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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

APR 16 1979

UNIVERSITY OF UTAH
RESEARCH INSTITUTE
EARTH SCIENCE LAB.

Memorandum

To: Interested Parties

From: Acting Area Geothermal Supervisor

Subject: Plan of Operation for Development and Production,
Union Oil Company, Geysers-Calistoga KGRA, Lake and
Sonoma Counties, Ca.

Union Oil Company has submitted a Plan of Operation for Development and Production in accordance with CFR 270.34 to prepare a drill site and drill well no. 35A-12 as a make-up well for Pacific Gas and Electric's geothermal power plant Units 5 and 6, on private surface land (Stockraising and Homestead Land) (Federal Lease CA-5634, in the Geysers-Calistoga KGRA, Lake and Sonoma Counties, Ca. A copy of the Plan of Operation is attached for your review and files.

An Environmental Analysis (EA#123-9) will be prepared by the Office of the Area Geothermal Supervisor for the proposed action.

Since the subject Plan does not propose any surface disturbance beyond the confines of the existent drill site, no significant environmental impact is anticipated and no field inspection is considered necessary for this proposal. You are encouraged, however, to visit the site at your own convenience. Additional information concerning the proposed operation can be obtained from Ted Hudson, Santa Rosa, District Geothermal Supervisor. (Tel: (707) 525-4326, FTS: 450-4326). Visitors should inform the Santa Rosa office when they propose to be on the site.

We urge you to send written commentary and will appreciate hearing from you even if you are of the opinion that the existing regulations, lease terms, and operational orders provide adequate environmental protection.

All comments concerning the proposed actions should be received no later than April 27, 1979:

Area Geothermal Supervisor
U.S. Geological Survey - Conservation Div.
345 Middlefield Road MS 92
Menlo Park, CA 94025

Tel: (415) 323-8111, Ext. 2848 (FTS: 467-2848)

All comments will be given serious consideration in the preparation of the Environmental Analysis and any subsequent conditions of approval.

The Area Geothermal Supervisor's Office will not send a draft Environmental Analysis to interested parties for review for the proposed action. Certain parties, however, such as the surface managing agency, the lessee, GEAP and USFWS will receive a copy of the completed EA. Other interested parties will not receive a copy of the final EA unless such parties comment on the proposed action in writing or request a copy of the particular EA pursuant to the Freedom of Information Act. Copies of Environmental Analyses are available for inspection during normal business hours at the Area Geothermal Supervisor's Office, the Santa Rosa District Geothermal Supervisor's Office, and the Ukiah BLM District Manager's Offices.

Barry A. Boudreau

Attachment

INTERESTED PARTIES EA #123-2

Union Oil Company
Plan for Development and Production

CA-5634
Geysers-Calistoga KGRA

* * * * *

District Geothermal Supervisor
USGS, Conservation Division
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Conservation Manager, Western Region
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California State Director
Bureau of Land Management
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Utah District Manager
Bureau of Land Management
555 Leslie Street
Utah, California 95426
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U.S. Fish and Wildlife Service
ATTN: Field Supervisory Ecological Serv
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U.S. Fish and Wildlife Service
ATTN: Neil Kscheditich
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Sacramento, California 95825
*FIS: 468-4516 Com: 916-449-4516

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ATTN: Rennie Birona
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Washington, D.C. 20545
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Mr. Jack Miller
California Division of Oil & Gas
240-B Coddingtown Center
Santa Rosa, California 95401
*Com: 707-525-6479

California Department of Fish & Game
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Sacramento, California 95814
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State of California
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Sacramento, California 95811

Regional Water Quality Control Board
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*Tel: 707-545-2620

Governor's Office of Planning and
Research - State Clearinghouse
ATTN: Bill Kirkham and Susan Brown
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INTERESTED PARTIES for EA #123-0

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Native American Heritage Committee
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*916-322-7791

Mr. Tom Cordill
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Mr. John Kramer
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John Emig
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SAYRIGHT Corporation
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INTERESTED PARTIES for EA #125-9

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Environmental Science Associates, Inc
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Foster City, CA 94404
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URS Athion Resources Company
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675-476-5211 702-925-3079

PLAN OF DEVELOPMENT OPERATION
AND
PLAN OF PRODUCTION OPERATION

LEASE NO. CA-5634
SECTIONS 2, 11, and 12 T 11N, R 9W, M.D.B.&M.
BIG GEYSERS, SONOMA COUNTY, CALIFORNIA

UNION OIL COMPANY OF CALIFORNIA
GEOHERMAL DIVISION
2099 RANGE AVENUE
SANTA ROSA, CALIFORNIA 95406
(707) 542-9543

Proposal to commence operations for development and production of the geothermal resource on Lease No. CA-5634 with a production well, related pipelines, and testing and surface facilities necessary to supply steam for the production of electricity.

Estimated Starting Date: June 1, 1979

Estimated Completion Date: Life of project expected to be in excess of thirty years.

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EXHIBITS

Exhibit A	A-1 Vicinity and Location Map
	A-2 Development Plan Map
B	B-1 & B-2 LOCATION SITE PLAN
C	APD and Drilling Program
D	Environmental Baseline Data
E	Manner of Steam Production

UNION OIL COMPANY

PLAN OF DEVELOPMENT OPERATION &
PLAN OF PRODUCTION OPERATION

UNITED STATES GEOTHERMAL LEASE NO. CA-5634

BIG GEYSERS, SONOMA COUNTY, CALIFORNIA

PLAN OF OPERATION

SUMMARY OF PROPOSED ACTION

Union Oil Company proposes herein to commence production operations on Ottoboni Federal Well 35-12 (O.F. #2). The Plans of Development Operation and Plans of Production Operation are submitted in accordance with 30 CFR 270.34. Draft GRO No. 5 has been used as a content and format guide.

Ottoboni Federal Well 35-12 (O.F. #2) will be directionally drilled from Ottoboni Federal 5-1.2 drill site. Union Oil Company plans to use this well as a make-up well for PG&E's geothermal power plant Units 5 and 6.

I. PLAN OF DEVELOPMENT

1. LOCATION

a. Placement of Proposed Operation

Attached hereto and made a part hereof as Exhibit A is a lease and vicinity map (A-1) and a more detailed map of the development area (A-2), which displays topography, drainage patterns, well locations, existing access roads, and power plant site. Per listed criteria in draft GRO No. 5 2.E (1) (a)-(g), Ottoboni Federal Well 35-12 (O.F. #2) is spaced such that optimum production can be obtained with a minimum number of wells. The well will be drilled from the same site as Ottoboni Federal Well No. 1 resulting in a minimum disturbance to the surface and protection of the environment.

b. Site and Access Preparation

Attached hereto and made a part hereof as Exhibit B is drawing No. 3241 sheet 1 (B-1) and sheet 2 (B-2): Ottoboni Federal 5-1.2 Location Site Plan. Exhibit B displays engineering plans for the site expansion, sump construction and existing road alteration.

An investigation including detailed geologic mapping and exploration drilling of three shallow borings was performed on February 1-2, 1977 to assess stability and foundation conditions.

The exposed rock in adjacent road cuts near the Ottoboni Federal Well No. 1 indicate that the topographic nose which the well is situated on is underlain by in-place greenstone rock. The rock is highly fractured and laced with many small shear zones which are intensely weathered. Between the shear zones, the rock is moderately to highly weathered. The fracture spacing is

very close but the individual fragments between fractures interlock. Shallow landslide deposits occur in both the east and west flanks of the nose and could be distinguished from the in-place rock in the road cut.

All three exploratory borings confirmed the presence of in-place greenstone underlying the topographic nose. The borings mainly penetrated intensely sheared and fractured rock. Landslide deposits composed of greenstone debris were delineated on both the west and east sides of the well site. The landslides do not affect the well pad.

2. GEOLOGICAL AND GEOPHYSICAL DESCRIPTIVE INFORMATION

Ottoboni Federal Well No. 1, closest to the proposed well, has penetrated reservoir rock, but it is believed that it has not been drilled completely through the reservoir. The southeastern corner of Lease CA 5634 is expected to be productive, however, reservoir thickness is not known. The rest of this lease will be the subject of future exploration.

Ottoboni Federal Well 35-12 (O.F. #2) is expected to encounter the following lithology when drilled:

Surface to 2200' ±	Greenstone Fg
2200' to T.D.	Graywacke Fs2

For a detailed discussion of lithology please refer to USGS Open File Report #78-389 by R.J. McLaughlin.

The reservoir rock is fractured graywacke (Fs2) type distributed over the developed portion of the Geysers field. Effective porosity is unknown. Anticipated static pressure is 23.3 bars (325 psig) at the wellhead. Anticipated reservoir fluid is steam at or near saturation conditions with no free water.

Flow rates from 30,000 lb/hr to as high as 300,000 lb/hr are possible. Production rates of other wells have demonstrated decline with time.

3. DRILLING PROGRAM

A representative drilling program is contained in the application for "Permit to Drill" (Form 9-331C) (APD) for Ottoboni Federal 35-12 (O.F. #2) which is being submitted concurrently with these Plans of Development Operation and Production Operation. A copy of the APD and drilling program information required by 30 CFR 270.71 are included as Exhibit C. Any well testing, for the purpose of reservoir parameter determination, beyond that of the rig test, will be done flowing into the pipeline.

4. UTILIZATION

Steam produced from the geothermal resource will be utilized by the steam supply system used to drive two steam turbine generators having a nominal capacity of 55 MW each. There are no usable by-products.

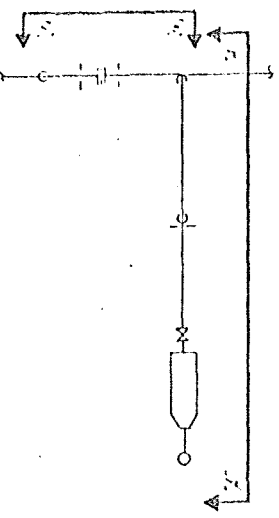
5. SURFACE EQUIPMENT INSTALLATIONS

Included is a detailed description of the surface facilities required to handle the steam production from these wells. Figure I is a system schematic showing the production facilities from the well head to the power plant. Figure II shows a typical well head tie-in assembly.

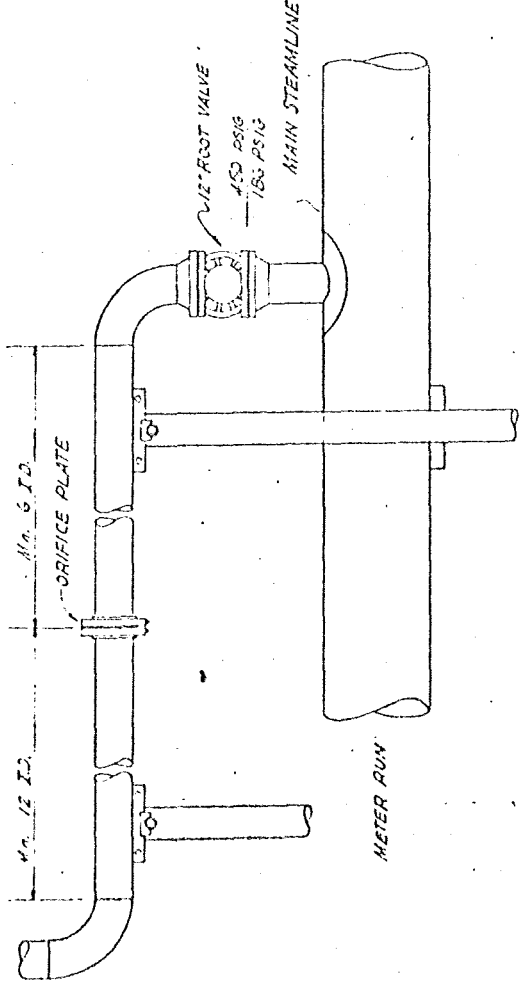
a. Well Head Assembly

The well head consists of a 27.30 centimeter (10 3/4") casing head flange, three 25.40

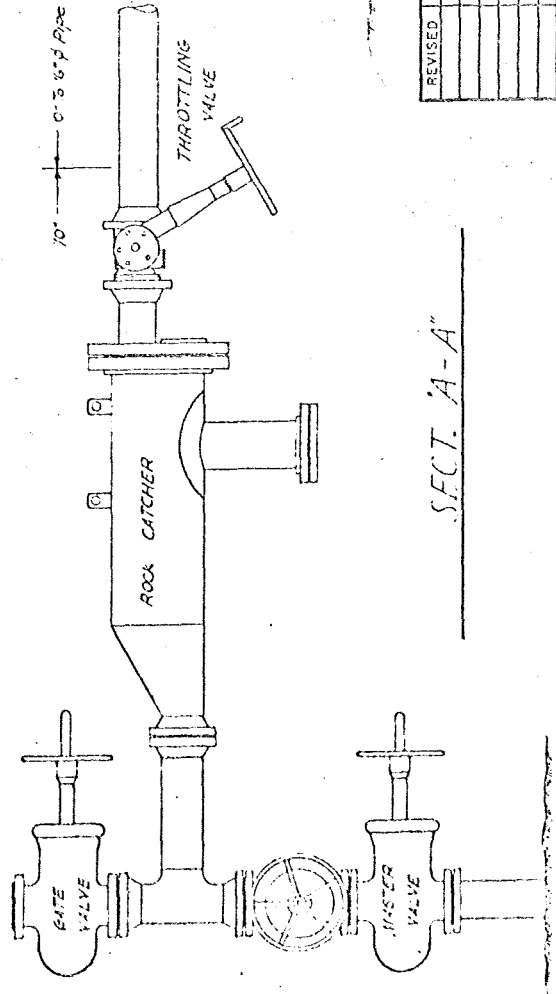
FIGURE II



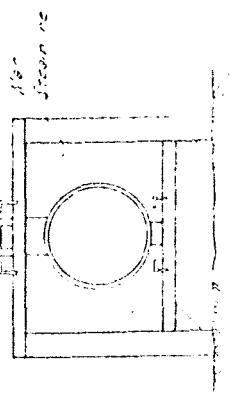
PLAN VIEW



SECT. B-B



SECT. A-A



See drawing set fig. 5025

REVISED	DATE	DRAWN	FOR:
		UNION	UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL DIVISION
			BY:
			DATE:
			SCALE:
			DRAWING NUMBER

TYPICAL WELL HEAD PIPING
THE GEYSERS

centimeter (10") ASA 20.7 bar (300#) WKM through conduit gate valves and one 25.40 centimeter (10") flow tee. The steam flows from the well head flow tee through a rock catcher designed to protect the pipeline and turbine from rock particulates which may be produced with the steam. The rock fragments will be purged from the rock catcher by periodically blowing them out through a 7.62 centimeter (3") vent valve or by manual clean-out.

Down stream of the rock catcher is a throttling valve used to reduce steam flow from the well whenever the plant goes down or to balance steam supply to the plant vs. plant demand.

Orifice flanges are included in the piping down stream of the throttling valve so that the production from the well can be metered and accounted for. A root valve is provided just before the main steam transmission line so that the well head piping assembly can be isolated from the rest of the steam gathering system for required maintenance. The designed working pressure of the well head piping assembly is sufficient to contain the shut-in pressure of the well.

b. Pipeline

The steam flows from the well head assemblage into the steam transmission pipeline which transports the steam to the power plant.

The pipeline is an insulated steel line designed to optimize pressure drop and heat loss. The pipeline will be installed above ground level and routed along existing roads or specially prepared rights of way. Expansion loops, anchors, and supports are installed as required to maintain temperature related stresses at acceptable levels.

The design working pressure of the pipeline is ASA 150# (13.9 bar (188 psi) at operating temperature). The pipeline is designed and installed in accordance with normally accepted codes. Auxiliary equipment associated with the pipeline are burst heads for emergency pressure relief, isolation valves, and condensate removal valves and facilities.

c. Plant Yard Facilities

Plant yard facilities consist of a steam water separator to remove condensate and particulates from the steam prior to delivery to the turbine. Relief valves and mufflers are also included to automatically vent the steam in the event of turbine outage. Yard facilities are designed to adequately handle to 910,000 kg/hr (2,000,000 lbs/hr) of steam required to operate the turbine at full capacity.

d. Safety Provisions

Normally acceptable codes and regulations will be followed during construction and operation. All facilities will have protective over pressure systems designed to prevent damage to equipment of personnel as a result of equipment malfunction.

6. LIQUID DISPOSAL PROGRAM

The energy conversion cycle utilized by PG&E results in 80% of the steam supplied to the turbine being vaporized and exhausted to the atmosphere as steam vapor. Approximately 20% of the steam is condensed and returned to Union Oil. This excess water over flows through a weir in the cooling tower basin, and is disposed of by reinjection into the steam reservoir under a different lease.

Spent liquids (water) from the drilling program are solar evaporated or hauled to a dump approved by the California Water Quality Control Board.

II. PLAN OF PRODUCTION

1. Environmental Baseline Data

In compliance with 30 DFR 270.34 (k) Union has completed a minimum of one year of required environmental baseline monitoring. Descriptions of the studies and summaries of results are presented in Exhibit D.

2. Production

Union plans to finish surface equipment installation, and produce Ottoboni Federal Well 35-12 (O.F. #2) in December, 1979.

a. Use for the Geothermal Resource Production

Geothermal Federal Lease CA-5634 is located in Units 5&6 generating area, hence, most of the steam produced will be used by Units 5&6 to produce electricity. At times, steam may be transported through crossover piping to be used to supply steam to other units within The Geysers project.

b. Manner and Rates of Production, Commingling

Steam from Ottoboni Federal Well 35-12 (O.F. #2) will be produced and metered through the well head assemblage described previously. The metering specifications and methods of accountability are described in the Exhibit E. Steam produced from these wells will be commingled with steam from other leases when it enters the main steam transmission line.

Essentially, the well will be produced at rates, along with other unit supply wells, sufficient to operate Units 5&6 at full capacity. Normal well head flowing pressure is 9.5 to 11.2 bars (125 to 150 psig). Approximately 910,000 kilo-

grams (2,000,000 pounds) of steam per hour at 7.8 bars (100 psig) and 179°C (355°F) are required for turbine operation.

In the event of unit outage, flow to the turbine is automatically shut-off by means of flow control valves. This causes the steam transmission line pressure to increase to a predetermined level at which time automatic relief valves open and the steam is vented through mufflers designed to attenuate noise to reasonable levels. Production from the supply wells is curtailed in accordance with the expected duration of the outage and with predetermined guidelines as described in Exhibit E.

Outages of long duration require that the wells be completely shut-in, with the exception of a small vent to keep the well bores hot, and the pipeline is allowed to cool. Prior to resuming steam delivery to the turbine the wells must be vented to purge the well bore of rock, and then steam must be passed through the pipeline and vented at the muffler to bring the line up to operating temperature, and purge the line of any condensate which might have collected during the shut-in or warm-up operation. Condensate purge valves are located at strategic locations along the pipeline for this purpose.

Steam is sometimes transferred from one unit area to other unit areas to make up steam deficiencies or reduce atmospheric emissions. Steam transferred from one unit area to another area shares in the revenue produced by that unit area in proportion to the quantity of steam transferred to the whole.

Revenue for steam produced is determined by the quantity and value of power produced. The wells serving any unit share in the revenue produced by that unit proportionally to the quantity of steam produced by that well to the whole. No revenue is paid for vented steam.

c. Reservoir Performance Parameters

Reservoir performance parameters will be evaluated using those methods commonly applied by the petroleum engineering profession in evaluating natural gas and saturated steam reservoirs.

d. Processing and Disposal of Waste Products

The significant waste product is the condensate that remains after the energy is extracted from the steam. The condensate from Units 5&6 cooling tower basin will be returned to Union and received in a concrete pond. From here the condensate is disposed by reinjection into existing deep wells according to the North Coast Regional Water Quality Control Board requirements. Condensate reinjection wells are approved and permitted by the State's Division of Oil and Gas.

e. Downhole Production and Processing Facilities

No downhole production or processing facilities will be needed.

III. ENVIRONMENT

1. The proposed measures for protection of the environment are listed below in compliance with section 270.34 (h).

a. Prevention and Control

(i) Fire Prevention Measures

Construction and drilling equipment are equipped with exhaust spark arresters. Smoking will be allowed in designated areas only. Fire extinguisher stations will be established at strategic locations around the drilling rig. Water trucks and sprayers are available to respond to any emergency. Drilling water stored on the drill site (approximately 1113 cubic meters (7000 barrels) is available for fire fighting. PG&E maintains a fire hazard warning sign near the project entrance to remind employees daily of the fire hazard level.

(ii) Soil Erosion

Access Road and Drill Site Pad: Access road and drill site location surfaces shall be sloped to drain toward the cut side or up-slope side of the roadway or drill pad. The slope shall be approximately two feet per hundred feet. A drainage system designed in accordance with the "Standards" of the Division of Highways, State of California, shall be provided to adequately carry away water collected on the surface of the roads or locations as well as water intercepted from upper slopes and natural drainage systems. The drainage system shall consist of ditches on the upslope side of roads and on the upslope perimeter of drill pads. These ditches shall be sloped to drain at a gradient between 1% and 2%, or greater with approval by the Engineer.

Sand/cement-filled bags shall be installed as

energy dissipaters where required to reduce flow velocities and prevent erosion. The drainage ditches shall be conducted to culverts, sized, designed and installed in accordance with the above standards. Culverts shall be installed with sand/cement-filled sand bag headwalls at the entrance, stilling basins at the exit, and shall be extended to existing natural drainage areas. A two-foot-high berm shall be provided along the upper edge of all fill slopes to prevent runoff over the fill.

Treatment of Seepage Zones: Springs and seepage zones uncovered during excavation shall be drained by constructing "French" drains, syphon wells, or other means as determined by the Engineer, and conveyed to natural or site-constructed drainage ways for discharge.

(iii) Protection of Surface and Ground Waters

According to the U.S. Geological Survey, the area is underlain by essentially non-water bearing rocks of the Franciscan assemblage. Further, this site is located where no surface waters occur.

To assure that pollutants do not escape the drill site, drilling wastes, machine drippings, and rain on and around the equipment will be directed into the mud sump.

(iv) Protection of Fish and Wildlife

Habitat disturbance will be confined to the described construction area.

Access road and drill site cut and fill slopes and other areas exposed by grading shall be revegetated with approved grasses and/or woody plants and trees. Areas to be revegetated shall be determined by the Engineer.

The revegetative effort shall be done prior to the

start of the growing season in late summer or early fall in order to utilize the first light rains to germinate grass seeds.

As determined by a soils laboratory determination for soil pH and lime requirement as directed by the Engineer, lime shall be broadcast over areas to be revegetated and mixed with the soil by track walking with track-laying equipment.

For areas to be revegetated, 14-14-14 granular fertilizer shall be applied at the rate of 300 lbs. per acre.

Grass seeds shall be applied at 60 lbs. per acre. The seed mix shall be as follows, depending on availability:

Blando Brome, Wymera Ryegrass or Common Ryegrass	50 lbs. per acre
Red Leafed Clover	10 lbs. per acre

Chopped straw shall be blown over revegetated areas for seed protection and added erosion control when required by the Engineer. The straw shall be tacked with a tackifying agent or "punched" into place

Stream siltation will be prevented by proper erosion control

(v) Protection from Air and Noise Pollution

While drilling with air, dust and noise will be reduced to a minimum by use of the blosie line and separator/muffler. Noise levels will not exceed an equivalent sound level (Leq) of 65 db (A) at a distance of 0.8 km (0.5 mile). The nearest Geysers project property line is approximately 1.6 km (1 mile) away and the nearest residence is approximately 1.6 km (1 mile) away from the drill site.

(vi) Protection of Public Health and Safety

Hard hats will be worn by personnel during construction and drilling.

Personnel will not be allowed in trenches five feet or more in depth.

OSHA regulations will be followed.

Drinking water and sanitary facilities will be provided.

b. Section 270.34 (g), (i) and (j) Compliance(i) Method for Disposal of Waste Materials

Portable chemical sanitary facilities will be used by personnel on the drilling or construction sites. These will be maintained and wastes disposed of by a local contractor. Permanent sanitary facilities will be located at Union's field office.

(ii) Delineation of Potential Environmental Impacts

Union anticipates that there should be only negligible environmental impacts from these proposed operations over and above those from existing approved operations.

c. Crew Size and Housing and Support Facilities

Approximately twelve to fifteen people may be working on the location at any one time during drilling and/or production testing operations. No housing or special support facilities will be required on-site during these operations due to proximity of existing facilities.

2. MONITORINGa. Air Quality/Meteorology

The Stanford Research Institute study begun in 1976,

sponsored by Union Oil Company, PG&E, Aminoil USA and Thermogenics will continue monitoring until April 1979. Additional monitoring is under review by industry and the Northern Sonoma County APCD.

Noncondensable gases will be monitored in accordance with the requirements of the Sonoma County Air Pollution Control District.

b. Water Quality

The long term monthly monitoring study described in references 1 and 2 in Exhibit D "Water Quality" will continue.

Geothermal fluids will be monitored and disposed of in accordance with the requirements of the California Regional Water Quality Control Board, North Coast Region.

c. Noise, Seismic Activity and Land Subsidence Activity

Periodic specific studies will be conducted in the area.

d. Ecological Systems

An evaluation of the effects of development has been conducted (see Exhibit D). Periodic monitoring of indicator species or parameters may be conducted.

IV. EMERGENCY CONTINGENCY PLANS

If any emergency develops or is determined to be impending, appropriate control procedures will be initiated. The specific procedures will vary greatly depending on the nature of the problem. During the years of operation Union has developed the following Contingency Plans for the Big Geysers Project.

- Fire Prevention and Control Plan
- Emergency Medical Response and Transport Plan

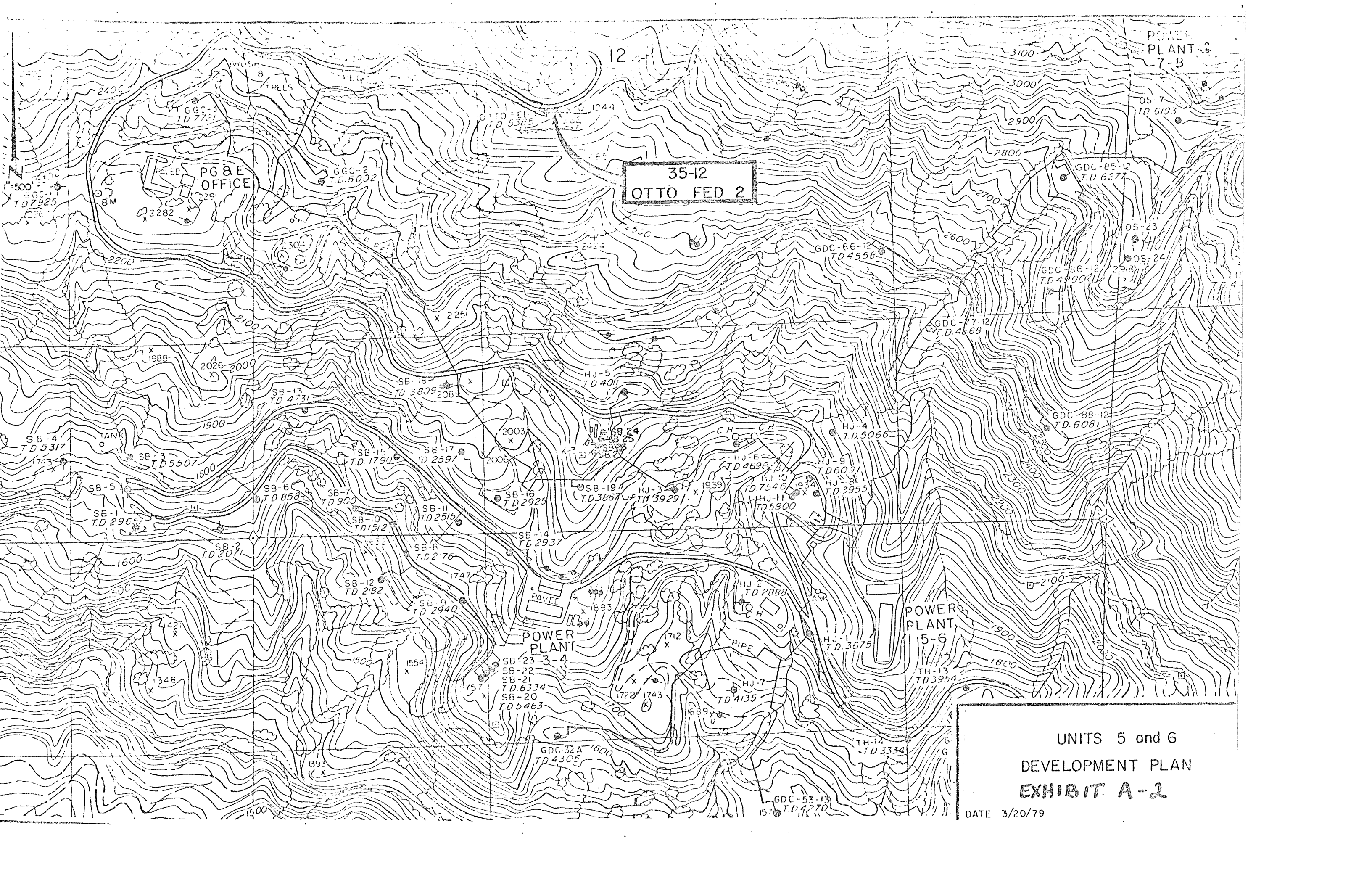
- Hydrogen Sulfide and Ammonia Contingency Plan
- Spill Prevention Control and Countermeasure Plan
- Geothermal (Water) Fluid Spill Control Plan

A copy of each Contingency Plan is available to each employee who operates in field and copies are sent to respective local, state and federal agencies. These Plans are updated periodically and training sessions are held to acquaint the operation personnel with recent developments and improved operation procedures.

EXHIBIT A

A-1 VICINITY AND LOCATION MAP

A-2 DEVELOPMENT PLAN MAP



35-12
OTTO FED 2

PG&E
OFFICE

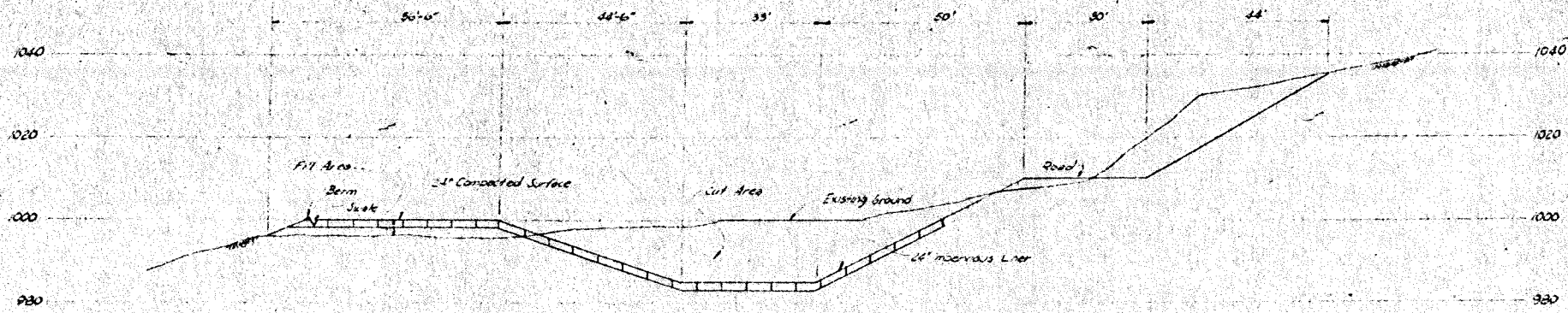
POWER
PLANT
7-8

POWER
PLANT

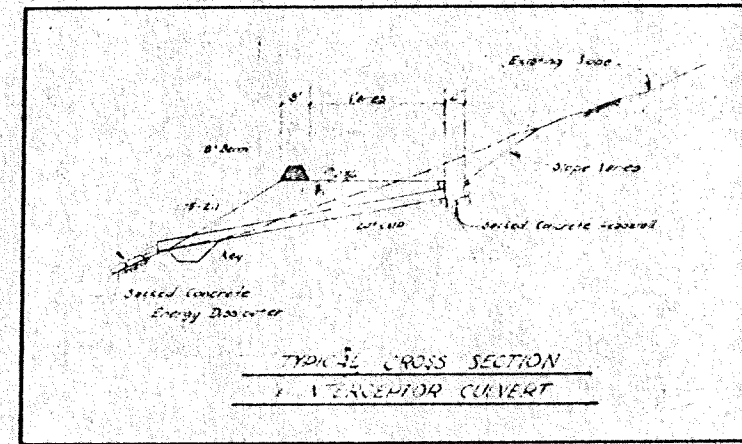
POWER
PLANT
5-6

UNITS 5 and 6
DEVELOPMENT PLAN
EXHIBIT A-2

DATE 3/20/79

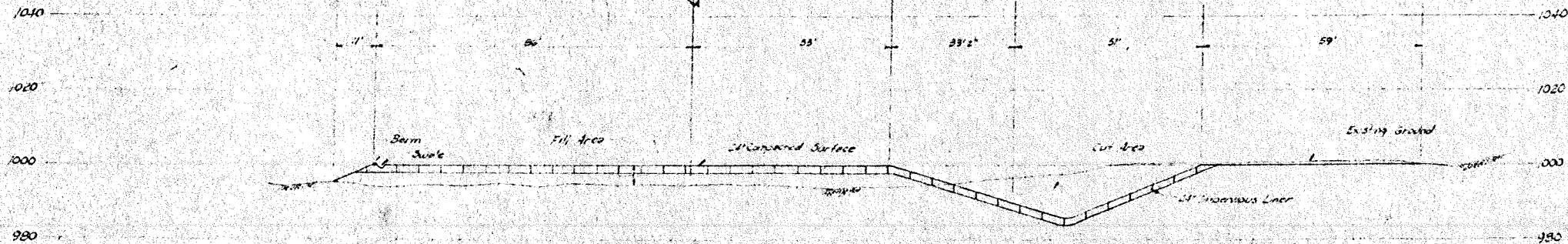


ELEV. "B-B"



TYPICAL CROSS SECTION
12\"/>

Proposed H&M 0+00 Loc. #2



ELEV. "A-A"

EXHIBIT B-2

REVISED		UNION 76	
Date	By		
		UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL DIVISION	
		OTTOBONI FEDERAL 5-1.2	
		LOCATION, SITE PROFILE (Wells Otto Fed. 142)	
		THE GEYSERS SONOMA CO. CALIF.	
DRAWN	DATE	SCALE	DRAWING NUMBER
For: REC	3-5-76	1"=40'	5-41
By: [Signature]			Sheet of 2 Sheets

EXHIBIT B

B-1 & B-2 LOCATION SITE PLAN

EXHIBIT C
DRILLING PROGRAM

CONFIDENTIAL

This document contains
confidential information
which is proprietary to
United Oil Co. of Canada.
The contents of this
document are not to be
revealed to any party
without the express
written consent of United
Oil Co. of Canada.

EXHIBIT D
ENVIRONMENTAL BASELINE DATA

EXHIBIT D

ENVIRONMENTAL BASELINE DATA

The Geysers geothermal field has been the object of numerous extensive environmental studies and monitoring programs. Thus, the effects of geothermal development in The Geysers are well defined and well documented. Of the many potential environmental hazards, some have been proven insignificant and some have been mitigated by improved technology and/or improved operating practices. The odor of hydrogen sulfide receives the most attention and is the most significant impact on the local environment.

A general evaluation of the baseline environmental conditions can be reviewed in the Environmental Impact Report, "The Geothermal Leasehold of Union Oil Company at The Geysers, Sonoma County, California," February 1975. The following are studies and monitoring programs conducted to evaluate the areal air quality, water quality, noise, seismic activity, subsidence activity and ecological systems:

a. Air Quality

The air quality in The Geysers area has always been influenced by geothermal emissions. Before the advent of geothermal resource development, fumeroles and hot springs were reported to emit loud noises, billowing tall plumes and the putrid odor of rotten eggs. Development has increased the emissions and several studies have been conducted to ascertain the compositions and quantities of emissions, the meteorology of The Geysers area and the ambient air quality. The subject lease is a part of the area studied.

Meteorology and Hydrogen Sulfide

1. R.E. Ruff, L.A. Cavanaugh and J.D. Carr, "1976-77 Biennial Report -- Specialized Monitoring Services", SRI International, December 1978.

The SRI Geysers monitoring network was established

in January of 1976 to quantitatively assess hydrogen sulfide concentrations in the vicinity of The Geysers, define population exposure to H₂S and define meteorological conditions in the area. The network which has operated continuously for over three years now, consists of 8 automatic monitoring stations (Figure 1-A) measuring H₂S concentration, SO₂ concentration (2 stations), wind speed, wind direction, temperature and precipitation.

Analysis of the data has shown the California State standard of 0.03 ppm to be equaled or exceeded up to 0.7% of the time at stations near populated areas in Lake County (3,4,5,6 & 7).

2. S.L. Altshuler, "Ambient Air Quality At and In the Vicinity of The Geysers, 1970-75," PG&E, April 1976.

Prior to the installation of the SRI network, PG&E conducted air quality sampling at several locations. In the above study ambient concentrations of hydrogen sulfide (H₂S) at sample location #27, approximately one-quarter of a mile southwest of Ottoboni Federal Well 35-12 (O.F. #2) location, were an average 23 parts per billion by volume for the time period 1972 to 1975. From this study it was revealed that 84 percent of the measured H₂S concentrations were less than the State ambient air standard of 0.03 parts per million at The Geysers Power Plant areas. The study indicated the presence of nocturnal inversions within the Big Sulphur Creek Valley can result in a buildup of H₂S concentrations.

Suspended Particulate Matter

1. "High Volume Air Sampler Data, Feb. 6, 1977-Aug. 17, 1977", Environmental Systems and Service.

In this study suspended particulate matter

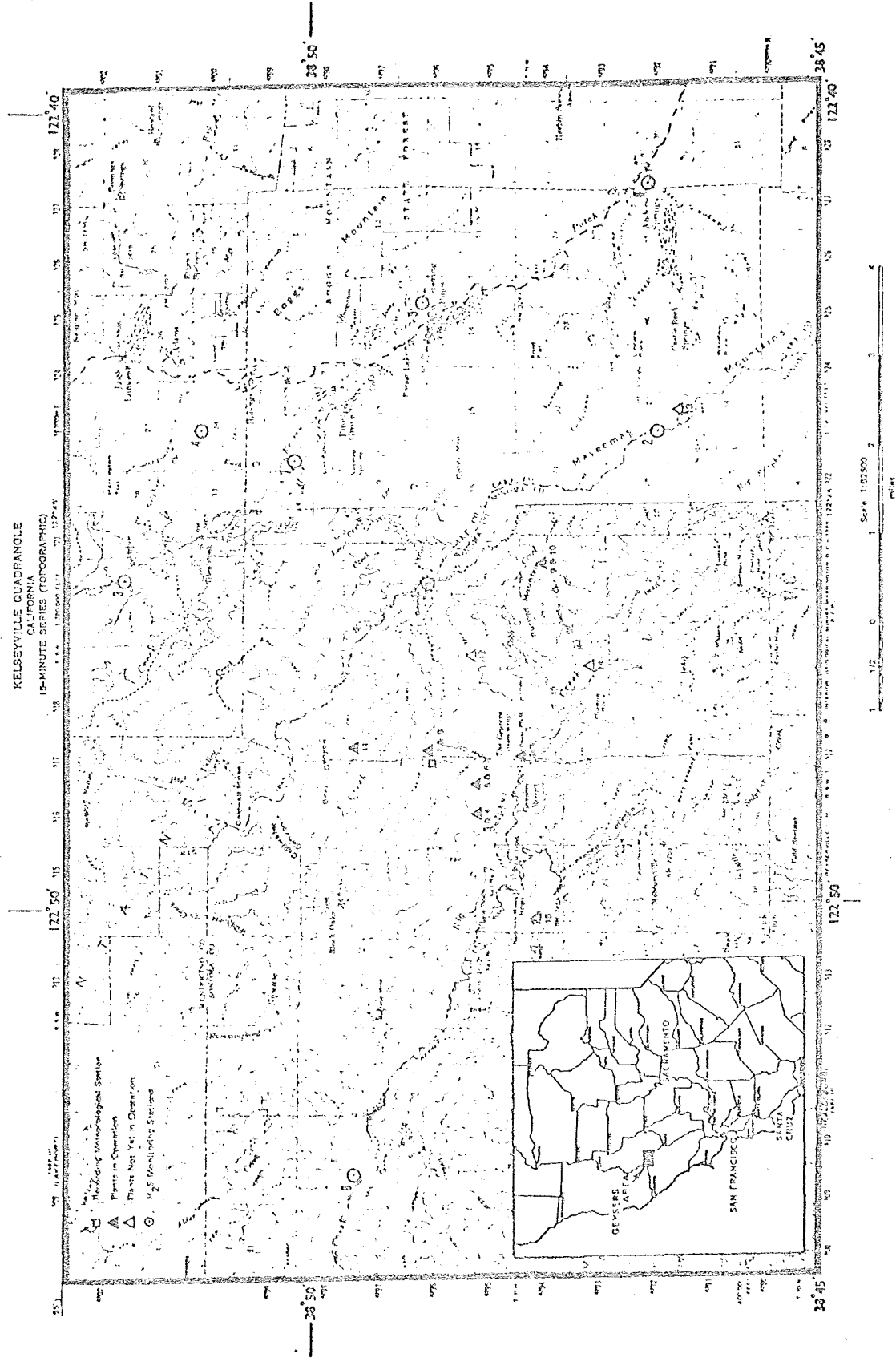


FIGURE 1-A MAP OF AREA AROUND THE GEYSERS SHOWING POWER PLANT AND MONITORING NETWORK LOCATIONS

was measured at ten locations around The Geysers and surrounding areas. The ten sampling stations and their respective geometric means from February 6, 1977, to August 17, 1977 are as follows:

<u>Station Number & Location</u>	<u>Suspended Particulate Weight in mg/m³</u>
#1 - Geysers Rock	19
#2 - Anderson Ridge	20
#3 - Kahm Ranch	16
#4 - Central-Hobergs	16
#5 - Whispering Pines	17
#6 - Anderson Springs	28
#7 - Sawmill Flats	32
#8 - Big Sulphur Creek	19
#9 - Power Plant 7 & 8	23
#10 - Middletown	35

All values are lower than the State standard of 60 mg/m³ mean annual particulates.

Intensive testing by the Northern Sonoma County APCD and Union Oil Company, during Dec. 1976 and Jan. 1977, revealed similar results to the above. Samples were collected every other day. Samples were collected once every six days in the February-August study.

- O.D. Whitescarver, "Mufflers to Abate Noise and Particulate Emissions from Geothermal Development Operations," presented at 3rd Annual Geothermal Environmental Conference, May 10, 1978.

Also, a long-term total suspended particulate matter monitoring program has been conducted near Unit 3 and 4 at the Union Oil maintenance shop. Records from April, 1975, to June, 1976, show that the stated 24-hour ambient air quality standard of 100 mg/m³ was exceeded on 6 days. The geometric mean for the period April, 1975, to March, 1976, was

43 mg/m³. The high values correlated to unusual local activity such as sweeping the parking lot.

Radon 222

1. D.P. Serpa, "Summary Report of The Geysers Radiological Measurement Program," PG&E, May 3, 1978.

This report, by PG&E Department of Research, summarizes the results and conclusions of radiological reports done from 1974 to 1978 by the following:

2. Serpa, D.P. 1974, "Measurement of Radon 222 at The Geysers Power Plant", PG&E.
3. _____ . 1975, "The Determination of the Source of 210-Pb in Cooling Tower Sludge at The Geysers Power Plant", PG&E
4. _____ . 1977, PG&E Department of Engineering Research, San Ramon, CA private communication.
5. Anspaugh, et al, "The Geysers Power Plant: Environmental Impact of the Release of 222-Rn. L.L.L., 1977.
6. Anspaugh, L.R., "Final Report on the Investigation of the Impact of the Release of 222-Rn, Its Daughters, and Precursors at The Geysers Geothermal Field and Surrounding Area," L.L.L., 1978.
7. LFE Environmental, "Investigation of the Release of Radon 222, Its Daughters, and Possible Precursors at The Geysers Geothermal Field and Surrounding Areas". 1975.

The summary report indicated that the geometric mean concentration of the measurements taken

was 0.00112 WL, well below the applicable standard of 0.01 WL for continuous exposure in uncontrolled areas. The overall conclusion was that the operation of The Geysers Power Plant has no discernable impact upon the radiological environment of the surrounding area. This is because the amount of radon 222 released by the operation of the power plant is small in comparison to the radon 222 exhaled from soil in the general area.

b. Water Quality

The subject lease, U.S. Geothermal Lease CA-5634, is in the Russian River watershed. Squaw Creek flows in a westerly direction, north of the lease, into Big Sulphur Creek. The southern end of the lease containing Ottoboni Federal Well 35-12 (O.F. #2) site location is part of the Big Sulphur Creek watershed. The proposed site is located 4000 feet from Big Sulphur Creek. Big Sulphur Creek and its tributaries drain a watershed of about 82 square miles before joining the Russian River. Several studies have been completed on the Big Sulphur Creek system and a long-term monitoring program continues.

1. D.G. Price and D.P. Griffin, "An Evaluation of Stream Water Quality Monitoring Data Collected from May, 1968, Through May, 1975 At The Geysers and Its Implications to the Biological, Chemical, and Physical Environment", PG&E, Nov, 14, 1975.

In the above report Squaw Creek was sampled immediately upstream from its confluence with Big Sulphur Creek and Big Sulphur Creek was sampled immediately upstream of its confluence with Squaw Creek. The sampling locations are shown as locations 5 and 6 on the following map. The mean values of parameters of interest are as follows:

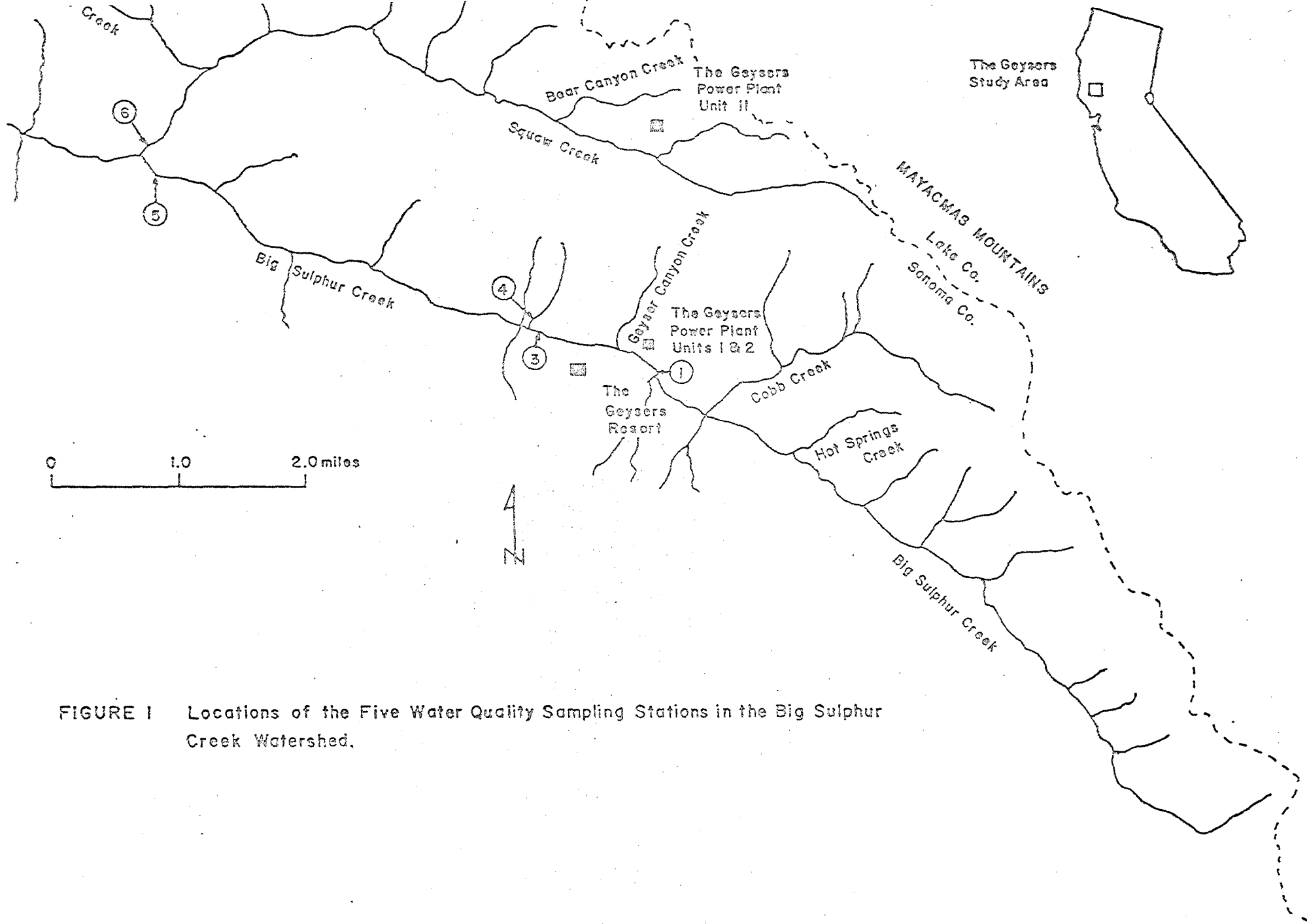


FIGURE 1 Locations of the Five Water Quality Sampling Stations in the Big Sulphur Creek Watershed.

Parameter	Squaw Creek	Big Sulphur Creek
Flow (GPM)	3821	7007
Temperature (°F)	52	55
PH	8.3	8.2
Color (Alpha)	12.0	15.1
Turbidity (JTU)	12.7	20.7
Settleable Solids (mg/l)	10.7	28.1
Dissolved Oxygen (mg/l)	10.7	10.4
NH ₃ -N (mg/l)	0.04	0.30
NO ₃ -N (mg/l)	0.14	6.66
SO ₄ (mg/l)	17.95	107.2
Boron (mg/l)	0.21	3.3

2. R.S. LeGore, "The Effects of Geothermal Energy Utilization on Stream Biota and Water Quality At The Geysers, California", Parametrix, 1975.

This extensive study took place between April 1974 and June 1975. The object of the report was to measure the possible effects of the geothermal development on stream life. The study concluded that any variations from normal populations, because of higher than normal ammonia concentrations and temperatures in certain areas, are due to natural phenomena.

In the above report Squaw Creek and Big Sulphur Creek were both sampled immediately upstream of their confluence as in the former report. The data collected from this report is displayed in Table I-A and II-A.

c. Noise

The report by Whitescarver (reference #2 under "Suspended Particulate Matter") describes a long-term monitoring program near Unit 3 & 4 at the Union Oil

TABLE II-A

BIG SULPHUR CREEK

Water quality characteristics at station BS 11.9 throughout the study effort.

Characteristic	Units	1974					1975		
		May	June	July	Sept.	Nov.	Jan.	Feb.	Mar./Apr.
Flow	cfs	5/9	6/8	7/13	9/17	11/10	1/5	2/9	4/5
Discharge	MGD	1130	1435	1100	0940	1100	0935	0815	1330
Water Temperature	°C	22.8	29.5	29.0	20.1	--	6.7	11.7	10.6
Air Temperature	°C	18.9	27.0	21.2	16.0	11.2	6.1	10.6	11.1
Stream Flow	cfs	20.7	7.5	6.7	4.9	2.22	22.4	--	--
Total Coliform	MPN/100 ml ²	150	1100	1100	240	--	--	--	--
Turbidity	JTU	3	<1	2	2	--	<1	170	6
pH	APHA	5	--	--	--	--	--	--	--
Hardness	mg/liter	8.3	8.2	8.4	7.8	7.6	7.8	7.1	6.5
Total Solids	mg/liter	134.7	142.5	137.0	144.2	154.8	126.8	47.6	82.2
Filtrable Solids	mg/liter	<0.1	--	--	--	--	--	0.25	--
Filtrable, Filtrable	mg/liter	20	--	--	--	--	--	111	--
Filtrable, Non-filtrable	mg/liter	0	--	--	--	--	--	194	--
Filtrable, Total	mg/liter	20	--	--	--	--	--	305	--
Iron	mg/liter	8.0	--	24.0	22.0	22.0	6.2	6.7	1.0
Copper, Total organic	mg/liter	21	--	--	--	--	--	--	--
Copper, Total	mg/liter	1.0	--	--	--	--	--	--	--
Nitrate Nitrogen	mg/liter	1.20	--	0.26	0.34	0.40	0.074	<0.01	0.039
Nitrite Nitrogen	mg/liter	--	--	4.5	11.8	--	3.40	0.42	0.48
Nitrogen, Ammonia	mg/liter	1.18	0.22	0.26	0.16	4.80	5.75	1.56	3.30
Nitrogen, Un-ionized	mg/liter	0.10	0.03	0.03	--	0.05	0.049	0.005	<0.004
Nitrogen, Dissolved	mg/liter	8.2	8.4	9.2	8.6	11.0	11.4	10.4	8.9
Sulfate	mg/liter	58.0	80.0	98.0	140.0	150.0	62.0	9.1	39.0
Sulfide	mg/liter	<0.02	--	--	<0.1	--	--	--	--
Ammonia, Free	mg/liter	--	--	<0.1	--	--	--	--	--
Ammonia, Total	mg/liter	--	--	0.1	--	--	--	--	--
Chlorinated Hydrocarbons:									
Heptachlorepoxyde	µg/liter	--	--	--	--	--	--	--	--
Other known metabolite	µg/liter	--	--	--	--	--	--	--	--
Similar to above	µg/liter	--	--	--	--	--	--	--	--
Mercury	µg/liter	<0.2	--	--	--	--	--	--	--
Lead	µg/liter	0.40	<0.05	--	<0.3	--	1.7	--	--
Cadmium	µg/liter	<3	--	--	--	--	--	--	--
Copper	µg/liter	5.0	6.2	4.0	2.0	1.0	<0.4	<0.04	1.7
Iron	µg/liter	<1	--	--	--	--	--	--	--
Nickel	µg/liter	<0.2	--	--	--	--	--	--	--
Chromium	µg/liter	<0.02	--	--	--	--	--	--	--
Manganese	µg/liter	0.10	--	--	--	--	--	--	--
Zinc	µg/liter	<0.02	2.06	<0.02	0.65	1.10	0.02	<0.02	0.02
Fluoride	µg/liter	4.5	--	--	--	--	--	--	--
Chloride	mg/liter	<0.5	--	--	--	--	--	--	--
Sulfate	mg/liter	<10	--	--	--	--	--	--	--

maintenance shop approximately 0.8 km (0.5 mile) south of the Ottoboni Federal Well 35-12 (O.F. #2) location. The usual sound energy level measured was Leq (24) 55 with occasional excursion up to Leq (24) 65. Exhibit 1-A, taken from the above report, indicates sound levels typically associated with several geothermal development activities.

d. Seismic and Land Subsidence Activities

Seismicity

No active faults are recognized or suspected in the lease area. The nearest known active fault in the region is the Healdsburg fault, which trends northwest through the Healdsburg area. The October 1, 1969 earthquake at Santa Rosa appears to have had its epicenter along the fault. Although that earthquake was felt at The Geysers, there were no damages caused by it.

1. R.M. Hamilton and L.J.P. Muffler, "Microearthquakes At The Geysers Geothermal Area, California", 1972, J. of Geophysical Research, 4/77, pp 2081-2086.

In the above report 53 earthquakes were recorded during a three week period in 1971 within about 10 km of The Geysers. Most epicenters lie in a zone about 4 km long and 1 km wide passing through the geothermal field along a principle fault zone. Microearthquakes have been detected in Lease CA-5634.

2. E. Majer and T.V. McEvelly, "Seismological Investigations at The Geysers Geothermal Field", Lawrence Berkeley Laboratory, U.C.B., December, 1977.

The authors of this report concluded the following:

- a) Microearthquakes occur in a diffuse pattern.
- b) It is possible microearthquake activity is related to an expanding steam zone.

EXHIBIT 1-A

SOUND LEVELS ASSOCIATED WITH
GEOHERMAL DEVELOPMENT ACTIVITIES
SPL @ 50 feet (15.2M)

ACTIVITY	SOUND PRESSURE LEVEL @ 15.2M DBA						
	60	70	80	90	100	110	120
<u>CONSTRUCTION</u>							
BACKHOES							
COMPACTORS							
SCRAPERS							
TRACTORS							
TRUCKS							
<u>DRILLING</u>							
MUD							
AIR (NO STEAM)							
AIR (BLOOIE LINE EXPANDER TUBE)							
AIR (BLOOIE LINE W/ DRY MUFFLER)							
AIR (BLOOIE LINE W/ WET MUFFLER)							
<u>WELL CLEANOUT AND TESTING</u>							
VENT W/O MUFFLER							
VENT W/ COMMERCIAL MUFFLER							
<u>PLANT STACKING</u>							
PIPELINE COMMISSIONING							
COMMERCIAL MUFFLER							
DRAG VALVE							
ROCK MUFFLER							
<u>MISCELLANEOUS</u>							
POWER PLANT							
BLEEDS UNMUFFLED							
BLEEDS COMMERCIAL MUFFLER							
BLEEDS ROCK MUFFLER							
BLEEDS INTO VENT GATHERING SYSTEM							
	INAUDIBLE						
	INAUDIBLE						

NOTE: THE AUTHOR WISHES TO THANK DR. PHILIP LEITNER OF SAINT MARY'S COLLEGE FOR HIS HELP IN THE PREPARATION OF THIS TABLE.

The most recent work done in the area of seismicity was done by Marks, Ludwin, Louie, and Bufe. The findings are published in open file paper #78-798.

Land Subsidence

Ben Lofgren, formerly of the USGS, has been conducting vertical and horizontal first order surveys over the Clear Lake-Geysers KGRA since 1973. His latest report, open file paper #78-597, is referenced in compliance with baseline subsidence monitoring requirements.

Site Stability

Site stability is covered in depth in I. l. b., "Site and Access Preparation", of this report. This section, written by Jim Vantine, California Engineering Geologist #504, concludes that with proper engineering, site stability should not pose a problem in the future.

Soils

The soils on the leasehold include Yorkville clay loam, Sobrante loam and Stoneyford gravelly loam. The proposed drill site is situated entirely on Yorkville clay loam according to the 1975 "Draft EIR for the Geothermal Leasehold of Union Oil Company at The Geysers, Sonoma County" by Ecoview Environmental Consultants. The suitability as a topsoil source is fair to a depth of 19 inches, and poor below 19 inches. Depth to rock is two to five feet.

e. Ecological Systems

Monitoring programs to estimate shifts in status of condition of biological elements in the KGRA, containing lease CA-5634, have been the concern of the developers, the public and the government.

Vegetation

Comarc Design Systems, "A Vegetation and Wildlife Habitat Mapping", 1976.

Vegetation mapping reveals that the majority of lease CA-5634 is mixed chaparral. Also present are Chamise and Oak Savannah. Oak Savannah is the predominant vegetation at Ottoboni Federal Well 35-12 (O.F. #2) site. This vegetation type is composed of scattered oak trees on a grassland of introduced annual grasses. Associated species of trees are: Big Leaf Maple (Acer Mycrophallum), Blue Oak (Quercus douglasii), Oregon Oak (Quercus garryana), California Black Oak (Quercus kelloggii), Valley Oak (Quercus lobata), Digger Pine (Pinus sabiniana), and Elderberry (Sambucus mexicana). Associated species of grasses and herbs are: Hairgrass (Aira caryophylla), Whitlow grass (Anthysanus pusillus), Wild Oats (Avena barbata, A. fatua), Small Quaking Grass (Briza minor), Brome grasses (Bromus diandrus, B. inermis, B. mollis), Dogtail grass (Cynosurus echinatus, Fescue (Festuca dertonensis, F. erecta, F. idahoensis), and Tall stephanomeria (Stephanomeria virgata). No rare or endangered plant species have been observed in lease CA-5634.

Wildlife

PG&E et al*, "The Distribution and Abundance of Wildlife Populations in Relation to Geothermal Development: Interim Report - The Geysers KGRA Wildlife Study", October 1977.

*PG&E, Union Oil Co., USFWS, CDFG, St. Mary's College, Western Ecological Services Co., University of California, Berkeley.

It was the objective of this report to assess the status of the wildlife in six habitats in The Gey-

sers area, and to compare developed and undeveloped area populations. The study lasted from April 1976 to June 1977. The final report has not yet been published and the above referenced report covers results obtained from April to July 1976. The six habitat types studies are: oak savannah, oak woodland, mixed evergreen forest, chamise chaparral, mixed chaparral, and riparian. Preliminary data were obtained for the following animal groups:

- 1) Aquatic amphibians and reptiles
- 2) Terrestrial reptiles
- 3) Diurnal raptors
- 4) Owls
- 5) Songbirds
- 6) Bats
- 7) Small mammals
- 8) Western gray squirrels
- 9) Mammalian carnivores
- 10) Deer

In addition incidental sightings were recorded. The report did not make any conclusions concerning the effects of geothermal development on wildlife, but the issue will be clarified in the final report.

In the Oak Savannah habitat (characteristic of the Ottoboni Federal Well 35-12 (O.F. #2 location) the following was observed:

1. Aquatic Amphibians and Reptiles

The proposed Ottoboni Federal Well 35-12 (O.F. #2) location is approximately 4000 feet from Big Sulphur Creek and any geothermal development at this site is not anticipated to affect the creek. But data concerning both Big Sulphur Creek and Squaw Creek aquatic life is given in the following reports:

See reference #2 under "Water Quality".

R.S. LeGore et al, "Substrate and Sediment Studies in the Big Sulphur Creek Drainage, California," Parametrix, 1976.

P.F. Kubicek and D.G. Price, "An Evaluation of Water Temperature and Its Effect on Juvenile Steelhead Trout in Geothermically Active Areas of Big Sulphur Creek, Final Report," PG&E, Jan. 16, 1976.

2. Terrestrial Reptiles

From May 24 to June 11, 1976 2 species of lizards and 3 species of snake were observed. A summary of snake observations from April to August of 1976 revealed six different species of snakes; the most common of which was common kingsnake.

3. Diurnal Raptors

Raptors were not counted according to individual habitat out in the general Big Sulphur Creek watershed for the geothermically developed area. During April 1976, 6 species of raptors were observed, including 7 sightings of Golden Eagle. The most common raptors were turkey vulture followed by red-tailed hawk.

4. Owls

Owl calls and tape recordings were used to find owls. In the Oak Savannah habitat 3 great horned owl responses were heard, but none others.

5. Songbirds

Songbird densities were determined for the Oak Savannah to be 165 birds per 100 acres during May 1976. Particular species were not accounted for, except those 20 species detected five or more times.

6. Bats

Bat populations were measured only in riparian habitat. Twelve to fourteen species of bats are believed to occur in The Geysers area.

7. Small Animals

Three species of small mammals were observed during April-May 1976, the most common of which was the deer mouse. In July of 1976 the same number of species were observed and the deer mouse was again the most common.

8. Western Gray Squirrels

The study did not determine the number of squirrels in the Oak Savannah. The study did conclude that the mixed evergreen forest habitat was the best for gray squirrels.

9. Carnivores

Carnivores were accounted for according to developed or undeveloped area. In June 1976 the following was observed:

	<u>Total Visits</u>		
	<u>Bobcat</u>	<u>Raccoon</u>	<u>Unidentifiable Carnivore</u>
developed	2 (16.7%)	2 (16.7%)	8 (66.7%)
undeveloped	3 (37.5%)	2 (25%)	3 (37.5%)

10. Deer, Rabbits and Cattle

Deer, rabbit, and cattle densities were determined by counting pellets. Based on data collected in April to June of 1976 the following

was observed for Oak Savannah habitat:

	Sample Size (acres)	Deer per acre	Rabbit Groups p/acre	Cattle Droppings p/acre
developed	0.10	.021	60	450
undeveloped	0.10	.189	560	880

It is not very possible that all the above species will be found around the proposed well site because it is only a small part of the total oak savannah habitat of the study area. But this list should give a representative sample of what might inhabit the area.

Cultural Resources

The cultural resources of the area have been assessed by Ecoview Environmental Consultants. One archaeological site was discovered in the leasehold (location A1 in Exhibit A-map 1) with four other archaeological sites on the lease's borders (locations A2-A5) including an historic site (location H1) of an abandoned farmstead. The ages of the sites are not given. The archaeological sites were created by the Wappo Indians who controlled most of The Geysers area during the pre-European period. The proposed Ottoboni Federal Well 35-12 (O.F. #2) site is about 300 meters away from the nearest site, A4, and will not affect it or any of the other archaeological sites.

Climate

The following climate information is taken from the February 15, 1977, "Environmental Analysis Prepared for a Multiple-Well Drill Site on Lease CA-1863 and Adjoining Private Lane, Union Oil Company", USGS.

The Geysers KGRA climate is a Mediterranean type climate typical of Northern California. The hot and

dry summers are influenced by a high pressure system off the coast of California. The high pressure system shifts to the south during the winter, allowing frontal systems to pass over the state. Average annual rainfall is about 60 inches with occasional snowfall. During fair weather winds are primarily influenced by mountain-valley air circulation caused by solar heating and night time cooling. During cloudy weather regional wind patterns predominate.

Land Use

Land use surrounding the leasehold is primarily geothermal development, wildlife habitat and grazing. Deer season lasts six weeks in the area but most of the hunting is concentrated in the less-developed areas. Ottoboni Federal Well 35-12 (O.F. #2) will have a minimum effect on the present land use because it will be located at the already existing Ottoboni Federal Well No. 1 site.

The surrounding areas contain power generating units and the necessary facilities to operate the steam field. There are only a few local residents in the area. Local businesses are limited to The Geysers Cattle Company and two small saloons.

EXHIBIT E

MANNER OF STEAM PRODUCTION

EXHIBIT E - Manner of Steam Production

a. Steam Accountability

The basis for steam accountability is generating unit areas. Wells assigned to unit areas will share in the revenue from their respective generating units proportionally to flow rates. Individual well flow rates are monitored continuously and accumulated each 24-hour day. This accumulated figure is then divided by the total accumulated flow rate for all wells within the unit area to determine the well's proportion of the unit output for that 24-hour period. Our Drawing No. 5048 shows the steam measurement schematic at The Geysers Geothermal Project.

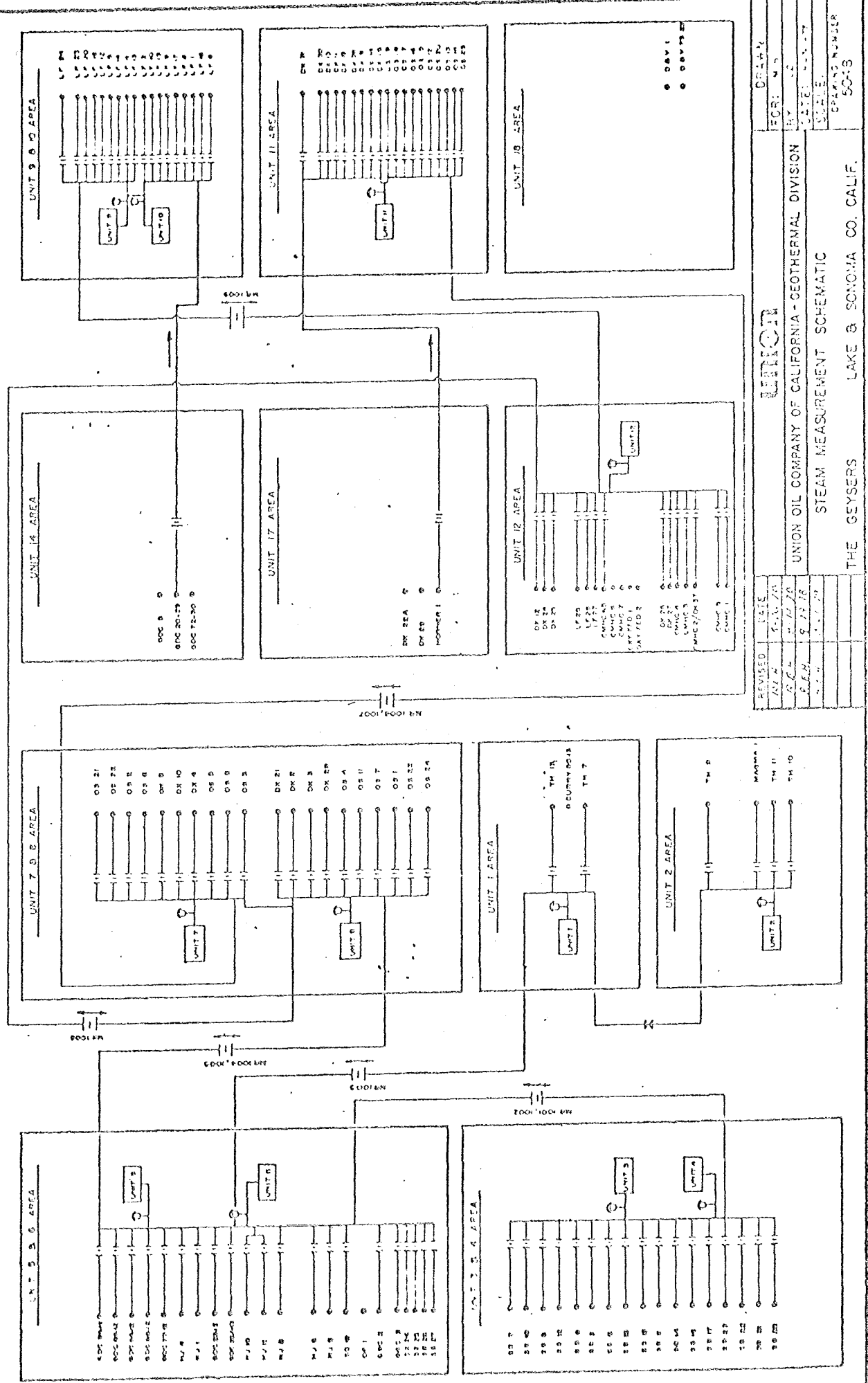
Two way crossovers are provided between generating unit areas. The metering orifice on each of these crossovers is considered a point source. Steam entering a unit area through the crossover is monitored continuously, accumulated daily, and is treated as a well in determining its proportional share of the generating unit revenue. This revenue is then credited back to the contributing unit area and is proportioned by flow rates among all wells in the supplying area.

In some instances, isolation valves are provided to direct steam from certain wells in one unit area to another area. When these valves are in service, the wells whose total steam production is positively directed to the new area are transferred to that new area and steam production is accounted for as if the wells were assigned to that unit area. Meters are calibrated monthly with master test gauges and orifice plates are pulled and inspected once every two years.

b. Operational Guidelines for Mixed Working Interest Steam Crossovers

The mixed working interest crossovers are defined as those which cross boundaries between different working interests in the project. The existing crossovers which fall into this category are those between Units 5 and 6 and Units 7 and 8 and between Units 7 and 8 and Unit 11.

The purposes of the crossovers are to maximize the utilization of available steam in the most



UNION

UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL DIVISION

STEAM MEASUREMENT SCHEMATIC

THE GEYSERS LAKE & SONOMA CO. CALIF.

REVISED	DATE	BY	FOR	DRAWN
1/1/78	1/1/78	R.C.H.	UNION OIL CO.	W.H.
2/1/78	2/1/78	R.C.H.	UNION OIL CO.	W.H.
3/1/78	3/1/78	R.C.H.	UNION OIL CO.	W.H.
4/1/78	4/1/78	R.C.H.	UNION OIL CO.	W.H.
5/1/78	5/1/78	R.C.H.	UNION OIL CO.	W.H.
6/1/78	6/1/78	R.C.H.	UNION OIL CO.	W.H.
7/1/78	7/1/78	R.C.H.	UNION OIL CO.	W.H.
8/1/78	8/1/78	R.C.H.	UNION OIL CO.	W.H.
9/1/78	9/1/78	R.C.H.	UNION OIL CO.	W.H.
10/1/78	10/1/78	R.C.H.	UNION OIL CO.	W.H.
11/1/78	11/1/78	R.C.H.	UNION OIL CO.	W.H.
12/1/78	12/1/78	R.C.H.	UNION OIL CO.	W.H.
13/1/78	13/1/78	R.C.H.	UNION OIL CO.	W.H.
14/1/78	14/1/78	R.C.H.	UNION OIL CO.	W.H.
15/1/78	15/1/78	R.C.H.	UNION OIL CO.	W.H.
16/1/78	16/1/78	R.C.H.	UNION OIL CO.	W.H.
17/1/78	17/1/78	R.C.H.	UNION OIL CO.	W.H.
18/1/78	18/1/78	R.C.H.	UNION OIL CO.	W.H.
19/1/78	19/1/78	R.C.H.	UNION OIL CO.	W.H.
20/1/78	20/1/78	R.C.H.	UNION OIL CO.	W.H.

DRAWING NUMBER
50-18

efficient manner, and to minimize the total amount of steam vented. The crossovers will be operated in a manner which best satisfies both purposes.

Generally, the crossovers will be used to transfer steam from supersufficient areas to deficient areas for the period of time that the deficiency exists. The operator will strive to maintain steam availability such that steam movement out of a unit area will eventually be balanced by steam movement into the area.

The crossover may be utilized for short periods of time to increase the back pressure in an otherwise sufficient adjoining system in the case where a unit trips out creating an instant surplus of steam.

This will serve to reduce flow rate from wells in both systems, thereby cutting down on total emissions. This condition will be allowed to exist only during the time necessary for analysis of the problem, and, if necessary, the time required to secure the wells in the tripped out unit area.

c. Steam Metering and Calibration Equipment Specifications

(1) Producing Well Meters

All producing wells are equipped with ITT Barton Differential Flow Recorders, Model No. 202A.

- (a) 0-10 psig differential pressure range
- (b) 0-250 psig static range
- (c) 7 day clock rotation
- (d) Chart No. P250-W10-S, Arcco Recording Charts
- (e) Belilove Company model 1207, 7 valve manifolds

(2) Pipeline Crossover Meters

Crossovers are equipped with ITT Barton Differential Flow Recorders (2-way) Model No. 202A.

- (a) 10-0-10 psig differential pressure range
- (b) Two 0-250 psig static ranges

- (c) 7 day clock rotation
- (d) Chart No. F-61007, Arcco Recording Charts
- (e) Belilove Company Model 1207, 7 valve manifolds with two static connections

(3) Meter Calibration and Inspection

- (a) All meters are shop calibrated prior to initial service and when reconditioned.

-- Differential bellows calibration

Differential calibration is accomplished with a Meriam Instrument Company Model No. 33KB35 mercury monometer with a dual scale No. RC6379, ranges of 0-101 inches of mercury or 0-4942 psig.

-- Static spring calibration

Static calibration is accomplished with a Seegers Precision Pressure Transfer Gauge (Reference Standard) 0-800 psig calibrated for pneumatic use.

The Seegers gauge is calibrated with an Ashcraft Deadweight Tester, Serial No. 1HA-54695. The Testers Certification of Accuracy is traceable to N.B.S. Test No. 323.09/204651 dated October 21, 1971 and N.B.S. Test No. 38126 dated March 4, 1968. A Certification of Accuracy was issued for the Deadweight Tester dated October 20, 1972 by Dresser Industrial Valve and Instrument Division, Stratford, Connecticut.

Accuracy: 1/10th of 1% of indicated pressure.

- (b) Field Meter Inspection

All charts are changed on Monday of each week. Recorders are inspected for malfunctions at this time and repaired if necessary.

All field recorders are inspected and calibration is checked with master test gauges once per month. Equipment used for calibration check is as follows:

-- Differential is checked with ITT Barton Model 227 Indicators, differential ranges, 0-20 psig and 0-25 psig, serial nos. 227-71850 and 227-84013 respectively.

-- Static check is made with Marsh Master Test Gauges, Type 210, 0-200 psig, (Deadweight proved).

Field error exceeding .1 psig differential or 2 psig static, requires removal of that instrument for reconditioning and installation of a re-calibrated recorder.

(4) Orifice Plates and Meter Runs

(a) All orifice plates are machined to the nearest thousandth of an inch.

(b) Meter run inside diameters are calipered to the nearest thousandth of an inch.

(c) All orifice flanges are flange-tapped.

(d) Inspection of equipment is as follows:

-- Orifice plates and meter runs are inspected for wear and are recalipered to the nearest thousandth of an inch during unit shutdowns.

-- Orifice plates are replaced or re-machined if wear is detected. Experience has indicated negligible wear.

-- Inspection period depends on unit and well production performance. All orifice plates and meter runs are inspected a minimum of once every two years.

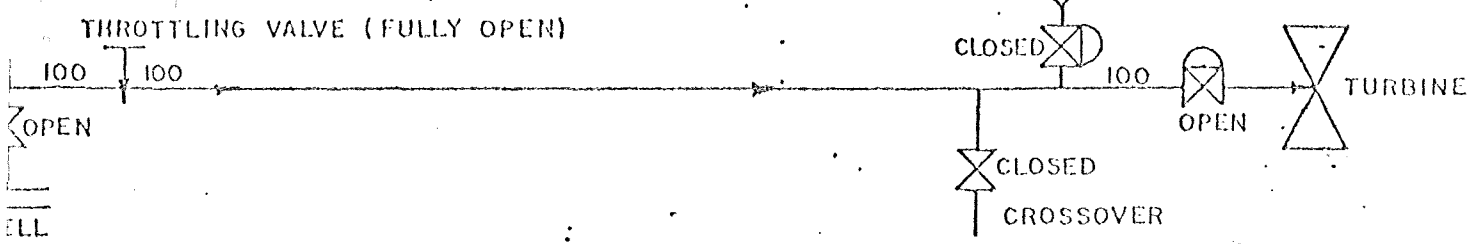
d. Guidelines for Curtailing Production from Geothermal Wells During Plant Outages

When an unscheduled outage occurs a determination is made of the cause of the outage and the estimated time of repair. In some cases the cause of failure can be quickly corrected and the unit brought back on line. When the outage is more extensive, the following procedures will be followed.

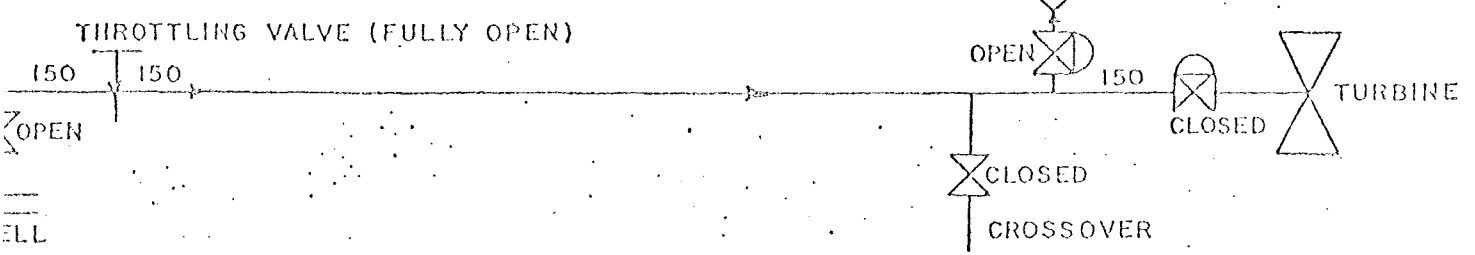
(1) Unit shutdown or curtailment of less than 2 hours.

-- Adjust steam supply system to maximum vent pressure.

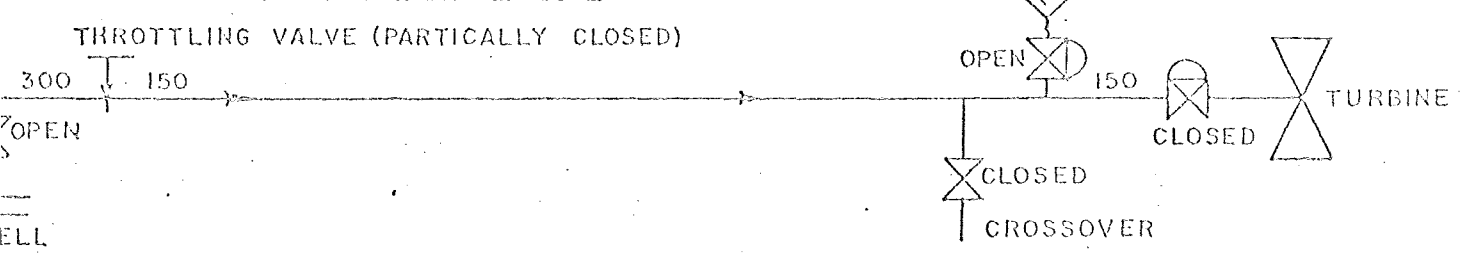
NORMAL OPERATIONS



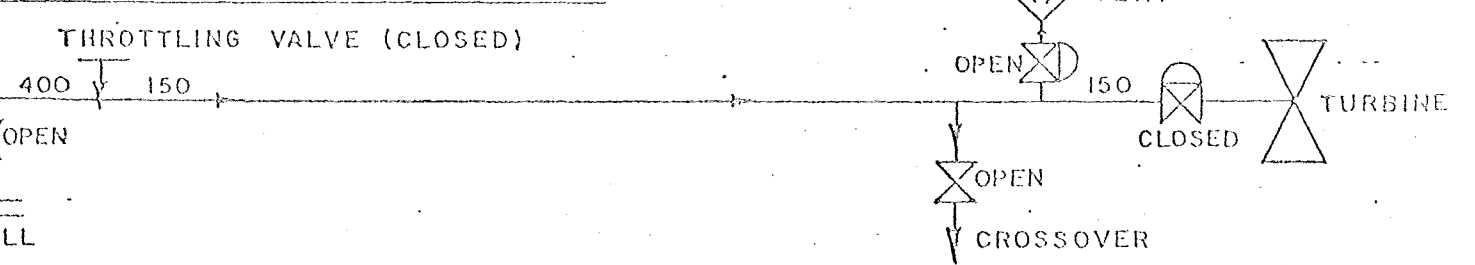
SITUATION A < 2 HR. OUTAGE



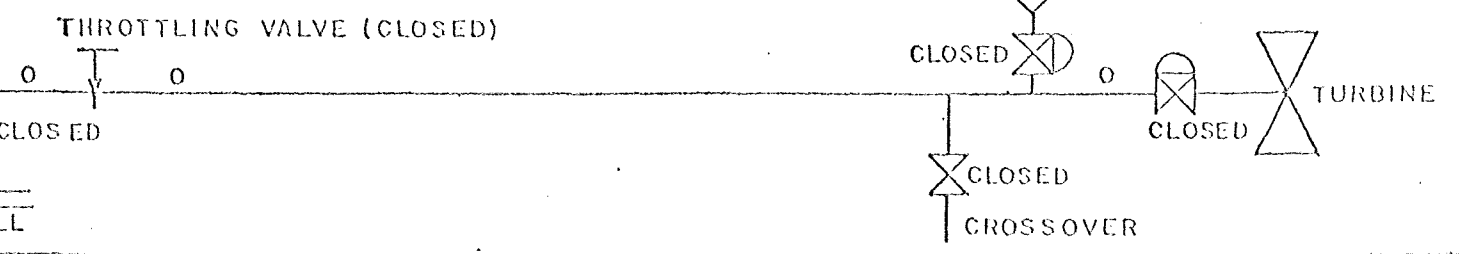
SITUATION B 2 - 24 HR. OUTAGE



SITUATION C 24 - 96 HR. OUTAGE



SITUATION D > 4 DAY OUTAGE



DATE	 UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL DIVISION	DRAWN
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		BY: V.T.
		DATE: 12-1-77
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		DRAWING NUMBER
TYPICAL VALVING ARRANGEMENTS FOR VARIOUS UNIT OUTAGE SITUATIONS		

(2) Unit shutdown or curtailment of 2 to 24 hours.

--- Adjust steam supply system to maximum vent pressure.

-- Throttle wells equipped with vee-ball valves in unit area to a wellhead flowing pressure of 300 psig.

(3) Unit shutdown or curtailment of 24 to 96 hours.

--- Adjust steam supply system to maximum vent pressure.

-- Throttle wells equipped with vee-ball valves in unit area to fully closed position (this will reduce flow from well to approximately 20% of capacity).

--- Adjust crossover piping system to maximize steam transfer to adjacent unit areas.

--- Throttle wells equipped with vee-ball valves in adjacent unit area as required to balance steam supply with demand.

(4) Unit shutdown or curtailment in excess of 4 days.

-- All procedures as in situation (3) above shall be initiated.

--- Shut-in wells as required in affected and adjacent unit areas to eliminate steam venting.