Environmental

GL03120

Plan of Development Operation
Geysers Power Plant Unit 16

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AREA GEOTHERMAL SUPERVISOR'S OFFICE
CONSERVATION DIVISION
U.S. GEOLOGICAL SURVEY
MENLO PARK, CALIFORNIA

Lease Unit Nos. 8 CA956A and 10 CA958
Sections 35 and 36, T11N, R8W, MDB & M
Castle Rock Springs Field
Lake County, California

July 31, 1979

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Plan proposes drilling 16-18 geothermal resource wells and constructing a pipeline for steam supply to Pacific Gas and Electric Company's Unit No. 16. Drilling of the wells will begin in March 1980 with construction of the steam supply pipeline system scheduled for 1981-83.

Aminoil USA, Inc.
Plan of Development Operation

Contents

		Page
A.	Introduction	1
B.	Details of the Plan of Development Operation	1
	1. Site Location	1
	2. Reservoir Characteristics	1
	3. Well Spacing	4
	4. Representative Drilling Program	4
	5. Steam Reservoir Adequacy and Commercial Utilization	4
	6. Steam Accountability	4
	7. Proposed Development	7
	a. Well Pads	7
	b. Access	7
	c. Steam Supply Pipeline System	7
	d. Cross-over Pipeline	11
	e. Condensate System.	11
	8. Control Functions of Unit 16 Computer Control System	12
	9. Protection of the Environment	13
	a. Emergency Contingency Plans	13
	b. Soil Erosion	13
	c. Surface and Ground Water	13
	d. Fish and Wildlife	14
	e. Air Quality and Noise	14
	10. Methods for Disposing of Waste Material.	15

Page

C. Plan of Injection Operation 15

D. Environmental Concerns 15

1. Regional and Local Geology 15

2. Potential Geological Engineering Hazards 17

a. Seismicity 17

b. Landslides 17

3. Hydrology 19

a. Surface Water 19

b. Ground Water 19

c. Water Uses 20

d. Water Quality 20

4. Meteorology 20

5. Soils 22

6. Biota 22

a. Fauna 22

b. Flora 25

7. Cultural Resources 30

8. Current and Prospective Land Uses and Local Economy 30

. Emergency Contingency Plans. 30

. Schedule of Operations 31

EXHIBITS

XHIBIT	TITLE	PAGE
A	Regional Map	2
B	Area Map	3
C	Surface Geology Map	Appendix 1
D	Typical Well Site	5
E	Well Profile	6
F	Proposed Well Sites and Pipeline System	Appendix 2
G	Well Pad Collector System	8
H	Plant Collector System	10
I	Report of Noise Associated with Unit ~~16~~ 13 Blow-down	Appendix 3
J	Water Quality Monitoring Report	Appendix 4
K	Rare and Endangered Species Study Map	28

Plan of Development Operation
Lease Unit Nos. 8 CA956A and 10 CA958
PG&E Geysers Power Plant Unit 16

A. Introduction

Pursuant to 30 CFR 270.34, Aminoil USA, Inc., formerly Burmah Oil and Gas Company, hereby submits its Plan of Development Operation Lease Unit Nos. 8 CA956A and 10 CA958. The Plan proposes the drilling of 16-18 geothermal resource wells, installation and construction of a steam supply pipeline and a condensate pipeline to provide part of the steam supply for Pacific Gas and Electric Company (PG&E) Unit 16. A concrete pond will be constructed near the power plant to receive excess condensate from the cooling towers. Some new access road will be constructed and portions of an existing road will be improved.

Aminoil USA, Inc. has been designated as operator of Lease Unit No. 10 CA958 by the lessee, Occidental Petroleum Corporation, by execution of Designation of Operator (Form 9-1123) on September 25, 1974.

B. Details of the Plan of Development Operation

1. Site Location

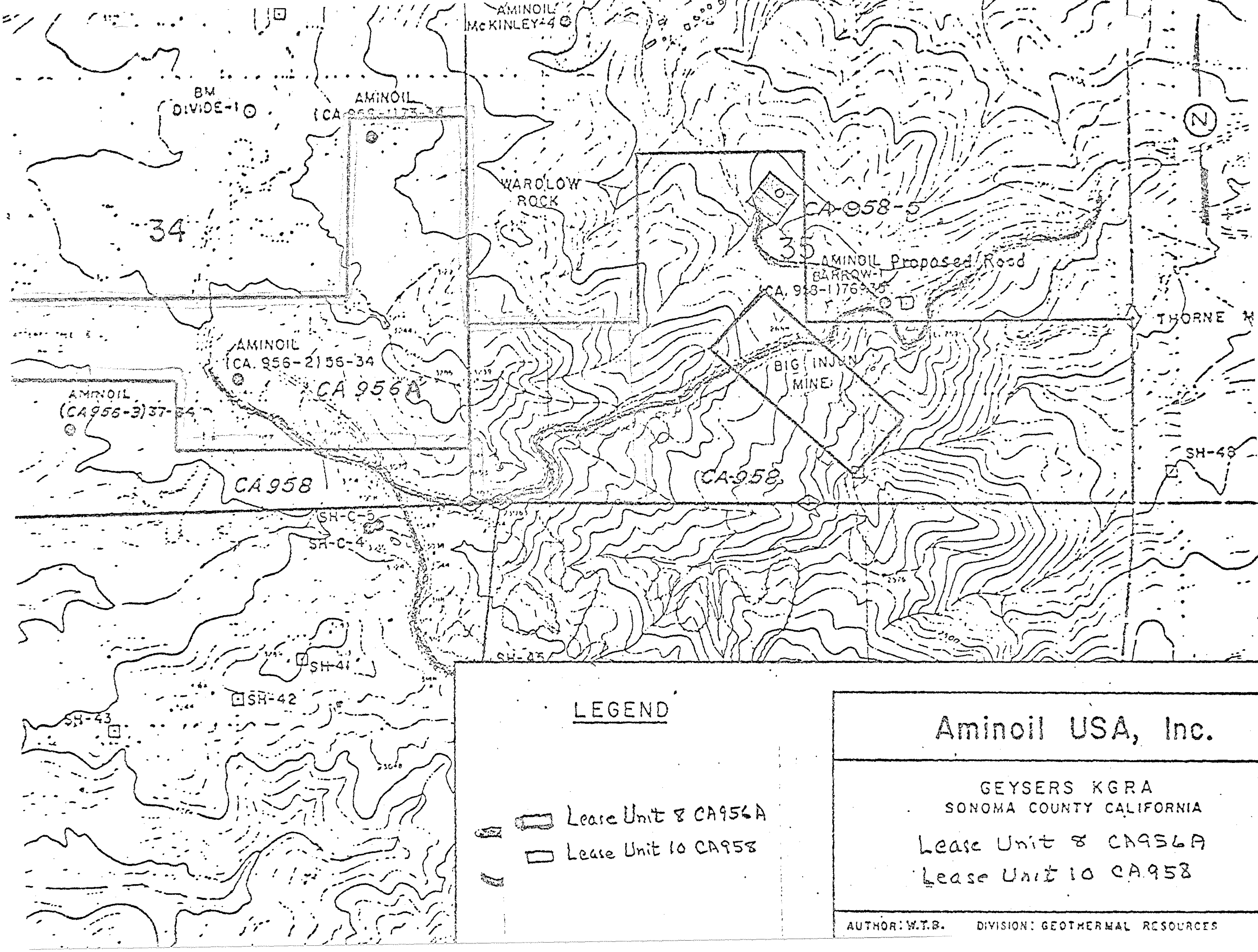
The project site is near Castle Rock Springs, Lake County, California. (See Exhibit "A" Regional Map and Exhibit "B" Area Map). The area encompasses about 300 hectares (750 acres), including the southern portion of Section 35 and the eastern portion of Section 36, T11N, R8W, MDB & M. The Castle Rock Springs area is also the site of Aminoil USA, Inc.'s geothermal steam field which is being developed to supply PG&E's Units 13 and 16. Access to the site is via Socrates Mine Road, which branches from Highway 175 north of Anderson Springs, and then via the Davies Estate Road, a privately maintained geothermal access road. There are numerous other jeep trails and unimproved roads which provide access to most portions of the area.

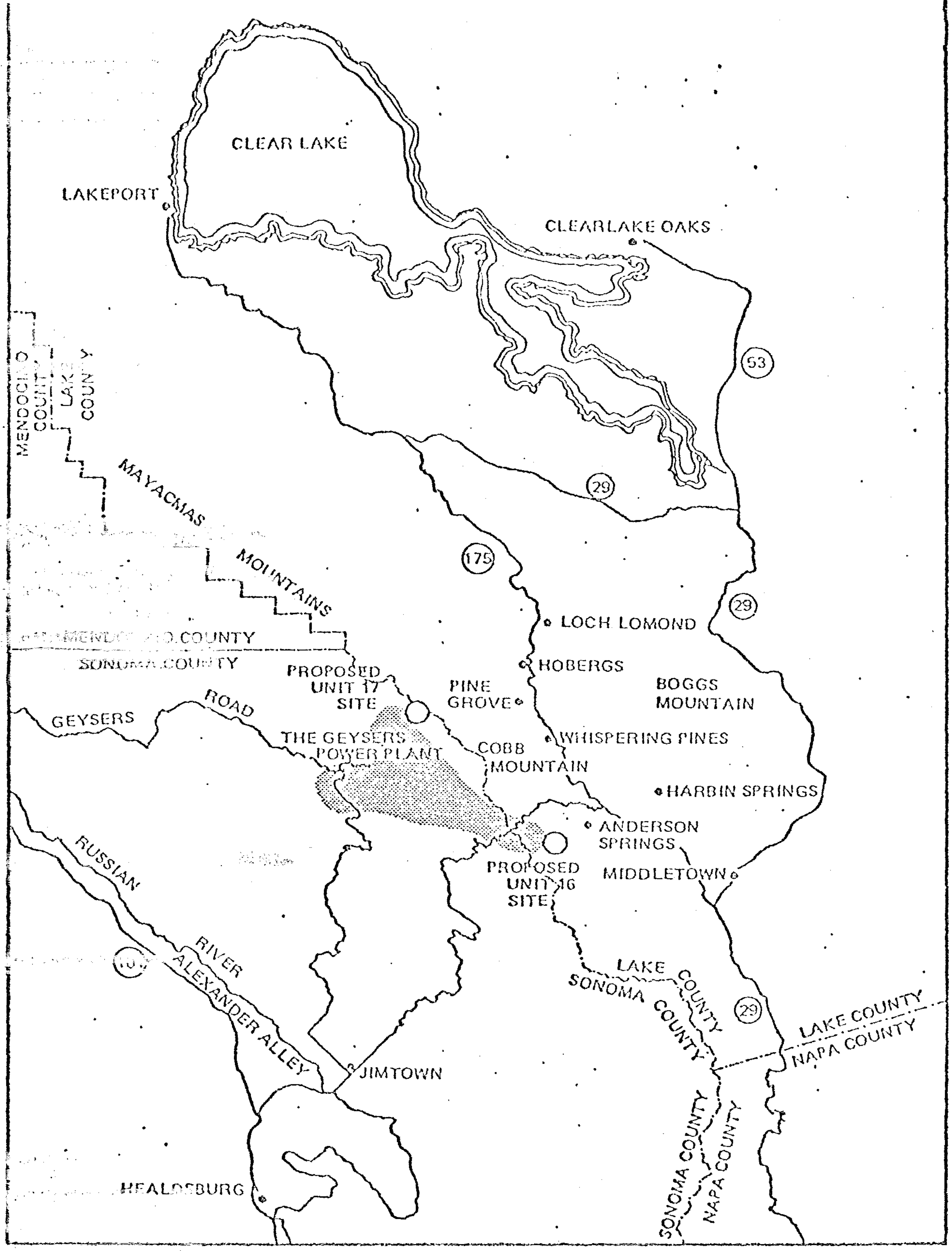
2. Reservoir Characteristics

The geothermal resource from wells on Lease Unit Nos. 8 and 10, as with the balance of the wells in the Castle Rock Springs Geothermal Development Area, is dry steam generally at saturation. Results of tests identifying the characteristic of the steam from six wells now completed on Lease Unit Nos. 8 and 10 are on file with the USGS. Characteristics of steam produced from the wells to be drilled is not expected to differ materially from that produced from the now completed wells.

The wells drilled within the development area encountered reservoir rock at measured depths below 914 meters (3000'). Though two of these wells penetrated approximately 914 meters (3000') of reservoir rock, it is not believed that any reached basement. Although the total area of the leases committed to development for the Unit 16 project is considered to be productive, the thickness of the reservoir has not yet been defined.

Porosity and permeability of the metagraywacke reservoir rock is low. Permeability in the reservoir is thought to be the result of fractures. Static pressure at each well head is expected to be $\pm$ 32 Kg/cm^2 (450 psig) as encountered in the wells previously drilled. As noted, reservoir fluid is dry steam, generally at saturation, with little or no free water. Production from all wells completed in the Unit 16 project area


AMINOIL McKINLEY-4
BM DIVIDE-1
AMINOIL (CA-956-1)73-34
WARDLOW ROCK
34
CA-958-5
35
AMINOIL Proposed Road
BARROW-1 (CA. 958-1)76-35
THORNE
AMINOIL (CA. 956-2)56-34
CA 956A
AMINOIL (CA956-3)37-34
BIG INJUN MINE
SH-48
CA 958
CA-958
SH-C-5
SH-C-4
SH-45
SH-41
SH-42
SH-43
N
LEGEND
Lease Unit 8 CA956A
Lease Unit 10 CA958
Aminoil USA, Inc.
GEYSERS KGRA
SONOMA COUNTY CALIFORNIA
Lease Unit 8 CA956A
Lease Unit 10 CA958
AUTHOR: W.T.B.
DIVISION: GEOTHERMAL RESOURCES



REGIONAL MAP

EXHIBIT. "A"

ranges from 40,370 Kg/hr (89,000 lbs/hr) to 161,000 Kg/hr. (355,000 lbs/hr). The wells yet to be drilled are expected to be within this range.

No wells within the vicinity of the development area have been placed on commercial production and therefore, no experience factor is available to predict future well performance. Production rates of wells located elsewhere within the Geysers Field have experienced some decline over time. It is expected that the wells drilled to date, those to be drilled under this Plan of Development, and additional replacement wells will provide adequate steam supply for the commercial operation of the PG&E Unit 16 for at least a 30 year period.

3. Well Spacing

Spacing of wells to be developed from Federal Lease Unit Nos. 8 CA956A and 10 CA958 for the Unit 16 project will be determined following evaluation of reservoir characteristics to determine optimum production from a minimum number of wells. Surface location will be selected to correlate with bottom hole objectives and precisely located following an evaluation of topographic features, drainage areas and surface geologic conditions (refer to Exhibit "C" Geologic Map for details). Detailed information on well spacing and bottom hole locations will be filed with Applications to Drill (Form 9-331D) under separate cover.

Multiple well pad sites will be developed in an effort to minimize surface disturbance and the resultant environmental impacts. When appropriate, site specific geotechnical studies have been performed and a report will be forwarded upon completion. A typical drilling site is represented by Exhibit "D". The multiple well pad sites will also provide locations for the drilling of replacement wells which might become necessary to maintain the steam flow rate required to operate the plant for the life of the project.

4. Representative Drilling Program

Detailed drilling programs for seven wells have been submitted previously with the Application to Drill (Form 9-331C). The drilling program for any future well is not expected to differ materially from those approved for the above mentioned wells. Profile of a typical geothermal well is depicted by Exhibit "E".

5. Steam Reservoir Adequacy and Commercial Utilization

Aminoil USA, Inc. has determined that an adequate steam reservoir exists at its Geysers Castle Rock Springs Field to supply steam for commercial operation of the Pacific Gas and Electric Company Geysers Power Plant Unit 16. Aminoil has committed approximately 300 hectares (750 acres) of its Geysers Castle Rock Springs Field in Lake County to the production of steam for operation of the plant. Acreage committed includes a combination of Federal and Fee lease properties. Approximately 130 hectares (330 acres) of the land surface committed to the project are on fee lease lands. Approximately 170 hectares (420 acres) are on the Federal Leases.

Unit 16 is expected to start commercial operation in the fall of 1983.

6. Steam Accountability

Steam produced from Lease Unit Nos. 8 CA956A and 10 CA958 for operation of Unit 16 will be commingled with steam produced from wells on fee lands. Production from individual wells, including those on the federal leases, will be accounted for by individual well orifice meters in accordance with GRO Order No. 7.

TOP VIEW OF A TYPICAL DRILLING SITE

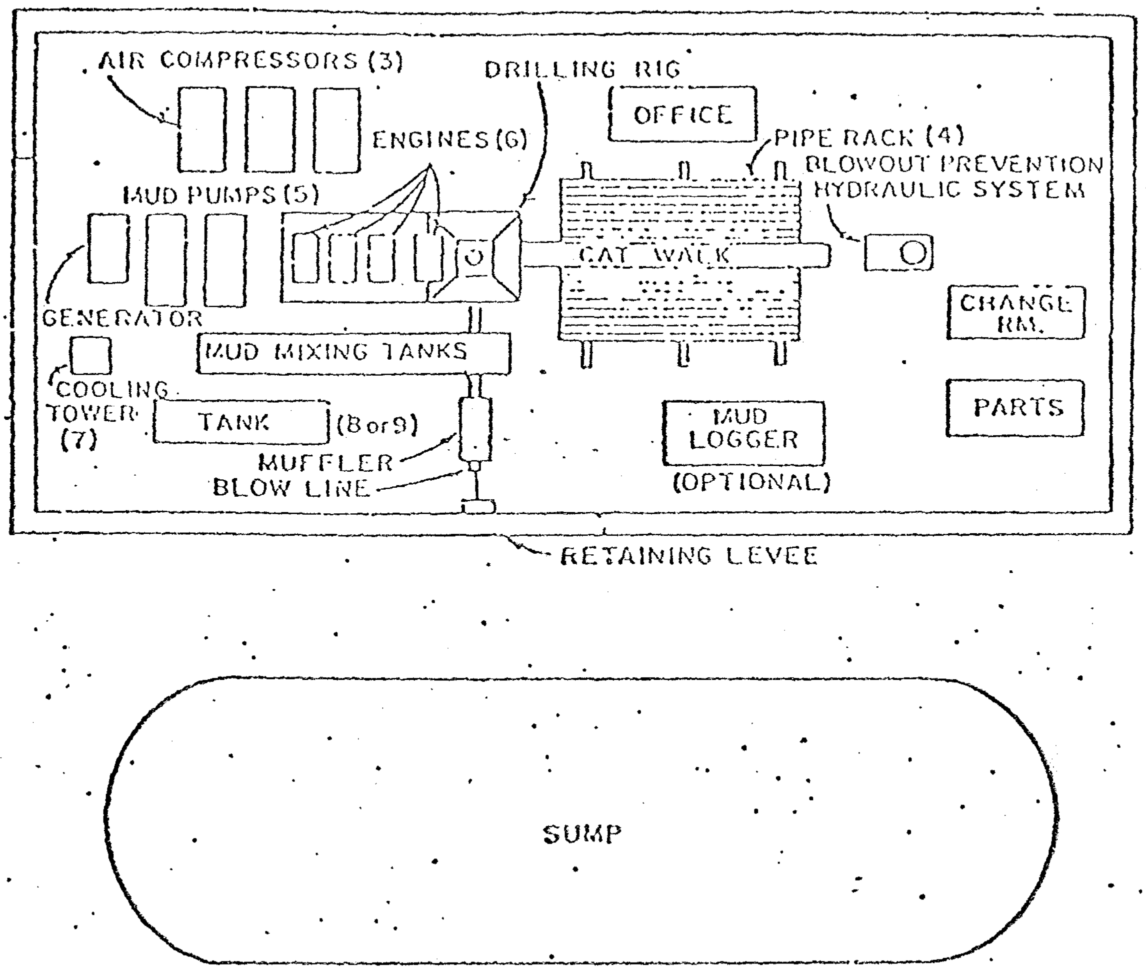
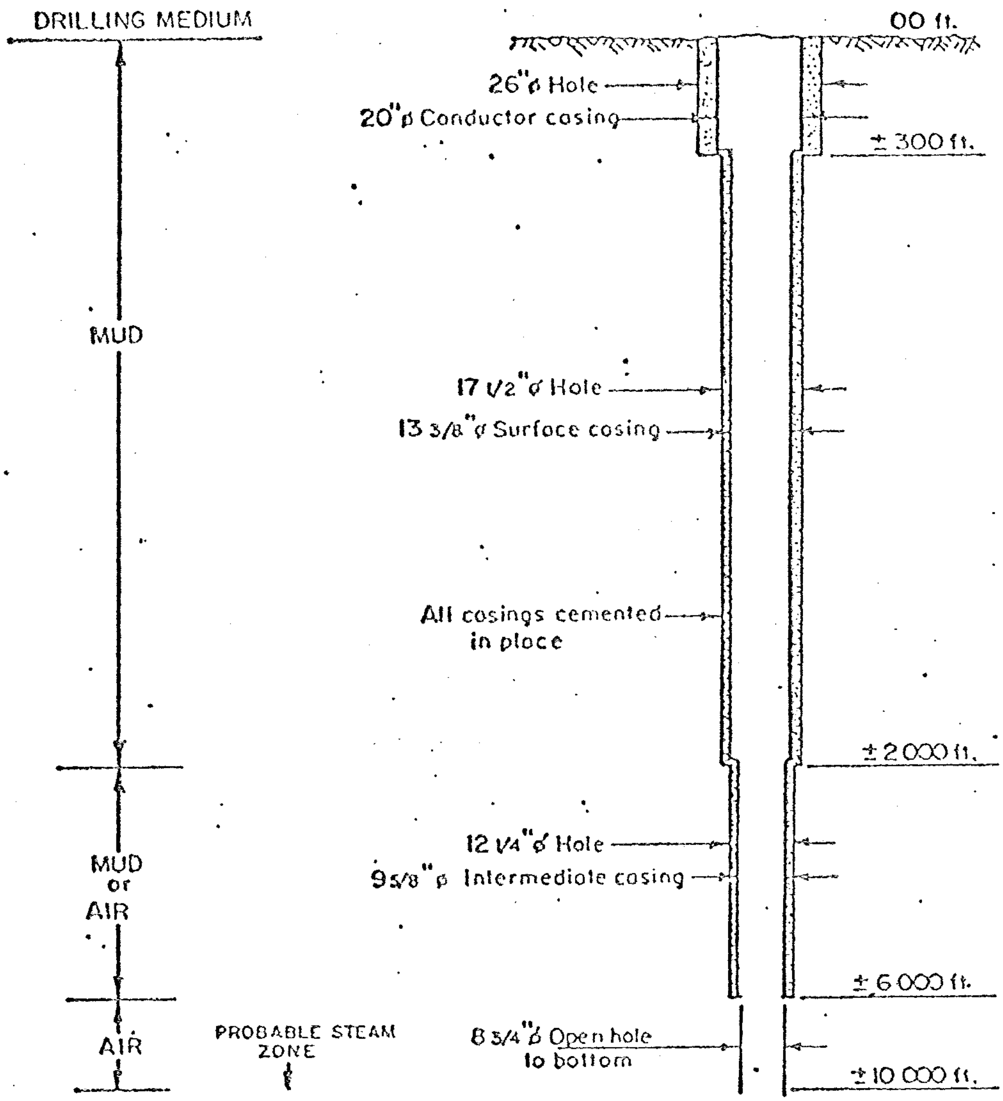


EXHIBIT "D"



PROFILE OF TYPICAL GEOTHERMAL WELL

EXHIBIT "E"

7. Proposed Development

The Plan of Development Operation proposes drilling 16-18 geothermal resource wells, installation and construction of about 4600 meters (15,000') of steam supply pipeline and an unspecified amount of condensate pipeline. A concrete pond will be constructed near the power plant to receive excess condensate from the cooling towers. Approximately 1.5 Km (1 mile) of new access road will be constructed and about 1 Km (0.6 mile) of existing road will be improved.

a. Well Pads

Two wells for the Unit 16 project have previously been completed from one existing drillsite located on fee land. The producing zone for one well is located on the fee land and the producing zone for the other, CA958 76-35, is located on Federal Lease Unit 10 CA958. Complete development of the field for initial start up of Unit 16 will require the drilling of an additional 16 to 18 wells from 3 existing and 11 proposed multiple drill pad sites. One of the existing drill pad sites and five of the proposed drill pad sites are located on Federal lease Unit Nos. 8 and 10 (see Exhibit "F").

Each well site will require construction of a level pad of about 4000 square meters (43,000 square feet) with a drainage system and an adjacent waste sump with a capacity of about two to six million liters (1/2 to 1-1/2 million gallons). Two or more wells will be drilled from each site. Pad sites in general have been selected to take advantage of existing topographic flats or ridge lines.

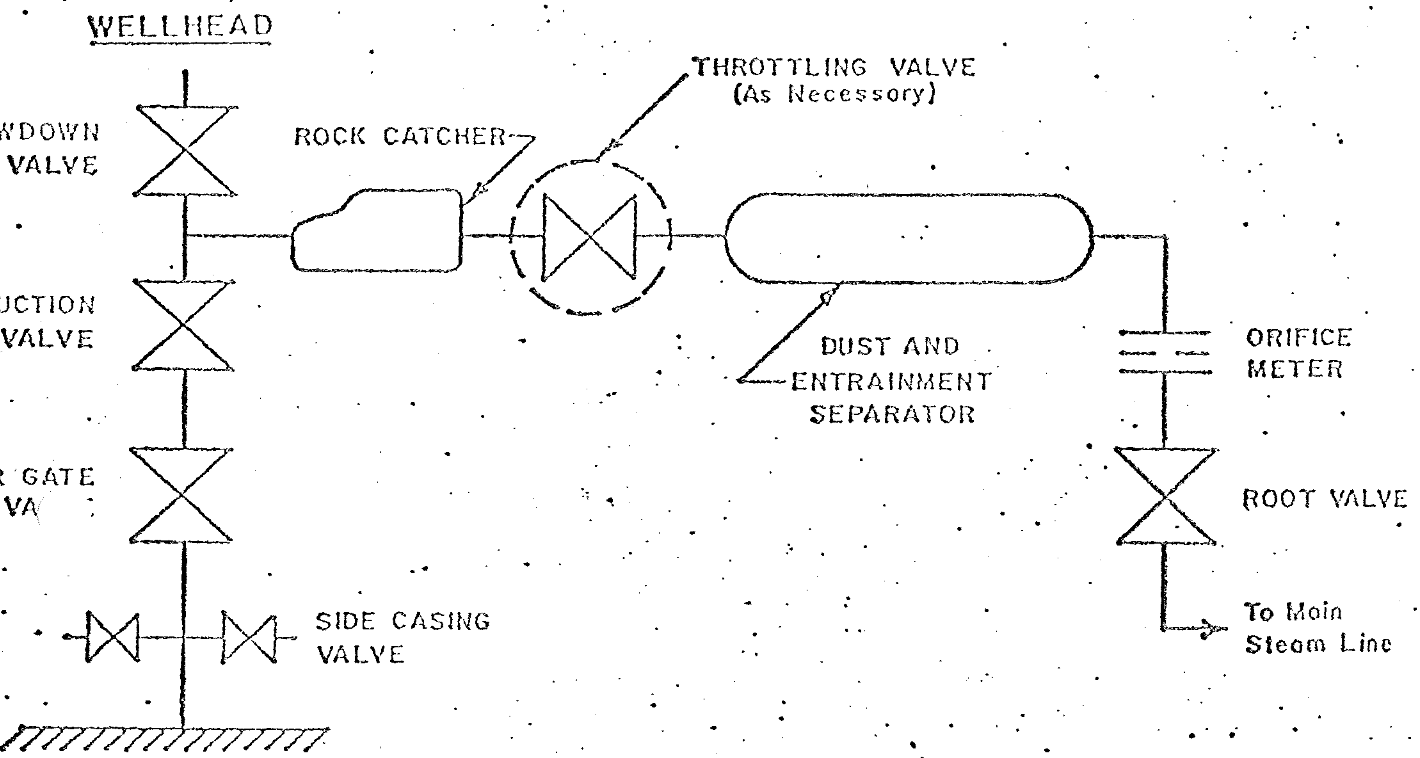
b. Access Roads

Davies Estate Road, the existing access, is adequate for the intended use and will require no improvement. Approximately 0.3 Km (0.2 mile) of existing road, however, will have to be rerouted because one of the proposed well pads is astride the Davies Estate Road. About 1.5 Km (1 mile) of new road construction is proposed; approximately 1 Km (0.6 mile) of this is existing jeep trails which will be improved. The proposed road alignment is to follow the natural contours of the land with grades limited to 15 percent and will utilize any existing trails where possible to minimize environmental impacts. The road width is to be limited to the width required to provide for safe equipment operations and to safely accommodate heavy drilling equipment. Turnouts are to be provided at strategic locations. The road will be designed to utilize balance cuts and fills wherever possible.

c. Steam Supply Pipeline System

Steam will be carried from the wells to the power plant in insulated steel pipelines supported above ground by drilled, cast-in place concrete piers. The pipeline system is designed to provide a steam supply of not less than 9×10^5 Kgs (20×10^5 pounds) per hour at 7 Kg/cm^2 (100 psig) and 170° C (340° F) at the power plant inlet. The size of the pipeline increases as required by steam volumes from a minimum of 25 cm (10") at the well head to a maximum of 122 cm (48") for the main trunk line at the power plant inlet. Average diameter will be about 61 cm (24").

The pipeline collector system (Exhibit "G") for each well includes a well head master and production valves, rock catcher (where necessary), well head throttling valve, well head separator, well head meter run with orifice flange, and a well head isolation (root) valve. The collector system from the well head to the isolation (root) valve will be designed to withstand maximum well head shut-in pressure and temperature of 34 Kg/cm^2 (490 psig) and 240° C (465° F)



TYPICAL WELL PAD COLLECTER SYSTEM

(SCHEMATIC)

EXHIBIT "G"

The main pipeline system (Exhibit "H") from beyond the well pad collector to the plant inlet includes two master clean up separators on either side of the plant inlet line, a series of automated steam relief valves which direct steam to a rock muffler silencer during power plant outages and a series of 13 Kg/cm^2 (180 psig) rupture discs located at strategic points along the line to provide for the safety and integrity of the system. The main pipeline beyond the well pad collector system will have a normal operating pressure of 9 Kg/cm^2 (125 psig).

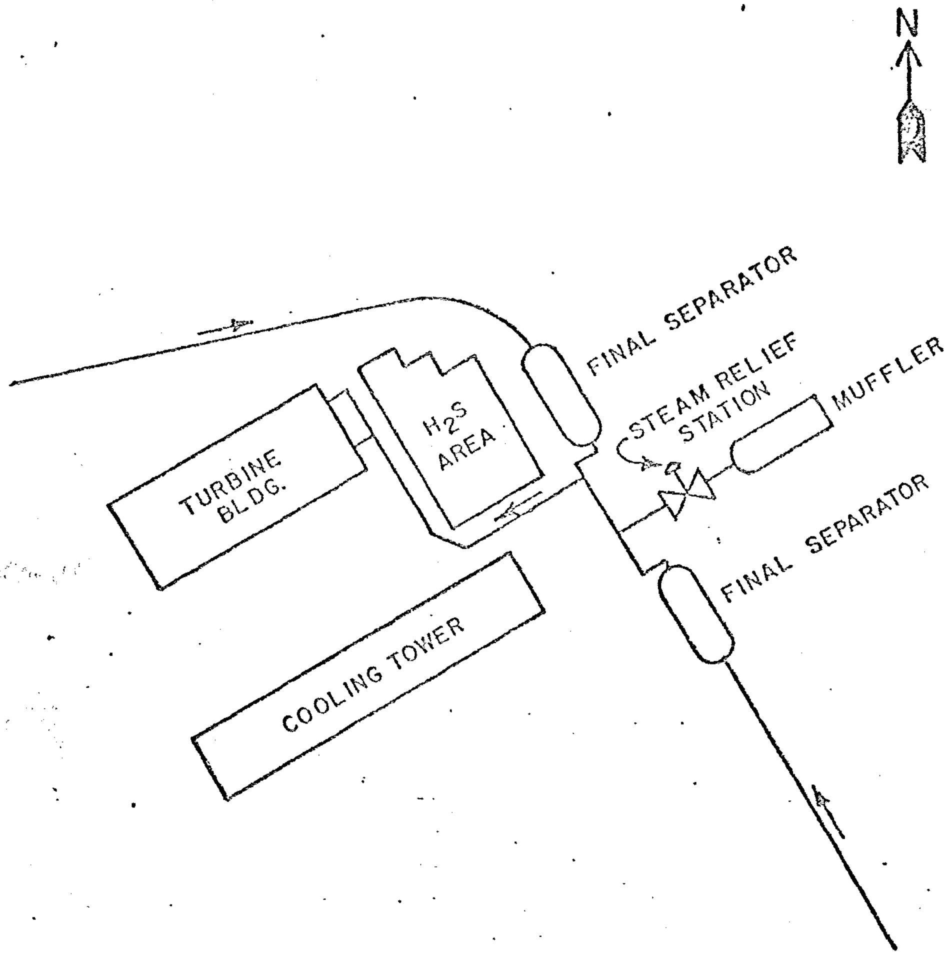
A vent collector system will parallel the main pipeline and collect all steam emissions and condensate downstream from the well flow meter and exhaust into the reinjection system.

Steam transmission line routes are generally selected as the shortest distance to the generating unit, thus minimizing heat and friction loss. However, the layout of the pipeline system is somewhat dictated by the terrain of the rugged area. For ease of maintenance, routes will follow road alignments wherever possible. Turns and changes in elevation required by the rugged terrain offer some advantages in helping to provide relief for pipe stresses and anchor loads. Areas of active slope instability are avoided wherever possible. A low profile has been emphasized to reduce visual impacts.

Pipeline segments will be sized on the basis of pressure drop and steam velocity. Pressure drops are in the order of 0.01 Kg/cm^2 (0.15 psig) to 0.02 Kg/cm^2 (0.25 psig) per 30 meters (100') of equivalent pipe length resulting in total pressure drops between the well head and plant inlet of 0.35 Kg/cm^2 (5 psig) to 2.1 Kg/cm^2 (30 psig). Steam velocity varies from 30 meters/sec (100 fps) to 75 meters/sec (250 fps) with a 45 meters/sec (150 fps) velocity being the most desireable from the standpoint of minimizing noise levels and condensate losses.

Experience at the Geysers Field has proven pipe fabricated from low carbon steel such as ASTM A53, Grades A or B or piping of equal composition, to be highly satisfactory for steam transmission line. Internal corrosion of pipe used at the Geysers has not been a problem. Insulation, used to minimize heat losses, has proven to be very effective in protecting external pipeline surfaces. Because of the relatively low pipeline temperatures, exterior pipeline insulation need not be fabricated from expensive high temperature resistant materials. Fiber glass having an organic binder is satisfactory. Densities of 16 or 32 Kilograms per cubic meter (1 or 2 pounds per cubic foot) are sufficient having K factors of 0.343 and 0.300 respectively. Heat losses on windy days can be expected to vary from 68,000 to 109,000 calories per hour per square meter (25 to 40 BTUs per hour per square foot) of pipe when insulated with thicknesses of 7.5 to 10 cms (3" to 4"). Because of its longer life and its ability to be reused after removal for pipeline repairs, aluminum has proven to be the most effective material for use in covering the pipeline insulation. A colored external surface which blends with background vegetation is to be used to reduce visual impacts.

Pipewall thicknesses vary in range from 0.64 cm to 1.3 cm (1/4" to 1/2") in accordance with the ANSI B31.1 Power Piping Code, current edition. Stresses in pipeline material have also been designed to be within the limits as specified by the ANSI B31.1 Power Piping Code, current edition. The temperature of the pipeline from a cold condition to a hot condition ranges from about 70° C (160° F) to 175° C (350° F) which can result in movement of about 6.3 cms (2-1/2") per 30 meters (100') of lineal pipe.



PLANT COLLECTOR SYSTEM
(SCHEMATIC)

EXHIBIT "H"

This expansion produces the forces which require the anchors for holding the pipeline within its prescribed alignment. Concrete support piers will vary in size from 20 cm (8") to 75 cm (30") in diameter and will be set about three meters (10') deep. Supports will be spaced about 10 meters (33') apart. Depending on conditions at each pier location; one of the following supports will be provided:

1. Solid Anchor
2. A one direction sliding plate
3. A two direction sliding plate with limiting devices for lateral movement, or
4. A free floating support which allows both horizontal and vertical movement of the pipeline.

The rigid anchor points will be placed at about 150 meter (500') intervals at locations considered to be reasonably stable. Where forces are expected to be too great, expansion loops are provided to relieve the excess stress which might result. Earthquake and wind forces will be factored into the final pipeline design.

Valves selected for service in the steam gathering system will have cast steel bodies with stainless steel trim to protect against corrosion from exposure to minor amounts of hydrogen sulfide. Slab gate valves, such as the WKM Power Seal Type, or equivalent, are to be used at the well heads. Isolation (root) valves are to be typical gate valves with rising stems. Small valves of 5 cm (2") and under are to have forged steel bodies with stainless steel trim and stems.

Each well head collector system will be equipped with an automated throttling valve which can be actuated by a central control system. The pipeline control system is being designed to provide for a maximum reduction of steam flow during power plant outage consistant with good engineering practices and the least adverse impact upon individual wells and the total pipeline system. Actuation of the control system provides the control strategy for reduction of hydrogen sulfide emissions associated with steam vented to the atmosphere during power plant outages.

Exhibit "F" indicates the location of the proposed pipeline gathering system.

d. Cross-Over Pipeline

A cross-over pipeline will be constructed from Unit 16 to Unit 13 so that excess steam can be diverted if either Unit has an outage. The size of this line has not yet been determined.

e. Condensate System

An enclosed concrete pond will be installed near Unit 16 to function as a particulate sedimentation basin for excess condensate from the Unit 16 cooling towers. The pond will have a capacity of 625,000 liters (163,000 gallons) with approximate dimensions of 20 meters (65') x 10 meters (32') x 2.5 meters (8'). Normal condensate outflow from the cooling tower basin is estimated to be 3450 liters (900 gallons) per minute. The condensate pond will be equipped with automatic level sensing devices set to indicate alarm conditions at specific high water levels. The control devices will be of the "fail safe" type and powered by an uninterrupted power source.

Excess condensate will be piped to an, as yet, undesignated well for reinjection into the geothermal reservoir. The pipeline will be constructed of 20 cm (8") flanged, epoxylined, steel pipe elevated above ground and when possible parallel the steam pipeline. The line is sized to accommodate a maximum cooling tower outflow of 9600 liters (2500 gallons) per minute. The pipe will be rigidly supported by 20 cm (8") diameter, concrete piers set 3 meters (10') deep.

8. Control Functions of the Unit 16 Computer Control System

The control functions for Unit 16 will be an extension of the Honeywell Computer Control System installed on Unit 13. The basic operational functions of the Honeywell Computer Control System are:

1. Ramping up of wells from a minimum flow condition to a PG&E detailed load - possibly varying from 25% to 100% of guaranteed load.
2. Ramping up of wells from a reduced load condition to a higher load.
3. Ramping down of wells due to a load reduction by PG&E.
4. Ramping down of wells due to a scheduled outage or turbine trip to prevent exceeding the Lake County Air Pollution Control District Authority to Construct H_2S Emission Conditions.
5. Maintenance of production accounting records to determine royalty allocation and to produce California Division of Oil and Gas reports.

The general procedure for ramping up wells to a predetermined load is as follows:

1. PG&E notifies Aminoil, operator, of the estimated load and steam flowrate required.
2. Wells are selected to be ramped by the operator. Guidelines for well selection by the operator will be primarily based on prudent operation.
3. Visual inspection of the pipeline to determine readiness by field personnel. Control System Operator notified by field personnel that the pipeline is ready for computer control.

4. Operator notifies PG&E that they can begin taking steam for initial turbine roll (approximately 227,000 Kg/hr (500,000 lbs/hr)). As this is happening the operator signals the computer to begin monitoring steam flow rates. The basic function of the control system at this point will be to:

   a. Maintain a constant venting flowrate based on the difference of individual well flows and the 118 cm (48") header flowrate.
   b. Ramp the necessary wells at the specified ramping rate to reach the predetermined load condition and maintain the vent rate.
5. When PG&E Unit 16 reaches the predetermined load, the control system will survey all wells and fully open as required. As soon as this is accomplished, the trim wells will sequentially lower venting rate to 0 Kgs steam per hour.
6. The control system now converts to a "feed forward" control function by matching steam demand of PG&E. This demand matching will be affected by turbine inlet pressure obtained from PG&E. The "trim" wells will respond to the demand fluctuations sequentially in a predetermined order.

9. Protection of the Environment

a. Emergency Contingency Plans

Contingency plans for (1) Emergency Accidental Spills and Discharge Control Procedures, (2) Emergency Fire Control Procedures, (3) Hydrogen Sulfide Contingency Plan and (4) Blowout Contingency Plan were forwarded with cover letter dated July 26, 1977 and are on file at the USGS Office of the Geothermal Supervisor, Menlo Park, California.

b. Soil Erosion

The Draft Environmenal Impact Report "Geothermal Pipeline System, Aminoil USA, Inc., Unit 16 Castle Rock Springs Area, Lake County, California" Cooper-Clark & Associates February 16, 1979 includes the project area. The Cooper-Clark & Associates' Report finds that natural soil erosion within the study area appears to be low to moderately low. Soils of the project area are typically shallow, stony variants of eight upland and mountain soil series. Present are representatives of the Dubakella, Henneke, Hugo, Josephine, Laughlin, Los Gatos, Maymen and Stonyford series.

Water holding capacity of these soils is generally low, fertility is moderate to very low, runoff is rapid to very rapid, and erosion potential is high to very high.

Care will be taken at the project site to minimize the potential for erosion and disturbance of natural drainage. The outer limits of the entire area to be disturbed will be staked for field inspection prior to commencement of any construction activities. Vegetation will be cleared and earthwork and installation of culverts and drainage ditches will be done pursuant to specifications as provided by Hawke Engineers, San Francisco, California. On completion of construction all outer fill slopes will be dressed and compacted by rollers or by walking with a crawler tractor. Vegetation will be re-established on all fill slopes and appropriate cut slopes pursuant to recommendations of a qualified vegetation consultant acceptable to the USGS, Menlo Park, and BLM, Ukiah District Office. Revegetation will take place prior to the wet season immediately following completion of construction activities.

c. Surface and Ground Water

All construction will be completed pursuant to specifications for protection of ground water resources. The waste discharge sumps at the well sites will be constructed with a 61 cm (24") thick impervious clay liner compacted to insure a maximum permeability of 1×10^{-6} cm/sec. (0.4×10^{-6} inches/sec). Subsurface ground waters will be further protected by casing and cementing procedures proposed in the Application to Drill (Form 9-331C) and approved by the office of the Geothermal Supervisor, Menlo Park.

The project area lies near the headwaters of two small subdrainages, both part of the 920 square Kilometer (330 square mile) Lake Berryessa Watershed. The northern portion is drained by an ephemeral stream, Hot Spring Creek, a tributary to Anderson Creek. The southern portion is drained by Bear Canyon Creek, also tributary to Anderson Creek. The potential for stream pollution will be minimized by construction of earthen berms at appropriate locations along the drill pad sites which will direct any accidental spillage of oil and grease from operating facilities into the waste disposal sumps. Waste disposal sumps will be constructed with capacities to accomodate all of the liquid wastes from drilling operations plus the maximum precipitation which could be expected to fall within its area. The sumps will be operated with a minimum 91 cm (36") of freeboard above the liquid level at all times.

d. Fish and Wildlife

Direct impacts to resident wildlife will be from the alteration or removal of habitat for the construction of well pads, pipeline installation, and new access roads. Displacement or elimination of the smaller and more sedentary forms of wildlife will be most affected. The affected area will be a small fraction of Lease Unit Nos. 8 CA956A and 10 CA958.

No drilling muds or other fluids associated with geothermal operations will be discharged to any surface other than to the sumps, thus avoiding potential hazards to aquatic life in Hot Spring Creek and Bear Canyon Creek drainage.

Observations indicate that increased noise levels caused by well clean-outs, testing, and standby venting, as well as disturbance from human activity had little obvious effect on wildlife usage of adequate habitat. (Neilson, et al, 1976).

The BLM Environmental Assessment Record of September 1978 states that endangered and fully protected wildlife species sighted in the Geysers area, include the golden eagle, the peregrine falcon and the white-tailed kite. The observed use of the area for all of these birds appears to be for foraging. No nesting is known to occur on or adjacent to the subject leases.

e. Air Quality and Noise

The potential impacts of the project on air quality are: (1) increased suspended particulates from road and pipeline construction, vegetation removal, and vehicular traffic, (2) particulates generated during air drilling, and (3) production of hydrogen sulfide (H_2S) during drilling, testing and producing. The particulates from construction activities will be mitigated by the exercise of good engineering practices and by the wetting of problem dust areas when necessary. Particulates generated from drilling will be abated by use of injected water and a cyclone separator/muffler. Potential impacts from the production of H_2S will be mitigated as required by the Lake County Air Pollution Control District. A Hydrogen Sulfide Contingency Plan was forwarded with a cover letter dated July 26, 1977 and is on file at the USGS office of the Geothermal Supervisor, Menlo Park, California.

Potential environmental impacts by increased noise levels exist from the various construction and drilling equipment and from testing of the wells and pipeline. Mitigation of engine noise will be accomplished through the use of mufflers on the air compressor and drilling rig engines. Noise during air drilling will be abated by the cyclone muffler/separator. Altogether noise from drilling operations, even though of only 60-90 days duration, will be abated to a level of 65 dB(A) at a distance of 0.80 Km (0.5 miles). Noise levels during pipeline testing (blow down) will not exceed Ldn 55 dB(A) at Anderson Springs approximately 1.7 Km (1 mile) away during each 12 hour test period. Exhibit "I" is a "Report of Noise Associated with westside portion of Unit 13 blowdown" prepared by Consultants in Engineering Acoustics June 12, 1979. This report indicates that the sound levels from blowdown noise at Anderson Spring were well below the land use permit criterion of an Ldn of 55.

10. Methods of Disposing of Waste Material

Waste disposal for the project will be in accordance with methods described in Supplement I to the Plan of Operation for Lease Unit No. 10 CA958 submitted October 9, 1974 and approved November 1, 1974.

Plan of Injection Operation

At this time the well to be selected as an injection well is not known. Details regarding the well selected as an injector will be provided in the Plan of Production to be submitted at a later date. Condensate from producing wells will be collected through the 5 cm (2") collection line to be installed adjacent to and with the steam pipeline transmission system. The 5 cm (2") collection line will carry the condensate from production wells into the main injection line or the sedimentation basin at the power plant site along with the condensate from the cooling tower. Condensate from the sedimentation basin will flow through a 30 cm (12") non-corrosive line to a point just beyond the outer perimeter of the power plant site and a 20 cm (8") epoxy coated line from that point to the well head. As described previously, a fail-safe, two-stage alarm system operated by an uninterruptable power supply will protect the condensate system from overflow.

The condensate system will be operated in compliance with Waste Discharge Requirements Or r No. 78-184 adopted October 27, 1978, by the California Regional Water Control Bo..d, Central Valley Region.

If located on fee land, the California Division of Oil and Gas has responsibility for approval and permitting of the injection well.

Environmental Concerns

1. Regional and Local Geology

The Draft Environmental Impact Report "Geothermal Pipeline System Aminoil USA, Inc. - Unit 16 Castle Rock Springs Area, Lake County, California" Cooper-Clark & Associates, February 16, 1979, covers the project area which is located in the Mayacmas Mountains of the California Coast Ranges. These ranges are known for their complex geology, active and potentially active faulting, rugged terrain, highly erodible soils, and widespread landslide conditions.

The central Mayacmas Mountains, in which the study area is located, have been mapped by R. J. McLaughlin (1978) as a structurally complex, southeastward-plunging anticline (regionally upfolded and tilted mass of rock). The eroded core of this structure consists of late Mesozoic sedimentary, igneous and metamorphic rocks of the Franciscan Assemblage which may range up to 15,000 meters (49,000') in thickness. Sedimentary rocks of the Great Valley Sequence, in places, overlie the Franciscan core rocks but are contemporaneous in age. Large-scale thrust-faulting (Coast Range thrust) has placed the Great Valley Sequence above the Franciscan Assemblage. This thrust fault is characterized in most areas by serpentinite or other basic intrusive rocks.

North and east of the main Geysers area, rocks of the Franciscan Assemblage are unconformably overlain by Tertiary volcanics of the Clear Lake Volcanic Series. West of the Geysers, Franciscan rocks are unconformably overlain by Tertiary and Quaternary sediments. Throughout the Coast Range Mountains, the Franciscan Assemblage has been severely folded, fractured and faulted producing an extremely complex mixture of rock types. Serpentinite and basic intrusive rocks are common throughout the assemblage. The distribution of these bedrock units in the vicinity of the site is shown on Figure 16, Regional Geologic Map of the above referenced 1979 Cooper-Clark & Associates report and on Exhibit "C" attached.

The leasehold is entirely underlain by rocks of the Franciscan Assemblage of Jurassic to Cretaceous age and by rocks closely associated with the Franciscan Assemblage. Regionally metamorphosed graywacke sandstone is the most prevalent rock type, underlying approximately 50% of the area. It occurs principally in the eastern half of the area, but outcrops as pods and lenses of various sizes throughout much of the western portion. Wardlow Rock, which has been previously mapped as greenstone, consists entirely of metagraywacke. Much of the metagraywacke mapped in the western portion of the area, including Wardlow Rock, occurs as "tectonic blocks" within a melange unit. Serpentinite, melange, and metagreenstone underlie approximately 40% of the area, principally in the western portion. The remaining 10% is underlain by graywacke sandstone, metamorphosed ultramafic rock, silica carbonate rocks, high grade metamorphics (principally blueschist within the melange), and chert in decreasing order of prevalence.

Melange occurs in two separate bodies within the southwestern quarter of the area. Within the melange there are numerous inclusions or tectonic blocks of metagraywacke, greenstone and blueschist. To the southwest, the melange is in fault contact with a large body of serpentinite, but the project area itself overlies only a small portion of this serpentinite. To the northeast, a narrow northwest trending band of serpentinite, metamorphosed ultra-mafic rock and silica carbonate rock separates the melange from a broader band of metagreenstone in the central portion of the area. The contacts in this area are dominantly ancient faults. To the north, this same serpentinite body separates the melange from graywacke sandstone. In general, the contacts between most rock units within the area are ancient faults. These faults, although not sources for future seismic activity, have in many instances produced severe shearing and deformation of the rocks immediately adjacent to them and have provided conduits for hydrothermal fluids which have altered the rocks in their vicinity.

Shale units in Franciscan terrain are locally common but not often seen in outcrop because their fractured and sheared condition tends to accelerate the weathering process to produce an obscuring layer of soil. The relative scarcity of outcrops in some of the areas mapped as underlain by metagraywacke and melange suggests that shale may be a significant constituent within these units. Conglomerate units are also known to occur within graywacke and metagraywacke units. Although not observed in outcrop within the area, the presence of pebbles derived from the conglomerate lenses on the ground surface within various portions of the area suggest that these units may be present.

2. Potential Geological Engineering Hazards

a. Seismicity

The Geysers KGRA is located in a region known to be seismically active. The San Andreas, Healdsburg-Rodgers Creek, and Maacama Faults are the closest known active faults within the region which are capable of producing damaging ground shaking within the study area. They are located 53 km (32 mi), 20 km (12 mi) and 13 km (8 mi) southwest of the study area, respectively.

There are no known active faults through or closely adjacent to the project area. The Collayomi Fault, which may be active, located about 2 km (1.2 mi) north of the project area, would generate the greatest ground shaking due to its proximity.

The largest historically recorded earthquake which affected the area was the 1906 San Francisco Earthquake which occurred along the San Andreas Fault. Lawson (1908) indicated Modified Mercalli ground shaking intensities of VI in the vicinity of the project area as a result of this event. Little or no damage was reported to communities in the nearby region. However, the region was sparsely populated at that time, and it is possible that some shaking effects may have gone unreported.

The Healdsburg-Rodgers Creek Fault was the source of the 1969, Magnitude 5.6 and 5.7 Santa Rosa Earthquakes. A Modified Mercalli ground shaking intensity of V was reported in the vicinity of the Geysers as a result of this earthquake (U. S. Department of Commerce, 1971). Little or no damage was documented.

b. Landslides

Based on field mapping and aerial photo study done for the previously referenced 1979 Cooper-Clark & Associates report, 72 landslides of varying dimensions and degrees of activity were identified within the area. The location of each and its classification nomenclature are shown on Figure 10, Landslide Map and Exhibit "C". The map provides an explanation of the landslide classification nomenclature used.

Analysis of Figure 10 of the 1979 Cooper-Clark & Associates report shows that 13 landslides are classified as recently active, 48 as dormant, 5 as static and 6 as ranging from dormant to static*. One of the 13 recently active landslides mapped is a landslide zone consisting of numerous, small to moderately sized slides which cannot be individually delineated. In terms of identification reliability, 43 are classified as definitely identified, 14 as probable landslides, and 15 are of questionable existence.

It is estimated that about 35% of the slides are between 30 meters (100') and 150 meters (500') in length, with most of these in the 60 meters (200') or more range. About 50% are estimated to be greater than 30 meters (100'). Maximum depths of sliding are estimated to range from 1.5 meters (4') to over 60 meters (200').

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*Dormant landslides are classified as inactive under existing, natural slope conditions but may be reactivated by moderate changes in the slope environment. "Moderate" is relative to the overall size of the landslide. As such, a moderate change to a very large landslide could be considered a very substantial change in a small landslide.

(Footnote continued to following page).

Changes can be natural or manmade. Static landslides are classified as not likely to reactivate, except possibly in response to a gross disturbance of the slope environment, such as severe seismic ground shaking or massive grading at a sensitive location on the landslide (fill placement at the slide head or large cuts removing the toe) and/or substantial increases in the moisture content of the slide mass.

Individual landslide movement is primarily a combination of slumping and flow movement with the flows occurring downslope of the slump toe. The flow portion of the slide is usually much larger than the slump portion. In many instances, the slump portion is difficult to recognize due to the effects of erosion. Slide movements involving high velocities (several meters per second or greater) do not appear to be characteristic of the study area. Rather, movements are considered to be relatively slow and mostly occur during or shortly after the winter and early spring when ground moisture is high. At these times, total displacements of a few centimeters to possibly a few meters occur. Mapped landslides are distributed relatively evenly over the area, although there does appear to be some clustering of landslides in the southcentral and northcentral portions. Relative to other mapped geothermal leases in the Geysers-Calistoga KGRA, the landslide conditions within the study area are moderately high in terms of the total number of slides and the area involved, and moderate in terms of activity.

Soil creep (the very slow downhill movement of soil, probably a few millimeters to centimeters per year) appears to be very low within the area. This seems to be due to the very dense vegetation characteristic to much of the area. Vegetation and its root structure tends to hold the soil in place, thus, limiting the amount of downslope movement.

General information on the natural landslide susceptibility within the study area is presented on Figure 11 of the 1979 Cooper-Clark & Associates report, Landslide Susceptibility Map. Figure 11 is a predictive map representing Cooper-Clark & Associates' best judgment of the landslide potential of the existing study area terrain. Modification of the terrain by man or nature can increase or decrease the susceptibilities shown.

Figure 11 was prepared by outlining areas within the study area which have or appear to have differing susceptibilities or potentials for future instability. One of six stability categories was assigned to each delineated area. Assigned categories range from I - Least Susceptible to future landsliding to V - Highest Susceptibility, and Variable Susceptibility (i.e., II to III). The boundaries of the areas and the categories assigned them were based on several criteria, including: bedrock type and condition, slope and slope form, presence and estimated depth of soil, existing landslides, vegetation, and known or suspected seepage conditions. Appendix 3 of the Cooper-Clark & Associates report presents the combinations of the above criteria for each of the five categories.

Figure 11 provides an overview of the study area and indicates if instability is a concern with regard to the nature and location of proposed land uses. The map is intended to provide an indication of present and future stability of larger areas within the study area. In the majority of cases, the map is not sufficiently precise for use in site specific feasibility decisions. However, it does indicate whether instability may be a potential problem at a specific site.

Based on the above information and that contained in Appendix 3 of the 1979 Cooper-Clark & Associates report, about 80 separate susceptibility areas have been mapped within the study area. The map shows that about 50% of the entire study area is classified as moderate to high susceptibility. About 30% is classified as highest susceptibility, and about 20% is classified as least to slight susceptibility.

3. Hydrology

a. Surface Water

The project area lies near the headwaters of two small subdrainages, both part of the 920 square kilometer (330 square mile) Lake Berryessa Watershed. The northern portion is drained by an ephemeral stream, Hot Spring Creek, a tributary to Anderson Creek. The drainage area of Hot Spring Creek above the confluence of Anderson Creek is about 3 square kilometers (1 square mile). The southern portion is drained by Bear Canyon Creek, also tributary to Anderson Creek. The drainage area of Bear Canyon Creek above the confluence with Anderson Creek is about 9 square kilometers (3 square miles). Estimated normal monthly mean runoff for the Bear Canyon and Hot Spring Creek subdrainages is shown on Table 8 of the 1979 Cooper-Clark & Associates Report, Normal Monthly Mean Flows. Calculated normal annual runoff from Bear Canyon subdrainage would be about 909 hectare-meters (7,000 acre-feet) and about 280 hectare-meters (2,250 acre-feet) from Hot Spring Creek subdrainage. Almost 98% of the runoff occurs between November through May.

Steep slopes and low substrata permeability offer a limited reservoir for storing precipitation. Underlying rock is generally not conducive to infiltration from percolating soil water. During the rainy period, short, ephemeral streams augment local stream flow causing runoff to be highly responsive to rainfall amounts. As a result, waterways are subject to rapid increase and decrease of flow rates. Flood frequency curves for Bear Canyon and Hot Spring Creek subdrainages are presented in the PG&E Unit 16 Environmental Data Statement, 1977, Figures IV-8 and IV-9, pp. 54-55.

b. Ground Water

No regional groundwater aquifers of significant yield have been reported to date in the underlying rock formation of the Mayacmas Mountains in the Geysers area. Franciscan rocks are generally classified as non-water bearing. They are considered impermeable except along fracture zones which locally yield small quantities of water to springs and wells. The presence of cold springs and seeps within the project area indicates some near surface groundwater. Springs and seeps are particularly common in landslides. Two springs are located within the project area, Castle Rock Springs and Anderson Hot Spring. Water issuing from these springs is of poor quality for beneficial uses. During field investigations near the proposed Unit 16, PG&E investigators encountered groundwater in exploratory bore holes at depths of 14 to 30 meters (45' to 100'). Piezometers were installed in the exploratory bore holes to measure groundwater fluctuations. The data is summarized in the PG&E Unit 16 Environmental Data Statement, 1977, Table IV-6, p. 56.

The nearest groundwater basin is Collayomi Valley situated about 3.5 km (2 miles) west of the project area.

c. Water Uses

The major beneficial use of Bear Canyon and Hot Spring Creeks is the preservation and enhancement of wildlife, fish, and other aquatic resources. The only surface water diversions near the project area are on Hansen Creek, an ephemeral tributary to Bear Canyon Creek, and on Anderson Creek. The diversion on Hansen Creek is for domestic and recreational purposes. Anderson Creek is diverted just above its confluence with Hot Spring Creek for domestic and recreational purposes.

d. Water Quality

Water quality characteristics of Hot Spring Creek and Bear Canyon Creek are reviewed in Atlantis Scientific's EIR for Castle Rock Springs, 1975, pp. II-23 to II-25, and in PG&E's Unit 16 Environmental Data Statement, 1977, pp. 56-67, Appendices C and I.

Comparing the data to "Quality Criteria for Water", U. S. EPA, 1976, the water quality of Bear Canyon Creek is acceptable for municipal, industrial, domestic, and recreational uses, as well as for non-consumptive uses such as the preservation and enhancement of wild-life, fish and aquatic resources. During the drought conditions of 1976, the waters of Bear Canyon creek were hard and contained large quantities of dissolved solids. Data for Hot Spring Creek during this period indicate water generally unacceptable for any of the above uses due to low pH, low dissolved oxygen concentrations, and high sulfide and trace metal concentrations.

A cooperative water quality monitoring program has been conducted for PG&E and Aminoil by Brown and Caldwell, Consulting Engineers, since March, 1978. Monthly reports prepared for this program are on file at Aminoil's Santa Rosa office. A copy of the last quarterly report dated May, 1979 is included as Exhibit "J".

4. Meteorology

Climate of the Geysers Region is a mild two-season type with wet winters and dry summers. Most precipitation occurs October through May, with rain predominating. The dry season usually occurs June through September, and is long enough for soil moisture to be depleted producing dry range lands before fall rains commence.

The complex terrain of the Geysers Region is a major factor affecting local climate. Interplay between terrain and climate is reflected in data from the area's several meteorological monitors.

Precipitation recorded at Anderson Springs and other local monitors reflects the region's characteristic wet-dry regime (Figure 8 of the 1979 Cooper-Clark & Associates Report, Monthly Average Precipitation). Mean seasonal precipitation in the project area is about 230 cm (90"). Winter precipitation often occurs as snow at elevations above 600 m (2000') where annual snowfall averages about 50 cm (20").

The Mayacmas Mountain ridge deflects incoming marine air, thus producing temperatures within the Geysers region relatively continental in character. Interpolating from Elford (1964), temperature pattern at the project site is:

January mean maximum temperature	0°C	32°F
January mean maximum temperature	13°C	55°F
Lowest observed temperature	-10°C	14°F
July mean maximum temperature	30°C	86°F
July minimum temperature	9°C	48°F
Highest observed temperature	43°C	109°F

Average relative humidity at the Geysers ranges from 13% during the driest months up to 80% in the winter.

Potential annual moisture utilization in the project area is about 75 cm (30"). Stored soil moisture usually is depleted by early June.

Wind speed generally increases with elevation. At elevations below 300 m (1000') annual average wind speeds, excepting calms, are 3 to 5 kph (2 to 3 mph). At elevations of about 760 m (2500'), average speeds range between 6 and 10 kph (4 to 6 mph). At and above 915 m (3000') elevation, the average exceeds 16 kph (10 mph).

Frequency of calms (winds less than 2 to 3 kph) (1 to 2 mph) varies from 55% at stations below 610 m (2000'), to less than 0.3% at exposed elevated peaks. At lower elevation stations, highest frequency of calms is in winter, and lowest in summer.

Directional frequency distribution of local wind flow is more complex. At higher elevations (915 m) (3000'), yearly average directional frequency is either from the NE ± 45° or SW ± 45° nearly all the time. This bimodal distribution is observed in all seasons, but with the NE quadrant slightly favored in winter, and the SW quadrant strongly favored in summer.

At lower elevations, local terrain effects become increasingly important in determining directional distribution. These effects are of two types: Channeling of moderate and strong flows within valleys and around obstacles, and buoyancy driven slope flows consisting of upslope flow over sun heated surfaces and downslope nocturnal flow. Low elevation wind frequency distributions also tend to be bimodal, except that preferred directions are defined by local topography and, thus, vary considerably from site to site. With the exception of low elevation stations located in valleys oriented NE-SW or on slopes with a fall line downward to the SW, very little similarity is found between directional distribution aloft and that at lower elevations.

As implied by the rate of buoyancy mentioned above, the bimodal distribution frequently observed at lower levels is also diurnal, (i.e. each of the preferred directions is generally limited to a particular time of day). The exact local variation depends on slope orientation on or below which the monitoring station is located. At a low elevation site on or below eastward facing slopes and not in a N-S oriented valley, the typical sequence of events is: Predawn westerlies (downslope), midmorning easterlies (upslope), and afternoon through evening southwesterlies (sea breeze). On westward facing slopes, early morning flows are normally easterly (downslope) becoming westerly (upslope) in late morning, followed by more southwesterly flows through evening (sea breeze). Downslope, drainage flows are best developed in winter, and upslope and sea breeze flows are strongest and most frequent in summer.

Directional frequency of high elevation flows at the meteorological station nearest the project area (SRI-2, located 2.4 km (1.4 mi) to the north) has the typical NE-SW bimodal distribution and seasonal variability. In summer, the frequency distribution is diurnal, with northeasterly winds observed only between midnight and noon. In winter, no significant correlation between NW flows and time of day can be established.

5. Soils

Soils of the project area are typically shallow, stony variants of eight upland and mountain soil series. Present are representatives of the Dubakella, Henneke, Hugo, Josephine, Laughlin, Los Gatos, Maymen and Stonyford series. Figure 4, page II-5 of Atlantis Scientific Castle Rock Springs EIR (1975) and Figures IV-3 and IV-4 of the PG&E Unit 16 NOI (1977) show the distribution of soils within the area.

Available water holding capacity of these soils is generally low, fertility is moderate to very low, runoff is rapid to very rapid, and erosion potential is high to very high.

6. Biota

a. Fauna

A wide variety of habitat types are found within the leaseholds, including barren and cleared ground, grassland-oak savannah, chaparral, mixed evergreen forest, broadleaf woodland, knobcone pine woodland, cypress woodland, and riparian woodlands/fresh water streams. The distribution of habitats in the project area and the faunal elements characteristic of each habitat type are reviewed in the Atlantis Scientific Castle Rock Springs EIR, 1975, Appendix F, and the PG&E Unit 16 NOI, 1977, Appendices D and E.

Areas of Critical Concern

Areas of special concern for wildlife in the project area include:

Riparian Habitat - The California Department of Fish and Game has designated riparian areas as a critical habitat type. These areas are important to wildlife since they provide a source of permanent water as well as cover and food. In the project area, riparian habitat is limited to the lower elevation borders of Bear Canyon Creek and its tributaries. At elevations from approximately 820 meters (2700') and above, the extent and density of riparian vegetation decreases until riparian zones are barely noticeable.

Wardlow Rock - The Wardlow Rock area provides roosting habitat for various raptors. Sightings in 1975 confirm that peregrine falcons have used the Wardlow Rock Ridge-Bear Canyon Creek drainage area for feeding. Subsequent studies by PG&E and the California Department of Fish and Game did not reveal any use of Wardlow Rock by peregrines. This rock outcrop supports a large population of western fence lizards, an important prey species for numerous predatory birds.

Rare, Threatened, Endangered and Fully Protected Species:

American Peregrine Falcon - An Endangered Species

According to available reports, this species has been observed on nine occasions within the Geysers-Calistoga KGRA since 1974. One sighting was made near Wardlow Rock on June 10, 1975. No active breeding sites are known to occur in the vicinity of the leasehold.

Golden Eagle - A Fully Protected Species

This species is occasionally seen in the Geysers-Calistoga KGRA. Within the region, the majority of golden eagle sightings have occurred in the Cobb Mountain and Gunning Cliffs area. One sighting of a golden eagle has been made within the leasehold, and another was made near the ridge line to the west. The project area is not believed to be a significant feeding and breeding area for the species.

Species of Special Concern:

Pacific Gas and Electric Company, in consultation with California Department of Fish and Game staff, have identified the following as potential species of special concern occuring within the leasehold:

Mountain Lion - A sign of lion activity was reported by PG&E staff in the area of the proposed Unit 16 site in June, 1977. Mountain lion use of the area is undetermined.

River Otter - A sighting of the species was reported 3 km (2 miles) southwest of the proposed Unit 16 site at the headwaters of Big Sulphur Creek. Bear Canyon Creek provides potential otter habitat.

Cooper's Hawk - Potential habitat for this species occurs within the leasehold.

Sharp-shinned Hawk - Two sightings of this species in the immediate vicinity of the proposed Unit 16 site have been reported.

Prairie Falcon - This species may occur infrequently in the leasehold area. An unconfirmed sighting on Cobb Mountain was reported in April, 1978.

Pacific Giant Salamander - Small populations of this species occur in the headwaters of most permanent streams in the KGRA. The species is found in the headwaters of Bear Canyon and Anderson Creeks.

Fishery

The downstream section of Bear Canyon Creek provides an important spawning and nursery habitat for rainbow trout which supports the fishery of Lake Berryessa. Field investigation to evaluate the aquatic resources of Bear Canyon and Hot Spring Creeks were conducted in fall 1976 by PG&E staff. Findings of the investigation are presented in the Unit 16 NOI, Appendix E (PG&E, 1977).

Preliminary results of a fish monitoring program being conducted by PG&E and Aminoil are presented in PG&E Report 420-7.41 issued May 21, 1979 and titled "Upper Putah Creek Monitoring Studies: Fishery Resources and Stream Sedimentation Interim Report".

Impacts

A small percentage of the leasehold will be lost as habitat as a result of the proposed pipeline access road and well pad construction. Wildlife species directly impacted will be the smaller, more sedentary species such as fence lizards, salamanders, small birds such as wrentits and rufoussided towhees, and small rodents. Habitat for a few individuals of these common, widespread forms will be lost to the population. Those species which are adapted to open or "edge" situations may benefit because of their ability to utilize fill slopes and road sides. These would probably include deer mice, mourning doves and small birds that feed upon grass and weed seeds. Habitat and wildlife corridor disturbance from pipeline construction should be minimal. Cattle continue to graze in areas where pipelines have been constructed and to walk under raised pipes. Deer and other mammals would be expected to do the same.

Noise levels and human disturbance will increase, especially during site construction. This is expected to cause minor and in some cases only temporary reduction in habitat useage.

Noise and disturbance from drilling operations may have some adverse impact on fauna by discouraging the use of adjacent habitat. During the 60 to 90 day period required for drilling a well, the maximum noise levels expected at the edge of the pad (about 50 m (165') from the rig) are 75-85 dBA. At 200 to 250 m (650 to 820') from the rig, noise levels should be well below 65 dBA. Between the latter distance and the edge of the pad, some reduction in bird nesting and feeding activities may occur but other animals will probably be unaffected. Well cleanout and production testing may produce noise levels of 85 to 115 dBA at the edge of the pad, depending on the noise control technology employed. The behavioral responses of wildlife to noise of this intensity are not well understood but, since it would be of brief duration, no serious impact is expected.

During operation of a steam supply field, ambient noise levels in wildlife habitats adjacent to development generally range from 45 to 65 dBA. On rare occasions, large amounts of steam may be vented from one or more wells. Noise levels may reach 100 to 110 dBA for periods of a few hours. Because of the short duration of such exposures, no serious impacts on wildlife are expected.

The potential exists for accelerated erosion, especially during site construction. This could result in the siltation of Bear Canyon Creek with deleterious effects on the fishery and benthic invertebrate fauna. The magnitude of these impacts depends upon the success of mitigations such as revegetation.

Accidental spills of drill wastes, condensate, petroleum and other fluids may occur which can cause adverse impacts on fish and aquatic life if they enter streams. The bentonite clay in drilling mud is of particular concern as are toxic materials and heavy metals (arsenic and mercury) found in geothermal fluids.

Since fauna is dependent upon vegetation for food and cover, damage to vegetation from development will affect wildlife indirectly. Several conditions may lead to damage. Settling of dust from roads, construction work, and particulate emissions on leaves may cause a decline in vigor and productivity. Increased humidities and release of biosensitive materials such as boron from steam venting may cause a decline in vegetation. Direct venting of steam can cause damage and death to adjacent vegetation.

Mitigations

Riparian corridors and water sources such as streams and springs are of critical importance to wildlife. The effective mitigation is to avoid development in these areas.

Large conifer snags and other dead, hollow trees should be protected because of their importance as nesting and perching sites for many bird species.

Erosion potential should be reduced by exposing as little surface areas as possible during construction and grading. Steam pipelines will be aligned to the maximum extent possible along access roads to reduce clearing requirements. Once welding operations are completed, the nine meters (30') clearing initially required along pipelines will be revegetated with native grass.

Aminoil will participate in the PG&E proposed Wildlife Mitigation Plan for the Geysers Unit 16 project. A copy of the proposed plan has been submitted to the USGS at Menlo Park and the BLM at Ukiah for comments.

Other mitigations that will help to reduce or eliminate the impacts of the development on fauna are:

- Toxic material control through careful construction of sumps and maintenance and operation of condensate pipelines.

- Dust control by sprinkling work sites and roads as with water or other acceptable dust retardant.

- Particulate emission control by use of water injection in the cyclonic muffler during air drilling and production tests.

- Noise control by circulation of steam discharges through effective mufflers.

- Venting damage control by directing steam away from vegetation, and by erecting temporary shields between the steam source and vegetation where necessary.

b. Flora

The flora of the Unit 16 supply area is an aggregation of communities that are common in the Mayacmas Mountain Range. These communities have been described in detail elsewhere (Neilson, et al). In general, these communities reflect changes in soil types and soil parent material, but their composition is usually modified by slope aspect and to some extent disturbance.

Serpentinite derived soils support both MacNab and Sargents' Cypress, either in pure stands or with an understory of Jepson's ceanothus, leather oak, and/or Stanford's manzanita. This community is well developed west of Well Site A as identified in the 1979 Cooper-Clark & Associates report. Where serpentine is highly concentrated, barrens occur which support sparse communities of serpentine jewel flower, naked stemmed buckwheat, snow mountain buckwheat, birds foot fern, and occasionally Solano milkweed. In this study area, the latter community is confined to the canyon sides south of Well Site A and would be of importance only if alternate access roads to Site A might be necessary.

Graywacke derived soils have a much wider range of communities, although, ecotones are common where serpentine underlies graywacke at relatively shallow depths. Rock barrens on graywacke occur along the access road to Well Sites A and B. These support a sparse herb community comprised of squirreltail grass, rock cress, buckwheat, etc.. Grasslands are very localized, and limited mostly to disturbed areas on this leasehold. Only two types of grassland occur: The California introduced annual grassland and a mixed perennial type. Both are anthropogenic, i.e. man determined. The former is mostly bromes, fescues, oats and filarees introduced by the Spanish colonials mixed with a few hardy native grasses and herbs. These occur in small isolated patches often as an understory to Digger pine. The other is a sown mixture of common pasture grasses and herbs mixed with a number of weedy annuals and native herbs. These occur along roadsides and well pads, and to some extent along old mining claims and abandoned clearings.

Brushlands occur in large stands over much of the study area. Exposure and soil type are critical factors in segregating brushlands. South and southwest facing hillsides on shallow graywacke soils support chamise communities. Pure chamise occurs on the hottest, driest and thinnest soils. As soil mantle increases, buckbrush, Eastwood's manzanita and mountain mahogany become codominant. Ridge tops also support silktassel brush. North facing slopes support shrubby live oak communities and where soils are best developed some of these eventually develop into oak woodlands or Douglas fir forests depending on fire frequency. Shrubby live oak communities vary considerably in composition but characteristically include Eastwood's or big manzanitas, wavy leaved ceanothus, coffeeberry, mountain mahogany and buckbrush. Deer brush, California nutmeg, bay and madrone also occur on more moist sites.

Knobcone pine woodlands appear to occur mostly in response to frequent burning and seem to be more or less independent of soil type and exposure. They have a wide range of associates depending on pre-burn communities. Closed stands contain Eastwood's manzanita as an understory.

Extensive stands of black oak occur on the study area. They dominate deep, rich soils and in most cases are sub-climax communities to Douglas fir. Black oaks, however, occur as a sub-dominant or incidentally in many communities mostly on north and east exposures where there is a good soil mantle. It is also a common member in Douglas fir climax forests.

Canyon oak communities occupy ravines and are subdominant in north and east facing slopes that have a good water supply.

There are several stands of Douglas fir in various stages of development. These occur mostly on north exposures opposite Anderson Springs. As a rule, the largest trees are in canyons that escape the full brunt of wildfires.

Critical Vegetation Communities

Critical vegetation communities are rock barrens, Douglas fir communities, and riparian.

Non-serpentine barren communities are of botanical interest. Wardlow Rock is a station for mountain pride (Penstoman newberryi var sonomensis) and California fushia (Fauschneria californica), and these two subshrubs form most of the sparse community on this and on two other nearby rock outcrops.

Douglas fir communities support species having both commercial and recreational value. In particular, Douglas fir and ponderosa pine have commercial potential. These, together with black oak, are noted for their stateliness and the aesthetic forests they form. Black oak woodlands can also be considered as communities of recreational value, particularly those nearby pure stands which have limited undergrowth and form a parklike aspect.

Riparian areas have been described in considerable detail in previous EIR's (Neilson, et al, 1974, 1975 and 1976). On the basis of these earlier works, the sensitivity of such communities is well established both from the standpoint of water quality control and wildlife habitat. All of the major waterways in this study area are considered as perennial or intermittent streams that flow eight months or more. These types are the most sensitive and approaches will be limited to 90 m (300') minimum except for necessary pipeline or road crossings.

Rare and Endangered Plant Species

A survey of rare and endangered plant species has been conducted by Aminoil's revegetation consultant, Ralph Osterling, during the period April to June, 1979. The ground area covered by the survey was agreed upon by BLM and USGS personnel and is indicated on the Map Exhibit "K" by the green shaded portion. The report is now being prepared and will be forwarded upon completion.

Potential adverse impacts on flora from the project include:

- Vegetation removal with potential concomitant increases in soil erosion, indigenous nutrient loss, watershed effects, and wildlife readjustments.

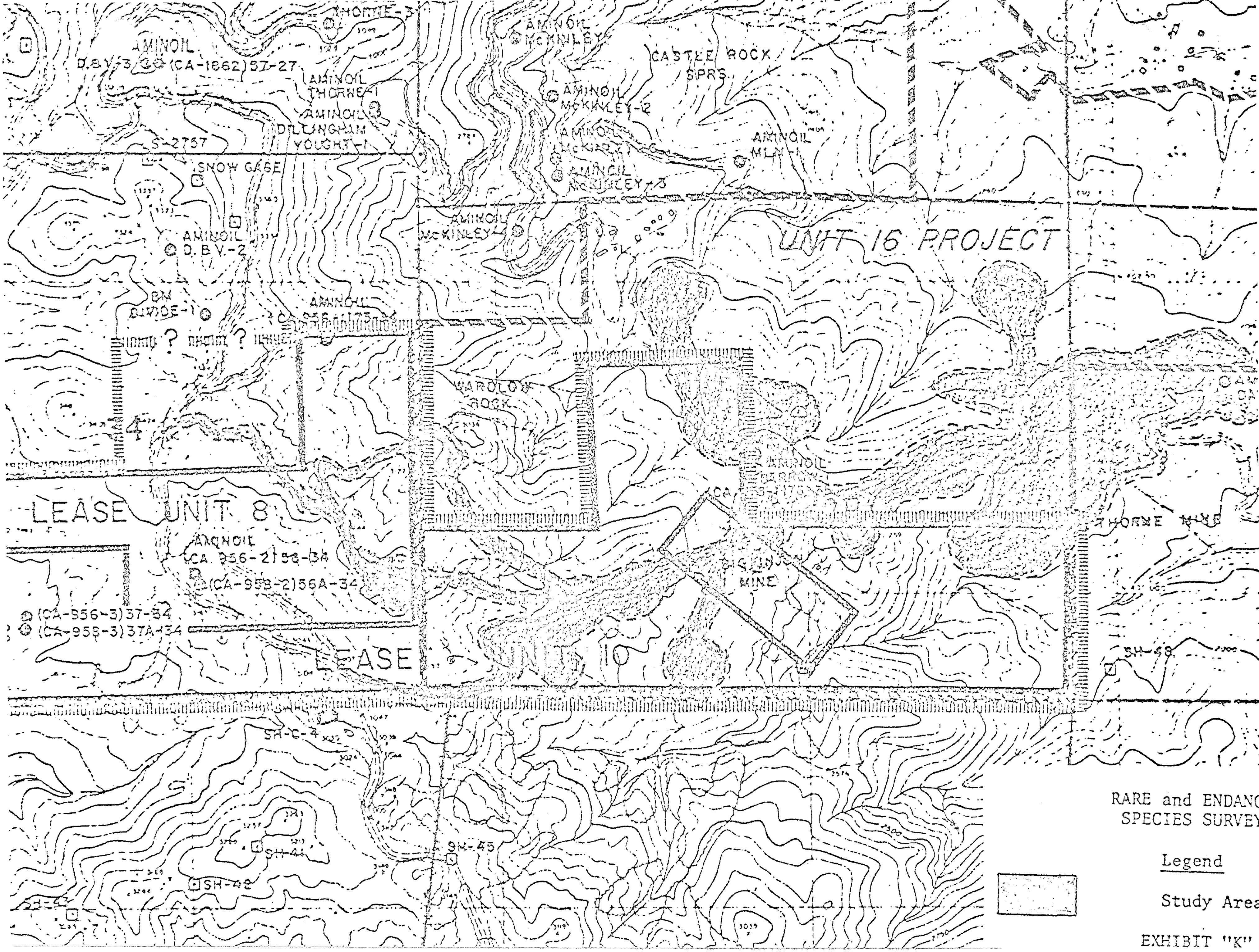
- Direct scalding or condensate adsorption and absorption of boron and other salts into plant tissue.

- Accumulation of salts and sulfur compounds from H_2S emissions, condensate water, etc, in plant tissues.

- Increased potential of wildfire from human access and acitivity.

Mitigations

Mitigations applying to vegetation to lessen the impact of development include avoidance of critical areas (including steep slopes, populations of species of special concern, and mature stands of forest trees), re-establishment of vegetation on denuded areas, or removal of above ground portions without destroying the regenerative crown along the pipelines.



RARE and ENDANG
SPECIES SURVEY

Legend

Study Area

EXHIBIT "K"

Avoidance

Riparian habitats, rock balds, and mature or near-mature stands of Douglas fir will be avoided where it is feasible. Where not feasible, narrow roads or pipeline clearings, designed for minimum surface disturbance and minimum cuts and fills, will be constructed. The rock balds in question in this study area will be avoided by rerouting the roadway to the east side of the crest at the same grade.

Populations of rare or endangered species and most species of special concern will be avoided or appropriate mitigation measures will be followed where their presence is positively established. Pipelines will follow existing roads where possible and hence avoid new disturbance that will increase overall impact.

Re-establishment of Vegetation

The re-establishment of native communities following geothermal development is highly unlikely especially where ground surfaces are disturbed. After about ten years of testing and general application in the Geysers KGRA, the best that can be expected is the establishment of hardy perennials and a number of native annuals and weed.

Graywacke material is very poor nutritionally and has very little water holding capacity. Yorkville, Maymen, Los Gatos and similar soils do better in support of revegetation and the establishment of native shrubs partially because they are more common on north and east facing slopes that are not so warm and dry.

Almost no results can be expected on serpentine soils, which are inherently poor and coarse. A few native species can be re-established such as squirreltail grass and buckwheats. However, even natural communities are sparse and growth is usually measured in decades rather than years.

Since the Forest Service requires a 9 meter (30') cleared path for fire protection along pipeline routes, revegetation can be effective only by allowing crowns of shrubs to resprout and then maintain a close pruning program to restrict growth to 30 cm (12"). An alternative method is to reseed with native grasses or acceptable mixes that include: Blando brome, Idaho fescue, California fescue, red brome, wooly sunflower (Erioplaylum lanatum), and pubescent wheat grass.

Ethnobotanical Species

Species that were commonly used for food and medicinal purposes by indians of the area do occur on the study area. Black oak, shrubby live oaks, and canyon oaks occur in all major communities. All of these species are widespread throughout the Mayacmas Mountains. Pines, particularly Digger and yellow pine, provided nuts, however, neither species is particularly important on the leasehold nor common in these mountains. Similarly, several medicinal plants are known from the area: Yerba Santa, Pitcher sage, and coyote mint. All are very common and need not be specially protected.

Torrent sedge and the bark of several trees and shrubs were used for fibers. As with the other species, all are common and widespread.

No known ethnobotanical species is jeopardized by the proposed development even though this area is convenient to the local rancheria at Middletown.

7. Cultural Resources

An ethnographic and historical resources study was conducted for the fee leaseholds within which the project area is located. This study was performed for Pacific Gas and Electric Company by the Ethnographic Laboratory, Department of Anthropology, Sonoma State University, David A. Fredrickson, Professor of Anthropology. The study concludes that no adverse impact on these resources is anticipated from the project.

Field work for an extension of that study to include Lease Units 8 and 10 has now been completed. Work was done by the Department of Anthropology, Sonoma State University, David A. Fredrickson, Professor of Anthropology and the Report will be forwarded when available.

8. Current and Prospective Land Uses and Local Economy

The site vicinity is presently committed to geothermal development by County use permit. The nearest proved field, Unit 13 Steam Field developed by Aminoil, borders the site to the north. Recreational uses such as fishing, hunting, hiking, etc. also occur. Mercury has been mined, but the mines in the area, Big Chief, Thorne and Big Injun, are inactive. Camp Verdant Vales, a year round school, is located at the northern boundary of the project site. Steep terrain, low fertility soils and limited water supply severely constrain potential land uses in the immediate area.

The site is bounded on the east by Anderson Springs, a small recreation-residential community. The region to the south is largely undeveloped land currently being explored for geothermal resources. The Geysers Steam Field operated by Union Oil Company lies west of the site across the Mayacmas Mountain ridge line.

The majority of the local population resides in and around Middletown in Collayomi Valley about four kilometers (2.5 miles) east of the project. Flat valley and adjacent hills are devoted to ranching, residential and some commercial uses. Land use statistics for the area are given in Table 16 and 17, Land Use Statistics - Middletown Area, 1972, and Agricultural Land Use - Middletown Area, 1972, of the 1979 Cooper-Clark & Associates report.

Principal transportation corridors through southern Lake County are State Highways 29 and 175. Socrates Mine Road, a light-duty County road, provides part of the access to the leasehold.

Emergency Contingency Plans

Contingent plans for (1) Emergency Accidental Spills and Discharge Control Procedures, (2) Emergency Fire Control Procedure, (3) Hydrogen Sulfide Contingency Plan and (4) Blowout Contingency Plan were forwarded with cover letter dated July 26, 1977 and are on file at the USGS Office of the Geothermal Supervisor, Menlo Park, California.

F. Schedule of Operations

Start of Construction (Drilling of wells under Plan of Development).	March, 1980
Completion of Construction	June, 1983
Start of Commercial Operation	Sept. 1983
Life of Project	30 years +

APPENDIX 1

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

Exhibit C is a geologic map of the area.

It was not easily reproducible so it was not included in this mailing.

It can be seen at the AGS office in Menlo Park.

If you have questions call Dave Fach at (415) 323-8111 x2848.

APPENDIX 2


THORNE
AMINOIL
MURPHY, LASTER & McNEIL
CA 958-A
BARROWS-A
POWER PLANT
PG&E UNIT 16
35
BARROWS-B
MC KINLEY
AMINOIL
McKINLEY
ARMSTRONG
AMINOIL
BARROWS
SHEL
U.S.A
CA 958-D
CA 956-A
CA 956-B
POWER PLANT SITE
DISPOSAL AREA
AMINOIL
ARMSTRONG
AMINOIL
U.S.A (CA-956)
CA 958-C
CA 956-B
AMINOIL
U.S.A (CA-958)
SHELL
U.S.A
2

APPENDIX 3

consultants in engineering acoustics

Analysis and Design for Vibration and Noise Control • *Thomas R. Norris, P.E., Wayne B. McDonald*

12 June 1979

Mr. Doug Bell
Aminoil USA
P.O. Box 11279
Santa Rosa, CA 95406

Subject: Report of Noise Associated with West Side Portion of Unit 13 Blowdown

Dear Mr. Bell:

This letter report documents noise measurements of the west side blowdown of the Unit 13 steam supply system. The noise measurement procedures are described and the measured sound levels are compared with our estimates of 21 May 1979.

During the design of this blowdown, an important goal was to assure that all environmental noise requirements were met. This included a quantitative noise limit of an L_{dn} of 55 and a self-imposed goal of eliminating complaints of noise from Anderson Springs. The latter goal required that noise levels be much lower than has been achieved by conventional blowdown practice at the Geysers-Calistoga KGRA. The resulting noise levels were well within the quantitative limit and there were no known complaints of noise.

Summary of Important Observations

The following are the important acoustical observations based on the Unit 13 west side blowdown noise measurements:

1. This blowdown demonstrated that the technology is available to quietly clean out and pressure test a steam system even very near a noise sensitive community without noise causing an adverse environmental impact.

2. The blowdown noise was virtually inaudible in Anderson Springs except for the few minutes a 12-inch valve was opened on an emergency basis. We would classify the blowdown as having produced no acoustic impact in Anderson Springs. The sound levels from blowdown noise were well below the land-use permit criterion of an L_{dn} of 55.

3. Noise level measurements compare well with prior design estimates. In all cases of discrepancy, the estimates were slightly higher than the measurements.

EXHIBIT "I"

4. The highest noise level at the steam relief site was generated by the emergency opening of a 12-inch valve during the pressurization test. Then, noise levels up to 112 dBA were measured at 300 feet. This would have been momentarily disruptive to PG&E's construction had it occurred during working hours.

5. Orifice plate noise is attenuated at a modest rate in propagation down steam pipes (in one case, a reduction of 35 dBA in the first 600 feet of pipe).

Instrumentation and Measurement Locations

Sound levels were measured in Anderson Springs at a location about one quarter mile east of the dam and 650 feet north of the creek. This location was chosen because even low level blowdown noise could be detected here; creek waterfall noise was below 30 dBA and there are few nearby activities that would produce noise. (See Figure 1 for map.) Sound levels were monitored at this location for a 24-hour period using a statistical noise monitoring system. This system onsisted of a Bruel & Kjaer 2219 sound level meter, a Sony TC153SD tape recorder, and a timing device. Later, in our laboratory, a continuous time plot of these sampled, A-weighted sound levels was obtained from the tape using a B&K 2305 graphic level recorder. During this playback, it was possible to identify, by listening, all significant noise sources. Also, the percentage of time that the sound levels were within a given 2.5-dB range was obtained using a Bruel & Kjaer model 166/S45 Environmental Noise Classifier. Calculations of the L_{eq} and L_{dn} are based on statistical data from this instrument.

A-weighted sound levels were continuously monitored on the top of the Unit 13 cooling tower near the steam relief station. The measurement system used here consisted of a General Radio model 1565-C sound level meter and a Bruel & Kjaer model 2305 graphic level recorder set to a writing speed of 25 mm/sec. This system produces a paper strip chart of the A-weighted noise level. The microphone location was near the lengthwise center of the Unit 13 cooling tower, four feet above its 50-foot-high roof deck, and 10 feet from its edge. Here, the microphone had a direct line of sight to the steam release station but was partly shielded from nearby construction noise.

The distances from the microphone to the steam relief noise sources were 250 feet to the 48-inch pipe outlet, 200 feet to the 12-inch valve, 200 feet to a small unmuffled steam bleed valve, and 300 feet to a 1½-inch bleed equipped with a 12-inch diameter portable rock muffler.

Live octave band and A-weighted sound levels were measured with a General Radio 1933 sound level meter at the above two locations as well as other locations in the steam field, primarily near CA 956-2 and along the G line. The measurements at these other locations will be described in more detail later in this report.

Noise Measurement Results and Comparison with Predictions

In Anderson Springs. Figure 2 presents a plot of A-weighted environmental sound levels in Anderson Springs *vs.* time from 4 a.m. to 8:17 p.m. on 22 May 1979. The period before 4 a.m. has not been presented, because the nighttime sound levels were near or below the electronic limits of the sound level meter used, and the data therefore do not represent environmental noise.

The noise peaks during the daytime hours have been identified by the sound sources which produced them. The only blowdown noise which was identifiable coincides with the short time the 12-inch valve at the steam relief station was opened for a mechanical emergency, which produced a maximum of 53 dBA. For comparison, we note that aircraft routinely fly over this region and typically produce noise levels of 45 to 55 dBA.

Weather conditions no doubt helped prevent more of the 12-inch valve noise from reaching Anderson Springs. Specifically, winds were calm to a very slight breeze from the east. This situation should have produced slightly more attenuation of noise originating near Unit 13 than the more common west wind.

Table 1 presents a statistical breakdown of A-weighted noise recorded in Anderson Springs between 5 a.m. and 8:17 p.m. on 22 May 1979. Table 2 presents the A-weighted L_{eq} (noise energy average) levels throughout the day, based on the data in Table 1. The L_{eq} for the daytime period from 7:00 a.m. to 8:17 p.m. is 41 dBA. As was mentioned previously, instrumentation limitations prevented accurate recording of the very quiet nighttime noise levels. Therefore the L_{dn} which is based on the L_{eq} cannot be calculated explicitly. Based on available data, however, we estimate that the L_{dn} was between 38 and 42. This is well below the L_{dn} of 55 that was allowed and is due almost entirely to noises not associated with the blowdown.

Representative background environmental noise octave band sound levels in Anderson Springs are presented in Figure 3. These measurements were made using a precision sound level meter and were taken at times when momentary noise sources such as insects, animals, cars, and airplanes, were not audible. Typical A-weighted sound levels are 35 to 40 dBA. In the 4000 Hz octave band at 1:05 p.m. on 23 May 1979, a considerable amount of noise is bird chatter. Otherwise the distinctive sounds heard are leaves rustling in the light wind and the low-level (below 30 dBA) rushing noise of the creek.

Near Unit 13. Figure 4 is a plot of the A-weighted noise level vs. time as measured on the Unit 13 cooling tower from 2:30 p.m. to 7:38 p.m. Prior to 3:00 p.m., PG&E construction noise was the dominant sound and consisted of engine-powered equipment, impact tools, and hammering. Beginning with the pressurization test after 4:00 p.m., the blowdown noise became dominant. PG&E was mostly off work by this time.) The noises consisted of hammering, a crane, and steam releases. Other than noise from a single 12-inch valve, the sound levels were similar to the construction noise described. The 12-inch valve produced about 102 dBA for several minutes at this location during planned operations. After this valve was closed, sound levels were much lower. They rose again to an average of 83 dBA at the maximum pressure of about 240 psig. This noise was due to a muffled steam bleed. The jumps in the plot are due to the opening and closing of small unmuffled steam bleeds and the one 12-inch valve.

Figure 5 shows octave band sound levels of the 12-inch valve as measured on the cooling tower. As we had not been informed prior to the day of the blowdown that steam might be vented through this valve, we had not made previous estimates. However, we determined in the field that noise levels in Anderson Springs would be acceptable. Based on a line pressure of approximately 20 psig and a flow of 150,000 lb/hr, we estimate a sound level of about 108 dBA on the cooling tower. This is slightly more than the measured noise levels, which varied from 96 to 108 dBA. The calculation is quite sensitive to valve position and actual line pressure; a 5 psi pressure change would make a noticeable difference in noise level.

Once full pressurization (240 psig) was reached, the noise measured at the cooling tower was mostly emitted by a 12-inch diameter rock muffler at the PG&E end of the 48-inch steam supply pipe. (We understand that all other bleeds were closed at this time.) A noise level averaging 83 dBA was measured. Our prediction for the noise from this source, adjusted for this microphone location, is 91 dBA.

Octave band sound levels for steam venting through the 48-inch header are presented in Figure 6. Measurements were taken at 60 feet from the pipe center and just downstream of the steam exit. The noise is largely very low in frequency. The measured noise level was 74 dBA. Our prediction, corrected for this measuring distance, is 81 dBA. This included a contingency of 15 dB because of noise created where the steam turns upward at the exit. It appears this estimate was conservative and that instead a 7 dB correction would have been more accurate.

Along the G line. During the pressurization test, unmuffled, high pressure drip leg noise near CA 956-2 was measured at the aximum pressure attained. The octave band spectrum is presented n Figure 7 and shows a fluctuation, largely due to wind. The A-weighted levels varied between 77 and 87 dBA. These measurements were made at the bottom of the hill on the road below CA 956-2, approximately 1100 feet from the well. (See Figure 8.)

These measurements provide an interesting opportunity to measure noise that is partly blocked by a well pad rim with a geography similar to that of more easterly pads facing Anderson Springs. Such data is very useful in developing noise predictions for the east side blowdown. Our estimate of the noise for the three drip legs near CA 956-2 is 89 dBA, including a 5 dB attenuation based on the slight break in the line of sight. The estimated octave band spectrum is also plotted in Figure 6. The estimates compare well with the measured noise level, and suggest that the 5 dB attenuation for a slight break in the line of sight is slightly conservative. It is our feeling that the lower levels were the result of the winds, which were somewhat gusty and varying in direction at the time of measurement. This also shows the large effect weather conditions can have on sound propagation.

Octave band sound levels of orifice plate noise, measured at 1300 feet from the 2.8-inch orifice downstream of CA 956-2, are plotted in Figure 9. The geography here is similar to that for the drip leg measurements described above, except the orifice plate measurements were taken about 200 feet further away (See Figure 7). The measured noise level was 65-70 dBA. This is slightly below the prediction of 74 dBA.

Figure 10 shows A-weighted sound levels along the steam line for noise generated at the 2.8-inch orifice plate downstream from CA 956-2. All measurements were taken at 10 feet from the center of the pipe. The noise attenuated moderately with distance along the pipe. After traveling 600 feet, the A-weighted sound level was reduced by 35 dB. By 1500 feet of travel, steam flow shear noise was dominant and produced a sound level of 57 dBA.

Figure 11 shows A-weighted sound levels around the "T" at the junction of the G and G_1 lines. Mr. Frye of Aminoil had alerted us to the noise generated at this location. This noise source shows that appreciable noise can be generated at junctions. The attenuation with distance along the G line 's similar to that from other pipeline noises. This data ould be very useful in predicting long-term noise from "T" junctions located in environmentally sensitive areas, such as close to a community.

An unsilenced drip leg during the clean-out test generated a noise level of 96 dBA at 50 feet. We had not predicted the noise from unsilenced drip legs for the clean out portion of the test, as we expected it to be much less than during the pressurization test. Our estimate at a 50-foot distance for the pressurization test was 122 dBA. Therefore, drip leg noise for the low-pressure clean out test was indeed comparatively negligible.

Overall, the blowdown noises were controlled as anticipated and were virtually inaudible in Anderson Springs with the exception of the emergency steam release at the 12-inch valve. The latter noise had not been noticed by those persons queried afterwards by Mr. Woods of Aminoil. No complaints of noise were received.

This concludes our report on noise associated with the west side portion of the Unit 13 blowdown. If you have any questions or comments, please call.

Sincerely,

Wayne B. McDonald

Wayne B. McDonald

WBM/ss

enclosures: Figures 1-11
Tables 1 and 2

cc: George Frye
Mark Kumataka
C. E. Woods

TABLE 1

STATISTICAL DISTRIBUTION OF A-WEIGHTED SOUND LEVELS IN ANDERSON SPRINGS

ON 22 MAY 1979

PERCENTAGE OF TIME SOUND LEVEL WAS IN INDICATED RANGE (%)

TIME INTERVAL

dBA Range	5:00-7:00am	7:00-8:15am	8:20-10:20am	10:20am 12:20pm	12:20-2:20pm	2:20-4:20pm	4:20-6:20pm	6:20-8:17pm
30.0-32.5	7.5%	1.4%	3.8%	26.6%	27.3%	16.6%	16.6%	19.8%
32.5-35.0	34.4	36.5	36.2	42.1	27.0	35.3	41.4	29.4
35.0-37.5	29.0	35.2	32.4	17.7	20.3	26.2	22.5	25.9
37.5-40.0	9.1	8.2	10.2	4.3	6.8	8.6	6.4	8.4
40.0-42.5	13.4	12.3	11.5	5.4	9.7	8.6	5.6	10.8
42.5-45.0	4.3	2.7	2.9	2.2	4.1	2.4	3.2	1.7
45.0-47.5	1.6	1.8	1.9	.8	1.6	1.6	1.6	1.7
47.5-50.0	.5	.9	.8	.3	.8	.3	.8	.6
50.0-52.5	0	.5	.3	.3	.8	.5	.8	.3
52.5-55.0	0	0	0	.3	.8	0	.8	0
55.0-57.5	0	.5	0	0	.3	0	.3	.6
Above 57.5	0	0	0	0	0	0	0	.9

TABLE 2

ENERGY-AVERAGED A-WEIGHTED SOUND LEVELS (L_{eq}) IN ANDERSON SPRINGS

FOR TIME INTERVALS ON 22 MAY 1979

Time Interval	L_{eq}
5:00 - 7:00 am	36.3
7:00 - 8:15 am	40.9
8:20 - 10:20 am	39.7
10:20 am - 12:20 pm	38.4
12:20 - 2:20 pm	41.6
2:20 - 4:20 pm	39.1
4:20 - 6:20 pm	41.0
6:20 - 8:17 pm	43.0

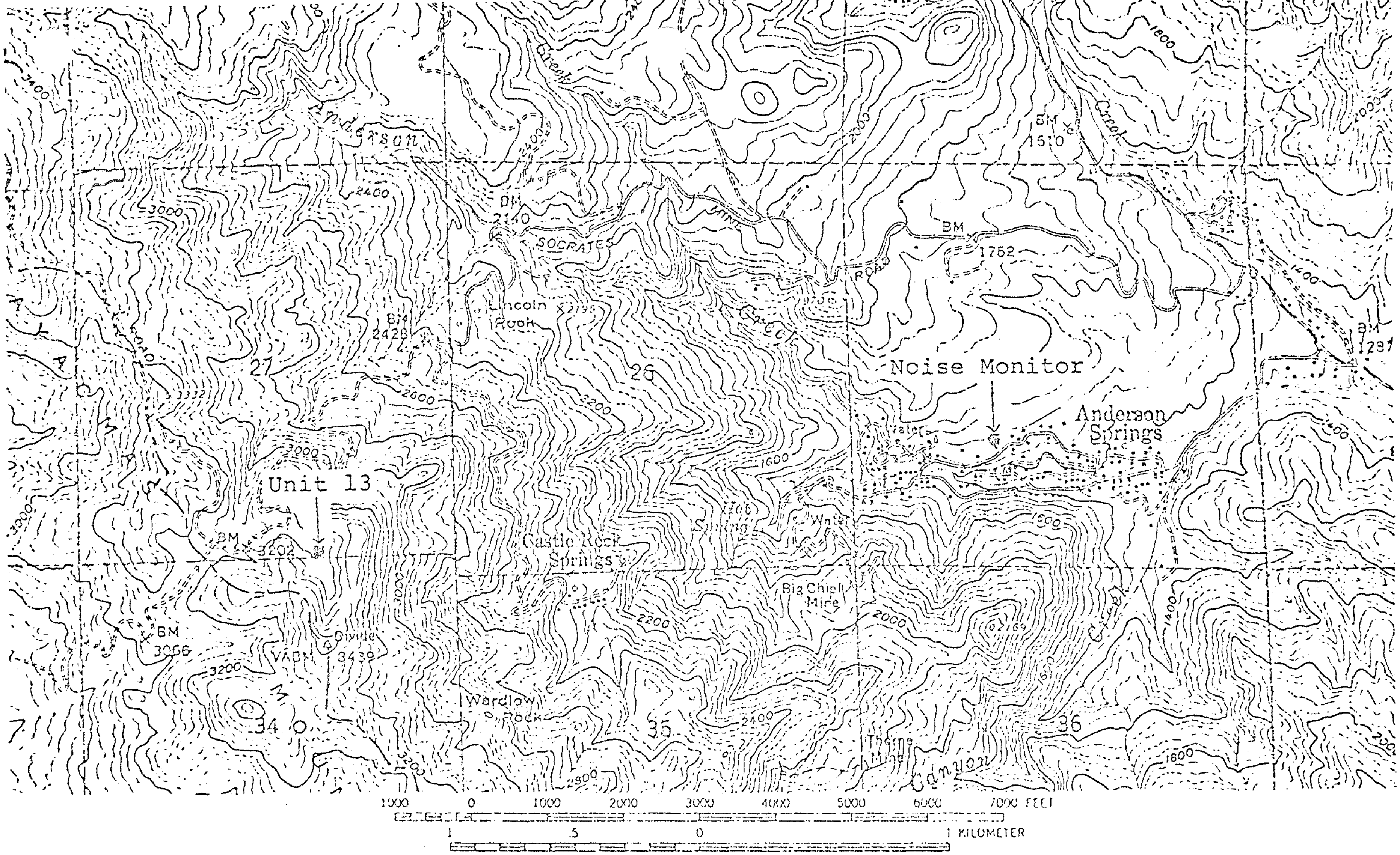


Figure 1: Location of noise monitor in Anderson Springs.

UNITED STATES
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Area Geothermal Supervisor's Office
Conservation Division, MS 92
345 Middlefield Road
Menlo Park, CA 94025

Figure 2 is a copy of a strip chart showing the A-Weight Sound Pressure Level vs. Time in Anderson Springs on 22 May 1979.

The copy was not easily reproducible so it was not included with this mailing.

It can been seen at the AGS office in Menlo Park.

If you have questions call Dave Fach at (415) 323-8111 x 2848.

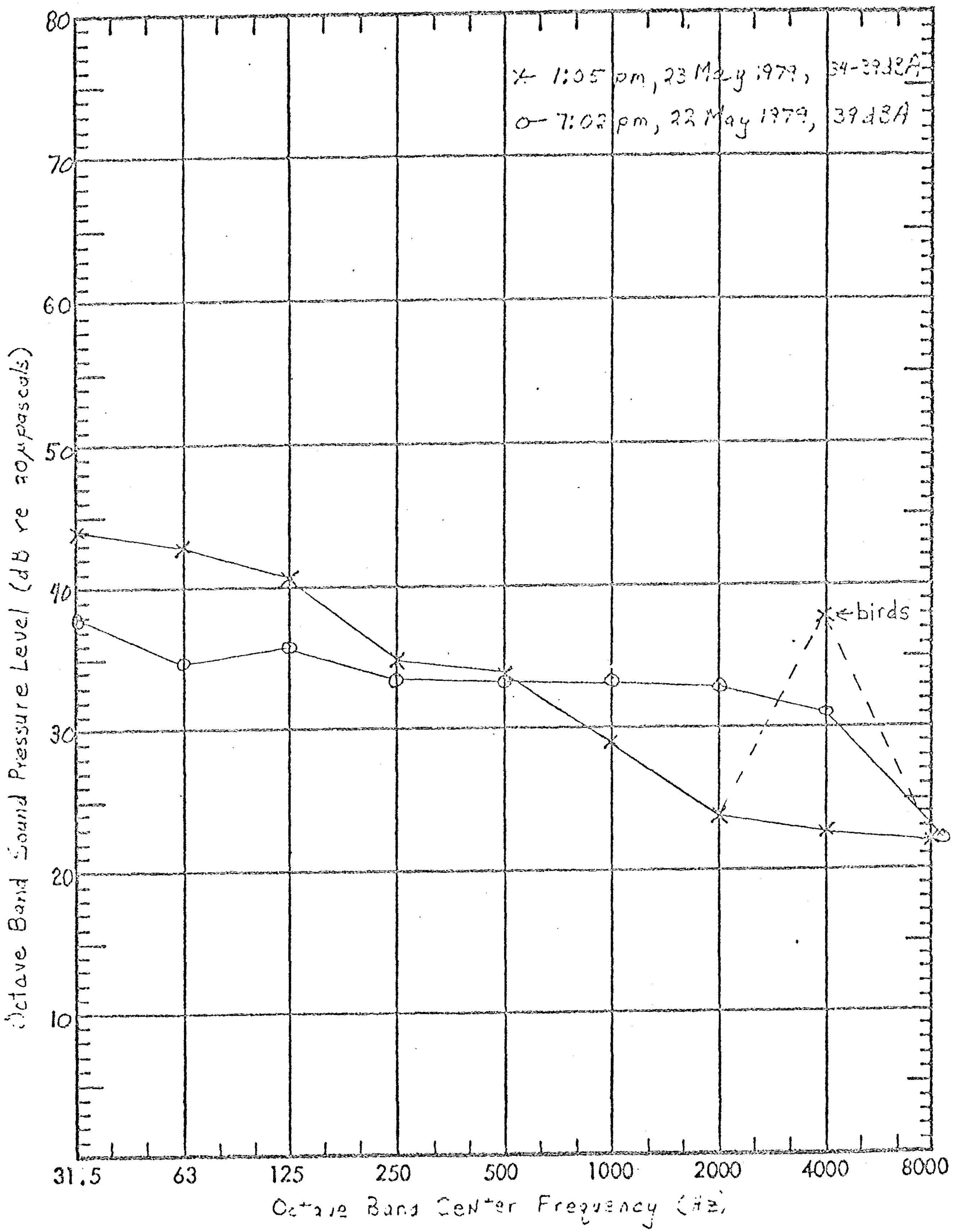

Figure 3: Typical Sound Spectra in Anderson Springs

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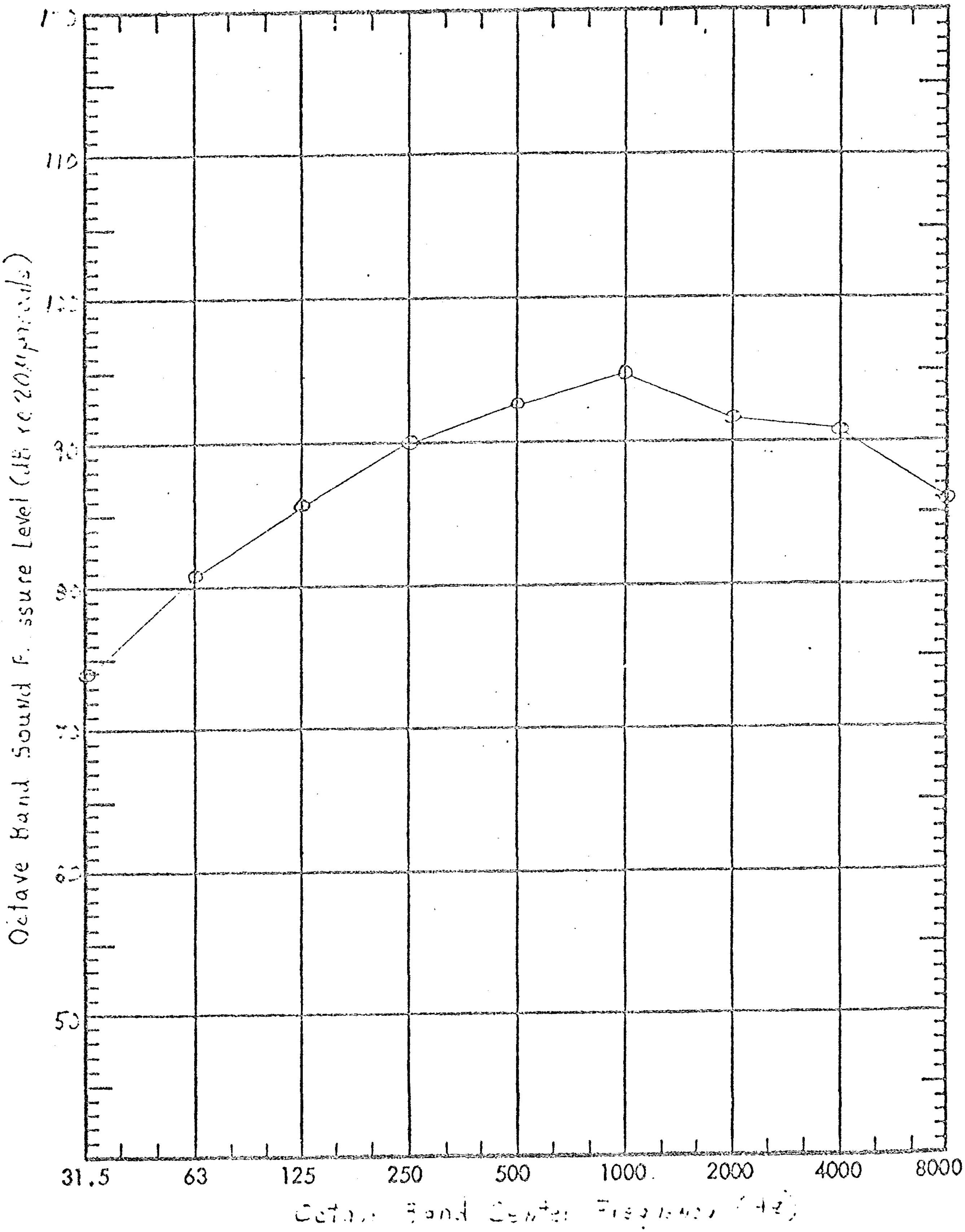
Menlo Park, CA 94025

Figure 4 is a copy of a strip chart showing A-Weighted Sound Pressure Level vs. Time on top of cooling tower at Unit 13.

The copy was not easily reproducible so it was not included with this mailing.

It can be seen at the AGS office in Menlo Park.

If you have questions call Dave Fach at (415) 323-8111 x 2848.



F[illegible] 5 Spectrum of 12 inch [illegible] noise during pressurization test measured on top of [illegible] [illegible] 150,000 [illegible]

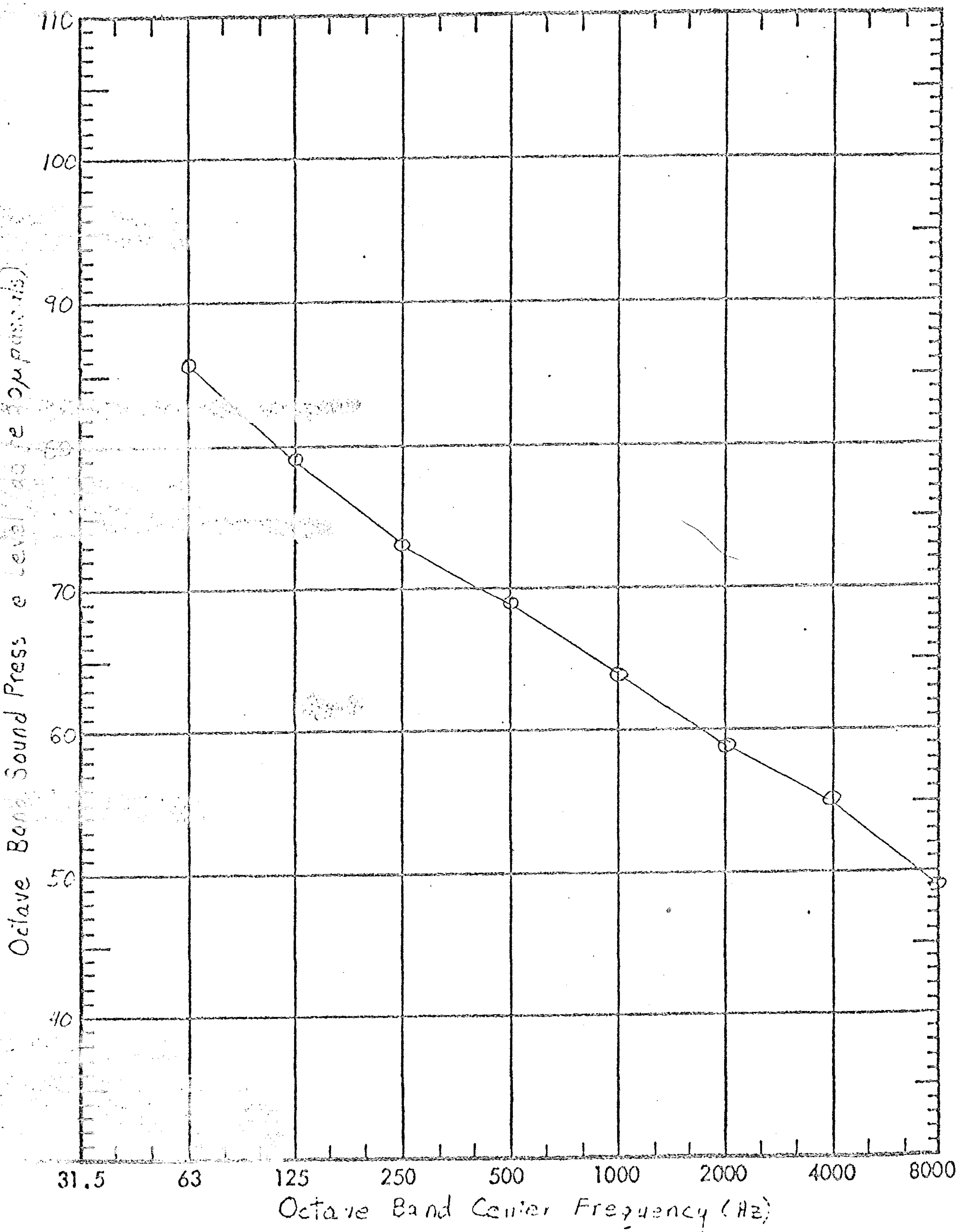


Figure 6 Spectrum of venting Noise from 45 inch pipe at steam outlet station at maximum flow 74 dBA.

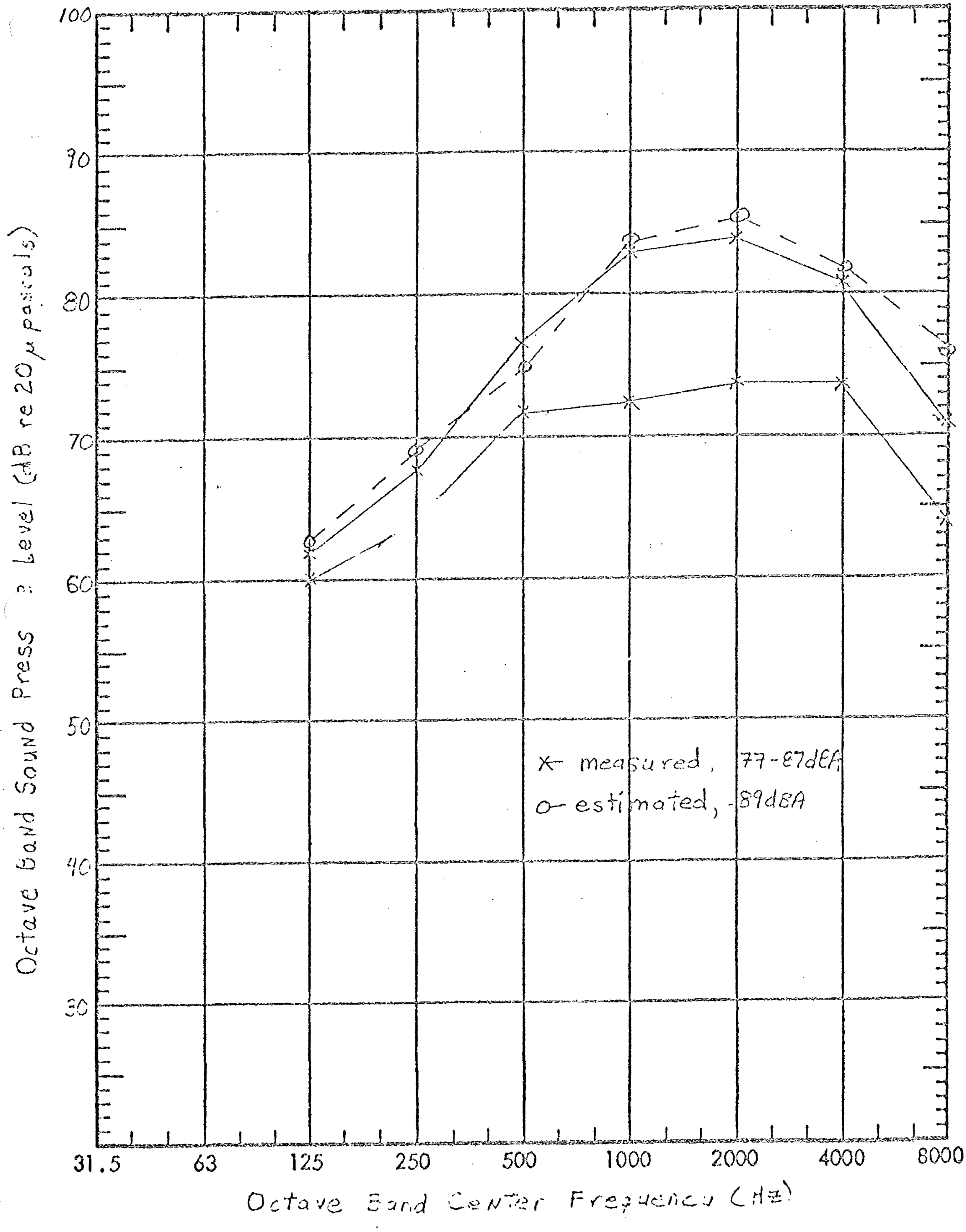


Figure 7: Comparison of measured and estimated sound spectra [illegible] during [illegible] test. Measured 1100 feet [illegible]

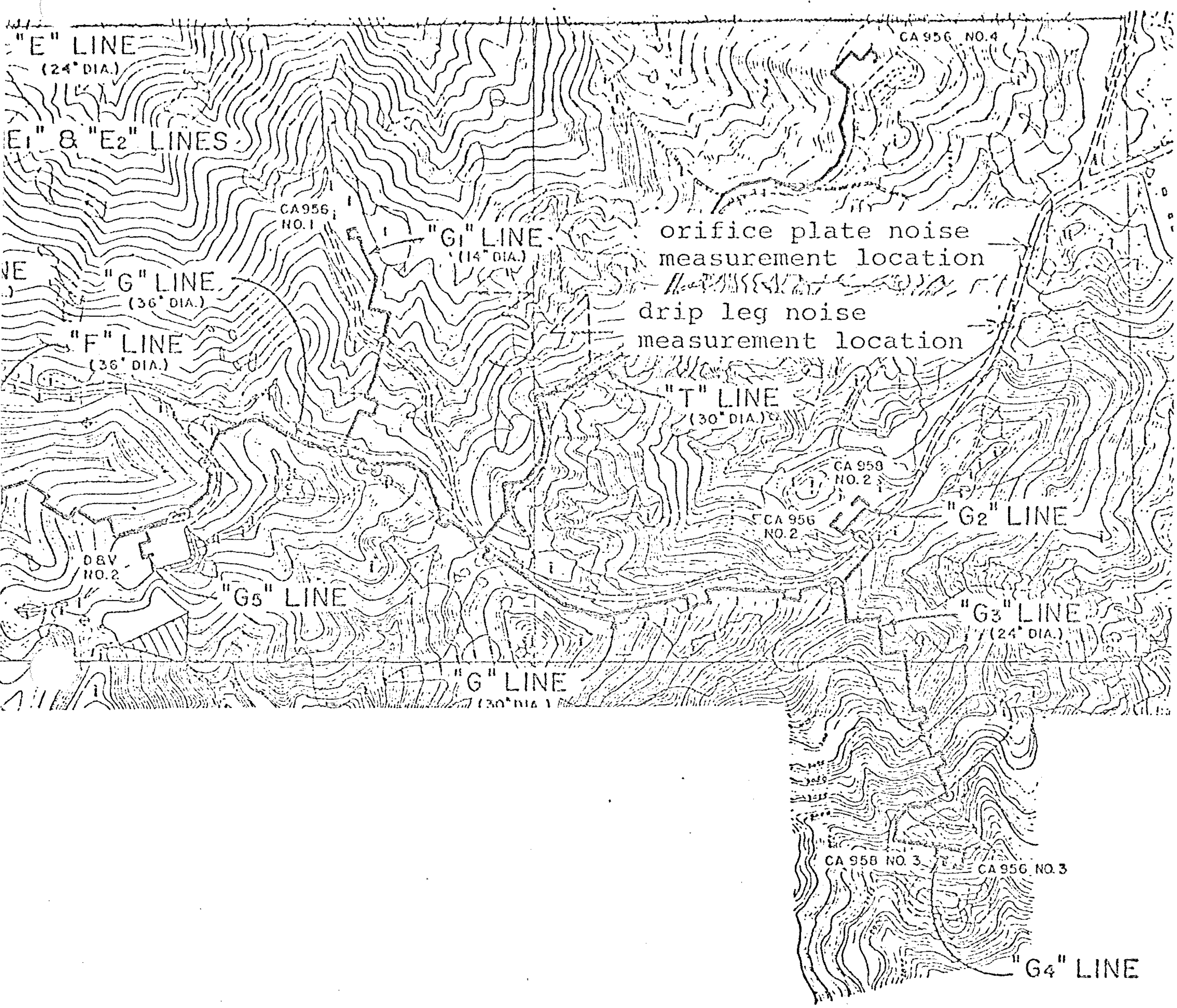


Figure 8: Map showing location of drip leg and orifice plate noise measurements.

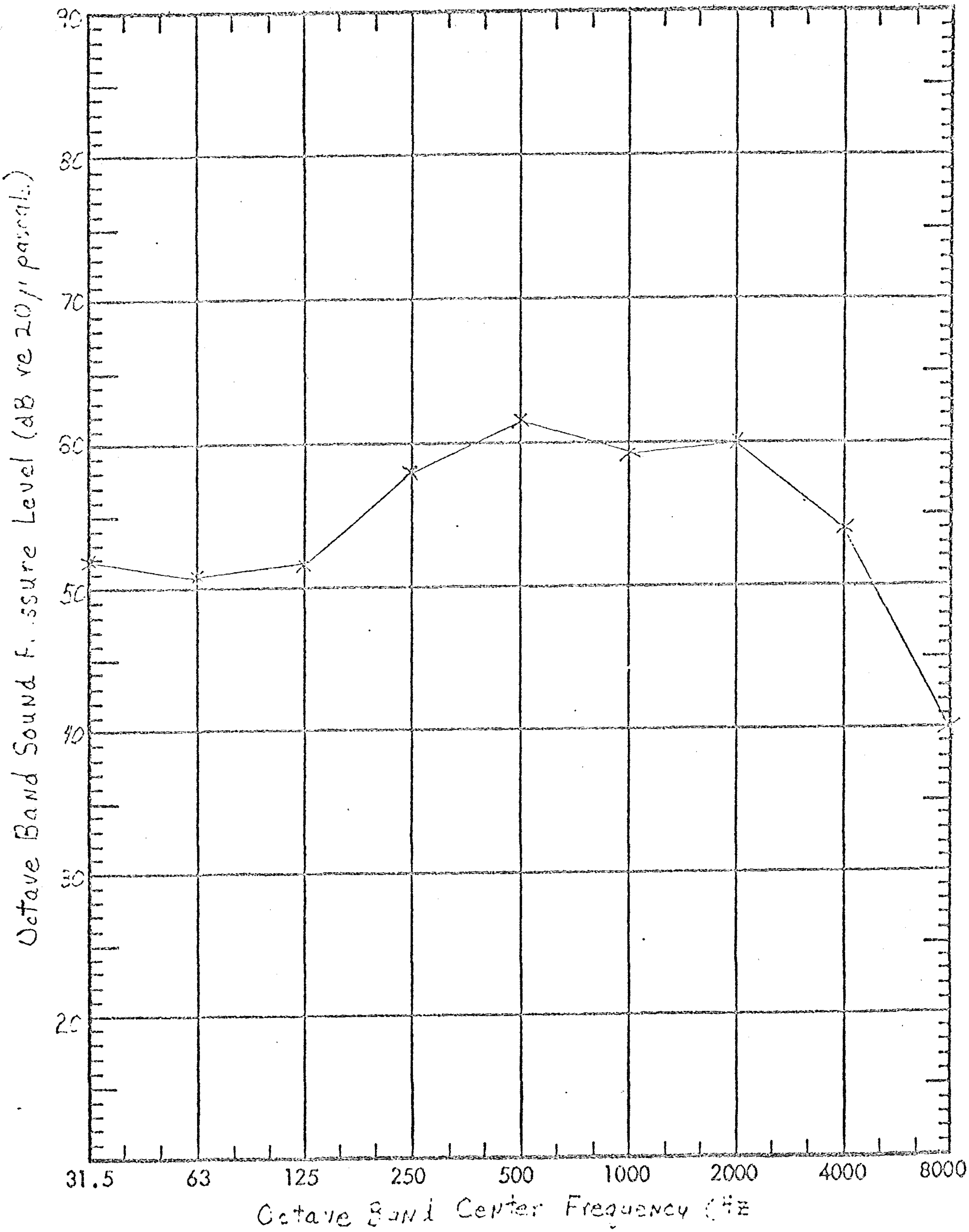


Figure 9: Spectrum of Orifice plate noise measured [illegible] feet from CA 253-2 on road past CA 253-2 just beyond [illegible] of hill, 35 dBA

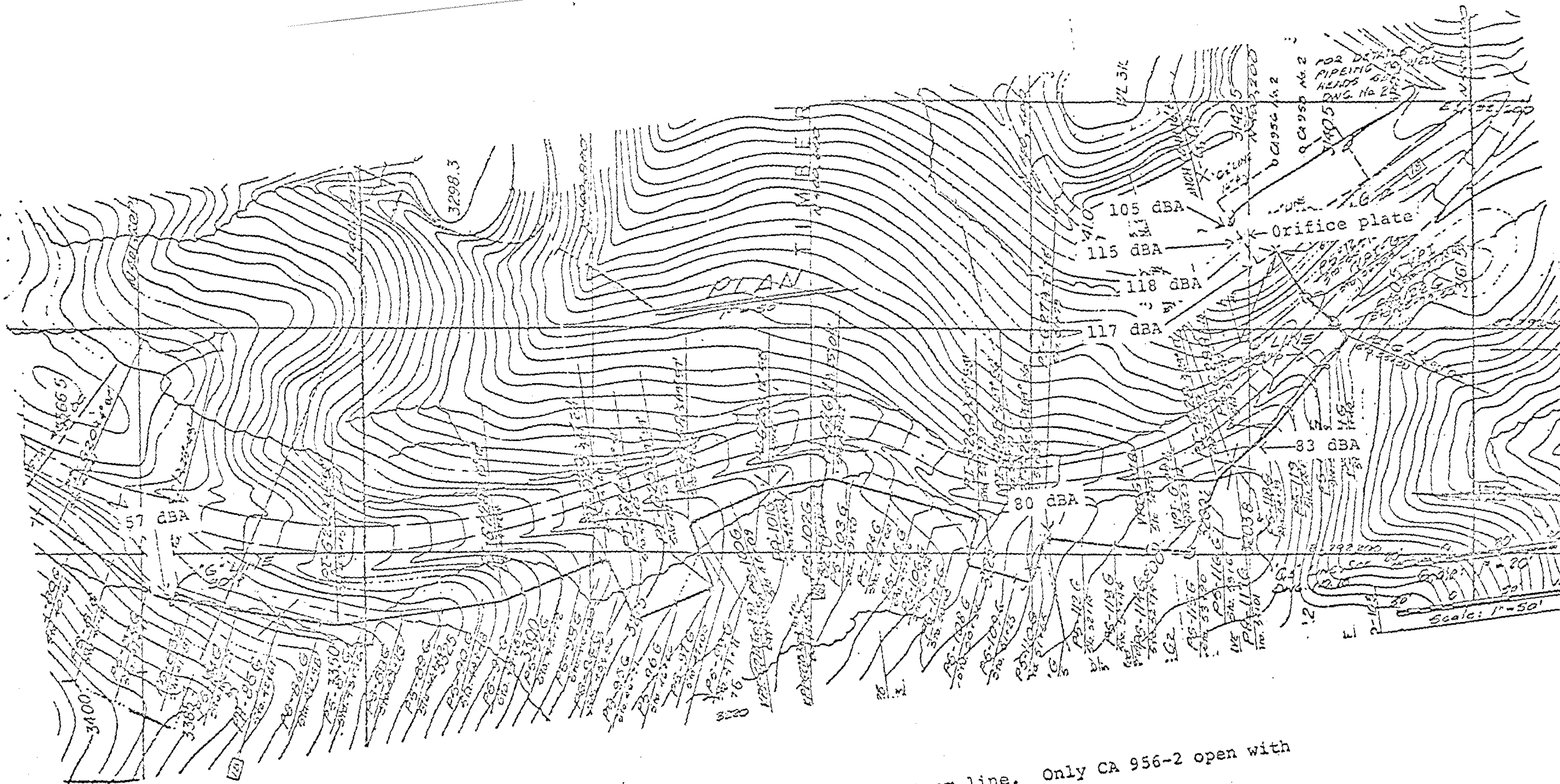


Figure 10: A-weighted sound levels along G steam line. Only CA 956-2 open with 2.8 inch orifice plate in place

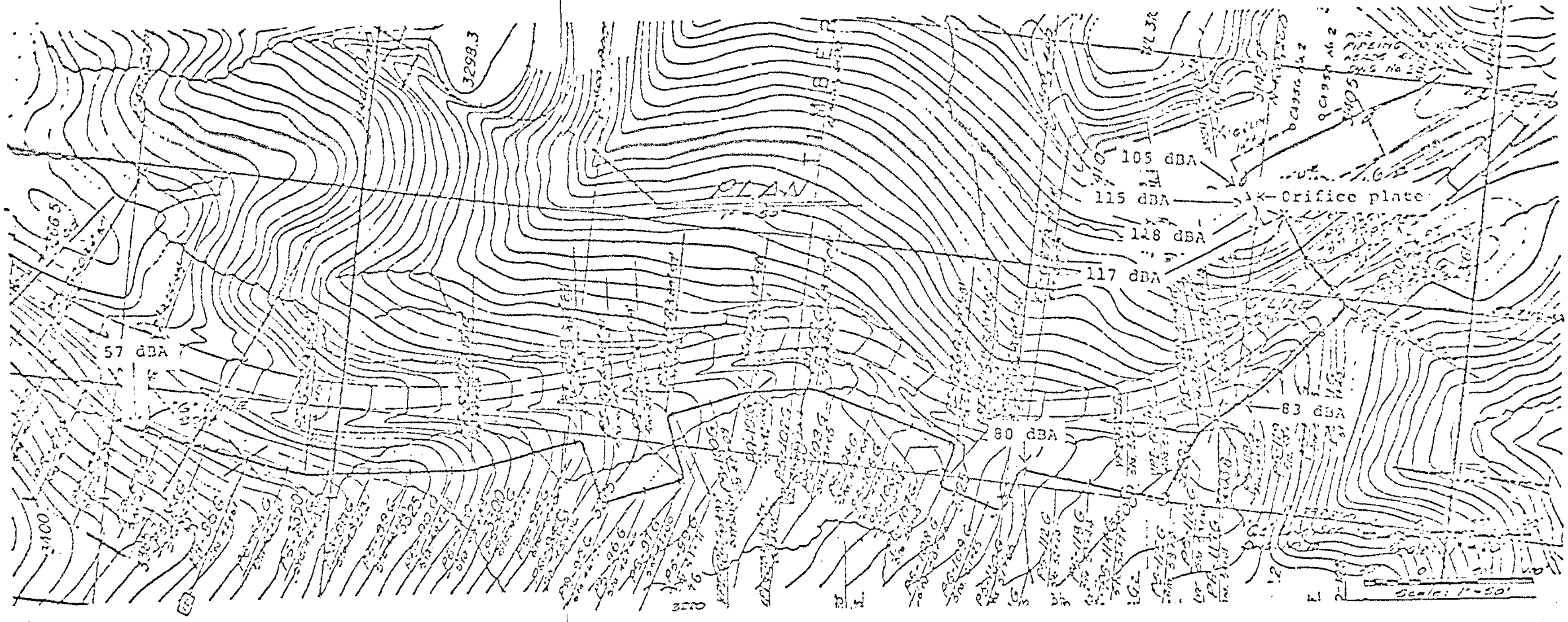


Figure 10: A-weighted sound levels along G steam line. Only CA 956-2 open with 2.8 inch orifice plate in place

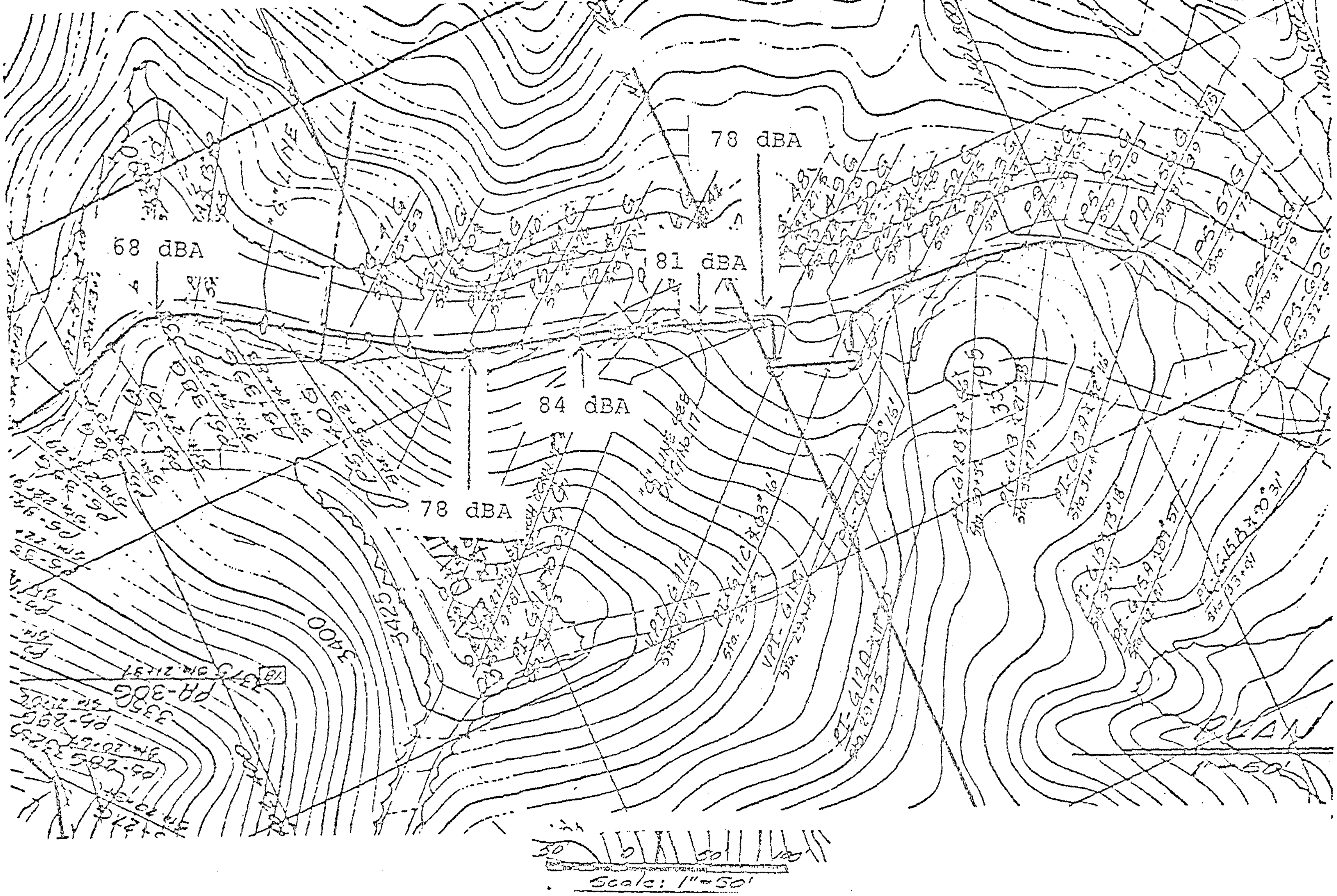


Figure 11: A-weighted sound levels near "T" intersection of G and G_1 lines during cleanout test (CA 956-1, CA956-2, and CA 958-3 on steam).

APPENDIX 4

BROWN AND CALDWELL
CONSULTING ENGINEERS

ENVIRONMENTAL SCIENCES DIVISION

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une 18, 1979

... A. McMillan
Pacific Gas & Electric Company
Department of Engineering Research
3400 Crow Canyon Road
San Ramon, CA 94583

UPPER PUTAH CREEK DRAINAGE
...ORING REPORT - QUARTERLY REPORT, MAY 1979

... is the data summary for your first quarterly sampling.

BR... N AND CALDWELL

...ven A. Fisher
...aboratory Director

...nclosure

...c: B. Woods
B. Westphal

EXHIBIT "J"

	Units					
on Number:		P0.8	P2.4	P3.8	P4.8	A0.5
C[illegible]cted:		5/09	5/09	5/08	5/08	5/08
Collected:		0920	0800	1000	0915	1025
her Conditions:		< ----------------Clear ---------------->				
of Collector:		<------------Glimme, Pomerleau------------>				
Number:		71H1	71H2	71H3	71H4	71H5
ical Oxygen Demand	mg/l	< 5	----	----	----	< 5
olved Oxygen	mg/l	11.0	11.0	11.8	11.6	11.7
(Estimated)	gm	46	1385	3425	20300	12200
		6.6	7.6	7.8	7.7	7.7
fic Conductance - 25° C	μmhos/cm^2	67	230	271	226	207
erature	°C	9.5	9.5	9.9	9.5	9.5
Dissolved Solids	mg/l	60	139	162	126	118
Suspended Solids	mg/l	9.2	2.0	2.0	2.8	2.0
dity	NTU	2.5	2.0	1.4	1.6	0.95
nia Nitrogen (as N)	mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	mg/l	< 0.01	< 0.01	0.09	0.1	0.05
te Nitrogen (as N)	mg/l	0.14	< 0.01	< 0.01	< 0.01	< 0.01
e [illegible]trogen (as N)	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
te	mg/l	3.2	3.1	4.1	8.6	9.8
Grease (Freon Extractable)	mg/l	< 5	< 5	---	---	< 5
nity (as $CaCO_3$)	mg/l	35	120	142	111	101
Hardness (as $CaCO_3$)	mg/l	27	118	140	116	108
	mg/l	0.72	0.63	0.50	0.32	0.55
ury	μg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
l	mg/l	0.001	0.001	0.001	0.003	0.001
	mg/l	0.005	0.009	0.069	0.007	0.014
num	mg/l	0.5	0.2	< 0.1	< 0.1	< 0.1
nium	mg/l	0.015	0.036	< 0.001	< 0.001	< 0.001
	mg/l	< 0.001	< 0.001	0.002	0.003	0.016

on ^^ 'mber:		A1.3	A1.8	A2.7	A2.8	G0.3
Co.. ected:		5/08	5/08	5/08	5/08	5/08
Collected:		1315	1425	1540	1600	1500
her Conditions:		< ----------------		Clear		---------------->
of Collector:		< ------------		Glimme, Pomerleau		--------->
Number:		71H6	71H7	71H8	71H9	71H10
	Units					
ical Oxygen Demand	mg/l	----	< 5	----	----	----
olved Oxygen	mg/l	10.3	11.4	11.0	11.0	11.2
(Estimated)	gm	5100	4600	3320	2220	1600
		7.7	7.7	7.8	7.7	7.3
fic Conductance - 25° C	μmhos/cm^2	185	177	181	160	77
erature	°C	11.0	9.9	10.5	10.5	9.9
Dissolved Solids	mg/l	105	101	94	89	72
Suspended Solids	mg/l	8.4	13.2	1.6	< 0.8	1.6
lity	NTU	5.6	7.1	1.8	0.35	0.55
nia Nitrogen (as N)	mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	mg/l	0.09	0.05	< 0.01	0.08	< 0.01
e Nitrogen (as N)	mg/l	< 0.01	< 0.01	< 0.01	0.01	< 0.01
e Nitrogen (as N)	mg/l	< 0.004	0.005	< 0.004	< 0.004	< 0.004
e	mg/l	11.6	5.9	5.1	4.6	1.1
Grease (Freon Extractable)	mg/l	----	< 5	< 5	----	----
nity (as $CaCO_3$)	mg/l	85	87	89	77	37
Hardness (as $CaCO_3$)	mg/l	90	87	92	77	28
	mg/l	1.3	1.4	0.50	0.50	0.54
ry	μg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
l	mg/l	0.003	0.003	0.004	< 0.001	0.002
	mg/l	0.007	0.011	0.020	< 0.001	0.001
num	mg/l	0.9	1.2	< 0.1	< 0.1	< 0.1
ium	mg/l	0.035	0.043	0.038	< 0.001	0.047
	mg/l	< 0.001	0.010	< 0.001	< 0.001	0.003

		G1.2	HS 0.5	B1.0	H0.2	S 23B1
on Number:		G1.2	HS 0.5	B1.0	H0.2	S 23B1
Cc cted:		5/08	5/08	5/08	5/08	5/09
Collected:		1520	1330	1200	1100	0830
ner Conditions:		<-----------------Clear----------------->				
of Collector:		<----------------Glimme, Pomerleau--------->				
Number:		71H11	71H12	71H13	71H14	71H15
	Units					
ical Oxygen Demand	mg/l	----	< 5	< 5	< 5	8.3
olved Oxygen	mg/l	11.2	10.1	11.6	11.6	10.0
(Estimated)	gm	1060	660	13450	660	----
		7.2	7.5	8.0	7.6	7.0
fic Conductance - 25° C	µmhos/cm^2	77	196	276	163	87
erature	°C	10.5	11.0	10.1	9.9	12.0
Dissolved Solids	mg/l	72	117	161	100	78
Suspended Solids	mg/l	2.4	0.8	< 0.8	1.2	6.4
lity	NTU	0.30	0.95	0.35	0.75	4.7
nia Nitrogen (as N)	mg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
	mg/l	0.02	0.10	0.14	0.02	< 0.01
e Nitrogen (as N)	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
e Nitrogen (as N)	mg/l	< 0.004	< 0.004	< 0.004	0.005	< 0.004
e	mg/l	1.1	19.9	5.6	4.1	5.1
G se (Freon Extractable)	mg/l	----	----	< 5	----	----
nity (as $CaCO_3$)	mg/l	36	78	145	78	39
Hardness (as $CaCO_3$)	mg/l	28	94	154	77	55
	mg/l	0.32	0.54	0.32	0.54	0.54
ury	µg/l	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
l	mg/l	< 0.001	0.002	0.005	0.002	0.003
	mg/l	0.014	0.003	0.007	0.024	< 0.001
num	mg/l	< 0.1	< 0.1	< 0.1	< 0.1	0.6
nium	mg/l	0.033	0.006	0.030	0.054	0.018
	mg/l	0.004	0.007	0.001	0.006	0.007

BROWN AND CALDWELL
QUALITY CONTROL DATA

on Number:		A0.5-I	A0.5-II	P4.8-I	P4.8-II	Percent Recovered[a]
Number:		71H5	71H5	71H4	71H4	
	Units					
ical Oxygen Demand	mg/l	< 5	< 5	----	----	----
Dissolved Solids	mg/l	114	122	129	122	----
Suspended Solids	mg/l	1.6	2.4	2.8	2.8	----
dity	NTU	0.95	0.95	1.7	1.5	----
nia Nitrogen (as N)	mg/l	----	----	----	----	----
	mg/l	----	----	----	----	----
te Nitrogen (as N)	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	----
te Nitrogen (as N)	mg/l	< 0.004	< 0.004	< 0.004	< 0.004	----
te	mg/l	9.6	9.9	8.6	8.6	----
le	mg/l	----	----	----	----	----
Grease (Freon Extractable)	mg/l	----	----	----	----	----
inity (as $CaCO_3$)	mg/l	101	102	111	112	----
Hardness (as $CaCO_3$)	mg/l	108	109	116	116	----
	mg/l	----	----	----	----	----
ury	µg/l	----	----	----	----	----
el	mg/l	----	----	----	----	----
	mg/l	----	----	----	----	----
num	mg/l	< 0.1	< 0.1	< 0.1	< 0.1	100
nium	mg/l	< 0.001	< 0.001	< 0.001	< 0.001	96
	mg/l	----	----	----	----	----

a) Percent of spike recovered form A0.5