal resource development in the U.S.G.S. Circular 790. In addition, the areas were selected on the basis of a numerical technique, recently formulated at NBMG, that evaluates data from several distinct geothermal parameters and yields a semi-quantitative probability function. The value of the probability function is used to determine resource development favorability.

The basic program will combine geological mapping, physical measurements, geophysical surveys, and geochemical surveys to identify and place limits on the reservoir boundaries of the hydrothermal resource. An option, which involves drilling at selected sites within each of the study areas, is included.

The scope of the investigation is briefly outlined below:

Option I

- Task 1. Review pertinent geological and geophysical literature and construct preliminary surface manifestation maps as well as subsurface cross-sections.
- Task 2. Geological field checking of stratigraphic units in hydrographic basin.
- Task 3. Fly low sun-angle photographic reconnaissance of hydrographic basin to delineate lineaments.
- Task 4. Conduct leveling survey and gravity survey at selected intervals across the hydrographic basin.
- Task 5. Conduct resistivity surveys in areas adjacent to hot springs.

Task 6. Conduct a one-meter temperature survey in areas adjacent to hot springs.

Task 7. Sample surface waters for chemical analysis.

Task 8. Prepare maps, diagrams, and cross-sections of traversed areas.

Task 9. Prepare final report and critique of scientific methods used in the investigation.

Task 10. Submit all pertinent data to USGS GEOTHERM data file, including information gathered in the continuing State-wide Geothermal Assessment.

Option II

Task 11. Select one drill site at each study area and drill aproximately 600 feet for temperature gradient and reservoir confirmation.

Task 12. Log wells during drilling.

Task 13. Prepare detailed lithologic logs from drill chips.

Task 14. Analyze selected intervals of drill chips both petrographically and by X-ray diffraction.

Task 15. Measure temperature profile and collect water samples for chemical analysis.

RATIONALE

The Rocky Mountain - Basin and Range Regional Hydrothermal Commercialization Plan has identified the "lack of adequately tested reservoirs" as one of the "most critical barriers to accelerating the development of hydrothermal resources." In addition, the Plan outlines the objectives of the State-Coupled Direct Heat program. These objectives include: assisting the U.S.G.S. data compilation of low- to moderate-temperature resources; publishing maps and reports detailing these resources; and testing the highest priority areas for reservoir confirmation. The NBMG proposes a two year, multi-task reservoir-confirmation program for four sites of high potential for direct utilization of geothermal resources.

Several factors influenced the choice of the four sites. They are all within the Battle Mountain Heat-Flow High and also contain a number of thermal springs and wells. Twenty-seven broad regions, which include the selected sites, were outlined by U.S.G.S. and NBMG personnel as areas of high potential for direct utilization and included in U.S.G.S. Circular 790. In addition, a numerical scheme has been developed at the NBMG for ranking areas with regard to potential for direct utilization. The scheme evaluates physical, chemical, and demographical parameters for specific sites. On the basis of this scheme, the Carson City, Carlin, Moana, Hawthorne, and Wells areas were rated high for development of geothermal residential space heating and the Big Smoky Valley, Gerlach, Golconda, Wabuska, Crescent Valley, and Smith Creek Valley areas rated high for the development of geothermal industrial process heat. These areas are also favored because adequate baseline data exists in the form of topographic, geologic, and regional gravity maps, as well as chemical analyses of thermal waters.

The site-specific tasks, outlined in the introduction, and discussed in the following sections, are designed to provide sub-surface information and to place limits on the boundaries of the geothermal reservoir. The need for this information is based on the premise that "a very substantial increase in direct utilization is possible by 1985 if reservoir confirmation efforts . . . are extensive enough", as outlined in the Regional Hydrothermal Commercialization Plan.

The information provided by the program will be used in many ways by several agencies (Federal, State, and local) and by the private sector (companies and individuals). The results of this proposed investigation will provide information to:

1) support the DOE funded Nevada Department of Energy's Operations Research and Outreach programs;
2) supplement and update data to the U. S. Geological Survey's GEOTHERM computer data file;
3) eliminate uncertainties attendant to resource exploitation by potential developers and,
4) define site-specific resource characteristics.

The Option II investigation will provide more detailed subsurface information that will further enhance credibility of the reservoir characteristics as determined in Option I.

The final report will include a critical evaluation of the geothermal exploration techniques used in this study and will suggest, on the basis of the developed criteria, future site-specific reservoir studies.

PROPOSED PROGRAM

The NBMG is presently completing work on the low- to moderate-temperature geothermal assessment program for Nevada, Contract No. ET-78-S-08-1556. During the course of this work, the NBMG identified sites where detailed geological and geophysical investigations could be carried out to delineate geothermal reservoir boundaries (fig. 1). Most of these sites are already well known because of the numerous hot springs and wells in these areas. The USGS has also broadly outlined 21 such sites, in Nevada, in Circular 790.

In the first year of the program, the investigation will focus on the northern half of the Big Smoky Valley and the Carson City area. In the second year, two other areas will be selected from the following possible sites:

Areas rated high for Industrial Process Heat Applications

1. Crescent Valley
2. Golconda
3. Gerlach
4. Smith Creek Valley
5. Wabuska

Areas rated high for Residential Space Heating Applications

6. Moana
7. Carlin
8. Wells
9. Hawthorne

The selection will be based on information gained during the first year and on availability of suitable topographic base maps.

Description of the areas

The Big Smoky Valley is one of the largest in central Nevada, encompassing nearly 3000 square miles. It extends from the city of Tonopah, north, approximately 100 miles, to the city of Austin (fig. 1). The Toiyabe Range, to the west, and the Toquima Range, to the east, rise to over 6000 feet above the valley floor. A slight structural high, near the town of Round Mountain, bisects the valley into two smaller drainage basins.

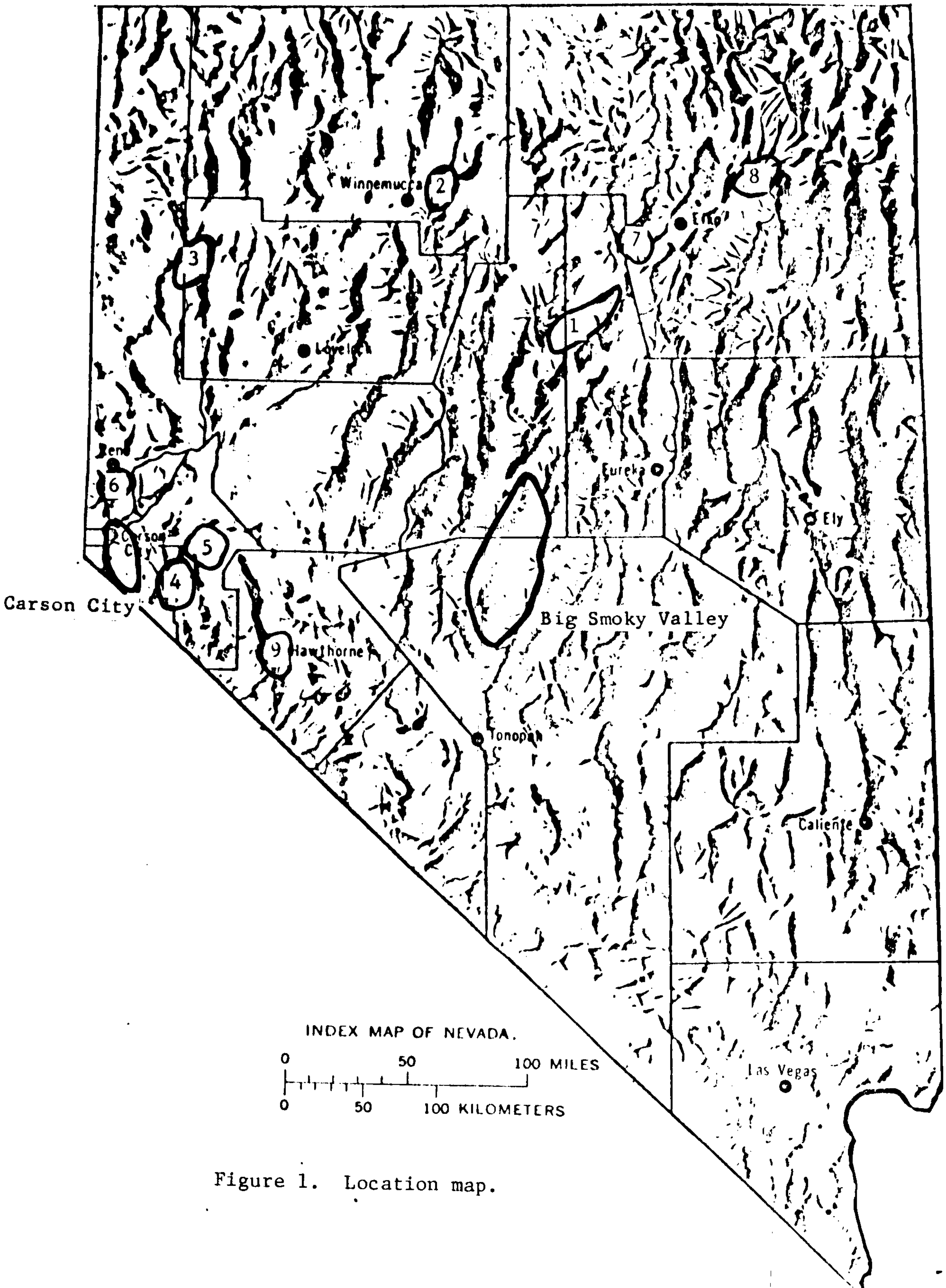

Figure 1. Location map.

The basin to the north contains a number of geothermal occurrences including: Spencer's Hot Spring (73°C), McCleod Ranch Hot Springs (82°C), and Darrough Hot Springs (97°C). The average elevation of these springs is 5500 ft. The point of discharge is apparently related to permeable sands and gravels of Quaternary age.

The adjacent ranges consist of Paleozoic sediments, both clastic and carbonates, that have been intruded by Mesozoic igneous rocks. Tertiary volcanics cover many of the older rocks. The Quaternary valley fill has been estimated at 3000 to 5000 feet thick (John Erwin, 1979, personal commun.).

Access to the area includes a major north-south highway (Nevada 8A) and many additional secondary roads and trails.

Based on the numerical technique that was previously described, this area was rated very high for industrial process heat applications.

The Carson City site (fig. 1) is a moderately urbanized area, and includes the City of Carson City (population 25,000) and the community of Gardnerville-Minden (population 1500). The investigation will be limited to the northern part of the physiographic basin that is bordered on the north by the Virginia Range, on the east by the Pine Nut Mountains, on the south by the Sierra Nevada, and on the west by the Carson Range. The site encompasses approximately 300 square miles and the work will be concentrated on areas that surround the five major thermal springs: Carson Hot Springs (50°C); Nevada State Prison Springs (24°C); Saratoga Hot Springs (50°C); Hobo Hot Springs (45°C); and Wally's Hot Springs (50°C). In addition, geothermal wells, which are used for residential space heating, are common in the Pine Nut Mountains, immediately adjacent to the Carson City municipal limits.

The oldest rocks at this site consist of Jurassic and Triassic metavolcanics. The granitic rocks of the Cretaceous Sierra Nevada Batholith are exposed in the Carson Range, to the west, and at other locations scattered throughout the basin. An extensive sequence of Cenozoic volcanics and interbedded sedimentary rocks overlies the older metavolcanics and granites. The basin is filled with recent and Quaternary alluvium. This site lies entirely within the Basin and Range Province and the mountain ranges are bounded on one or both sides by range-bounding normal faults (Moore, 1969).

Access to this area includes a major north-south highway (U. S. 395), as well as numerous secondary roads.

Based on the numerical technique, this area was rated high for the development of geothermal space heating.

Detailed statement of work

The investigation for OPTION I consists of ten functionally interwoven tasks which will be applied to each area of investigation. The incorporation of these tasks into the program is derived, in part, from Goldstein (1977), in which geothermal exploration techniques for northern Nevada were semi-quantitatively evaluated on the basis of cost/benefit. The NBMG anticipates varying degrees of success as these techniques are applied to the different sites. That information will itself be valuable to future geothermal reservoir site-specific studies.

The investigation will begin with a thorough compilation of all available maps (7½' and 15' topographic maps, geologic maps, and regional gravity maps) air photos, well logs, and any additional information from the literature that may be useful in constructing the geologic baseline for each area. The USGS data file GEOTHERM will be used extensively for spring and well locations, water chemistry, and flow rates. Special attention will be given to rock type and age, range-bounding faults, and valley fill components. These baseline data will be projected onto the available topographic maps and selected cross-valley traverses. Five traverses in the Big Smoky Valley and three in the Carson City area will be delineated for detailed geological and geophysical surveys.

The first detailed survey will consist of checking the lithology/mineralogy, stratigraphy, and structure, in the bordering ranges and, to an extent limited by the number of exposures, the valley fill. Special attention will be given to the stratigraphic units at the tops of the ranges. The presence of similar units detailed prior to the Basin and Range Faulting would likely imply the presence of that same unit in the valley subsurface. Unit correlation may also be useful in the interpretation of the geochemical data for hot springs. Chemical variations within the same drainage may be due to the effects of mineralogically different stratigraphic units.

To augment the geological investigation, low sun-angle photography (LSAP) of both sites will be flown to provide information on the spatial relationship between surface faulting and hot spring activity. Relationships between geothermal anomalies in western and north-central Nevada and geologic structures have been shown to be important in the localization of hot spring activity (Trexler and others, 1978). The surface fault patterns provide pertinent information on subsurface structural controls. Special attention will be given to the relationship between and influence of regional structural trends, in these site-specific areas, and their adherence to the patterns recognized in the Winnemucca AMS sheet (Trexler and others, 1978). The structural interpretation provided by enhancement of surface faults by low sun-angle photography (Walker and Trexler, 1977) will provide information on the subsurface controls of the reservoirs under investigation.

Regional gravity data is available for all sites (Erwin and Berg, 1977; Erwin and Bittleston, 1977; Healy, 1967; Oliver and Robbins, 1973), but only at a scale of 1:250,000. The aim of the gravity survey proposed here is to provide more detailed information along the same transects as the geological surveys. The information derived will give a reasonable indication of the depth of the valley fill and may resolve the configuration of the basement below the fill. Elevations will be determined by the stadia-transit technique and gravity measurements will be tied to existing stations of previous surveys. Samples will be collected for density determination in the laboratory.

No shallow depth (1 meter) temperature survey information is available at the proposed sites. Heat flow measurements received high ratings (Goldstein, 1977) in both scales of geothermal exploration, 2500 and 100 square mile areas. A technique that was developed by Olmsted (1977) and used with some success in Nevada, will be applied, in a modified version, to these sites. The technique consists of the temporary installation of a 30 station expandable rectangular grid. The holes will be augered, to a depth of one meter, in the vicinity of suspected reservoirs. Temperatures will be measured periodically and the resulting isotherm configuration will be plotted on the base maps. The iostherm configuration could be useful in determining the extent of the structural controls, as determined from LSAP interpretation, on heat flow. Radial symmetry may indicate a point source for the hot water, possibly the intersection of two faults. Linear or elongate patterns, on the other hand, would almost certainly indicate a single deep fault as the responsible structure.

Since depth to the resource is an important parameter governing the economics of the direct-use of geothermal energy, an electric resistivity survey, at selected sites, has also been incorporated with the field work. The shape of the top of the water table will define the possible upper limits of the geothermal reservoir. The distribution of sediments saturated with highly conductive brines, geothermal waters, may also indicate the extent of near-surface geothermal aquifers. An example of this may be evident in the Big Smoky Valley, where the average elevation of discharge of the springs is related to the spatial distribution of Lake Lahontan (late Quaternary) beach sands and gravels.

The final field task consists of sampling the surface waters, measuring the temperature and pH in situ, and determining the specific conductance and alkalinity at 25°C. In addition, water samples will be chemically analyzed for major anions and cations and, to a limited extent, for stable light isotopes. These data will be used to identify areas that are geochemically similar and possibly structurally related. Certain geochemical signatures may also be used to identify the source of recharge.

Option II is included here because it is field oriented. The objective of the task is to extend the surface and near-surface investigations by providing detailed lithologic, geochemical, and temperature data from several drill holes. The plan includes drilling one hole, 600 feet deep, at each site. This task constitutes reservoir confirmation and will be based wholly on data gathered from the previous tasks. Should one of the holes penetrate a significant reservoir, arrangements will be made to leave the hole open for more testing.

The final tasks include data interpretation, map and final report preparation, and submission of all pertinent information to GEOTHERM. A final report at the end of the first year of the investigation will be limited to the Carson City/Big Smoky Valley investigations. Likewise, the second year's final report will be limited to two areas. Data interpretation will be aided by the use of the NBMG's Tectronix 4014 graphic display in conjunction with PDP 11/34 and CDC 6400 computers. The final product will include a map that outlines known or suspected geothermal reservoir boundaries. Structures responsible for these boundaries will be included along with temperature distributions, water table configuration, and chemical compositions of the water. The final report will also include a critical evaluation of the exploration techniques used in this study and a projection of those techniques that could be successfully applied to site-specific studies at the remaining high-potential areas in Nevada.

The data on the suitability of the sites for particular applications will be forwarded to the Nevada Department of Energy for use in the ongoing Outreach Program. This information will also be presented at regional technical sessions, as well as local, user-oriented meetings.

PROPOSED SCHEDULE OF ACTIVITIES

During the first year of funding, the investigation will be limited to two sites (the Big Smoky Valley site and the Carson City site). Should OPTION I be selected, the investigation will include Tasks 1 through 10, outlined below and shown in figure 2. Should OPTION II be selected instead, the investigation will consist of Tasks 1 through 10 and will also include Tasks 11 through 16, reservoir confirmation by drilling. With the OPTION II plan, Task 11 would be staggered, pending data compilation, and would begin six months after the initiation of Task 1. All work efforts will have been completed one year after the initiation of the program and the contents of the final product will depend on the OPTION selected. The final report under OPTION I will consist of surface and near surface geological surveys. Under OPTION II, the surface and near surface survey report would be supplemented by detailed subsurface information.

The second year would employ a similar strategy in two other areas of geothermal potential. This research will expand the knowledge of reservoir properties and aid the development of direct utilization of geothermal energy.

OPTION I (Surface and near-surface investigation)

Task 1. Review all pertinent geological and geophysical literature sources. Construct base maps on topographic sheets by projecting stratigraphic units and geologic structures from larger scale maps. Project available geophysical data onto base maps. Construct preliminary cross-sections of valleys at delineated areas of traverse.

Task 2. Field check stratigraphic units in both basin and range. Note especially age relations of superjacent units on each range; sample where appropriate. Estimate thickness and note sense of offset in fractures and faults.

Task 3. Conduct a low sun-angle photographic reconnaissance of basin and range-margins. Field check lineaments, verify fault trace and sense of displacement. Plot data on base maps.

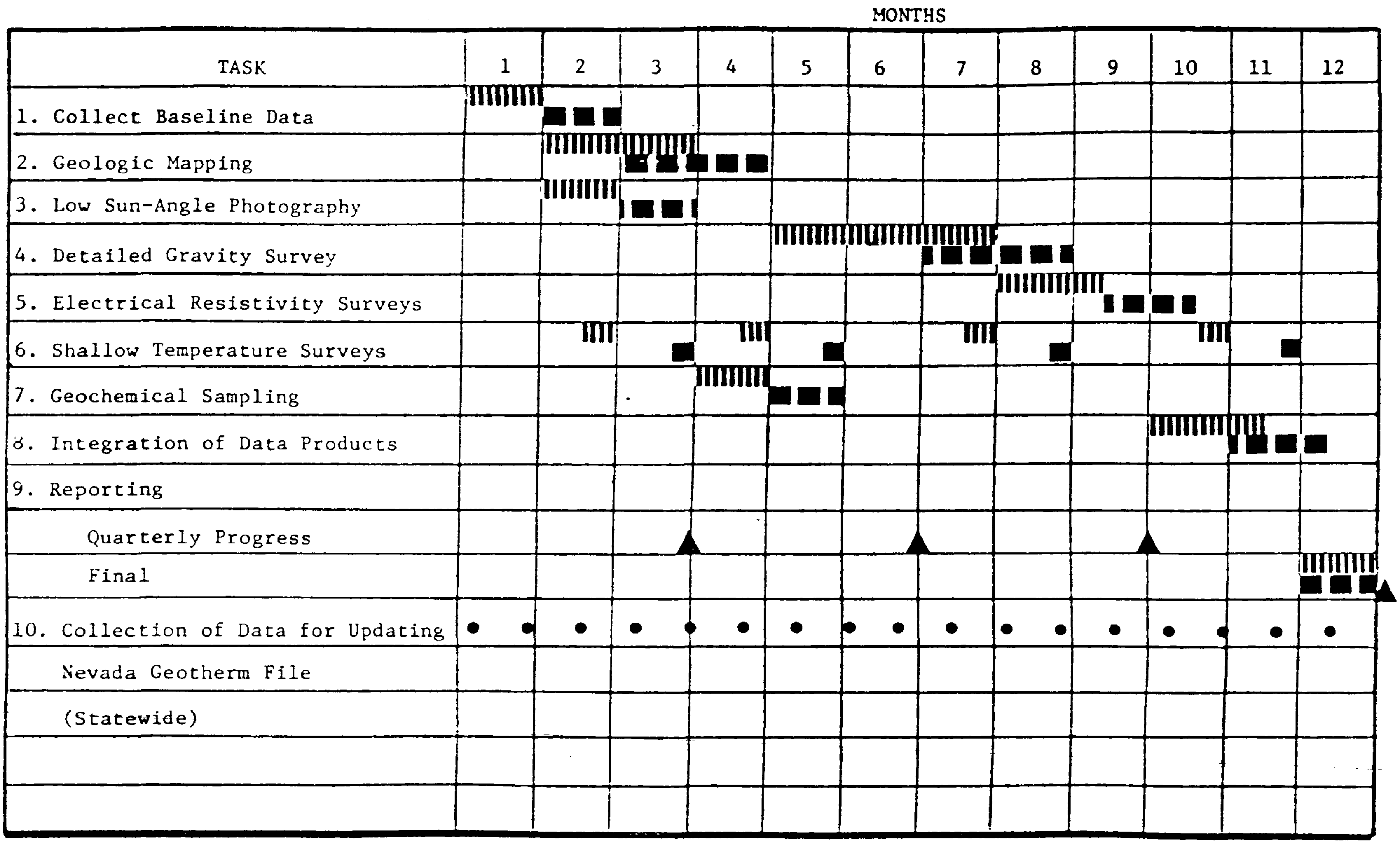

Figure 2. Tentative Program Schedule Option I

IIIII Northern Big Smoky Valley ■■ Carson City

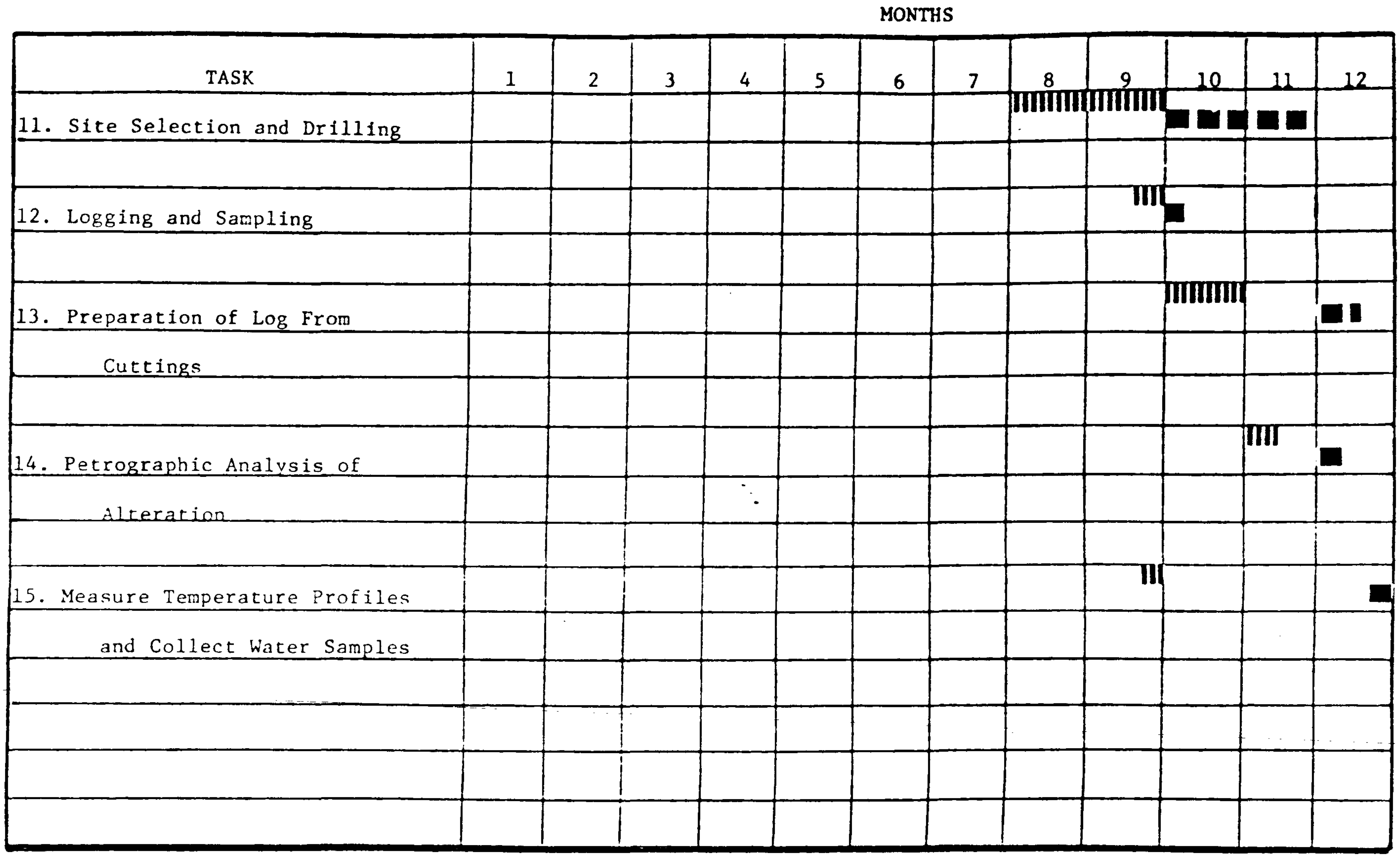

Figure 3. Tentative Program Schedule. Option II
Reservoir Confirmation

IIIII Northern Big Smoky Valley ■■ Carson City

Task 4. Conduct stadia and transit leveling along the selected traverses. Set up gravity stations and conduct a detailed gravity survey along transects, with high resolution in areas of faults and hot springs. Plot data on base maps.

Task 5. Conduct resistivity surveys in areas adjacent to hot springs along the selected traverses. Plot depth to top of ground water on base maps. Continue survey areally, if warrented.

Task 6. Construct an expandable grid of 30 stations (one-meter holes) in the vicinity of hot springs along the line of traverse. Install thermistor probes, allow time for equilibration, measure temperature periodically. Plot isotherms on base maps; continue areally if warranted.

Task 7. Collect water samples for bulk chemical and isotopic analysis. Measure, in field: temperature, pH, specific conductance, and carbonate/bicarbonate. Analyze appropriate samples for stable light isotopes, analyze all for major and minor anion and cation constituents.

Task 8. Prepare maps and diagrams including: detailed geologic maps and cross-sections along the selected traverses; isotherm configuration; depth to basement; and depth to ground water.

Task 9. Prepare final report indicating cost/benefit of the techniques used and an estimation of the probable effectiveness for other site-specific studies in Nevada.

Task 10. Continue to collect geothermal data on a statewide basis. Submit new data to the U. S. Geological Survey's GEOTHERM data file.

OPTION II (Reservoir Confirmation)

Option II will include tasks 1-10 of Option I and the following tasks associated with the drilling program.

Task 11. Drill one hole 600 feet deep at each area of investigation (total 2 holes).

Task 12. Log well during drilling.

Task 13. Prepare a detailed lithologic log from drill chips and selected spot cores.

Task 14. Select intervals for X-ray and petrographic identification of unaltered mineral assemblages and alteration products.

Task 15. Measure temperature profile in the well bore and collect water samples for chemical analysis, bulk chemistry, and stable light iostopes.

Task 16. Integrate data derived in Tasks 11-15 with data obtained in OPTION I.

PROJECT ORGANIZATION

The Nevada Bureau of Mines and Geology is a research and public service division of the Mackay School of Mines, one of the several colleges of the University of Nevada, Reno. Research includes all phases of Nevada's geology and mineral resources: basic geologic mapping and laboratory studies, geophysical and geochemical surveys, engineering geology, earth-environmental considerations in urban and rural planning, the preparation of educational guides and boolkets, statewide investigations of mineral commodities, the geology of ore deposits, and the exploration, development, mining, processing, utilization, and conservation of metal ores, industrial minerals, fossil and nuclear fuels, geothermal power, and water.

The proposed research is a two year program, OPTION I will utilized 3 senior agency professional staff members, two on full time and one on part time. Personnel for OPTION II will include those already listed for OPTION I plus an additional part-time research associate. The principal staff members to be involved in the program are:

First Year

OPTION I

Dennis T. Trexler, Research Associate/Geologist - 6 months

Brian Koenig, Research Associate/Geologist - 12 months

Thomas Flynn, Research Associate/Geologist - 12 months

OPTION II

OPTION I personnel - 30 months

Research Associate/Geologist - 6 months

Second Year

OPTION I

Dennis T. Trexler, Research Associate/Geologist - 6 months

Brian Koenig, Research Associate/Geologist - 12 months

Thomas Flynn, Research Associate/Geologist - 12 months

OPTION II

OPTION I personnel - 30 months

Research Associate/Geologist - 6 months

FACILITIES AND EQUIPMENT

The Nevada Bureau of Mines and Geology occupies parts or all of three floors in the west wing of the Scrugham-Engineering and Mines building on the University of Nevada-Reno campus. Office, laboratory, and drafting room space for the research program will be made available by the University of Nevada-Reno. In addition, a graphite crystal monochrometer-equipped Norelco radiation diffraction unit, and International Scientific Instruments model Super IIIA scanning electron microscope/microprobe, and a fully-equipped thin-section laboratory are also available for detailed examination of drill core minerals. The Bureau maintains a Tectronix 4014 computer terminal, with hard-copy capabilities, that can access either a DEC PDP-11/34 or a Control Data Corporation 6400 computer; a high speed, large storage-capacity disc drive can interface directly with the DEC PDP-11/34.

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APPENDIX A

Resumes of Principal Staff Members

DENNIS THOMAS TREXLER

Born: August 6, 1940

Registered Geologist - State of California - #2382

Education: B.S. Geology - University of Southern California - 1965, Los Angeles, California 90007
M.S. Geology - University of Southern California - 1968, Los Angeles, California 90007

Experience:

Dec. 1974-present Nevada Bureau of Mines and Geology, University of Nevada, Reno
Title: Research Associate
I have been involved as principle investigator or co-principle investigator in numerous research programs concerned with Earthquake Hazard Reduction (USGS), National Uranium Resource Evaluation (LLL, DOE) and Geothermal Evaluation (DOE). These projects have required both direct research participation, administrative and research direction of research assistants.

Feb. 1971-Dec. 1974 Mackay School of Mines, University of Nevada, Reno. Title: Research Associate. Duties included coordination and interpretation of remote sensing data acquired by high altitude aircraft and Skylab in relation to natural resources in the Great Basin. Interpretation included evaluating Skylab photographic imagery for lithologic, structural and geomorphic data and the cost-benefits derived. Also performed research in applications of remote sensing techniques to the solution of geologic and natural resources problems. Techniques employed included the use of the visual, infrared and microwave portions of the elctromagnetic spectrum. Computer programming for utilization of geologic parameters in interpretation techniques.

Aug. 1970-Feb. 1971 Microwave Sensor Systems Division of Spectran, Inc. Title: Manager Earth Resources Applications. At Microwave Sensor Sustems I conducted investigations on the detection and discrimination of oil spills using multispectral photography, 8-13.5 micron infrared imagery and multifrequency microwave radiometer data.

May 1968-July 1970 Aerojet-General Corporation, Space Division, Azuza, California. Title: Member of the Staff, Geologist. At Aerojet I was engaged in development of passive microwave techniques for earth resources. I participated as either Project Engineer or Program Manager on the following investigations:

1. Microwave Emissions of Snowpacks (U. S. Geological Survey).
2. Passive Microwave Measurements of Snow, Ice and Oceanography (Office of Naval Research).
3. Feasibility of using Microwave Techniques as Applied to Geologic Problems (U. S. Geological Survey).

Nov. 1967-May 1968 Geolabs, Inc. Santa Ana, California. Title: Engineering Geologist. Duties entailed site evaluation for engineered structures and preparation of geologic reports for Los Angeles and Orange Counties, California.

Sept. 1966- State of California, Dept. of Water Resources Los Angeles, California. Title: Engineering Geologist. While assigned to the planning and special investigations branch, duties included interpretation of ground water basin characteristics from exploratory drilling, preparation of ground water basin simulization by digital computer models and a survey of the impact of degradation of water quality on industry.

Memberships: Geological Society of Nevada, Sigma XI, American Association of Petroleum Geologists, Geothermal Resources Council.

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Trexler, D. T. (1977) Summary report of availability of geothermal data for potential direct heat application in Nevada, U. S. DOE Report NVO/0671-1. 10 p., NTIS.

Slemmons, D. B., Glass, C. E., Carver, G. A., Trexler, D. T. and Tillson, D. D. (1978) Remote sensing analysis of fault activity and lineament pattern of the epicentral region of the 1872 Pacific Northwest Earthquake, 3rd Inter. Conf. on Basement Tectonics.

Bell, E. J., Trexler, D. T. and Bell, J. W. (1978) Computer-simulated composite earthquake Hazard Model for Reno, Nevada, Proceedings of the 2nd Inter. Conf. on Microzonation, San Francisco, CA.

Trexler, D. T., Bell, E. J. and Raquemore, G. R. (1978) Evaluation of lineament analysis as an exploration technique for geothermal, Central and Western Nevada, U. S. Dept. of Energy Report NVO-0671-2, 78 p.

BRIAN ALFRED KOENIG

Born: December 14, 1944

Education: B.S. Geology - University of Wisconsin - 1973, Madison, Wisconsin 53706
M.S. Geosciences - University of Arizona - 1978, Tucson, Arizona 85721

Experience:

Apr. 1978- present
Nevada Bureau of Mines and Geology, University of Nevada, Reno
Title: Research Associate
Current project includes cataloging and examining low- to moderate-temperature geothermal resources in the State of Nevada with regard to updating the USGS file Geotherm and producing a map detailing the location and other data pertinent to the direct utilization of the resources. On site checks of specific locations for temperature and chemical data are required.

Apr. 1976- Jul. 1977
Department of Geosciences, University of Arizona, Tucson
Title: Research Assistant
Carried out research leading to a detailed description of mineralogical and chemical changes with depth in a weathered porphyry copper deposit. The data gathered formed the basis for an interpretation of the weathering processes and controls on these processes.

Aug. 1973- Aug. 1975
Ray-O-Vac Division of ESB Inc., Madison, Wisconsin
Title: Chemical Technician
Duties included routine wet chemical analyses of battery components and method development. A method I developed provides a high degree of accuracy in the analysis of mixtures of MnO_2, Ag_2O, and graphite.

Oct. 1965- Aug. 1968
U. S. Army
Title: Artillery Meteorological Team Chief
Duties included the acquisition and reduction of data from radiosonde flights and the supervision of 5-7 team members.

Special training: Additional skills include: scientific computer programing with courses in FORTRAN, assembly language programing, and numerical analysis; experience with atomic absorption spectrophotometry, polarography, and x-ray diffraction; and photography.

Thesis: Oxidation-Leaching, and Enrichment Zones of a Porphyry Copper Deposit - a Mineralogic and Quantitative Chemical Study, University of Arizona, Tucson.

KOENIG - Additional Information

The contract under which I am currently employed, Assessment of Low- to Moderate-Temperature Geothermal Resources in Nevada (DOE/DGE Contract No. ET-78-S-08-1556) has provided me with the opportunity to familiarize myself with the location and nature of geothermal resources in Nevada. During field investigations I have measured parameters such as in situ pH and specific conductance, prepared samples for chemical analysis, performed field alkalinity titrations, and participated in the reduction and quality control of analytical data.

My academic background has emphasized chemical and physical chemical aspects of hydrothermal systems as well as practical experience with X-ray diffraction and whole rock geochemical analysis in altered rocks. I have used and am familiar with the computer programs used to convert input fluid chemistry to equilibrium chemical (mineralogical) assemblages. Familiarity with programming allows me to design software as needed to augment our study.

Applicable Meetings: GSA Penrose Conference, Heat Transport Processes in the Earth, Vail, CO, 1978.

Abstract submitted to GSA Cordilleran Section for April 1979 meeting: Compositional change and chemical mass transport as a result of supergene processes at the San Xavier north porphyry copper deposit, Arizona.

THOMAS FLYNN

Born: May 15, 1948

Education: B.S. Geology - State University College at New Paltz - 1971, New Paltz, New York
M.S. Geology - State University of New York at Binghamton - 1976, Binghamton, New York

Experience:

May 1978-present — Nevada Bureau of Mines and Geology, University of Nevada, Reno. Title: Research Associate/Geologist. Duties include geologic assessment and evaluation of energy-related resources in Nevada. Presently working on update and revision of U.S. DOE Geotherm Data File for geothermal resource assessment in Nevada. Additional duties include preparation of research proposals and editing of geological research manuscripts prior to publication.

Feb. 1976-May 1978 — Engineering Index, Inc., United Engineering Center, 345 East 47th Street, New York, New York 10017. Title: Editor. Duties included technical evaluation of energy-related literature and preparation of the literature for input to the U.S. DOE (Oak Ridge, Tennessee) Energy Data Base. Preparation included both abstract writing and descriptive indexing; indexing based on 20K controlled vocabulary.

Sept. 1972-May 1975 — S.U.N.Y.-Binghamton, Hydrothermal Laboratory. Title: Research Assistant. Duties included operation and maintenance of advanced hydrothermal laboratory for an experimental investigation of high-temperature, high-pressure metamorphism of common sedimentary rocks. Master's thesis was derived from these investigations.

Membership: American Geophysical Union

Bibliography

Flynn, T., (1977) Filter pressed partial metls: an experimental formation of migmatites, (abs.), American Geophysical Union, Spring Meeting, Washington, D.C.

Flynn, T., (1976) Filter pressed partial melts, an experimental formation of migmatites, (Master's Thesis).

Reports

Trexler, D., Flynn, T., and Koenig, B. A. (1978) Assessment of Low- to Moderate-Temperature Geothermal Resources of Nevada, First and Second Quarter Progress Reports; Prepared for the U. S. Department of Energy, Division of Geothermal Energy, under Contract ET-78-S-08-1556.

APPENDIX B

Cost Estimate

EXPLANATION OF COSTS

All costs presented on Optional Form 60 are self explanatory, except the purchase of a vehicle and an explanation of the cost sharing provided by the Nevada Bureau of Mines and Geology.

The second year program costs are estimated on an 8% salary increase for professional staff members and a 10% inflationary increase for all other costs.

Vehicle Purchase

A four-wheeled drive pickup truck with camper is included as a capitol equipment purchase for the first year of the proposed two year program. As a result of a shortage of 4-WD vehicles at the University of Nevada all funded research projects are required to provide their own vehicles. Rental costs for a 4-WD vehicle from commercial rental companies @ $500/mo., $.23/mi. plus fuel at an estimated $.75/gallon are presented in tabular form below:

Rental

First year	9 mos. @ $500	=	$4500
Option I	12,000 mi @ $.23/mi	=	2760
	1,200 gal. fuel @ $.75	=	900
Total first year			$8160

Second year using same strategy as Option I

First year and allowing 10% increase total vehicle rental would be $8980

Total rental for 4-WD vehicle (18 month) = $17,140

Purchase

If a vehicle is purchased during first year and used for a similar amount of mileage and time throughout the duration of the proposed program a savings is indicated:

First year;

Purchase price 4-WD pickup w/camper	$ 8800
Mileage charge first year 12,000 @ $.20	2400

Second year;

Monthly charge $80/month for 9 months	720
Mileage 12,000 miles @ $.22/mile	2640
Total vehicle cost for proposed two year study	$14,560

As shown in the previous two examples (rental vs. purchase) a savings of more than $2000 can be realized by purchase of a vehicle over the two year duration of the proposed investigation. If the Geothermal Assessment Programs extends beyond the anticipated two years, greater savings in field transportation costs will be realized.

Cost Sharing

Materials and services to be provided by the University of Nevada through the Nevada Bureau of Mines and Geology include clerical, secretarial, and drafting services, computer time, and X-ray analytical work. These materials and services represent 5% of the total cost of OPTION I and include:

Drafts person	½ person-month at $1500/mo.	$ 750
X-ray analysis		400
Secretarial/clerical services	2 person-months at $1044/mo.	2088
Computer time	50 hrs. at $75/hr.	3750
Total		$6988

CONTRACT PRICING PROPOSAL
(RESEARCH AND DEVELOPMENT)

Office of Management and Budget Approval No. 29-RO184

This form is for use when (i) submission of cost or pricing data (see FPR 1-3.807-3) is required and (ii) substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. 1 | NO. OF PAGES 5

NAME OF OFFEROR: Board of Regents, University of Nevada System	SUPPLIES AND/OR SERVICES TO BE FURNISHED: Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies - OPTION I, Year 1
HOME OFFICE ADDRESS: University of Nevada, Reno, Reno, Nevada 89557	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Nevada Bureau of Mines and Geology	TOTAL AMOUNT OF PROPOSAL: $140,630 — GOV'T SOLICITATION NO.:

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL (Itemize on Exhibit A)					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS (At other than cost)					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD[3] (Rate %X$ base=)					
3. DIRECT LABOR (Specify)	**ESTIMATED HOURS**	**RATE/HOUR**	**EST COST ($)**		
Trexler (Geologist)	1040	12.82	13,326		
Flynn (Geologist)	2080	9.61	19,992		
Koenig (Geochemist)	2080	9.61	19,992		
TOTAL DIRECT LABOR				53,310	
4. LABOR OVERHEAD (Specify Department or Cost Center)[3]	**O.H. RATE**	**X BASE =**	**EST COST ($)**		
Retirement	8%	53,310	4,265		
Nevada Industiral Commission, Health Insurance, unemployment	4%	53,310	2,132		
TOTAL LABOR OVERHEAD				6,397	
5. SPECIAL TESTING (Including field work at Government installations)			**EST COST ($)**		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT (If direct charge) (Itemize on Exhibit A)				8,800	Ex. A
7. TRAVEL (If direct charge) (Give details on attached Schedule)			**EST COST ($)**		
a. TRANSPORTATION			5,455		
b. PER DIEM OR SUBSISTENCE			7,945		
TOTAL TRAVEL				13,400	Ex. A
8. CONSULTANTS (Identify—purpose—rate)			**EST COST ($)**		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS (Itemize on Exhibit A)				22,806	Ex. A
10. TOTAL DIRECT COST AND OVERHEAD				104,713	
11. GENERAL AND ADMINISTRATIVE EXPENSE (Rate 34.3 % of cost element Nos. 3,4,6,7,9				35,917	
12. ROYALTIES[4]					
13. TOTAL ESTIMATED COST				140,630	
14. FEE OR PROFIT					
15. TOTAL ESTIMATED COST AND FEE OR PROFIT					

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
9	Equipment rental	
	Rock coring equip. rental · 10 days @ $30/day	300
	Vehicle mounted drill 2 wks. @ $300/wk.	600
	TOTAL	900
9	Equipment	
	Portable drilling equipment	700
	Walkie talkies 3 @ $100	300
	20 thermistor probes @ $48 ea.	960
	2 digital thermometers @ $300 ea.	600
	PVC pipe 100 ft. @ 20¢/ft.	20
	2 Brunton compasses @ $100	200
	TOTAL	2,780
9	Non-expendable supplies	
	Mylar base maps 16 @ $34.25	548
	Existing airphotos 200 @ $4 ea.	800
	Topo geophysical, geological maps	175
	Low sun-angle photography: Big Smoky Valley	3,276
	Carson City	1,966
	TOTAL	6,765
9	Expendable supplies	
	Film, flagging, stakes, notebooks, batteries, etc.	500
	Drafting supplies	250
	Sample bottles, chemicals, glassware	436
	TOTAL	1,186
	PAGE TOTAL	11,631

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.):* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.):*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*				EST COST *($)*
9 Chemical analyses					
	Anal. Type	# Samples	$/Anal.	Lab.	
Whole rock samples					
	Major-Minor	12	125	Teledyne	1,500
	Sulfide Isotopes	5	40	Isochron Lab.	200
	Sulfate Isotopes	5	60	Isochron Lab.	300
				TOTAL	2,000
Geothermal fluids					
	Major-Minor	40	125	Amtec	5,000
	O Isotopes	10	75	Hebrew Univ.	750
	H Isotopes	10	75	Hebrew Univ.	750
	S Isotopes	10	60	Isochron Lab.	600
				TOTAL	7,100
7 Travel					
7a	Mileage: 12,000 mi. @ $.20/mi				2,400
7a	Air transportation				3,055
7b	Per diem 227 days @ $35/day				7,945
				TOTAL	13,400
				PAGE TOTAL	22,500

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify):* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.):*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
6	Special equipment	
	3/4 ton SWB 4 WD pickup truck with following:	
	Heavy duty suspension	
	Extra fuel tank	
	Power steering	
	A/C	
	AM Radio	
	Rear barden bumper	
	4 speed transmission	
	Locking hubs	
	Phone quote Jones-West Ford Reno 1 Mar 79	8,000
	Camper for above vehicle	800
	TOTAL	8,800

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*
Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies - OPTION I, Year 1
and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE
John E. Nellor Graduate Dean and Research Coordinator	[signature]

NAME OF FIRM	DATE OF SUBMISSION
University of Nevada System University of Nevada, Reno	March 3, 1979

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
7	Miscellaneous:	
	Map preparation	500
	Thin sections 15 @ $5.00	75
	Publication costs (journal page costs)	600
	Communication (postage, telephone, shipping)	900
	TOTAL	2,075
	PAGE TOTAL	2,075

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION
Dept. HEW, Wallace Chan	(415) 556-8343

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify):* [ ] ADVANCE PAYMENTS [ ] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes

OPTIONAL FORM 60 (10-71)

CONTRACT PRICING PROPOSAL

(RESEARCH AND DEVELOPMENT)

Office of Management and Budget Approval No. 29-RO184

This form is for use when *(i)* submission of cost or pricing data (see FPR 1-3.807-3) is required and *(ii)* substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. 1 | NO. OF PAGES 5

NAME OF OFFEROR: Board of Regents, University of Nevada

HOME OFFICE ADDRESS: University of Nevada, Reno, Reno, NEvada 89557

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies - OPTION II, Year 1 (Reservoir Confirmation)

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Nevada Bureau of Mines and Geology

TOTAL AMOUNT OF PROPOSAL: $205,585

GOV'T SOLICITATION NO.:

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*					
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
Trexler (Geologist, P.I.)	1040	12.82	13,326		
Flynn (Geologist)	2080	9.61	19,992		
Koenig (Geochemist)	2080	9.61	19,992		
Unnamed (Geologist)	1040	9.61	9,996		
TOTAL DIRECT LABOR				63,306	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Retirement	8%	63,306	5,065		
Nevada Industrial Commission, Health Insurance, unemployment	4%	63,306	2,532		
TOTAL LABOR OVERHEAD				7,597	
5. SPECIAL TESTING *(Including field work at Government installations)*			EST COST ($)		
TOTAL SPECIAL TESTING					
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*				8,800	Ex. A
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST ($)		
a. TRANSPORTATION			6,055		
b. PER DIEM OR SUBSISTENCE			8,820		
TOTAL TRAVEL				14,875	Ex. A
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*				58,501	Ex. A
10. *TOTAL DIRECT COST AND OVERHEAD*				153,079	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 34.3 % of cost element Nos. 3,4,6,7,9)*				52,506	
12. ROYALTIES[4]					
13. *TOTAL ESTIMATED COST*				205,585	
14. FEE OR PROFIT					
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*					

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Equipment rental	
	Rock coring equip. rental 10 days @ $30/day	300
	Vehicle mounted drill 2 wks @ $300/wk.	600
	TOTAL	900
9	Equipment	
	Portable drilling equipment	700
	Walkie talkies 3 @ $100	300
	20 thermistor probes @ $48 ea.	960
	2 digital thermometers @ $300 ea.	600
	PVC pipe 100 ft. @ 20¢/ft.	20
	2 Brunton compasses @ $100	200
	TOTAL	2,780
9	Non-expendable supplies	
	Mylar base maps 16 @ $34.25	548
	Existing airphotos 200 @ $4 ea.	800
	Topo geophysical, geological maps	175
	Low sun-angle photography: Big Smoky Valley	3,276
	Carson City	1,966
	TOTAL	6,765
9	Expendable supplies	
	Film, flagging, stakes, notebooks, batteries, etc.	500
	Drafting supplies	250
	Sample bottles, chemicals, glassware	436
	TOTAL	1,186
	PAGE TOTAL	11,631

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*				EST COST ($)
9	Chemical analyses				
	Anal. Type	# Samples	$/Anal.	Lab.	
Whole rock samples					
	Major-Minor	12	125	Teledyne	1,500
	Sulfide Isotopes	5	40	Isochron Lab.	200
	Sulfur Isotopes	5	60	Isochron Lab.	300
				TOTAL	2,000
Geothermal fluids					
	Major-Minor	40	125	Amtec	5,000
	O Isotopes	10	75	Hebrew Univ.	750
	H Isotopes	10	75	Hebrew Univ.	750
	S Isotopes	10	.60	Isochron Lab.	600
				TOTAL	7,100
Travel					
7a	Mileage 12,000 mi. @ $.20/mi.				2,400
7a	Air transportation				3,055
7b	Per Diem 227 days @ $35/day				7,945
				TOTAL	13,400

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes

OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
6	Special equipment	
	3/4 ton SWB 4 WD pickup truck with following:	
	Heavy duty suspension	
	Extra fuel tank	
	Power steering	
	A/C	
	AM Radio	
	Rear barden bumper	
	4 speed transmission	
	Locking hubs	
	Phone quote Jones-West Ford Reno 1 Mar 79	8,000
	Camper for above vehicle	800
	TOTAL	8,800

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
	OPTION II	
9	Drilling costs	
	2 holes total footage 1300 @ $26/ft.	33,800
	TOTAL	33,800
9	Chemical analyses	
	Major-Minor 10 @ $125	1,250
	O Isotopes 2 @ $75	150
	H Isotopes 2 @ $75	150
	S Isotopes 2 @ $60	120
	TOTAL	1,670
9	Miscellaneous	
	Sample bags 500 @ $15/100	75
	Thin sections 30 @ $5.00	150
	TOTAL	225
Travel		
7a	Mileage 3000 mi. @ $.20/mi.	600
7b	Per diem 25 days @ $35/day	875
	TOTAL	1,475

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies - OPTION II, Year 1 (Reservoir Confirmation)

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE: John E. Nellor, Graduate Dean and Research Coordinator

SIGNATURE: John E. Nellor

NAME OF FIRM: University of Nevada System, University of Nevada, Reno

DATE OF SUBMISSION: March 3, 1979

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Miscellaneous	
	Map preparation	500
	Thin sections 15 @ $5.00	75
	Publication costs (journal page costs)	600
	Communication (postage, telephone, shipping)	900
	TOTAL	2,075

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL: Dept. HEW, Wallace Chan

TELEPHONE NUMBER/EXTENSION: (415) 556-8343

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*: [ ] ADVANCE PAYMENTS [ ] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

CONTRACT PRICING PROPOSAL
(RESEARCH AND DEVELOPMENT)

Office of Management and Budget Approval No. 29-RO184

This form is for use when (i) submission of cost or pricing data (see FPR 1-3.807-3) is required and (ii) substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. 1 — NO. OF PAGES 4

NAME OF OFFEROR: Board of Regents University of Nevada System

HOME OFFICE ADDRESS: University of Nevada, Reno Reno, NV 89557

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies OPTION I, Year 2

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Nevada Bureau of Mines and Geology

TOTAL AMOUNT OF PROPOSAL: $ 136,469

GOV'T SOLICITATION NO.:

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD[3] *(Rate %X$ base =)*					
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
Trexler (Geologist, P.I.)	1040	13.67	14,214		
Flynn (Geologist)	2080	10.25	21,325		
Koenig (Geochemist)	2080	10.25	21,325		
TOTAL DIRECT LABOR				56,864	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Retirement	8%	56,864	4,549		
Nevada Industrial Insur. Health and unemployment	4%	56,864	2,275		
TOTAL LABOR OVERHEAD				6,824	
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			7,715		
b. PER DIEM OR SUBSISTENCE			7,975		
TOTAL TRAVEL				15,690	Ex. A
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*				22,237	Ex. A
10. TOTAL DIRECT COST AND OVERHEAD				101,615	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 34.3 % of cost element Nos. 3,4,7,9)*[3]				34,854	
12. ROYALTIES[4]					
13. TOTAL ESTIMATED COST				136,469	
14. FEE OR PROFIT					
15. TOTAL ESTIMATED COST AND FEE OR PROFIT					

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*				EST COST *($)*
9	Chemical Analyses				
	Anal. Type	# Samples	$/Anal.	Lab.	
Whole	Rock Samples				
	Maj-Minor	12	137.50	Teledyne	1,650
	Sulfide Isotopes	5	44.00	Isochron	220
	Sulfate Isotopes	5	66.00	Isochron	330
				TOTAL	2,200
Geotherma	l Fluids				
	Maj-Minor	40	137.50	Amtec	5,500
	O Isotopes	10	82.50	Hebrew Univ.	825
	H Isotopes	10	82.50	Hebrew Univ.	825
	S Isotopes	10	82.50	Isochron	825
				TOTAL	7,975
7a					
Travel	4-WD vehicle (UNR) 12 mos. @ $80/mo.				960
	15,000 miles @ $.22/mile				3,300
	Air fares				3,455
7b					
Per diem	227 days @ $35/day				7,975
				TOTAL	15,690

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes

OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
9		
Equipment Rental		
	Rock coring equipment 10 days @ $33/day	330
	Vehicle mounted drill 2 wks. @ $330/wk.	660
	TOTAL	990
9		
Equipment		
	2 thermistor probes @ $53.00	106
	PVC pipe 100 ft. @ $.22/ft.	22
	TOTAL	128
9		
Non-expendable equipment		
	Mylar topo bases	500
	Existing airphotos 200 photos @ $4.40 ea.	880
	Topo, geophysical and geological maps	193
	Low sun-angle photography: Site 1	3,500
	Site 2	2,300
	TOTAL	7,373
9 Expendable supplies		
	Film, flagging, stake, notebooks, batteries, etc.	550
	Drafting supplies	275
	Sample bottles, chemicals, glassware	463
	TOTAL	1,288

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

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III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

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IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies, OPTION I, Year 2

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE

John E. Nellor
Graduate Dean, Research Coordinator

SIGNATURE

John E. Nellor

NAME OF FIRM

University of Nevada System
University of Nevada, Reno

DATE OF SUBMISSION

March 3, 1979

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9	Map preparation	550
	Thin sections 15 @ $5.50	83
	Publication costs (Journal page costs)	660
	Communication (postage, telephone, shipping)	990
	TOTAL	2,283

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL: Department HEW, Wallace Chan

TELEPHONE NUMBER/EXTENSION: (415) 556-8343

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*: [ ] ADVANCE PAYMENTS [ ] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

CONTRACT PRICING PROPOSAL
(RESEARCH AND DEVELOPMENT)

Office of Management and Budget Approval No. 29-RO184

This form is for use when (i) submission of cost or pricing data (see FPR 1-3.807-3) is required and (ii) substitution for the Optional Form 59 is authorized by the contracting officer.

PAGE NO. 1 — NO. OF PAGES 5

NAME OF OFFEROR: Board of Regents, University of Nevada System

HOME OFFICE ADDRESS: University of Nevada, Reno, Reno, NV 89557

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Low- to Moderate-Temperature Geothermal Assessment for Nevada: Site Specific Studies OPTION II, Year 2

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Nevada Bureau of Mines and Geology

TOTAL AMOUNT OF PROPOSAL: $ 208,704

GOV'T SOLICITATION NO.:

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*					
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
Trexler (Geologist, P.I.)	1040	13.67	14,214		
Flynn (Geologist)	2080	10.25	21,325		
Koenig (Geochemist)	2080	10.25	21,325		
Research Associate (unnamed)	1040	10.51	10,932		
TOTAL DIRECT LABOR				67,796	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Retirement	8%	67,796	5,424		
Nevada Industrial Commission, Health Insurance, unemployment	4%	67,796	2,712		
TOTAL LABOR OVERHEAD				8,136	
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			8,595		
b. PER DIEM OR SUBSISTENCE			8,850		
TOTAL TRAVEL				17,445	Ex. A
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
TOTAL CONSULTANTS					
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*				62,024	Ex. A
10. TOTAL DIRECT COST AND OVERHEAD				155,401	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 34.3 % of cost element Nos. 3,4,7,9)*[3]				53,303	
12. ROYALTIES[4]					
13. TOTAL ESTIMATED COST				208,704	
14. FEE OR PROFIT					
15. TOTAL ESTIMATED COST AND FEE OR PROFIT					

OPTIONAL FORM 60
October 1971
General Services Administration
FPR 1-16.806
5060-101

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*				EST COST *($)*
9	Chemical Analyses				
	Anal. Type	# Samples	$/Anal.	Lab.	
Whole	Rock Samples				
	Maj-Minor	12	137.50	Teledyne	1,650
	Sulfide Isotopes	5	44.00	Isochron	220
	Sulfate Isotopes	5	66.00	Isochron	330
				TOTAL	2,200
Geothermal Fluids					
	Maj-Minor	40	137.50	Amtec	5,500
	O Isotopes	10	82.50	Hebrew Univ.	825
	H Isotopes	10	82.50	Hebrew Univ.	825
	S Isotopes	10	82.50	Isochron	825
				TOTAL	7,975
7a					
Travel	4-WD vehicle (UNR) 12 mos. @ $80/mo.				960
	15,000 miles @ $.22/mile				3,300
	Air fares				3,455
7b					
Per diem	227 days @ $35/day				7,975
				TOTAL	15,690

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

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☐ YES ☐ NO *(If yes, identify.):*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

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TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
9		
Equipment Rental		
	Rock coring equipment 10 days @ $33/day	330
	Vehicle mounted drill 2 wks. @ $330/wk.	660
	TOTAL	990
9		
Equipment		
	2 thermistor probes @ $53.00	106
	PVC pipe 100 ft. @ $.22/ft.	22
	TOTAL	128
9		
Non-expendable equipment		
	Mylar topo bases	500
	Existing airphotos 200 photos @ $4.40 ea.	880
	Topo, geophysical and geological maps	193
	Low sun-angle photography: Site 1	3,500
	Site 2	2,300
	TOTAL	7,373
9 Expendable supplies		
	Film, flagging, stake, notebooks, batteries, etc.	550
	Drafting supplies	275
	Sample bottles, chemicals, glassware	463
	TOTAL	1,288

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

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☐ YES ☐ NO *(If yes, identify.)*: ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE

NAME OF FIRM	DATE OF SUBMISSION

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
9	Map preparation	550
	Thin sections 15 @ $5.50	83
	Publication costs (journal page costs)	660
	Communication (postage, telephone, shipping)	990
	TOTAL	2,283

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

☐ YES ☐ NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify):* ☐ ADVANCE PAYMENTS ☐ PROGRESS PAYMENTS OR ☐ GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

☐ YES ☐ NO *(If yes, identify.):*

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

☐ YES ☐ NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes

OPTIONAL FORM 60 (10-71)

This proposal is submitted for use in connection with and in response to *(Describe RFP, etc.)*

Low- to Moderate Temperature Geothermal Assessment for Nevada: Site Specific Studies - OPTION II (Reservoir Confirmation)

and reflects our best estimates as of this date, in accordance with the Instructions to Offerors and the Footnotes which follow.

TYPED NAME AND TITLE	SIGNATURE	
John E. Nellor Graduate Dean and Research Coordinator	John E. Nellor	
NAME OF FIRM: University of Nevada System University of Nevada, Reno		DATE OF SUBMISSION: March 3, 1979

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)
	OPTION II	
9	Drilling costs	
	2 holes total footage 1300 ft. @ $29/ft.	37,700
	TOTAL	37,700
9	Chemical analyses	
	Major-Minor 10 @ $137.50	1,380
	O Isotope 2 @ $82.50	165
	H Isotope 2 @ $82.50	165
	S Isotope 2 @ $66.00	132
	TOTAL	1,842
9	Miscellaneous	
	Sample bags 500 @ $16/100	80
	Thin sections 30 @ $5.50	165
	TOTAL	245
	Travel	
7a	Mileage: 4000 mi @ $0.22/mi.	880
7b	Per Diem 25 days @ $35/day	875
	TOTAL	1,755

I. HAS ANY EXECUTIVE AGENCY OF THE UNITED STATES GOVERNMENT PERFORMED ANY REVIEW OF YOUR ACCOUNTS OR RECORDS IN CONNECTION WITH ANY OTHER GOVERNMENT PRIME CONTRACT OR SUBCONTRACT WITHIN THE PAST TWELVE MONTHS?

[X] YES [ ] NO *(If yes, identify below.)*

NAME AND ADDRESS OF REVIEWING OFFICE AND INDIVIDUAL	TELEPHONE NUMBER/EXTENSION
Department HEW Wallace Chan	(415) 556-8343

II. WILL YOU REQUIRE THE USE OF ANY GOVERNMENT PROPERTY IN THE PERFORMANCE OF THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify on reverse or separate page)*

III. DO YOU REQUIRE GOVERNMENT CONTRACT FINANCING TO PERFORM THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*: [ ] ADVANCE PAYMENTS [ ] PROGRESS PAYMENTS OR [ ] GUARANTEED LOANS

IV. DO YOU NOW HOLD ANY CONTRACT *(Or, do you have any independently financed (IR&D) projects)* FOR THE SAME OR SIMILAR WORK CALLED FOR BY THIS PROPOSED CONTRACT?

[ ] YES [X] NO *(If yes, identify.)*:

V. DOES THIS COST SUMMARY CONFORM WITH THE COST PRINCIPLES SET FORTH IN AGENCY REGULATIONS?

[X] YES [ ] NO *(If no, explain on reverse or separate page)*

See Reverse for Instructions and Footnotes OPTIONAL FORM 60 (10-71)

PROPOSAL FOR SUPPORT FOR SCIENTIFIC RESEARCH

PROPOSAL NO. 77-4

SUBMITTED TO:	Division of Geothermal Energy U. S. Energy Research and Development Administration Washington, DC 20545
INSTITUTION:	Nevada Bureau of Mines and Geology University of Nevada - Reno Reno, NV 89557
PRINCIPAL INVESTIGATOR:	Dennis T. Trexler
TITLE OF RESEARCH:	ASSESSMENT OF LOW- TO MODERATE-TEMPERATURE GEOTHERMAL RESOURCES OF NEVADA
SUPPORT REQUESTED FOR PERIOD:	October 1, 1977-September 30, 1978
SUPPORT REQUESTED:	$124,227

D. T. Trexler
D. T. Trexler
Principal Investigator (702) 784-6691

APPROVED: John Schilling
John Schilling, Director
Nevada Bureau of Mines and Geology

John E. Nellor
John E. Nellor
Graduate Dean, Research Coordinator
University of Nevada, Reno

CONTENTS

LIST OF FIGURES

INTRODUCTION

The Nevada Bureau of Mines and Geology proposes to produce a Geothermal Resource Map of the State of Nevada which will provide detailed information on low- to moderate-temperature geothermal systems which have potential for direct non-electric utilization. The map will be prepared from data existing within the files of the Nevada Bureau of Mines and Geology and data on-file in the U. S. Geological Survey Geotherm computer file. In addition, new data will be collected from field studies as warranted to complete this investigation.

The proposed investigation will follow the tasks outlined below and will yield a verified and updated GEOTHERM data file.

1.) Editing and verifying the existing GEOTHERM Data File for Nevada springs and wells which has been supplied by the U. S. Geological Survey.

2.) Supplementing the U. S. Geological Survey GEOTHERM Data File with information residing in the Nevada Bureau of Mines and Geology's files that are not present in GEOTHERM.

3.) Digitization of 1:250,000 scale AMS sheets which have verified geothermal spring and well locations.

4.) Updating water chemistry data by collecting water samples for chemical analyses in areas which are devoid of water quality data and estimating discharge or potential pumping capacity where flow rate data are unavailable.

5.) Field check those springs and wells which have been designated as warm or hot on topographic maps and in published reports. At the present time 103 springs and wells are so designated. Field checking of locations and measurement of temperatures will provide complete, accurate and up-to-date data on location, temperature, discharge and water chemistry.

6.) Preparation of multi-color map ranking areas for potential direct utilization at a scale of 1:500,000.

RATIONALE:

The need for complete data on the existing and potential low- to moderate-temperature geothermal resources for the State of Nevada is necessary to provide prospective users with data on location, potential volume, and temperatures available for direct utilization. A major factor which effects direct utilization of a geothermal energy source is the water chemistry. Waters high in total dissolved solids or having high corrosivity are not optimum sources of energy from low- to moderate-temperature resources. The economic factors involved in utilizing water high in total dissolved solids or those that are high in corrosive potential may preclude direct utilization.

A map at 1:500,000 scale delineating areas of potential direct utilization based on temperature and water chemistry would provide potential users with the necessary information to make sound decisions on potential sites which may provide heat for industrial processing and, more significantly, space heating.

At the present time only a small portion of the potential geothermal energy in Nevada is being used. Direct utilization in the form of space heating for both residential and commercial buildings is the major use. Approximately 40 residential dwellings and 5 commercial structures are being heated by geothermal energy in the greater Reno area. The potential utilization within the local area has not been utilized to its upmost and has primarily been on a hit-or-miss basis by individual homeowners.

By providing a map showing the distribution of sources of geothermal energy available for direct utilization and having exact temperature, location and chemistry data in tabular computer format, potential users could define the exact area which meets the need of their particular application or amount of heat needed for space heating application to large structures such as warehouses.

The map and concise up-to-date physical data would allow developers and management personnel to make prudent planning decisions on utilization of geothermal energy.

PROPOSED PROGRAM

The Nevada Bureau of Mines and Geology has been the principle State agency in Nevada investigating geothermal resources (Garside, 1974). The Bureau's charter, as the agency responsible for research in mineral and energy resources, provides the ideal vehicle for development of a statewide geothermal resource assessment focusing on low- to moderate-temperature systems.

At the present time the Bureau has over 1100 data sheets on file for springs and wells having temperatures in excess of 20°C. Some data are replicate in that an earlier reference may have provided location, temperature and descriptive data, while a later reference provided the same location data plus chemical analyses and an updated temperature.

The proposed investigation will concentrate on areas which have springs and wells in the low- to moderate-temperature range that have not been as extensively studied as the higher temperature systems. By using personnel familiar with the geothermal resources of Nevada and a detailed integrated approach an assessment for direct utilization of low- to moderate-temperature geothermal waters will be made.

The final product to be produced by the proposed research will be a map at 1:500,000 scale (32 x 62 in) of Nevada showing the areas of highest geothermal potential for direct utilization. These areas will be defined not only on the basis of temperature but will include the combined parameters of temperature and chemistry. Knowledge of the chemistry is an important aspect of geothermal waters anticipated for direct utilization. Several factors such as pH, TDS and corrosivity effect the reaction of the waters with pipes, pumps and heater units.

Waters with deleterious properties require some type of closed system operation where interchange of heat is made by a medium which does not come into contact with the geothermal brines (Bateman and Scheibach, 1975). These types of systems employing down well trombones are used in the Truckee Meadows where some waters have concentrations of total dissolved solids in excess of 3000 ppm.

Other areas of western Nevada such as Bower's Mansion Spring have water temperatures that are lower (120°F, 49°C) but have a total dissolved solid concentration of 200 ppm. The waters can be pumped directly into the heating system at volumes that maintain sufficient heat capacity to provide comfortable conditions even with low (compared with heat exchange systems) temperatures.

Another important factor for direct utilization is volume of flow. Low temperature systems may be viable sources of energy if flow rates are high. This factor will be addressed in our investigation where valid discharge data are available. A low temperature system with high volume may suffice the needs of many potential users where only moderate temperatures are required.

A second product to be produced by this investigation will be an updating and verification of the U. S. Geological Survey's GEOTHERM data file. This will entail a complete editing and verification of existing data maintained in the U. S. Geological Survey's GEOTHERM data file. The Bureau's file plus the U. S. Geological Survey's file represent the most complete data available on geothermal resources in Nevada. Some discrepancies between our files and those in the computer generated geothermal file have been noted in the cursory examination that has been made as a modification to Contract EY-76-S-08-0671 for a feasibility evaluation of the level of effort necessary to provide a complete and correct detailed analysis of Nevada's low- to moderate-temperature geothermal resources for direct non-electrical utilization.

The computer printout provided by the U. S. Geological Survey has 544 records for springs and wells in Nevada. Personnel involved in the program and under direct supervision of D. Trexler assisted by J. Schilling and L. Garside will cross-reference and verify all references used in both the geotherm file and the file maintained by the Nevada Bureau of Mines and Geology. This will entail searching the original references and verifying that the citation is correct. Discrepancies between the original reference and supplemental references will be resolved by consulting the best available large scale topographic map (1:24,000 or 1:62,500 scale). If the disparity in location cannot be resolved by map location then field checking of the location will be necessary to assure accurate data input.

After all data in both files have been cross-checked, springs and wells which cannot be located with some degree of confidence by the staff of the Bureau will be field checked. At the present time the exact number of such sites is not known but may approach several tens of springs and wells.

In conjunction with field checking of spring and well locations, temperatures will be taken at all mislocated or otherwise ambiguous locations. If the spring or well falls within an area of sparse chemical data, a sample will be collected for analysis to provide complete coverage of chemical data which will aid in determining the potential utilization of the area.

Since the data maintained in the Bureau's file are located by Section, Township and Range as are many of the earlier references it will be necessary to digitize our existing AMS sheets to obtain longitude and latitude coordinate locations. By digitizing the verified locations from a map base longitude and latitude can be derived and supplemental coordinate systems such as UTM can be cross correlated.

Any data found to be in error in either file will be corrected and verified. The ability to double check and cross-reference files should provide an error free documentation of the geothermal resources of Nevada. For all data not residing in the GEOTHERM data file reporting forms supplied by the U. S.

Geological Survey will be prepared and submitted for input into the computer file.

Project Organization

The Nevada Bureau of Mines and Geology is a research and public service division of the Mackay School of Mines, one of the several colleges of the University of Nevada, Reno. Research includes all phases of Nevada's geology and mineral resources: basic geologic mapping and laboratory studies, geophysical and geochemical surveys, engineering geology, earth-environmental considerations in urban and rural planning, the preparation of educational guides and booklets, statewide investigations of mineral commodities, the geology of ore deposits, and the exploration, development, mining, processing, utilization, and conservation of metal ores, industrial minerals, fossil and nuclear fuels, geothermal power, and water.

The proposed research will utilize 3 senior agency professional staff members on a part-time basis and 2 members full-time. In addition a geologic consultant (Mr. Beal) will be used in an advisory capacity during the course of the investigation. The principal staff members to be involved in the program are:

Dennis T. Trexler, Research Associate/Geologist - 2 months
Larry J. Garside, Geologist-Energy Resources - 3 months
John H. Schilling, Director-Economic Geologist - 1 month

Detailed Statement of Proposed Research

The Nevada Bureau of Mines and Geology anticipates the successful completion of the proposed research using an integrated team of professional staff members and a geologic consultant who has had more than 20 years experience in Nevada. The proposed program will follow the tasks outlined below and shown graphically in Figure 1.

Proposed Program Schedule

1. Edit, verify and cross-correlate GEOTHERM with data in the file of the Nevada Bureau of Mines and Geology.
    a. Staff personnel will check all references against the original and resolve any ambiguities between the original reference and supplemental references where possible.
    b. Locations which appear to be in conflict between references will be plotted on the best, large scale topographic map and located by land survey to ascertain if the described location is correct.

2. Field-check locations which cannot be plotted on the large scale topographic maps with certainty. This will also entail temperature measurements to confirm that similarly described springs represent those visited during the field checking phase of the program.
    a. Water samples will be collected in areas which are lacking chemical analyses.

3. Transfer locations of existing springs and wells from AMS topographic maps to stable base mylars. Plot verified locations of confirmed springs and wells to the same base.
    a. Digitize stable base mylars for longitude and latitude coordinates.

4. In conjunction with 2 above all springs and wells which have been designated as hot or warm will have temperature measurements made. This task requires the measurement of at least 103 springs and wells which are on file with this relative temperature designation.

TASKS	1	2	3	4	5	6	7	8	9	10	11	12
	MONTHS											
1. Edit, verify and cross-correlate Geotherm and NBMG files	—	—	—	—								
a) Plot on large scale maps to resolve location conflicts.			—	—	—							
2. Field check ambiguously described locations.					—	—						
3. Plot springs and wells on AMS sheets.						—	—					
a) Digitize AMS sheets.								—				
4. Measure temperatures of springs and wells designated as hot or warm.						—						
5. Prepare Geotherm reporting forms.									—	—	—	
6. Prepare and publish 1:500,000 scale map of low- to moderate temperature Geothermal Resources of Nevada.											—	—

FIGURE 1. PROPOSED PROGRAM SCHEDULE

5. Update GEOTHERM by preparing and submitting recording forms for all corrections and data not presently in the computer file. This will require meetings with James R. Swanson of the U. S. Geological Survey to acquaint our personnel with the procedures for data input.

6. Prepare and publish a multi-color map at 1:500,000 scale of Nevada designating and ranking areas as to potential for direct non-electric utilization of the geothermal resources.
    a. Attendance at national meetings during the course of the proposed program will provide necessary contact with other state agency personnel concerning the format each state is using for their final geothermal assessment for low- to moderate-temperature geothermal systems. This would ensure compatibility of map scales and designations in adjoining states to provide a more useful regional format.

Personnel Qualifications

The Principal Investigator for the proposed study will be Mr. Trexler. He has been actively engaged in research projects concerning geothermal resources in Nevada for the past 4 years. Previous experience had been with Aerojet-General Corp. using passive microwave techniques of natural resource investigations sponsored by ONR and the USGS. Since coming to Nevada 6 1/2 years ago he has participated in research investigations using passive microwave techniques for geothermal exploration with the Jet Propulsion Laboratory and Coal Resources of Nevada sponsored by the U. S. Bureau of Mines. Mr. Trexler is presently involved in evaluating lineament analysis as an exploration technique for geothermal energy through a contract funded by the Division of Geothermal Energy. His participation in the proposed program as P.I. is based on the experience gained in determining the necessary direction needed to successfully complete the proposed program based on a 2-month feasibility study funded by ERDA to determine the man-power and potential milestones to be completed during the proposed investigation.

Mr. Garside and Mr. Schilling will actively participate in the implementation of the tasks outlined in the detailed statement of proposed research. They have had over 14 years collectively in the assessment of geothermal energy in Nevada and have published several articles and reports on the subject (see Appendix A).

To aid in coordinating the proposed effort a consultant with over 20 years experience in Nevada will be employed. Mr. Beal has had considerable experience in preparing resource assessments for various mineral commodities within the State of Nevada (see Mr. Beal's resumé, Appendix A).

A Research Associate and a Research Assistant will be assigned to the project on a full-time basis and will be directed by Mr. Trexler with the assistance of Messrs. Schilling, Garside and Beal.

Map preparation will be performed by S. Nichols (Cartographer) and press-ready peelers will be supplied to the printer by the Nevada Bureau of Mines and Geology.

All principal personnel except for Mr. Beal are employees of the University of Nevada, Reno. Brief resumés of the staff to be employed in the successful completion of the proposed program including Mr. Beal are presented in Appendix A.

Facilities and Equipment

The Nevada Bureau of Mines and Geology occupies parts or all of three floors in the west wing of the Scrugham-Engineering and Mines building on the University of Nevada-Reno campus. Office, laboratory, and drafting room space for the research program will be made available by the University of Nevada-Reno. Field vehicles for the field checking phase of the proposed effort are available through the University at standard cost.

Most equipment and instrumentation for performance of the proposed investigation are the property of the University and are assigned to the Bureau of Mines and Geology. A computer terminal with hard copy capabilities is an item of equipment requested in the proposed cost estimate. This piece of equipment would facilitate access to the GEOTHERM data files to provide updated information on geothermal resources in Nevada for users in industry and the public sector.

References

Bateman, R. L. and Scheibach, R. B. (1975). Evaluation of geothermal activity in the Truckee Meadows, Washoe County, Nevada, Nevada Bur. Mines and Geol. Rept. 25, 37 p.

Garside, L. J. (1974) Geothermal exploration and development in Nevada through 1973, Nevada Bur. Mines and Geol. Rept. 21, 12 p.

APPENDIX A

Resumés of Professional Staff

DENNIS T. TREXLER

PERSONAL HISTORY

Born August 6, 1940 in Compton, California

Married.

EDUCATION

Elementary and high school education in Lynwood, California through 1958.

Compton College, Compton, California, graduated 1961 A.A.

University of Southern California, Los Angeles, California, graduated in 1965 with B.S. in Geology.

University of Southern California, Los Angeles, California, graduated in 1968 with M.S. in Geology.

EXPERIENCE:

1966-1967: State of California, Department of Water Resources-engineering geologist.

1967-1968: Geolabs Inc., Santa Ana, California-engineering geologist.

1968-1970: Aerojet-General Corporation, Microwave Division, Staff Geologist -Remote Sensing.

1970-1971: Microwave Sensor Systems Division, Spectran, Inc., Manager Earth Resources Applications.

1971-1974: Mackay School of Mines, University of Nevada, Reno-Research Associate-Remote Sensing.

1975-present: Nevada Bureau of Mines and Geology-Research Associate/Geologist, Energy Resource Research.

PUBLICATIONS:

Over 10 publications in Remote Sensing and Geology including:

Blinn, J. C., III, Quade, J. G. and Trexler, D. T., 1975, Microwave geothermal exploration, Final Report for Jet Propulsion Laboratory, Pasadena, Calif.

Quade, J. G. and Trexler, D. T., 1975, Geologic investigations in the Basin and Range using Skylab/EREP Data, Final Report to NASA JSC.

Bingler, E. C. and Trexler, D. T., 1975, Composite earthquake hazard index map: A synthesis of hazard elements for the Reno Quadrangle, (abs.), Geol. Soc. Amer. Annual Mtg., Salt Lake City.

Walker, P. W. and Trexler, D. T., 1977, Low sun-angle photography, Photogram. Eng. and Remote Sensing Vol. XLIII, No. 4.

PROFESSIONAL MEMBERSHIP

Geological Society of Nevada

Registered Geologist - State of California

LARRY J. GARSIDE

PERSONAL HISTORY

Born May 2, 1943 in Omaha, Nebraska.

Married.

EDUCATION

Elementary and high school education in Anita, Iowa, through 1961.

Iowa State University, Ames, Iowa--graduated in 1965 with B.S. in Geology.

Mackay School of Mines, University of Nevada, Reno, Nevada--graduated in 1968 with M.S. in Geology.

EXPERIENCE:

1963: Iowa State Univ. Summer Field Camp--mapping of Paleozoic and Mesozoic sedimentary rocks in part of the Bighorn Basin, Wyoming.

1964: National Science Foundation grant for undergraduate research - with two other undergraduates; an analysis of sandstone jointing as related to structure, combined with the mapping of the Lovell S.E. 15-minute Quadrangle, Bighorn Basin, Wyoming.

1965: Laboratory assistant for Dr. Donald Biggs, Professor of Geology, Iowa State University--worked on an Iowa Highway Commission grant for study of limestones as concrete aggregates.

1965:1967: Nevada Bureau of Mines Graduate Research Assistantship--work mainly in the mineral preparation lab.

1967: Thesis research--library investigation and geologic mapping of Paleozoic and Tertiary rocks in eastern Nevada.

1968-present: Economic Geologist, Nevada Bureau of Mines and Geology, University of Nevada, Reno, Nevada--work on statewide commodity surveys and geologic quadrangle mapping.

1974-present: Executive Secretary, Nevada Oil and Gas Conservation Commission-administering affairs of this regulatory agency.

PUBLICATIONS:

Over 9 including,

Garside, L. J., and Schilling, J. H., 1967, Wells drilled for oil and gas in Nevada: Nevada Bureau of Mines Map 34.

Schilling, J. H., and Garside, L. J., 1968, Oil and gas developments in Nevada, 1953-1967: Nevada Bureau of Mines Report 18, 43 p.

Garside, L. J., and Schilling, J. H., 1972, Geothermal exploration and development in Nevada: Overviews of States, Geothermal Resources Council, El Centro, Calif.; also in Meadows, K. F. (ed), 1972, Geothermal World Directory, p. 146-151.

Garside, L. J., 1973, Radioactive mineral occurrences in Nevada: Nevada Bureau of Mines Bulletin 81, 116 p.

Garside, L. J., 1974, Geothermal Exploration and Development in Nevada through 1973: Nevada Bureau of Mines Report 21.

PROFESSIONAL MEMBERSHIPS

American Association of Petroleum Geologists

Geological Society of America

Society of the Sigma Xi

Phi Kappa Phi

Geological Society of Nevada (Sec.-Treas. 1969-70, Pres. 1973-74)

JOHN H. SCHILLING

PERSONAL HISTORY

Born September 7, 1927 in Lincoln, Nebraska.

Married with two children.

EDUCATION

Elementary education in Lincoln, Nebr., through 1939.

High school in State College, Pa., through 1945.

Pennsylvania State University--graduated 1951 with B.S. in geology.

New Mexico Institute of Mining & Technology--graduated 1952 with M.S. in economic geology.

Harvard University--graduate study 1952-1953 in mining geology.

New Mexico Institute of Mining & Technology--additional courses in mining engineering, 1954-1956.

EMPLOYMENT

1945-1946: U. S. Army.

1947-1950: Geology Dept., Penn. State Univ.--part time assistant while attending university.

Summer 1950: New Mexico Bureau of Mines--field assistant.

1951-1952: New Mexico Bureau of Mines--geologic assistant, part time and summers while attending school.

1952-1953: Geology Dept., Harvard Univ.--part time assistant while attending university.

1953-1956: New Mexico Bureau of Mines-as economic geologist doing geologic mapping, and studies of various ore deposits.

1956-1958: Cerro de Pasco Corp.--mine geologist at the Cerro de Pasco silver-lead-zinc-cooper mine, Peru.

1958-1959: New Mexico Bureau of Mines--as economic geologist doing geologic mapping, and studies of various ore deposits.

1959-present: Nevada Bureau of Mines and Geology--as mining geologist-engineer making laboratory and field studies and compilations concerning Nevada geology and mineral resources, and providing consultation for those needing data and advice; and as director administering the operations of the Bureau of the Nevada Mining Analytical Laboratory.

1965-present: Nevada Oil and Gas Conservation Commission--as executive secretary administering the affairs of this regulatory agency.

1951-present: Consulting for various companies, individuals, and governmental agencies--specializing in geology, geothermal, mineral resources, mining, including environmental problems.

PUBLICATIONS

Over 60 publications on geology and mining including:

Garside, L. J., and Schilling, J. H., (in preparation), Geothermal resources of Nevada: Nevada Bureau of Mines and Geol. Bull.

Garside, L. J., and Schilling, J. H., 1972, Geothermal Exploration and Development in Nevada: Overviews of States, Geothermal Resources Council, El Centro, Calif.

Schilling, J. H., 1968, Nevada's geothermal resources: Nevada Business Review, V. 13, No. 9, p. 3-5.

PROFESSIONAL MEMBERSHIPS AND LISTINGS

Society of Economic Geologists

Society of Mining Engineers

Geological Society of America

Geological Society of Nevada

Listed in Who's Who in the West, American Men of Science, Dictionary of International Bibliography

Laurence H. Beal

PERSONAL HISTORY

Born December 12, 1921.
Married with three children - ages 19, 22, & 24.

EDUCATION

University of California at Berkeley - graduated with B. A. in geology - 1950
University of California at Berkeley - graduated with M. A. in geology - 1956

EMPLOYMENT

1941-1945: U. S. Coast Guard
1945-1950: U. C. Berkeley student
1950-1952: Consolidated Coppermines Corporation; Assistant Geologist, project engineer, property evaluation, general reconnaissance, and field work.
1952-1954: American Metals Company, Limited (AMAX); Geologist, various exploration and drilling programs.
1954-1956: University of California, Berkeley: teaching assistantship while attending the University.
1956-1966: University of Nevada, Mackay School of Mines - Nevada Bureau of Mines: Assistant and Associate Mining Geologist, commodity studies, research, limited teaching, etc.
1966-1975: Phelps Dodge Corporation: Geologist and Senior Geologist, property examination in Western U. S., supervision of exploration programs and administrative duties at Corporation's Reno Exploration Office.
1975-present: Consulting for various companies, individuals and government agencies - specializing in geology, exploration and mining.

PUBLICATIONS

Titanium Occurences in Nevada: Nevada Bureau of Mines, Map 4-1962.
Cobalt-Nickel-Platinum Occurrences in Nevada: Nevada Bureau of Mines, Map 21-1964.
Beryllium Occurrences in Nevada: Nevada Bureau of Mines, Map 22, 1964.
Investigation of Titanium Occurrences in Nevada: Nevada Bureau of Mines, Report 3, 1963.
Cobalt and Nickel in Mineral and Water Resources of Nevada: Nevada Bureau of Mines, Bulletin 65 p. 78--81, 1964.
Platinum - Mineral and Water Resources of Nevada: Nevada Bureau of Mines, Bulletin 65, p. 132-133, 1964
Geology and Mineral Deposits of the Bunkerville Mining District, Clark County, Nevada: Nevada Bureau of Mines, Bulletin 63, 1965.

PROFESSIONAL AND SCIENTIFIC MEMBERSHIPS

AIME - member; Chairman, Northern Nevada Section, 1966-67.
Geological Society of Nevada - member; Vice President, 1960-61.
Society of Economic Geologists - member.
Professional Engineer - State of Nevada, Regis. No. 1406
Professional Engineer - State of California, Regis. No. 3294
Listed in Who's Who in the West, American Men of Science.

FRATERNAL ORGANIZATIONS

Charity Lodge, F. & A. M., Campbell, California.
Scottish Rite Bodies, Reno, Nevada.
Shriner-Kerak Temple, Reno, Nevada.

APPENDIX B

Cost Estimate

Cost Estimate

DIRECT LABOR	FY78 Request	FY78 Local
Dennis T. Trexler, Principal Investigator 2 man-months @ $2,054/mo.	$ 4,108	
John H. Schilling, Director Nevada Bureau of Mines and Geology 1 man-month @ $2,678/mo.		$ 2,678
Larry J. Garside, Geologist, Energy Resources 3 man-months @ $1,744/mo.		5,233
Research Associate, Geologist		
9 man-months @ $1,535/mo.	13,815	
*3 man-months @ $1,658/mo.	4,974	
Research Assistant, Geologist		
9 man-months @ $1,394	12,546	
*3 man-months @ $1,506	4,518	
Susan Nichols, Cartographer 2 man-months @ $1,384		2,768
Total Direct Labor	$39,961	$10,679
Fringe		
Health insurance, NIC, unemployment insurance @ 4%.	$ 1,598	$ 427
Retirement @ 8%	3,197	854

*University FY79 (July-September) estimated 8% increase.

OPERATING--(Supplies and Expendable Equipment)		
1. Plastic water bottles, topographic maps, downhole temperature probe and miscellaneous expendable equipment.	$ 3,000	
2. Mylar base maps each AMS sheet in Nevada; 18 @ $60/ea.	1,080	
3. Communications (postage, phone).	600	
4. 100 water analyses @ $36/analysis.	3,600	
5. Digitizing spring and well locations 8 hrs. @ $50/hr.	4,000	

	FY78 Request	Local
EQUIPMENT		
1. Tectronics graphic CRT terminal with hard copy attachment.	$ 16,000	—
TRAVEL		
1. Out-of-State Airfares and perdiem 2 round-trips Menlo Park, CA Trips to national meetings, locations presently unknown	2,500	
2. In-State field checking, temperature measurements and sample collection 100 days at $30/day	3,000	
Vehicle 4-WD (University rates) $.175/mile for 10,000 mile	1,750	
and $7.50/day for 75 days	563	
SUBCONTRACT		
1. Printing: color map 1:500,000 scale 2000 copies; Williams & Heintz Map Corp. Washington, D. C.	6,000	
Consultant Mr. L. H. Beal 100 days @$150/day	15,000	
Indirect Cost 50% salaries, fringe and retirement (Auditing agency - HEW)	22,378	5,980
TOTAL	$124,227	$17,940

NVO/0671-1

SUMMARY REPORT OF AVAILABILITY OF GEOTHERMAL DATA FOR POTENTIAL DIRECT HEAT APPLICATION IN NEVADA

By
Dennis T. Trexler

September 1977

Work Performed Under Contract No. EY-76-S-08-0671

Nevada Bureau of Mines and Geology
University of Nevada
Reno, Nevada

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

NVO/0671-1
Distribution Category UC-66g

SUMMARY REPORT OF AVAILABILITY OF GEOTHERMAL DATA FOR POTENTIAL DIRECT HEAT APPLICATION IN NEVADA

Submitted To
U. S. Energy Research and Development Administration
Division of Geothermal Energy, HQ
Washington, DC

As Required Under
Modification No. A001
Contract No. EY-76-S-08-0671

by

Dennis T. Trexler
Nevada Bureau of Mines and Geology
University of Nevada, Reno
Reno, NV 89557

September, 1977

INTRODUCTION

An assessment of available data on geothermal springs and wells was performed by first ascertaining which agencies both State and Federal maintain files which have water temperatures. The principle files are maintained by the Nevada Bureau of Mines and Geology, U. S. Geological Survey, and Water Resources Center - Desert Research Institute. The State Engineer's office maintains files of driller's logs. Requirements for completing driller's logs under subsection 5 states water temperature will be reported, if thermometer is unavailable an estimated temperature will be given as cold, warm or hot.

The second phase of the assessment of available data was to determine the quality of the data in each file. This was performed by inventory of files and by cross-correlating files by cursory examination. An estimate of the number of entries in the Nevada Bureau of Mines and Geology (NBMG) file with inferred temperatures that could be associated with confidence to replicate data was also made.

RESULTS

Geothermal data available on Nevada resides in several data banks. The principal sources are Nevada Bureau of Mines and Geology, U. S. Geological Survey, and Water Resource Center's Water Analysis Data System (WADS).

Table 1

Existing Data >20°C for Nevada in Principle Data Files

	Entries
NBMG	>1100
U.S.G.S. GEOTHERM	559
WRC-DRI	250*

*Increasing because of data derived from Lawrence Livermore Laboratory uranium study in Nevada.

At the inception of this study a cut-off temperature of 35°C was used. Subsequent discussion with ERDA, Division Geothermal Energy, HQ and Jim Swanson of the U. S. Geological Survey confirm that the cut-off temperature for geothermal waters for direct heat utilization is now 20°C. This lower value coincides with the Nevada Bureau of Mines and Geology's file and the U. S. Geological Surveys GEOTHERM file.

The inventory of existing data considered 35°C as the cut-off temperature and the subsequent tables and figures were prepared using the 35°C criteria. The number of data sheets in the NBMG file (>1100) is a factor of 2 greater than the number of entries (538) using the 35°C cut-off temperature. This factor probably applies to all parameters considered in this evaluation.

Data in the NBMG file for springs and wells >35°C were inventoried and such parameters as the completeness of the data, chemical analyses, flow rate (discharge) and depth of wells was considered. Table 2, (shown graphically in Figure 1) provides a tabular listing by county of data in the NBMG file.

Table 2 indicates that 78 percent of all springs and a slightly higher proportion of the wells (87%) have measured temperatures. Approximately one-half of all entries (51%) have chemical analyses. Approximately 50 percent of the entries have ancillary data such as flow rate, well depth and other remarks, 52%, 49% and 48% respectively.

A comparison was made between the NBMG geothermal file and the U. S. Geological Survey, Conservation Division, Geothermal Land Classification Map to ascertain the quality of data contained in separate data files. Table 3 is a comparison of the NBMG geothermal file and data presented on U. S. Geological Survey, Conservation Division, Geothermal Land Classification Map. Of the 196 springs and wells located on the Land Classification Map, 31 springs and 2 wells have disagreement in location, temperatures and/or type of occurrence, i.e.

TABLE 2

GEOTHERMAL DATA STATEWIDE
WITH TEMPERATURES >35°C
OR INDICATED AS HOT OR WARM

County	Spring	Well	Total Data Sheets	Chem. Analysis	Flow Rate	Depth	Other
Carson City	2(1)*	3(1)*	7	4	1	2	1
Churchill	5(11)	10(2)	28	5	10	8	23
Clark	(5)	3	8	2	0	3	4
Douglas	6	1	7	5	3	1	5
Elko	36(13)	5(3)	57	18	23	7	35
Esmeralda	7	1(1)	9	4	4	2	6
Eureka	33	9	42	24	22	5	22
Humboldt	55(11)	13	79	46	31	9	40
Lander	22(4)	5	31	16	16	2	21
Lincoln	4(1)	4(4)	13	7	2	5	6
Lyon	4	11(4)	19	12	6	10	7
Mineral	4(1)	6(1)	12	7	4	2	3
Nye	53(9)	20(2)	84	38	47	18	32
Pershing	27(5)	6(1)	39	19	14	2	21
Storey	1(mine)	-	1	-	-	-	1
Washoe	26(18)	45(2)	91	65	11	4	30
White Pine	7(3)	1	11	3	5	1	3
Total	292(82)	143(21)	538	275	199	81	260

* Temperature indicated as Hot or Warm

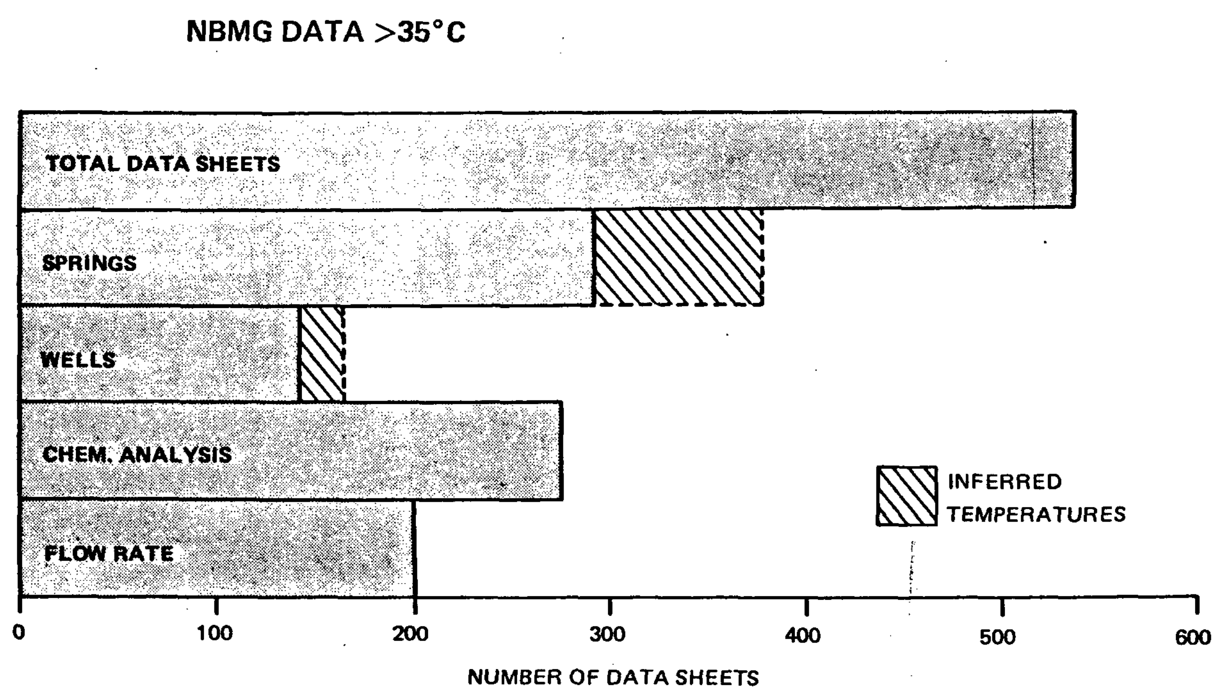

Figure 1. Graphic representation of the quantity and type of data in the NBMG Geothermal file.

TABLE 3

COMPARISON OF NBMG AND U.S.G.S.
CONSERVATION DIVISION GEOTHERMAL
LAND CLASSIFICATION MAP

	NBMG		USGS Geothermal Land Classification	
County	Spring	Well	Spring	Well
Carson City	2(1)*	3(1)*	1(1)*	
Churchill	5(11)	10(2)	3(5)	
Clark	(5)	3	(3)	2
Douglas	6	1	2(2)	
Elko	36(13)	5(3)	15(8)	1(1)*
Esmeralda	7	1(1)	2(2)	1
Eureka	33	9	11(2)	
Humboldt	55(11)	13	18(11)	5(1)
Lander	22(4)	5	8(5)	1
Lincoln	4(1)	4(4)	2	3
Lyon	4	11(4)	2(4)	
Mineral	4(1)	6(1)	2(1)	2
Nye	53(9)	20(2)	10(8)	7
Pershing	27(5)	6(1)	7(3)	4
Storey	1(mine)	-	1	
Washoe	26(18)	45(2)	10(4)	7
White Pine	7(3)	1	5(3)	
Total	292(82)	143(21)	99(62)	33(2)

*Temperature indicated as hot or warm

spring or well. Twelve of the 31 springs have disagreement in location and 7 have disagreement in temperature. Three springs on the USGS map are wells in the NBMG geothermal files and 2 wells in Las Vegas Valley are apparently mislocated on the map.

It is apparent from the above comparison that many discrepancies between various sources of geothermal information exist. A further analysis was made on data within the NBMG geothermal file to ascertain the amount of additional data that will have to be generated to make the assessment of potential geothermal energy for direct utilization and production of a complete and comprehensive map. A cursory examination of those springs and wells which had inferred temperatures (hot or warm) was made to determine if they were replicate data and had measured temperatures or if they are located in an area which has measured temperatures. The findings of this cursory examination are presented in Appendix A. A total of 103 springs and wells within the NBMG geothermal file have inferred temperatures of these approximately 75 percent could not be associated with other data sheets with confidence. Further research, consulting the original references, large scale maps and in some cases field measurement of temperature will have to be made.

Considerable research and cross-referencing and correlation of existing data will have to be made on the Waring data to validate the location and temperatures of the described springs. There are approximately 30 data sheets in the NBMG geothermal file which are Waring references and will require further research to confirm the locations so that duplicate data or mislocated springs will not be included.

Duplication between NBMG data and that contained in GEOTHERM will probably not exceed 30 percent. All data on water with temperatures >20°C in the U. S. Geological Survey's Water Resources Division computer file have been incorporated into GEOTHERM. The NBMG file contains only data of the Water Resources Division file that has been published or used in open-file reports. Also GEOTHERM contains many entries which are from the personal files of Don White, U. S. Geological Survey, Menlo Park. These data do not reside in the NBMG file.

APPENDIX A

Examination of 103 Springs and Wells with Inferred Temperatures

NOTES ON INDICATED TEMPERATURES

Carson City

Well 6C	Wells in same section have 112°F Temp.

Churchill

Spring 13	Waring, general location
Spring(M)14	No data
Spring 15	Waring general location
Spring 17	Waring, appears to be Dixie Hot Spring >100°F
Spring 33	Waring, no data
Well 36	Drill Hole to 3700' Temp. probably exceeds 100°F
Spring 49	Waring, probably incorrectly located

Clark

Spring 12	If same as Spring 11 Temp=90°F Discharge 3240gpm
Spring 36	Apparently 81°F from adjoining data w/same name
Springs 95,96,97	No correlative data

Elko

Spring 26	Same location as Spring 25 Temp=194°F
Well 29	Same location as Well 28 Temp=138°F
Spring 31	No correlative data
Spring 38	No correlative data
Wells 41,44	No correlative data
Spring 55	Spring 2 miles away Temp=102°F
Spring 62	Spring in same section 70°F
Spring 63	No correlative data
Wells 70,71,72	Encountered hot water and were abandoned
Springs 74,75	No correlative data
Spring 78	No correlative data
Springs 87,88	Are located near Spring 86 Temp=149°F

Esmeralda

Well 12	No correlative data

Humboldt

Spring 12	Other spring and wells in area 200°F
Springs 19,20	No correlative data
Springs 41,42,55	Waring ref. Location uncertain
Spring 61	Waring ref. Location uncertain
Spring 72	In Double Hot Springs area probably >94°F
Springs 87,89	Location uncertain. No correlative data
Spring 27	Well in same sect. 85°F
Spring 29	Waring, location uncertain
Spring 32	Waring, location uncertain. Indicated as hot
Spring 43	Waring, location uncertain. Indicated as hot

Lincoln

Wells 12,17,20,21	Wells in area generally <90°F
Spring 50	No correlative data
Wells 37-42	Other wells in area >100°F

Mineral

Spring 1	Waring location uncertain. Indicated as warm
Well 2	No correlative data

Nye

Spring 1	No correlative data
Spring 5,11	>100°F personal knowledge
Spring 27	Probably <94°F from nearby data
Spring 32	No correlative data
Well 39	In Darrough Hot Spring area. Hot water cemented off.
Spring 45	Waring, location uncertain
Well 101	No correlative data
Spring 102	Waring, location uncertain. No temp.
Springs 113,114	No data.

Pershing

Spring 4	No data from nearby springs
Spring 13	Numerous springs, Waring location vague
Spring 25	No data. Location questionable
Springs 36,38	Probably >94°F, in area of high temp. Drill hole 41B >100°F near spring w/141°F.

Washoe

Spring 7	>190°F Steamboat Springs area
Spring 9	>190°F Steamboat Springs area
Spring 26	Waring, location uncertain.
Spring 27	No data, map ref.
Spring 28	Waring, location uncertain.
Springs 30,31	Waring, no data
Spring 33	Waring, no data
Spring 34	Waring, no data
Spring 36	Waring, no data
Spring 38	No correlative temp. data
Spring 39	Waring, no data
Spring 40	Waring, no data
Spring 46	Waring, no data
Springs 55,56	Adjacent springs and wells >100°F
Well 57	
Spring 94	>100°F Garside
Well 95	?>100°F by association in Moana area
Well 98	>100°F north of Steamboat Springs
Spring 123	Remarks indicate boiling mud

White Pine

Spring 17	Waring, poor location, no data
Spring 27	Waring, poor location, no data
Spring 38	Waring, poor location, no data

Parameter	Rank
Temperature	81
Water chemistry	27
Accessibility	9
Population centers	3
Depth to resource	1

where "accessibility" refers to land vehicle access to the resource. Note that the "rank" of the parameters is in terms of decreasing powers of 3. Use of powers of 3 preserves the established order of importance. This will be demonstrated in a later hypothetical application of the scheme. The weighting factors (WFi) associated with these parameters and the limits established for the factors are illustrated in figure 1. A weighting factor of "2" indicates the most desirable range for a parameter, "1" intermediate, and "0" the least desirable range. When judging the value to be assigned to the "water chemistry" weighting factor, consideration was given collectively to pH, TDS, and the presence or lack of corrosives, scaling compounds, or toxins. For example, although a fluid might have a pH between 5 and 6.5 and a total dissolved solids value of 450 ppm, the solids may consist of three hundred ppm dissolved silica which could cause scaling problems and thus the weighting factor used is "0".

The parameters used for the residential/commercial space heating (RSH) potential evaluation are similar, but they assume a different order of importance. Additionally, the weighting factor ranges have been adjusted to values more appropriate to the application. Note that areal extent is now considered because this parameter would be important to the development of a residential area where individual wells are used at each residence (as is the case in Reno, Nev., and Klamath Falls, Oreg.). Accessibility is no longer used because it is assumed to be tacitly accounted for by the presence of a population center. A listing of the residential/commercial space heating (RSH) parameters in their order of importance are:

Parameter	Rank
Population centers	81
Depth to resource	27
Temperature	9
Water chemistry	3
Areal extent	1

Ranges and limits used in weighting factor evaluations are given in figure 2. Arrows on the horizontal bars indicate that certain factors (for example TDS) have ranges that extend beyond those used in evaluating the weighting factor. However, once the established limit is exceeded the weighting factor value does not change.

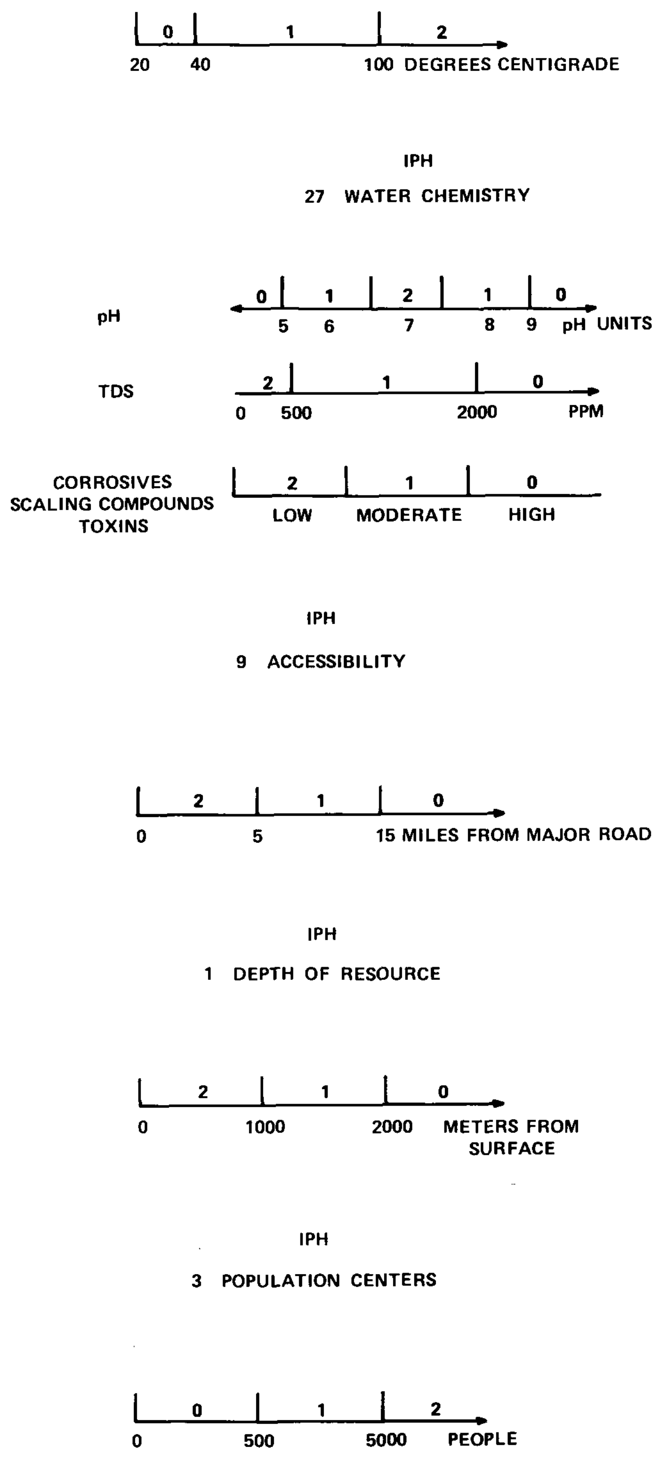

FIGURE 1. Weighting factors and their limits for industrial process heat applications.

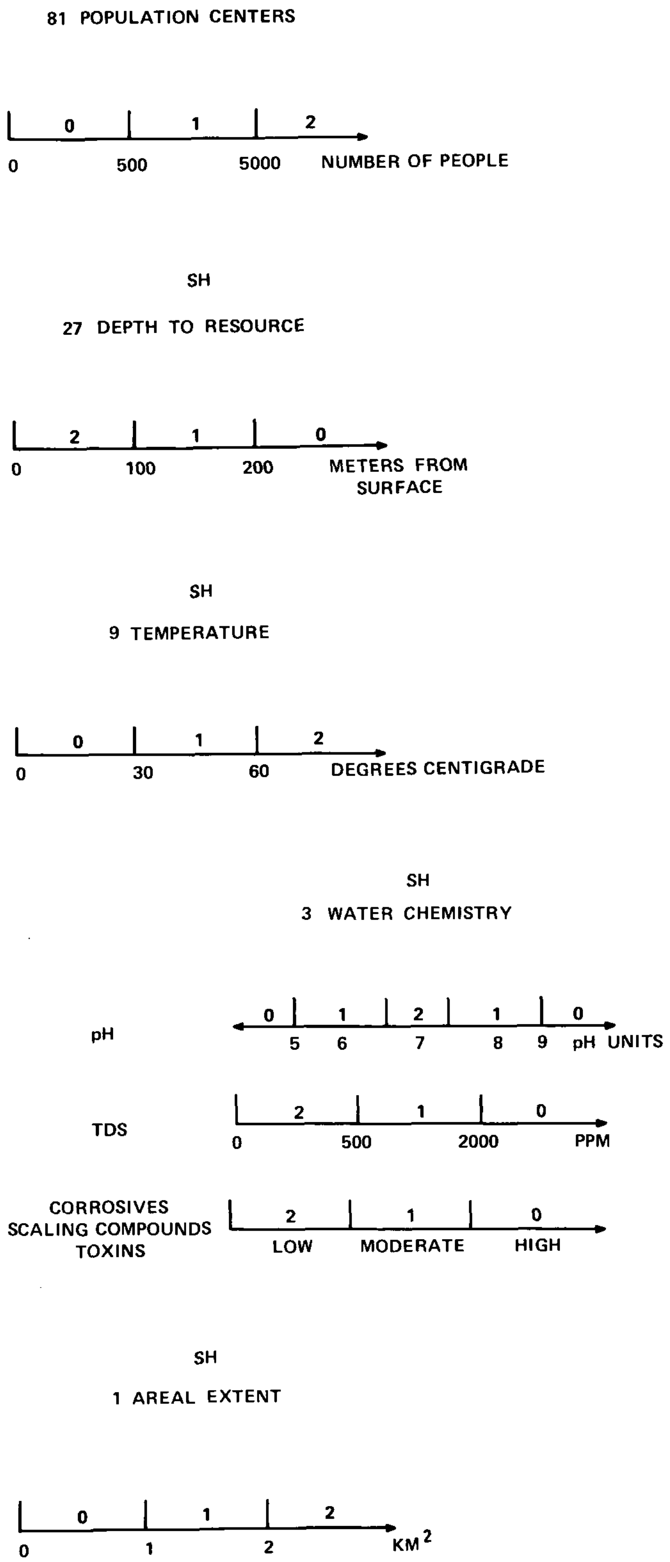

FIGURE 2. Weighting factors and their limits for residential space heating applications.

of the rank-weighting factor pairs, range from a low of 0 to a high of 242, thus defining the limits of the probability function. This range was divided into three equal parts to obtain the "low", "moderate", and "high" categories of the probability function rating, and are:

Probability function rating	PF value
High	(+) 216–242 (±) 188–215 (–) 162–187
Moderate	(+) 136–161 (±) 109–135 (–) 81–108
Low	(+) 55–80 (±) 28–54 (–) 0–27

Each category is further divided into thirds and this is represented by the "–", "±", and "+" symbols.

The usefulness of powers of 3 in preserving the selected order of parameter importance can be illustrated by a pair of hypothetical industrial process heat examples (table 1). Case A receives a non-zero weighting factor only for the temperature parameter, thus its probability function value is 162 and its probability function rating (PFR) is *High(–)* (table 1a). In case B, all weighting factor values are 2 except temperature, which receives a 1 because it is less than 100°C. Here the probability function value equals 161 and the PFR is *Moderate(+)* (table 1b). Thus, the importance of temperature above all other parameters in the evaluation scheme is demonstrated.

TABLE 1a. Hypothetical IPH example, Case A.

	Weighting factor	Rank	Product
110°C	2	81	162
TDS > 2000 ppm pH > 9 Corrosive	0	27	0
> 15 mi. from major road	0	9	0
< 500 people	0	3	0
> 2000 m	0	1	0
		TOTAL	162

PFR = High(–)

	factor	Rank	Product
60°C	1	81	81
TDS < 500 ppm pH 7.0 No corrosives	2	27	54
< 5 mi. to major road	2	9	18
> 5000 people	2	3	6
< 1000 meters	2	1	2
		TOTAL	161

PFR = Moderate(+)

APPLICATION OF THE SCHEME — AN EXAMPLE —

Application of the scheme to the region surrounding and containing Gabbs, Nev. provides a factual example of the probability function's use in evaluating the potential for direct utilization. Data from the geothermal occurrences in the area indicate an average temperature of 51°C, an average pH of 8.7, an average total dissolved solids of 582 ppm, an average depth to resource of 97 meters, an areal extent greater than 2 km^2, a population greater than 500 but less than 5000, and a distance of less than 8 km (5 mi) from an asphalt highway. Using these data the evaluation scheme applied to Gabbs is as follows:
Probability function ratings are *Moderate(±)* and *Moderate (+)* respectively for industrial process heat and residential space heating applications.

Application	Parameter	Rank	Weighting factor	Product
Industrial Process Heat	Temperature	81	1	81
	Chemistry	27	1	27
	Accessibility	9	2	18
	Population	3	1	3
	Depth to Resource	1	2	2
			TOTAL	131
Residential Space Heat	Population	81	1	81
	Depth to Resource	27	2	54
	Temperature	9	1	9
	Chemistry	3	1	3
	Areal Extent	1	2	2
			TOTAL	149

with respect to the number of parameters it can accommodate; however, modifications are not limited to that aspect of its use. The ordering of parameters and the choice of limits for the weighting factors were based on the characteristics of Nevada and its geothermal resources. This ordering and choice of limits can be changed when using different parameters or a larger or smaller number of parameters to accommodate the data availability, geothermal resource characteristics, or application requirements of non-Nevada resources. It should be emphasized that the scheme is intended to be applied to regions of relatively similar resource characteristics. Geological, hydrological, and other pertinent sources of information should be used when bounding regions for potential evaluation.

FOR THE STATE OF NEVADA GEOTHERMAL ASSESSMENT MAP

Prepared by

Dennis T. Trexler, Brian A. Koenig,
and Thomas Flynn

Prepared for

U. S. Department of Energy
Division of Geothermal Energy
under
Contract No. ET-78-S-08-1556

July 1979

INTRODUCTION

The major problem that must be addressed in any attempt to define the potential for direct utilization of Nevada's geothermal resources is the diversity of the resources in both areal distribution and character. While some resources are closely spaced and can be easily grouped, others cannot be readily associated.

Many geothermal occurrences, for instance, are inaccessible by land vehicles. Temperatures may vary from 20° C to over 200° C, and resources may discharge at the surface or be confined to a reservoir at a depth of 2 km or more. In addition, geothermal fluids range in total dissolved solids (TDS) from 150 ppm (drinking water quality) to over 6000 ppm (saline solution).

The facts that various direct-use applications place differing constraints on the nature of the required resource and that, in many specific geothermal resource areas, detailed data are not yet available, present additional problems to the question of resource assessment. Therefore, any method used to evaluate geothermal potential should be: a) generally applicable, b) sufficiently flexible to allow for future data input or changing priorities in resource requirements, and c) be of limited complexity, yet produce a semiquantitative basis for area to area comparisons.

APPROACH—RATIONALE

To overcome the problems and meet the requirements discussed above, a numerical scheme was developed. The basis of the method is a simple function called the probability function (PF) defined as follows:

$$PF = \Sigma Ri\,WFi$$

where Ri = Rank ith parameter (3^0–3^4)

WFi = Weighting factor of ith parameter (0,1,2)

Several parameters could be viewed as useful for defining potential, a partial list includes: temperature, land vehicle accessibility, rock type, rock age, depth to resource, population centers, geophysical data, fluid chemistry, areal extent, flow rate, permeability, recharge, economics, structure, and environmental considerations. Although the potential function could accommodate any number of parameters, the quantitative data necessary to establish limits for the weighting factors is unavailable in many instances. Such data are presently available for the following parameters: temperature, fluid chemistry, population centers, land vehicle accessibility, depth to resource, and areal extent. These parameters were selected for use with the function.

The direct-use applications selected for evaluation using the scheme are industrial process heat (IPH) and residential/commercial space heating (RSH). Potential for agriculture/aquaculture applications was not evaluated because the nature of the resource required and the method of exploitation are currently in a developmental stage. Having chosen the parameters to be used and the applications to be evaluated, the tasks remaining included establishing an order of importance for both IPH and RSH parameters and defining the limits to be associated with the weighting factor values.

MUSEUM OF NATURAL HISTORY
ENVIRONMENTAL RESEARCH CENTER
DIVISION OF EARTH SCIENCES
UNIVERSITY OF NEVADA, LAS VEGAS
255 BELL ST., SUITE 200 • RENO, NEVADA 89503 • (702) 784-6151

March 10, 1982

Duncan Foley, Associated Geologist
Earth Science Laboratory
University of Utah Research Institute
Salt Lake City, Utah 84108

Duncan:

I have included several pages from NOAA's most recent listing of the table for the Nevada map. Some of the entries are from George Berry's publication and are not in Geotherm or Garside & Schilling. Others are given by a map reference only in G & S with no other information.

Hopefully, George has some better data but I do not have it to qualify the information given in the listing. Skip said that you will probably have George consulting on the listing and I thought you should be aware that I don't have any way of checking his information.

Regards,

Dennis

Dennis T. Trexler

DTT:mj

Enclosure

NOT GIVEN IN ← GARSIDE & Schilling

MUST BE A BERPUE NO WAY TO QU[illegible] INPUT

HOT SPRING	S	EL- 35	73	SE SE SW	29	38N	62E	41.14500114.99400	H			
~~0074352PAN AM PETROL. CORP.-COBRE MINERALS NO. 1~~	~~W~~	~~EL- 36~~	~~75~~	~~SW SE~~	~~03~~	~~37N~~	~~67E~~	~~41.11166114.38000~~	~~77~~	~~1611~~		
0000826UNNAMED HOT SPRING (SSE PATSVILLE)	S	EL- 37		NE	20	37N	54N	41.08333115.91666	41			
WARM SPRINGS	S	EL- 38	74	NE SE	26	37N	58E	41.06400115.38900	W			
SPRING	S	EL- 39	73		29	37N	62E	41.06600114.99000	W			
	S	EL- 40			30	37N	62E	40.97300115.01200	W			
0074781RALPHS WARM SPRINGS	S	EL- 41	76	SE NE NW	04	35N	64E	40.95200114.75000	30		4516	
0074762JOHNSON RANCH SPRINGS	S	EL- 42	77		28	36N	66E	40.96700114.51500	22		114	
0074763CITY OF ELKO WELL NO. 12	W	EL- 43	78	SW	11	34N	55E	40.84333115.75500	24	174		269
ELKO HEAT CO. NO. 1	W	EL- 44		SW SW	15	34N	55E	40.828 115.767	82	260	3217	
WESTERN PACIFIC R.R. CO. WELL	W	EL- 45	78	SW	15	34N	55E	40.829 115.766	W	110	26	
0000631HOT HOLE	S	EL- 46	78	NE	21	34N	55E	40.81850115.77550	56		76	908*
0074216ELKO HOT SPRING	S	EL- 47	78	SE SE	21	34N	55E	40.81300115.77600	88		1703	600
WARM SPRING [illegible] Topographic Sheet only	S	EL- 48	79	SW SE	31	34N	59E	40.78200115.36300	W			
0074726DRY SUSIE CREEK SPRING	S	EL- 49	81	NW	08	33N	53E	40.76333116.04000	64		57	1056
	S	EL- 50	82	SW SW SE	12	33N	61E	40.751 115.035	W		7570	398
0000633HOT SPRINGS (CARLIN)	S	EL- 51	80		33	33N	52E	40.69900116.13333	79		1136	625*
WARM SPRING (CARLIN)	S	EL -52	80	SW	05	32N	52E	40.6861 116.1527	23		934	390
0001027ELLISON RANCH SPRING	S	EL- 53			05	32N	52E	40.68400116.15333	93		4	
0000587SULPHUR HOT SPRINGS	S	EL- 54	83	NW	11	31N	59E	40.58666115.28466	96		500	601*
UNION OIL CO. STONIER NO. 2	W	EL- 55	83+	SE SW	11	31N	59E	40.580 115.291	H	960		
0000816HOT SPRINGS	S	EL- 56	98	NW	12	28N	52E	40.32666116.06000	26		6000	408*
0000827SMITH RANCH SPRINGS	S	EL- 57	84	NW	02	27N	58E	40.24900115.40900	65			600*
0074764FISH SPRING	S	ES- 1	85	NW SW	25	02N	35E	37.99700118.03900	24			363*
BIG DIVIDE MINE	M	ES- 2	87	NW SW	26	02N	42E	37.993 117.240	H	305		
0074765	S	ES- 3	85	SW SW SW	28	02N	36E	37.99000117.98400	27		4	3900*
0074766GAP SPRING	S	ES- 4	85	SW	32	02N	36E	37.97900117.99300	23		38	2500

CHEVRON OIL CO. HOT SPRINGS POINT NO. 1	W	EU-	25	96	NW	SW	NW	01	29N	48E	40.414	116.524	H	712		
0074253MAGMA POWER CO. HOT SPRINGS POINT NO. 1	W	EU-	26	96					29N	48E	40.40666	116.51833	74	125		
0000637CRESCENT VALLEY HOT SPRINGS	S	EU-	27	96			NE	11	29N	48E	40.40350	116.51666	59		125	1730*
DANN RANCH WELL	W	EU-	28					2	28N	49E	40.325	116.417	28			
0074338HOT SPRING	S	EU-	29	97	NW	NW	NE	10	28N	49E	40.31600	116.43333	86		9	
CHEVRON USA, INC. CRESCENT FAULT NO. 1	W	EU-	30	97+				09	28N	49E	40.311	116.461	H	328		
0074337CARLOTTI RANCH SPRINGS	S	EU-	31	99			SE	24	28N	52E	40.29000	116.05000	39		378	
0000946BRUFFEY'S HOT SPRINGS	S	EU-	32	100				14	27N	52E	40.22000	116.06666	65		189	
0074758FLYNN RANCH SPRINGS	S	EU-	33	101				05	25N	53E	40.07750	116.03500	26		38	
0074159	W	EU-	34	104		SW	NE	06	24N	53E	39.99000	116.04000	35			276
0074703SIRI RANCH SPRING	S	EU-	35	104		NW	SW	06	24N	53E	39.98666	116.04500	35		1136	
0074759SHIPLEY HOT SPRING	S	EU-	36	103		NE	SE	23	24N	52E	39.94333	116.07300	41		11355	346
0000639WALTI HOT SPRINGS	S	EU-	37	102			SW	33	24N	48E	39.90166	116.58700	72		299	592*
0074737THOMPSON RANCH SPRING	S	EU-	38	106		NW	SE	03	23N	54E	39.89916	115.86833	20		3407	358
0074736SULFUR SPRING	S	EU-	39	105			NW	36	23N	52E	39.83500	116.06616	23		76	
0074264BARTINE HOT SPRINGS	S	EU-	40	107		NE	NE	05	19N	50E	39.55833	116.36166	42		38	
WARM SPRING	S	EU-	41				NW	18	19N	50E	39.52900	116.38800	W			
0074263BARTINE RANCH WATER WELL NO. 4	W	EU-	42	107			NE	17	19N	50E	39.52833	116.36333	47	148	125	
0074741BARTHOLOMAE CORP. WATER WELL	W	EU-	43	108			SW	18	18N	51E	39.43666	116.27916	23	204	53	
0074742BARTHOLOMAE CORP. WATER WELL	W	EU-	44	108			NW	30	18N	51E	39.41333	116.27583	22		757	319*
0074099KLOBE (BARTHOLOMAE) HOT SPRING	S	EU-	45	108	NW	NW	SE	28	18N	50E	39.40333	116.34500	69		185	265
0074155HOT SPRING RANCH WATER WELL	W	EU-	46	108	NW	NW	SE	28	18N	50E	39.403	116.345	70	12	11	315*
0074743NOQUE'S NEVADA WELL	W	HM-	1	109	NE	NE	SE	17	47N	38E	41.95166	117.71616	33	214		323*
WARM SPRINGS *ref tops sheet only*	S	HM-	2	110		SW	NW	07	46N	28E	41.93400	118.80800	W			
0074046CORDERO MINING CO. WELL	W	HM-	3	109				28	47N	37E	41.92666	117.82000	59	177		
0074050CORDERO MINING CO. WELL	W	HM-	4	109				28	47N	37E	41.92666	117.82000	48	168		
0000820	W	HM-	5	111			NW	13	46N	28E	41.92333	118.70833	90		25	934*

0074760CANE SPRINGS	S	HM- 43	130			SE	30	39N	27E	41.25800118.93700	23		19	186
	S	HM- 44					33	38N	26E	41.14700119.02200	67			
	S	HM- 45				NE	04	37N	25E	41.13700119.13500	27			
0074117	W	HM- 46	131			NW	11	37N	25E	41.12333119.10166	40	92		
0074149	W	HM- 47	131			SE	10	37N	25E	41.11500119.10833	36		321	
0074079	S	HM- 48	131				10	37N	26E	41.11200119.00166	66		11	
0074705	W	HM- 49	131			NE	26	37N	25E	41.08000119.09333	22			
0074704	W	HM- 50	131			SW	26	37N	25E	41.06666119.10000	26	61		
0000621DOUBLE HOT SPRINGS	S	HM- 51	131				04	36N	26E	41.05166119.02666	81		175	910*
	S	HM- 52				NE	09	36N	26E	41.02900119.01700	46			
0074125	S	HM- 53	131				16	36N	26E	41.01300119.01000	78			
0074127	S	HM- 54	131				22	36N	26E	41.00300119.00800	96			
0074384BLACK ROCK HOT SPRING	S	HM- 55	131			NW	34	36N	26E	40.97000119.01000	58		189	1330
0074708CAINE SPRING	S	HM- 56	135			NE	16	35N	24E	41.02200119.27500	23		38	256
0074126MACFARLANE HOT SPRING	S	HM- 57	132			NW	27	37N	29E	41.05000118.71666	62		19	
0074385HOT SPRINGS	S	HM- 58	133		SW	SW	03	37N	39E	41.10833117.58000	70		8	
0074379	W	HM- 59	133		SW	SE	03	37N	39E	41.10666117.57000	69	19	8	
HOT SPRINGS RANCH SPRINGS	S	HM- 60	134				26	37N	43E	41.05000117.10000	25		7570	
0074694	S	HM- 61	140	SW	NE	NE	02	36N	41E	41.03000117.31800	21		95	2340*
0074709SPRING	S	HM- 62	136	SE	NE	SW	13	36N	37E	40.99333117.76300	34			1040
0074711CALIFORNIA PACIFIC UTILITIES CO. WELL	W	HM- 63	138	NE	SW	SE	30	36N	38E	40.96000117.74333	23	151		452
0074710BLM WELL	W	HM- 64	137	SW	NE	SE	26	36N	38E	40.96333117.66333	23	17		536
0000649GOLCONDA HOT SPRING (NORTH)	S	HM- 65	139			SE	29	36N	40E	40.96150117.49383	74		750	810*
0074692	W	HM- 66	139	NE	SE	SW	29	36N	40E	40.96000117.49666	23	6		478
0074367	W	HM- 67	139		NE	NE	32	36N	40E	40.95666117.48666	81	53		
0000922GOLCONDA HOT SPRING (SOUTH)	S	HM- 68	139		SE	NE	32	36N	40E	40.95333117.48833	42			
0074261GOLCONDA TUNGSTEN MINE DRILL HOLE 302	W	HM- 69	139			SW	36	36N	40E	40.94666117.42500	62	79		
0000643HOT POT (BLOSSOM HOT SPRINGS)	S	HM- 70	144			SW	11	35N	43E	40.92216117.10850	58		265	1400*

~~0074725BROOK'S SPRING~~	~~S~~	~~HM-~~	~~75~~	~~145~~		~~NW~~	~~NE~~	~~13~~	~~34N~~	~~41E~~	~~40.83166~~	~~117.30666~~	~~34~~		~~76~~	
0000595HOT SPRINGS	S	HM-	76	146			SE	05	33N	40E	40.76150	117.49166	85		98	1060*
MAGMA POWER CO. TIPTON NO. 1 WELL	W	HM-	77	146	SW	NW	SW	04	33N	40E	40.761	117.485	104	936		
0074724IZZENHOOD RANCH SPRINGS	S	LA-	1	147	SW	NE	NW	10	35N	45E	40.93000	116.89500	31		3785	
HOT SPRINGS	S	LA-	2	149		NE	SW	06	32N	46E	40.67300	116.83800	50			
0002134BATTLE MOUNTAIN	W	LA-	3					17	32N	45E	40.64666	116.92833	23	221	946	
0074701	S	LA-	4	150			NW	11	31N	42E	40.57666	117.22000	24			244
CHEVRON-AMERICAN THERMAL RES. GINN NO. 1-13	W	LA-	5	94		SE	SE	13	31N	47E	40.558	116.629	(H)	2916		
CHEVRON USA, INC. NEVADA 76-18	W	LA-	6	94+				18	31N	48E	40.562	116.613	(H)			
GETTY OIL 76-17 COLLINS	W	LA-	7	94+	SW	NE	SE	17	31N	48E	40.562	116.595	(H)			
CHEVRON USA, INC. NEVADA 85-18	W	LA-	8	94+	SE	NE	SE	18	31N	48E	40.558	116.614	(H)	1807		
CHEVRON U.S.A., INC. ROSSI NO. 21-19	W	LA-	9	94+		SW	NW	19	31N	48E	40.550	116.619	(H)	2200		
CHEVRON USA, INC. J.L. ROBERTSON NO. 43-19	W	LA-	10	94+	SE	NE	NW	19	31N	48E	40.548	116.614	(H)			
0074027BUFFALO VALLEY HOT SPRINGS	S	LA-	11	151			SE	23	29N	41E	40.36833	117.32500	79		11	1460*
0074053MOUND SPRINGS	S	LA-	12	152				07	28N	44E	40.31166	117.07000	43		11	
0074414HOT SPRINGS	S	LA-	13	153		SW	NE	23	27N	43E	40.20000	117.10500	53		1703	519
0074052HOT SPRINGS *Appears TO Be Same as 0074414 above*	S	LA-	14	153				23	27N	43E	40.19166	117.10666	53			
0074096HOT SPRINGS RANCH	S	LA-	15	153				26	27N	43E	40.18166	117.10200	54		189	627
0002135HOT SPRINGS BEACH	S	LA-	16					25	27N	45E	40.18300	116.86200	50			
0074095CHILLIS HOT SPRING	S	LA-	17	154				27	27N	46E	40.18700	116.79000	39		38	
0074682SPRING	S	LA-	18	154			NW	28	27N	46E	40.18666	116.80500	22			2330*
0074683	S	LA-	19	155			NE	15	26N	45E	40.12916	116.88666	22			806*
0074335JAMES LISTER WELL	W	LA-	20	156				27	24N	43E	39.92000	117.12500	39	4		905
LITTLE HOT SPRINGS	S	LA-	21	158			NE	02	23N	47E	39.89300	116.64900	H			
0074685	W	LA-	22	159			NW	36	20N	40E	39.56000	117.42666	29			477*
0074684PETERSON'S MILL HOT SPRING	S	LA-	23	159		NW	NW	36	20N	40E	39.55666	117.43000	23			
0074686	W	LA-	24	161			SW	08	18N	47E	39.43166	116.70666	22			

0074408	CALIENTE HOT SPRINGS	S	LI-	25	173			NE	08	04S	67E	37.62166	114.51300	48			430
0074356	CALIENTE PUBLIC UTILITY NO. 4 WELL	W	LI-	26	173			SW	05	04S	67E	37.62666	114.51333	40	40		
0026001	CALIENTE HOSPITAL REINJECTION WELL	W	LI-	27	173				08	04S	67E	37.62166	114.51333	29	11		
0026004	K. PHILLIPS WELL	W	LI-	28	173				08	04S	67E	37.62166	114.51333	42	36		
0026000	HOT SPRINGS MOTEL WELL	W	LI-	29	173				08	04S	67E	37.62000	114.51333	45	5		
0026002	L.D.S. WELL	W	LI-	30	173				08	04S	67E	37.62000	114.51333	24			
0026003	MILLER WELL	W	LI-	31	173				05	04S	67E	37.62000	114.51333	40	36		
0026005	LLOYD VAN KIRK WELL	W	LI-	32	173				08	04S	67E	37.62000	114.51333	43	36		
0026006	CALIENTE HOSPITAL OLD WELL	W	LI-	33	173				05	04S	67E	37.62000	114.51333	49	15		
	ASH CREEK SPRING	S	LI-	34			NW	NE	01	12S	58E	36.94200	115.42500	22		2	510*
0074000	MAGMA POWER CO. HAZEN NO. 1	W	LY-	1	177			SW	18	20N	26E	39.60166	119.10833	135	229		
	MAGMA POWER CO. HAZEN NO. 2	W	LY-	2	177				18	20N	26E	39.597	119.112	H	91		
	MAGMA POWER CO. HAZEN NO. 3	W	LY-	3	177				18	20N	26E	39.597	119.112	H	91		
0074380	PATUA HOT SPRINGS (FERNLEY)	S	LY-	4	177			SW	18	20N	26E	39.59666	119.11000	86			3530*
	MAGMA ENERGY INC., FERNLY NO. 1	W	LY-	5	177	SW	SW	SE	24	20N	25E	39.579	119.129	H	1118		
0074624	SUTRO TUNNEL	M	LY-	6	178	NE	NE	SE	02	16N	21E	39.279	119.593	28		189	1320
0074626		W	LY-	7	179	NW	SE	NW	07	16N	22E	39.26833	119.56000	27	31		583
0074383		W	LY-	8	179	SE	SW	NE	12	16N	21E	39.26500	119.57333	35	81		1280*
0074627		W	LY-	9	181		NW	NE	14	15N	25E	39.17166	119.14833	30	44	95	1480*
0074389	MAGMA POWER CO. WABUSKA NO. 1	W	LY-	10	181		NW	SW	15	15N	25E	39.16166	119.17666	97	149	1514	1250
0000607	WABUSKA HOT SPRINGS	S	LY-	11	181			SE	16	15N	25E	39.16150	119.18266	97			1610*
	MAGMA POWER CO. WABUSKA NO. 2	W	LY-	12	181	SE	NE	SW	16	15N	25E	39.162	119.190	H	162		
0074011	MAGMA POWER CO. WABUSKA NO. 3	W	LY-	13	181	NW	SE	SE	16	15N	25E	39.15833	119.18500	108	678	95	1090
0074628		W	LY-	14	181		NE	SW	21	15N	25E	39.14500	119.19333	29	122	757	560*
0074629		W	LY-	15	181		SE	NE	28	15N	25E	39.14200	119.18600	30	305	57	652*
0074630		W	LY-	16	182	NE	NE	NW	01	14N	25E	39.11166	119.13500	21	111		333
0074602	AMBASSADOR WELL	W	LY-	17	183		NW	SW	25	13N	23E	38.95666	119.36166	28	165	1514	305*
0074612		W	LY-	18	183		SE	SE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

0000659NEVADA (HINDS) HOT SPRINGS	S	LY-	23	184		SE	16	12N	23E	38.89950119.41166	62		200	509*
0074370U.S. STEEL CORP. HIND'S NO. 1	W	LY-	24	184	SW	SE	16	12N	23E	38.89833119.41166	66			
U.S. STEEL CORP. HIND'S NO. 2	W	LY-	25	184	SW	SE	16	12N	23E	38.896 119.411	H			
U.S. STEEL CORP. HIND'S NO. 3	W	LY-	26	184	SW	SE	16	12N	23E	38.891 119.409	H			
HOT SPRING	S	LY-	27	185	CW1/2		34	12N	25E	38.85900119.17500	H			
WILSON HOT SPRING	S	LY-	28	186	SE	SW	34	11N	25E	38.76800119.17400	84		0	
	W	LY-	29	187	NE	NW	12	10N	23E	38.742 119.363	W	25		350
0074373[WALKER WARM] SPRING	S	LY-	30	188	SW	SE	04	07N	27E	38.49166118.96500	43			
DOUBLE SPRING	S	MN-	1	189			25	13N	29E	38.96500118.68900	W			
0074376WEDELL HOT SPRINGS	S	MN-	2	191		SW	07	12N	34E	38.92200118.19800	62		227	1370*
DEAD HORSE WELLS	W	MN-	3	190			21	12N	32E	38.888 118.399	H			
0074361NAVAL AMMUNITION DEPOT WELL NO. 1	W	MN-	4	192	NE	NE	18	08N	30E	38.55500118.67000	51			
0074359NAVAL AMMUNITION DEPOT WELL NO. 5	W	MN-	5	192	SW	SE	18	08N	30E	38.54900118.67500	46			
0074616NAVAL AMMUNITION DEPOT WELL NO. 2	W	MN-	6	192		SE	26	08N	30E	38.52166118.59833	24	129		1000
0002153	W	MN-	7	192		SE	27	08N	30E	38.52833118.62000	27	183	3785	
0074617CITY OF HAWTHORNE WELL	W	MN-	8	192		SW	27	08N	30E	38.52000118.62750	27	184		810
0074357CITY OF HAWTHORNE WELL	W	MN-	9	192		SW	27	08N	30E	38.52000118.62666	38			
0074015NAVAL AMMUNITION DEPOT WELL NO. 3	W	MN-	10	192		NW	32	08N	30E	38.51166118.66333	38	138		1340*
0074618	W	MN-	11	192			33	08N	30E	38.51000118.64083	33			620
EL CAPITAN WELL	W	MN-	12	192	NW	SW	33	08N	30E	38.5066 118.6483	97	350		1003
0074619NAVAL AMMUNITION DEPOT WELL NO. 4	W	MN-	13	192	NE	SW	02	07N	30E	38.49416118.60750	23			
0074249SODA SPRINGS	S	MN-	14	193		SE	29	06N	35E	38.34166118.10500	38		100	1640*
0074715	W	MN-	15				UNSURVEYED			38.33333117.96666	40			
0074268U.S. BUREAU OF LAND MANAGEMENT WELL	W	MN-	16	194		NE	19	05N	31E	38.28000118.56666	43	105		370
0074621U.S. BUREAU OF LAND MANAGEMENT NO. 2 WELL	W	MN-	17		NE	SW	07	03N	31E	38.13166118.56416	26	20		360*
0074369	W	MN-	18	196			32	02N	33E	37.98833118.32500	45			316
0000794POTT'S RANCH HOT SPRINGS	S	NY-	1	200		NE	02	14N	47E	39.07833116.64000	[illegible]		[illegible]	[illegible]
[illegible]														

NAME NOT IN GEOTHERM OR GARSIDE & SCHILLING

0000818LOWER RANCH HOT SPRINGS	S	PR- 25	247	NW	18	25N	39E	[illegible]	[illegible]			[illegible]
0074519SPRING	S	PR- 26	248	NW	19	25N	39E	40.02666117.64833	28		189	
0000803HYDER HOT SPRINGS	S	PR- 27	246	SW	28	25N	38E	40.00333117.71666	80			
0001021SPRING	M	ST- 1		NE	29	17N	21E	39.31333119.64333	77			
0074434NEW YELLOW JACKET SHAFT M ? (M)	W	ST- 2	252	SW SE	32	17N	21E	39.29000119.64666	77	914		
0074668WARM SPRINGS	S	WA- 1	253		12	44N	19E	41.74600119.80000	23		19	
0074671SEEPS (HILL'S WARM SPRING)	S	WA- 2	253		18	44N	20E	41.73000119.78666	28		38	
0074562TWIN (VYA) SPRING	S	WA- 3	254	NW	04	42N	19E	41.59333119.86500	22		757	
Need better location, may be in Co...	S	WA- 4	255			38N	18E	41.17500119.95700	H			
0074565	W	WA- 5	258	SE NE	23	35N	23E	40.90166119.33500	24			440*
0074566	W	WA- 6	258	NW SE	24	35N	23E	40.89500119.31833	25			420*
0074567	W	WA- 7	258	SW NE	25	35N	23E	40.88900119.33900	21	48		339
0074051CORDERO FLY NO. 1	W	WA- 8	258	NW SE NE	01	34N	23E	40.86500119.32333	42	201		
0074452UNNAMED SPRING	S	WA- 9	258	NE	10	34N	23E	40.85500119.35333	22		11	549
0074093 FLY RANCH (WARDS) HOT SPRINGS	S	WA- 10	258	SW SW	01	34N	23E	40.85833119.32800	82		1893	
0074061GEYSER WELL	W	WA- 11	258		02	34N	23E	40.86166119.34666	84			
SUNEDCO HOLLAND L. RANCH NO. 1-2-FR	W	WA- 12	258+	NE NE	02	34N	23E	40.861 119.339	H	1589		
0074064WELL H-18	W	WA- 13	258	SE SE NE	02	34N	23E	40.86000119.33333	91			
0074067WESTERN GEOTHERMAL INC., FLY RANCH NO. 1	W	WA- 14	258	SW NE SE	02	34N	23E	40.85833119.34833	97	305	1666	1800*
0074 "THE GEYSER" WELL	W	WA- 15	258	SW	01	34N	23E	40.85833119.33000	104			
0074065WELL H-16	W	WA- 16	258	SE NW SE	02	34N	23E	40.85666119.34833	94			
JOHN CASEY STEAM WELL	W	WA- 17	258	NE SE	02	34N	23E	40.858 119.342	H			1170
0074563SPRINGS	S	WA- 18	257		18	34N	22E	40.83166119.53800	29		1893	
WESTERN GEOTH. INC. GRANITE CREEK RANCH 1	W	WA- 19	259		35	34N	23E	40.782 119.339	H	244		
CORDERO FLY NO. 3 TEST HOLE	W	WA- 20	259	NW SE SE	35	34N	23E	40.780 119.339	H	141		
USGS TEST HOLE BR AH-9	W	WA- 21	259	NE	02	33N	23E	40.772 119.340	H	31		
0000798	S	WA- 22		SW	10	32N	23E	40.67400119.36400	90			7800*
0074256GREAT BOILING SPRING (GERLACH)	S	WA- 23	261	NW NW	15	32N	23E	40.66500119.3[illegible]	[illegible]			

0074521		W	WA-219	279			07	17N	20E	39.35000	119.78250	22			
0074520		W	WA-220	279		SE	07	17N	20E	39.35000	119.77166	24	33		211
0074058		W	WA-221	279	NW	SW	07	17N	20E	39.34833	119.78000	38	51		
0074410	BOWERS MANSION HOT SPRING	S	WA-222	280	NE	NW	03	16N	19E	39.28333	119.84000	56		288	243*
0074055		W	WA-223	280			03	16N	19E	39.28333	119.83666	47			212
0074444		W	WA-224	280	SW	NW	03	16N	19E	39.28166	119.83333	24			171*
0074446		W	WA-225	281			06	16N	20E	39.27500	119.78000	26	24		253
0026062	COLLAR AND ELBOW SPRING	S	WH- 1	282			33	26N	65E	40.08700	114.64733	22		76	248
0074084	SHELL OIL CO. STEPTOE UNIT NO.1 WELL	W	WH- 2	283	NE	NE	19	24N	64E	39.94333	114.77166	151	2562		
0074689	SPRING	S	WH- 3	284		NE	31	24N	65E	39.91683	114.66700	28		1703	
0000807	CHERRY CREEK HOT SPRINGS	S	WH- 4	285			06	23N	63E	39.88300	114.89300	62			692*
0074691	HANS L. ANDERSON WATER WELL	W	WH- 5	286		NW	31	23N	66E	39.83166	114.56333	26	317	114	
0074690	LAWRENCE HENROID WATER WELL	W	WH- 6	286		NE	31	23N	66E	39.83166	114.55166	32	183	189	309*
0074672	GIOCOECHA WARM SPRINGS	S	WH- 7	287	NE	NE	01	22N	56E	39.81166	115.61200	23		4239	
0074674	UPPER SHELLBOURNE SPRING	S	WH- 8	288	SE	NW	08	22N	65E	39.80000	114.65500	23		1703	
0074673	LOWER SHELLBOURNE SPRING	S	WH- 9	288			12	22N	64E	39.79333	114.69200	25		1703	
	W.H. HUNT SCHELLBOURNE NO. 74-23	W	WH- 10	289+			23	22N	63E	39.757	114.823	191	3359		
	W.H. HUNT SCHELLBOURNE NO. 37-23	W	WH- 11	289+		SW	23	22N	63E	39.755	114.828	91	1374		
	MAGMA POWER CO. MONTE NEVA NO. 1	W	WH- 12	289			24	21N	63E	39.672	114.804	88	123		
0002204	MONTE NEVA HOT SPRINGS	S	WH- 13	289			24	21N	63E	39.66666	114.80500	79		2366	522*
0074675	CAMPBELL RANCH SPRINGS	S	WH- 14	291		SW	05	19N	63E	39.54700	114.91500	24		5110	320
	SCHOOLHOUSE SPRING	S	WH- 15	292	NW	SE	03	18N	64E	39.45800	114.75600	24		1703	
0074678	MCGILL SPRING	S	WH- 16	292	SE	NW	21	18N	64E	39.41500	114.78000	29		17329	
0074699	LACKAWANNA HOT SPRINGS	S	WH- 17	293		NE	03	16N	63E	39.28500	114.86500	35		511	420
0002200	ELY WARM SPRING	S	WH- 18	293			10	16N	63E	39.26666	114.86500	29		83	314
	Delete BIG BLUE SPRING measured by our [illegible] 7/81 at 12°C	~~S~~	~~WH- 19~~	~~294~~			~~23~~	~~14N~~	~~58E~~	~~39.07200~~	~~115.63500~~	W			
0074353	WILLIAMS HOT SPRING	S	WH- 20	295		NE	33	13N	60E	38.95333	115.23000	52		700	
0074663	BUREAU OF LAND MANAGEMENT WELL	W	WH- 21	297		SE	35	13N	67E	38.94500	114.41666	23	121	26	158*