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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Area Geothermal Supervisor's Office
Conservation Division, MS 92
345 Middlefield Road
Menlo Park, CA 94025

SEP 29 1977

Memorandum

To: INTERESTED PARTIES

From: Area Geothermal Supervisor

Subject: Plan of Operation, Environmental Baseline Study, Phillips Petroleum Company, Roosevelt Hot Springs Unit Operator, RHSU, Beaver County, Utah

Phillips Petroleum Company has submitted a Plan of Operation to acquire base line data pursuant to 30 CFR 270.34(k) for the Roosevelt Hot Springs Unit, Beaver County, Utah.

A copy of the proposed Plan and a map of Unit area is attached for your information, review, and files.

Since the Plan concerns environmental study methods and data collection, no field inspection will be scheduled and no environmental analysis will be prepared.

However, we solicit your comments on the adequacy of the proposed base line data acquisition program. All comments will be given full consideration prior to BLM-USGS approval of the said Plan. All comments must be received by this office prior to October 14, 1977:

Area Geothermal Supervisor
Conservation Division
U.S. Geological Survey
Attn: Chief, Environmental & Safety Section
345 Middlefield Road, MS 92
Menlo Park, CA 94025
(415) 323-8111, Ext. 2848
FTS 467-2848

Keid Stone

INTERESTED PARTIES LIST
PHILLIPS PETROLEUM COMPANY
Plan of Operation: Environmental Baseline Study
Roosevelt Hot Springs Unit
Roosevelt Hot Springs, Utah KGRA

USGS-Conservation Division
District Geothermal Supervisor
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USGS-Conservation Division
Office of Conservation Mgr., CR
Attn: Don Libbey
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Denver, CO 80225
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USGS-Subsidence Research
Attn: Ben Loffgren
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Geothermal Environmental Adv. Panel
Attn: Max Crittenden
U.S. Geological Survey
345 Middlefield Rd., MS 75
Menlo Park, CA 94025
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U.S. Bureau of Land Management
Office of the Utah State Director
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136 E. South Temple
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FTS: 588-5311

U.S. Bureau of Land Management
Cedar City District Office
P.O. Box 729
Cedar City, UT 84720
(801) 586-2401

U.S. Bureau of Land Management
Beaver River Resource Area Office
Attn: Lanny Ream
P.O. Box 729
Cedar City, UT 84720
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U.S. Bureau of Land Management
Attn: Theodore W. Holland,
Geothermal Specialist
Building 50 (D-310)
Denver Federal Center
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FTS: 234-5098

U.S. Fish & Wildlife Service, R 1
Attn: L.A. Mehrhoff
4620 Overland Rd., Rm. 210
Boise, ID 83705
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U.S. Fish & Wildlife Service, R 6
Regional Director
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U.S. Fish & Wildlife Service
Area Office
Attn: Lewis Richardson
Federal Building, Rm. 2222
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Salt Lake City, UT 84138
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FTS: 588-5637

INTERESTED PARTIES for PHILLIPS PETROLEUM CO., ENVIRONMENTAL BASELINE STUDY

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Regional Office, VIII
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U.S. Environmental Protection Agency
Environmental Monitoring & Support Lab
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P.O. Box 15027
Las Vegas, NV 89114
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FTS: 595-2969

U.S. Energy Research & Development Adm.
Div. of Geothermal Energy, 3rd Floor
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U.S. Energy Research & Development Adm.
Nevada Operations Office
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State of Utah
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Salt Lake City, UT 84114
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State of Utah
Water Resources Division
Attn: Bryce Montgomery, Geologist
Rm. 435, State Capitol
Salt Lake City, UT 84114
(801) 533-5401

State of Utah
Utah Water Rights Division
Attn: Dee Hansen, State Engr.
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Salt Lake City, UT 84114
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State of Utah
Wildlife Resources Division
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Salt Lake City, Utah 84116
(801) 533-5081

State of Utah
Utah Division of Health
Environmental Health Service Branch
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University of Utah Research Institute
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Attn: Dr. Stan Ward
Salt Lake City, UT 84112
(801) 581-6553

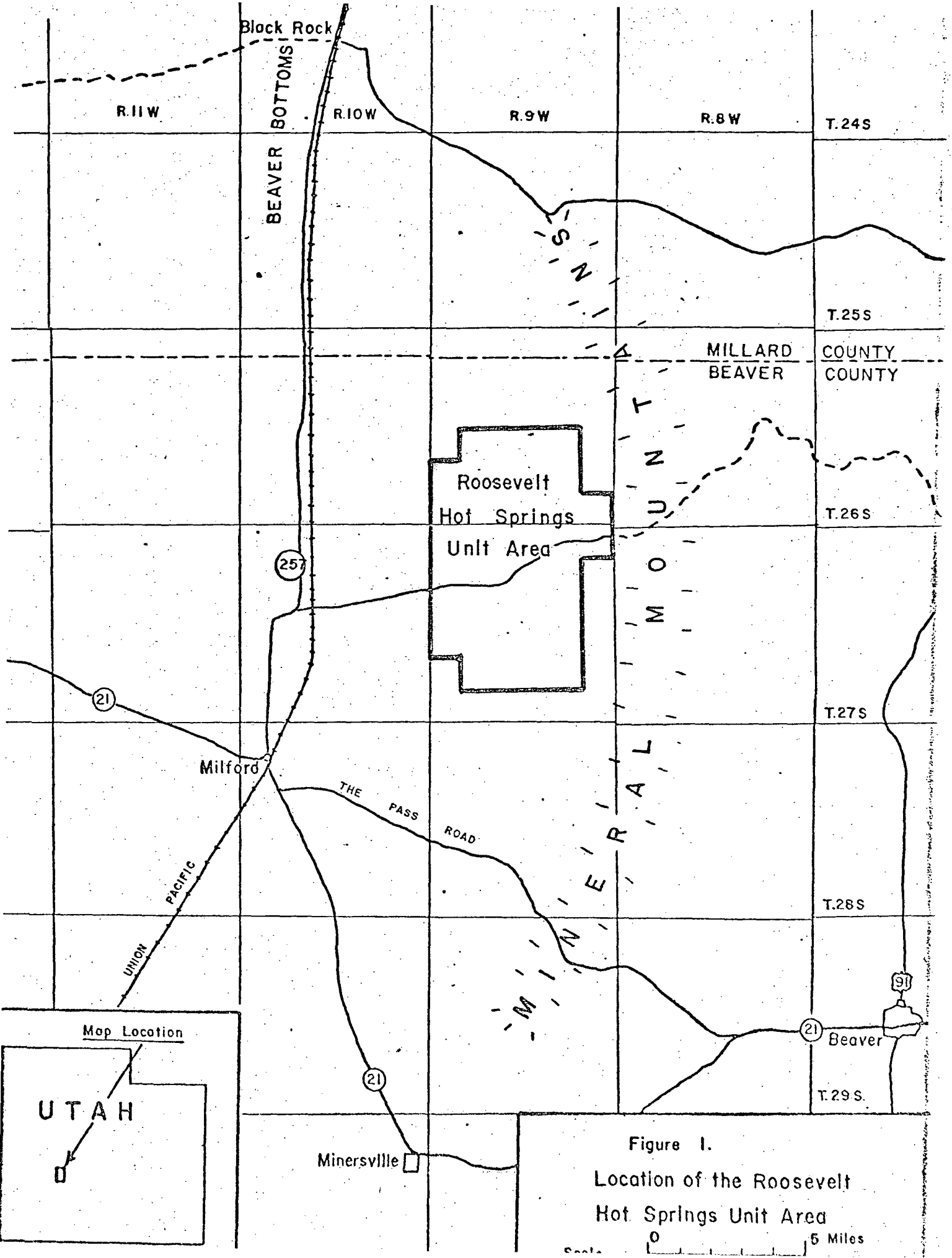

Figure 1.

Location of the Roosevelt Hot Springs Unit Area

Scale 0 5 Miles

Plan of Operations
Environmental Baseline Study
Roosevelt Hot Springs Unit

(T26S, T27S, R9W, Beaver County)

Roosevelt Springs, Utah KGRA

Prepared for

Unit Operator - Phillips Petroleum Company
P.O. Box 752
Del Mar, California, 92014
(714) 755-0131

September 9, 1977

Woodward-Clyde Consultants

3489 Kurtz Street, San Diego, CA 92110
Tel. (714) 225-9381

CONTENTS

CONTENTS (continued)

This Plan of Operations is prepared in accordance with guidance outlined in the United States Department of the Interior, Geothermal Environmental Advisory Panel, Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases, dated January 1977. As noted in those Guidelines, a requirement exists, under the Geothermal Steam Act of 1970 (Title 30 CFR 270.34[k]) for the collection of data concerning the existing air and water quality, noise, seismic and land subsidence activities and ecological system of the leased lands, the data collection covering a period of at least one year prior to the submission of a plan for production.

PURPOSE

The program of data collection described in this Plan of Operations relates to operations in the Roosevelt Springs, Utah Unit and is designed to provide a baseline representing selected physical, chemical and biological conditions prior to significant disturbance by lease operations, against which later environmental data can be compared. The Plan of Operations provides for the acquisition of environmental baseline data which will allow description of both the regional and site specific environmental characteristics of the area studied. The regional coverage of the specified environmental factors suggested in the Guidelines are expected to vary with the factor studied, i.e., air quality, biological data and noise, may deal with different areal requirements in order to achieve regional descriptive goals. In general, the region is expected to encompass areas of about 300 to 5000 square miles centered on Township T27S and Range R9W surrounding the Roosevelt Springs, Utah Unit. The general site will be centered within that Unit and will be controlled both by operations planned and ongoing and the vegetative, faunal, hydrological and other factors within the general region of those operations.

APPROACH

The program of data collection has been carefully designed to utilize the results of known and defined programs of data collection now being undertaken by both the U. S. Geological Survey and the Environmental Protection Agency's Environmental Monitoring and Support Laboratory at Las Vegas, Nevada. The programs being carried out specifically under contract to Phillips Petroleum Company will both supplement and, in some factors being studied, parallel the agency studies, as well as produce specific required data not being collected by others.

Key programs which will contribute to the definition of the environmental baseline will include:

- Specific air quality and meteorological programs to be carried out by Woodward-Clyde Consultants for the site and region.
- Incorporation of regional meteorological data from Milford, Utah.
- Use of the data output from a comprehensive air quality/meteorology program to be conducted by the Environmental Protection Agency at several sites in the region.
- Specific field and literature analysis programs for biological assessment related to medium-sized mammals, big game and birds to be done by Woodward-Clyde Consultants for the site and region.
- Incorporation of small mammal data to be developed by the Environmental Protection Agency for the site and region.
- Incorporation of vegetative descriptive data also being developed by EPA for the site and region.
- Completion of a water quality monitoring and description program to be carried out jointly by Woodward-Clyde Consultants and Phillips Petroleum Company.

- Specific noise measurement studies by Woodward-Clyde Consultants in the vicinity of the site and at such locations as necessary to define both site and regional noise environment.

- Incorporation of data being developed under USGS and University of Utah programs which are expected to define the seismic and subsidence baseline data.

These programs are described in the following sections of the plan, within the limits of the details provided to Phillips regarding USGS and EPA programs. Where specific materials developed by others are necessary to the plan description they have been included in the appendices.

TIMING AND REPORTING

The plan contemplates a one-year program with field measurements by Woodward-Clyde Consultants to commence upon approval by the Area Geothermal Supervisor, tentatively in October 1977. This permits the completion of a one-year baseline study prior to the submission of a Plan of Production.

Data from all programs will be analyzed and interpreted in an orderly and scheduled manner. All data from Phillips/Woodward-Clyde Consultants field and office analyses will be available and reported on a quarterly basis. Programs by EPA and USGS will provide data to Phillips/Woodward-Clyde Consultants in a manner which is consistent with U. S. Government organizational requirements and regulations. If data is not available quarterly it will be submitted as supplements to the basic quarterly reports on a when-available basis.

A high level of uniformity will be maintained through quality assurance procedure normal to Woodward-Clyde Consultants environmental studies. Careful and continuing liaison will be maintained with all

agencies and groups from which data must be acquired so that the value of these data to the environmental baseline description will be enhanced.

Additional reports relating to environmental baseline data and interpretation will be prepared and presented in response to specific requests by the Area Geothermal Supervisor.

DESCRIPTION OF PROPOSED OPERATIONS

The proposed operations under this plan will pertain to the development of environmental baseline data related to geothermal operations at the Roosevelt Springs Unit. Exhibit 1 (in back cover pocket) provides detail on the geographic coverage of the Unit, the leases within the area, well locations, the topographic character and drainage patterns, the existing system of road networks, and the meteorology/air quality and water quality sampling sites. The following information clarifies and supplements the operational information appearing on Exhibit 1:

- Existing and Planned Access and Lateral Road - will remain as depicted on Exhibit 1. All operations will be conducted using the present road system for access. No new roads will be constructed.

- Location and Source of Water Supply and Road Building Material - None will be required.

- Location of Camp Sites, Airstrips and Other Support Facilities - No camp sites or airstrips will be required. A 15'x20' instrument trailer site is to be located in Section 3, Township T27S, Range R9W (Exhibit 1) immediately adjacent to the Environmental Protection Agency Meteorological Site No. 1.

- Other Areas of Surface Disturbance - None

- Topographic Features of the Land and Drainage Patterns - are defined by Exhibit 1 which is a composite map developed from four USGS 7½ minute topographic maps.

As required under 30CFR270.34(h) this statement provides a description of the measures proposed to be taken for the protection of the environment. The effect the planned operations will have on the environment is expected to be a very minimum one, since it is the purpose of the plan to document the environmental baseline conditions prior to geothermal development.

With respect to the prevention and control of fires, Phillips or WCC will make every reasonable effort to prevent, control, or suppress any fire started on or near lands occupied by Phillips by taking initial attack action. The authorized officer shall be informed as soon as possible of all fires in the lease area.

Soil erosion will not be a problem. All travel will be accomplished using existing roads. The only proposed surface disturbance is the clearing of brush from a 15'x20' instrument trailer site. There will be no pollution of the surface and groundwater as a result of the proposed activities, nor will there be damage to fish and wildlife or other natural resources. The only expected air and noise pollution will be that resulting from vehicular travel and the operation of a portable generator to provide power to instrumentation systems. There will be no hazards to public health and safety generated during the environmental baseline data gathering operations. The only waste materials which might be produced would be limited quantities of garbage or foreign debris. Such materials will be disposed of at an authorized dump site.

The following sections of this plan, with their pertinent appendices, present detail on the environmental baseline data collection program for air quality, water quality, biological data, noise and seismicity subsidence.

INTRODUCTION

In order to characterize air quality and meteorological conditions in the Roosevelt Hot Springs project area, Phillips Petroleum Company, using the service of Woodward-Clyde Consultants (WCC), will conduct a comprehensive field monitoring program for a continuous one year period. WCC will also investigate and document all other local and regional sources of data and information available which may be pertinent to the impact of proposed geothermal activities on the environment of the project area. These programs will be further supplemented by data obtained from extensive baseline studies to be simultaneously conducted by the United States Environmental Protection Agency (EPA) in the immediate project area.* Arrangements to accomplish these programs on a cooperative basis including the joint use of equipment and facilities and the mutual and timely exchange of data (for six site-specific monitoring locations in the project area) have been made between Phillips Petroleum Company and the United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada (EMSL-LV) (see Appendix A).

The baseline and investigative programs described in this plan will be directed toward compliance with regulations adopted pursuant to the Geothermal Steam Act of 1970, appropriate state and Federal baseline monitoring guidelines which insure maintenance of ambient air quality standards and the non-degradation of the existing environment, and specifically, the Department of the Interior, Geothermal Environmental Advisory Panel, "Guidelines for Requiring Environmental Baseline Data on Federal Geothermal Leases."

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* It is anticipated that the EPA program will be conducted for a two year period.

The on-site monitoring program will provide for the collection, summarization, and interpretation of data suitable and ample for inclusion in anticipated environmental assessment statements and reports pertaining to the impact of projected geothermal activities. The program and plan of operation described in subsequent sections is intended to meet the following objectives as specified in the Geothermal Advisory Panel Guidelines:

- To characterize the ambient air quality prior to significant changes associated with geothermal development.
- To identify substances that may have an adverse effect on the environment and to establish baseline concentrations for these substances.
- To identify and quantify existing natural and man-made point sources.
- To collect meteorological data necessary for understanding dispersion and conversion patterns.
- To provide baseline data compatible with later measurements needed to assure compliance with state or regional air quality standards.

MEASUREMENT PROGRAM/SCHEDULE

Air Quality

The air quality monitoring program will identify and characterize ambient air quality conditions in the project area. Emphasis will be placed on analyses of potentially hazardous substances which may be moderately or substantially increased as a result of the proposed activities and/or those for which there are local, state or Federal standards. The program will include continuous or quasi-continuous monitoring of the following constituents: H_2S, TSP, SO_2, NH_3, NO_x, O_3, COH (coefficient of haze, as a measurement of visibility), and radon gas.

The monitoring program will be conducted for a full year with H_2S and COH measured hourly; TSP, SO_2, NH_3 and NO_2 measured for continuous 24-hour periods every sixth day as per EPA standard procedures; and radon gas measured seasonally for continuous 24- to 48-hour periods. Air quality measurements will be taken concurrently with meteorological measurement at a representative location approximately 500 meters from initial well testing operations (see Figure 1). It is anticipated that the monitoring program will commence on/about mid October 1977. Specific details pertaining to the planned program including parameters to be measured, monitoring instruments, sampling intervals, data collection and maintenance procedures are outlined in Appendix A.

The EPA air quality monitoring program will be conducted seasonally for two week periods. A mobile unit equipped to measure H_2S, NH_3, SO_2, O_3 and TSP will be transported from Las Vegas and located at a representative site in the Roosevelt Hot Springs geothermal project area. It is anticipated that the program will commence during the 1977 fall season. Additional details pertaining to the EPA air quality program have been provided in Appendix A.

Sampling of H_2S. Initial sampling of H_2S will be on a sequential one-hour interval using the prescribed AISI Filter Tape Sampler, and for selected continuous 24-hour intervals using the methylene blue (RAC) gas bubbler or equivalent method. In addition, H_2S will be measured continuously for two week intervals on a seasonal basis by the EPA. It is anticipated that these three approaches will provide indications of potentially high baseline levels of H_2S in the ambient air. Should H_2S be found to be present in the ambient air at significant levels, i.e., concentrations exceeding 10 ppb, Phillips will provide for the installation and servicing of lead acetate tabs to measure H_2S at wells, natural seeps, and areas where risk to people or to the ecosystem may be especially actue. Additional measurements will also be provided using monitoring instruments with prescribed accuracy as indicated in the Guidelines (precision of 0.01 ppm with minimum detectable sensitivity of 0.005-0.01 ppm).

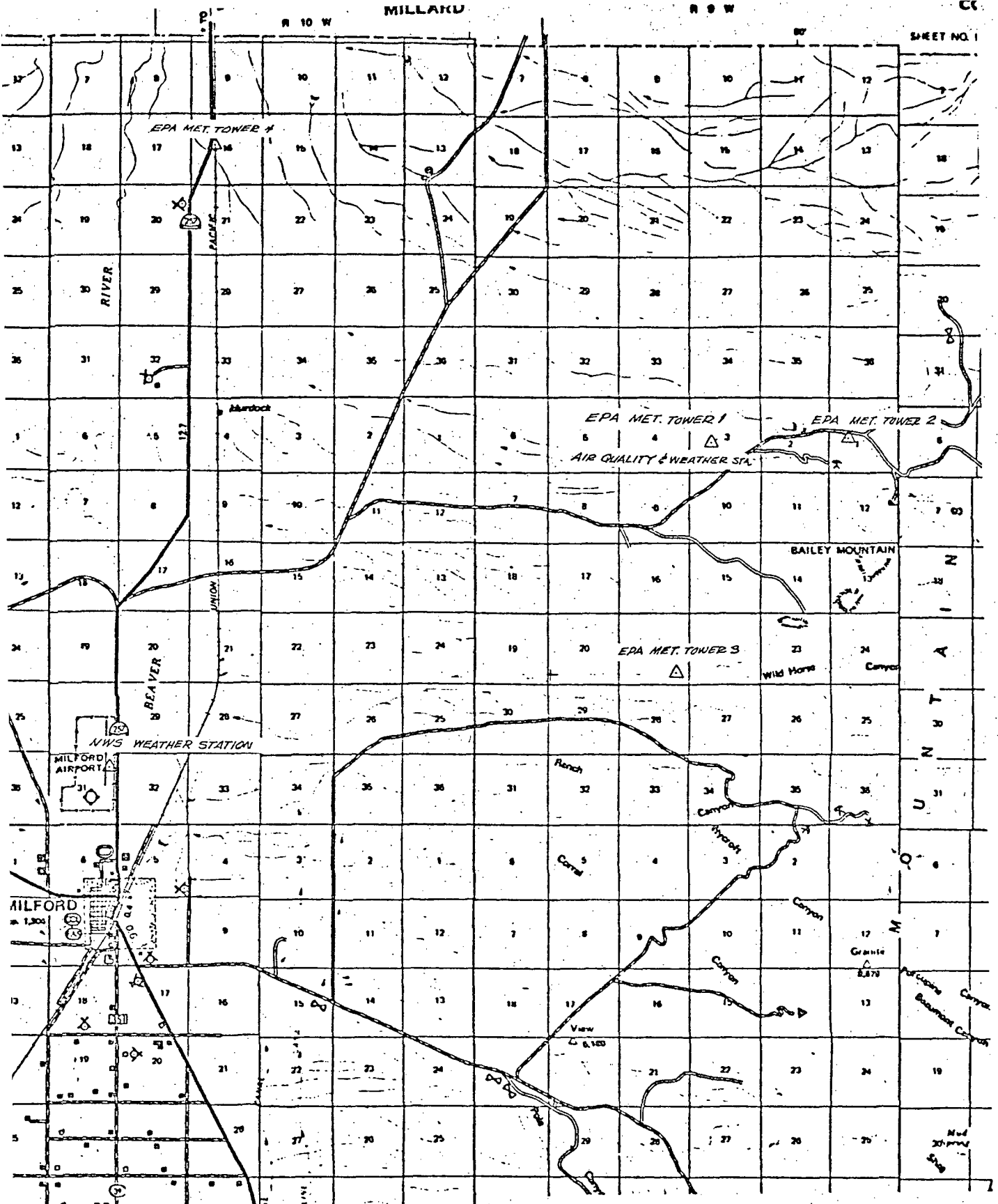


Figure 1.
ROOSEVELT AREA
AIR QUALITY STATIONS

Drawn by: T.L. Griffin Date: 9-1-77
Scale: 1" = 2 miles (approx.)

Analysis of daily, seasonal, and annual concentrations of H_2S concurrent with meteorological measurements will also be provided if ambient measurements indicate significant levels of H_2S which justify this analysis.

Meteorology

This plan will provide for the collection, analysis, and interpretation of meteorological data and information necessary to characterize the existing environment, and as a means of understanding and calculating the pathways and distributions in the ambient air resulting from the various sources. The meteorological field monitoring program will be conducted in conjunction with the Environmental Protection Agency Roosevelt Hot Springs baseline studies and will include the monitoring of data at six separate locations in the project area vicinity (see Figure 1). Parameters to be measured include wind speed and direction (at six locations, including winds at 10 meters and 30 meters at Monitoring Site 1), humidity and temperature (at three locations), precipitation (at two locations), barometric pressure and visibility (at the Milford Weather Station), and atmospheric stability as represented by ΔT (at Monitoring Site 1).

The EPA program includes the erection of a 30-meter meteorological tower at Monitoring Site 1 and 10-meter towers at Monitoring Sites 2, 3, 4 and 5, collection of wind speed and wind direction data at all five sites, and the digital recording and computer processing of these data in a timely manner. Computer tapes or processed summaries will be made available to Phillips expeditiously as per agreement. The EPA will also install a Memodyne data logger at the Milford National Weather Service (NWS) Station in order to acquire continuous measurements of wind speed and direction at that location; these data will also be made available to Phillips. In conjunction with the mobile air quality monitoring program previously outlined, the EPA will provide two-week seasonal PIBAL and radiosonde measurements. Additional information pertaining to the EPA program is provided in Appendix A.

The program outlined in this plan will complement the EPA program by providing wind speed and wind direction measurements at the 30-meter level at Monitoring Site 1, ΔT measurements (10-30 meters) at Site 1, humidity and temperature measurements at Sites 1 and 2, and precipitation measurements at Site 1. Phillips (WCC) will also process continuous recorded measurements of temperature, humidity, precipitation, wind speed, wind direction, visibility and barometric pressure at the Milford NWS Station. Specific details pertaining to the planned Phillips program are provided in Appendix A.

Summary of Air Quality/Meteorology Programs

A summary of the combined EPA/Phillips field monitoring programs which will provide baseline air quality and meteorological data for the Roosevelt Hot Springs geothermal project area is shown in Table 1. The proposed schedule for accomplishement of this program is shown in Table 2.

DATA PROCESSING AND ANALYSIS

Raw data from the air quality and meteorological instruments for both this program and EPA programs will be collected weekly or bi-weekly, validated, reduced to hourly values as appropriate, quality assured and computer processed. The EPA, as per agreement, will provide wind speed and wind direction summaries and wind roses for the five project site monitoring locations and the Milford NWS Station. If these summaries are not available in time for appropriate applications, EPA will provide 800 bpi data tapes containing raw data from which pertinent information can be processed as required. The EPA will also provide results of two-week seasonal air quality and meteorological upper air monitoring programs. Phillips (WCC) will process air quality, wind, temperature, humidity, precipitation and

SUMMARY OF AIR QUALITY/METEOROLOGICAL EQUIPMENT
FOR THE ROOSEVELT HOT SPRINGS, UTAH, GEOTHERMAL BASELINE STUDY

ITEM - AIR QUALITY	PARAMETER MEASURED	LOCATION	ELEVATION (HEIGHT)	OPERATOR PHILLIPS	EPA	NWS
Mobile Trailer	--	Sta. 1 (main base)	6,050' MSL	x		
AISI Filter Tape Sampler	H_2S	" " " "	(2.5M AGL)	x		
AISI Filter Tape Sampler	COH	" " " "	(2.5M AGL)	x		
RAC 3-Gas Sampler	SO_2, NO_2, NH_3*	" " " "	(2.5M AGL)	x		
HiVo Sampler	TSP	" " " "	(3.5M AGL)	x		
Dual Pen Recorder	H_2S, COH	" " " "	(2.0M AGL)	x		
Industrial Hygiene Badges	H_2S	" " " "	(1.5M AGL)	x		
EMI Pulse Pump	Rn	See Figure	(1.0M AGL)	x		
Mobile Trailer Unit	--	Variable (mobile unit)	Variable		x	
Sampler	H_2S	" " " "	( )		x	
Sampler	NH_3	" " " "	( )		x	
Sampler	NO_x, NO_2	" " " "	( )		x	
Sampler	HC	" " " "	( )		x	
Sampler	Rn	" " " "	( )		x	
Hi Vol Sampler	TSP	" " " "	(3.5M AGL)		x	

ITEM - METEOROLOGICAL	PARAMETER MEASURED	LOCATION	ELEVATION (HEIGHT)	OPERATOR PHILLIPS	EPA	NWS
Wind System & Recorder	WD, WS	Sta. 1 (main base)	6,050' MSL (30M AGL)	x		
Temperature & Recorder	T	" " " "	(10M AGL)	x		
Delta Temperature & Recorder	ΔT	" " " "	(10-30M AGL)	x		
Precipitation & Recorder	PCPN	" " " "	(2.0M AGL)	x		
Hygrothermograph	T, RH	" " " "	(1.5M AGL)	x		
Wind System & Data Logger	WD, WS	" " " "	(10M AGL)		x	
Wind System & Data Logger	WD, WS	Sta. 2 (Negro Mag Wash)	6,000' MSL (10M AGL)		x	
Hygrothermograph	T, RH	" " " " "	(1.5M AGL)	x		
Wind System & Data Logger	WD, WS	Sta. 3 (Wild Horse Canyon)	6,000' MSL (10M AGL)		x	
Wind System & Data Logger	WD, WS	Sta. 4 (Read)	4,900' MSL (10M AGL)		x	
Wind System & Data Logger	WD, WS	Sta. 5 (Bradshaw Mt)	5,200' MSL (10M AGL)		x	
Wind System & Data Logger	WD, WS	Sta. 6 (Milford Aprt)	5,040' MSL (8M AGL)		x	x
Wind System & Recorder	WD, WS	" " " " "	(8M AGL)	x		x
Barograph	Pressure	" " " " "	(1.5M AGL)			x
Hygrothermograph	T, RH	" " " " "	(1.5M AGL)			x
Precipitation Gage & Recorder	PCPN	" " " " "	(2.0M AGL)			x
Wind System & Data Recorder	WD, WS	(Mobile Unit)	Variable (10M AGL)		x	
Pibal	Winds Aloft WD, WS	" " " "	10- (2000M AGL)		x	
Radiosonde	Press, T, RH	" " " "	10- (2000M AGL)		x	

* and/or H_2S

Table 2

AIR QUALITY/METEOROLOGY/NOISE SCHEDULE

Phase	Start	Completion
1. COORDINATION		
U. S. Dept. Interior/EPA & Others	Current	12/15/78
2. PROCURE FIELD EQUIPMENT		
Air Quality Monitors	Current	9/3/77
Meteorology Sensors	Current	10/10/77
Support Equipment	Current	10/15/77
3. ON-SITE INSTALLATION		
Fence (Mobile Trailer - Station 1)	9/19/77	9/20/77
Air Quality Monitors	10/3/77	10/14/77
Meteorological Sensors	10/3/77	10/14/77
4. OPERATIONAL PERFORMANCE TESTS		
Air Quality	10/12/77	10/14/77
Meteorological	10/12/77	10/14/77
5. ON-SITE MONITORING & DATA ACQUISITION		
Air Quality	10/17/77	10/31/78 (continuous)
Meteorology	10/17/77	10/31/78 (continuous)
Noise	10/16/77 1/20/78 4/14/78 7/16/78	10/17/77 (seasonal) 1/21/78 4/15/78 7/17/78
EPA(EMSL-LV)		
Air Quality	10/77 1/78 4/78 7/78	Two Weeks (seasonal) Two Weeks (seasonal) Two Weeks (seasonal) Two Weeks (seasonal)
Meteorology	10/77	10/79 (continuous)
6. DATA REDUCTION		
Air Quality	10/12/77	10/3/78 (quasi-continuous)
Meteorology	11/1/77	10/31/78 (monthly)
Noise		10/77 (seasonal) 1/78 4/78 7/78

Table 2 (continued)

Phase	Start	Completion
7. DATA ANALYSIS		
Air Quality	11/77	11/78 (monthly/ seasonal/annual
Meteorology	11/77	11/78 (monthly/ seasonal/annual
Noise	10/77	11/78 (seasonal)
8. REPORTS		
Quarterly Status		2/3/78 5/5/78 8/4/78 10/20/78
Data Summary & Analysis (final)		12/20/78

ΔT from Monitoring Site 1; temperature and humidity from Monitoring Site 2; and winds, temperature, humidity, precipitation, pressure, and visibility data from the Milford NWS Station. These data will be processed expeditiously and summarized monthly and by seasons. Quarterly reports will be provided summarizing progress and results of the ongoing air quality and meteorological monitoring programs. These reports will enable the Supervisor to anticipate potential problems and to provide pertinent data which may allow for possible changes to the scope of the Operational Baseline Monitoring Program as appropriate.

At the termination of the on-site monitoring program, a baseline report will be prepared which will summarize results of the monitoring programs as well as characterize local and regional meteorology and air quality in the geothermal development project area. The report will contain the following specific information:

1. A description of the air quality and meteorological monitoring programs.

2. Data summaries and results of the monitoring programs including -

   a. Highest hourly and daily measured concentrations of pertinent pollutants; 24-hour, monthly and seasonal average concentrations of these pollutants as appropriate.

   b. Pertinent relationships between pollutant concentrations and meteorological conditions, i.e., relationships between TSP and/or hydrogen sulfide (H_2S) concentration and wind direction, diurnal variations in pollutant concentration relative to micro-meteorological parameters, etc.

   c. Diurnal and monthly averages and extremes in temperature, humidity, wind speed, wind direction and atmospheric stability classes.

   d. Joint frequency of wind speed, wind direction and stability.

   e. Climatic factors which might affect reclamation and other climatic factors such as storm and severe weather occurrences, intensity and duration.

3. An analysis and discussion of meteorological and air quality background information representative of the site, to be used as a basis for predicting dispersion and effluents and other environmental effects. Strong emphasis will be placed on the identification of micrometeorological and topographical influences on local circulation patterns and resultant dispersion effects. In this respect additional NWS and Federal Aviation Agency (FAA) local and regional data, i.e., Milford and Cedar City, Utah, plus data from other available sources in the vicinity of the project area, such as the Alunite Report, will be reviewed and summarized for comparison purposes and to determine the appropriateness of using regional long-term records to estimate site-specific meteorological and air quality characteristics. It is significant to note that the National Climatic Center (NOAA) Star Program which provides joint frequency distributions of wind speed, wind direction and stability parameters is available for Milford NWS Station, Utah, which is approximately 12 miles from the site area. This information can be extremely useful in validating baseline dispersion characteristics obtained from the on-site monitoring program.

4. The baseline summary will include an overall assessment of existing airborne pollutants in the proposed area of operations. Emphasis will be placed on those constituents which might be increased as a result of the proposed geothermal development activities. The data will be compared to existing state and Federal ambient air quality standards and also considered in light of projected state and Federal regulations and guidelines relating to the non-degradation of air quality (if this should appear to be a factor of concern at the time of the preparation of the baseline report). Anticipated or potential problems, if any, will be identified so that possible mitigating actions can be considered at an early date.

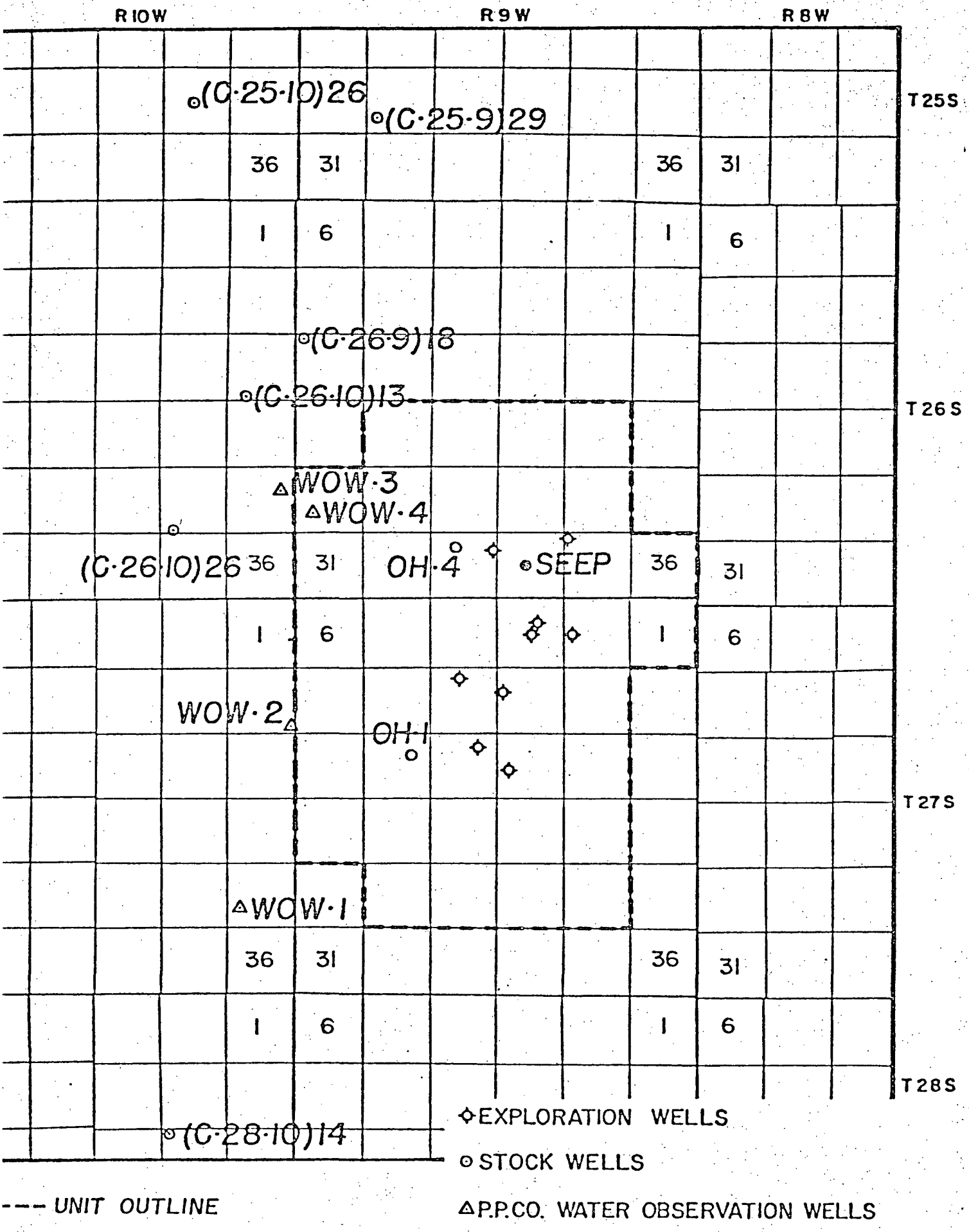
INTRODUCTION

Phillips Petroleum Company is required to establish a water quality baseline at the Roosevelt Hot Springs Unit prior to the submission of a plan for production. The requirement for baseline data may be satisfied by collecting data for a one-year period from surface water and groundwater sources on or in the vicinity of the Unit and by gathering data on geothermal fluids, produced from the lease. There are no surface water sources near the unit area, therefore, baseline activities will focus on groundwater and geothermal reservoir water sources. An inventory of surface water sources will be included wherever such an inventory appears to be needed.

The necessary groundwater data will be gathered using a water monitoring system initiated by the Phillips Petroleum Company in January-February 1976. The system was established to monitor water quality and water levels in the principal groundwater reservoir on and near the Roosevelt Hot Springs Unit. At present, the system includes six stock wells; the Roosevelt seep (the only water discharge point within the Unit area), four water observation wells specifically drilled by Phillips for that purpose, and one stratigraphic test hole drilled by Phillips modified to act as a water observation well. Phillips is preparing to modify its stratigraphic test Observation Hole #4 to function as a water observation well. Figure 2 shows the location of the monitoring sites, the geothermal wells and the unit boundary.

The sparse distribution of existing water sources in the area prompted Phillips after consulting the USGS Water Resources Division to drill the four water observation wells mentioned above and labeled WOW #1 through #4 on Figure 2. The Phillips wells are located between the existing water users points of diversion and the geothermal wells and penetrate the same reservoir utilized by the ranchers and the farmers in the valley. The well sites were located far from existing irrigation wells to minimize or eliminate the effect present pumping has on the water table in the area.

Figure 2.


R10W
R9W
R8W
T25S
T26S
T27S
T28S
(C-25-10)26
(C-25-9)29
(C-26-9)18
(C-26-10)13
WOW-3
WOW-4
(C-26-10)26
OH-4
SEEP
WOW-2
OH-1
WOW-1
(C-28-10)14
36
31
1
6
EXPLORATION WELLS
STOCK WELLS
UNIT OUTLINE
P.P.CO. WATER OBSERVATION WELLS

Phillips is presently generating data on a monthly basis. The USGS has two continuous water level recording devices near the north and south ends of the KGRA; one at WOW 1 and the other at Hanson Sheep Co. Well located in Sec. 18, T26S, R9W.

SURFACE WATER

Although surface water sources are not known to exist on the Unit, a careful review of topographic and other maps depicting ephemeral streams and drainage patterns will be made, and an inventory will be prepared if it appears applicable. The need to sample such surface sources during or immediately after high precipitation events (if and when occurring) will be evaluated.

GROUND WATER MONITORING SYSTEM

Each monitoring site and the type of data to be generated at each site is given in the following table:

Owner	Location	Designation on Figure 2	Water Quality	Water Level	Well Depth
Phillips	T27S, R10W, Sec 25	WOW 1		X[1]	415'
Phillips	T27S, R10W, Sec 12	WOW 2	X	X	402'
Phillips	T26S, R10W, Sec 25	WOW 3	X	X	300'
Phillips	T26S, R9W, Sec 30	WOW 4	X	X	305'
Phillips	T27S, R9W, Sec 17	O H 1	X	X	600'
Phillips	T26S, R9W, Sec 33	O H 4	X	X	
Hanson Sheep Co.	T26S, R9W, Sec 34	(C-26-9) 34	X	X[2]	Surface
V. Kaufman	T25S, R10W, Sec 26	(C-25-10) 26	X	X	Unknown
F. Anderson	T25S, R9W, Sec 29	(C-25-9) 29	X	X[3]	Unknown
Hanson Sheep Co.	T26S, R9W, Sec 18	(C-26-9) 18	X[4]	X[1]	Unknown
Hanson Sheep Co.	T26S, R10W, Sec 13	(C-26-10) 13		X	Unknown
Hanson Sheep Co.	T26S, R10W, Sec 26	(C-26-10) 26	X[4]		140'
Hanson Sheep Co.	T28S, R10W, Sec 14	(C-28-10) 14	X[4]		255'

1. USGS has mounted a continuous recorder on this well.
2. This is the Roosevelt seep. Discharge measured in l/min.
3. Monitor well is 500' from new irrigation well.
4. Pumps removed in summer and fall. No water quality samples possible after pump removal.

Water Level Measurements

Two wells have USGS continuous water level recorders. Discharge at Roosevelt seep will be reported in liters/minute. Water levels at observation wells without recorders will be determined using steel tapes.

Water Quality Measurements

The water quality sampling program will involve sampling up to eleven sampling sites. The various physical and chemical parameters to be measured, and frequency of sampling are described as follows:

Parameters to be measured:

The parameters to be measured on site are temperature, pH, specific conductance and (where applicable) discharge. Data precision for temperature and pH measurements will meet suggested standards published in The Geothermal Environmental Advisory Panel Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases.

The first water sample from each site will be given a standard analysis. Chemical parameters measured in the standard analysis include SiO_2, Ca, Mg, Na, K, alkalinity, SO_4, Cl, NO_3, F and B and specific conductance and gross radioactivity.

Thereafter, water samples will receive a partial analysis which will include specific conductance, B, Cl, K.

The collection and analysis of water samples shall be done according to current methods published by U.S. Geological Survey in "Recommended Methods for Water-Data Acquisition" 1972. Analyses will be performed by American Technical Laboratories Inc., 8909 Complex Drive, San Diego, California, an approved water laboratory under the provisions of the State of California.

Frequency:

Measurements will be taken monthly.

Geothermal Fluids

Analyses of geothermal fluids produced from the lease are included here as Figures 3 and 4. Due to the risk and high cost in sampling geothermal wells the acquisition of any new data is dependent upon implementation of reservior tests.

COMPOSITION OF LIQUID FRACTION

Figure 3.

WELL 54-3

November 11, 1975

Constituent	Quantity		
Sodium	2000	Milligrams/Liter	
Lithium	20	"	"
Potassium	400	"	"
Arsenic	3.8	"	"
Fluorine	6.0	"	"
SiO_2	300	"	"
Calcium	7.0	"	"
Magnesium	0.1	"	"
CO_3	200	"	"
O_3	0	"	"
O_4	55	"	"
Chlorine	3600	"	"
Boron	28	"	"
O_3	< .05	"	"
Ammonia	< 1	"	"
Bromine	< 5	"	"
Iron	.2	"	"
Barium	< .4	"	"
Manganese	< .02	"	"
Strontium	< 5	"	"
Lead	.18	"	"
Aluminum	.5	"	"
Rubidium	3.9	"	"
O_4	< 1	"	"
Cesium	3.1	"	"
TDS (approximate)	6700	"	"
pH	6.9 - 7		
Sp. GR.	.999		
pH (MV.)	-140		
Conductivity (MHO/M)	1.1		

Figure 4. SELECTED WATER ANALYSES OF ROOSEVELT K.G.R.A.

	Roosevelt [1] Hot Springs	Roosevelt [1] Hot Springs	Roosevelt Seep	Roosevelt Seep	54-3	3-1
Date	11-4-50	9-11-57	5-9-73	8-15-75	8-26-75	5-25-75
Temperature (°C)	85	55	17	28	> 260	> 205
Silica (ppm)	405	313	76	107	560 +	560 ?
Calcium (ppm)	19	22	113	107	10.1	8.0
Magnesium (ppm)	3.3	0	17	23.6	0.24	0.01
Sodium (ppm)	2080	2500	2400	1800	2000	2437
Potassium (ppm)	472	488	378	280	410	448
Bicarbonate (ppm)	158	158	536	300	200	180
Sulfate (ppm)	65	73	142	70	54	59
Chloride (ppm)	3810	4240	3800	3200	3400	4090
Fluoride (ppm)	7.1	7.5	5.2	3.3	5.0	5.0
Nitrate (ppm)	1.9	11	TR	TR	TR	0.1
Boron (ppm)	–	38	37	29	29	25
Lithium (ppm)	–	0.27	–	17	19.0	20.0
TDS (ppm)	7040	7800	7506	5948	6442	7067
pH	–	7.9	8.2	6.43	6.5	6.3
[2] Na-K-Ca GEOTHERMOMETER (°C)	295	285	247	239	294	273
Na-K GEOTHERMOMETER (°C)	307	282	250	248	290	294

1. Mundorff (1970) 2. $\beta = 1/3$

ADDITIONAL SOURCES OF INFORMATION

The USGS and State of Utah Division of Water Resources are presently engaged in a long-range program of cooperative investigations in the Milford area of Escalante Valley.

The USGS has gathered water level data and water quality data from Escalante Valley for more than ten years. Their program involves measuring water levels twice yearly at the sites shown on Figure 5. Their analysis of this data is published annually by Utah Division of Water Resources. Water quality samples are obtained once yearly at sites shown on Figure 6. This information is published annually by the U. S. Geological Survey. These cooperative studies resulted in the publication in 1974 of a detailed study of the water resources of the Milford area. This comprehensive report, Technical Publication 43, is published by the State of Utah Department of Natural Resources and is an accurate documentation of the condition of the basin at that time.

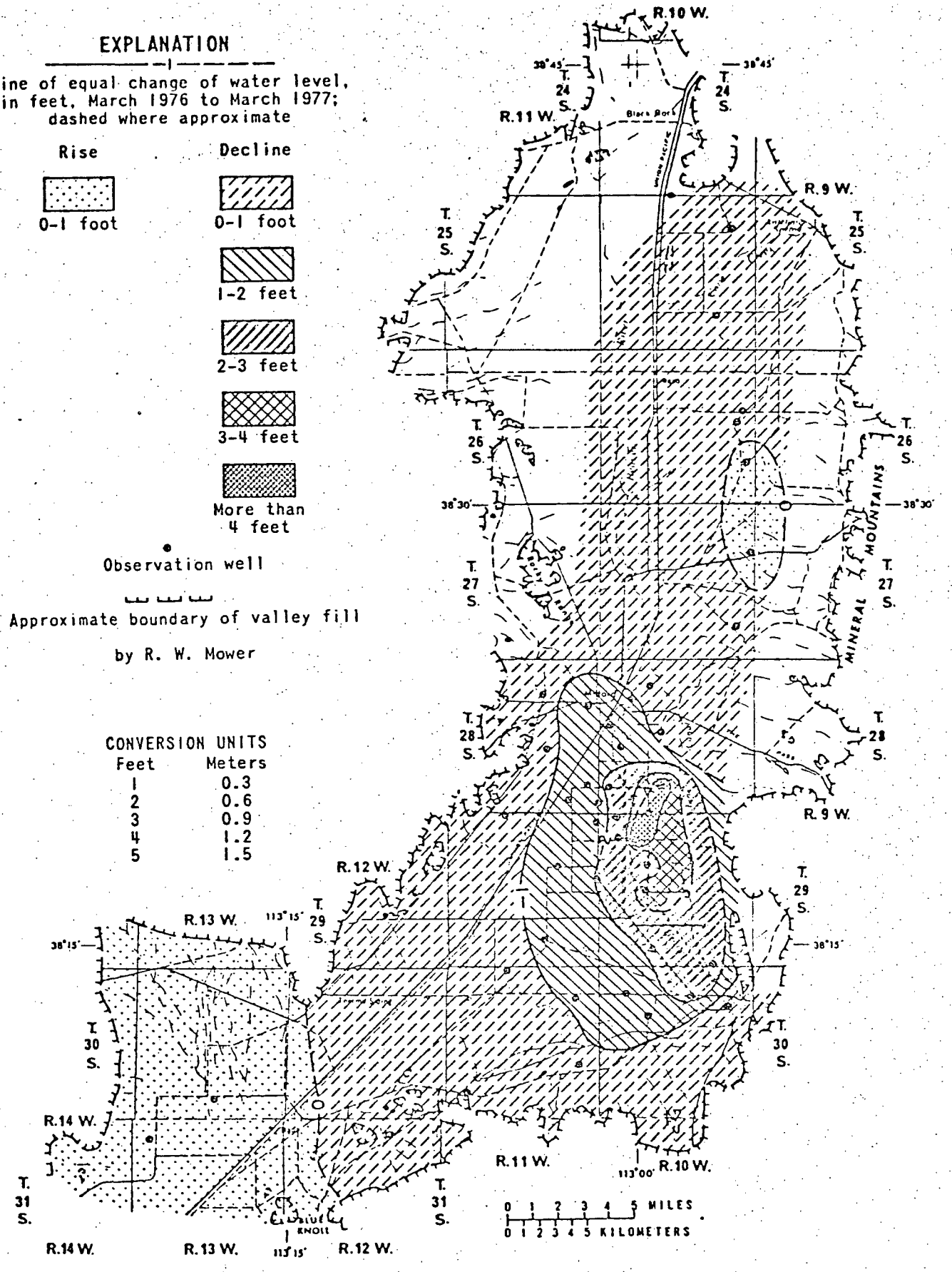
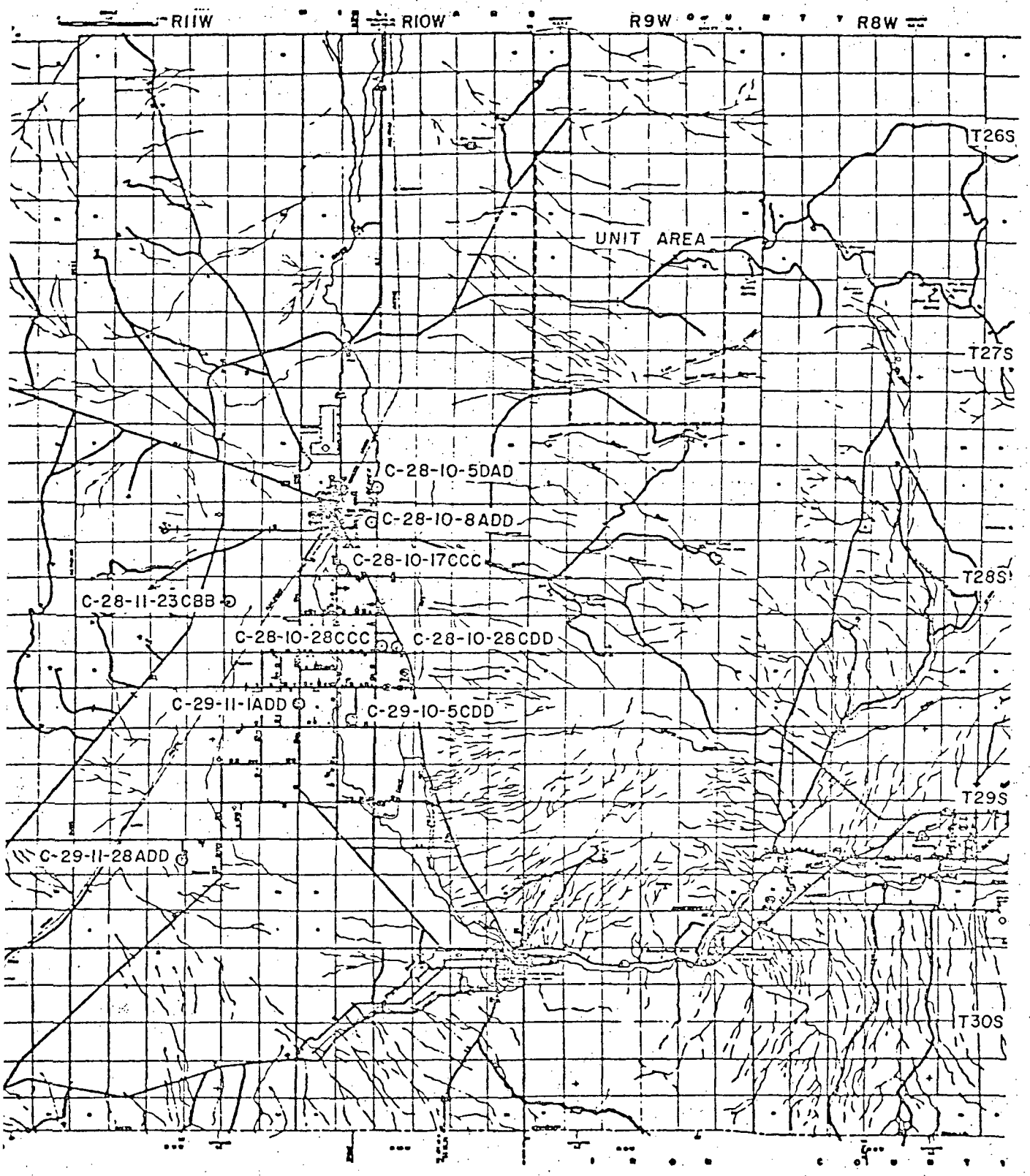


Figure 5.—Map of the Milford area, Escalante Valley, showing change of water levels from March 1976 to March 1977.

WATER QUALITY ANALYSES 1975

Figure 6.



⊙ SAMPLE SITE

INTRODUCTION

Phillips Petroleum Company is required to establish a biological baseline at the Roosevelt Hot Springs Unit prior to the submission of a plan for production. The requirement for biological baseline data may be satisfied by either data collected directly by Phillips and its consultants, or by credible agencies or individuals, during the required one year period prior to submission of a plan of production. Published data and records of other information collected more than a year before submission of the plan of production may be used to supplement the baseline requirements. The data compiled from the information sources discussed above will be used to describe the existing terrestrial ecological baseline. No aquatic ecology studies are proposed because of the lack of significant aquatic habitats within the Unit (the only surface water is in the area of a small spring which has been cleaned out and modified to provide a low flow to a small nearby stock pond).

GENERAL METHODOLOGY

Phillips Petroleum Company through its consultants and using data derived from ongoing studies by the EPA proposes to develop an adequate, detailed, biological baseline for the Roosevelt Hot Springs Unit.

Vegetation

A description of the existing vegetation within the Unit including cover and composition data and a vegetation map will be developed by EPA in the course of their studies within the Unit area. A further discussion of the EPA's vegetation program is presented in Appendix B.

Wildlife

Small Mammals. Small mammal baseline inventory and population information will be obtained from the EPA as the results of their small mammal studies within the Unit become available. Ongoing EPA studies will also provide information on rabbits and hares. Phillips' understanding of the scope and methodology for the EPA studies is discussed in Appendix

Big Game. Baseline data on big game and other game species will be obtained from the Utah Division of Wildlife Resources, when appropriate.

Medium-Sized Mammals. Medium-sized mammals (usually predators) such as coyote, fox, bobcat, etc. will be surveyed using the scent-post technique (slightly modified) developed by the U. S. Fish and Wildlife Service (USFWS, 1974). The basic technique incorporates an attractant placed in the center of a cleared, sifted and smoothed one square meter plot of soft soil. These plots are placed along a 15 mile transect at about one-third mile intervals (the length transect and placement of the plots may be modified during the proposed study). Prints made by individuals visiting the site are noted, and identified to the extent possible. Relative visitation to the plots by species are calculated as a measure of the relative abundance of the species utilizing the Unit. The tentative locations of the medium-sized mammal transects are shown in Figure 7. The final selection of the transect/scent post locations will be made following review of the initial draft of the EPA vegetation map when it becomes available in October 1977. Because of their wide ranging habits, the medium-sized mammals are expected to utilize, at least on a temporary basis, all vegetation types that occur within the Unit. Therefore, it is desirable to select a transect that will traverse most or all of the vegetation types within the Unit. Scent post sampling will be conducted on a quarterly/seasonal basis. Additional information will be obtained through observations of dens, scat and other signs, and sightings of individuals.

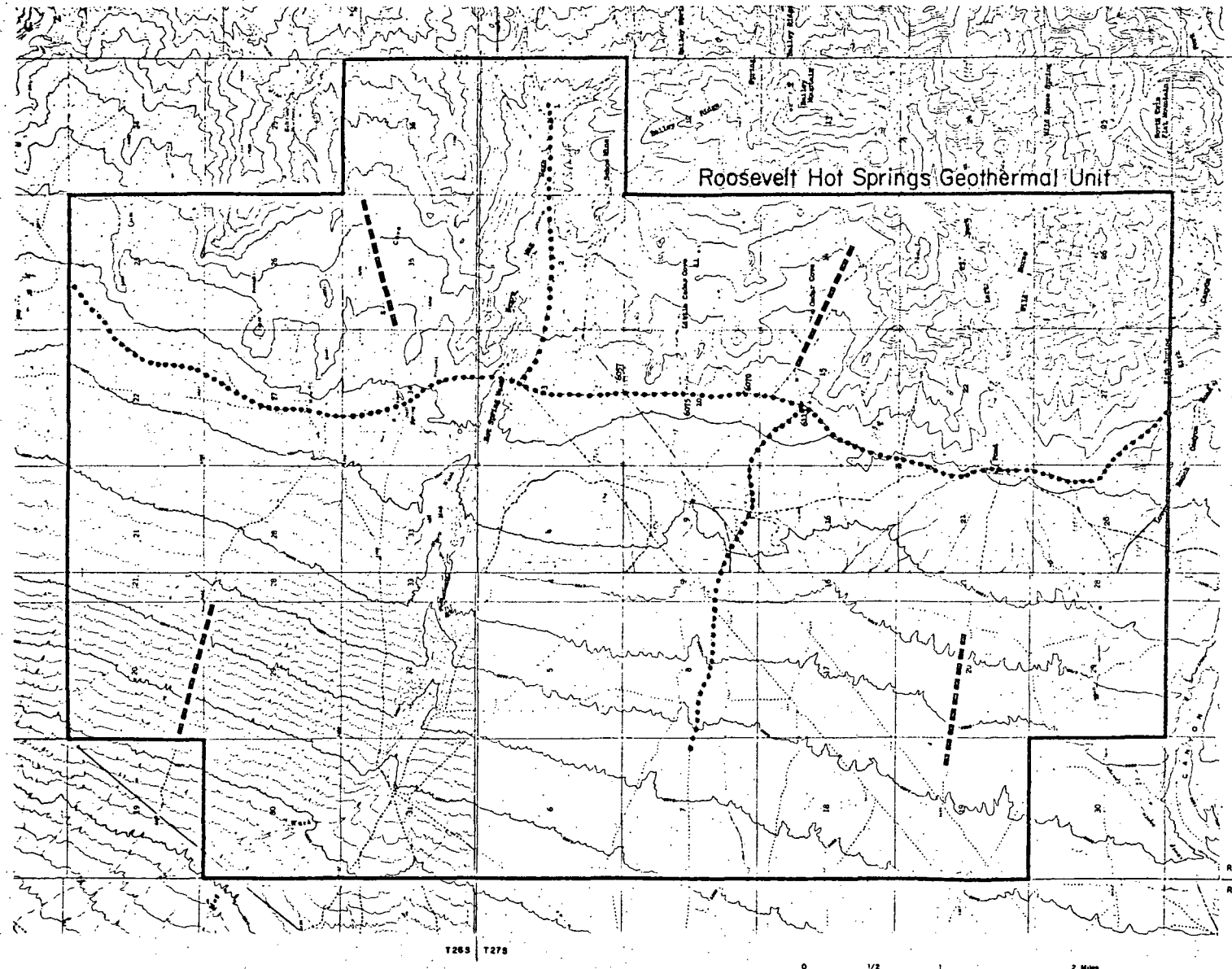
Birds. Bird species will be inventoried on both qualitative and quantitative techniques. Bird surveys will be conducted on a seasonal/quarterly basis to provide information on utilization of the Unit, and on nesting and breeding seasons. Quantitative estimates of the abundance of bird species will be made using the Emlen strip transect method (Emlen, 1971). Proposed locations of the Emlen transects are provided in Figure 7. Transects will be placed, as a minimum, in each major vegetation type and in other unique habitat areas when appropriate. Final selection of the transect locations will be based on a review of the initial draft vegetation map developed by the EPA.

Qualitative observations will be made along road transects at approximately one-half mile intervals with an observation period of five minutes. Final selection of the road transect locations will be made following review of the initial draft of the EPA vegetation map. Qualitative observations will also be made in any unique habitats or vegetation types not covered by either the Emlen strip transects or the road surveys.

REFERENCES

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323-342.

U. S. Fish and Wildlife Service. 1974. Relative indices of predator abundance in Western United States. U. S. Department of Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Denver, Colorado.



Woodward-Clyde Consultants

Figure 7.
Approximate locations of bird survey transects and scent post transects for medium sized mammals.

Proj 80284 A	Date 8 Sep 1977	Draft W W	Appd

INTRODUCTION

Ambient noise levels in the project vicinity are established mostly by natural sources. The natural background level obviously increases during high winds and thunderstorms (thunderstorms can have noise levels up to 120 dB(A) for short periods of time. It is anticipated that additional noise levels in the area result from drilling and other exploration activities. In light of recent legislation in many western states regarding industrial noise problems and the increasing interest in the effects of noise on wildlife, existing ambient noise levels will be established so that the contribution of project activities to ambient noise levels can be accurately assessed.

The propagation of sound in the open at distances of several hundred feet or more may be significantly affected by atmospheric and ground conditions. In evaluating the ambient noise characteristics of the area, many factors will be considered, including meteorological data, terrain, ground cover, and the physical aspects of the noise sources, such as agricultural machinery, traffic and aircraft.

Noise Measuring Program

In order to describe the existing noise environment in terms which can be related to standards and guidelines, the noise level and its diurnal variation will be determined. The variability of noise levels is commonly expressed in terms of three exceedance levels: L_{10}, L_{50}, L_{90}. That is, the noise level exceeded 10, 50 and 90 percent of the sample time, respectively. These measurements will be conducted on weekdays and weekends to determine any variations in ambient noise characteristics that are due to human activities.

The measurements will be made in accordance with American National Standards Institute ANSI-SI.13-1971, "Methods for the Measurement of Sound Pressure Levels." Instrumentation for these measurements will consist of General Radio Type 1933 Precision Sound Level Meters and Analyzers. Data will be recorded in analog form on battery operated Simpson recorders. The systems will be calibrated before each set of measurements with GR-1562 calibrators.

An on-site survey will be performed to characterize the ambient sound levels within and in the vicinity of the unit area and thus provide baseline information permitting the assessment of the noise generated by construction and operating activities. Noise measurements shall be made at locations including along the unit boundary and nearby residences for a two-day period four times during the one-year program, once during each season of the year.

The actual measurement locations were selected with appropriate consideration given to the guidelines and the physical locations of the above ground facilities associated with a geothermal resource facility. At each measurement location the following noise levels shall be made and recorded continuously:

- A ten-minute measurement each hour (or as often as possible of the A-weighted, broad-band ambient noise level.

NOISE DATA ANALYSIS

The above data will be statistically analyzed to provide cumulative noise levels. For each of the measurement locations the following information will be provided:

- A statistical description of hourly ambient sound levels including Leg, Lmax, L_{10}, and L_{90} and the Ldn
- An illustration showing the location of the measurement stations
- Identification of the major noise sources

The recorded levels will be tabulated and logarithmically averaged in all useful combinations. Examinations of these tabulations will reveal general patterns in diurnal variations of the ambient levels as well as deviation from these general patterns that may be a result of intermittent man-made noises. The noise data recorded on the A-weighted sound pressure level (dBA) will be reported in terms of a statistical-time-distribution that describes the percentage of the time the ambient noise pressure levels exceed a set level within a given time. This analysis of ambient noise levels takes into account the constant variations in amplitude of the sound pressure level over both short-term and longer term intervals. Three descriptors of ambient noise levels will be used: the 90 percent level (L_{90}) which describes the noise level that is expected to be exceeded 90 percent of the time; the 50 percent level (L_{50}) which describes the noise level that is expected to be exceeded 50 percent of the time; and the 10 percent level (L_{10}) which represents the noise level that is expected to be exceeded only 10 percent of the time. The L_{10} level represents the peak noise levels experienced at a given location during a given time interval. The L_{90}, L_{50} and L_{10} levels will be averaged over the time period to provide a single number (Leq)--an ambient noise level descriptor for each monitor point.

Results of the noise monitoring program plus additional sources of information pertaining to noise levels and factors for similar natural and climatic conditions will be evaluated in order to establish the baseline levels for the Roosevelt Hot Springs project area, in accordance with provisions of GRO Order No. 4, Section 11.

INTRODUCTION

30 CFR 270.34 (K) requires the collection of data on seismicity and subsidence as part of base line monitoring.

Measurements of seismic activity on a regional basis and at the Roosevelt Springs area, and programs to detect possible land subsidence resulting from fluid withdrawals, will be the subject of programs developed by the University of Utah. Networks of precise horizontal measurements and first-order leveling, East-West and North-South across the project area, are either now accomplished or in process by the U. S. Geological Survey. Phillips has established a system of benchmarks at existing wells and proposed wells which is tied to the USGS network of benchmarks. The data developed through these programs will provide the basis for the baseline description of seismicity and subsidence in the area.

Seismicity

GRO Order 4 and the GEAP Guidelines state that measurements of seismic activity, on a regional basis, are the responsibility of public agencies. Also the installation of seismographs in geothermal areas may be initiated from time to time by appropriate public agencies. The lessee should cooperate with the appropriate public agencies in the regard.

Seismicity of the area is currently being monitoring by the University of Utah. The three stations operating on and near the Roosevelt Hot Springs Unit are shown on Fig. 8. The University program, describing information on all seismograph stations operated by the University including the several instrumentation systems employed for measurement, telemetering and recording of the data is outlined in Appendix C. The pending University agreement with Phillips for the preparation of a report containing the analysis of seismic records produced, during a minimum one-year period, by the present seismic array in the vicinity of the Roosevelt geothermal field, as well as other seismic analysis and review of historical seismicity is also included in Appendix C.

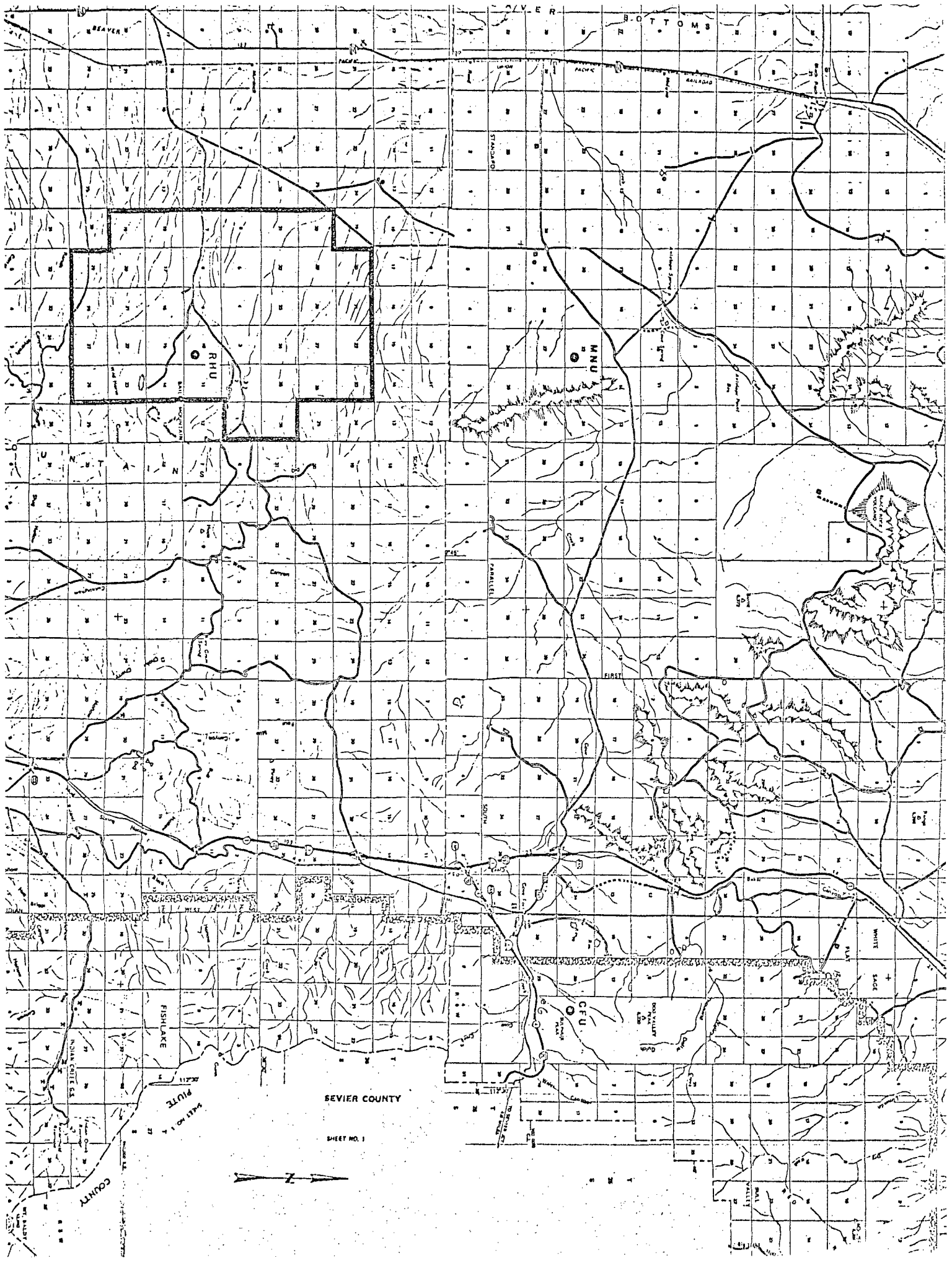
Data developed in these programs will be reviewed and assessed by the geotechnical personnel of Woodward-Clyde Consultants and utilized in the baseline description of the seismic character of the region.

Subsidence

Phillips has established a system of thirty permanent well site bench-marks as required by GRO Order 4. The surveys establishing the bench-marks were second order or better and were conducted by a registered land surveyor. The U. S. Geological Survey has established a system of bench-marks for precise horizontal and vertical control. Their surveys are first order surveys. The U. S. G. S. has tied the U. S. G. S. and Phillips networks of bench-marks together. The University of Utah has on several different occasions taken precise gravity measurements at the system of benchmarks established at the Roosevelt Hot Springs Unit. Information on the above activities, contained in correspondence from the University, is included in Appendix C.

Phillips is negotiating an agreement with the University of Utah to prepare a formal report on the findings of repeat gravity observations on the monument network established by Phillips and the U. S. Geological Survey over and in the vicinity of the Roosevelt geothermal field for assessment of possible subsidence at the Roosevelt field (Appendix C). Additional information on the leveling survey and network of horizontal measurements are discussed in correspondence from the USGS also presented in that appendix. A map of the area showing the first order survey line established by the USGS and benchmarks for horizontal measurements and gravity measurements by University of Utah is provided as Figure 1 of Appendix C. Descriptions of the USGS bench-marks and the Phillips benchmarks are also included in Appendix C.

Data developed in these studies will be reveiwed and evaluated by the geotechnical personnel of Woodward-Clyde Consultants and used in the description of baseline conditions related to subsidence in the areas of interest.


BEAVER
BOTTOMS
RHU
MNU
CFU
FISHLAKE
SEVIER COUNTY
SHEET NO. 1
PARALLEL
FIRST
SOUTH
WEST
WHITE
SAGE
FLAT
PIUTE
COUNTY

AIR QUALITY

Contents

ITEM 1

AIR QUALITY PROGRAM DETAIL

In order to satisfy the requirements of the Geothermal Steam Act of 1970 and the subsequent environmental data collection guidelines issued by the United States Department of the Interior (The Geothermal Advisory Panel) in February 1977 to form a framework for acquiring environmental baseline data on Federal Geothermal Leases, Phillips will conduct the following field data collection program which is scheduled to begin about mid October 1977, or sooner if possible.

FIELD DATA COLLECTION PROGRAM

A mobile trailer will be moved to the Roosevelt Hot Springs Geothermal Unit Area and located in the west, central portion of Section 3 of T27S/R9W, at an elevation of approximately 6,050 feet MSL, and adjacent to the Main Base Meteorological Tower (Station 1) which will be erected by the U.S. Environmental Protection Agency (EPA), Environmental Monitoring and Support Laboratory, Las Vegas, Nevada (EMSL-LV). A concrete pad for the tower has been constructed and a chain link fence erected 10x10x6-foot high. Phillips will erect a chain link fence 15x25x6-foot high to encompass the air quality mobile trailer. Three strands of barbed wire shall be installed atop the fence and gates.

A complete summary of the air quality/meteorological program for the Roosevelt Hot Springs, Utah, Geothermal Baseline Study is given in Table 1 of the main text. This table summarizes the field data collection program listing each sampler, the parameters to be measured, and the location and elevation of each site. Specific locations of monitoring sites are also shown in Figure 1 of the main text. A summary of parameters to be measured at each monitoring site are indicated below:

Station 1 - Main Base (elevation 6,050 feet)

Air Quality Measurements

- Hydrogen Sulfide (H_2S)[1]
- Coefficient of Haze (COH)[1]
- Sulfur Dioxide (SO_2)[1]
- Nitrogen Dioxide (NO_2)[1]
- Ammonia (NH_2)[1]
- Total Suspended Particulates (TSP)[1]
- Industrial Hygiene Badges (H_2S)[1] (as required)
- Radon 222 (Rn)[1]

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters
- Wind Direction (WD)[1] 30 meters
- Wind Speed (WS)[1] 30 meters
- Temperature (T)[1] 10 meters
- Delta Temperature (ΔT)[1] 10 to 30 meters
- Temperature (T)[1] 1.5 meters
- Relative Humidity (RH)[1] 1.5 meters
- Precipitation (PCPN)[1] 2 meters

Station 2 - Negro Mag Wash (elevation 6,400 feet)

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters
- Temperature (T)[1] 1.5 meters
- Relative Humidity (RH)[1] 1.5 meters

Station 3 - Wild Horse Canyon (elevation 6,000 feet)

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters

1 Monitoring program conducted by Phillips Petroleum Company
2 Monitoring program conducted by EPA

Station 4 - Read (elevation 4,900 feet)

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters

Station 5 - Bradshaw Mountain (elevation 5,200 feet)

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters

Station 6 - Milford Airport (elevation 5,040 feet)

Meteorological Measurements

- Wind Direction (WD)[2]~8 meters
- Wind Speed (WS)[2]~8 meters
- Barometric Pressure (P)[3]~1.0 meter
- Temperature (T)[3]
- Relative Humidity (RH)[3] 1.5 meters
- Precipitation (PCPN)[3] 2 meters

In addition to the above listed fixed monitoring sites, the EPA Environmental Monitoring and Support Laboratory will provide a mobile trailer to be located at a representative location in the project area to measure seasonally, for two-week periods, the following parameters:

Mobile Unit

Air Quality Measurements

- Hydrogen-Sulfide (H_2S)
- Ammonia (NH_3)
- Sulfur Dioxide (SO_2)
- Ozone (O_3)
- Total Suspended Particulates (TSP)

Meteorological Measurements

- Wind Direction (WD)[2] 10 meters
- Wind Speed (WS)[2] 10 meters
- Pibal (Winds-Aloft, WD, WS)[2]
- Radiosonde (Pressure, T, RH)[2]

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2 Monitoring program conducted by EPA
3 Phillips will process data which are available from NWS records

Phillips Petroleum Company, the Environmental Protection Agency (EPA), and/or their subcontractors, will be responsible for the procurement, installation, maintenance, operation, calibration and data collection where appropriate, and as indicated above.

Phillips has permission to add their indicated instruments to the EPA's meteorological towers for this field data gathering program, and an agreement with the EPA to freely interchange all data gathered from the above baseline study network. Also, permission has been given to Phillips by the NWS to add a wind recording instrument to the NWS's wind system located at the Milford, Utah Airport. Phillips will procure, install, interface and operate this instrument with an interchange of this data with the EPA and the NWS.

AIR QUALITY MEASUREMENTS

Air quality monitoring equipment and instrumentation to be employed in the baseline collection program are shown in Table A-1. A RAC-3 Gas Sampler will be operated quasi-continuously, every sixth day (24-hour samples) for a one-year period, to measure SO_2, NO_2 and NH_3. H_2S will also be measured at selected periods using the bubbler method. (The minimum detectable limit using this technique is 0.8 ppb.) This approach provides an accurate measurement of the baseline air quality constituents (when ambient concentrations of these pollutants are believed to be quite low, as in the current case). As an alternative, if more feasible,the following equivalent method sensors will be employed: 1) for SO_2, Philips SO_2 monitor model PW9700/00, automated; 2) for NO_2, Bendix Model 8101-1, automated oxides of nitrogen analyzer; 3) for H_2S, Philips H_2S automated monitor PW9700/00 (modified) with minimum detachable limits of 4 ppb on a standard range of 0 - 1.5 ppm. These are sophisticated continuous monitoring devices which will amply characterize the baseline levels for these pollutant constituents.

TABLE A-1

AIR QUALITY EQUIPMENT (PHILLIPS)
FOR ROOSEVELT HOT SPRINGS, MILFORD, UTAH
GEOTHERMAL BASELINE STUDY

Phillips P. 145 to detect H_2S
Phillips P 9700 to record SO_2

ITEM	MAKE	MODEL	PARAMETER MEASURED	SAMPLING INTERVAL	MINIMUM DETECTABLE
Mobile Trailer	Scotsman	Custom	House all air quality equip.		
AISI Filter Tape Sampler	RAC	5000	Hydrogen-Sulfide (H_2S)	Sequential on a 1-hr interval continuous for one year	0-0.3 ppm 0.0005
AISI Filter Tape Sampler	RAC	5000	Coefficient of Horizon visibility (COH)	Sequential on a one to three hour interval for one year	0.01
3-Gas Sampler (Bubbler)	RAC	Collecting Sampler	Sulfur Dioxide (SO_2) Nitrogen Dioxide (NO_2) Ammonia (NH_3)*	also a continious monator Quasi-continuous, every 6th day for one year (24-hour samples taken every 6th day	0.002 2.70 5.0
High Volume (HiVol) Sampler	General Metal	305	Total Suspended Particulates (TSP)	Quasi-continuous for a one-year period (24-hour samples taken every 6th day)	1.0 $\mu g/m^3$
Dual Pen Recorder	Linerr Instr.	232	H_2S COH	Continuous Analog Strip Chart Recorder	+ 0.5% (Accuracy)
Industrial Hygiene Badges	Corning Lab.		H_2S	2-8 hour exposure	10 ppm
Air Sampling Pluse Pump	EMI	II	Radon 222	Quasi-continuous for a one-year period (two,24- 48-hour continuous samples at approx. four locations, once each of four seasons)	0.10
Air Sample Bags	EMI	30 Liter Tedlar	Radon 222	" " " "	

* and/or hydrogen sulfide (H_2S)

In addition, a standard HiVol sampler will be operated at the Main Base Station quasi-continuously, every sixth day (24-hour sample) for a period of one year, to collect and measure TSP concentrations with laboratory facilities and certified equipment. The ammonium salts of both fluorides and chlorides will also be collected as particulate matter on the filter of the HiVol sampler. Selected samples of particulate matter from these filters will be routinely analyzed (at least once each month) by standard method for fluoride, chloride and ammonium content. Trace metals including arsenic, boron and mercury will be analyzed from the collected particulates on the HiVol filters. None of these trace metals will occur as volatile compounds at ambient air temperatures. Also, selected samples of these particulates will be analyzed for trace metals by atomic absorption spectroscopy.

Two RAC tape samplers will be operated continuously for a one-year period at Station 1 to measure baseline concentrations of H_2S and COH.

The baseline H_2S concentrations will be sampled by the RAC H_2S Gas Monitor (Model 5000-A). This model provides an advanced design/operating feature and specifications. To sample H_2S, the monitor uses a filter paper tape impregnated with lead acetate and is equipped with a prefilter that removes particulates from the air sample, a humidifier to assure adequate relative humidity (necessary for accurate H_2S measurements), and a precharged soda lime tube that removes entrained H_2S from the filtered air sample before the cleaned sample air enters and pressurizes the instrument's sealed filter tape sampling compartment. Detectable measurements of H_2S using this method, in conjunction with the bubbler sampling technique, will be used as a basis for initiating a more extensive H_2S monitoring and analysis program if required as outlined in the Air Quality Section of the main text.

Should H_2S be found to be present in the ambient at significant levels, i.e., concentrations exceeding 10 ppb, using monitoring techniques described above plus results of the EPA H_2S sampling program, Industrial Hygiene Badges by Corning Laboratory for the measurement of H_2S

concentrations will be exposed at the Main Base Station, and at other locations as may be appropriate, routinely during the baseline study. These badges give color changes indicating dangerous levels of H_2S concentrations.

The baseline coefficient of haze (COH) will be evaluated during the field study and compared with the visibility values recorded by the NWS station at the Milford, Utah Airport. During the sampling period light is transmitted through the filter paper tape onto a light-sensitive resistor of the RAC sampler. The transmittance is converted into a unit called the coefficient of haze, defined as the quantity of particulate matter which produces an optical density equivalent of 0.01. In order to take into account the amount of air sampled, the final results are reported in COH for 1,000 linear feet of air pumped through the filter.

Radon 222 samples will be collected at the four monitoring locations in the geothermal unit area as indicated in Figure 1. The Radon 222 baseline program will consist of a "continuous" low-volume sampling system, EMI Pulse Pump II, used to obtain the ambient outdoor Radon sample (U.S. Public Health Service, 1969). This sampling technique consists of drawing filtered air through a small, low-volume air pump (less than 10 ml/min sampling rate) into a 30-liter Tedlar or Mylar Bag. The air intake is located about one meter above the ground surface and is usually continuous for a period of 24 to 48 hours. The collected sample will then be analyzed for its Radon content by an approved laboratory. Using this technique, Phillips will collect Radon samples at the indicated monitoring locations for each of the four seasons of the year-long baseline study.

METEOROLOGICAL MEASUREMENTS

Meteorological monitoring equipment and instrumentation to be employed in the baseline collection program are shown in Table A-2. Phillips will operate a wind system, a temperature and delta temperature (ΔT) system on the 30 meter EPA meteorological tower for the

TABLE A-2

METEOROLOGICAL EQUIPMENT (PHILLIPS)
FOR ROOSEVELT HOT SPRINGS, MILFORD, UTAH
GEOTHERMAL BASELINE STUDY

ITEM	MAKE*	MODEL	PARAMETER MEASURED	SAMPLING INTERVAL	ACCURACY
Wind System	MRI	1022	Wind Direction Wind Speed	Continuous for one year	--
or Wind System	WEATHER-tronics	2020 and 2030			0-540° ±2° 0.5-100 ±0.5 MPH
Dual Pen Recorder	WMC	EPR-200A	Wind Direction Wind Speed	Continuous Analog Strip Chart Record	±0.5%
Temperature and ΔT Sensor with Aspirated Radiation Shields	WEATHER-tronics	4480 1141 1146 8150	Ambient Temp. and Delta Temp.	Continuous Analog Strip Chart Record	±0.1°F
Multipoint Recorder	Esterline-Angus	E1124E	Temperature and Delta Temp.	Continuous Analog Strip Chart Record	--
Precipitation Gage	WMC	P511-E E1/7	Rain and Snow	Continuous Analog Strip Chart Record	0.01"
Wind System Recorder	Esterline-Angus	Z-FOLD	Wind Direction	Continuous Analog Strip Chart Record	±0.5%
Hygrothermo-Graph and Shelter	WMC	H 311-E and IS1-MRD	Ambient Temp. and Relative Humidity	Continuous Analog Strip Chart Record	±1.0°F and ±3%
Hygrothermo-Graph and Shelter	WMC	H 311-E and IS1-MRD	Ambient Temp. and Relative Humidity	Continuous Analog Strip Chart Record	±1.0°F and ±3%

*All equipment will be equal for equivalent

one-year baseline study. The wind system will be installed at the top (30 meter level) of the tower with the temperature probes installed at the 10 and 30 meter levels. Thus, the wind direction and speed at the 30 meter level, the ambient temperature at the 10 meter level and the ΔT between the 10 and 30 meter levels will be recorded continuously on analog strip chart recorders located in the air quality trailer. These sensor signals are also programmed to be interfaced with the EPA's Memodyne Data Logger thereby providing a digitized and a backup record for these parameters.

Phillips will also install at Station 1 and adjacent to Station 2 an instrument shelter (U.S. Weather Bureau Cotton Region Type) to house a hygrothermograph to continuously record the ambient temperature and relative humidity at the 1.5 meter level for the duration of the study.

In addition, Phillips will install, interface with the existing NWS wind system located at the Milford Airport (Station 6) and operate a strip chart recorder to record continuously the wind direction. The wind speed of this wind system is presently being recorded in like manner. Available also for inclusion in the baseline data base from Station 6 are the continuously recorded records of barometric pressure, ambient temperature, relative humidity and precipitation. Additionally, the sky condition, visibility, present weather, and the amount, type and height of clouds are reported hourly from 0700 to 1600 hourly, daily, seven days per week.

EQUIPMENT SERVICE AND MAINTENANCE

The field data collection instrumentation network installed and operated by Phillips will be maintained and serviced by Air Quality/Meteorological Technicians on a routine basis to insure calibration reliability and quality assurance of data acquisition. This service and maintenance will be scheduled at a frequency sufficiently great enough to also insure better than 75% data recovery through the one-year field collection program.

DATA PROCESSING

Raw data from the air quality and meteorological instruments will be collected weekly or biweekly, validated, reduced to hourly values as appropriate, quality assured and computer processed. Additional details pertaining to the processing and analysis of data and arrangements made between Phillips Petroleum Company and the EPA, Environmental Monitoring and Support Laboratory, Las Vegas for the collection, summarization and exchange of data are provided in Item 2 and the Air Quality Section of the main text.

ITEM 2

EPA AIR QUALITY PROGRAM DETAIL

Extensive air quality and meteorological baseline studies will be conducted by both the contractor (WCC) for Phillips Petroleum Company and the United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada (EMSL-LV) commencing on/about October 15, 1977. Arrangements have been made to accomplish these programs on a cooperative basis including the joint use of equipment and facilities and the mutual exchange of data and information. The enclosed correspondence and memorandums pertain to planned activities to expedite this cooperative program.

Enclosure 1: Memorandum, "Roosevelt Hot Springs, Utah Study" August 30, 1977

This memorandum provides the Project Job Task Description of the proposed EMSL-LV monitoring program in the Roosevelt Hot Springs geothermal site area.

Enclosure 2: Letter from D. C. Sheesley, NSI to Donald Gilmore, Monitoring System Design and Analysis Staff EMSL-LV, August 30, 1977. This letter discusses background measurements at Roosevelt Hot Springs, Utah for concentrations of H_2S, CH_4, CO and O_3.

Enclosure 3: Letter from George B. Morgan, Director EMSL-LV to C. W. Berge, Manager, Geothermal Operations, Phillips Petroleum Co., June 27, 1977. This letter grants Phillips permission to place sensors on EPA towers in the Roosevelt Hot Springs KGRA.

Enclosure 4: Letter from William Adams, Monitoring Systems Design and Analysis Staff EMSL-LV to Ronald J. Forrest, Phillips Petroleum Company, July 18, 1977

This letter provides an update of the EMSL-LV planned baseline data gathering program for the Roosevelt Hot Springs area. It also indicates authorization for Phillips to add instruments to the EPA towers and states that Phillips will be given data gathered by the EPA.

Enclosure 5: Memorandum, "Discussion with EMSL-LV Personnel Relating to Roosevelt Hot Springs Baseline Monitoring Programs", August 26, 1977

The memorandum prepared by Herbert Edson, Chief Air Quality and Meteorology Group, Woodward-Clyde Consultants, retained by Phillips to conduct the geothermal site area baseline monitoring programs, outlines most recent discussion and EPA plans to accomplish the baseline programs.

EPA CONTRACT #68-03-2591

WORK PLAN

Title and Number: Roosevelt Hot Springs, Utah Baseline Air and Meteorological Study, 4005-1020

Date Prepared: August 19, 1977

Revised: August 30, 1977

EPA Technical Monitor: William Adams

NSI Project Coordinator: Tom Russell

Purpose:

This scope of work describes the elements and costs necessary to provide field support for the continuous collection of meteorological field data and for the intensive measurement of selected air quality parameters in and around the Roosevelt Hot Springs, Utah, geothermal resource area.

The end objectives of this project will be to determine the prevailing climatic conditions and background concentration levels of selected parameters.

Deliverables:

NSI will be responsible for providing the following during the course of the project:

1. Approved Quality Assurance Plan. This plan will address all applicable items listed in Appendix 2, "Items to be addressed in the Quality Assurance Section of Protocols," of the EMSL-LV Quality Assurance Plan (updated April 1976).

2. Installation and operation of the five sites. This includes erecting (4) 10-meter towers and (1) 30-meter tower; installing the R. M. Young Propvanes and associated equipment; all operational procedures to include cassette changes, calibrations, scheduled and unscheduled maintenance; collection, analysis and reduction of all recorded data.

   NOTE: All equipment, spare parts, and required apparatus and supplies to be furnished by EMSL-LV, MSA.

3. Data reduction reports to include wind rose plots, tabular listing of wind data and time concentration profiles of air quality data for representative periods as determined and provided to NSI by the Project Officer. All reports are due in the Project Officer's office within 30 days after completion of a data acquisition period (normally a two-week period).

   NOTE: Report due date is dependent on EMSL-LV MSA providing adequate debugged software to NSI prior to starting monitoring operations. NSI will provide an optional plan for development of software.

4. Trip report within 5 working days after return for each unscheduled maintenance trip. This report will include description of malfunction, corrective action, list of parts used, and possible effect on data, if known.

5. Final report. A rough draft report providing overall details of the project will be furnished within 30 days after completion of first year's operation.

6. Copies of all logs, records, tapes, charts, graphs, etc., applicable to the project shall be turned over to EMSL-LV MSA within 60 days of project completion.

Work Elements and Procedures:

Task 1 - Joint review of design, schedule, and budget by NSI and EPA.

(a) Design will allow mutual agreement on minor design change and planning of any required modifications. All installation problem areas should be resolved during this stage.

(b) Schedule: Acceptability of the attached milestones will be determined during this phase. Inventory of all equipment and supplies will be accomplished.

NOTE: Schedule is dependent on all required material being on hand prior to implementation of effective date.

(c) Budget: The attached budget reflects the cost of installing and operating the system for one (1) year. This includes one intensive study period that can be related to at least 2 more periods. Any additional requirements must be funded separately and prior to accomplishment. Additional work generated by events or circumstances beyond the reasonable control of NSI will also require additional funding.

Task 2 - Modification of instrument shelters. Shelters (includes the battery shelter) will be modified in accordance with plans formulated during Task 1 (a). The modification will allow shelters to be attached to the met towers with ease of access and maintenance of primary concern.

Task 3 - Install five met towers and equipment. Four of the five towers will be 10 meters and will be manually positioned in the vertical position and mounted on the existing concrete pad. Guy wires will be positioned at 120° intervals and secured to stakes installed in the ground outside the fenced area. The fifth tower (30 meters) will be assembled using a "gin pole" arrangement on the concrete pad. Three holes will be dug approximately 70 feet from the tower base and at 120° intervals. Reinforced 3 x 3 x 3 concrete "deadmen" will be poured with "eye" bolts installed. Guy calbes will be attached 5 per "deadman" and attached at the 20', 40', 60', 80', and 100' levels of the tower. Turnbuckles will be used to tighten cables and align tower vertically. All legal requirements for installing towers will be the responsibility of EMSL-LV MSA, however, in oral communications the technical monitor has informed the NSI Project Coordinator that the FAA did not require lights or special paint for any of the towers including the 30-meter tower. Equipment shelters and ancillary equipment will be installed in accordance with plans formulated in Task 1 (a).

ask 4 - Develop operational Quality Assurance Plan. This plan must be approved by the Project Officer and EMSL-LV MSQ/MSD prior to implementation of monitoring operations. The plan shall include a written log of sampling procedures, standards, instrument calibrations and maintenance, and analytical procedures for the methods of measurement under consideration. A detailed

approach recommended for the intensive studies will be included.

Task 5 - Install meteorological equipment. R. M. Young Propvanes will be installed on the top of each tower to lessen tower interference to representative measurement. The unit for the 30-meter tower will be mounted on a track with a cable and hand operated winch to insure "positive" vertical movement. Using a transit and procedures described in the plan formulated in Task 4, the units will be aligned physically and electrically to true north. Memodyne data loggers will be interfaced, operationally checked and systems placed in operation.

Task 6 - The stations will be serviced including exchanging cassette tapes and batteries, and routine preventive maintenance performed. This service operation is scheduled on a two-week recurring basis. Cost projection of this operation has been based on sending two men from NSI Las Vegas to perform the task. This option will involve a minimum of two days travel time and one day direct labor plus associated per diem. Also included in the cost factor is a leased four-wheel drive truck in the event GSA does not have one available. A four-wheel drive vehicle is a requirement for safety reasons during the months of October through May inclusive and any time there may be rain in the area.

Task 7 - A photovoltaic battery recharging system is to be installed at each of the sites when made available by EMSL. Additional funds may be required, depending on the complexity of the units, for installation and maintenance.

Task 8 - Instensive Study: Intensive study periods will be conducted at times to be selected by EMSL. These periods will normally be two weeks in duration and will collect data on concentration levels of H_2S, SO_2, O_3, NH_3, and CH_4. Total suspended particulates will be measured and wind speed and direction will be continued under normal operating procedures.

Task 8 -

1. A portable battery operated unit will be obtained through an inter-agency agreement. This portable unit will measure SO_2, O_3, and NH_3.

2. Impregnated filters will be used to measure H_2S. The filters will be mailed to Trace Elements, Inc. for analysis. A system of three filters will be exposed simultaneously to provide a comparison of results for the Quality Assurance program.

3. CH_4 Measurements will be conducted by collecting bag samples. These samples will be analyzed at NSI-LV laboratory for CH_4 concentrations.

4. The 47 millimeter Nucleopore membrane filters and battery operated pump will be used to determine total suspended particulates at the meteorological tower to be determined by EMSL personnel. A separate particle collection will be performed using the EMSL Hi-Mass Hi-Volume equipment at a location different from the background site. See Note. The membrane filters will be returned to NSI-LV for weighing.

5. Wind speed and direction will be measured using a tethered balloon and radiosonde (tethersonde).

Task 9 - Data reduction and reporting: this includes reduction, computation and plotting of wind roses, tabular listing of wind data, tabulations of all recorded aerometric data~~, collected by the mobile unit in whichever form agreed upon~~. Time concentration profiles of air quality data will be prepared using data collected during the intensive study periods. An interim report as specified in the deliverable section will be prepared within 30 days after completion of the intensive. All report schedules, data reduction, etc., listed under Task 8 are contingent on proper software being developed prior to processing any data.

Task 10 - Move portable shelter (provided by EPA) to the 30-meter tower site. NSI recommends that the shelter be moved to the site and be left there during the operational period of the project for staging. A flat bed truck and fork lift will be required for each move.

Task 11 - NSI will develop the software for providing data reduction. The software package will be debugged and capable of processing all data collected in the project.

NOTES: A Memodyne data logger will be interfaced to existing equipment at Milford Airport. The installation, operation and maintenance of the Memodyne unit will be accomplished by NSI. Data from this unit will be processed with data from the other five sites.

A massive volume air sampler is to be furnished by EMSL-LV/MSM for each intensive period. A generator capable of providing the required power will be furnished. EMSL-LV/MSM will provide one technician to train NSI personnel in the operation techniques of the massive volume air sampler. This training will be for 5 days during the first intensive study. This unit must not be operated at the same site as the unit described in Task 8 to prevent contamination from the generator exhaust.

Facilities Required:

NSI facilities, Las Vegas.

Equipment and Material Required:

(1) 4 each 10-meter met towers
(2) 1 each 30-meter met tower
(3) 10 each equipment and battery shelters
(4) 5 each R. M. Young Propvanes and associated equipment
(5) 6 each Memodyne Data Loggers
(6) 10 sets of batteries
(7) Mobile unit capable of measuring all required parameters
(8) One 4-wheel drive vehicle
(9) Primary and secondary standards as required in Quality Assurance Plan
(10) Instrument mount, track, cable, winch, and mounting hardware for 30-meter tower
(11) Guy cables and associated hardware

Milestones and Schedules:

Task	Completion Date
1	September 1, 1977
2	September 9, 1977
3	September 23, 1977
4	September 23, 1977
5	October 1, 1977
6	October 1, 1978
7	Upon availability
8	To be selected
9	October 30, 1978
10	October 1, 1977
11	December 20, 1977

NORTHROP SERVICES, INC. A Subsidiary of Northrop Corporation P. O. Box 19130
ENVIRONMENTAL SCIENCES GROUP Las Vegas, Nevada 89119
(702) 732-1902

August 30, 1977

Mr. Donald B. Gilmore, Geologist
Monitoring Systems Design & Analysis Staff
Monitoring Systems Research & Development
Division
U.S. Environmental Protection Agency
P.O. Box 15027
Las Vegas, NV 89114

Subject: Background Measurements-Roosevelt Hot Springs, Utah

Dear Mr. Gilmore:

This will document my discussion with you and Mr. W. Adams regarding background measurement requirements for the Roosevelt Hot Springs, Utah project.

The purpose of this project is to establish background levels of concentration for H_2S, CH_4, CO, and O_3 consistent with baseline development of geothermal energy resources. This type of ambient evaluation and monitoring is accomplished through monitoring techniques, sensitive and precise, that will measure real concentrations of the trace constituents of interest.

To ensure development of true background measurements requires an energy source for in-situ measurement that will not contaminate the atmosphere locally and obviate the objective. NSI does not recommend the use of fossil fuel generator power in the vicinity of the intensive and continuous monitoring site.

The in-situ measurements and data acquisition can be powered with battery and solar collectors. The measurement approach is to combine continuous and integrated sampling techniques which have demonstrated sensitivity, simplicity, reliability, and are cost-effective. The analytical approach will be supported from EMSL Las Vegas.

Individual methods were developed at the National Center for Atmospheric Research and have been applied by NOAA at Mauna Loa Observatory in Hawaii and various locations in the Western U.S. by investigators concerned with geo-chemical trace chemical measurements. It has been suggested that this equipment which will operate for days unattended be applied to the Roosevelt Hot Springs project. Availability is being investigated.

Background Measurements-Roosevelt Hot Springs, Utah

In the event that the automatic sampling version of this system cannot be obtained in the time frame of interest, a second manual version utilizing the same technology is proposed. The standard operating procedures have been developed and need only be edited for this specific requirement. Procurement of the materials to support the approach is estimated at 25% complete here on site. The remainder of procurement can be achieved in the time frame of schedules discussed at our last meeting. Training for both field personnel and laboratory support personnel is estimated to be complete in November 1977 on a non-interferring schedule consistent with other EMSL projects.

Sampling and analytical sensitivity of the methods are summarized for your review.

Detection Limit	Trace Constituent	Method
0.6 ppb v	Sulfur dioxide	Impregnated filter Axlerod, Natush, et al. (1975)
5 ppt v	Hydrogen sulfide	Natush, et al. (1972) Journal of Anal. Chem. 44 (1972)
2.5 ppb v	Ammonia	Harwood (1970) Water Research 4
10 $\mu g/m^3$	Total Particulate	Breeding, Sheesley, et al., "Background Trace Gas Concentrations in the Central U.S.", Journal of Geophysical Research 78 (1973)

Sincerely yours,

NORTHROP SERVICES, INC.

D. C. Sheesley

DCS/sg

cc: T. D. Russell
S. J. Gordon
A. E. Smith, EPA/MOD

Gary GWC
Hawaii
Dick RCC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL MONITORING AND
SUPPORT LABORATORY
P.O. BOX 15027
LAS VEGAS, NEVADA 89114
702/736-2969 (FTS:595-2969)

JUN 27 1977

Our Reference: MSA

Mr. C. W. Berge
Manager, Geothermal Operations
Phillips Petroleum Company
P. O. Box 752
Del Mar, CA 92014

Dear Mr. Berge:

In response to your letter of June 7, 1977, we are pleased to honor your request to place several sensors on three of our towers in the Roosevelt Hot Springs KGRA. We will also make available to Phillips Petroleum Company the raw data collected at our stations after it is processed and our quality assurance procedures are applied.

If you have any specific question regarding scheduling or implementation of the above, please contact Mr. Leslie Dunn, telephone (702)736-2969, extension 241.

Sincerely yours,

George B. Morgan
Director

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL MONITORING AND
SUPPORT LABORATORY
P.O. BOX 15027
LAS VEGAS, NEVADA 89114
702/736-2969 (FTS:595-2969)

July 18, 1977

Our Reference: MSA

Ronald J. Forrest
Phillips Petroleum Company
429 South Main Street
Milford, UT 84751

Dear Ron:

In response to your telephone request of July 7, the following information will point out our planned baseline data gathering program for the Roosevelt Hot Springs KGRA.

The U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada (EMSL-LV), plans to erect towers instrumented to automatically and continuously gather wind speed and direction at five site locations in the Roosevelt Hot Springs KGRA. A 10-meter tower will be erected at each of four sites; a fifth site will have a 30-meter tower. A listing of tower sites is enclosed.

Phillips Petroleum Company (Richard Lenzer) has permission to add instruments to the towers for its data gathering program and will be given data gathered by EPA. Hopefully, data gathering will begin no later than September 1, 1977, and continue through one year. The American Fence Company in Ogden, Utah, will construct a concrete pad at each site and erect a chain link fence, 10 x 10 x 6-foot high, with one 4-foot wide gate. Atop the fence and gate, three strands of barbed wire will be installed. Each tower will be supported by three guy wires. A special Land-Use Permit for three years has been obtained from the Bureau of Land Management office in Cedar City, Utah.

EPA will soon give American Fence the "go-ahead" for site pad construction and advise them exactly what is wanted and where the pads are to be placed. Arrangements have been made for representatives from our Las Vegas contractor to visit the area along with those from American Fence Company. The Las Vegas contractor will install the towers. Storage batteries will provide power for the instruments.

Intensive measurement of air quality parameters will also be accomplished. A mobile unit, equipped to measure H_2S, NH_3, NO, NO_2, HC, Rn, and particulates, will be transported from Las Vegas for a two-week period on three specified dates. This program will begin around November, 1977.

If this does not give you adequate information about the project, please contact me. Thank you for your assistance in clearing the five sites.

Sincerely yours,

Bill

William Adams, Earth Scientist
Monitoring Systems Design
and Analysis Staff
Monitoring Systems Research
and Development Division

Enclosure

cc:
R. C. Lenzer, Phillips Petroleum Company

1. Main Base; T27S/R9W , Section 1
SE1/4, SE1/4, SW1/4, NW1/4
30 meter tower. Delta T on tower. Complete weather station.
EPA to do all data reduction.

2. Negro Mag Wash. T27S/R9W, Section 1
SE1/4, SW1/4, SE1/4, NW1/4
Wind direction and speed - EPA
Temperature - Phillips Petroleum
EPA to do all data reduction
10 meter tower

3. Entrance to Wildhorse Canyon; T27S/R9W, Section 21
NE1/4, NW1/4, SE1/4, SE1/4
10 meter tower
Wind direction and speed - EPA
Temperature - Phillips Petroleum
EPA to do all data reduction

Alternate 3. T26S/R9W, Section 27
SW1/4, SE1/4, SE1/4, NW1/4

4. Read; T26S/R10W, Section 16
SE1/4, NW1/4, SE1/4, NW1/4
10 meter tower
Wind direction and speed - EPA

5. Bradshaw Mountain; T28S/R9W, Sectin 10
SW1/4, NW1/4, SE1/4, SW1/4
10 meter tower
Wind direction and speed - EPA

6. Milford airport weather station
Continuous wind speed and direction.
With strip chart - Phillips Petroleum to supply strip chart and reduce data.
If tape - EPA to furnish tape and reduce data.

MEMORANDUM

August 26, 1977

SUBJECT: Discussions with Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas (EMSL-LV) Personnel Relating to Roosevelt Hot Springs Baseline Monitoring Programs

FROM: Herbert Edson
Chief, Air Quality and Meteorology Group

The undersigned attended a meeting held at the EPA EMSL-LV offices in Las Vegas, Nevada on August 24, 1977 to discuss most recent plans to jointly expedite Phillips Petroleum Company - EPA EMSL-LV baseline monitoring programs in the Roosevelt Hot Springs geothermal site area. Also attending the meeting were Richard Lenzer of Phillips Petroleum Company, and Don Gilmore and William Adams of the Monitoring Systems Research and Development Division, EMSL-LV. The following is a summary of pertinent information covered relating to the proposed EPA baseline programs.

1. The EMSL-LV programs remain basically as stated in the Project Job Task Description of April 7, 1977. All meteorological monitoring will be accomplished essentially as outlined in this memorandum with the exception that it is now anticipated that the program will be conducted for a two year period. The start of the monitoring program will commence in several weeks when contractual arrangements have been concluded with Northrop Services Incorporated (NSI) (who are being retained by the EPA to conduct the field maintenance and servicing portions of the program). Air quality parameters to be measured include H_2S, SO_2, O_3, NH_3 and TSP. The two-week mobile monitoring program will begin during the fall season. It is now planned that two or four seasonal programs will be conducted depending upon results achieved.

2. Northrop Services Incorporated has been advised in contractual discussions that Phillips has permission to use the EPA towers and that a cooperative data gathering effort will be conducted.

3. Phillips will gather and process wind speed, wind direction and temperature, humidity, and precipitation parameters from its own sensors using strip chart recorders. This will allow for redundancy and back-up in the meteorological data collection program. The EPA will also independently process Phillips' wind data using a Memodyne recorder.

4. The EPA will provide a Memodyne recorder for the Milford Weather Station in order to obtain continuous measurements of wind speed and direction at that location. This data will be made available to Phillips along with wind data at the other five monitoring locations.

5. EMSL-LV will process all wind speed and wind direction data expeditiously as soon as final software programs are completed. It is anticipated that processed summaries can be available within a reasonable period after the data is collected. A rough estimate at this time is eight to ten weeks. Also an EPA Project Summary Report will be due next October which will contain all available processed data through that date. EPA has indicated that if summaries are not available in time for appropriate applications, they will provide Phillips with 800 bpi data tapes containing raw data from which pertinent information can be processed as required.

6. Mr. William Adams will "expedite" the EMSL-LV program. Contacts relating to the program and coordinating efforts between Phillips and the EPA and/or NSI should be conducted through Mr. Adams.

7. A new written description of the scope of the EPA program will be available as soon as contractual arrangements have been completed with NSI (but should be essentially as stated in the meeting). EMSL-LV would also like a written description of the Phillips program when it is finalized.

8. EMSL-LV will provide Phillips with more detailed descriptions of equipment, sampling and analytical techniques used in their monitoring programs. Mr. Adams is researching this information and will provide WCC with the information when it is available.

9. At the conclusion of the meeting, Mr. Curt Edmonds (PME) provided a briefing on the functions and capabilities of the Memodyne recorder and the procedure for data reduction from the Memodyne tape.

PLANNED EPA BIOLOGICAL PROGRAMS

INTRODUCTION

Meetings and discussions with personnel of the Environmental Protection Agency, particularly the staff of their Environmental Monitoring and Support Laboratory at Las Vegas, Nevada, indicate that EPA will be conducting biological studies which should provide key data for this Plan of Operations.

The details of these programs as presently understood by Phillips and WCC are as follows.

VEGETATION PROGRAM

The primary emphasis of the EPA study will be contaminant analysis of the vegetation within the Roosevelt Hot Springs Geothermal Unit. This study is being conducted to provide baseline data with which to develop and test monitoring paramenters and methodologies.

The initial phase of this study will provide descriptive habitat data and will include the development of information on the species present, their distribution and a plant community map. Black and white aerial photography will be used for initial delineation of plant community boundaries. Verbal discussions with EPA staff on August 16 and 18, 1977 indicate that their program will involve extensive vegetation sampling over the whole Unit, with a sample location of the intersections of a one quarter mile grid system. This sampling program will provide validation for the vegetation map, and cover and composition data on the major plant species. Transect and quadrat techniques will be used for vegetation sampling. A floristic list of the species observed within the Unit will also be compiled during the vegetation program.

FAUNAL PROGRAM

EPA's faunal studies are primarily oriented to sampling small rodent populations with secondary emphasis on rabbits and hares. The study is basically designed to establish tissue concentrations of selected elements in the major species sampled within and adjacent to the Unit. In verbal discussions on August 16 and 18, 1977, EPA staff indicated that they are placing increased emphasis on a study of small mammal population parameters within the Unit. They will be conducting mark and recapture sampling on two permanent grids, one in Section 3 of T27S R9W and one in Section 30. This phase of the study should provide baseline information on population fluctuations, rodent density, and home range, as well as details on species present. These permanent grids are placed in sagebrush scrub vegetation. Additional, non-permanent grids will be placed in other vegetation and habitat types within and adjacent to the Unit to provide data on species that utilize these areas.

The EPA program will also include sampling of rabbits and hares for contaminant analysis. This program will provide relative abundance information on these species based on collecting success and sightings. These data will be presented in annual reports due in October of 1977 and 1978.

Based on these verbal communications and the attached letters from EPA (May 24, 1977 and June 7, 1977) the vegetation and small mammal surveys to be conducted by EPA will provide adequate data to meet the guidelines for geothermal development baseline studies.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT

ENVIRONMENTAL MONITORING AND
SUPPORT LABORATORY
P.O. BOX 15027
LAS VEGAS, NEVADA 89114
702/736-2969 (FTS:595-2969)

June 7, 1977

Our Reference: MSE

Mr. R. C. Lenzer
Phillips Petroleum Company
P.O. Box 752
Del Mar, CA 92014

Dear Mr. Lenzer:

We are planning a series of geothermal related studies that include wildlife collections at the Roosevelt Hot Springs area. This wildlife phase should provide results applicable to items 5.33 A and B (p.23-24) of the 1977 document entitled Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases.

For clarification purposes, it should be noted that our objectives, and therefore the resulting data, may not be identical to your requirements. The EPA-Las Vegas work on wildlife species is designed to establish tissue concentrations of selected elements in the fauna of Roosevelt Hot Springs as well as to evaluate the feasibility of using animals as biological monitors for potential pollutants associated with geothermal energy. However, as part of this program we plan to identify the small mammal species, establish their relative abundance and provide some description of local ecological characteristics.

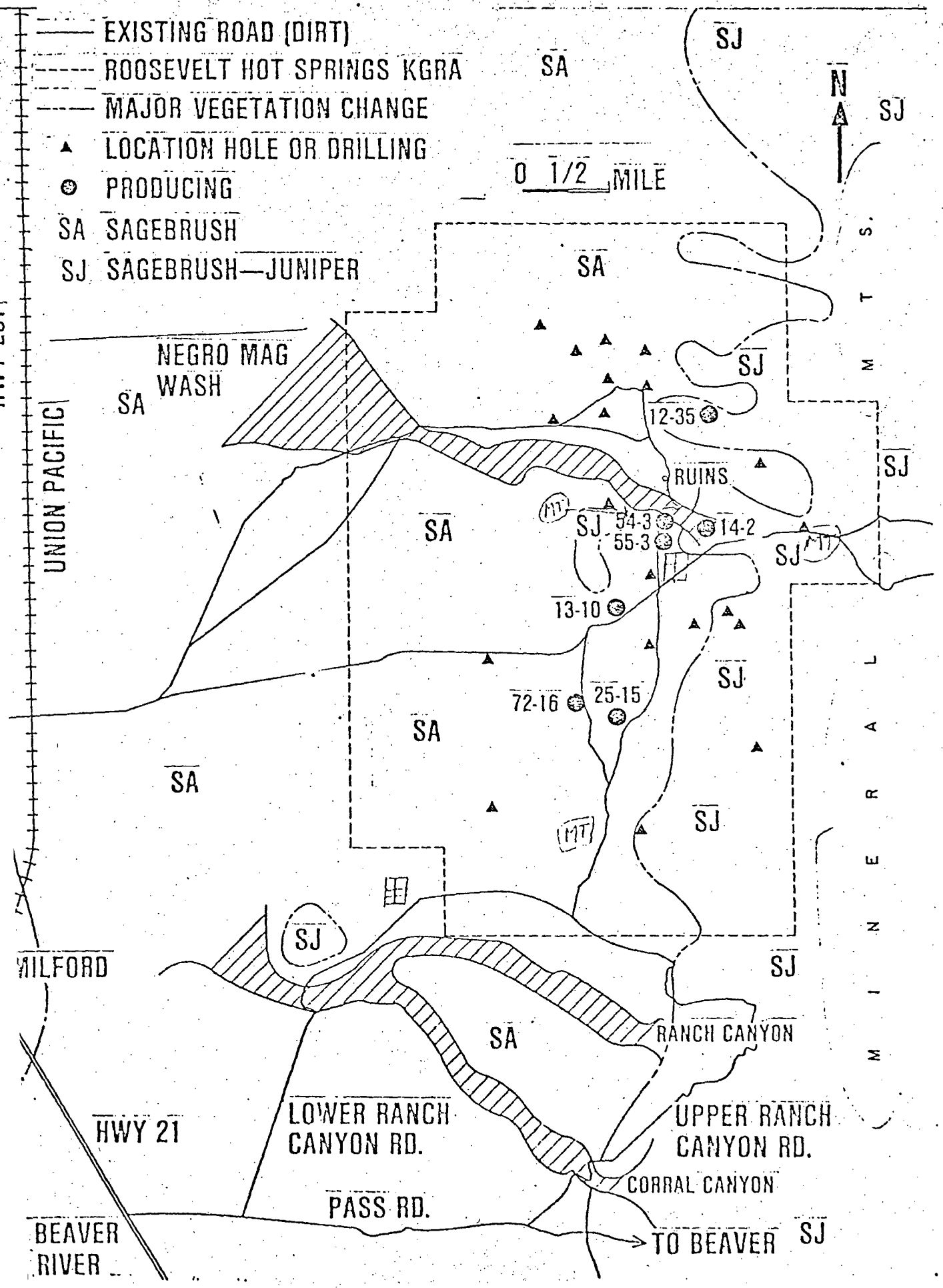
We have conducted two trapping trips to Roosevelt Hot Springs and have collected deer mice, canyon mice, Great Basin pocket mice and Ord's kangaroo rats. During these trips, traps were placed in parallel lines extending west and north of two geothermal drilling locations as well as at a control area several miles west of the geothermal operation. Selection of trapping areas was primarily based on the prominent plant communities, prevailing wind direction and local drainage conditions. Jackrabbits were also collected along roadways and the relative sampling effort for this species will probably be expanded on future trips. Our work at Roosevelt Hot Springs is currently scheduled to extend through 1978 with collections being made on a quarterly basis.

We intend to publish our results and will be happy to provide you with copies of all reports, if you so desire.

Sincerely yours,

R. E. Stanley

R. E. Stanley,
Acting Director
Monitoring Systems Research
and Development Division


EXISTING ROAD (DIRT)
ROOSEVELT HOT SPRINGS KGRA
MAJOR VEGETATION CHANGE
LOCATION HOLE OR DRILLING
PRODUCING
SA SAGEBRUSH
SJ SAGEBRUSH—JUNIPER
0 1/2 MILE
N
SA
SJ
NEGRO MAG WASH
UNION PACIFIC
12-35
RUINS
54-3
55-3
14-2
13-10
72-16
25-15
MT
MINERAL MTS.
MILFORD
HWY 21
LOWER RANCH CANYON RD.
UPPER RANCH CANYON RD.
RANCH CANYON
CORRAL CANYON
PASS RD.
BEAVER RIVER
TO BEAVER

U.S. ENVIRONMENTAL PROTECTION AGENCY

ENVIRONMENTAL MONITORING AND
SUPPORT LABORATORY
P.O. BOX 15027
LAS VEGAS, NEVADA 89114
702/736-2969

May 24, 1977

Our Reference: MSP

Mr. Dick Lenzer
Phillips Petroleum Company
P.O. Box 752
Del Mar, CA 92014

Dear Mr. Lenzer:

Please find enclosed a copy of our investigation objectives concerning the plants and soils found in and on the vicinity of the Roosevelt Hot Springs geothermal site. Also, listed are the proposed benchmarks, target dates, and the expected output. If I can be of further assistance, please let me know.

Sincerely,

Kenneth W. Brown

Kenneth W. Brown
Research Botanist
Pollutant Pathways Branch
Monitoring Systems Research
and Development Division

Enclosure

cc:
R. E. Stanley
J. A. Santolucito
E. A. Schuck
G. B. Wiersma
D. B. Gilmore
W. Adams
A. B. Crockett
L. M. Dunn
P. N. Lem
Z. E. Nelson
W. W. Sutton

ROOSEVELT HOT SPRINGS GEOTHERMAL SITE
(PLANT AND SOIL BASE LINE INVESTIGATION)

The U.S. Environmental Protection Agency's (EPA) Region VIII office in Denver and other interested groups, such as State conservation and water quality agencies have expressed concern over the possible environmental impact caused by the development of geothermal areas. In addition, the EPA's Environmental Monitoring and Support Laboratory located in Las Vegas (EMSL-LV) is interested and concerned with the need and the development of adequate environmental monitoring programs for geothermal energy production activities. Therefore, as part of an overall integrated monitoring/environmental assessment effort in the Roosevelt Hot Springs area, the following investigation is being conducted.

The initial phase will be the collection of base line and descriptive habitat data necessary to identify the impact of the geothermal development on the local biota. This fact-finding phase will include species identification, distribution, and plant community mapping. Aerial photographs will be used for delineating plant community boundaries, in addition to illustrating information concerning soil type and series.

The second phase will involve the collection of plant and soil samples from predetermined sampling sites. These sites will be selected and located in part by the following parameters: vegetative type; windrose data; terrain features; and the present and proposed drilling site locations. Samples will be properly preserved, transported to EMSL-LV, and prepared for analysis. Contaminant analysis will be contingent on the chemical composition of the brines found in the Hot Springs area.

Obtaining background data in the areas of geology, hydrology, and climatology for the Roosevelt Hot Springs geothermal site are essential for predicting, measuring, and/or identifying the impact and kinetics of any brine contaminants which may be deposited on the local biota. As such, this information will be

collected and obtained from the EPA Geothermal Contractor (Geonomics, Inc.) as well as from the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, Phillips Petroleum Company, and from local universities and libraries.

The benchmarks and target dates for portions of this investigation are as follows:

BENCHMARKS

1.	Field and background literature surveys	3rd Quarter, CY76 & 2nd Quarter, CY77
2.	Initial sampling (plants & soil)	1st & 2nd Quarter, CY78
3.	Sample preparation and analysis	3rd & 4th Quarter, CY78
4.	Annual progress report	September 1978
5.	Additional plant and soil sampling	3rd & 4th Quarter, CY78

The expected outputs include:

1. Summarization of the potential impact of geothermal extraction activities on the local flora and fauna.

2. Identify and define the kinetics of geothermal contaminants that may be deposited on the soils and local biota.

3. Make recommendations as to the need and most effective biological monitoring systems in areas of geothermal extraction activities.

SEISMICITY AND SUBSIDENCE

Contents

SUMMARY

ROOSEVELT HOT SPRINGS GEOTHERMAL

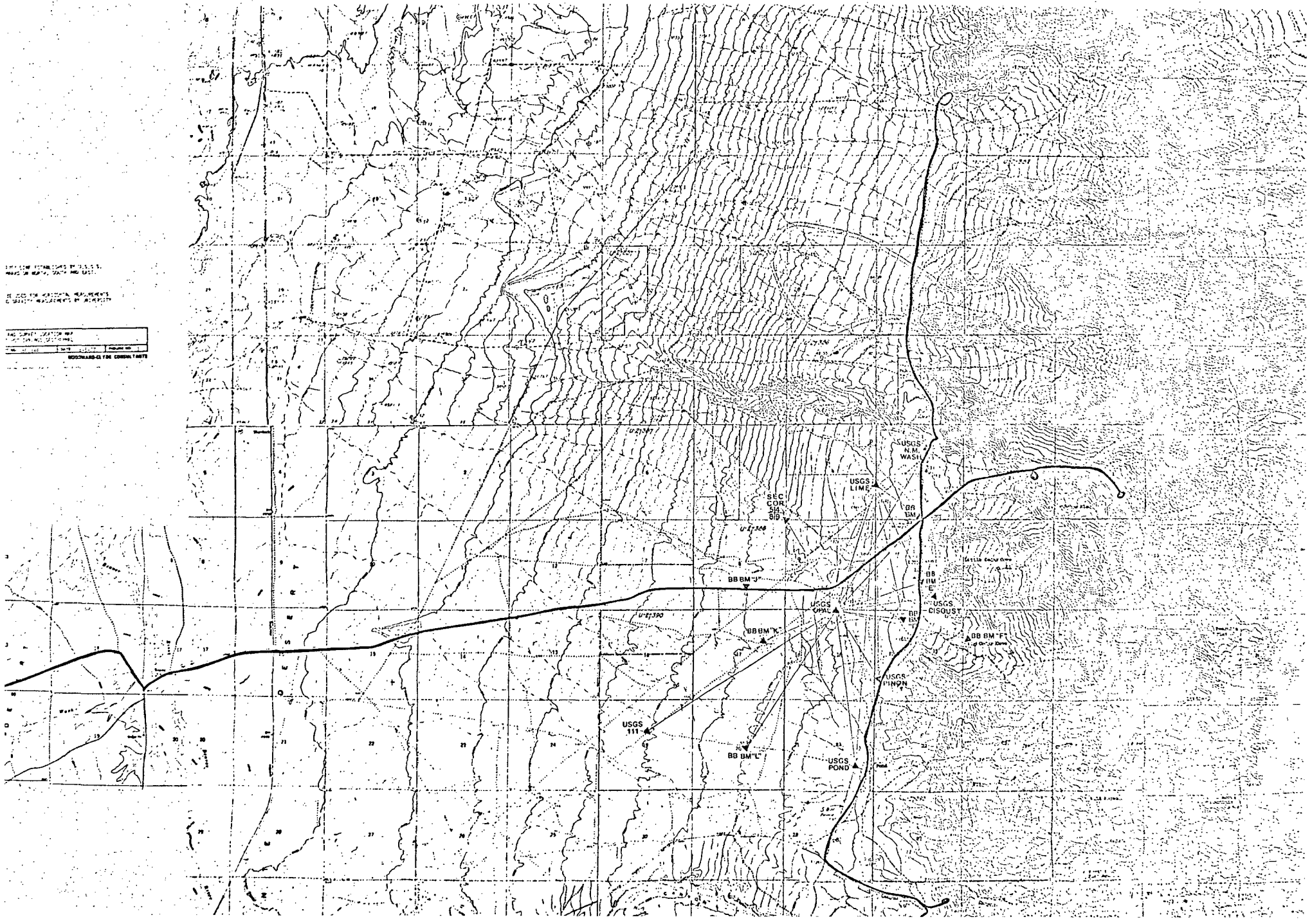
SEISMICITY AND SUBSIDENCE

Operational procedures to determine rate of subsidence (change in elevation) and the level of seismicity of the KGRA will be provided by the University of Utah. In addition, any subsidence in the horizontal mode will be monitored by surveys provided by the USGS as indicated in Attachment A and at the locations shown on Fig. 1.

The rate of subsidence in a vertical sense will be determined by occupying the benchmarks shown on Fig. 1 and as indicated in Attachment B.

Seismicity of the KGRA is currently being monitored by the University of Utah at the stations indicated in Attachment C and will continue to be monitored as described in Attachment B.

Scheduling of these procedures requires constant monitoring of the seismicity and arrangements for measurement of benchmarks in a three part program. Measurements are to be taken prior to, during and subsequent to pumping operations in the KGRA.


USGS N.M. WASH
USGS LIME
SEC COR SEC 9
BB BM
BB BM "J"
BB BM "E"
USGS CISQUST
USGS OPAL
BB BM "K"
BB BM "F"
USGS PINON
USGS 111
BB BM "L"
USGS POND

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room W-2528, Federal Building
2800 Cottage Way
Sacramento, Calif. 95825

July 18, 1977

Gary Crosby
Phillips Petroleum Co.
Box 752
Del Mar, CA 92014

Dear Gary:

As you know, we are involved in baseline monitoring surveys to detect possible ground movement in Roosevelt Hot Springs geothermal area, Utah. The network of first-order leveling control was completed in May. Elevations and bench-mark descriptions are not yet available but should be finalized in a week or so. Please advise if any of this information is of interest to you.

We are advised that during an environmental hearing, held in Beaver City, Utah, last year, you reported on subsidence occurrences in the Milford farming area. We are very much interested in any information available on possible subsidence. Are copies of your statement available? Any information that you might have on water-level changes, subsidence, and regional trends would be appreciated.

Next week our crews will be in the Roosevelt area expanding the network of horizontal control throughout the area of geothermal interest. Any of the data from these surveys are public information and available if needed.

Sincerely,

Ben E. Lofgren

Ben E. Lofgren

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room W-2528, Federal Building
2800 Cottage Way
Sacramento, Calif. 95825

May19, 1977

R. C. Lenzer, Geologist
Phillips Petroleum Co.
Box 752
Del Mar, CA 92014

Dear Dick:

As requested last Monday I am sending herewith a rough map of the Roosevelt Hot Springs area showing:

(1) in yellow and blue the 40°C/100 m and 10°C/100m geothermal contours, based on figure 5 of your Lenzer-Crosby-Berge report,

(2) in red pencil the route of the first-order leveling East-West and North-South across the hot area. Granite bench marks are set on the North, East, and South outside the 10°C/100m contour, and

(3) in light red and green a preliminary network of precise horizontal measurements by this office. This net will be greatly expanded in August.

As I mentioned, the first-order leveling is being completed this month by the Topographic Division, USGS. Many ties are being made to the Bullock network throughout your production area. However, we have not attempted to relevel all of the Bullock points. Any of the leveling data are available if you desire.

These precise horizontal and vertical control networks are designed for base-line monitoring, and will be resurveyed periodically to detect possible ground movement. To the extent that these surveys meet the requirements of the Conservation Division in providing base-line controls, you are free to report these data in the statement you are preparing. This is public information. It probably will be several years before we see measured changes of significance. We would appreciate the Survey being credited if you present these nets in your report.

We appreciate the ozalid prints you supplied of the Roosevelt area. We could use to good advantage either six additional ozalid prints of this map or a transparency so we can make our own copies.

We are especially appreciative of the Lenzer-Crosby-Berge report you supplied of the Roosevelt Hot Springs KGRA. This is a very good report and supplies the background information we needed.

Thank you for your continued assistance and cooperation.

Sincerely,

Ben E. Lofgren

Ben E. Lofgren

cc, letter only:
Frank Olmsted
Robert Christiansen

THE UNIVERSITY OF UTAH

COLLEGE OF MINES
AND MINERAL INDUSTRIES

DEPARTMENT OF GEOLOGY
AND GEOPHYSICS
717 MINERAL SCIENCE BUILDING

July 22, 1976

Dr. Gary W. Crosby
Exploration Director
Geothermal Operations
Phillips Petroleum Company
11526 Sorrento Valley Road
San Diego, California 92121

Reference: Cr-103-76 GO

Dear Dr. Crosby:

In checking over my past correspondence, I note that I failed to acknowledge receipt of your letter to me dated April 22, 1976 and the material (tabulation of elevations and map showing locations of the concrete pads) enclosed with the letter. I thank you for this material and apologize for delaying my acknowledgement of receipt of it.

As we discussed on the phone today, I plan to have two graduate students, Robert F. Sawyer and James Carter (who are doing gravity surveys in the Mineral Range area this summer, incident to our ERDA Geothermal Project) take the precise gravity readings on the Phillips monuments during the middle of August, using simultaneously two LaCoste and Romberg G-type gravity meters: 1) our University of Utah Meter No. 264 and 1) Meter No. 269, which we have on temporary loan from the U. S. Geodetic Survey Squadron at the FEI Warren Air Force Base, Wyoming. As discussed, we will provide you with a copy of the raw gravity data.

As we also discussed on the phone today, Mr. Ben Lofgren of the Ground Water Division of the USGS plans to be in Milford during the week of August 22 to arrange for the eventual setting-out of new monuments on the bedrock areas on both sides of Milford Valley, for the purpose of USGS precise surveys of vertical and horizontal control, to detect ground movements. I have advised him that I would like to extend precise gravity measurements to cover these new monuments, as part of ~~one~~ our ERDA Geothermal Project; and I hope to be in Milford at that time to discuss this matter further with him.

As you know, it is our intention to take continuous hourly gravity readings on the monument nearest to any well at which the Phillips Company makes withdrawal tests, as we did in February 1976. Therefore, I herewith respectfully request that you advise me in advance of any such tests (say, for example, two weeks if possible), so that we can make the necessary advanced preparations for these gravity readings.

I wish to take this opportunity to thank you for your continued cooperation in the matter of these gravity measurements on the Phillips monuments.

Sincerely yours,

/Kenneth L. Cook

Kenneth L. Cook
Professor of Geophysics

KLC:ncs

cc: S. H. Ward

JUL 21 1977

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room W-2528, Federal Building
2800 Cottage Way
Sacramento, Calif. 95825

July 18, 1977

Gary Crosby
Phillips Petroleum Co.
Box 752
Del Mar, CA 92014

Dear Gary:

As you know, we are involved in baseline monitoring surveys to detect possible ground movement in Roosevelt Hot Springs geothermal area, Utah. The network of first-order leveling control was completed in May. Elevations and bench-mark descriptions are not yet available but should be finalized in a week or so. Please advise if any of this information is of interest to you.

We are advised that during an environmental hearing, held in Beaver City, Utah, last year, you reported on subsidence occurrences in the Milford farming area. We are very much interested in any information available on possible subsidence. Are copies of your statement available? Any information that you might have on water-level changes, subsidence, and regional trends would be appreciated.

Next week our crews will be in the Roosevelt area expanding the network of horizontal control throughout the area of geothermal interest. Any of the data from these surveys are public information and available if needed.

Sincerely,

Ben E. Lofgren

Answered
8/10/77

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
Room W-2528, Federal Building
2800 Cottage Way
Sacramento, Calif. 95825

JUL 21 1977

July 19, 1977

Gary Crosby
Phillips Petroleum Co.
Box 752
Del Mar, CA 92014

Subject: Bench-mark descriptions--Roosevelt Hot Springs, Utah

Dear Gary:

Attached for your information and file is a list of bench-mark descriptions and elevations for the recently completed leveling control at Roosevelt Hot Springs.

I am sending additional copies to Ken Bull, Conservation Division, USGS, and Kenneth Cook, University of Utah.

Sincerely,

Ben E. Lofgren

BENCH MARK DESCRIPTIONS, FIELD SUMMARY

State

Adj.

By

Date

Altitude by Field Book

INDEX

ROOSEVELT HOT SPRINGS REPAY

UTAH

By: W.B. Cook, 1977

Books: PV 1007 (a-i)

Bench Mark		Page	Quadrangle
1 WBC	1977 4976	1,4	Adamsville (121)
2 WBC	1977 4967	2	Milford (122)
3 WBC	1977 4942	2	" "
4 WBC	1977 5027	2	" "
5 WBC	1977 5092	2	" "
6 WBC	1977 5162	2	" "
7 WBC	1977 5215	3	Adamsville (121)
8 WBC	1977 5070	4	" "
9 WBC	1977 5130	4	" "
10 WBC	1977 5249	4	" "
11 WBC	1977 5377	4	" "
12 WBC	1977 5531	4	" "
13 WBC	1977 5765	5	" "
14 WBC	1977 5870	5	" "
15 WBC	1977 6141	5	" "
16A WBC	1977 6441	6	" "
16B WBC	1977 6386	6	" "
16C WBC	1977 6518	6	" "
17A WBC	1977 6116	7	" "
17B WBC	1977 5986	8	" "
18 WBC	1977 5958	8	" "
19 WBC	1977 5941	9	" "
20 WBC	1977 6095	9	" "
21 WBC	1977 6274	9	" "
22 WBC	1977 6288	10	Black Rock No. 3 (142)
23 WBC	1977 6078	12	" "
24 WBC	1977 5953	12	" "
25 WBC	1977 5925	13	" "
26 WBC	1977 5931	13	" "
27 WBC	1977 5850	13	" "
28 WBC	1977 5830	13	" "
29 WBC	1977 5773	14	" "
30 WBC	1977 5799	14	" "
31 WBC	1977 6435	9	Adamsville (121)
E		7	" "
G		5,7,11	" "
I		7	" "
USGS Disgust		7	" "
USGS Line		11	" "
USGS N M Wash		11	" "
USGS Opal		5	Adamsville (121)
USGS Pinon		8	" "
USGS Pond		8	" "
5258 FRR		3	Milford (122)
			Adamsville (121)
NGS		1	" "
	1970	1	

dlh

BENCH MARK DESCRIPTIONS, FIELD SUMMARY

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
9-1128

...woods. ...pe	Miles	State Adj.	By Date	Altitude by Field Book
ADAMSVILLE (121)		Utah	W.B. Cook, 1977	
First Order Spur Line		Mean Field Elevations		
Book:		PV 1008 Latitude 38°15' Longitude 112°45'		
(4)		FROM A POINT ABOUT 6.5 MILES NORTHEAST OF MILFORD SOUTH 0.5 MILE ALONG UNION PACIFIC RAILROAD THENCE WEST TO THE EAST EDGE OF MILFORD QUADRANGLE (122)		
	0.00	BM "Q 182 1970" (NGS Quad 38 112 3; L-22149)		4968.664
	0.62	Milford, 4.4 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 1.3 mi E. along graded rd. to Union Pacific RR. grade X-ing.; near center of section 16, T27S, R10W, 96 ft E. of east rail, 34 ft NW. of centerline of cattleguard, 32 ft N. of centerline of rd.; 2.2 ft NW. of 2-inch angle iron gatepost with angle iron braces and witness sign, 1.7 ft W. of east RR. right-of-way fence; set on copper-coated rod driven to depth of 22.5 ft, encased in green plastic pipe; standard tablet stamped "1 WBC 1977 4976"		4975.756
		CHECK LINE TO NGS BM "R 182 1970"		
	0.73	BM "R 182 1970" (NGS Quad 38 112 3; L-22149)		4970.998
		R 182 by NGS 4970.974 R 182 this run 4970.998 Closure = -0.024		
		RETURN TO MAIN LINE		
	0.62	BM "1 WBC 1977 4976" (as described above)		4975.756

7/7/77 dlh

BENCH MARK DESCRIPTIONS, FIELD SUMMARY

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY P-1136

Page Bk.—Page	Quads. Miles	State Adj.	By Date	Altitude by Field Book
	KILFORD (122)	Utah	W.B. Cook, 1977	
	First Order Spur Line	Mean Field Elevations		
	Book: TV 1008	Latitude 38°15' Longitude 113°00'		
	(7)	FROM THE WEST EDGE OF ADAMSVILLE QUADRANGLE (121) WEST ALONG ROADS TO A POINT ABOUT 8.6 MILES NORTHWEST OF KILFORD		
a/9	1.58	Kilford, 4.4 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.3 mi E. along graded rd. to Y-rd. NW.; in section 17, T27S, R10W; about 450 ft NE. of intersection, 107 ft N. of centerline of rd., 106 ft NE. of "CURVE" warning sign, 1.4 ft S. of 4 x 4 witness post and cairn; set on copper-coated rod driven to depth of 25 ft, encased in green plastic pipe; standard tablet stamped "2 WBC 1977 4967"	4967.139
	2.30	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd.; in section 18, T27S, R10W; 95 ft E. of Y-rd. fork, 72 ft NE. of centerline of rd., 1.5 ft SW. of cairn; set on copper-coated rod driven to depth of 12.5 ft, encased in green plastic pipe; standard tablet stamped "3 WBC 1977 4942"	4942.362
	3.35	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd. to fork, thence left 1.0 mi SW.; in southeast 1/4 section 13, T27S, R11W; 54 ft NW. of centerline of rd., 3 ft SE. of cairn; set on copper-coated rod driven to gradual refusal at 10 ft, encased in green plastic pipe; standard tablet stamped "4 WBC 1977 5027"	5026.731
	4.61	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd. to fork, thence left 2.1 mi SW. to X-rd.; in northeast corner section 23, T27S, R11W; 72 ft NE. of centerline of X-rd., 37 ft NW. of centerline of rd., 1 ft SW. of cairn; set on copper-coated rod driven to gradual refusal at 12.5 ft, encased in green plastic pipe; standard tablet stamped "5 WBC 1977 5092"	5091.543
	5.23	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd. to fork, thence left 2.1 mi SW. to X-rd., thence right 0.55 mi NW.; in southeast 1/4 section 14, T27S, R11W; 170 ft up the slope (SW.) from centerline of rd., 70 ft NE. of base of prominent granite outcrop, 1 ft NE. of cairn, 1 ft above orange fluorescent letters "BM" painted on northeast side of exposure; in top of 3-ft high granite bedrock exposure; standard aluminum tablet stamped "6 WBC 1977 5162"	5162.502

38 113 21

BENCH MARK DESCRIPTIONS, FIELD SUMMARY

UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY P-1136

Page Bk.—Page	Quads. Miles	State Adj.	By Date	Altitude by Field Book
	KILFORD (122)	Utah	W.B. Cook, 1977	
	First Order Spur Line	Mean Field Elevations		
	Book: TV 1008			
a/21	6.02	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd. to fork, thence left 2.1 mi SW. to X-rd., thence right 1.25 mi NW. to low saddle; in northwest 1/4 section 14, T27S, R11W; 500 ft SW. of base of prominent butte, 265 ft SW. of centerline of rd., on northeast point of stony ridge; in top of 3-ft high granite outcrop with letters "BM" painted in orange fluorescent paint on north and east sides; old aluminum tablet with portion of west edge missing stamped "5258 FRR" (Also in line 3)	5179.439
		5258 FRR USGS 1905 5180.120 5258 FRR this run 5179.459 Difference = -0.661		
	6.21	Kilford, 4.1 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 0.5 mi NW. along graded rd. to fork, thence left 2.1 mi SW. to X-rd.; thence right 1.45 mi NW.; 500 ft SW. of centerline of rd., about 500 ft E. of southwest corner section 11, T27S, R11W; 1 ft E. of small cairn, 18 inches below orange fluorescent painted letters "BM"; in ledge 4 ft higher than ground level on north side of prominent granite outcrop; aluminum tablet stamped "7 WBC 1977 5215"	5215.428

ADAMSVILLE (121) Utah W.B. Cook 1977

First Order Spur Line -- Beam Field Elevations

Books: TV 1008 Latitude 38°15' Longitude 112°45'

(1) FROM A POINT ABOUT 6.3 MILES SOUTHEAST OF MILFORD EAST JCT. ABOUT 11 MILES TO A POINT ABOUT 2 MILES NORTH OF BAILEY SPR.

6.00 BM "1 WRC 1977 4976" (Described in Line 24) 4975.256

1.04 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 2.3 mi E. along graded rd.; near center of section 13, T27S, R10W; on inside of curve, 200 ft NW. of intersection of track rd. NE., 110 ft E. of centerline of main rd., 2 ft W. of cairn; set on copper-coated rod driven to depth of 23 ft, encased in green plastic pipe; standard tablet stamped "8 WRC 1977 5070" 5069.651

2.01 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 3.3 mi E. along graded rd.; in southeast 1/4 section 14, T27S, R10W; 75 ft E. of centerline of rd., 1 ft S. of cairn; set on copper-coated rod driven to depth of 17.5 ft, encased in green plastic pipe; standard tablet stamped "9 WRC 1977 5130" 5129.762

3.04 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 4.3 mi E. along graded rd.; about 730 ft SE. of north 1/4 corner section 13, T27S, R10W, 150 ft E. of centerline of rd., 1 ft E. of cairn; set on copper-coated rod driven to depth of 17.5 ft, encased in green plastic pipe; standard tablet stamped "10 WRC 1977 5245" 5240.108

4.03 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 5.3 mi E. along graded rd.; in southeast 1/4 section 7, T27S, R9W; on outside of curve, 60 ft E. of centerline of rd., 1 ft E. of cairn; set on copper-coated rod driven to absolute refusal at 3 ft, encased in green plastic pipe; standard tablet stamped "11 WRC 1977 5377" 5376.925

5.05 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 6.3 mi E. along graded rd.; in southeast 1/4 section 8, T27S, R9W; opposite track rd. E., 72 ft E. of intersection, 1 ft E. of cairn; set on copper-coated rod driven to refusal at 4 ft, encased in green plastic pipe; standard tablet stamped "12 WRC 1977 5531" 5530.960

ADAMSVILLE (121) Utah W.B. Cook 1977

First Order Spur Line -- Beam Field Elevations --

Books: TV 1008

6.02 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 7.3 mi E. along graded rd.; in southeast 1/4 section 9, T27S, R9W; 48 ft E. of centerline of rd., 1 ft E. of cairn; set on copper-coated rod driven to refusal at 6 ft, encased in green plastic pipe; standard tablet stamped "13 WRC 1977 5743" 5744.346

6.56 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 7.5 mi E. along graded rd., thence 0.3 mi SE. to highest point on E.-W. oval ridge; about 450 ft E. of south 1/4 corner section 9, T27S, R9W; 30 ft E. of large juniper tree, 24 ft E. of highest point; in quartzite outcrop; 2 1/2-inch brass disk stamped "USCS 1977" 5801.757

7.41 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.2 mi E. along graded rd.; about 1400 ft NW. of east 1/4 corner section 9, T27S, R9W; about 0.1 mi NW. of stone wall No. 13-10; 67 ft NW. of wood transmission line pole, 65 ft E. of centerline of rd., 1 ft NW. of cairn; set on copper-coated rod driven to refusal at 27 ft, encased in green plastic pipe; standard tablet stamped "14 WRC 1977 5870" 5869.782

8.12 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd.; about 200 ft NE. of north 1/4 corner section 18, T27S, R9W; 27 ft E. of centerline of X-rd., 25 ft NE. of centerline of main rd., 4 ft NW. of centerline of wood pole transmission line, 1 ft NE. of red steel fencepost; set in concrete post; 2-inch brass disk stamped "C" 6047.648

8.86 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 9.4 mi E. along graded rd.; about 600 ft NE. of west 1/4 corner section 2, T27S, R9W; at road in rd. and transmission line angle point, 40 ft NW. of centerline of rd., 25 ft NE. of transmission pole guy line anchor, 19 ft NW. of wood pole at transmission line angle point, 8 ft NW. of small juniper tree, 1 ft NE. of cairn; set on copper-coated rod driven to refusal at 32 ft, encased in green plastic pipe; standard tablet stamped "15 WRC 1977 6141" 6134.257

ADAMSVILLE (121) Utah W.B. Cook 1977

First Order Spur Line -- Beam Field Elevations --

Books: TV 1008

9.51 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 10.1 mi E. along graded rd. to top of ridge, thence right 0.1 mi NE. along dirt rd.; in southeast 1/4 section 2, T27S, R9W; 180 ft E. along dirt rd. from wire gate in fence line crossing ridge, 60 ft slope distance E. of centerline of rd.; in ledge on northwest side of 5-ft high granite bedrock exposure with 16-inch high red painted letters "BM"; standard aluminum tablet stamped "16A WRC 1977 6441" 6441.174

10.11 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 10.7 mi E. along graded rd.; about 1000 ft NE. of west 1/4 corner section 1, T27S, R9W; 35 ft E. of centerline of rd., 2 ft S. of cairn; set on copper-coated rod driven to refusal at 35 ft, encased in green plastic pipe; standard tablet stamped "16B WRC 1977 6385" 6385.872

10.76 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 11.0 mi E. along graded rd. to T-rd. fork, thence right 0.3 mi SE., about 0.5 mi NW. of southeast corner section 1, T27S, R9W; about 0.1 mi NE. of Negro Hag Enclosure; 130 ft NE. of centerline of rd., 75 ft NE. of southeast fork Negro Hag Wash; set in recess in sloping toe of granite bedrock exposure about 4 ft higher than ground level with 1-ft high red letters "BM" painted on each side; aluminum tablet stamped "16C WRC 1977 6518" 6518.333

DANSVILLE (121) Made W.B. Cook, 1977

First Order Spur Line Mean Field Elevations

Book: FV 1008 Latitude 38°25' Longitude 117°45'

(2) FROM A POINT ABOUT 24 MILES NORTHEAST OF MILFORD SOUTH TO A POINT ABOUT 2 MILES SOUTHWEST OF SOUTH TYZE FLAT MOUNTAIN

0.00 BM "C" Described in line 17 6047.446

0.69 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd, thence 0.7 mi E. to T-rd. E.; about 0.3 mi N. of south 1/4 corner section 18, T27S, R39; on low crest, 34 ft E. of centerline of main rd., 33 ft N. of centerline of T-rd. 1 ft E. of rod steel fencepost; set in 6-inch concrete post; 2-inch brass disk stamped "C" 6093.185

0.84 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd, thence 0.9 mi S. to base of rocky ridge about 500 ft E. of rd.; about 1200 ft NE. of south 1/4 corner section 18, T27S, R39; about 0.1 mi E. of water trough and pond; 22 ft S. of standard aluminum tablet stamped "17A NGC 1977" set in granite bedrock at toe of ridge; 2 1/2-inch brass disk stamped "USGS DISCENT" 6116.233

0.89 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd, thence 0.9 mi S. to base of rocky ridge about 500 ft E. of rd.; about 1200 ft NE. of south 1/4 corner section 18, T27S, R39; about 0.1 mi E. of water trough and pond; 22 ft S. of "USGS DISCENT"; set in top of granite bedrock exposure shown a 3-ft ledge painted with red letters "BM"; standard aluminum tablet stamped "17A NGC 1977 6116". 6116.036

1.30 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd, thence 1.3 mi S., thence 0.2 mi NE. to pad for well No. 21-25; about 1200 ft NE. of south 1/4 corner section 18, T27S, R39; 270 ft NE. of service rd., 36 ft E. of southeast corner of excavation for pad, 2 ft NE. of rod steel fencepost; set in concrete post; 2-inch brass disk stamped "T" 6041.065

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7/7/77 dlh

DANSVILLE (121) Made W.B. Cook, 1977

First Order Spur Line Mean Field Elevations

Book: FV 1008

2/18

2.11 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd, thence 2.9 mi S. to saddle; Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 6.7 mi NE. along Lower Ranch Canyon Rd. past fence line X-ing and steel cattleguard, thence 2.2 mi E. along dirt rd. to saddle; about 1200 ft E. and 250 ft N. of southeast corner section 33, T27S, R39; on highest portion of prominent hill, about 250 ft N. of centerline of rd., 20 ft N. of 5-ft pinion tree; in granite bedrock projecting 3 inches; bronze disk stamped "USGS FIRST" 6074.636

2.73 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 6.7 mi NE. along Lower Ranch Canyon Rd. past fence line X-ing and steel cattleguard, thence 1.6 mi E. along dirt rd. to T-rd. fork; about 1300 ft E. of northeast corner section 21, T27S, R39; 170 ft along distance E. from intersection; in top of granite bedrock outcrop about 3 ft high with letters "BM" in red paint on west side; bronze tablet stamped "17A NGC 1977 5956" 5956.168

3.28 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 6.7 mi NE. along Lower Ranch Canyon Rd. past fence line X-ing and steel cattleguard, thence 1.3 mi E. along dirt rd., thence 0.2 mi W. along dirt rd. to fence and gate; about 1800 ft NW. of southeast corner section 21, T27S, R39; 19 ft NE. of northeast gatepost, 0.5 ft NE. of fence; set in concrete post; 2 1/2-inch brass disk stamped "USGS POST" 5976.361

3.95 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 6.7 mi NE. along Lower Ranch Canyon Rd. past fence line X-ing and steel cattleguard, thence 0.5 mi E. along dirt rd.; about 2300 ft NE. of northeast corner section 28, T27S, R39; on low rise, 40 ft NE. of intersection of T-rd. fork, 1 ft NE. of cairn; set on copper-coated rod driven to refusal, encased in green plastic pipe; standard tablet stamped "18 NGC 1977 5958" 5957.905

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DANSVILLE (121) Made W.B. Cook, 1977

First Order Spur Line Mean Field Elevations

Book: FV 1008

4.45 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 6.7 mi NE. along Lower Ranch Canyon Rd.; about 1300 ft E. and south 1/4 corner section 28, T27S, R39; 435 ft NE. of steel cattleguard, 64 ft NE. of centerline of main rd., 35 ft NE. of centerline of T-rd. NE., 13 ft E. of large juniper tree, 1 ft SW. of cairn; set on copper-coated rod driven to refusal at 20 ft, encased in green plastic pipe; standard tablet stamped "19 NGC 1977 5941" 5941.130

5.11 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 7.6 mi NE. along Lower Ranch Canyon Rd.; inside left curve; about 500 ft NE. of northeast corner section 34, T27S, R39; on low rise; 33 ft NE. of centerline of rd., 1 ft SE. of cairn; set on copper-coated rod driven to refusal at 20 ft, encased in green plastic pipe; standard tablet stamped "20 NGC 1977 6093" 6093.484

5.78 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 8.1 mi NE. along Lower Ranch Canyon Rd.; about 0.5 mi SW. of northeast corner section 34, T27S, R39; inside extended right curve, 125 ft E. of intersection of side rd. NW., 100 ft E. of old mine shaft, 67 ft NE. of centerline of main rd., at granite bedrock exposure; in ledge 4 ft higher than ground with red letters "BM" painted on northeast side; standard aluminum tablet stamped "21 NGC 1977 6274" 6273.618

RETURN LINE TO "21 NGC 1977"

0.60 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 8.6 mi NE. along Lower Ranch Canyon Rd. to saddle; about 2000 ft E. of south 1/4 corner section 34, T27S, R39; 300 ft SW. of centerline of rd. from saddle, on rocky top, 4 ft lower than highest rocks, with letters "BM" in yellow paint on northeast side lower rocks; set in granite bedrock 6 inches higher than ground level; aluminum tablet stamped "21 NGC 1977 6435" 6435.299

RETURN TO MAIN LINE

5.78 BM "21 NGC 1977 6274" (As described above) 6273.618

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DANSVILLE (121) Made W.B. Cook, 1977

First Order Spur Line Mean Field Elevations

Book: FV 1008

2/24

6.30 Milford Post Office, 8.9 mi NE. of along State Hwy. 21, thence left 3.3 mi E. along graded rd., thence left 0.1 mi NE. along Lower Ranch Canyon Rd., thence left 0.3 mi NW. along dirt rd., thence right 0.1 mi E. along Kirk Canyon; about 1800 ft E. of northeast corner section 34, T27S, R39; 150 ft E. of centerline of dirt rd. on south side of drain, 85 ft E. of bottom drain, 60 ft NE. of southwest end of granite bedrock outcrop, 35 ft E. of centerline of dirt rd. on south side of drain; in ledge 1 ft higher than ground with letters "BM" painted in red on southeast side; standard aluminum tablet stamped "22 NGC 1977 6287" 6287.021

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7/7/77 dlh

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BENCH MARK DESCRIPTIONS, FIELD SUMMARY

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
9-1128

Page	Quads.	Miles	State	Adj.	By	Date	Altitude by Field Book

ADAMSVILLE (121) Utah W.B. Cook, 1977

First Order Spur Line Mean Field Elevations

Book: PV 1008 Latitude 38°15' Longitude 112°45'

(3) FROM A POINT ABOUT 14 MILES NORTHEAST OF MILFORD NORTHWEST 0.6 MILE THENCE NORTH TO SOUTH EDGE OF BLACK ROCK NO. 3 QUADRANGLE (142)

0.00	BM "G" (Described in line 1)	6047.468
0.68	Milford, 4.4 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 6.8 mi E. along graded rd., thence 1.7 mi NE. along dirt rd.; about 800 ft S. of east 1/4 corner section 4, T27S, R9W; on juniper-covered knob, about 0.1 mi NW. of centerline of dirt rd.; set in granite bedrock level with ground between higher tocks; 2 1/2-inch brass disk stamped "USGS LINE"	5999.403
1.54	Milford, 4.4 mi N. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 0.8 mi N. to saddle; about 2600 ft SW. of northeast corner section 3, T27N, R9W; on rocky top about 300 ft NW. of centerline of rd.; set in concrete post at north end of granite bedrock outcrop; 2 1/2-inch brass disk stamped "USGS N M WASH"	6168.538

7/7/77 dlh

BLACK ROCK NO. 3 (1A2) Utah U.S. Cook, 1977
First Order Spur Line Mean Field Elevations
Quad: MT 1008 Latitude 38°30' Longitude 113°43'

(3) FROM THE NORTH EDGE OF ADAMSVILLE QUADRANGLE (121) NORTH TO A POINT ABOUT 4 MILES SOUTHWEST OF ANTELOPE MOUNTAIN

2.14 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 1.4 mi N. to saddle; about 1200 ft NW. of south 1/4 corner section 34, T26S, R9W; 0.3 mi E. of old hot springs resort, 10 ft W. of centerline of rd.; in granite bedrock, 1 ft higher than ground level; aluminum tablet stamped "23 NGC 1977 6077" 6077.776

2.70 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 1.9 mi N. to X-rd.; near center of section 34, T26S, R9W; about 300 ft NW. of pond below Salt Spring, 75 ft E of small drain, 40 ft E. of centerline of X-rd., 40 ft E of rd. on low ridge, 1 ft NW. of cairn; set on copper-coated rod driven to refusal, encased in green plastic pipe; standard tablet stamped "24 NGC 1977 5932" 5932.908

3.13 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 2.3 mi N.; about 600 ft W. and 200 ft N. of south 1/4 corner section 27, T26S, R9W; 200 ft W. of N-rd. fence, 120 ft E. of NW "25 NGC 1977", on low crest, 34 ft E. of centerline of rd., 1 ft E. of rod steel fencepost and 1ch with letters "NH E"; in concrete post; 2-inch brass disk, unstamped 5929.214

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BLACK ROCK NO. 3 (1A2) Utah U.S. Cook, 1977
First Order Spur Line Mean Field Elevations
Quad: MT 1008

3.18 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 2.4 mi N. to X-rd.; about 400 ft E. and 600 ft N. of south 1/4 corner section 27, T26S, R9W; 220 ft E. of NW "E", on low crest, 33 ft NW. of centerline of X-rd., 20 ft E. of centerline of rd., 8 ft NW. of small juniper tree, 2 ft NW. of galvanized steel reflector post; set on copper-coated rod driven to refusal at 20 ft; encased in green plastic pipe; standard tablet stamped "25 NGC 1977 [illegible]" 5924.832

3.63 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 2.8 mi N. to fence X-ing. and gate; near center of section 27, T26S, R9W; 75 ft E. of south gatepost, 3 ft S. of NW "26 NGC 1977", 1 ft E. of fence, at rod steel fencepost and 1ch with letters "NH E"; 2-inch brass disk, unstamped 5931.342

3.64 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 2.8 mi N. to fence X-ing. and gate; near center of section 27, T26S, R9W; 75 ft E. of south gatepost; 3 ft S. of "NH E" and rod steel fencepost, 1 ft E. of fence; set on copper-coated rod driven to refusal at 15 ft, encased in green plastic pipe; standard tablet stamped "26 NGC 1977 5930" 5931.250

4.14 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 3.3 mi N. to dim X-rd.; about 50 ft NW. of north 1/4 corner section 27, T26S, R9W; 44 ft E. of centerline of main rd., 40 ft E. of centerline of X-rd., 1 ft W. of cairn; set on copper-coated rod driven to refusal at 23 ft, encased in green plastic pipe; standard tablet stamped "27 NGC 1977 5830" 5849.642

4.67 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 3.8 mi N.; near center of section 22, T26S, R9W; on low crest, 44 ft E. of centerline of rd., 1 ft E. of cairn; set on copper-coated rod driven to refusal at 8 ft, encased in green plastic pipe; standard tablet stamped "28 NGC 1977 5830" 5830.239

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BLACK ROCK NO. 3 (1A2) Utah U.S. Cook, 1977
First Order Spur Line Mean Field Elevations
Quad: MT 1008

5.16 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 4.3 mi N.; about 800 ft E. of north 1/4 corner section 22, T26S, R9W; on low crest, 55 ft E. of centerline of rd., 1 ft W. of cairn; set on copper-coated rod driven to refusal at 30 ft, encased in green plastic pipe; standard tablet stamped "29 NGC 1977 5773" 5772.606

5.80 Milford, 4.4 mi E. of along State Hwy. 257 from jct. with State Hwy. 21, thence 8.9 mi E. along graded rd. to X-rd., thence 4.9 mi N. to X-rd., thence E. 350 ft to intersection of rd. NE., thence 240 ft N.; about 1500 ft E. of east 1/4 corner section 15, T26S, R9W; 23 ft NW. of drain, 1 ft NW. of cairn; in white granite bedrock outcrop with painted red letters "NH" on southeast side; aluminum tablet stamped "30 NGC 1977 5799" 5799.343

PHILLIPS PETROLEUM - ROOSEVELT HOT SPRINGS AREA
WELL BENCHMARK TABULATION

ll #	Bearing & Distance From Well to B/C BM	B/C BM Elevation	Bearing & Distance From B/C BM to GLO Corner
RA-25-15	N 80°57'52" E, 411.61	6024.40	to W¼ cor. Sec. 15 N 81°36'40" W, 1,287.96
RA-13-14	N 79°32'56" E, 206.09	6358.99	to W¼ cor. Sec. 14 S 19°35'56" W, 786.99
RA-83-10	S 85°58'17" E, 199.88	6279.10	to E¼ cor. Sec. 10 S 12°19'42" E, 797.33
RA-46-10	N 41°48'07" E, 204.57	6094.03	to W¼ cor. Sec. 10 N 73°50'54" W, 2,801.14
RA-58-3	S 31°35'33" E, 319.70	6048.26	to N¼ cor. Sec. 10 N 67°13'50" W, 192.29
RA-31-15	S 26°52'19" E, 222.33	6041.85	to NW cor. Sec. 15 N 72°23'06" W, 1,808.92
RA-54-28	S 69°13'36" E, 214.89	5645.63	to S¼ cor. Sec. 28 S 10°21'42" W, 3,093.23
RA-84-28	N 89°02'25" E, 215.25	5765.16	to NE cor. Sec. 28 N 1°49'33" W, 2,161.05
RA-48-27	N 82°12'36" W, 206.33	5929.97	to S¼ cor. Sec. 27 S 71°46'13" E, 743.64
RA-87-28	S 86°25'31" E, 205.64	5794.95	to SE cor. Sec. 28 S 2°28'24" W, 1,240.80
RA-44-27	S 70°55'21" E, 169.90	5932.33	to S¼ cor. Sec. 27 S 9°52'07" E, 2,738.65
RA-22-28	S 86°16'09" E, 215.44	5527.02	to NW cor. Sec. 28 N 60°59'26" W, 1,558.43
RA-42-33	S 73°55'00" E, 216.01	5712.65	to N¼ cor. Sec. 33 N 14°19'33" E, 1,412.51

Well #	Bearing & Distance From Well to B/C BM	B/C BM Elevation	Bearing & Distance From B/C BM to GLO Cor.
GRA-55-20	S 81°47'08" E, 207.62	5712.48	to E¼ cor. Sec. 20 N 84°15'13" E, 2,108.47
GRA-82-4	S 88°51'44" E, 202.64	5946.37	to NE cor. Sec. 4 N 13°03'55" E, 1,177.08
GRA-57-8	N 1°09'23" W, 274.30	5597.64	to S¼ cor. Sec. 8 S16°32'58" W, 955.00
GRA-13-10	S 6°13'24" E, 208.40	5890.83	to W¼ cor. Sec. 10 S 22°19'39" W, 635.86
GRA-54-3	S 21°05'53" W, 159.29	6108.44	to E¼ cor. Sec. 3 S 88°43'55" E, 2321.81
.H. #1	N 4°19'11" E, 160.41	5647.81	to NE cor. Sec. 17 N 34°42'35" E, 2,249.27
.H. #2	S 71°19'20" E, 176.76	5890.83	to W¼ cor. Sec. 10 S 22°19'39" W, 635.86
KGRA-12-35	N 18°01'39" E, 154.25	6180.52	to NW cor. Sec. 35 N 19°54'51" W, 783.98
KGRA-42-9	S 67°11'41" E, 152.9°	5842.00	to N¼ cor. Sec. 9 N 7°34'18" W, 1,030.08
KGRA-82-33	S 39°41'59" E, 247.62	5845.44	to E¼ cor. Sec. 33 S 2°56'36" W, 1,179.16
KGRA-53-3	S 7°59'02" W, 725.20	6108.44	to E¼ cor. Sec. 3 S 88°43'55" E, 2,321.81
KGRA-34-1	N 18°38'25" W, 214.53	6441.77	to W¼ cor. Sec. 1 S 66°13'29" W, 2043.55
KGRA-44-11	N 36°10'05" E, 208.87	6572.86	to W¼ cor. Sec. 11 S 78°15'10" W, 2,395.49
KGRA-66-35	S 85°57'28" E, 231.97	6546.16	to N¼ cor. Sec. 35 N 19°02'13" W, 3,947.29

1 #	Bearing & Distance From Well to B/C BM	B/C BM Elevation	Bearing & Distance From B/C BM to GLO Corner
A-46-22	S 56°47'06" E, 229.18	6174.09	to S¼ cor. Sec. 22 S 2°57'21" E, 1,555.46
A-66-14	N 49°39'27" E, 181.22	6696.02	to S¼ cor. Sec. 14 S 32°59'25" W, 1,881.75
A-33-11	S 77°20'43" E, 171.58	6476.06	to W¼ cor. Sec. 11 S 59°31'09" W, 2080.72

:E: Elevations are mean sea level datum and are based on U.S.C. & G.S. BM #R-182, Elevation 4970.978.

Bearing basis for well & BM locations vary and are as shown on individual well location maps.

ATTACHMENT "B"
ROOSEVELT HOT SPRINGS GEOTHERMAL
60284 A

PHILLIPS PETROLEUM COMPANY
DEL MAR, CALIFORNIA 92014
BOX 752 714 755-0131

NATURAL RESOURCES GROUP
Energy Minerals Division
Geothermal Operations

August 26, 1977

Professor Stan Ward
Department of Geology and Geophysics
University of Utah
Salt Lake City, Utah 84112

Dear Stan:

Pursuant to our discussions in Salt Lake City on July 16, I have put in writing the content of these discussions to establish a record for the regulatory agencies with which we are working on Roosevelt development. The willingness of the University of Utah to provide support for Phillips' baseline studies, and other help that has been given, is very much appreciated.

The University of Utah will analyze seismic records produced during a minimum one-year period by the present seismic array on and in the vicinity of the Roosevelt geothermal field, Utah, and records of any additional seismometers that may be installed during the period of our baseline studies, for identification of seismic activity over and in the vicinity of the Roosevelt geothermal field, and will furnish a report of these findings to Phillips Petroleum Company on or about the 30th of September 1978. The report will include information on historical seismicity (summary), current seismicity with locations, magnitudes and spatial distribution by magnitude, mechanisms, recurrence predictions and risks.

Further, on the same date, the University will furnish a report on the findings of repeat gravity observations on the monument network established by Phillips and the U. S. Geological Survey over and in the vicinity of Roosevelt geothermal field including a description of the net and the meaning of measurement variations, or lack thereof, in terms of possible subsidence at the Roosevelt field.

Phillips Petroleum Company and its Environmental Contractor, Woodward and Clyde, will maintain these reports in a confidential status until such time as either the University of Utah or the U. S. Geological Survey places these documents in the public domain. Prior to public release of the above reports by the USGS or University of Utah, Phillips and its consultants will obtain written consent from the University of Utah before discussing the results of these reports publicly.

It is understood that transmittal of these reports to Phillips does not imply any exclusive or restrictive use of the information by Phillips, its contractor, or the Federal Government.

If the above is reconciled with your understanding of our discussions, please sign both copies in the space provided, returning one copy to us and retaining the other for your files.

Sincerely yours,

Gary W. Crosby
Exploration Director

GWC/skb

_____ _____

Dr. Stanley H. Ward — Date
Prof. & Chairman, Dept Geology and Geophysics
University of Utah

ATTACHMENT "C"
ROOSEVELT HOT SPRINGS GEOTHERMAL
60284A

THE UNIVERSITY OF UTAH

May 27, 1977

COLLEGE OF MINES
AND MINERAL INDUSTRIES

DEPARTMENT OF GEOLOGY
AND GEOPHYSICS
717 Mineral Science Building

Dear Mr Lenzer,

I have enclosed a copy of a letter to the NEIS dated March 15, 1977 where I tabulated all data regarding stations operated by the Univ. of Utah. Also included is a map of stations currently operating in southern Utah.

Unpublished data is available on request through our office and a summary of data collected to date should be available by late summer.

William D. Richins

THE UNIVERSITY OF UTAH

COLLEGE OF MINES
AND MINERAL INDUSTRIES

DEPARTMENT OF GEOLOGY
AND GEOPHYSICS
717 Mineral Science Building

March 15, 1977

Barbara B. Poppe
U.S. Geological Survey
Branch of Seismicity & Earth Structure
National Earthquake Information Service
Stop 967 - Box 25046 Denver Federal Center
Denver, CO 80225

Dear Ms. Poppe:

We have recently compiled the enclosed information on all seismograph stations operated by the University of Utah. Table 1 lists telemetered stations with data recorded at our facilities in Salt Lake City. Table 2 lists those stations where data is recorded at the site, usually on photographic paper. Tables 3 and 4 list rock type if known. All stations are currently operating unless a date closed is listed.

Telemetered Stations

Under instrumentation, in Table 1, I have tabulated seismometer type only as all other parts of the telemetry network are essentially identical. Data from the seismometer is amplified and FM modulated at the site using one of the following VCO-preamplifiers:

1) Interproducts J-302
2) Emhiser Rand SVA-2400
3) Develco Model 6202
4) Develco Model 6242

Data is transmitted by radio or telephone to the University of Utah where the amplified seismometer output is recovered using one of the following discriminators:

1) Interproducts J-101
2) Develco Model 6203
3) Develco (Emtel) Model 6243

Recording is presently done on 4 Geotech Develocorders with 14 signals per camera, the top and bottom traces recording WWVB time code reference. Our Mark Products L-4 seismometers lack calibration coils so a complete system response on these stations is not available. I have enclosed a response curve from the USGS NCER network (Figure 1) where instrumentation nearly identical to ours is used. Figure 2 is a response curve typical of our stations where Geotech 18300 (S-13) seismometers are installed. Magnifications range from 2.0 to 8.0 X 10^5.

Non-Telemetered Stations

Table 2 lists stations where data is recorded at the individual site and mailed to the University of Utah by the station attendant. Instrumentation at these stations is as follows:

CCU A 3-component short period system using Benioff portable seismometers recording on photographic paper. Timing from a Geotech Model TG110 crystal clock. Vertical magnification=70k, see response curves Figures 6, 7, 8.

DUG A WWSSN station with a 3-component short period system using large-mass Benioff seismometers. A 3-component long period system using Sprengnether seismometers. A 2-component Wood Anderson system. All data are recorded on photographic paper. Timing from a Geotech Model T-10 clock. Vertical magnification=200k, see response curves Figures 3, 4, 5.

FGU A 3-component short period system which recorded on 35mm film.

LOG A 3-component short period system and a 2-component Wood Anderson system recorded on photographic paper.

PCU A 3-component short period system using portable Benioff seismometers and a 2-component Wood Anderson system all recording on photographic paper. Timing from a Simplex Model 25 clock. Response similar to CCU.

SLC A 3-component short period system using portable Benioff seismometers and recording on photographic paper. Current timing is a Geotech Model 19000 crystal clock. Response similar to CCU.

UBO A 3-component short period system and a 3-component long period system recorded on develocorder film.

Summary Information

In addition to the above recording, we receive telemetry signals from DUG and SLC. Data is also received from HID, TMI, and DCI in southeastern Idaho as well as GCA, KNB, and RMU in southern Utah/northern Arizona. These signals are recorded on Develocorder film at the University of Utah. HID, TMI, DCI, GCA, KNB, and RMU are operated by other agencies.

I have authorization from your office to use the following codes:

MLU - Milford, Utah
CFU - Cove Fort, Utah

CFU is not yet complete. MLU became operational in Jan., 1977, but a final location is not available. Stations STI, PTU, MNU, PUU, and RFU were only recently installed and I am sending you these locations (Table 1) for the first time.

If possible, I would like to proofread your compilation on our station data before it is published. Please write or call me (801-581-6274) if I can provide additional information.

Sincerely,

William D. Richins

William D. Richins
Senior Staff Seismologist

WDR:vg

Enclosure

STATION	CODE	LATITUDE	LONGITUDE	ELEVATION (METERS)	DATE OPEN	DATE CLOSED	INSTRUMENTATION
Alta, Utah	AAU	40°35.52N	111°38.30W	2694	11/74	4/76	Mark Products L-4
Antelope Island, Utah	ANU	41°02.38N	112°13.90W	1353	11/75		Geotech 18300 (S-13)
Big Dutch Hollow, Utah.	BDU	40°52.43N	111°32.04W	2198	9/74		Mark Products L-4
Bear River, Idaho	BEI	42°07.00N	111°46.94W	1859	10/74		Mark Products L-4
Bountiful Peak, Utah	BPU	40°57.25N	111°49.05W	2652	10/74	3/75	Mark Products L-4
Coon Peak, Utah	CPU	40°40.38N	112°11.42W	2228	11/74		Mark Products L-4
Camp Williams, Utah	CWU	40°26.75N	112°06.13W	1945	10/74		Geotech 18300 (S-13)
Daniels Canyon, Utah	DAU	40°24.75N	111°15.35W	2771	11/74		Mark Products L-4
Deer Creek, Utah	DCU	40°24.82N	111°31.61W	1829	11/74		Geotech 18300 (S-13)
East Promontory, Utah	EPU	41°23.49N	112°24.53W	1436	9/75		Mark Products L-4
East Traverse, Utah	ETU	40°28.64N	111°50.67W	1884	7/74		Mark Products L-4
Francis Peak, Utah	FPU	41°01.58N	111°50.21W	2816	9/74		Mark Products L-4
Granite Mountain, Utah	GMU	40°34.53N	111°45.79W	1829	8/70		Mark Products L-4
Hyde Park, Utah	HDU	41°48.27N	111°45.89W	1853	3/75		Geotech 18300 (S-13)
Hoyt Peak, Utah	HTU	40°40.52N	111°13.21W	2576	11/74		Mark Products L-4
Hansel Valley, Utah	HVU	41°46.78N	112°46.50W	1609	11/76		Geotech 18300 (S-13)
Lake Mountain, Utah	LMU	40°16.99N	111°56.22W	2316	9/74		Mark Products L-4
Little Mountain, Utah	LTU	41°35.51N	112°14.83W	1585	9/74		Mark Products L-4
Monte Cristo, Utah	MCU	41°27.70N	111°30.45W	2664	12/74		Mark Products L-4
Malad, Idaho	MLI	42°01.61N	112°07.53W	1896	10/74		Mark Products L-4

STATION	CODE	LATITUDE	LONGITUDE	ELEVATION (METERS)	DATE OPEN	DATE CLOSED	INTRUMENTATION
Milford North, Utah	MNU	38°37.19N	112°50.84W	1664	1/77		Mark Products L-4
Marysvale, Utah	MSU	38°30.80N	112°10.45W	2141	11/75		Geotech 18300 (S-13)
North Pocatello Valley, Idaho	NPI	42°08.84N	112°31.10W	1640	4/75		Mark Products L-4
North Stansbury, Utah	NSU	40°54.49N	112°30.36W	1422	10/76		Mark Products L-4
Ogden, Utah	OGU	41°16.50N	111°56.64W	1506	9/75		Mark Products L-4
Perry Basin, Utah	PBU	41°28.09N	112°00.58W	1625	9/75		Mark Products L-4
Promontory Point, Utah	PPU	41°18.64N	112°25.82W	1875	9/74	8/75	Mark Products L-4
Portage, Utah	PTU	41°55.76N	112°19.48W	2192	12/76		Mark Products L-4
Piute Reservoir, Utah	PUU	38°21.48N	112°16.47W	2598	1/77		Mark Products L-4
Red Butte, Utah	RBU	40°46.85N	111°48.50W	1676	6/74		Mark Products L-4
Richfield, Utah	RFU	38°47.10N	112°07.95W	2027	1/77		Geotech 18300 (S-13)
Saltair, Utah (Down hole)	SAU	40°49.18N	112°04.38W	1283	3/74		Geotech 18300 (S-13)
Stansbury Island, Utah	SBU	40°49.31N	112°28.00W	1317	7/74	10/76	Mark Products L-4
Squaw Peak, Utah	SQU	40°16.90N	111°36.63W	2353	9/74		Mark Products L-4
Star Valley, Idaho	STI	42°48.14N	111°03.05W	2149	12/76		Mark Products L-4
Santaquin, Utah	SUU	39°53.32N	111°47.50W	1987	9/74		Mark Products L-4
Wild Horse, Utah	WHU	39°22.83N	112°10.19W	1993	10/74		Geotech 18300 (S-13)
Willard, Utah	WIU	41°25.33N	111°58.30W	2643	11/74	3/75	Mark Products L-4
West Mountain, Utah	WMU	40°05.30N	111°49.36W	2054	12/73		Geotech 18300 (S-13)

STATION	CODE	LATITUDE	LONGITUDE	ELEVATION (METERS)	DATE OPEN	DATE CLOSED	INSTRUMENTATION
Cedar City, Utah	CCU	37°40.52N	113°04.11W	1775	12/68		SEE TEXT
Dugway, Utah	DUG	40°11.70N	112.48.80W	1477	5/62		
Flaming Gorge, Utah	FGU	40°55.58N	109°23.17W	1982	7/70	6/76	
Logan, Utah	LOG	41°44.50N	111°48.80W	1455	1/64	9/76	
Price, Utah	PCU	39°36.40N	110°48.30W	1714	5/62		
Salt Lake City, Utah	SLC	40°45.83N	111°50.87W	1423	4/62		
Uinta Basin, Utah	UBO	40°19.30N	109°34.01W	1596	4/70	9/73	

Table 3

Station Code	Rock Type
AAU	Paleozoic shaly sandstone
ANU	Precambrian quartzite
BDU	Tertiary conglomerate
BEI	(undetermined)
BPU	Precambrian schist/gneiss
CPU	Paleozoic limestone
CWU	Paleozoic limestone
DAU	Paleozoic limestone
DCU	Paleozoic limestone
EPU	Paleozoic limestone
ETU	Paleozoic limestone
FPU	Precambrian schist/gneiss
GMU	Cretaceous/Tertiary quartz monzonite
HDU	Paleozoic limestone/dolomite
HTU	Paleozoic sandstone
HVU	Paleozoic limestone
LMU	Paleozoic limestone
LTU	Paleozoic limestone
MCU	Paleozoic limestone/dolomite
MLI	(undetermined)
MNU	Tertiary granitoid intrusive
MSU	Tertiary granitoid intrusive
NPI	(undetermined)
NSU	Precambrian quartzite/argillite
OGU	Paleozoic quartzite
PBU	Precambrian metasediment
PPU	Paleozoic limestone/dolomite
PTU	Paleozoic limestone
PUU	Tertiary volcanic flow
RBU	Triassic sandstone
RFU	Tertiary sandstone
SAU	Quaternary alluvium
SBU	Paleozoic limestone
SQU	Paleozoic limestone/dolomite
STI	(undetermined)
SUU	Paleozoic limestone/dolomite
WHU	Cretaceous sandstone/limestone
WMU	Paleozoic limestone
CFU	Tertiary volcanic flow

Table 4

Station Code	Rock Type
CCU	Quaternary alluvium
DUG	Paleozoic limestone/dolomite
FGU	Precambrian quartzite
LOG	Quaternary alluvium
PCU	Cretaceous shale
SLC	Quaternary alluvium
UBO	Tertiary sandstone

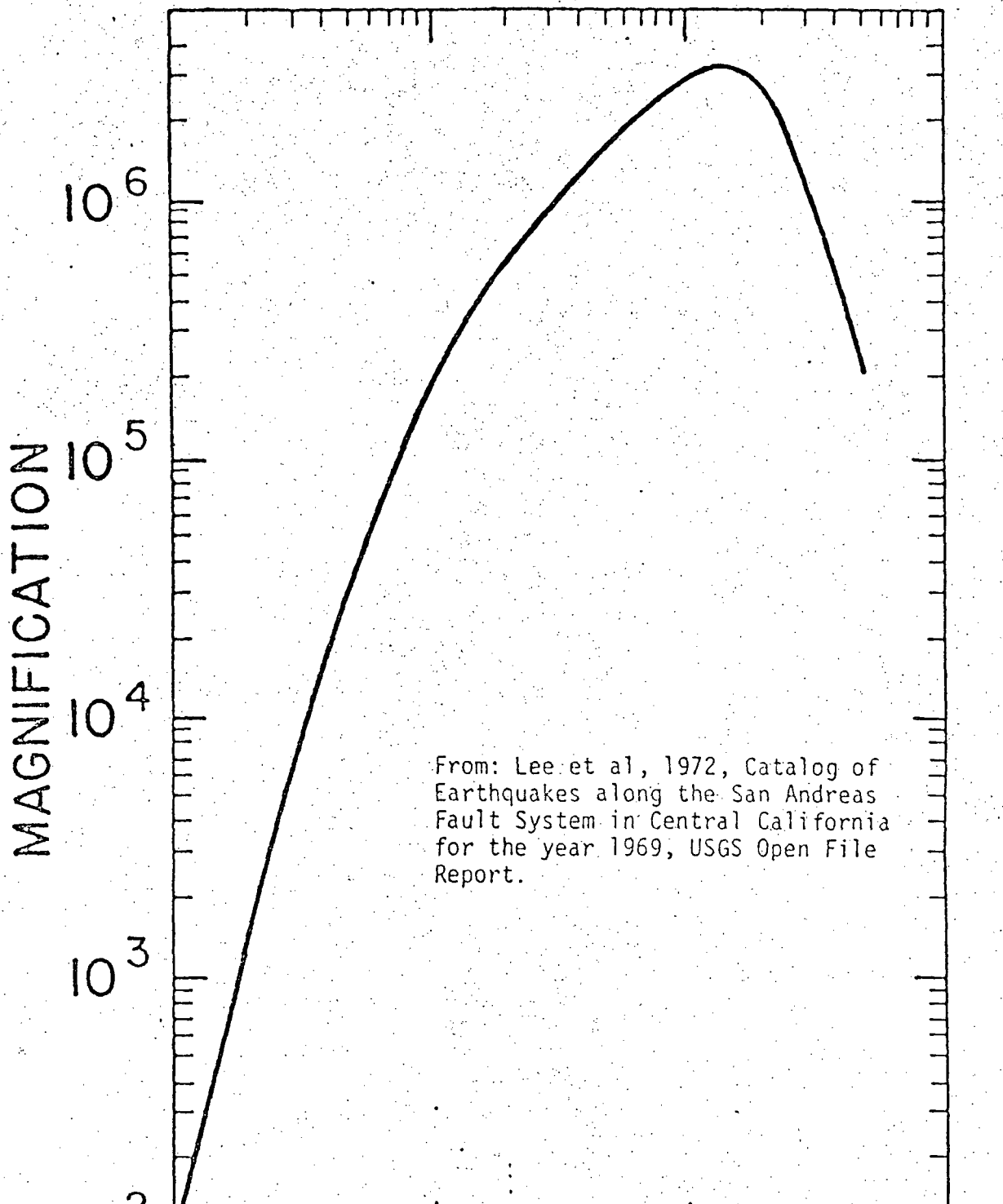


Figure 1. System response of a typical NCER telemetered seismograph station. This magnification curve is obtained for a typical system (L-4C seismometer, Develco VCO/Amplifier, Develco Discriminator, & Geotech Develocorder) with electronic gains adjusted to produce a 10 mm peak-to-peak record amplitude when a 10 μv rms, 5 Hz, calibration signal is introduced in place of the seismometer.

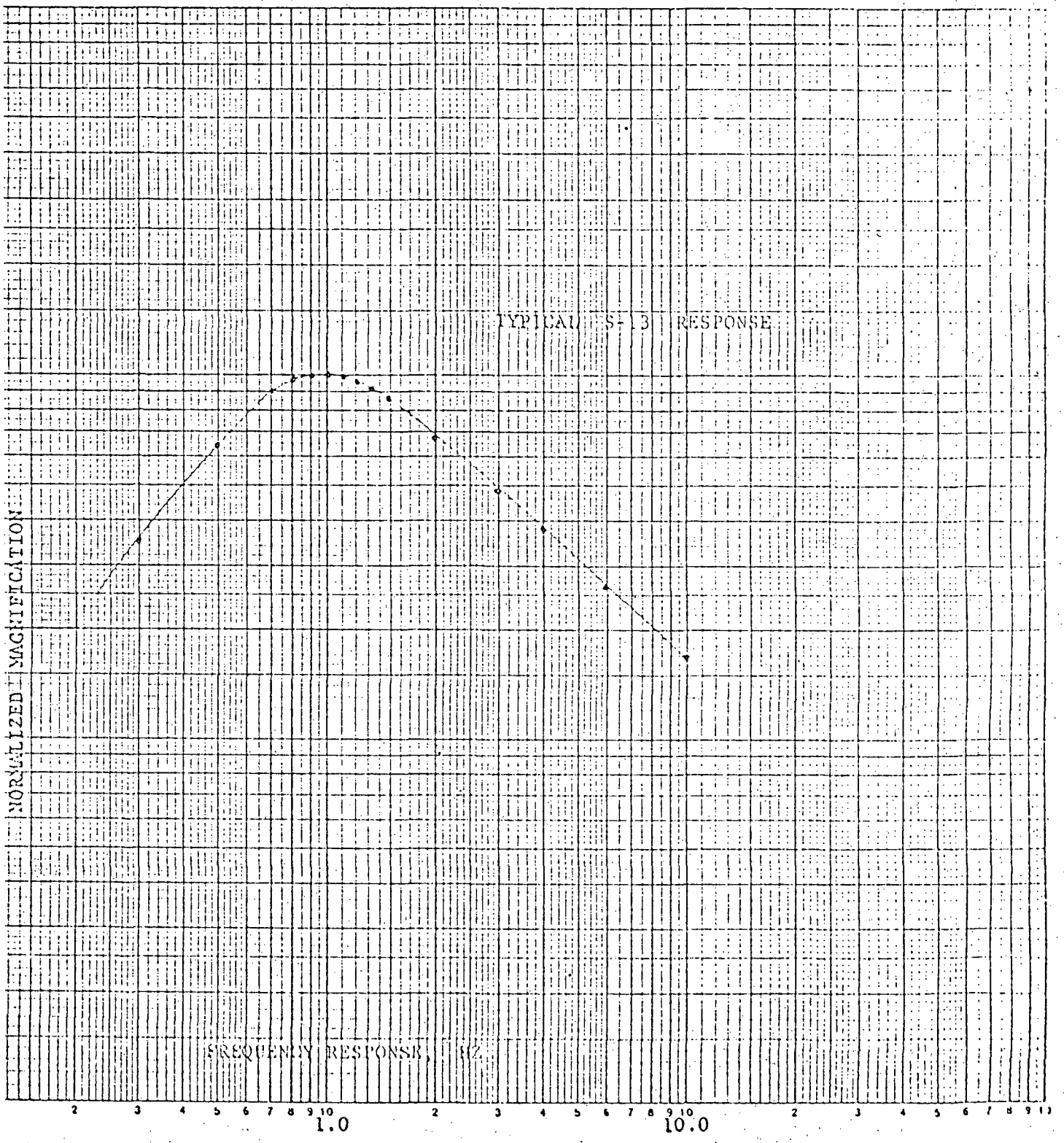

TYPICAL S-13 RESPONSE
NORMALIZED MAGNIFICATION
FREQUENCY RESPONSE, HZ
1.0
10.0

Figure 2

DUGWAY SEISMOGRAPH STATION
LARGE BENIOFF VERTICAL
FREE PERIOD = 1.0
MAGNIFICATION 200 K

JAN. 8, 196

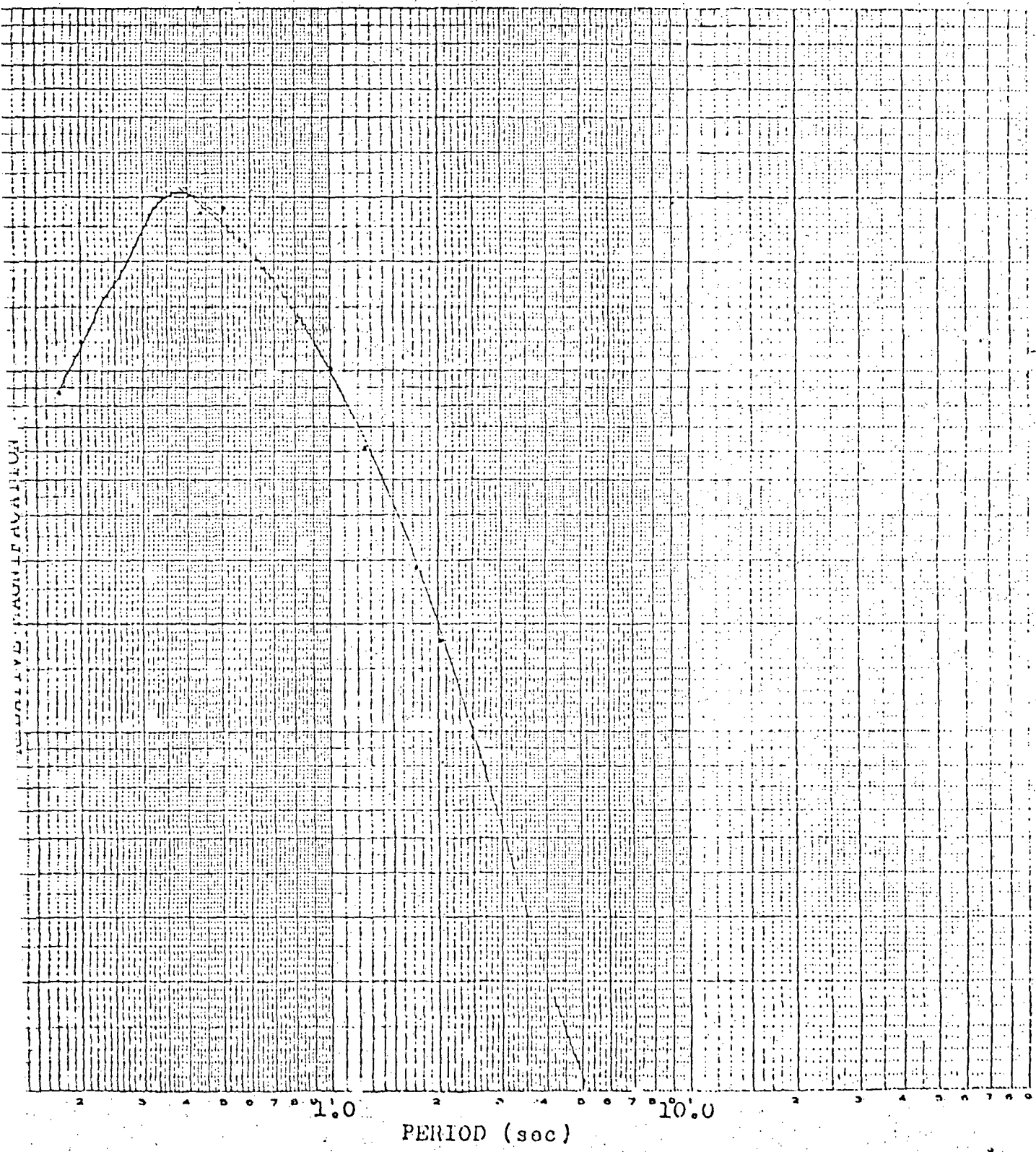


Figure 3

DUGWAY SEISMOGRAPH STATION
LARGE BENIOFF EAST WEST (SP)
FREE PERIOD= 1.0 sec.
MAGNIFICATION: 200 K

JAN. 8, 1976

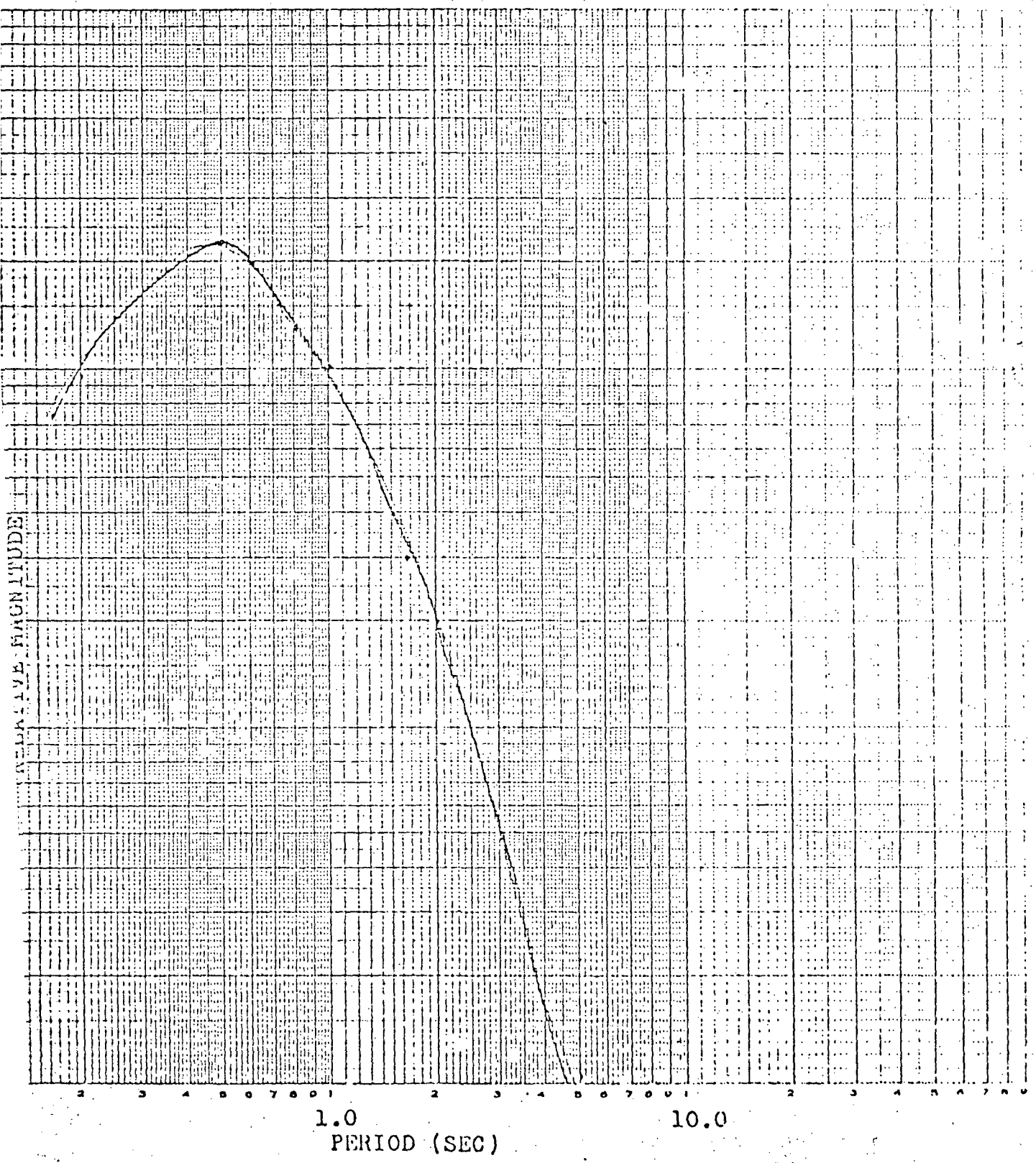


Figure 4

DUGWAY SEISMOGRAPH STATION
LARGE BENIOFF NORTH SOUTH
FREE PERIOD = 1.0
MAGNIFICATION 200 K

JAN.8, 1976

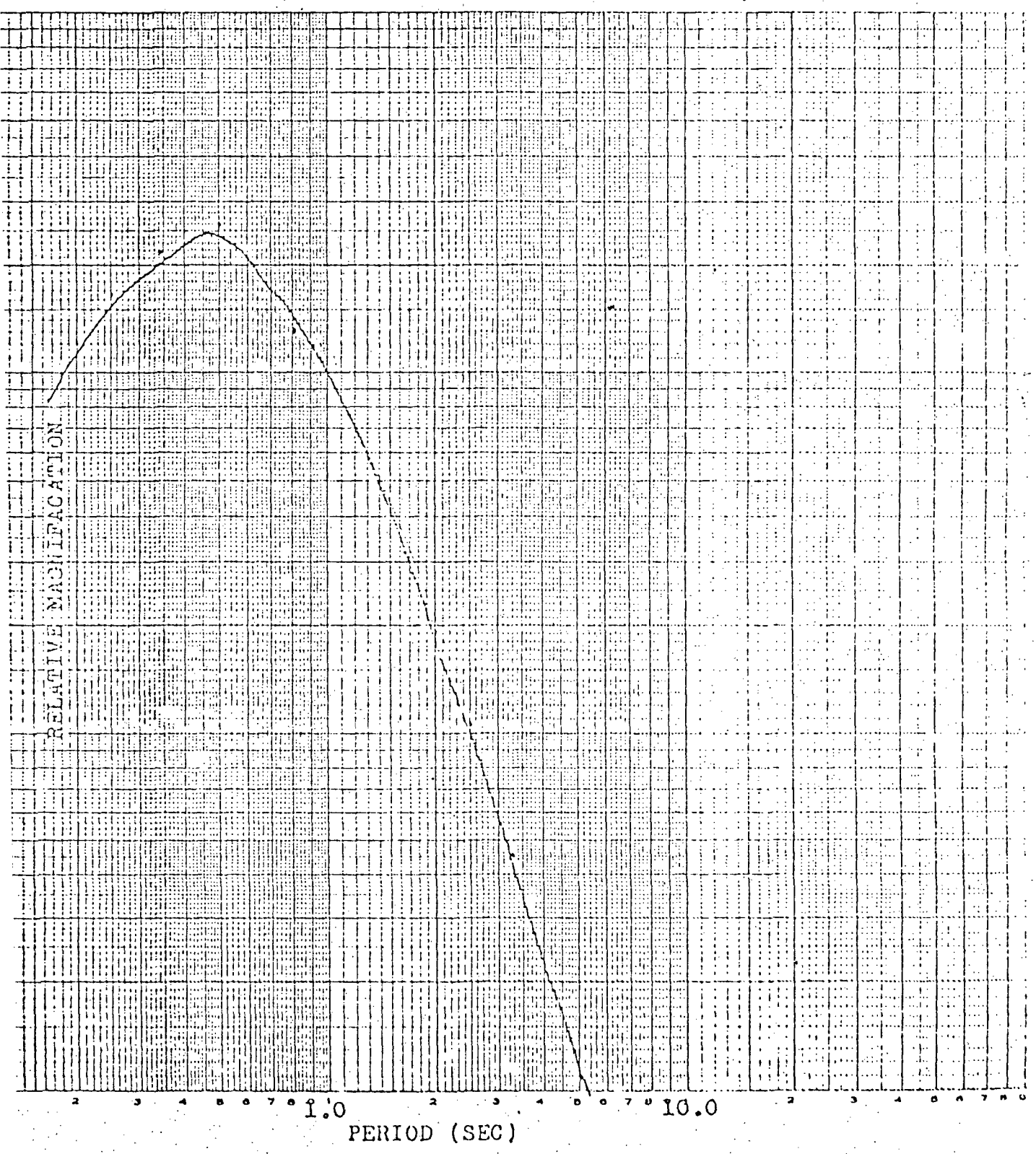


Figure 5

CEDAR CITY SEISMOGRAPH STATION
BENIOFF VERTICAL
FREE PERIOD = 1.0
MAGNIFICATION 70K

JAN 20,1976

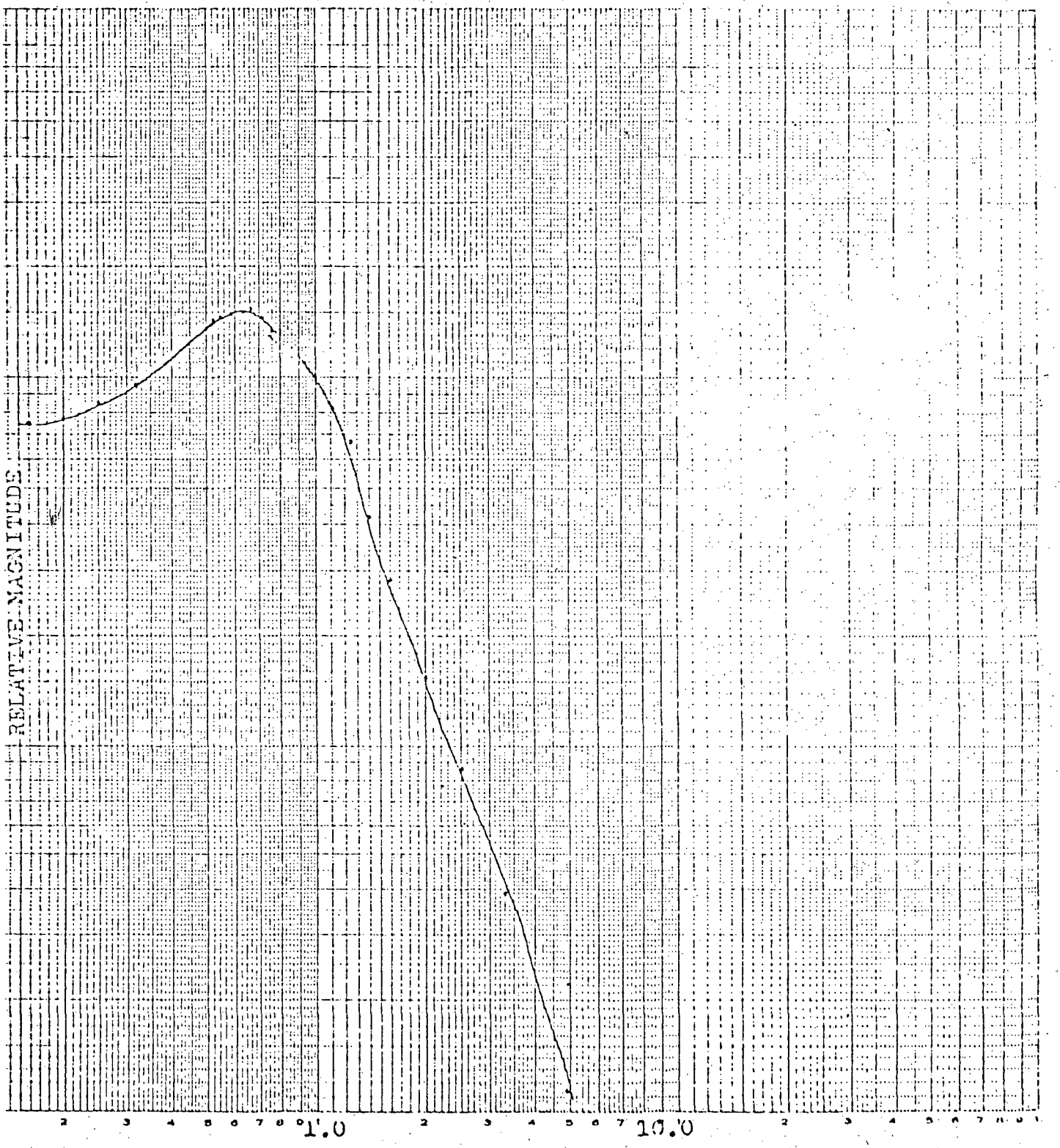


Figure 6

CEDAR CITY SEISMOGRAPH STATION
BENIOFF NORTH SOUTH
FREE PERIDD= 1.0
MAGNIFICATION 27K

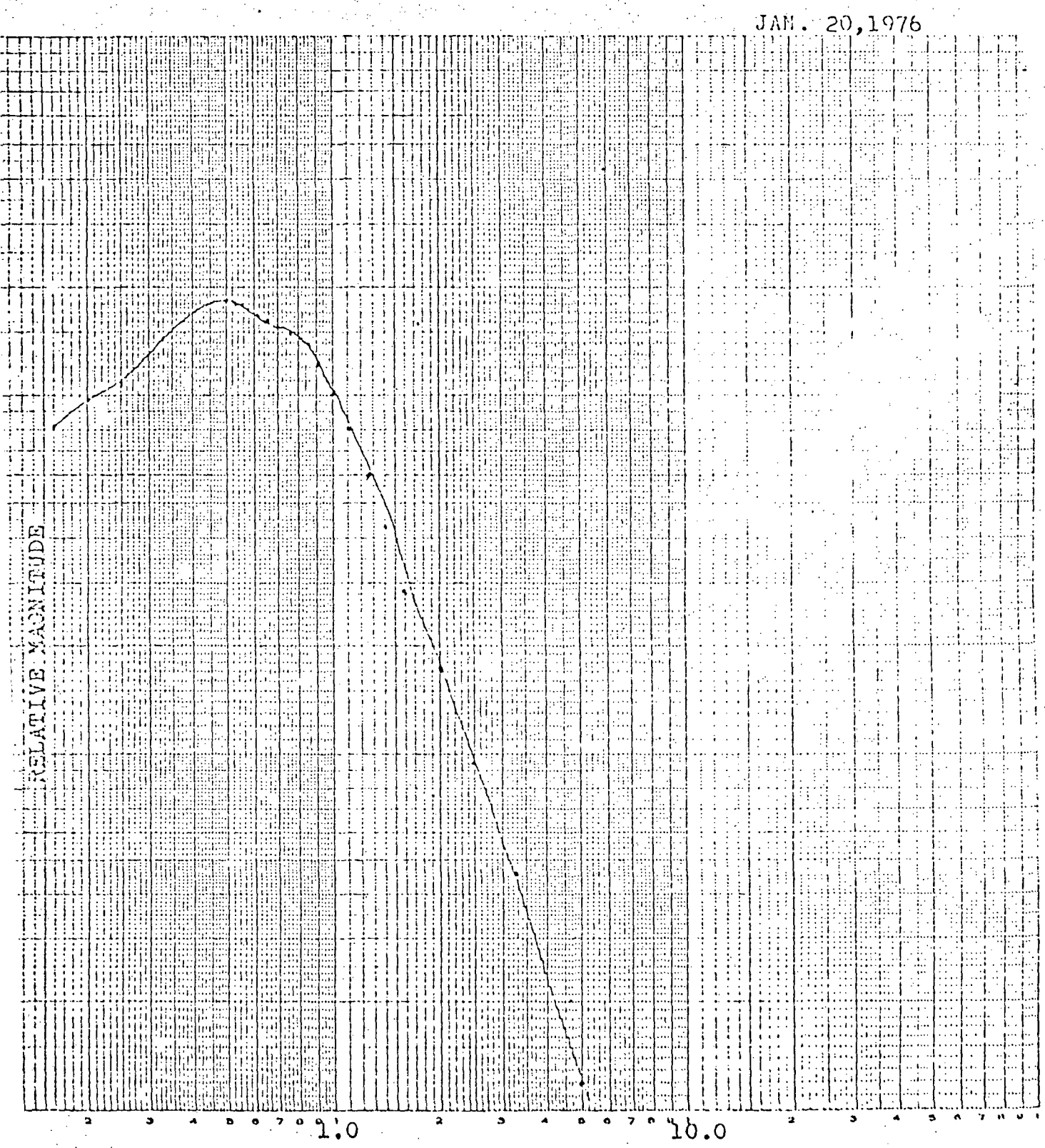


Figure 7

CEDAR CITY SEISMOGRAPH STATION
BENIOFF EAST WEST SHORT PERIOD
MAGNIFICATION 27K
FREE PERIOD = 1.0

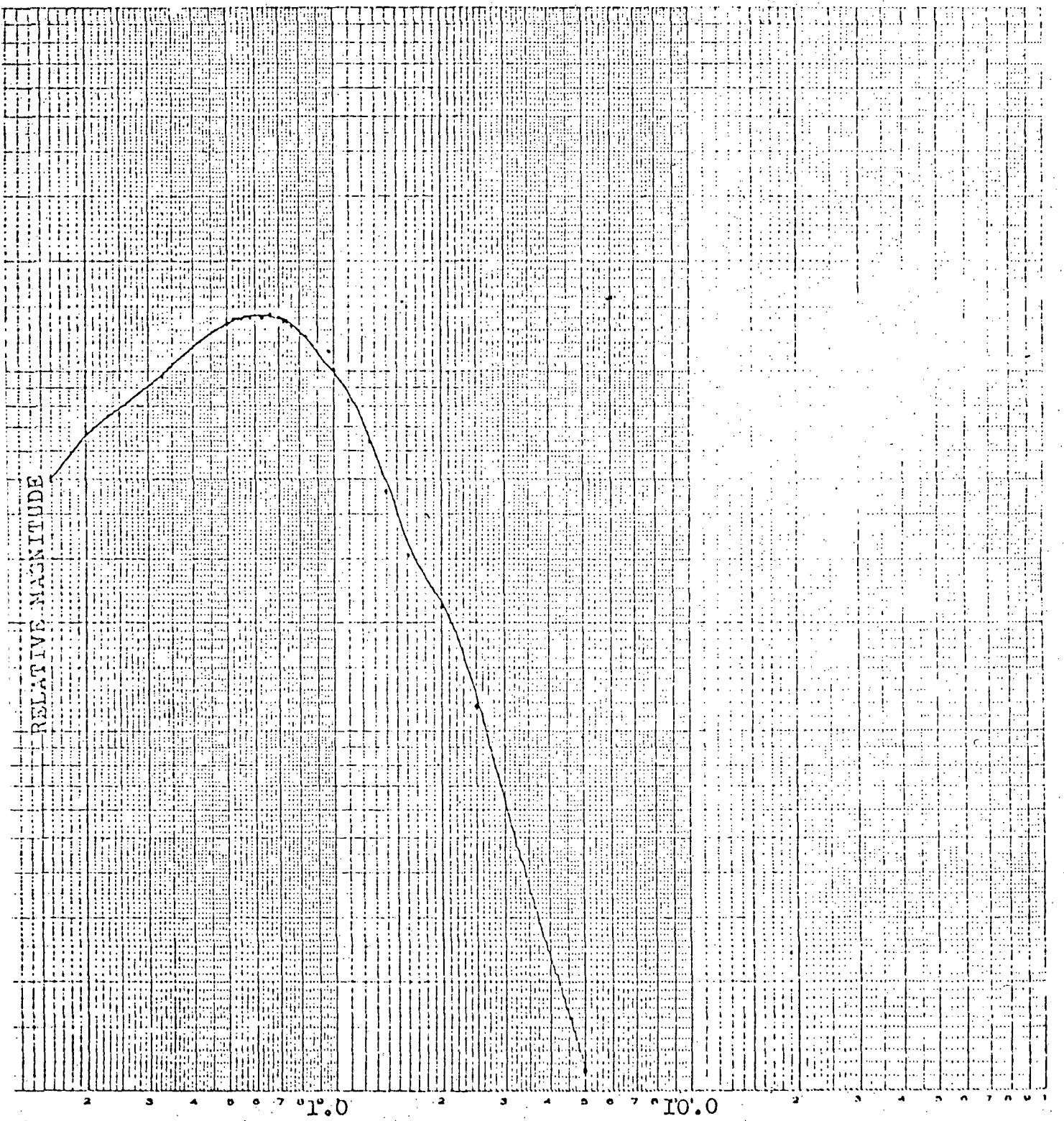
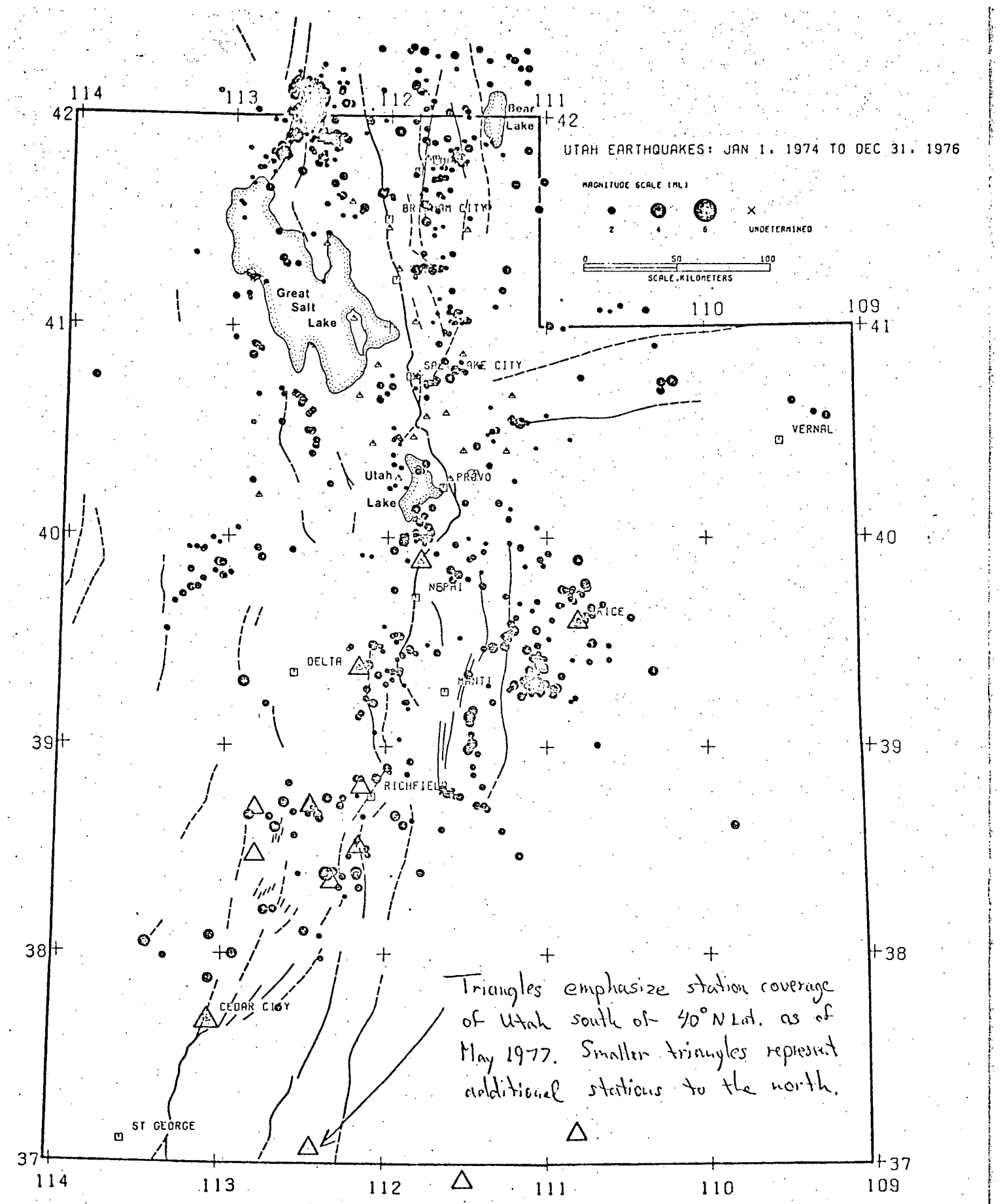


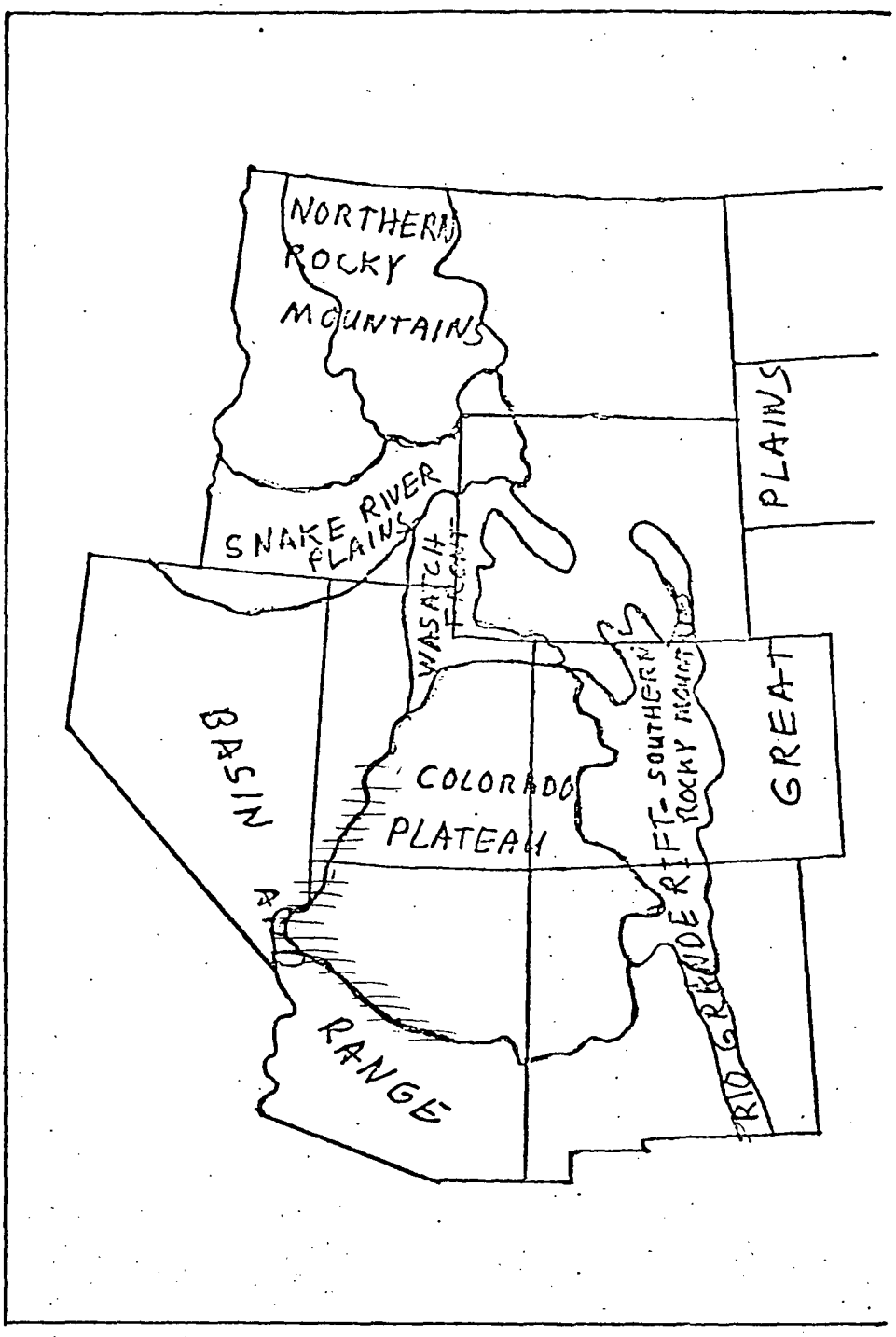
Figure 8


UTAH EARTHQUAKES: JAN 1, 1974 TO DEC 31, 1976
MAGNITUDE SCALE (ML)
2
4
6
UNDETERMINED
0
50
100
SCALE, KILOMETERS
114
113
112
111
110
109
42
41
40
39
38
37
Bear Lake
BRIGHAM CITY
Great Salt Lake
SALT LAKE CITY
VERNAL
Utah Lake
PROVO
NEPHI
PRICE
DELTA
MANTI
RICHFIELD
CEDAR CITY
ST GEORGE
Triangles emphasize station coverage of Utah south of 40° N Lat. as of May 1977. Smaller triangles represent additional stations to the north.

Changes & Additions April 15, 1977

STATION	CODE	LATITUDE	LONGITUDE	ELEVATION (METERS)	DATE OPEN	DATE CLOSED	INSTRUMENTATION
					3/22/77		
Cove Fort, Utah	CFU	38°37.13'N	112°32.32'W	2012	3/77		Geotech 18300 (S-13)
Richfield, Utah (Incorrect Location)	RFU	38°47.14'N	112°06.55'W	1871	1/77		Geotech 18300 (S-13)
Roosevelt Hot Springs, Utah (Old MLU Site)	RHU	38°28.34'N	112°50.83'W	1905	1/77		Mark Products L-4

Above information given to NEIS, Golden, Colorado by phone 4/15/77.


NORTHERN ROCKY MOUNTAINS
PLAINS
SNAKE RIVER PLAINS
WASATCH FRONT
SOUTHERN ROCKY MOUNTAINS
GREAT
BASIN
COLORADO PLATEAU
RIO GRANDE RIFT
RANGE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Area Geothermal Supervisor's Office
Conservation Division, MS 92
345 Middlefield Road
Menlo Park, CA 94025

NOV 23 1977

Memorandum

To: INTERESTED PARTIES

From: Acting Area Geothermal Supervisor

Subject: Revision to the Plan of Operation, Environmental Base Line Study, Phillips Petroleum Company, Roosevelt Hot Springs Unit Operator, RHSU, Beaver County, Utah

Phillips Petroleum Company has submitted a revised description of the Biological Field Tasks to be performed for their Environmental Base Line Study at Roosevelt Hot Springs, Beaver County, Utah.

A copy of this revision is attached for your information, review, and files.

We solicit your comments on this revision prior to the Bureau of Land Management-U.S. Geological Survey's approval of the said Plan. All comments must be received by this office prior to December 15, 1977, at the following address:

Area Geothermal Supervisor
Conservation Division
U.S. Geological Survey
Attn: Chief, Environmental & Safety Section
345 Middlefield Road, MS 92
Menlo Park, California 94025

If you have any questions pertaining to this matter, please do not hesitate to contact Bob Kent at (415) 323-8111, Ext. 2848 or FTS 467-2848.

Barry A Boudreau

Attachment

INTERESTED PARTIES LIST
PHILLIPS PETROLEUM COMPANY
Plan of Operation: Environmental Baseline Study
Roosevelt Hot Springs Unit
Roosevelt Hot Springs, Utah KGRA

USGS-Conservation Division
District Geothermal Supervisor
Attn: Ken Bull
Post Office Bldg., Rm. 443
350 S. Main St.
Salt Lake City, UT 84101
Comm.: (801) 524-5245
FTS: 588-5245

USGS-Conservation Division
Office of Conservation Mgr., CR
Attn: Don Libbey
Box 25046, MS 609
Denver Federal Center
Denver, CO 80225
Comm.: (303) 234-2855
FTS: 234-2855

USGS-Subsidence Research
Attn: Ben Loffgren
Federal Bldg., Rm. W2528
2800 Cottage Way
Sacramento, CA 95825
Comm.: (916) 484-4258
FTS: 468-4258

Geothermal Environmental Adv. Panel
Attn: Max Crittenden
U.S. Geological Survey
345 Middlefield Rd., MS 75
Menlo Park, CA 94025
Comm.: (415) 323-8111, Ext. 2317
FTS: 467-2317

U.S. Bureau of Land Management
Office of the Utah State Director
University Club Building
136 E. South Temple
P.O. Box 11505
Salt Lake City, UT 84111
Comm.: (801) 524-5311
FTS: 588-5311

U.S. Bureau of Land Management
Cedar City District Office
P.O. Box 729
Cedar City, UT 84720
(801) 586-2401

U.S. Bureau of Land Management
Beaver River Resource Area Office
Attn: Lanny Ream
P.O. Box 729
Cedar City, UT 84720
(801) 586-2458

U.S. Bureau of Land Management
Attn: Theodore W. Holland,
Geothermal Specialist
Building 50 (D-310)
Denver Federal Center
Denver, CO 80225
Comm.: (303) 234-5098
FTS: 234-5098

U.S. Fish & Wildlife Service, R 1
Attn: L.A. Mehrhoff
4620 Overland Rd., Rm. 210
Boise, ID 83705
Comm.: (208) 834-1931
FTS: 554-1931

U.S. Fish & Wildlife Service, R 6
Regional Director
Attn: Hal Boeker
Denver Federal Center
P.O. Box 25486
Denver, CO 80225
Comm.: (303) 234-2209
FTS 234-2209

U.S. Fish & Wildlife Service
Area Office
Attn: Lewis Richardson
Federal Building, Rm. 2222
125 S. State St.
Salt Lake City, UT 84138
Comm.: (801) 524-5637
FTS: 588-5637

INTERESTED PARTIES for PHILLIPS PETROLEUM CO., ENVIRONMENTAL BASELINE STUDY

U.S. Environmental Protection Agency
Regional Office, VIII
Attn: Jon Herrmann
1860 Lincoln St.
Denver, CO 80295
Comm.: (303) 837-5914
FTS: 327-5914

U.S. Environmental Protection Agency
Environmental Monitoring & Support Lab
Attn: Don Gillmore/Michael O'Connel
P.O. Box 15027
Las Vegas, NV 89114
Comm.: (702) 736-2969
FTS: 595-2969

Division of Geothermal Energy
U.S. Department of Energy
Attn: Bert Barnes
20 Massachusetts Ave., NW
Washington, D.C. 20545
Comm.: (202) 376-4902
FTS: 376-4902

U.S. Department of Energy
Nevada Operations Office
Attn: John O. Cummings
P.O. Box 14100
Las Vegas, NV 89114
Comm.: (702) 734-3591
FTS: 598-3591

State of Utah
Natural Resources Department
Attn: Clifford Colling
Rm. 438, State Capitol
Salt Lake City, UT 84114
(801) 533-5356

State of Utah
Water Resources Division
Attn: Bryce Montgomery, Geologist
Rm. 435, State Capitol
Salt Lake City, UT 84114
(801) 533-5401

State of Utah
Utah Water Rights Division
Attn: Dee Hansen, State Engr.
Rm. 442, State Capitol Bldg.
Salt Lake City, UT 84114
(801) 533-5071

State of Utah
Wildlife Resources Division
Attn: Earl Spark
1596 W. North Temple
Salt Lake City, Utah 84116
(801) 533-5081

State of Utah
Utah Division of Health
Environmental Health Service Branch
Attn: Lynn Thatcher, Director
44 Medical Drive
Salt Lake City, Ut 84113
(801) 533-6121

University of Utah Research Institute
Earth Science Laboratory
Attn: Phillip M. Wright
Research Park
391 Chipeta Way
Salt Lake City, UT 84108
(801) 581-5225

Phillips Petroleum Company
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(714) 755-0131

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2207 Carroll St., Apt. 3
Oakland, CA 94606
(415) 451-3714

State of Utah
Historical Preservation Officer
603 E South Temple
Salt Lake City, UT 84111
(801) 533-5755

Woodward-Clyde Consultants
3489 Kurtz St.
San Diego, CA 92110
(714) 225-9381

University of Utah
Dept. of Geology & Geophysics
Attn: Dr. Stan Ward
Salt Lake City, UT 84112
(801) 581-6553

BIOLOGICAL FIELD TASKS
TO BE CONDUCTED BY WOODWARD-CLYDE CONSULTANTS
FOR PHILLIPS PETROLEUM COMPANY

The biological tasks to be conducted by both WCC and EPA will include an emphasis on detecting the presence of threatened, endangered or otherwise unique species, populations and habitat that may occur within or closely adjacent to the Unit.

BIG GAME

Baseline data on big game and other game species will be obtained from the Utah Division of Wildlife Resources and from other surface management and other agencies (BLM, USFS, USFWS) when available. The state maintains records on the distribution and status of big game, upland game and other species as part of their management programs. The management units that include the Roosevelt Hot Springs KGRA Unit will provide comparative data from the past as well as providing data on a continuing basis.

MEDIUM-SIZED MAMMALS

Medium-sized mammals (usually predators) such as coyote, fox, bobcat, etc. will be surveyed using the scent-post technique (slightly modified) developed by the U. S. Fish and Wildlife Service (USFWS, 1974). The basic technique incorporates an attractant placed in the center of a cleared, sifted and smoothed one square meter plot of soft soil. These plots are placed along a 15 mile transect at about one-third mile intervals (the transect length and placement of the plots may be modified during the proposed study). Prints made by individuals visiting the site are noted, and identified to the extent possible. The tentative locations of the medium-sized mammal transects are shown in Figure 7 of the proposed Plan of Operations. The final selection of the transect/scent-post locations will be made following review of

the initial draft of the EPA vegetation map when it becomes available. Because of their wide ranging habits, the medium-sized mammals are expected to utilize, at least on a temporary basis, all vegetation types that occur within the Unit. Therefore, it is desirable to select a transect that will traverse most or all of the vegetation types within the Unit. Scent-post sampling will be conducted on a quarterly/seasonal basis. While conducting the survey additional information will be obtained through observations of dens, scat and other signs, and sightings of individuals.

The belief that the survey is capable of measuring "relative abundance" rests on the assumption that the relationship between the visitation rate and the density of a given species is sufficiently consistent for the index to provide reliable and useful information (USFWS, 1974).

Indices of relative visitation by species will be obtained for each survey line by totalling the number of operable stations visited by each species for three nights. The total number of "scent-station nights" is derived by subtracting from the total number of station nights (number of stations x number of nights) all those that were inoperable because of weather, human interference, or animal interference (e.g., cows, etc.). In this context, an "inoperable" station is one for which predator tracks, if present, cannot be distinguished. The index is calculated as follows for each species of interest:

$$\frac{\text{Total Number Visits}}{\text{Total Number Operable Station Nights}} \times 1000 = \text{Index}$$

For example, a line with 30 coyote visits and 235 operable scent station nights results in an index of 128 (30/235 x 1000 = 128). The indices derived from the Roosevelt study will be compared to statewide data compiled by the USFWS predator abundance program.

BIRDS

Bird species will be inventoried using both qualitative and quantitative techniques. Bird surveys will be conducted on a seasonal/quarterly basis to provide information on utilization of the Unit, and on nesting and breeding seasons. Quantitative estimates of the abundance of bird species will be made using the Emlen strip transect method (Emlen, 1971). Proposed locations of the Emlen transects are provided in Figure 7 of the proposed Plan of Operations. Transects will be placed, as a minimum, in each major vegetation type and in other unique habitat areas when appropriate. Final selection of the transect locations will be based on a review of the initial draft vegetation map developed by the EPA.

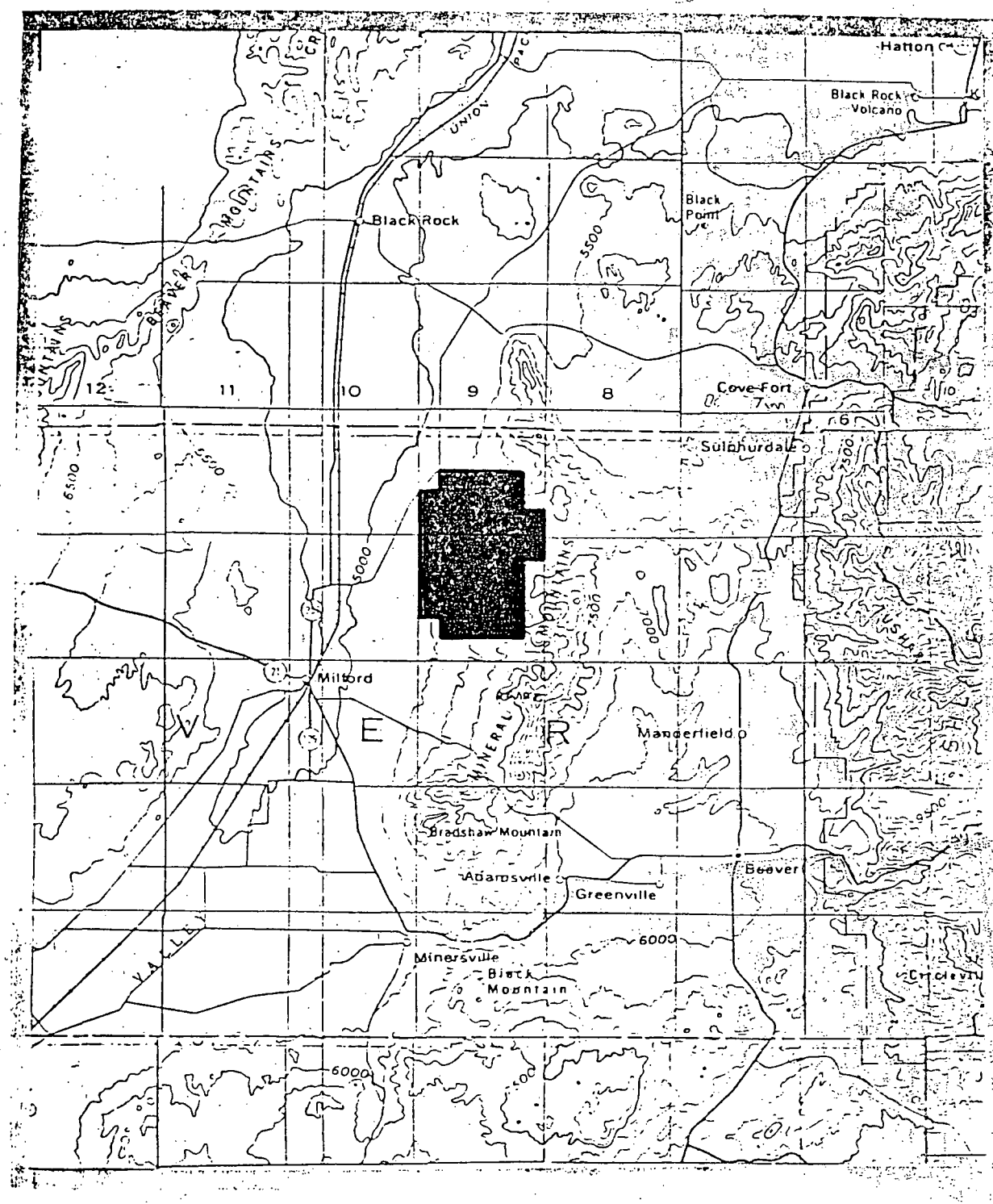
The Emlen strip technique consists of moving along an established transect one mile in length in each major vegetation or habitat type and recording individual species observed or heard to a lateral distance of 400 feet on either side of the observer. This method is applicable during any season and is more efficient in terms of area covered per unit of effort than nest or territory count methods, and is comparable in accuracy (Emlen, 1971). All detections for each species are multiplied by a conversion factor (coefficient of detectability) representing the percent of the population that is normally detected by these procedures. Conversion factors are derived directly from distribution curves of detection points laterally from the observer's path. The conversion values are finally adjusted for the incompleteness of the estimate toward the outer boundary, based on the strip of optimum coverage close to the transect trail.

Qualitative bird observations will be made along road transects at approximately one-half mile intervals with an observation period of five minutes. Final selection of the road transect locations will be made following review of the initial draft of the EPA vegetation map. Such observations will also be made in any unique habitats or vegetation types not covered by either the Emlen strip transects or the road surveys.

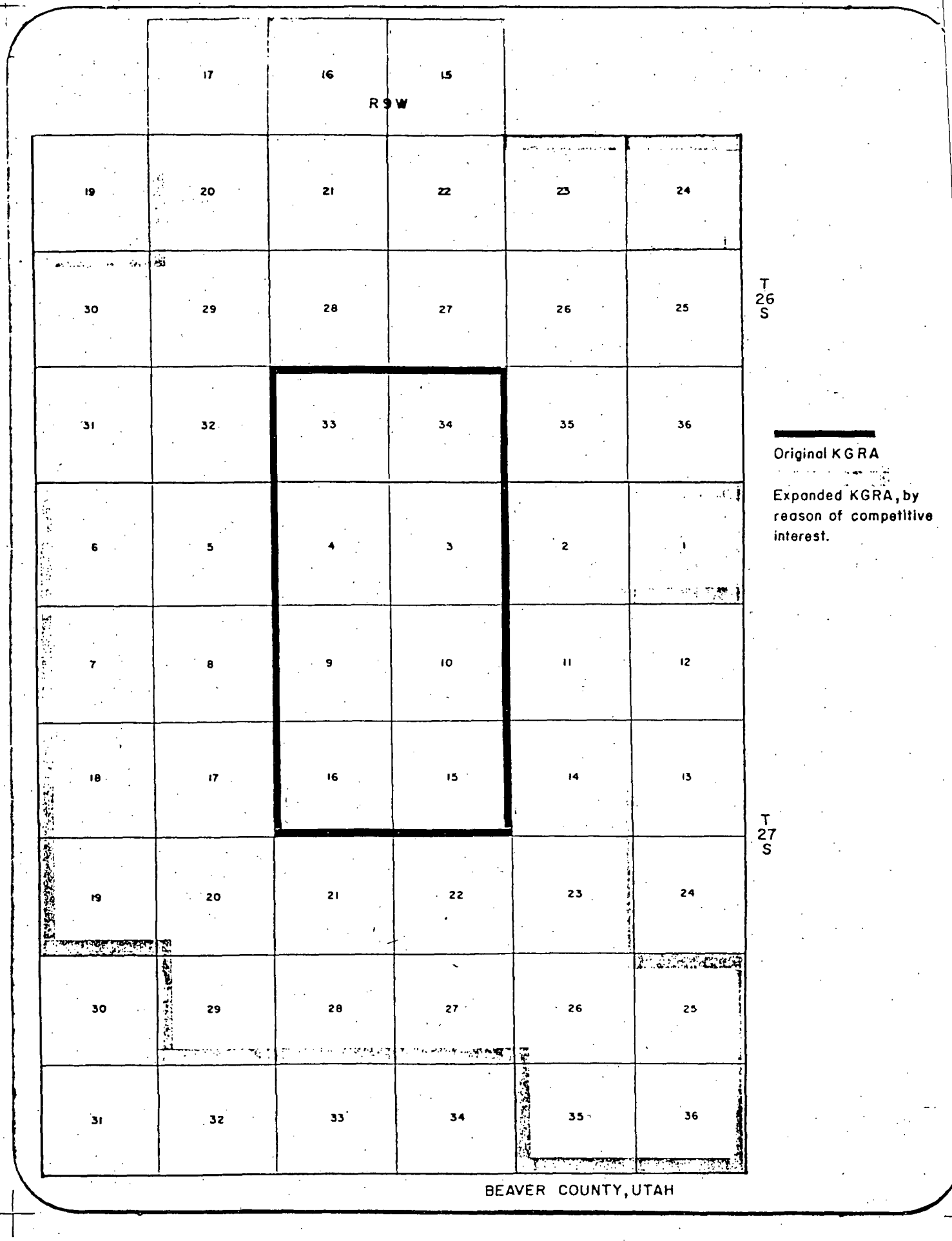
Qualitative observations will be made for raptors while conducting other surveys in the study area. Nesting counts and perching site locations will be recorded. Only raptors within a quarter-mile of the observer will be recorded. Individuals within this range can be readily identified to genus, and usually to species. This information may be used to provide comparative data on the relative abundance of the species present from year to year.

The raptor observation data developed within the Unit will be used in conjunction with that developed by the State Division of Wildlife Resources to provide relative data for evaluating the impacts of geothermal development on raptor populations.

Ward


Hatton
Black Rock Volcano
UNION PAC
Black Point
Black Rock
MOUNTAINS
BEAVER
5500
12
11
10
9
8
Cove Fort
7mi
6
Sulphurdale
6500
5000
2500
MINERAL
Milford
V
E
R
Manderfield
Bradshaw Mountain
Adamsville
Greenville
Beaver
6000
Minersville
Black Mountain

#1 W ↓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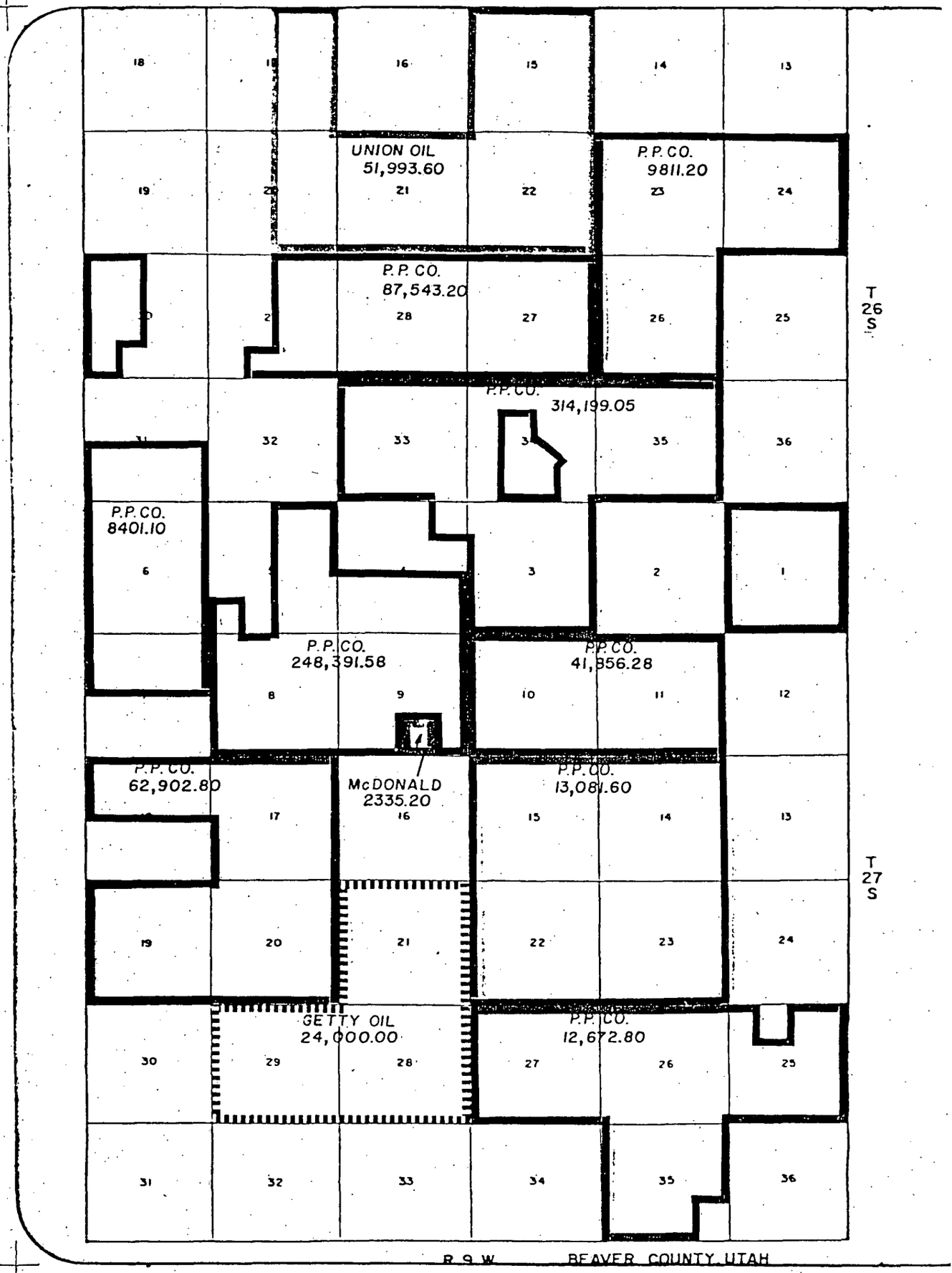
36
Original KGRA
Expanded KGRA, by reason of competitive interest.
BEAVER COUNTY, UTAH

#2 W


UNION OIL
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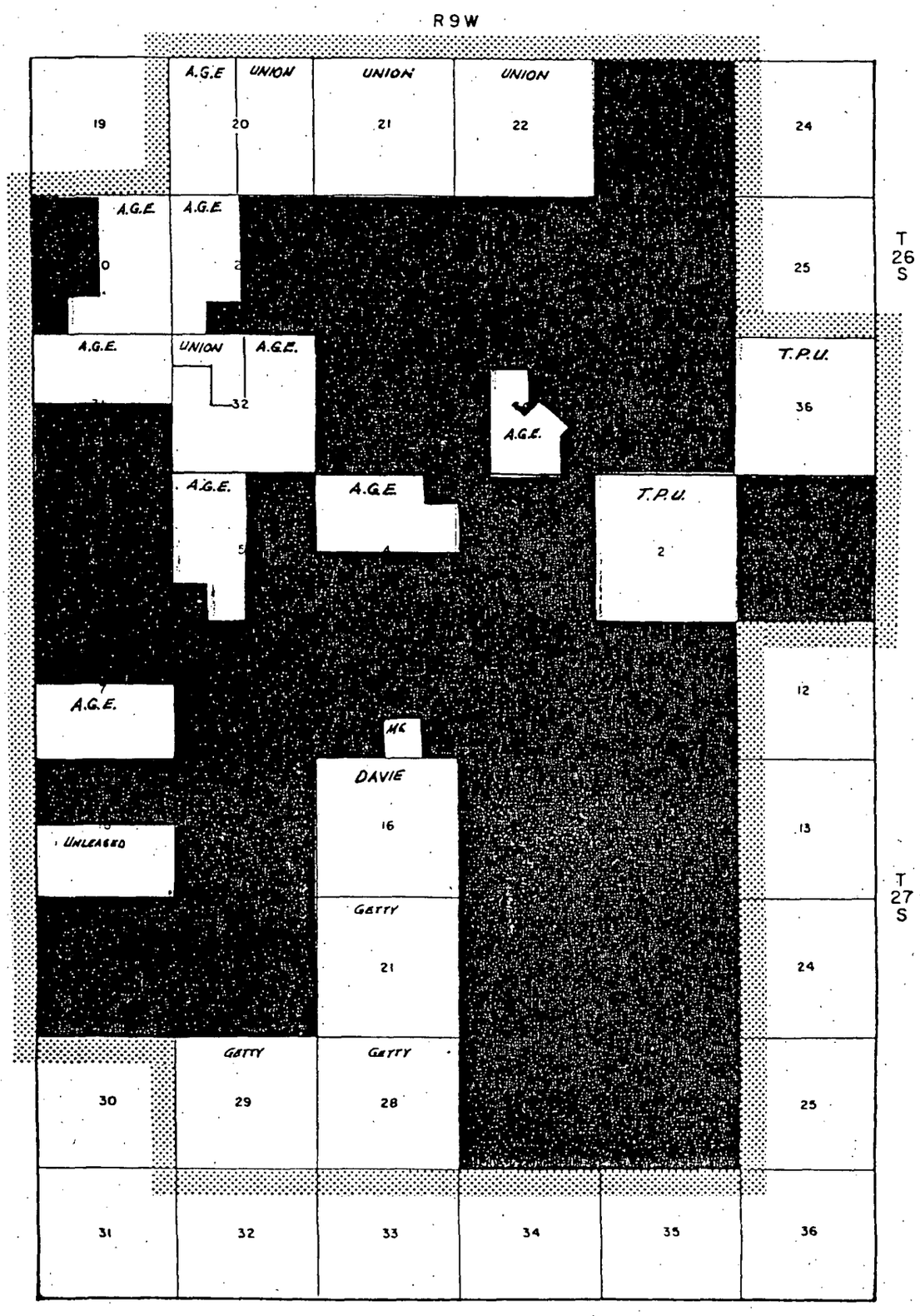
P.P.CO.
9811.20
P.P.CO.
87,543.20
P.P.CO.
314,199.05
P.P.CO.
8401.10
P.P.CO.
248,391.58
P.P.CO.
41,856.28
P.P.CO.
62,902.80
McDONALD
2335.20
P.P.CO.
13,081.60
GETTY OIL
24,000.00
P.P.CO.
12,672.80
T
26
S
T
27
S
R 9 W
BEAVER COUNTY UTAH

#3 W ↓


R 9 W
A.G.E
UNION
UNION
UNION
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A.G.E.
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A.G.E.
UNION
A.G.E.
32
T.P.U.
36
A.G.E.
A.G.E.
T.P.U.
2
A.G.E.
MK
DAVIE
16
12
UNLEASED
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Getty
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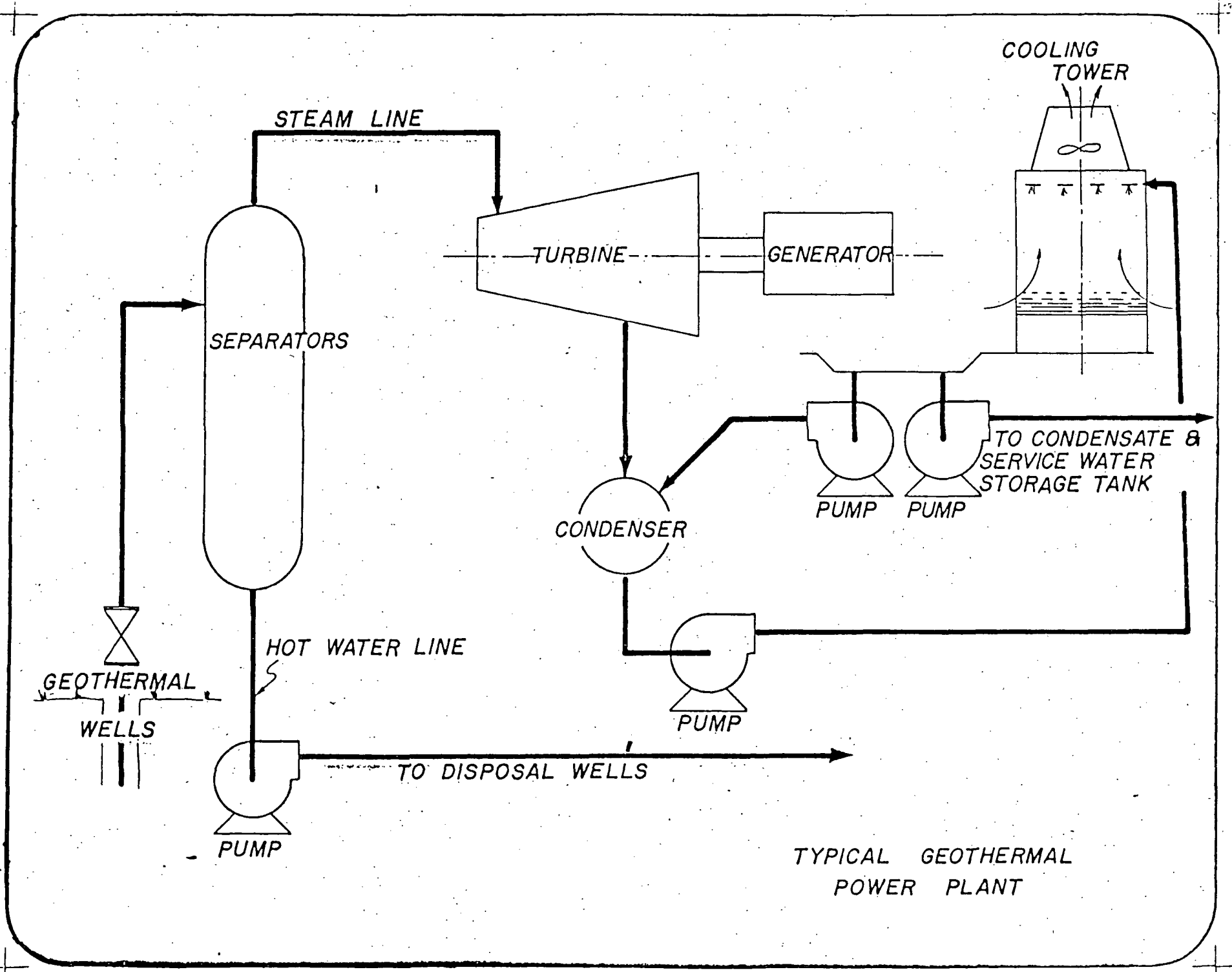
#4 W

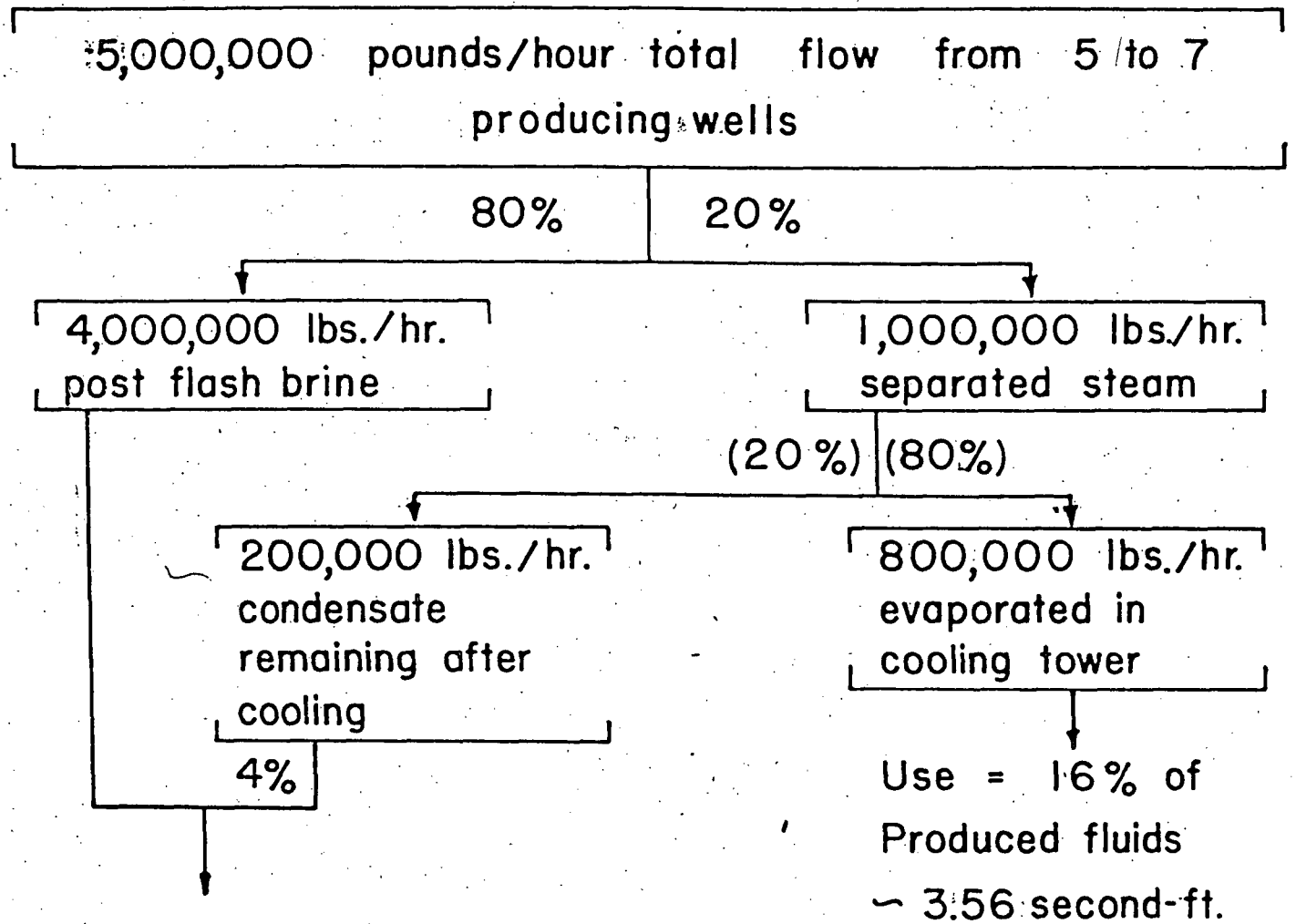


TYPICAL GEOTHERMAL POWER PLANT

CHARACTERISTICS OF SELECTED GEOTHERMAL FIELDS

Field	Reservoir temperature, °C	Reservoir fluid	Enthalpy, cal/g	Average well depth, meters	Fluid salinity, ppm	Mass flow per well, kg/hr	Non-condensable gases, %
Larderello	245	Steam	690	1,000	< 1,000	23,000	5
The Geysers	245	Steam	670	2,500	< 1,000	70,000	1
Matsukawa	230	Mostly steam	550	1,100	< 1,000	50,000	< 1
Otake	200+	Water	~ 400	500	~ 4,000	100,000	< 1
Wairakei	270	Water	280	1,000	12,000		< 1
Broadlands	280	Water	400+	1,300		150,000	~ 6
Pauzhetsk	200	Water	195	600	3,000	60,000	
Cerro Prieto	300+	Water	265	1,500	~ 15,000	230,000	~ 1
Niland	300+	Brine	240	1,300	260,000	~ 200,000	< 1
Ahuachapan	230	Water	235	1,000	10,000	320,000	~ 1
Hveragerdi	260	Water	220	800	~ 1,000	250,000	~ 1
Reykjanes	280	Brine	275	1,750	~ 40,000	~ 400,000	~ 1
Namafjall	280	Water	260	900	~ 4,000	400,000	6

WATER BALANCE
FOR A
55 MW GEOTHERMAL POWER PLANT
AT
MILFORD, UTAH



EXPLANATION

(C-24-10)21aba-1
(C-25-9)29cbd-1
(C-25-10)12bcc-1
31cbc-1
(C-27-10)31dcb-1
(C-28-10)5dad-2
8aad-2
14bba-1
16cda-1
17ccc-1
18cab-1
19bbc-1
19bcd-2
19ccd-4
28cdd-1
30bdc-3
31ddc-2
(C-28-11)12abb-1
23cbb-2
25dcd-1
35cad-1
36dcc-2
(C-29-10)5add-1
5cdd-5
8ddd-2
18daa-1
18dcd-1
(C-29-11)1add-2
4baa-1
10ddd-1
11cdd-2
12ddd-1
19caa-2
27dad-1
(C-30-11)22ddc-1
(C-30-12)9add-1
(C-30-13)8caa-1
25abb-1
30bdd-2
(C-31-13)18aad-1

iemical analyses
in table 16)

$$\text{ł} = \frac{(Na^{+})}{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}$$

re ion concentrations
in meq/l

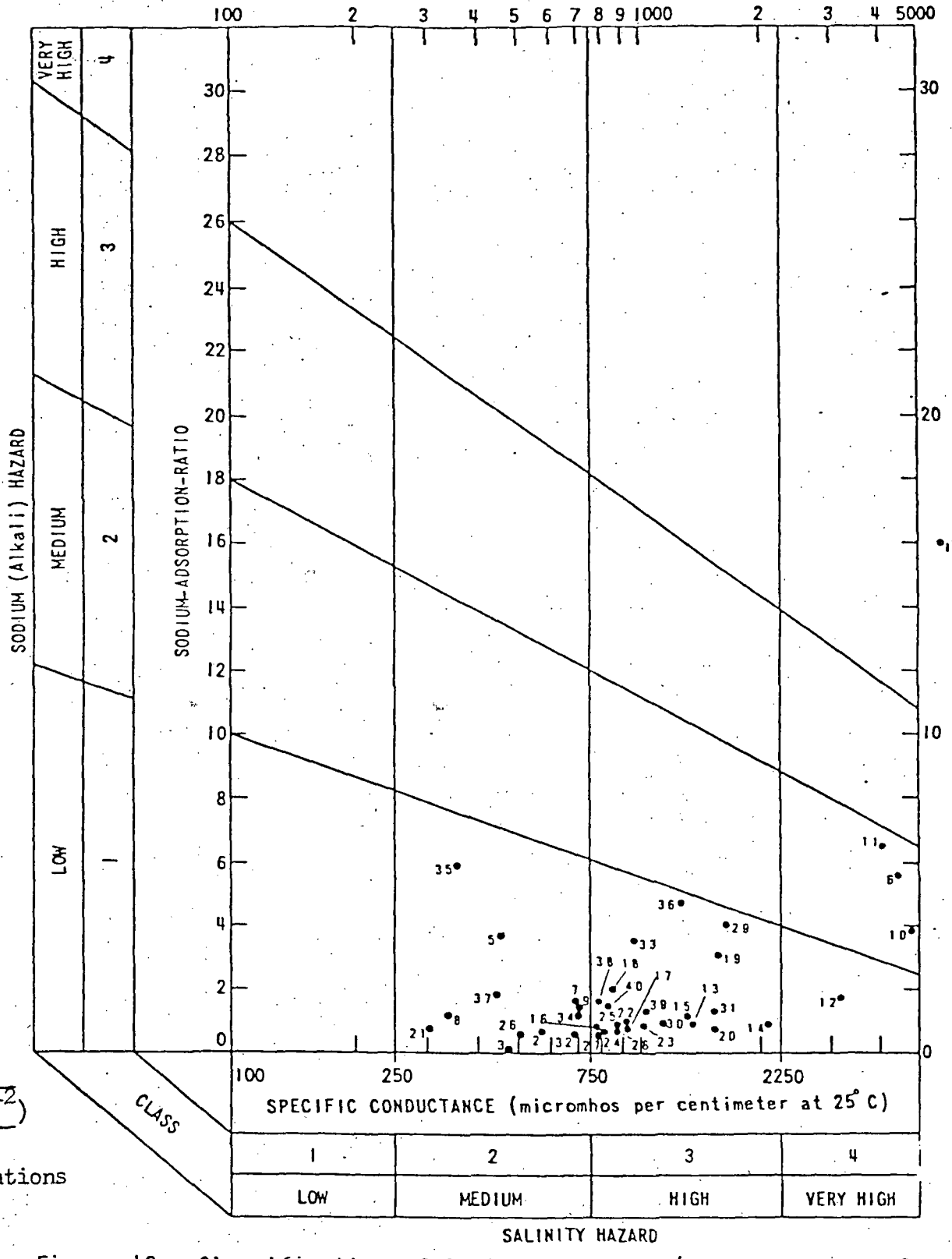
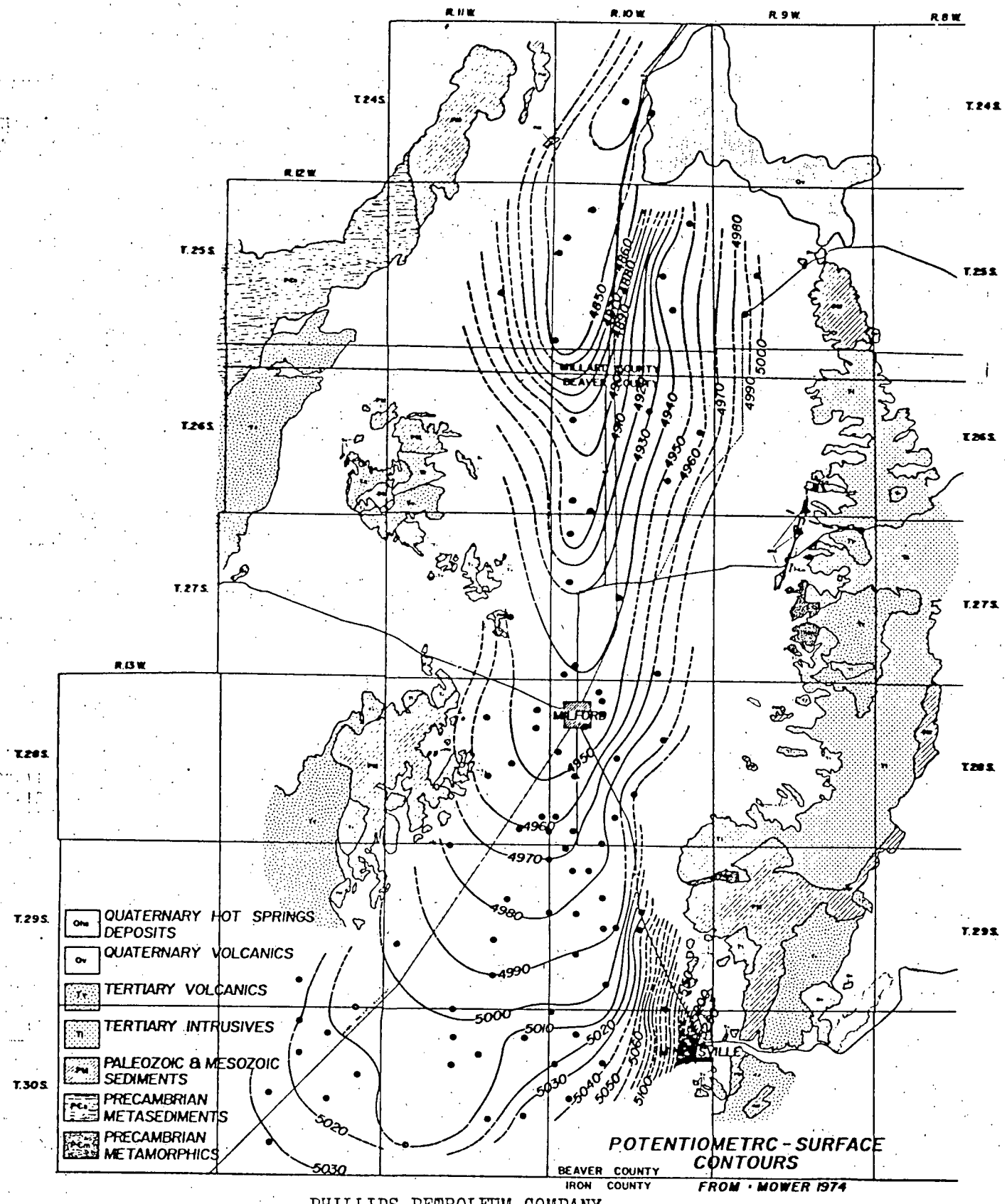


Figure 13.—Classification of irrigation water (method of the U.S. Salinity Laboratory Staff, 1954).

FROM MOWER & CORDOVA (1974)

L-10



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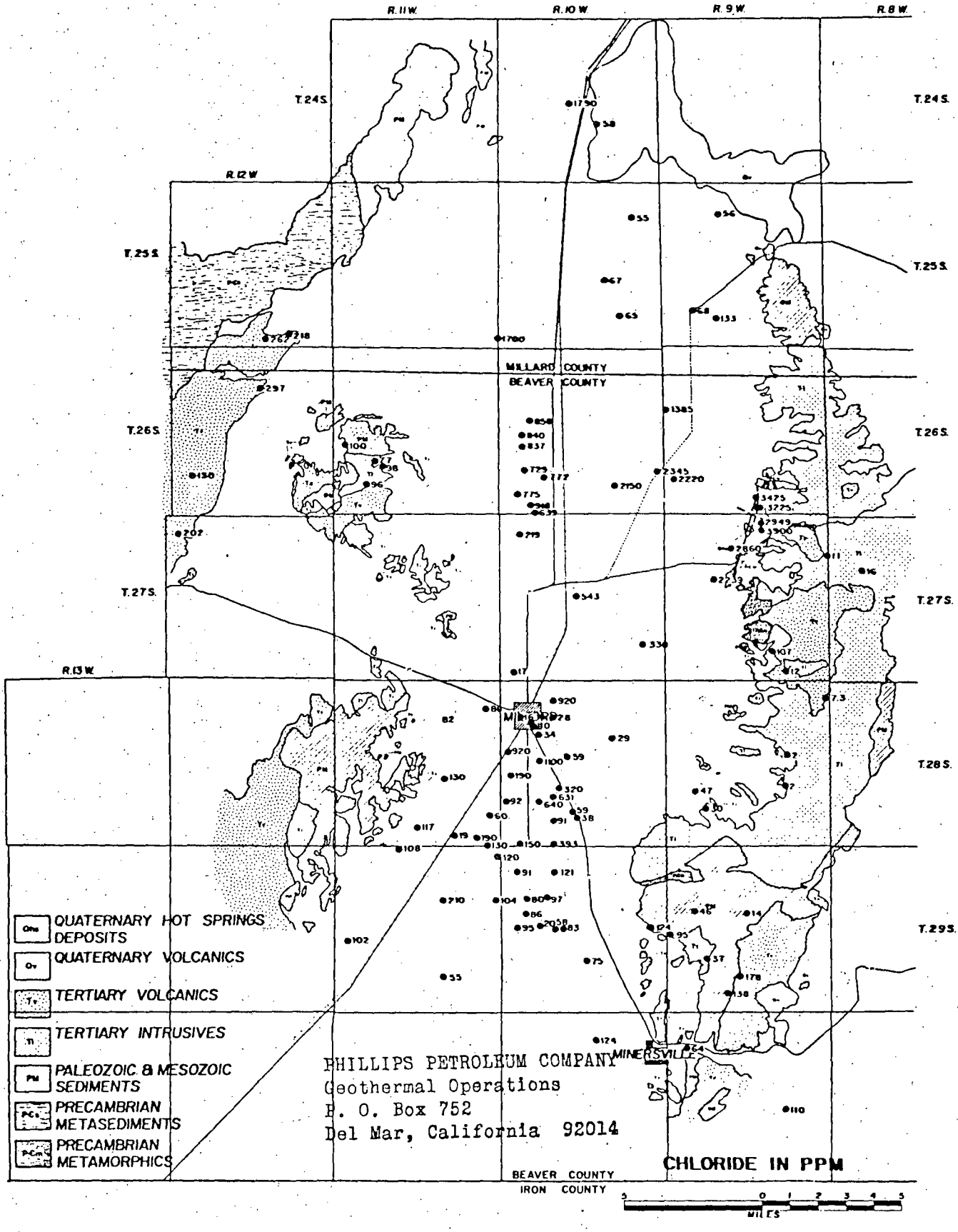
P. O. Box 752
Del Mar, California 92014

L-12


R.11W.
R.10W.
R.9W.
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T.24S.
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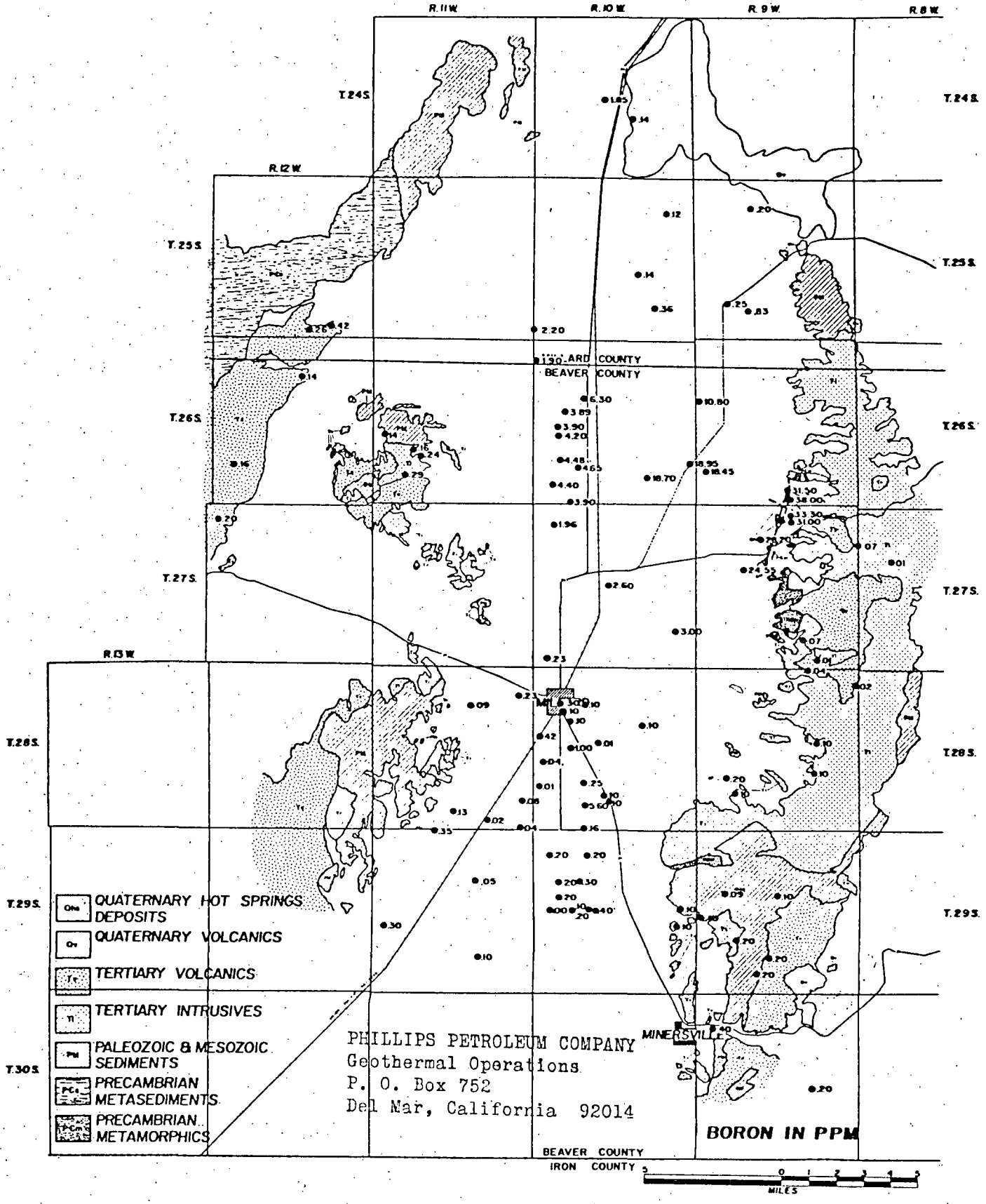
T.26S.
T.27S.
T.28S.
T.29S.
T.30S.
MILLARD COUNTY
BEAVER COUNTY
MINERSVILLE
QUATERNARY HOT SPRINGS DEPOSITS
QUATERNARY VOLCANICS
TERTIARY VOLCANICS
TERTIARY INTRUSIVES
PALEOZOIC & MESOZOIC SEDIMENTS
PRECAMBRIAN METASEDIMENTS
PRECAMBRIAN METAMORPHICS
PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014
BEAVER COUNTY
IRON COUNTY
CHLORIDE IN PPM
MILES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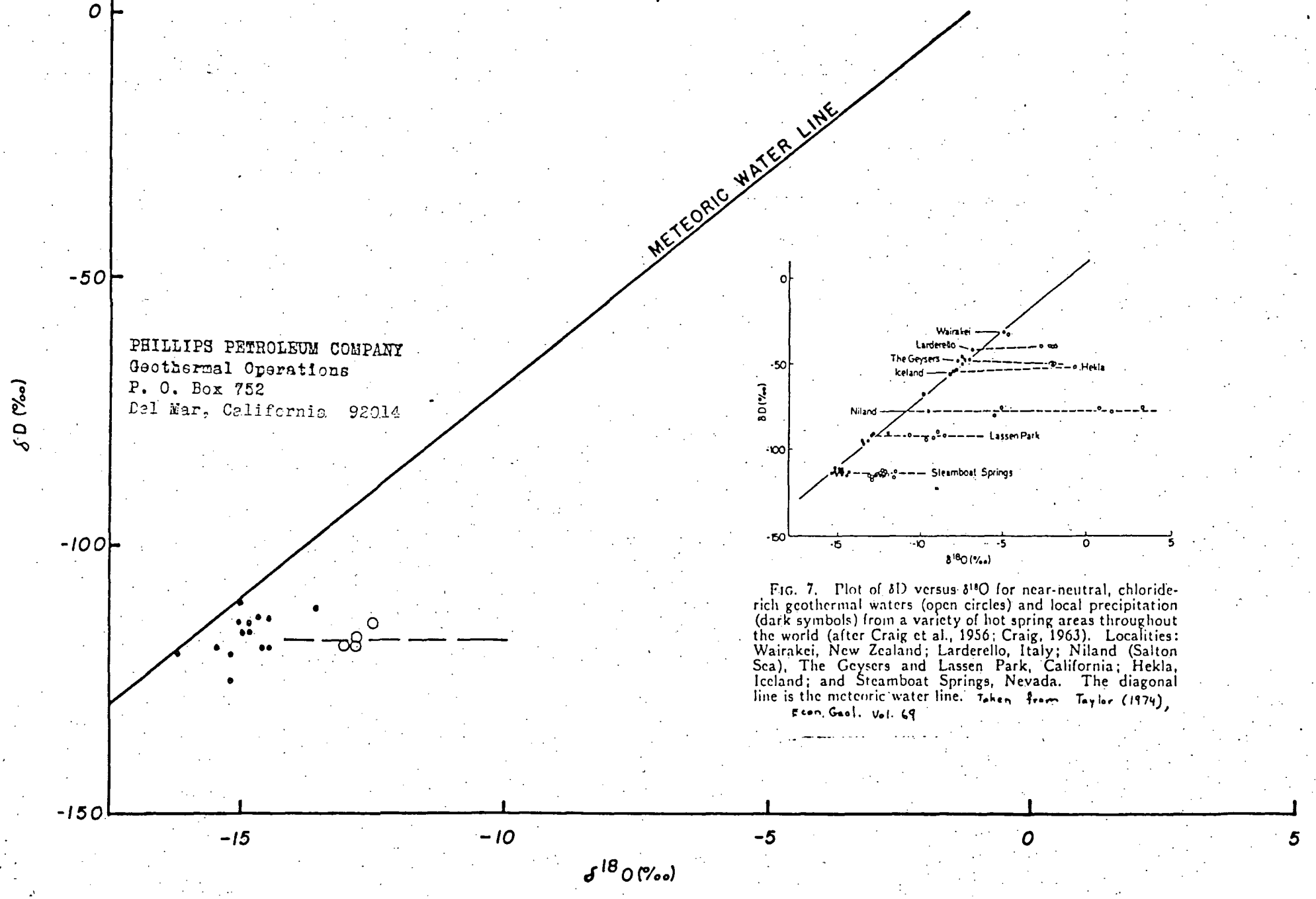
T.30S.
BEAVER COUNTY
IRON COUNTY
MINERSVILLE
QUATERNARY HOT SPRINGS DEPOSITS
QUATERNARY VOLCANICS
TERTIARY VOLCANICS
TERTIARY INTRUSIVES
PALEOZOIC & MESOZOIC SEDIMENTS
PRECAMBRIAN METASEDIMENTS
PRECAMBRIAN METAMORPHICS
PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014
BORON IN PPM
MILES

L-15

PLOT OF δD VERSUS $\delta^{18}O$ FOR CHLORIDE RICH GEOTHERMAL WATERS (OPEN CIRCLES) AND LOCAL PRECIPITATION (DARK SYMBOLS) MILFORD AREA, UTAH



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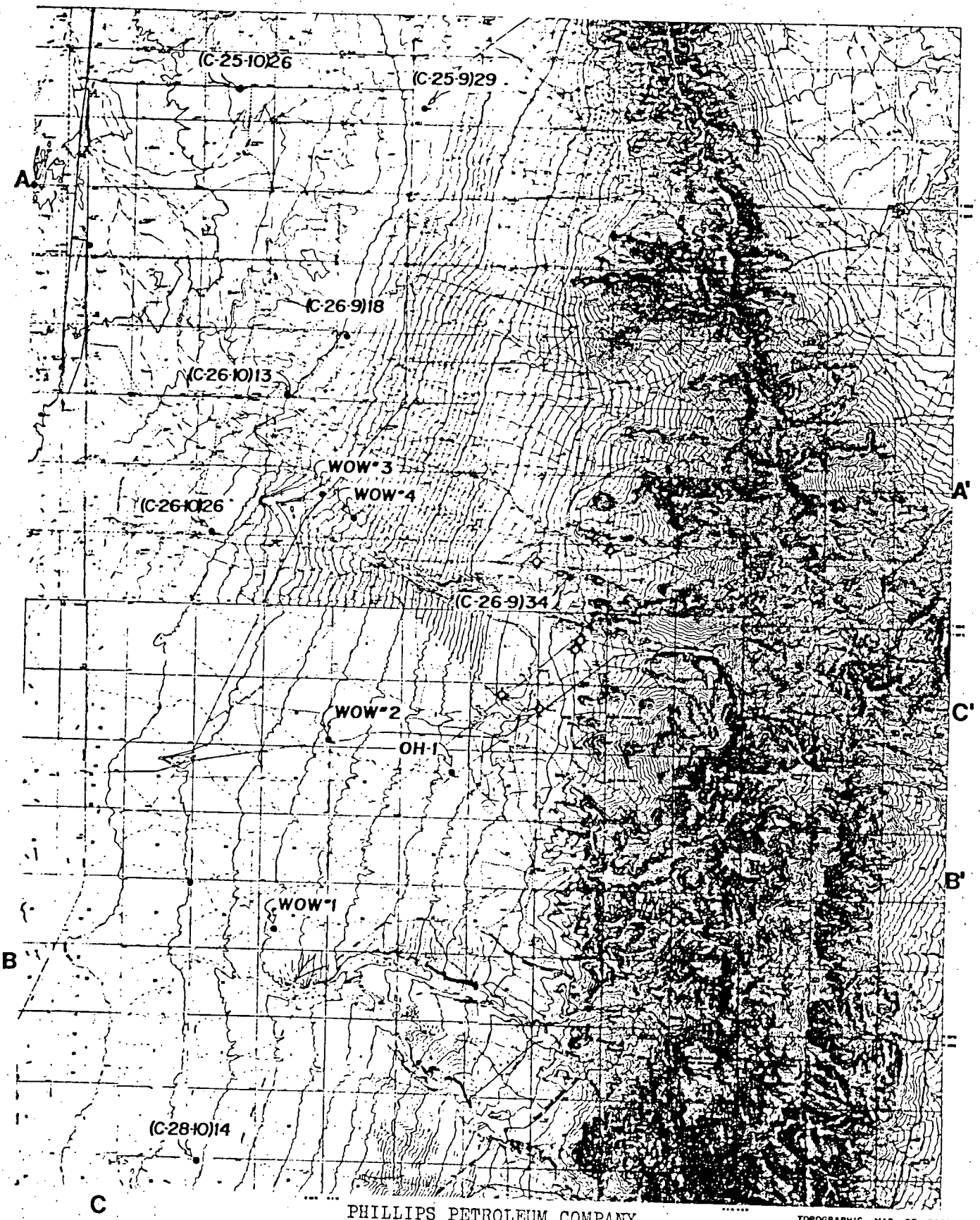
Geothermal Operations
P. O. Box 752
Del Mar, California 92014

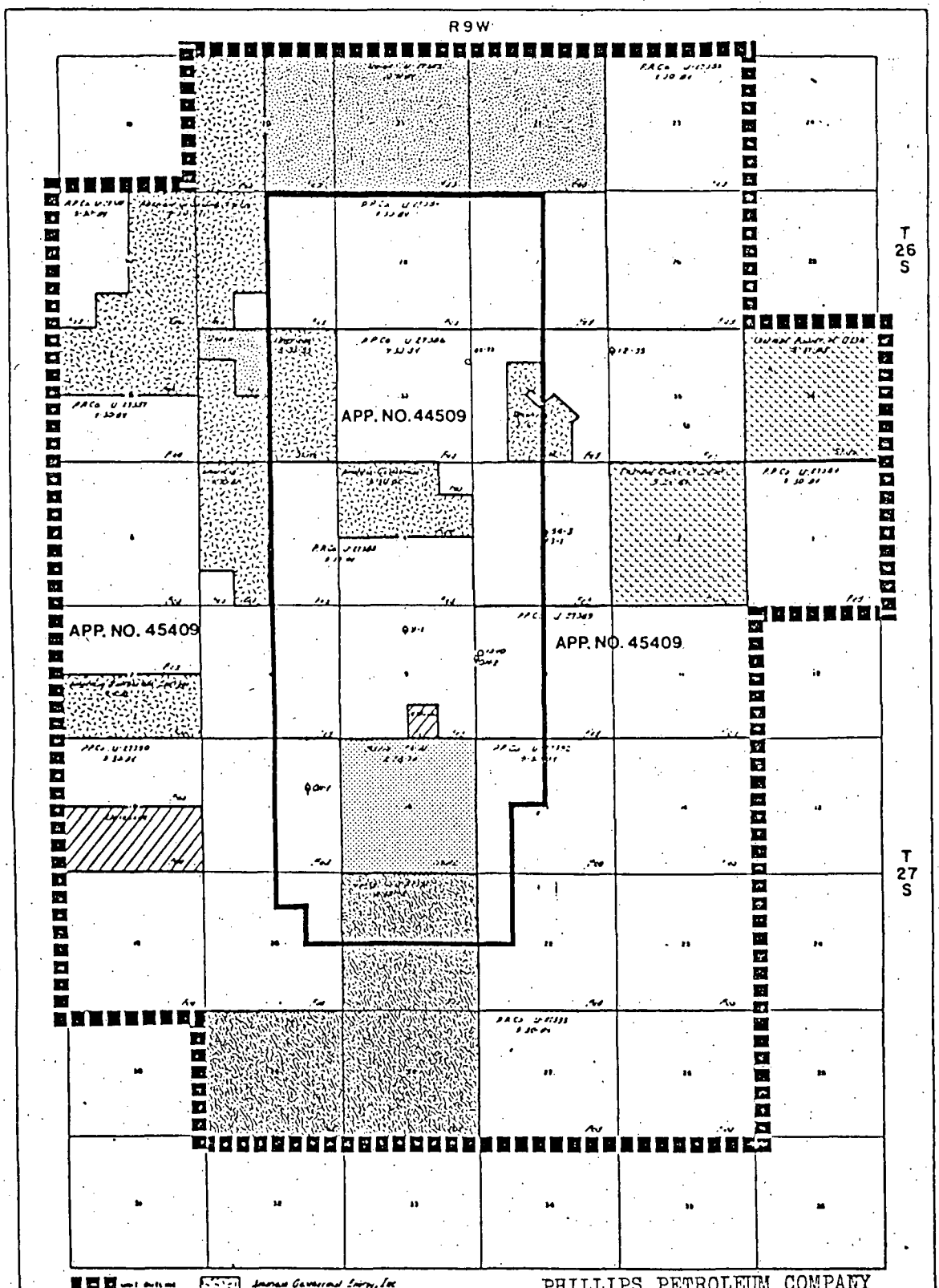
FIG. 7. Plot of δD versus $\delta^{18}O$ for near-neutral, chloride-rich geothermal waters (open circles) and local precipitation (dark symbols) from a variety of hot spring areas throughout the world (after Craig et al., 1956; Craig, 1963). Localities: Wairakei, New Zealand; Larderello, Italy; Niland (Salton Sea), The Geysers and Lassen Park, California; Hekla, Iceland; and Steamboat Springs, Nevada. The diagonal line is the meteoric water line. Taken from Taylor (1974), Econ. Geol. Vol. 69

L-16



TOPOGRAPHIC MAP OF ROOSEVELT KGRA & SURROUNDING AREA

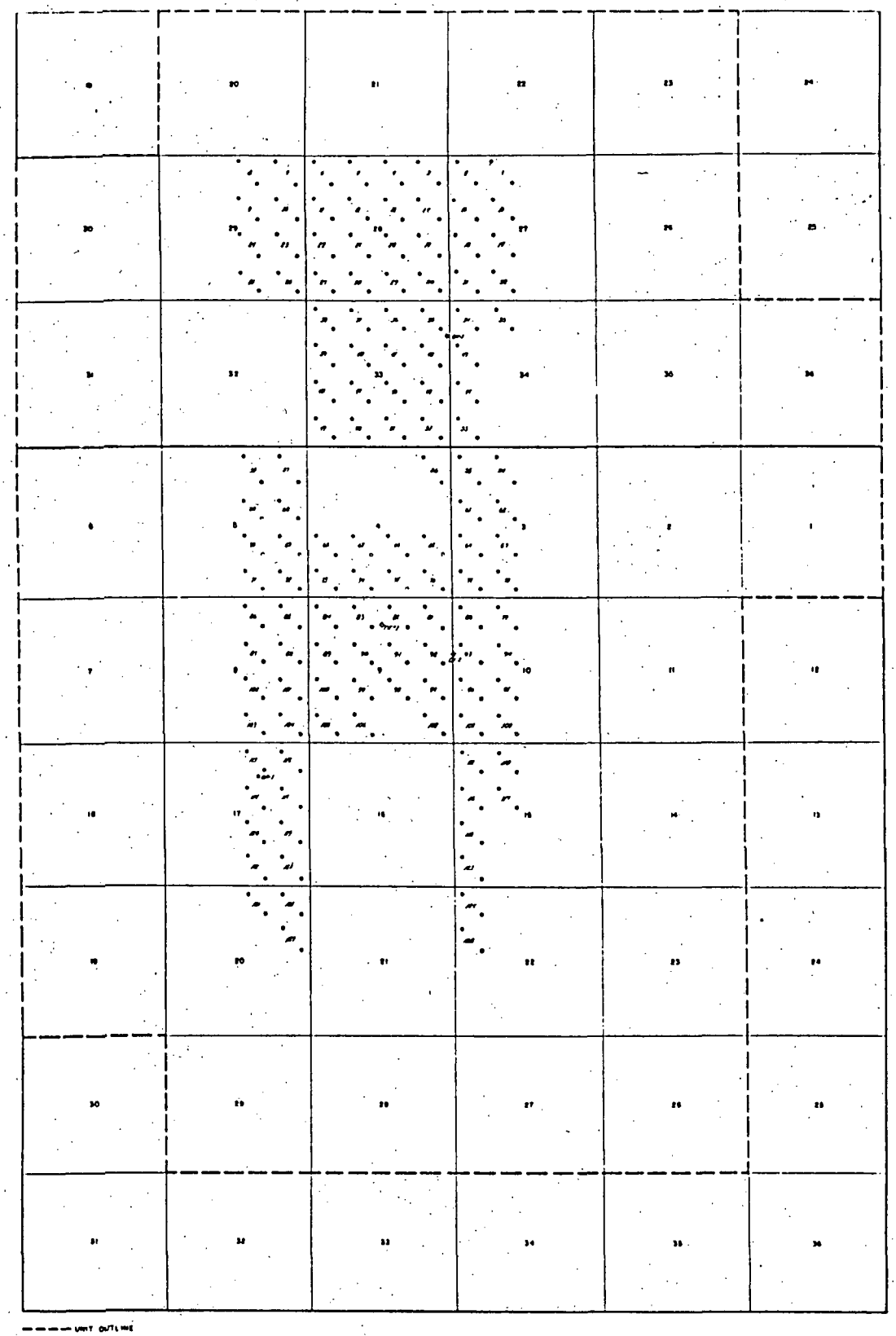
PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014



PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014

ROOSEVELT K.G.R.A. UNIT AREA

R9W



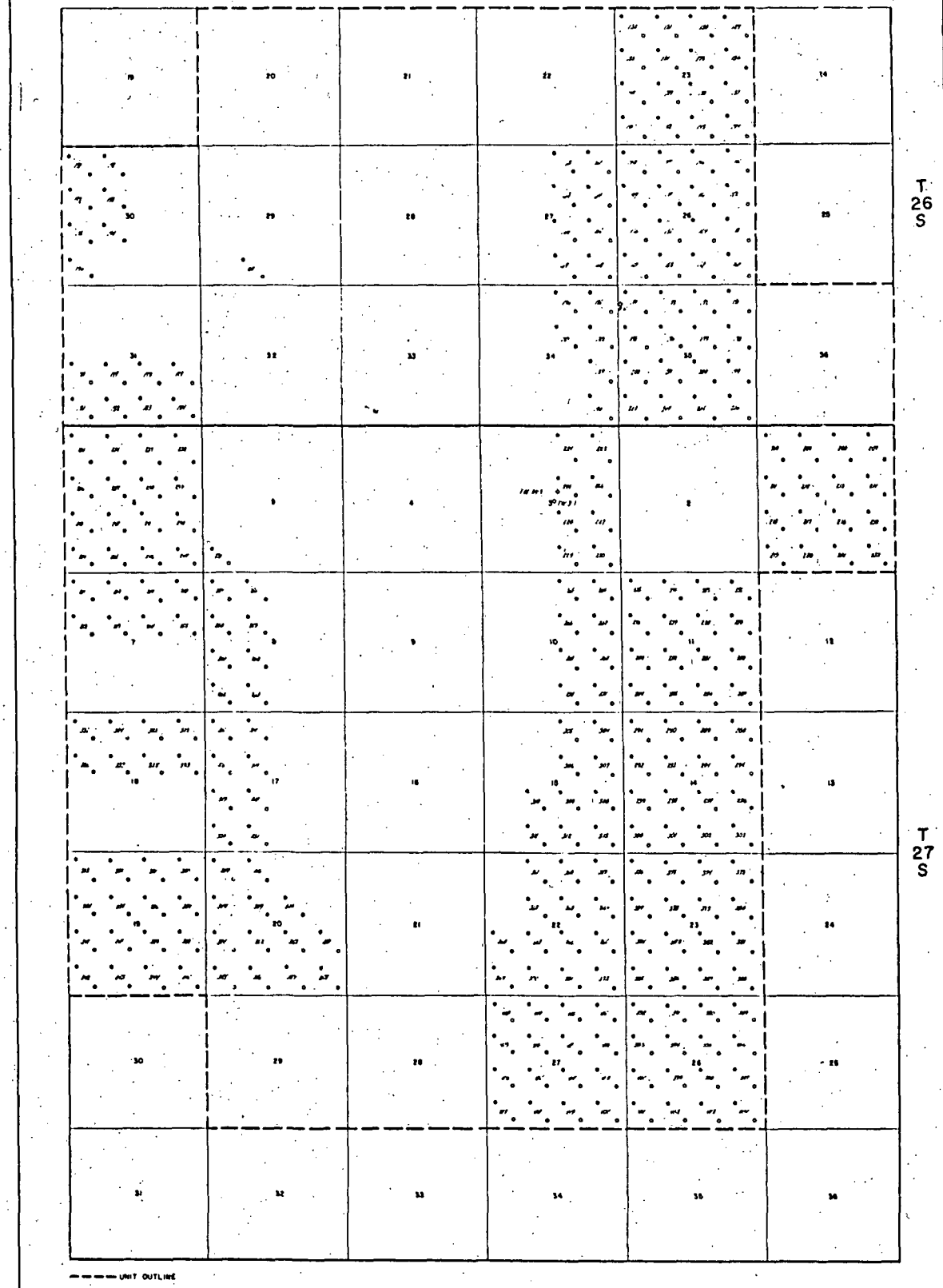
44509 (71-3274)

ROOSEVELT K.G.R.A. UNIT AREA

DRAWN BY: T.L. GRIFFIN
DATE: AUG 27, 1975
SCALE: 1" = 2000'

REVISIONS

PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014



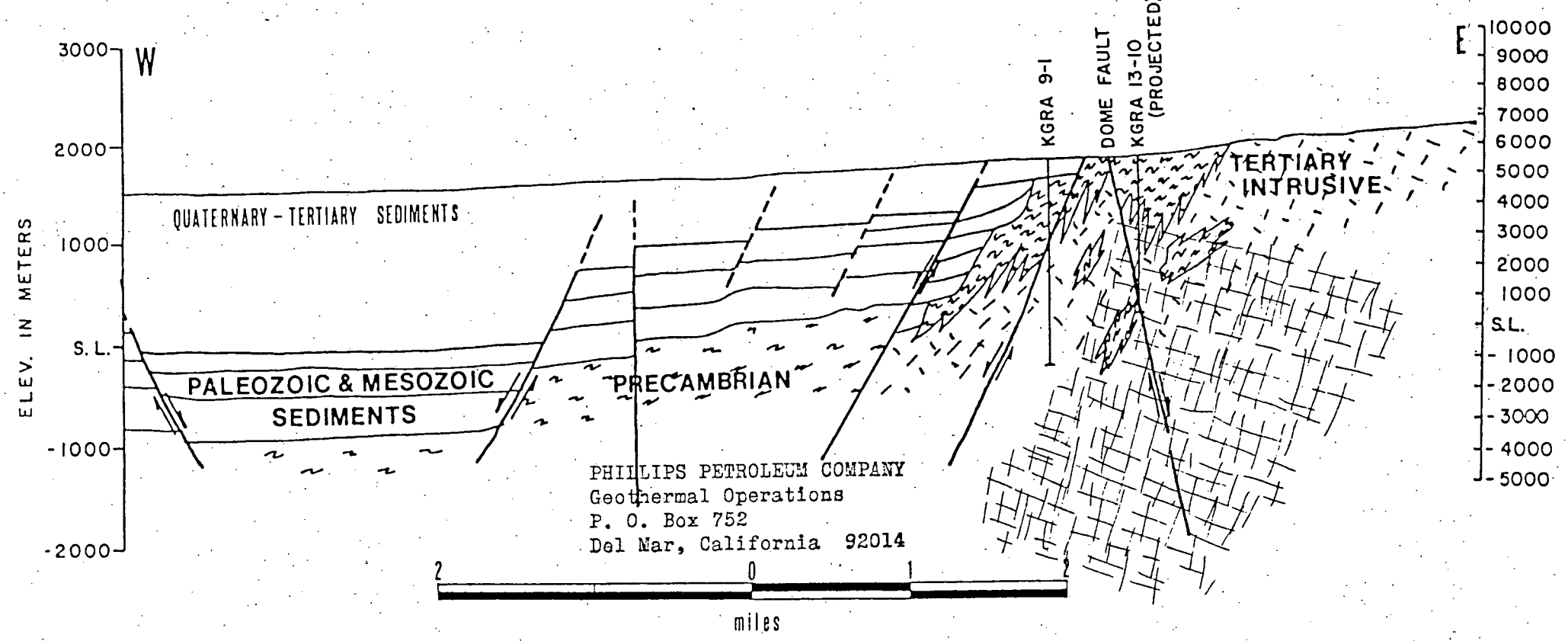
45409 (71-3299)

ROOSEVELT K.G.R.A. UNIT AREA

DRAWN BY: T.L. GRIFFIN
DATE: AUG 27, 1973
SCALE: 1" = 2000'

REVISIONS

PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014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2000
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S.L.
-1000
-2000
ELEV. IN METERS
10000
9000
8000
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S.L.
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-2000
-3000
-4000
-5000
KGRA 9-1
DOME FAULT
KGRA 13-10 (PROJECTED)
QUATERNARY - TERTIARY SEDIMENTS
TERTIARY INTRUSIVE
PALEOZOIC & MESOZOIC SEDIMENTS
PRECAMBRIAN
PHILLIPS PETROLEUM COMPANY
Geothermal Operations
P. O. Box 752
Del Mar, California 92014
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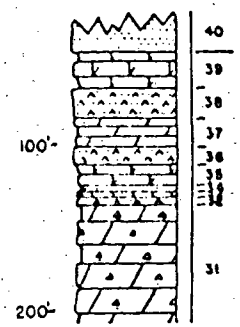
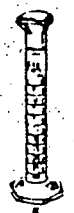
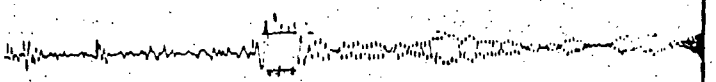
GEOLOGIC EVALUATION



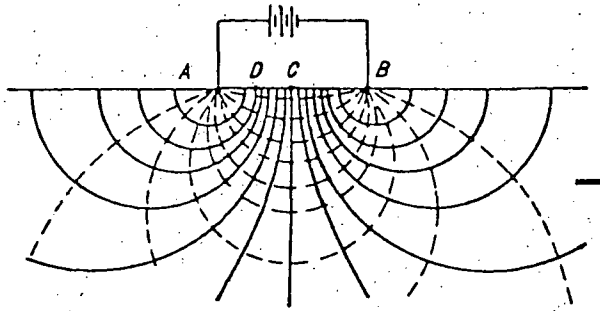
WATER CHEMISTRY



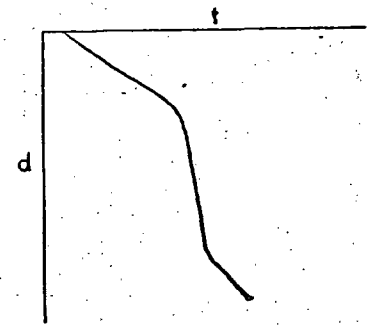
GROUNDNOISE & MICROEARTHQUAKES

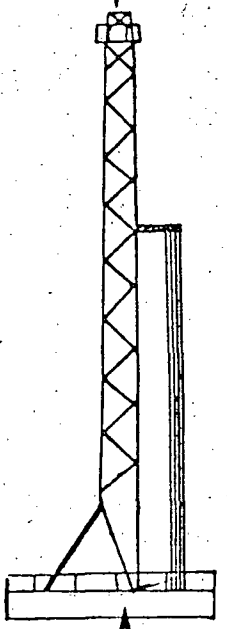


ELECTRICAL

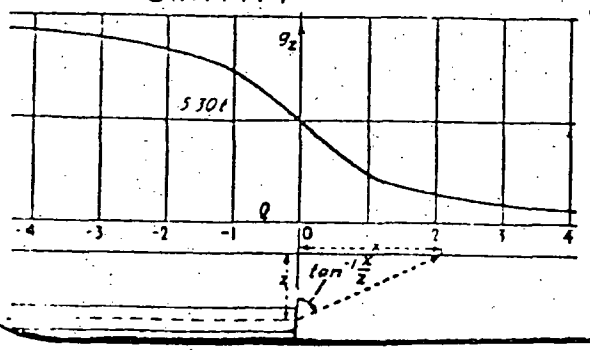


TEMP. GRAIDENT & HEAT FLOW

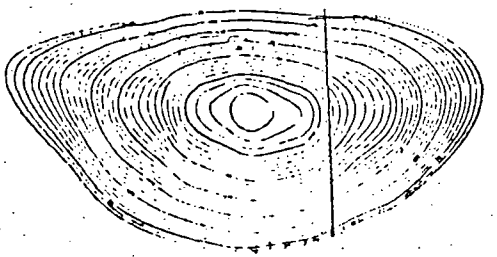




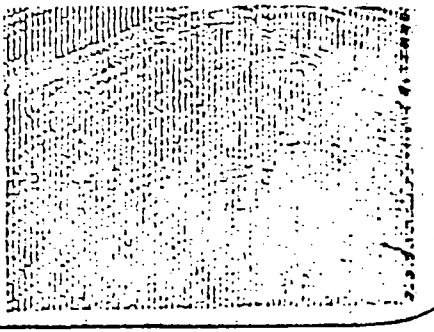
GRAVITY



MAGNETICS



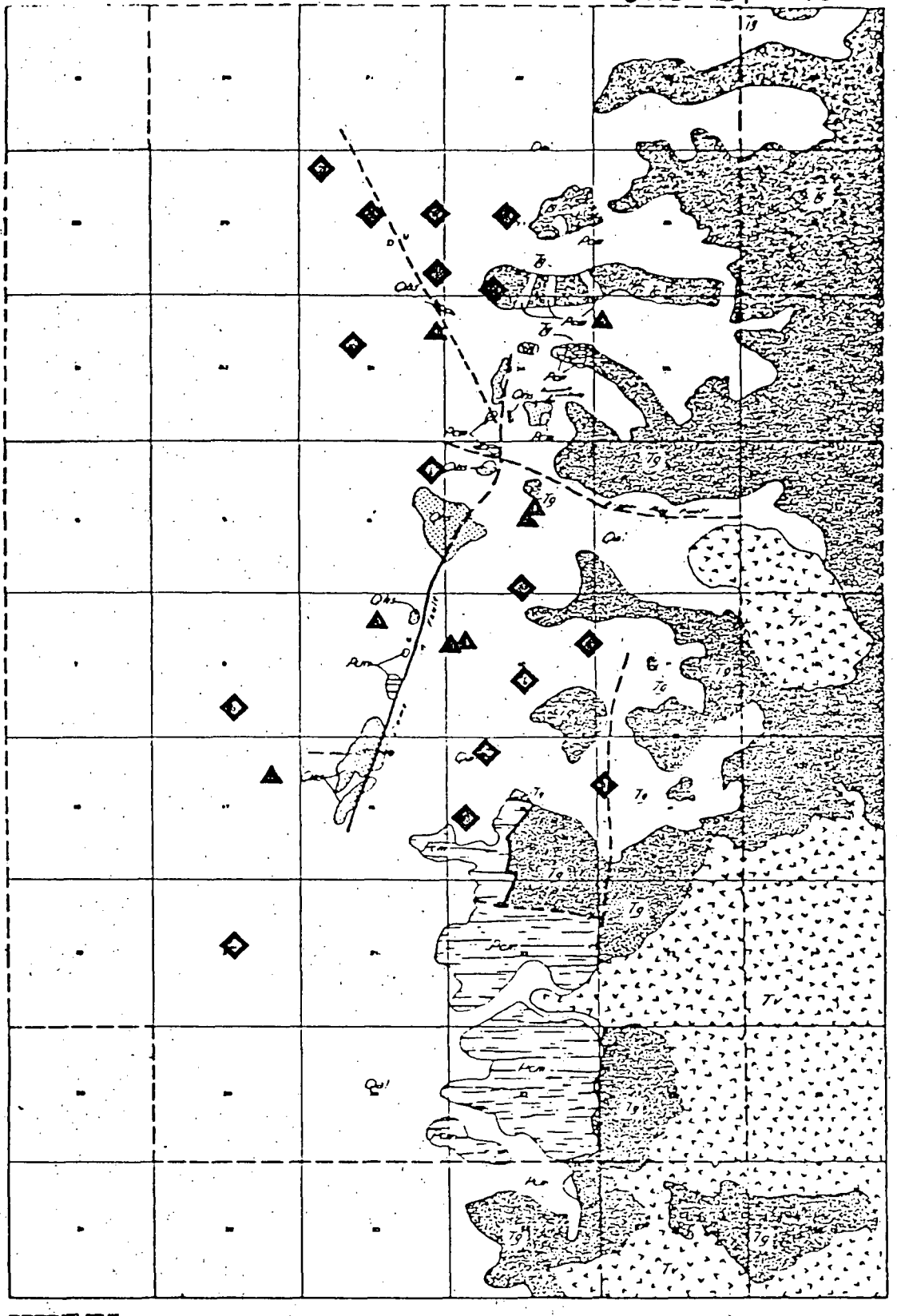
ACTIVE SEISMIC



Pad 4-26-76 SG.

CROSBY - 1

CROSBY - 2



Qal Quaternary Alluvium

Qbs Quaternary Post-Lake Sediments

Tv Tertiary volcanics

Tertiary Granite

Precambrian Metamorphic Rocks

ROOSEVELT K.G.R.A. UNIT AREA

▲ WELLS DRILLED

◆ WELLS PLANNED

ROOSEVELT EXPLORATION COSTS

DRILLING, 8 WELLS	$ 3,440,000.00
TESTING	285,000.00
MAGNETO-TELLURIC SURVEYS	62,400.00
SEISMIC REFLECTION SURVEY	43,500.00
TEMPERATURE GRADIENT SURVEY	42,200.00
DIPOLE SURVEY	21,000.00
GROUNDNOISE SURVEY	16,500.00
GRAVITY SURVEY	8,000.00
SOIL GAS SURVEY	8,000.00
WATER CHEMISTRY SURVEY	4,800.00
MAGNETIC SURVEYS	3,900.00
MICROEARTHQUAKE SURVEY	2,200.00
STAFF AND OVERHEAD	380,000.00
TOTAL	$ 4,317,500.00

TABLE OF UPPER LIMITS OF DISOLVED SOLIDS CONCENTRATION FOR STOCK WATER

Stock	Concentration (mg/l)
Poultry	2,860
Pigs	4,290
Horses	6,435
Cattle (dairy)	7,150
Cattle (beef)	10,100
Sheep (adult)	12,900

From McKee and Wolf (1963)

TABLE 6-6

REPORTED EFFECTS OF FLUORIDES IN DRINKING WATER FOR LIVESTOCK

Fluoride Concentration in mg/l	Dose	Animal	Remarks	Reference
1.0	—	cattle	harmless	292
1.0	—	sheep	fluoride poisoning	1183
1.4–4.5	—	mice	mottling of teeth	3460
—	0.4 mg per kg	cattle	no mottling	353
—	1 mg per kg	rats	mottled teeth	353
—	1 mg per kg	cattle	mottled teeth	1190, 3462
—	3 mg per kg	cattle	bone damage and death	353
—	5 mg	dogs	gave hypotension	3461
4.0	—	sheep	mottled and pitted teeth	1184
5.0	—	cows	disliked water	3457
5.0	—	sheep	slight dental mottling	1671
6 to 16	—	hogs, etc.	severe mottling	1005
11.78	—	cows	mottled teeth	1178
15	—	mice	affected thyroid and kidney	3460
18	—	cows	slowly increasing fluorosis	1190
20	—	sheep	5 percent reduction in weight	1571
25–100	—	young cattle	teeth lesions	3464
44–61	—	sheep	chronic fluoride poisoning	1184
50	—	hamsters	dental fluorosis in 10 weeks	1185
55	—	cows	disliked such water and drank less	1186
—	60 mg per day	sheep	affected teeth and bones	1187
—	65 mg per day	dogs	no effect on organs	3452
—	120 mg per day	sheep	threshold for general health	1187
—	200 mg per kg	rabbits	lethal dose	353
100	—	cattle	no economic harm	3463

From McKee and Wolf (1963)

TABLE 27.—*Relative tolerance of crop plants to boron*

[In each group, the plants first named are considered as being more sensitive and the last named more tolerant. After U.S. Dept. of Agriculture Handbook 60 (1954)]

Sensitive	Semitolerant	Tolerant
Lemon	Lima bean	Carrot
Grapefruit	Sweetpotato	Lettuce
Avocado	Bell pepper	Cabbage
Orange	Pumpkin	Turnip
Thornless blackberry	Zinnia	Onion
Apricot	Oat	Broadbean
Peach	Milo	Gladiolus
Cherry	Corn	Alfalfa
Persimmon	Wheat	Garden beet
Kadota fig	Barley	Mangel
Grape (Sultanina and Malaga).	Olive	Sugar Beet
	Ragged Robin rose	
Apple	Field pea	Palm (*Phoenix canariensis*)
Pear	Radish	Date palm (*P. dactylifera*)
Plum	Sweet pea	Athel (*Tamarix aphylla*)
		Asparagus
American elm	Tomato	
Navy bean	Pima cotton	
Jerusalem-Artichoke	Acala cotton	
Persian (English) walnut.	Potato	
Black walnut	Sunflower (native)	
Pecan		

TABLE 28.—*Rating of irrigation water for various crops on the basis of boron concentration in the water*

Classes of water		Sensitive crops (mg/l)	Semitolerant crops (mg/l)	Tolerant crops (mg/l)
Rating	Grade			
1	Excellent	<0.33	<0.67	<1.00
2	Good	.33-.67	.67-1.33	1.00-2.00
3	Permissible	.67-1.00	1.33-2.00	2.00-3.00
4	Doubtful	1.00-1.25	2.00-2.50	3.00-3.75
5	Unsuitable	>1.25	>2.50	>3.75

From Hem (1970)