GL03081 - 1 of 6

PLAN OF UTILIZATION

Lease Nos. CA 966 and CA 1903
Sec. 25, T15S, R16E; Secs. 19,20,28,29 and 30
T15S, R17E, SB B&M

East Mesa, Imperial County, California

Republic Geothermal, Inc.
11823 East Slauson Avenue, Suite One
Santa Fe Springs, California 90670
(213) 945-3661

Proposal to construct and operate a 10 Mw (gross) single-inlet steam turbine-generator utilizing steam separated from geothermal fluid to produce electricity, to construct an access road to the power plant site and to construct a transmission line adjacent to the access road.

Estimated Starting Date: April 1, 1978

Estimated Completion Date: Indefinite

REPUBLIC GEOTHERMAL, INC.

PLAN OF UTILIZATION
10 Mw POWER PLANT

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REPUBLIC GEOTHERMAL, INC.

PLAN OF UTILIZATION
UNITED STATES GEOTHERMAL LEASE NOS. CA 966 AND CA 1903
EAST MESA, IMPERIAL COUNTY, CALIFORNIA

A. INTRODUCTION

Republic Geothermal, Inc. proposes herein to construct and operate a 10 Mw (gross) single-inlet steam turbine-generator utilizing steam separated from geothermal fluid to produce electricity on Lease Nos. CA 966 and CA 1903. This Plan of Utilization is being submitted in accordance with the Proposed Rule to amend 30 CFR, Part 270, and covers proposed alternative power plant sites, access roads to the plant site, electric transmission line routes within lease boundaries, and the proposed method of utilizing the resource.

During the first year of operation, electricity produced by the power plant and not utilized by plant or field operations or by continued resource testing will be sold to the Imperial Irrigation District for use by residents of Imperial County. After the first year, the power plant is planned to be integrated into a larger generation facility at which time the electricity will be utilized to power production well pumps and supply internal power requirements of the larger facility.

Three alternative plant sites have been chosen, with the final selection to be made on the basis of environmental, engineering and economic data available by January, 1978. Five production wells (Nos. 16-30, 56-30 and 16-29, existing; 36-30 and 76-30, proposed) and three injection wells (18-28, existing; 52-29 and 56-29, proposed) are planned to be dedicated to the proposed power plant, as well as related pipelines, access roads and well testing and production facilities. These have been thoroughly discussed in Republic's Plan of Operation, Development previously submitted to the Supervisor. In addition, a Plan of Operation, Injection has been submitted to the Supervisor for discussion and evaluation of the proposed liquid disposal program and subsurface injection operations. More specific details regarding plant operation, market for the resource, manner and rates of production, method of processing and disposing of waste materials, downhole production and processing facilities, and programs for monitoring environmental effects of power plant operation will be contained in the Plan of Operation, Production to be submitted to the Supervisor prior to initiating production for commercial utilization of the resource.

B. DESCRIPTION AND PLANS OF FACILITIES AT PLANT SITE AND SUPPORTING FACILITIES OR ANCILLARY EQUIPMENT

1. Maps

a. Contour Map

Attached hereto and made a part hereof as Exhibit A is our Drawing No. 199-10, East Mesa Geothermal Project Vicinity Map, which shows the topography, drainage patterns, cultural features and existing roads and wells. The Vicinity Map also shows existing and proposed transmission lines to the lease boundaries. The facility site will be located within the lease boundaries as shown on the map referenced below.

b. Map Showing Existing and Planned Access and Lateral Roads, Development Plan and Facility Location

Attached hereto and made a part hereof as Exhibit B is our Drawing No. 199-13, East Mesa Geothermal Project Utilization Plan-10 Mw Power Plant, which shows three alternative power plant sites, a conceptual plot plan of the proposed power plant, alternative routes within the lease boundaries for the transmission line, and well locations.

2. Discussion of Proposed Plan

The proposed utilization project consists of a 10 Mw (gross) single-inlet steam turbine-generator utilizing steam separated from the geothermal fluid in a single-stage flash tank. After passing through the turbine the steam will be condensed in a direct contact condenser and then cooled in a forced draft cooling tower. The cooled condensate is then returned to the condenser and recycled. Ancillary equipment will include condensate and cooling water pumps, gas ejector pumps, a motor control room, a facilities control room, an electrical switchyard, an electrical transmission line, necessary access roads and parking facilities, and a water tank and pump house for fire protection.

The proposed 10 Mw power plant, with its related facilities, will be located within an area approximately 550 by 600 feet in size. All construction related activities will also be contained within this area, so that only this 7.6 acre plot will be disturbed for the plant. Approximately 1.1 acres of this land will have been previously disturbed during the completion of the nearby production well. Please refer to Exhibit B (Drawing No. 199-13) for details of the proposed plant layout. This plot plan is preliminary in nature in that the specific location of individual components may be altered, although all plant components are represented. The plant parking lot and perimeter road may or may not be paved. This decision will be made after additional investigation by the geotechnical consultants. The plant access road and the electric transmission line outside the specific plant site are discussed more fully in Section F, "Other Areas of Potential Surface Disturbance."

Republic is proposing three alternative power plant sites, each with its own access road and electric transmission line. The attached Exhibit B shows the location of each of these alternative power plant sites, the access road and electric transmission line. The proposed production and injection wells, the well access roads and the pipelines to and from these wells are addressed in the previously submitted Plan of Operation, Development.

The three alternative power plant locations were selected primarily on the need for a location central to the proposed development and near the existing access roads. Power plant locations were also selected on the basis of suitability for the possible construction of larger facility on the same site. Neither existing land uses or topography were deemed to be constraints on the selection of a plant site. Land in the area of Republic's proposed East Mesa development is all open desert land with very little topographic relief or expression. Environmental considerations have not as yet proved significant in the selection of these three alternative power plant locations, although each is now undergoing environmental analysis to add this input into the final site selection process. Final site selection will be made before January, 1978 on the basis of economic, engineering and environmental data available at that time.

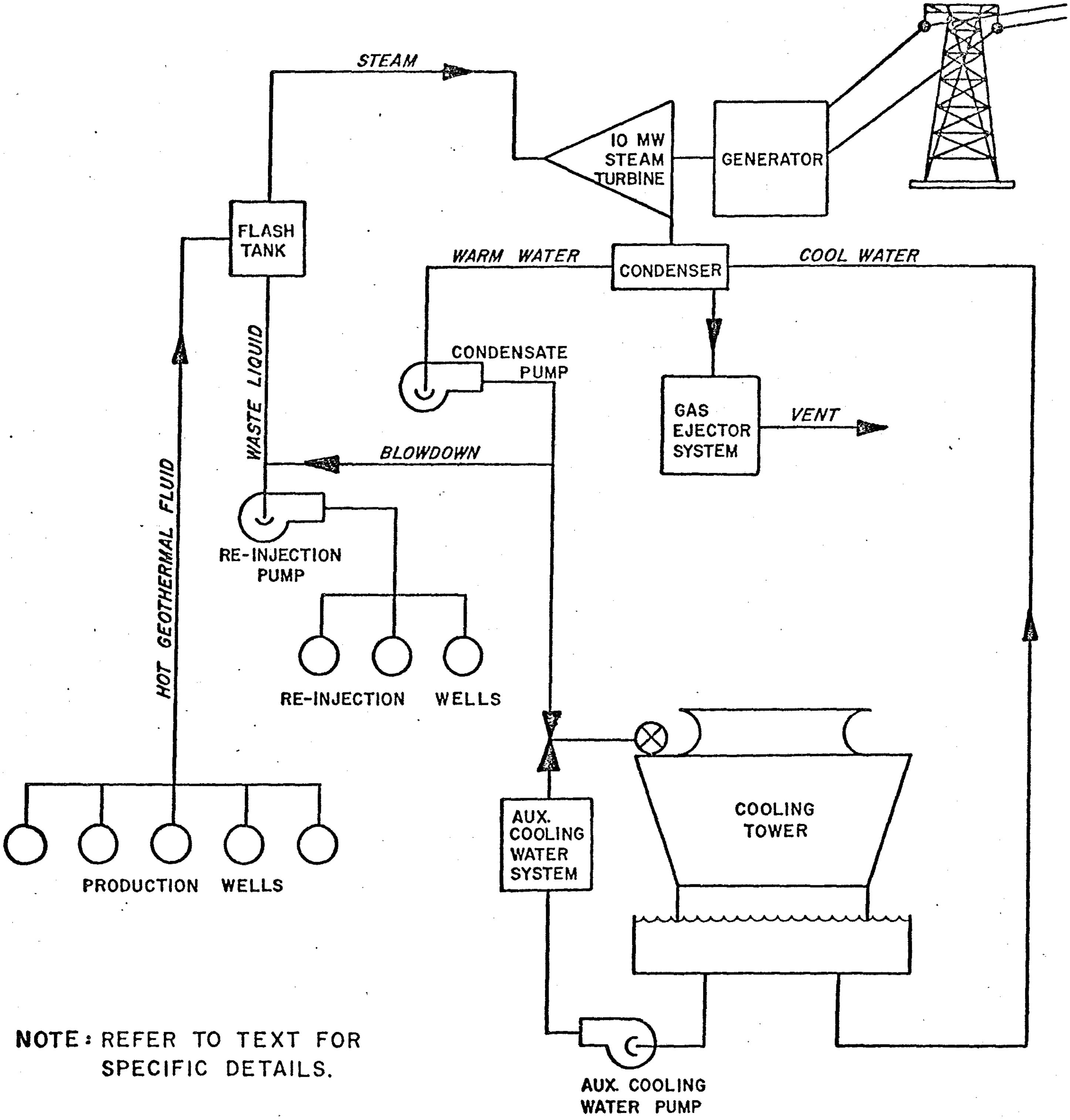
3. Schematic Flow Diagram and Narrative Description

Please refer to Figure 1 for a schematic flow diagram of the 10 Mw power plant. The following is a narrative description with details of the flow diagram.

The combined flow of geothermal fluid from the five production wells will enter the plant site in one 16-inch diameter (approximate) insulated steel pipe. The pipe will carry approximately 4.44 million pounds per hour of geothermal fluid in one-phase flow at 335°F and 110 psia into the flash tank. Although the final selection of flash tank style has not yet been made, it will be designed to flash the fluid and separate the steam and waste liquid at a pressure of 55 psia. Steam and waste fluid flow rates will be approximately 0.24 million and 4.2 million pounds per hour, respectively.

Steam will enter the turbine through a single inlet at about 52 psia. The turbine will rotate the 12MVA (0.9 power factor in-line) generator at 36,000 rpm to produce 2 pole, 3 phase electricity at 60 hertz and 4160 volts. The power in excess of that required for well and plant operation, or required for continuing field testing operations, will be conducted via buried cable to a 34.5 kV/ 4160 V transformer located in the electrical switchyard. From there a 35.4 kV power transmission line (paralleling the plant site access road) will connect to the existing transmission line erected and maintained by the Imperial Irrigation District, and thus to a market. A more extensive discussion of this transmission line is presented in Section F, "Other Areas of Potential Surface Disturbance," of this Plan.

BASIC FLOW DIAGRAM
10 MW POWER PLANT



NOTE: REFER TO TEXT FOR SPECIFIC DETAILS.

FIGURE 1

Steam exhausted from the turbine will be conducted to a single direct contact spray condenser operating at about 2 psia and 90°F. The combined condensed steam/cooling water (now at about 120°F) will be transferred via three condensate transfer pumps to the cooling tower water distribution system. Final selection of cooling tower design has not been made yet, although the system will be capable of cooling 7.5 million pounds per hour of 120°F water to 90°F under normal load. Wooden or ceramic forced draft towers will be used, and either one or two cells will be required, depending upon the final selection. Approximately 195,000 pounds of water per hour will be lost to the atmosphere through evaporation in the towers. Because the condensed steam will add about 240,000 pounds per hour of fresh water to the cooling system, the result will be a cooling system surplus of 41,000 pounds of water per hour. This excess water will be discharged as blowdown from the condensate transfer pumps to the geothermal waste water injection system.

Approximately 7.3 million pounds per hour of the cooled water will be pumped from the cooling water sump to the condenser, where it will be sprayed to condense the turbine exhaust steam and thereby repeat the cycle. About 530,000 pounds per hour of the cooled water will be pumped via the auxillary cooling water supply pumps to cool the generator, the turbine oil, the noncondensable gas ejector vacuum pumps, and the air compressors for the pneumatic control system. After collection, this water is returned to the cooling tower at about 94°F.

Some of the noncondensable gases contained in the produced geothermal fluid will be volatilized in the flash tank and carried with the steam through the turbine and into the condenser. At present, this is anticipated to amount to approximately 2200 pounds per hour, and is known to consist predominately of carbon dioxide (95 percent) and nitrogen (4 percent). To avoid accumulation of these gases in the condenser, which would quickly lead to an intolerable decrease in turbine efficiency due to a buildup of back pressure, gas ejectors will be installed on the condenser. Both electrically powered vacuum pumps and steam powered hogging jets (utilizing high pressure steam generated by a very small pre-flash of the geothermal fluid prior to flashing in the main flash tank) are currently being investigated. Either system will employ a separator-silencer to separate the gases from the condensate and to muffle the noise generated by exhausting these gases to the atmosphere.

Waste geothermal fluid exiting from the flash tank will be conveyed to four injection pumps arranged parallel at the plant site. The blowdown from the condenser will also be added to this fluid prior to pumping. The total quantity of waste fluid, approximately 4.25 million pounds per hour at 213°F, will be pumped from the plant site at about 200 psig in one 14-inch diameter (approximate) pipeline, eventually to be distributed to the three injection wells.

4. Architectural Plans

Plans for the architectural style of the plant site have not yet been finalized. Current plans entail use of a trailer for the administration building during initial stages of operation. An administration building may be constructed at a later date and will be included in a subsequent Plan of Utilization. At present no building is anticipated for the turbine, generator and condenser. Following are dimensions for basic components given to aid in evaluating the aesthetics of the proposed plant. These dimensions are approximate and may be subject to slight revision:

Cooling Towers:
    60' high, 72' wide, 50' long

Turbine-Generator:
    Foundation - 100' long, 23' wide, 13' high
    Turbine-Generator - 28' long, 12' wide, 6' high

Condenser:
11' wide, 13' high, 50' long, with 10' high piping on top

Flash Tanks:
Design 1 - 50' high, 11' diameter
Design 2 - 20' high (diameter), 35' long

Water Tank (for fire)
40' high, 48' diameter

Electrical Switchyard:
Transformer at ground level. Poles approximately 30' high.

Transmission Line:
Pole for 34.5 kV - 30' high

5. Schedule of Construction and Start-Up

Figure 2 is a Master Project Schedule prepared for Republic by The Rust Engineering Company. The schedule as presented allows no margin for deviation. Site work is scheduled to commence on April 1, 1978, and initial operation is to commence on January 1, 1979. Please refer to the schedule for more details.

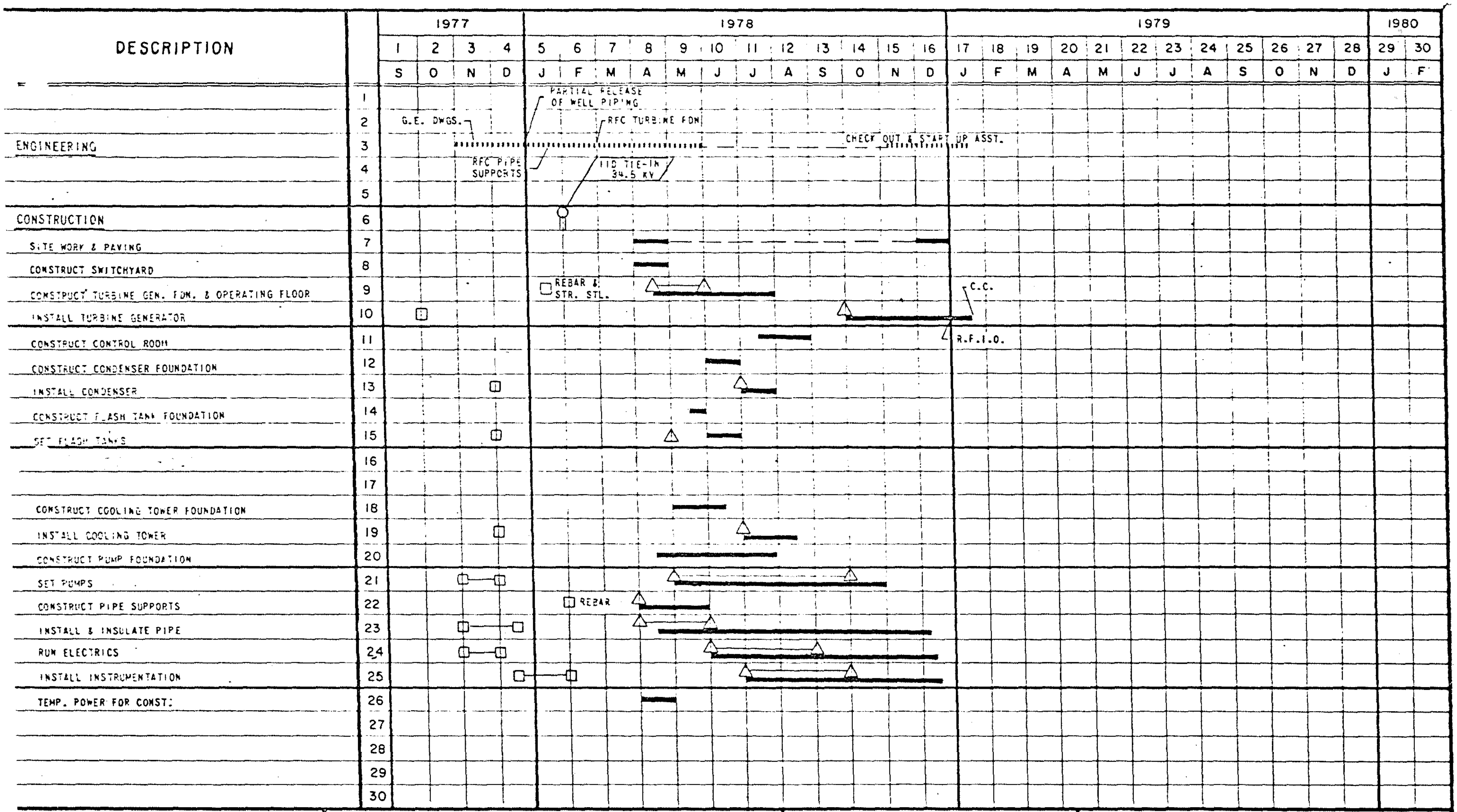
6. Emergency Safety Provisions

Emergency safety provisions are currently being designed into the 10 Mw power plant. Every effort is being made to anticipate possible emergency situations and design into the plant appropriate controls and abatement flexibility. Given below is a list of a few emergency safety provisions.

a. Automatic emergency steam venting through silencers to the atmosphere;

b. Manual steam bypass of turbines directly to condenser;

c. High liquid level controls in flash tank to throttle the geothermal fluid production line;



MASTER PROJECT SCHEDULE

LEGEND

▮▮▮▮	ENGINEERING	RFIO	RELEASE FOR INITIAL OPERATION
▬	CONSTRUCTION	CC	CONSTRUCTION COMPLETE
◇—◇	ISSUE INQUIRY/RECEIVE QUOTES	○	ISSUE SUBCONTRACT
□	ISSUE PURCHASE ORDER	△	SCHEDULED DELIVERY
▽	RELEASE FOR CONSTRUCTON	♀	MILESTONE

CLIENT REPUBLIC GEOTHERMAL
PROJECT EAST MESA-10MW TURB. GEN.
LOCATION EAST MESA, CALIFORNIA
PLANNER R. STROPE DRAWN BY N.M.
DATE 8-30-77 CONTRACT 21-1867 D
REV. 1 10-6-77 R.S.

The Rust Engineering Company
A Subsidiary of Wheelabrator-Frye Inc
BIRMINGHAM, ALA.

Figure 2

d. Hi-lo pressure cut-offs on each production well pump and injection pump;

e. Pipelines designed and tested to withstand one and one-half times the maximum shut-in pressure;

f. Pressure relief valves on the flash tank.

7. Facility Operation Personnel Coverage

Once normal plant operations have begun, the power plant will be controlled by an onsite plant operator on a 24 hour basis. During regular working hours the plant will also require two maintenance workers. One field operator will also be employed on a daily basis to operate and maintain the production and injection well system.

C. COPIES OF SITE EVALUATION REPORTS

Attached hereto and made a part hereof as Exhibit C is a copy of the "Preliminary Geotechnical Investigation, Republic Geothermal, Inc., East Mesa Project" prepared for The Rust Engineering Company by Woodward-Clyde Consultants. The preliminary geotechnical survey was conducted under the Plan of Operation approved as effective September 1, 1977 (Environmental Analysis #92-A). The report contains results of a geotechnical investigation at the three alternative power plant sites. The scope of the work includes: subsurface investigations and laboratory tests to evaluate the engineering properties of the soils encountered; preliminary conclusions regarding earthwork, foundation types and pavement design; and a discussion of the earthquake engineering aspects of the local geologic and seismic settings. From these preliminary investigations, Woodward-Clyde Consultants concluded that all three of the alternative sites were suitable for the proposed geothermal power plant.

D. DESCRIPTION OF ADDITIONAL TESTS, STUDIES OR SURVEYS PLANNED TO ASSESS GEOLOGIC SUITABILITY OF SITE

Based upon the preliminary geotechnical investigation, all three proposed power plant sites are suitable for construction. Subsequent to final selection of one of the three sites, additional studies will be undertaken to provide detailed information concerning foundation design, pavement and roadway design, and faulting and seismic safety, as recommended in the preliminary geotechnical investigation (please refer to Section C and/or Exhibit C). These studies will be conducted by registered geotechnical consultants in accordance with the standards of their profession.

E. SOURCE OF ROAD BUILDING MATERIAL AND SOURCE AND QUALITY OF WATER SUPPLY

No road building material will be obtained from federal lands for the proposed access road to the power plant. Any required road building material, such as gravel or paving material, will be transported to the site from outside commercial sources. Only one-quarter mile of new road will be necessary for Plant Site Alternatives B or C and one-half mile of road for Alternative A.

Water for construction will be supplied by either the previously approved well, WW-1, a shallow water well located in the northwest corner of Republic's East Mesa maintenance yard, or the East Highline Canal. Water for the initial fill of the two cooling towers, estimated to be approximately 400,000 gallons, will be obtained from the water well or the East Highline Canal. Additional external water will not be required for at least the first five years of plant operation, as cooling make-up water will be provided by the steam condensate from the condenser.

F. OTHER AREAS OF POTENTIAL SURFACE DISTURBANCE

Besides the power plant, other surface disturbance will result from construction of the main access road to the power plant and the electric transmission line adjacent to the access road. The main access road will be approximately 25 feet wide and will be located as shown in Exhibit B. The road may possibly be paved, and if so, will be built and maintained in accordance with specifications of the Bureau of Land Management and the Department of Public Works, County of Imperial.

The 34.5 kV electric transmission line will be located approximately 20 feet to the side of the main access road. It will follow this proposed road to the existing access road located between Sections 31 and 32, T. 15 S., R. 17 E., on land administered by the Bureau of Reclamation, and will tie in to the existing Imperial Irrigation District-U.S. Bureau of Reclamation 34.5 kV transmission line at the northwest corner of Section 5, T. 16 S., R. 17 E., one mile south of Republic's lease boundaries.

The total acreage of the power plant site includes portions of the transmission line and main access road as well as an electrical substation. In addition to the 7.6 acres required for the power plant site, approximately 1.0 acre of new land will be disturbed for construction of the access road and transmission line for Alternative Sites B and C and 2.0 acres of new land for Alternative Site A. Thus, an approximate total of either 8.6 or 9.6 acres will be disturbed for the power plant project.

G. METHODS FOR DISPOSAL OF WASTE MATERIAL

Power plant wastes fall into two classes: those arising from construction activities and those continously produced during operation of the power plant. Construction wastes will be produced only during a short period of time. During construction, temporary facilities for human wastes will be provided and the wastes will be transported to an approved sewage disposal location. All other construction waste material will be deposited in an approved dump site.

Solid waste will result from filtering the spent geothermal fluid, prior to injection, with suspended particle removal equipment. This waste will consist of non-saline formation sand, silt and clay with a high concentration of calcium carbonate. The volume of this waste will be relatively small, and it will be removed to an approved dump site.

During initial operation of the power plant, human wastes will be stored in temporary facilities and will eventually be transported to an approved sewage disposal location. At a later date, an administration building may be constructed and a septic system may be installed. This will be discussed in subsequent Plans of Utilization.

Liquid waste resulting from spent geothermal fluid and cooling tower blowdown will be injected as discussed above. Details of Republic's plan for injection of fluids were thoroughly discussed in the Plan of Operation, Injection, previously submitted to the Supervisor.

H. ENVIRONMENTAL PROTECTION

1. Fire

Vegetation on the lease is sparse and generally low lying, making the possibility of a wildfire very remote. Fire protection for the plant will be provided by a 500,000 gallon water storage tank and fire pump house, both designed in accordance with the Uniform Fire Code of 1976. This system is designed for maximum possible need, including the use of wooden cooling towers. Should ceramic cooling towers be utilized, the storage tank will be significantly smaller. Republic considers the likelihood of operational fires very low, primarily because noncombustible steam will be used as the process working fluid.

2. Soil Erosion

The soil in the area of proposed development is primarily of fine, sandy texture and is subject to natural wind erosion. Due to the essentially level topography at East Mesa, the infrequent rainfall and the lack of surface water or major washes, soil erosion is not anticipated to be a problem. Best efforts will be made to minimize disturbance of the perennial woody vegetation (mainly creosote, Larrea divaricata). Off-road vehicle use will be prohibited except where absolutely necessary.

3. Pollution of Surface and Ground Water

a. Surface Water

Republic's East Mesa leases are devoid of any obvious stream channels. Surface water is presently confined within the one-half mile section of the East Highline Canal located in the extreme southwestern portion of Lease CA 966. The East Highline Canal flows northward and contains water diverted from the Colorado River via the All American Canal. Irrigated farmlands lie to the west of the Canal, covering almost all of the Imperial Valley. To the east of the Canal is the East Mesa, which is essentially desert with only a few dry washes active only after heavy rains (usually in the winter). All drainage is toward the Salton Sea. No discharges to the East Highline Canal nor any drains are proposed during the operation of the power plant. Republic does not anticipate the proposed development will have a deleterious effect on the East Highline Canal.

b. Ground Water

There are no natural ground water sources such as springs or seeps within Republic's East Mesa leases. The California Regional Water Quality Control Board considers the ground water in the vicinity of Republic's leases saline and not beneficially used.

The major source of shallow ground water at East Mesa is seepage from the All American, Coachella and East Highline Canals which enclose the mesa on the south, northeast and east, respectively. The major ground water gradient is downslope to the west-southwest, although seepage from the East Highline Canal has created a small localized ground water mound. According to the U. S. Bureau of Reclamation, the ground water level immediately underlying Republic's proposed area of operations has apparently undergone very little change since the installation of the canals.

The quality of the shallow ground water is generally equivalent to the anticipated water quality of the geothermal fluid which will be produced. In some areas, as at the USBR geothermal test site, the shallow ground water is in fact of lower quality than the geothermal fluid previously produced from Republic's East Mesa wells. Water produced from Republic's shallow water well has a salinity of 1600 mg/l, very similar to the geothermal fluid.

All of Republic's previously approved Plans of Operation on East Mesa have been conducted under approved Orders No. 76-35 and No. 76-64(Revised) of the California Regional Water Quality Control Board, Colorado River Basin Region. These Orders have been previously submitted to the USGS-AGS.

The Board has determined that Republic's discharge of geothermal fluids into unlined temporary storage basins is acceptable for fluids of less than 2300 mg/l. They have approved the discharge of geothermal fluids onto roads and well sites in an amount not to exceed 136,000 gallons per day or 232 acre-feet for the life of the project. This Order also permits the disposal of geothermal waste fluids by subsurface injection into the zone of extraction or into zones which contain a total dissolved solids content which is equal to or greater than that contained in the zone of extraction.

Republic has previously submitted to the Supervisor a Plan of Operation, Injection which discusses in detail the proposed disposal of spent geothermal fluids from operation of the power plant. The only discharge of geothermal fluids resulting from plant operations will be the disbursement of fluid onto the access roads for dust control. No cooling ponds nor storage basins are proposed.

4. Damage to Fish and Wildlife

a. There are no fish in the area.

b. Construction of the power plant will result in some unavoidable dislocation of wildlife in the area due to loss of habitat. Disturbance of natural soil and vegetation will be kept to a minimum. Because of the relatively small amount of habitat disturbance and the homogeneous vegetation at East Mesa, displaced wildlife should be accommodated on nearby lands. To help provide replacement habitat, removed vegetation and excess soil will be stacked in several piles at a reasonable distance from the road and plant site.

5. Air and Noise Pollution

a. Air

Emissions from the proposed 10 Mw (gross) power plant and related facilities should not significantly degrade the ambient air quality of the region. The gaseous emissions which are anticipated to be released under normal operating conditions amount to about 2200 pounds per hour. Specific constituents are listed in Table 1. All federal, state and local emission standards will be adhered to.

The concentration of noncondensable gases in the geothermal fluid as produced is approximately 0.051 percent by weight. Current field tests have indicated that less than 97.5 percent of these gases will volatilize in the flash tank and be carried to the turbine with the steam. The other 2.5 percent will remain in the waste geothermal fluid and will be reinjected. The gases in the steam will be collected from the condenser and vented to the atmosphere. A barely perceptible trace of hydrogen sulfide has been detected in only one of the two wells which have as yet been adequately sampled. Volatile trace metal constituents carried over from the geothermal fluid to the flashed steam should also be negligible. Because the total quantity of noncondensable gases or other volatile components emitted during power plant operations are so minute, adverse environmental impacts are not anticipated.

During normal operations, approximately 195,000 pounds of cooling water will evaporate per hour from the cooling towers. This will

TABLE 1

ANTICIPATED NONCONDENSABLE GAS EMISSIONS FROM PROPOSED 10 Mw (GROSS) GEOTHERMAL POWER PLANT

Anticipated Emission(a)	Weight Percent Of Total Noncondensables Well 16-29	Weight Percent Of Total Noncondensables Well 38-30	Projected Emission Rate(b) (Pounds/Hour)
Carbon Dioxide (CO_2)	94.452	95.038	2080 - 2100
Nitrogen (N_2)	3.972	3.571	78.8 - 87.7
Methane (CH_4)	1.123	0.374	8.26- 24.8
Argon (Ar)	0.121	0.145	2.67- 3.20
Ethane (C_2H_6)	0.139	0.061	1.35- 3.07
Propane (C_3H_8)	0.114	0.084	1.85- 2.52
Benzene (C_6H_6)	0.065	0.015	0.33- 1.43
Hydrogen (H_2)	0.006	0.005	0.11- 0.13
Hydrogen Sulfide (H_2S)	0.005	0.000	0.00- 0.11
Toluene ($C_6H_5CH_3$)	0.004	0.000	0.00- 0.09

(a) Based on single sample molecular analysis of geothermal fluids from Wells 16-29 and 38-30.

(b) Assumes the concentration of noncondensable gases in the geothermal fluid is 0.051 percent by weight; that 97.5 percent of these gases will volatize in the flash; that the geothermal fluid flow rate before the flash is 4.44 million pounds per hour; and that the range of emissions is characterized by the range of noncondensable gases determined by the two sampled wells.

increase the relative humidity in the immediate vicinity of the power plant; however, the very localized climatic change should not significantly affect the existing desert ecology. Less than 0.05 percent of the circulating cooling water, or about 4,000 pounds per hour, will be lost to the atmosphere in the form of cooling tower drift. Because the salinity of the cooling water will remain very low due to the high quality of the source (the steam condensate) and the high blowdown rate, there should be little adverse impact on the surrounding vegetation.

Increased automobile and truck traffic to the plant site and vicinity should also create only a minimal decrease in air quality. Exhaust emissions will be insignificant even during construction phases. Some dust from unpaved roads and cleared drill pads should be anticipated; however, dust will be suppressed by the distribution of geothermal fluids on these areas as approved by the California Regional Water Quality Control Board. Republic does not anticipate any environmental impacts associated with air emissions from the proposed geothermal power plant or its ancillary operations to be significant to the immediate desert ecology, the more remote agricultural lands, or to the human population of the Imperial Valley.

b. Noise

Noise is expected to be of minor concern during the construction and operation of Republic's proposed East Mesa power plant facility. This is primarily due to the relatively low pressure steam used to power the turbine. Noise levels will be maintained within the limits prescribed by the County of Imperial, the Bureau of Land Management, the U. S. Geological Survey, and the Occupational Safety and Health Administration.

Noise emissions will be attenuated as necessary. This will include mufflers on all internal combustion engines and on the pneumatic control system air compressors. Silencers will also be placed on the gas ejector vacuum pumps and on the ejector vents themselves. In an emergency, should it be necessary to vent the steam to the atmosphere, it will be passed through vents equipped with silencers.

Noise impacts on wildlife at East Mesa will probably be minimal because of the relatively low intensity and steady, continuous nature of most of these noise emissions. The East Mesa area itself is also very isolated from any human receptors. The extant ambient noise levels on East Mesa are usually very low, but are frequently punctuated by the sounds of aircraft overflights and explosions from the nearby military gunnery range. Occasional off-road vehicle use of the area also adds to the ambient noise levels.

6. Hazards to Public Health and Safety

Public health and safety shall be ensured through the use of appropriate equipment, operating procedures and notices. The plant site is located in an area remote from human population. No hazardous emissions or waste materials will be produced.

7. Compliance With Existing Requirements and Standards

Republic will comply with all existing federal requirements and pertinent state and local standards.

The following is a list of codes and standards which will be utilized in the design of the power generating facility:

Uniform Fire Code	1976 Edition
Uniform Mechanical Code	1976 Edition

Uniform Building Code Standard	1976 Edition
Uniform Building Code	1976 Edition
1977 Supplement of the Uniform Building Code	
National Electrical Code	1975 Edition
Uniform Plumbing Code	1976 Edition
1976 Revision of the General Industry Standards of O.S.H.A.	
Code for Power Pipine ANSI-B31.1	1977 Edition
Pressure Vessels ASME Section 8, Division 1	1977 Edition
Design & Construction of Large Welded Low-Pressure Storage Tanks API Std. 620	1977 Edition
Welded Steel Tanks for Oil Storage API Std. 620	1977 Edition

The Department of Building Inspection of Imperial County operates under the 1973 Edition of the Uniform Building Code and the 1975 Edition of the National Electric Code. Between December, 1977, and December, 1978, the Department expects to adopt the 1976 Edition of the Uniform Codes, including the 1977 Supplement which will include the Building Code, Plumbing Code, Mechanical Code and Fire Code.

I. PROVISIONS FOR MONITORING FOR NOISE, AIR AND WATER QUALITY STANDARDS

Republic has submitted to the Supervisor a Program for Collection of Environmental Baseline Data for Federal Geothermal Leases CA 966, CA 967 and CA 1903 at East Mesa, in accordance with 30 CFR 270.34 (k).

Republic will comply with all air, noise and water quality monitoring provisions which may be required during the operation of the power plant by the Imperial County Air Pollution Control District and the California Regional Water Quality Control Board. Republic is also prepared to carry out provisions for monitoring deemed necessary by the Supervisor to ensure compliance with the regulations.

A more detailed program for monitoring noise, air and water quality during operation of the power plant will be submitted with the Plan of Operation, Production in accordance with draft GRO Order. No. 5.

EXHIBIT C

PRELIMINARY GEOTECHNICAL INVESTIGATION
REPUBLIC GEOTHERMAL, INCORPORATED
EAST MESA PROJECT

For

The Rust Engineering Company
Post Office Box 101
Birmingham, Alabama 35201

By

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers and Geologists

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San Diego, California 92110
714-224-2911
Telex 697-841

Woodward-Clyde Consultants

Project No. 57334S, SI01
October 25, 1977

The Rust Engineering Company
Post Office Box 101
Birmingham, Alabama 35201

Attention: Mr. Tom Falkenberry

PRELIMINARY GEOTECHNICAL INVESTIGATION
REPUBLIC GEOTHERMAL, INCORPORATED
EAST MESA PROJECT

Gentlemen:

In accordance with our proposal dated June 23, 1977, and your Purchase Order No. 1867-B-1, dated July 18, 1977, we have completed a preliminary geotechnical investigation at three sites in the East Mesa Geothermal Field, Imperial Valley, California.

The accompanying report presents our conclusions and recommendations as well as the results of the explorations and laboratory tests upon which they are based. Our engineering geologist assigned to this project was Mr. Ernest Artim. We were also assisted by Dr. Robert B. McEuen, Professor of Geophysics at San Diego State University, and consultant to our firm.

If you have any questions, or if we can be of further service, please give us a call.

WOODWARD-CLYDE CONSULTANTS

Steven C. Haley

Steven C. Haley
R.E. 18577

SCH/1km

Attachment

(6) The Rust Engineering Company
(1) Mr. John Bayliss
(1) Dr. J. H. Barkman

Consulting Engineers, Geologists
and Environmental Scientists

Offices in Other Principal Cities

PRELIMINARY GEOTECHNICAL INVESTIGATION
REPUBLIC GEOTHERMAL, INCORPORATED
EAST MESA PROJECT

SCOPE OF WORK

This report presents the results of our geotechnical investigation at three proposed sites for the Republic Geothermal, Incorporated, East Mesa Project. The sites are located as indicated in the Site Plan, Fig. 1, on Range 17 East, Township 15 South, Section 30. The scope of our services include:

- Subsurface investigations and laboratory tests to evaluate the engineering properties of the soils encountered,
- Preliminary conclusions regarding earthwork, foundation types, and pavement design, and
- A discussion of the earthquake engineering aspects of the local geologic and seismic settings.

DESCRIPTION OF PROJECT

We understand from discussions with Mr. John Bayliss of The Rust Engineering Company that it is proposed to construct a 10-megawatt geothermal power plant which would likely be followed-up by a 50-megawatt geothermal facility. We have been provided with the following drawings from Mr. Bayliss:

- "Preliminary Geotechnical Survey for the Proposed Power Plant," (Drawing No. IEM-55, July 20, 1977),
- An unidentified and undated topography map of Section 30 showing the three site locations,
- Plot plan (Drawing No. 02-32-002, September 28, 1977),
- "Turbine Building Frame Preliminary Analysis," (September 22, 1977),
- "Turbine Building," (August 29, 1977),
- "Turbine Generator Foundation - 10-Megawatt Unit," (Drawing No. 1, September 1, 1977),
- "Turbine Generator Foundation - 10-Megawatt Unit," (Drawing No. 2, September 1, 1977),
- "Turbine Generator Foundation - 50-Megawatt Unit," (Drawing No. 1, August 24, 1977).
- "Turbine Generator Foundation - 50-Megawatt Unit," (Drawing No. 2, August 26, 1977),

- "Cooling Tower Foundation - 10-Megawatt Unit," (Drawing No. 1, September 26, 1977),
- "Cooling Tower Foundation - 10-Megawatt Unit," (Drawing No. 2, September 26, 1977), and
- "Cooling Tower Foundation - 10-Megawatt Unit;" (Drawing No. 3, September 27, 1977).

The first drawing was prepared by Republic Geothermal, Incorporated, and the last ten, by the Rust Engineering Company.

From these drawings and our discussions with Mr. Bayliss, we understand that both the 10 and 50-megawatt units will be constructed at the same general location and will occupy a plant area of approximately 500 feet by 800 feet on one of the three sites. We further understand that the turbine building will have interior columns with maximum dead loads of approximately 48 kips and maximum live loads of about 60 kips. Under normal operating conditions exterior columns will have maximum axial loads of 185 kips, maximum shear of 5 kips, and maximum moment of 150 Kip-feet. Under seismic conditions, the maximum loads on the exterior columns will be 190 kips, with 20 kips maximum shear, and 495 kip-feet maximum moment.

The 10-megawatt turbine generator foundation will support a static weight of 157 kips from equipment with a foundation weight of 550 kips. For the 50-megawatt unit, the static weight of equipment will be 550 kips, and the estimated weight of the foundation is 1530 kips. Dynamic loads for the turbine generator foundations are not yet known.

The 10-megawatt turbine generator foundation will have approximately rectangular dimensions of 28 feet by 13 feet. The foundation for the 50-megawatt turbine generator will be approximately 72 feet long and varying in width from about 11 to 17 feet. The operating weight of the 10-megawatt unit cooling tower will be approximately 261 kips with plan dimensions of approximately 39 feet by 61 feet. The 50-megawatt cooling tower unit will have an operating weight of approximately 2,570 kips and will occupy an area of approximately 327 feet by 61 feet.

We understand that little grading is planned, except for drainage.

FIELD INVESTIGATION

Seven exploratory borings were advanced to depths of 30 to 101 feet during the period of September 13 through September 22, 1977, at the locations shown on the Site Plan, Fig. 1. Samples of soil were obtained using a modified California drive sampler (2-inch inside diameter and 2-1/2-inch outside diameter), with thin brass liners and a standard penetration test sampler (1-3/8 inside diameter and 2-inch outside diameter). Both samplers were driven 18 inches into the material at the bottom of the hole by a 140-pound hammer falling 30 inches.

Boring logs were prepared from the field data and the results of laboratory examinations and tests. A Key to Logs is presented as Fig. 2, and the Borings Logs are presented in Figs. 3 through 15.

LABORATORY TESTING

Grain size analyses were made for 14 representative samples of the more granular materials at the three sites. The results of these tests are presented on Figs. 16 and 17. Moisture contents and plasticity indices were determined for the more cohesive materials encountered. The results of the moisture contents are presented on the Boring Logs and the plasticity indices are indicated on Fig. 18.

The results of two resistance-value tests performed in representative samples of near-surface materials indicate that the materials tested have an R-value of approximately 76 to 78. Copies of the test results are attached.

SITE CONDITIONS

Surface Conditions

Elevations at the sites vary from 35 feet to 55 feet (MSL Datum) with a local relief of 8 feet to 10 feet. The general area slopes in a westerly direction and drainage is incomplete. The general geomorphic setting is that of a partially stabilized sand dune field. Vegetation is sparse and dominated by creosote bush and desert buckwheat. Distance between major clumps of vegetation varies from 10 to 50 feet.

Subsurface Conditions

In general, all three sites are underlain by sands with little cohesion. A summary of the subsurface conditions is presented on Table I. As indicated in Table I, the sands typically become medium-dense to dense at shallow depths, especially for Sites B and C. Except for 1 to 2-foot thick lenses encountered in Boring No. 1 at 36 feet and 56 feet and in Boring No. 3 at 16 feet and in Boring No. 6 at 11 feet, no cohesive materials were encountered at a depth shallower than 63 feet. All of the clays encountered were very stiff to hard. One lense of silt was encountered in Boring No. 6 from a depth of 12 to 18 feet in thickness.

In general, the materials appeared to represent pre-compressed, alluvial and lacustrine deposits. It appears that the groundwater level is relatively uniform across the sites at an elevation of approximately +18 (MSL).

Geologic Setting

The geologic setting of the East Mesa site is expressed well by Narasimhan, et al (1977):

> *The East Mesa Field is located 20 miles east of El Centro, California, in the Imperial Valley. This valley is part of a large structural feature known as the Salton Trough, a sediment-filled depression forming the landward continuation of the East Pacific Rise and the Gulf of California (Swanberg, 1975). The East Pafific Rise is one of several geological sutures on the earth's crust along which adjoining crustal plates move apart, causing thinning of the crust and upward movement of molten rock from the mantle. This crustal extension is responsible for the formation of the Salton Trough, and provides the heat source for the several geothermal resource areas located in the Imperial Valley. Faulting is a consequence of this crustal extension and many faults trend NW and are right lateral strike-slip faults. The major active faults close to the field are the San Andreas Fault, located approximately 20 miles from the East Mesa Field on the eastern margin of the Imperial Valley, and the Imperial Fault, located approximately 15 miles to the west of the field. Three local faults have been mapped within the field itself.*
>
> *The Imperial Valley is a broad depression, approximately 60 miles wide in the vicinity of East Mesa. It trends northwest to southeast, becoming wider southward toward the Mexican border. The valley is bounded on the east by the Chocolate Mountains, which rise to over 2000 feet, and on the west by the Fish Creek and Coyote Mountains, which attain elevations of 3000 feet. To the north, the valley is approximately 25 miles wide and is occupied by the Salton Sea, which has a surface elevation of approximately -230 feet. A greater part of the Imperial Valley south of the Salton Sea lies below sea level and receives benefit from the well-known irrigation systems of the all American and Coachella canals.*
>
> *Sea level constitutes a well-defined physiographic boundary between the irrigated, lower parts of the valley and the higher flanks of the valley on either side. These higher portions, called the West and East Mesas, rise to about 100 feet above sea level. The East Mesa exhibits a relatively flat, featureless desert-like terrain covered by alluvium and sand dunes. The geothermal well field under study is located near the western margin of the East Mesa on the eastern flank of the Salton Trough.*

The reservoir rocks at East Mesa are essentially flat-lying, poorly consolidated, late Pliocene to late Pleistocene, deltaic sandstones, siltstones and clays believed derived from the Colorado River. They aggregate a total thickness of about 10,000 feet on top of crystalline basement rocks. A predominantly clay sequence, about 2000 feet thick, caps the reservoir and hence no surface evidence of geothermal activity is seen. Within the field, three supposedly vertical intersecting faults have been mapped. It is thought that one or more of these faults and their intersections may act as vertical channels that allow hot water to rise from depth and cooler water to return to depth in a convective cycle. As mentioned, this convective regime is sustained by heat derived from the tectonic processes associated with the East Pacific Rise. The surface heat flow over the field is about five times that of the earth's average.

Regional Faulting

The power plant sites are located approximately 30 miles northeast of the Elsinore-Laguna Salada Faults; some 18 miles northeast of the San Jacinto Fault; approximately 10 to 15 miles southwest of the San Andreas Fault zone projection (including the Algodones Fault); and 10 miles northeast of the Imperial Fault along which the 1940 (6.7 magnitude) earthquake occurred.

Local Faulting

No major, active faults are known to exist within the East Mesa KGRA; however, at least four other faults are considered to cross the East Mesa KGRA as indicated in Fig. 19. As projected on the figure, at least one of the faults, the Calipatria, appears to cross Section 30 and may pass through one of the preliminary sites. These faults have been postulated by geophysical investigations, and in the case of the Holtville Fault, by the use of oblique infared aerial photography. The location of the Holtville Fault was based upon an aligned series of stable sand; however, a ground investigation did not reveal any surface exposures. In all cases, fault surface expressions or offsets are

are lacking or have not been verified. The locations of these faults are based primarily upon geophysical techniques and projections, with no verified or documented surface exposures, and therefore, the actual locations for these faults may be somewhat offset from those shown on the map.

SEISMICITY

The Imperial Valley has long been recognized as a seismically active area. As indicated in Fig. 20, recent trends show the Imperial Fault to be presently the most active feature near the site. The largest credible extent which might be associated with one of the major faults in the valley would be on the order of magnitude 8. Based on recent seismic history, a magnitude 7 earthquake on a major fault in the vicinity of the site might have an average recurrence interval on the order of 100 years. If one of these earthquakes was to occur at a distance of 10 miles from the site (for instance on the Imperial Fault), ground accelerations could be on the order of about 0.4g and 0.3g, respectively. Such events would most likely occur along the San Jacinto, extension to the San Andreas, or the Imperial Fault, and would not be expected to occur on faults within the general site area.

Work by McEuen, et al (1977), indicates that the historic seismicity in the nearest vicinity to the site is lower than for the Imperial Valley and that within a surrounding 60-square-mile area an earthquake of magnitude 5.5 might have an average recurrence interval of about 100 years. However, larger events are possible in the vicinity of the site and ground accelerations exceeding 0.46 also are possible.

DISCUSSION AND CONCLUSIONS

From our preliminary investigation described above, it is our conclusion that all three sites are suitable for the proposed Geothermal Power Plant. The near-surface soils consist of loose clean sands which will require some treatment and may be somewhat troublesome during construction of foundations and pavements due to their non-cohesive nature. The high seismicity of the area should also be taken into consideration in the design of structures and their associated facilities.

Foundations

From our previous discussions and a review of the plans furnished to us, we understand that foundation bearing pressures on the order of 3 kips per square foot are suitable for the proposed structures. For this loading condition and with recompaction of the near-surface loose sands to a relative compaction of at least 90 percent by ASTM test method D-1557, we anticipate that settlements for the proposed structures would not exceed 1/2 inch. We anticipate that greater bearing capacities can be used, if desired. Specific recommendations can be provided based on a more detailed foundation investigation in the selected site area.

Pavements

Preliminary pavement designs for a 20-year pavement life are presented below based on an assumed R-value of 70 and given traffic indices (which are related to the anticipated number of 5000-pound equivalent wheel loads (EWL) during the life of the structure).

Traffic Index	Number of EWL/year	Asphaltic Concrete Thickness (in)	Aggregate Base Thickness (in)
4	13,108	2	4
5	85,486	2	4
[illegible]	[illegible]	2-1/2	4

Full-thickness asphalt designs are not recommended for this site because the generally clean surface sands do not provide a good base material. A Class II aggregate base in conformance with Section 26-1.02B of the Standard Specifications for the State of California Department of Transportation should be used.

Faulting and Earthquake Considerations

As previously discussed, the site is located in a highly seismic area. It is not known from the depth of this study whether or not any potentially active faults pass through any of the specific sites. However, no indications have been found that any of the faults have surface exposures which would indicate they have moved in recent times. However, near-surface faulting indicating recent movement of faults has been found in trenching. we recommend that, once the site location is established, a trenching operation be completed during the more detailed foundation investigation phase to verify the presence or absence of recent fault movement. The trenching would be perpendicular to the general northwest-southeast trend of faulting in the area and located to shadow critical structures.

It is reasonable to believe that at least one moderate earthquake (perhaps magnitude 6 to 7) will occur within 10 to 20 miles (±) of the site during the life of the structure. We anticipate that ground accelerations at the site from such an event could be on the order of 0.3g's. Such ground accelerations would result in dynamic structural loading in excess of the current Uniform Building Code Standards applicable to the area. Depending on economic and other factors, it may be considered suitable to perform a seismic design for critical portions of the facility.

We would be happy to discuss this matter further, if desired. We can provide seismic design criteria in the form of acceleration-time histories or earthquake response spectrum.

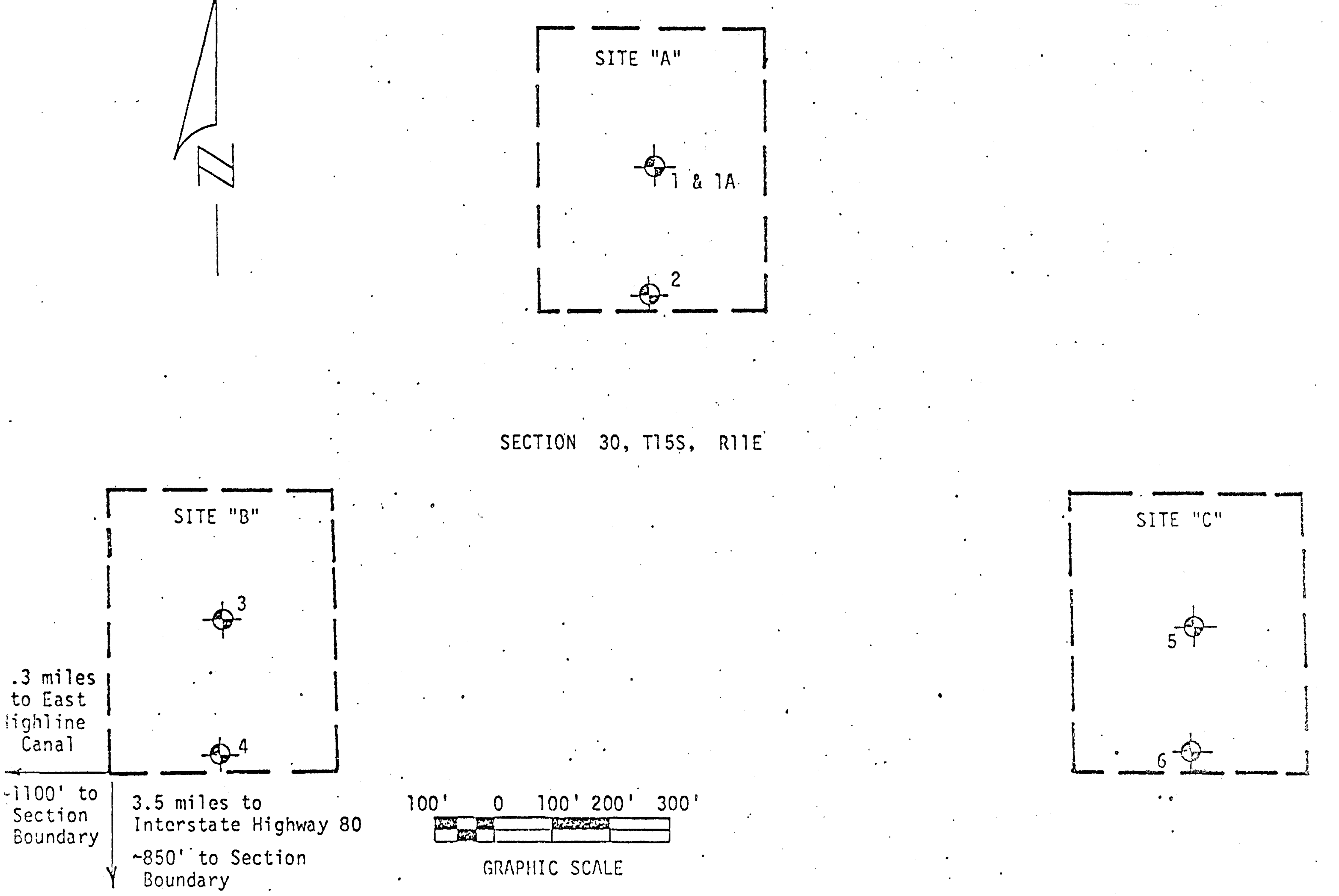
LIMITATIONS

The discussion and conclusions presented herein are based on a limited field investigation and should not be used for design without a more detailed study of the specific site selected.

TABLE I

GENERALIZED SUBSURFACE CONDITIONS

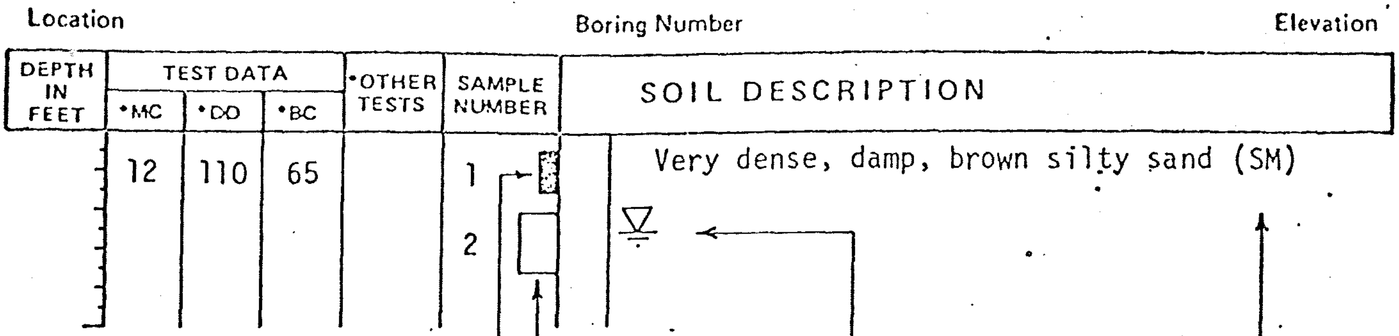
	Site A		Site B		Site C	
Boring No.	1,1A	2	3	4	5	6
Surface Elevation (MSL)	48	49	40	39	52	50
Profile (feet)						
Loose Sand	0- 2	0- 5	0- 2	0- 2	0- 1	0- 1
Medium Dense Sand	2- 12	5- 30	2- 7	2- 5	1- 7	1- 8
Dense to Very Dense Sand	12- 76	30- 31+	7- 76	5- 31+	7- 63	8- 31+
Hard Clay	76- 97	-	76- 91	-	63- 67	-
Very Dense Silty Sand	97-100+	-	91-100+	-	67- 96	-
Hard Clay	-	-	-	-	96-101+	-
Depth to Groundwater (feet)	30	31	-	21	32- 35	32
Elevation of Groundwater (MSL)	18	18	-	18	17- 20	18



SITE PLAN
EAST MESA

DRAWN BY: mrk
CHECKED BY:
PROJECT NO: 57334S
DATE: 10-6-77
FIGURE NO: 1

WOODWARD-CLYDE CONSULTANTS



WATER LEVEL
At time of drilling or as indicated.

SOIL CLASSIFICATION
Soil Classifications are based on the Unified Soil Classification System and include color, moisture and consistency. Field descriptions have been modified to reflect results of laboratory analyses where appropriate.

DISTURBED SAMPLE LOCATION
Obtained by collecting the auger cuttings in a plastic or cloth bag.

UNDISTURBED SAMPLE LOCATION

M MODIFIED CALIFORNIA SAMPLER
Sample with recorded blows per foot was obtained with a Modified California drive sampler (2" inside diameter, 2.5" outside diameter) lined with sample tubes. The sampler was driven into the soil at the bottom of the hole with a 140 pound hammer falling 30 inches.

S STANDARD PENETRATION TEST SAMPLER
Sample with recorded blows per foot was obtained with a Standard Penetration Test Sampler. (1-3/8" inside diameter, 2" outside diameter). The sampler was driven into the soil at the bottom of the hole with a 140 pound hammer falling 30 inches.

INDICATES SAMPLE TESTED FOR OTHER PROPERTIES

GS – Grain Size Distribution	CT – Consolidation Test
LC – Laboratory Compaction Test	UCS – Unconfined Compression Test
PI – Atterberg Limits Test	DS – Direct Shear Test
ST – Loaded Swell Test	TX – Triaxial Compression Test
CC – Confined Compression Test	

NOTE: In this column the results of these tests may be recorded where applicable.

BLOW COUNT
Number of blows needed to advance sampler one foot or as indicated.

DRY DENSITY
Pounds per Cubic Foot

MOISTURE CONTENT
Percent of Dry Weight

NOTES ON FIELD INVESTIGATION

1. REFUSAL indicates the inability to extend excavation, practically, with equipment being used in the investigation.

KEY TO LOGS
EAST MESA

DRAWN BY: SCG
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DATE: 10-6-77
FIGURE NO: 2

WOODWARD-CLYDE CONSULTANTS

Boring 1

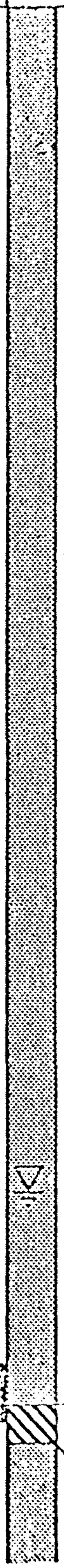
DEPTH IN FEET	TEST DATA *MC	TEST DATA *DD	TEST DATA *BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
			8	GS	1-1 S	Loose to medium dense, light brown, fine grained sand, with traces of medium grained sand and silt (SP-SM).
			21		1-2 M	
5			12	GS	1-3 S	
			17		1-4 M	
10			24	GS	1-5 S	
			32		1-6 M	Dense
15			36		1-7 S	
20			38		1-8 S	
						Very dense
25			62		1-9 S	
30			129/6"		1-10M	
35					1-11	
40						Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 1
EAST MESA

DRAWN BY: SCG | CHECKED BY: SG | PROJECT NO: 57334S | DATE: 10-6-77 | FIGURE NO: 3

Boring 1a



DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
						Dry, light brown, fine grained sand with traces of medium grained sand and silt (SP-SM)
5						
10						
15						
20						
25						
30						
35	29		31	PI	1a-1M	Stiff to hard, saturated, brown, silty clay
						Very dense, saturated, brown fine to coarse sand, with scattered fine gravel (SP)
40						

*For description of symbols, see Figure

LOG OF TEST BORING 1a
EAST MESA

DRAWN BY: SCG	CHECKED BY: SH	PROJECT NO: 57334S	DATE: 10-6-77	FIGURE NO: 4

Boring 1a

DEPTH IN FEET	TEST DATA *MC	TEST DATA *DD	TEST DATA *BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
			138		1a-2M	Very dense, saturated, brown fine to coarse sand with scattered fine gravel (SP)
45			100 5"		1a-3M	
50			123		1a-4S	
55						┬ Silty? ?——?——?——?——?——?——?——?-
			46		1a-5S	Hard, saturated, brown, silty clay ?——?——?——?——?——?——?——?-
60			81		1a-6S	Very dense, saturated, brown fine to coarse sand with trace of silt and scattered fine gravels (SP-SM)
65			90 6"		1a-7M	
70			88 6"	GS	1a-8S	
75					1a-9	Very stiff to hard, saturated, brown silty clay (CH)
80						

*For description of symbols, see Figure

LOG OF TEST BORING 1a
EAST MESA

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WOODWARD CLYDE CONSULTANTS

Boring 1a

DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
			42		1a-10S	Very stiff to hard, saturated, brown silty clay (CH)
85						Gravelly Gravelly Gravelly
90			46		1a-11S	
95					1a-12	
						Very dense, saturated, light brown silty fine grained sand (SM)
100			100/6"		1a-13S	
						Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 1a
EAST MESA

DRAWN BY: SCG
CHECKED BY:
PROJECT NO: 57334S
DATE: 10-6-77
FIGURE NO: 6

Boring 2

DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
			2		2-1 S	Loose, dry, light brown, fine grained sand with trace of medium grained sand and silt (SP-SM)
			6	GS	2-2 M	
5			13		2-3 S	Medium dense
					2-6	
			15		2-4 M	
10			16		2-5 S	
			23	GS	2-7 M	
15			18		2-8 S	
20			51		2-9 S	
25			22		2-10S	
30			52		2-11M	Dense
						Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 2
EAST MESA

DRAWN BY: SCG | CHECKED BY: SCL | PROJECT NO: 57334S | DATE: 10-6-77 | FIGURE NO: 7

WOODWARD-CLYDE CONSULTANTS

Boring 3

DEPTH IN FEET	TEST DATA *MC	TEST DATA *DD	TEST DATA *BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
			8		3-1 S	Loose, dry, light brown, fine grained sand with traces of medium grained sand and gravel (SM)
			25		3-2 M	Medium dense
5						
			18		3-3 S	
						Dense, silty
			35	GS	3-4 S	
10			48		3-5 M	
						Very dense, trace of silt
			57		3-6 S	
15						
			97		3-7 M	
						Hard, damp, brown, silty clay (CH)
						Very dense, wet, brown fine to coarse graine sand with trace of silt and fine gravel (SM-SP)
20			61		3-8 S	
25			98/6"		3-9 M	
30			134		3-10S	
35			110/6"		3-11M	
40						

*For description of symbols, see Figure

LOG OF TEST BORING 3
EAST MESA

DRAWN BY: SCG | CHECKED BY: | PROJECT NO: 57334S | DATE: 10-6-77 | FIGURE NO: 8

WOODWARD-CLYDE CONSULTANT

Boring 3

DEPTH IN FEET	TEST DATA •MC	 •DD	 •BC	•OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
			126		3-12S	Very dense, wet, brown fine to coarse grained sand with trace of silt and fine gravel (SP-SM)
45			86/6"	GS	3-13M	
50			116/6"		3-14S	
						Clayey ?
55			94/6"		3-15S	
						Clayey ?
						Clayey ?
60			87/6"		3-16M	
65			98/6"		3-17S	
70			100/6"		3-18S	
75	26		119/6"	PI	3-19S	Gravelly, saturated
						Very stiff to hard, brown silty clay, with silty layers (CH)
80						

•For description of symbols, see Figure

LOG OF TEST BORING 3
EAST MESA

DRAWN BY: SCG	CHECKED BY: Sit	PROJECT NO: 57334S	DATE: 10-6-77	FIGURE NO: 9

Boring 3

DEPTH IN FEET	TEST DATA *MC	*DD	*BC	*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
			38		3-20S	Very stiff to hard, brown silty clay with silty layers (CH)
85			46	PI	3-21S	
90			141		3-22S	Very dense, saturated, light brown silty fine grained sand (SM)
95			98/6"		3-23S	
100			98/6"		3-24S	Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 3
EAST MESA

DRAWN BY: SCG
CHECKED BY:
PROJECT NO: 57334S
DATE: 10-6-77
FIGURE NO: 10

Boring 4

DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
			6		4-1 S	Loose, dry, light brown, fine grained sand with trace of medium grained sand and silt (SP)
					4-1a	
			15		4-2 S	
5						Dense
			33		4-3 S	
			36		4-4 S	
10			30		4-5 S	Fine to medium grained (SP)
			42	GS	4-6 S	
15			51		4-7 S	
20			48	GS	4-8 S	Clay
25			42		4-9 S	
30			41	GS	4-10S	
						Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 4
EAST MESA

DRAWN BY: SCG	CHECKED BY:	PROJECT NO: 57334S	DATE: 10-6-77	FIGURE NO: 11

Boring 5

DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
					5-1	Loose to medium dense, dry, light brown, fine grained sand with trace of medium grained sand and silt. (SM)
			9		5-2S	
			27		5-3S	
5						
			28		5-4S	
						Dense, fine to coarse grained sand with trace of gravel and silt (SP-SM)
			35	GS	5-5S	
10						
			38		5-6S	
			48		5-7S	
15						
			49		5-8S	
						Very dense
20						
			98		5-9S	
						Clayey
25			154		5-10S	
30						Wet
			118		5-11S	
35						Saturated
			113		5-12S	
40						

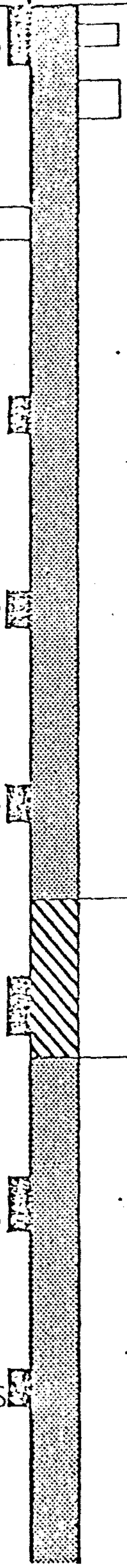
*For description of symbols, see Figure

LOG OF TEST BORING 5
EAST MESA

DRAWN BY: SCG
CHECKED BY:
PROJECT NO: 57334S
DATE: 10-6-77
FIGURE NO: 12

Boring 5

DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
			81		5-13S	Sandy clay
						Clayey ?
45				GS	5-14	Fine to coarse grained sand with scattered fine gravel (SP)
50			101 6"		5-15S	
55			86 6"		5-16S	
60			100 3"		5-17S	Fine to medium grained
						Very stiff to hard, saturated, brown silty clay, with scattered gravel (CH)
65			57		5-18S	
						Very dense, saturated, light brown, silty fine grained sand, with thin fine gravel zones (SM)
70			97		5-19S	
75			63 6"		5-20S	
80						



*For description of symbols, see Figure

LOG OF TEST BORING 5
EAST MESA

DRAWN BY: SCG | CHECKED BY: GL | PROJECT NO: 57334S | DATE: 10-6-77 | FIGURE NO: 13

Boring 5

DEPTH IN FEET	TEST DATA			•OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	•MC	•DD	•BC			
			59		5-21S	Very dense, saturated, light brown silty fine grained sand with thin fine gravel zones (SM)
85			98/6"		5-22S	
90			104/6"		5-23S	
95			130		5-24S	
						Very stiff to hard, moist, brown silty clay (CH)
100			37		5-25S	
						Bottom of Hole

•For description of symbols, see Figure

LOG OF TEST BORING 5
EAST MESA

DRAWN BY: SCG	CHECKED BY: SLi	PROJECT NO: 57334S	DATE: 10-6-77	FIGURE NO: 14

Boring 6

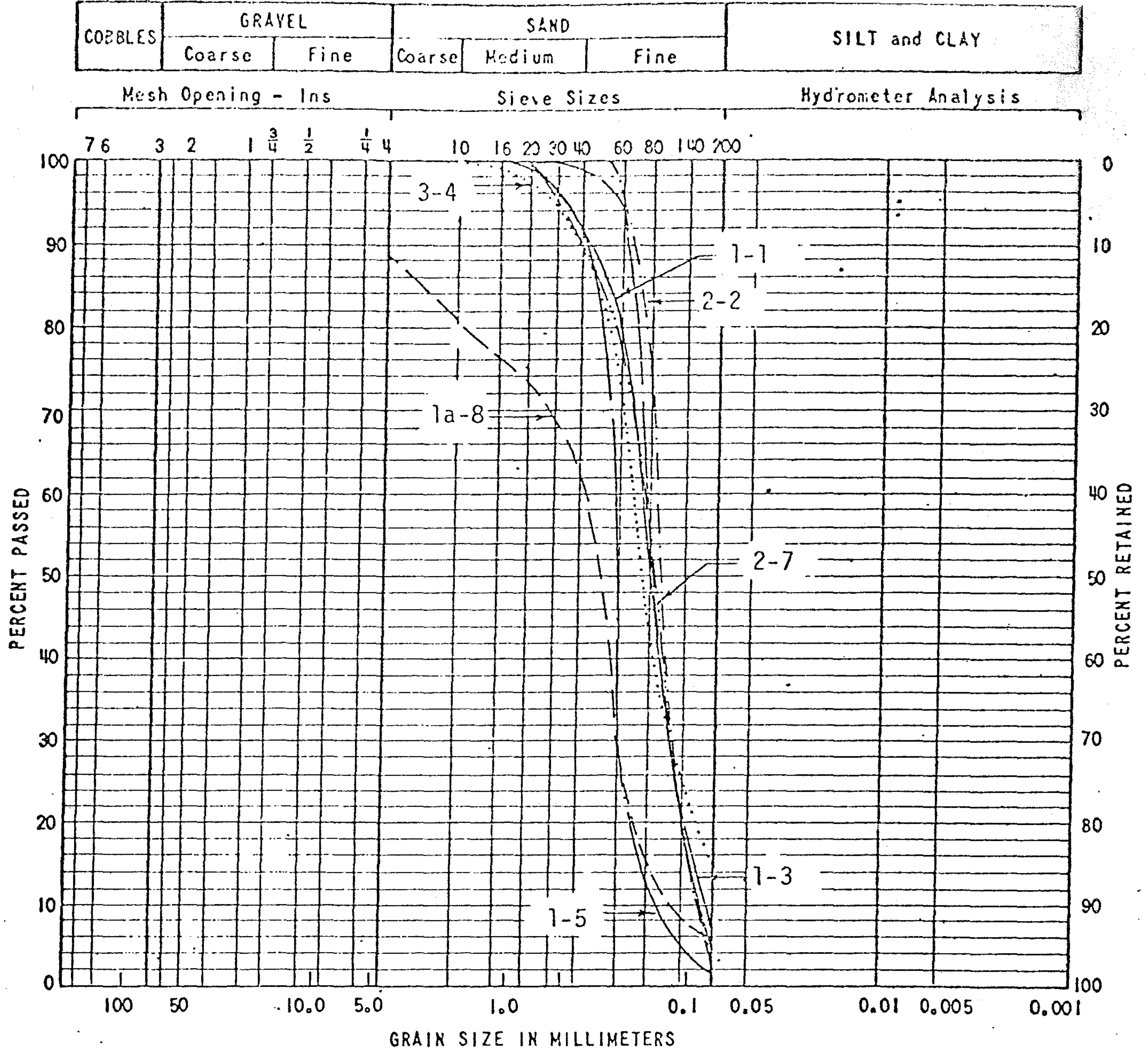
DEPTH IN FEET	TEST DATA			*OTHER TESTS	SAMPLE NUMBER	SOIL DESCRIPTION
	*MC	*DD	*BC			
			6		6-1 S	Loose, dry, silty fine sand on surface
						Loose, dry, fine grained sand with trace of medium grained sand and silt (SM-SP)
			9		6-2 M	Damp, medium dense
5			21	PI MC=24	6-6- 6-3 S	
			27	NR	6-4 M	
10			25		6-5 S	
						Hard, damp, red-brown, silty clay, with trace of sand (CH)
	7	90	35	GS	6-7 M	Medium dense to dense, damp, light gray, silt with trace of fine grained sand and clay, with sandy layers, (SM-ML)
15			30		6-8 S	
						?———?———?———?———?———?———?———?—
						Very dense, damp, light gray to light brown, fine to medium grained sand, with trace of silt (SP-SM)
20			106		6-9 M	
25			50		6-10S	
30			70		6-11M	Moist
						Bottom of Hole

*For description of symbols, see Figure

LOG OF TEST BORING 6
EAST MESA

DRAWN BY: SCG
CHECKED BY: S.L
PROJECT NO: 57334S
DATE: 10-6-77
FIGURE NO: 15

WOODWARD CLYDE CONSULTANTS

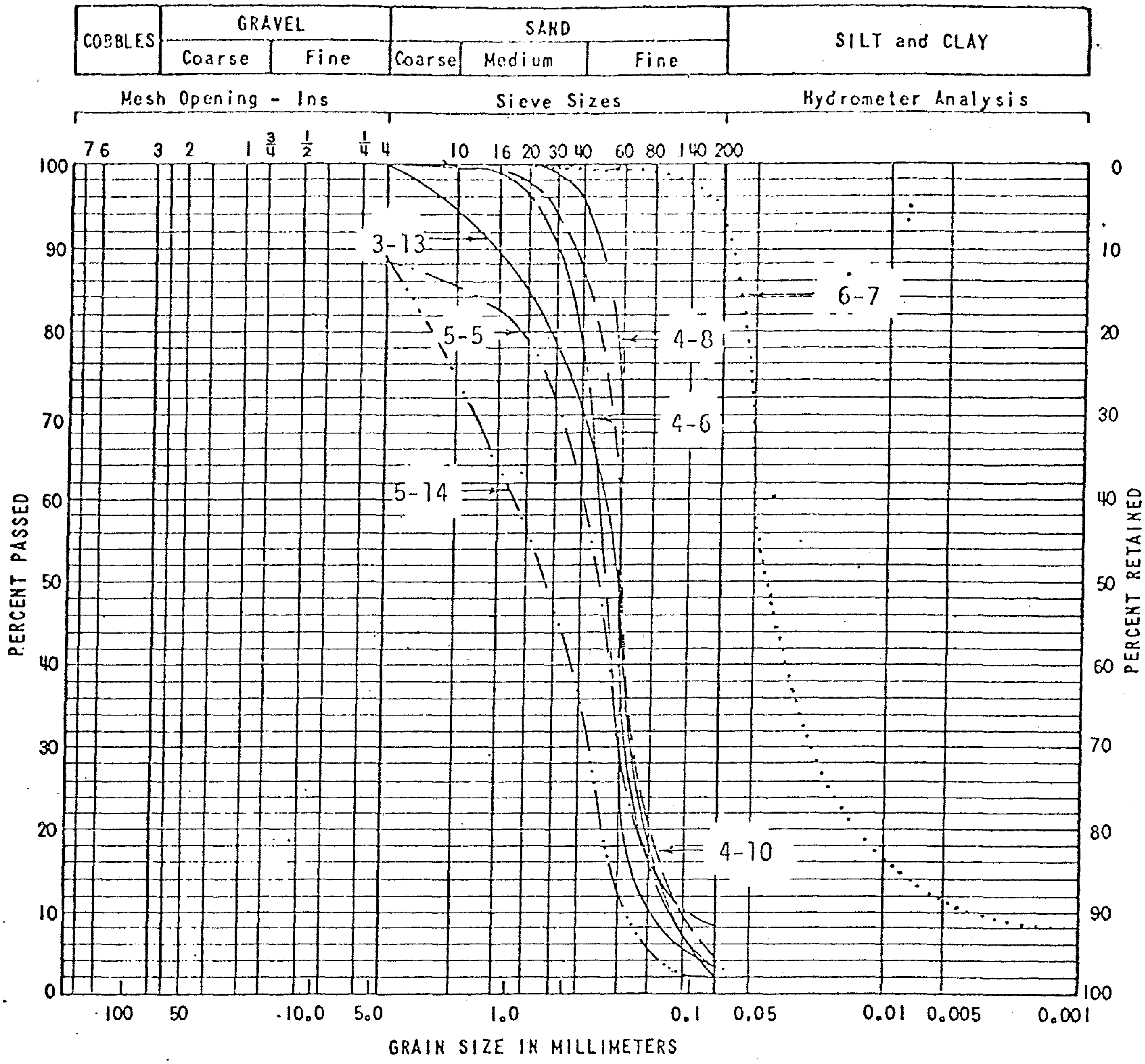


SAMPLE	CLASSIFICATION AND SYMBOL	*LL	*PI
1-1 (1')	Fine to medium grained sand (SP)		
1-3 (6')	Fine sand with trace of silt (SP-SM)		
1-5 (11')	Fine to medium grained sand (SP)		
1a-8(70')	Gravelly fine to coarse sand with trace of silt (SP-SM)		
2-2 (4')	Fine grained sand (SP)		
2-7 (13')	Fine to medium grained sand (SP)		
3-4 (8')	Silty fine to medium grained sand (SM)		

*LL - Liquid Limit
*PI - Plasticity Index

GRAIN SIZE DISTRIBUTION CURVES
EAST MESA

DRAWN BY: mrk
CHECKED BY: GLH
PROJECT NO: 57334S
DATE: 10-7-77
FIGURE NO: 16

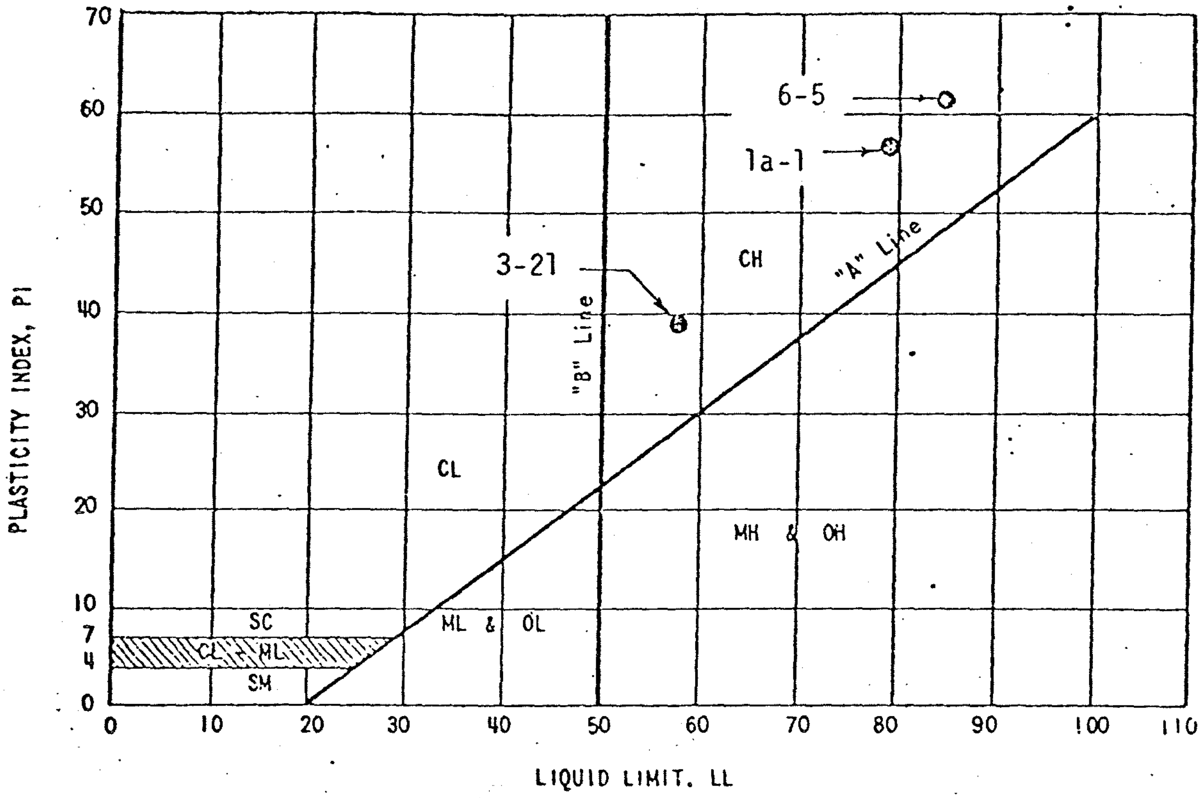


SAMPLE	CLASSIFICATION AND SYMBOL	*LL	*PI
3-13(46')	Fine to coarse grained sand (SP)		
4-6 (13')	Fine to medium grained sand (SP)		
4-8 (20')	Fine to medium grained sand (SP)		
4-10(30')	Fine to medium grained sand (SP)		
5-5 (8')	Gravelly fine to coarse sand with trace of silt (SP-SM)		
5-14(45')	Gravelly fine to coarse grained sand (SP)		
6-7 (14')	Silt with traces of fine sand and clay (ML)		

*LL - Liquid Limit
*PI - Plasticity Index

GRAIN SIZE DISTRIBUTION CURVES
EAST MESA

DRAWN BY: mrk	CHECKED BY:	PROJECT NO: 57334S	DATE: 10-7-77	FIGURE NO: 17



PLASTICITY CHART
For Classification of Fine - Grained Soils in Unified System

Legend

CL	Inorganic clay of low to medium plasticity.
CH	Inorganic clay of high plasticity.
ML	Inorganic silt of low plasticity.
MH	Inorganic soil of high plasticity.
OL	Organic silt or clay of low plasticity.
OH	Organic clay of high plasticity.
SM	Silty sand.
SC	Clayey sand.

PLASTICITY CHART
EAST MESA

DRAWN BY: mrk
CHECKED BY:
PROJECT NO: 57334S-SI01
DATE: 10-20-77
FIGURE NO: 18

WOODWARD-CLYDE CONSULTANTS

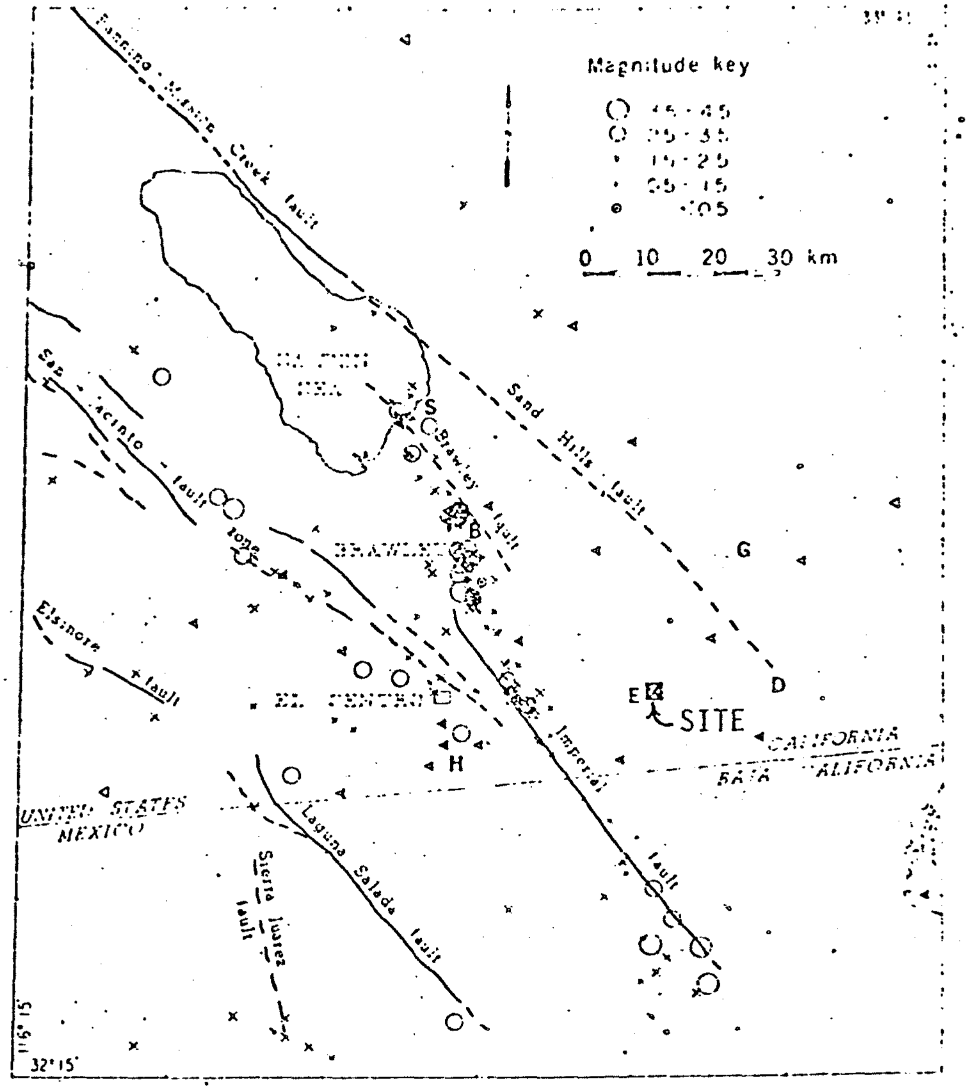


Fig. 1b. Location of earthquakes in the Imperial Valley region with respect to major faults and geothermal anomalies. The smallest and largest earthquakes plotted have magnitudes of 0.5 and 4, respectively. Solid triangles represent locations of seismograph stations in the Imperial Valley network; open triangles correspond to locations of Caltech regional seismograph stations. Known geothermal resource areas are indicated by capital letters as follows: *B*, Brawley; *D*, Dunes; *E*, East Mesa; *G*, Glamis; *H*, Heber; and *S*, Salton Sea.

...Taken directly from
Hill, Mowinckel and Peak, 1975.

NOTE: Earthquakes shown for period of June 1973 through May 1974.

SEISMICITY MAP
EAST MESA

DRAWN BY:	CHECKED BY:	PROJECT NO: 57344S-SI01	DATE: 10-12-77	FIGURE NO: 20

WOODWARD-CLYDE CONSULTANTS

Attachment 1
Page 1 of 2

Testing Engineers--San Diego

3467 Kurtz St., P.O. Box 80985, San Diego, Ca. 92138 (714) 225-9641
1903 West Vista Way, Unit B, Vista, California 90283 (714) 758-3730

BORATORY NUMBER SD32-3342

DATE October 11, 1977

E: 507-10

JECT: East Mesa
Job No. 57334C

SAMPLE DATA: Submitted to the laboratory on October 6, 1977 and identified as Sample # 3-1A 0 - 2½'.

DING ANALYSIS

	PERCENT AS RCVD.	PASSING AS USED

	R - VALUE DATA				
	A	B	C	D	
COMPACTOR PRESS - P.S.I.	200	200	210	195	
MOIST @ COMPACTION - %	12.0	12.8	14.5	13.6	
DENSITY - #/CU. FT.	105.1	105.2	104.7	106.3	
R-VALUE - STABILOMETER	--	78	77	78	
EXUD. PRESSURE - P.S.I.	--	800	220	340	
STAB. THICK - FEET	--	0.31	0.33	0.31	
EXPAN. PRESS. THICK-FEET	0.06	0.03	0.03	0.03	

T. I. (ASSUMED) = 4.5

DESIGN R. VALUE

BY STAB. @ 300 P.S.I. EXUD. = 78
BY EXPANSION PRESSURE = --
AT EQUILIBRIUM = --

SAND EQUIVALENT =

DURABILITY (COARSE) = ______
DURABILITY (FINE) = ______

LIQUID LIMIT = ______
PLASTIC LIMIT = ______
P. I. = ______

S:

(3) Woodward-Clyde Consultants, Attn: Mr. Jim Cavallin

TESTING ENGINEERS - SAN DIEGO
REVIEWED BY

Attachment I
Page 2 of 2

Testing Engineers—San Diego
3467 Kurtz St., P.O. Box 80985, San Diego, Ca. 92138 (714) 225-9641
1903 West Vista Way, Unit B, Vista, California 90283 (714) 758-3730

ABORATORY NUMBER SD32-3341

DATE October 11, 1977

.E: 507-10

OJECT: East Mesa
Job No. 57334S

SAMPLE DATA: Submitted to the laboratory on October 6, 1977 and identified as Sample #5-1

DING ANALYSIS

	PERCENT AS RCVD.	PASSING AS USED

	R - VALUE DATA			
	A	B	C	D
COMPACTOR PRESS - P.S.I.	210	215	215	
MOIST @ COMPACTION - %	13.6	15.3	14.5	
DENSITY - #/CU. FT.	105.2	104.4	104.9	
R-VALUE - STABILOMETER	78	76	76	
EXUD. PRESSURE - P.S.I.	800	140	430	
STAB. THICK - FEET	0.31	0.34	0.34	
EXPAN. PRESS. THICK-FEET	0.13	0.03	0.06	

DESIGN R. VALUE

T. I. (ASSUMED) = 4.5

BY STAB. @ 300 P.S.I. EXUD. = 76

BY EXPANSION PRESSURE = --

AT EQUILIBRIUM = 76

SAND EQUIVALENT =

DURABILITY (COARSE) = ______

DURABILITY (FINE) = ______

LIQUID LIMIT = ______

PLASTIC LIMIT = ______

P. I. = ______

S: (3) Woodward-Clyde Consultants: Attn: Mr. Jim Cavallin

TESTING ENGINEERS - SAN DIEGO
REVIEWED BY

APPENDIX

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