NVO-194




# GEOPRESSURED - GEOTHERMAL DRILLING AND TESTING PLAN

## GENERAL CRUDE OIL - DEPT. OF ENERGY PLEASANT BAYOU NO. 1 WELL, BRAZORIA COUNTY, TEXAS

MAY 1978

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NEVADA OPERATIONS OFFICE
GENERAL CRUDE OIL COMPANY
UNIVERSITY OF TEXAS

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# I. INTRODUCTION

## A. Background

In 1975, the U.S. Energy Research and Development Administration (now a part of the U.S. Department of Energy) initiated a research, development, and demonstration program to stimulate commercial development of the geopressured resources underlying the Gulf Coast region of the United States. Several investigators (see References 1, 2, and 3, Section XI) had recognized the energy potential and suggested that studies be conducted to assess the energy resource.

As part of the Department of Energy (DOE) program, the University of Texas Center for Energy Studies (CES) and Bureau of Economic Geology (BEG) undertook a comprehensive study of the geopressured resources in the Texas Gulf Coast region. (See References 4 and 5, Section XI.) The initial studies centered on the Frio formation, with subsequent investigations to examine the Vicksburg and Wilcox formations. The primary objective of the investigations is to select the optimum resource area for extensive studies (i.e., exploratory drilling, production testing, reservoir analysis, and environmental impact evaluation). The resource area was to be selected utilizing the criteria established for an "ideal" reservoir for commercial geopressured production. That criteria included:

1. Reservoir Volume--at least 3 cubic miles

2. Fluid Temperature-->300$^{o}$ F.

3. Minimum Permeability--20 millidarcys

4. Salinity of Water--<20,000-80,000 ppm

5. Initial Bottom Hole Pressure-->10,000 psia

6. Production Rate--20,000 to 40,000 bbls per day

As a result of the resource assessment studies conducted by the University of Texas, BEG, the Brazoria fairway, located in Brazoria County, Texas (Figure 1), was determined to be an optimum area for additional studies. (See Reference 11, Section XI.)

In order to conduct these studies, DOE executed a contract with General Crude Oil Company (GCO) of Houston, Texas, to conduct the drilling, completion, and testing of one geopressured-geothermal well (i.e., GCO-DOE Pleasant Bayou No. 1) and two disposal wells in Brazoria County, Texas, in cooperation with the University of Texas Center for Energy Studies (UTCES).

B. Program Objectives

The objectives of the well drilling and testing program are to determine the following parameters:

1. Reservoir permeability, porosity, thickness, rock material properties, depth, temperature, and pressure.

2. Reservoir fluid content, specific gravity, resistivity, viscosity, and hydrocarbons in solution.

3. Reservoir fluid production rates, pressure, temperature, production decline, and pressure decline.

4. Geopressured well and surface equipment design requirements for high-volume production and possible sand production.

5. Specific equipment design for surface operations, hydrocarbons distribution, and effluent disposal.

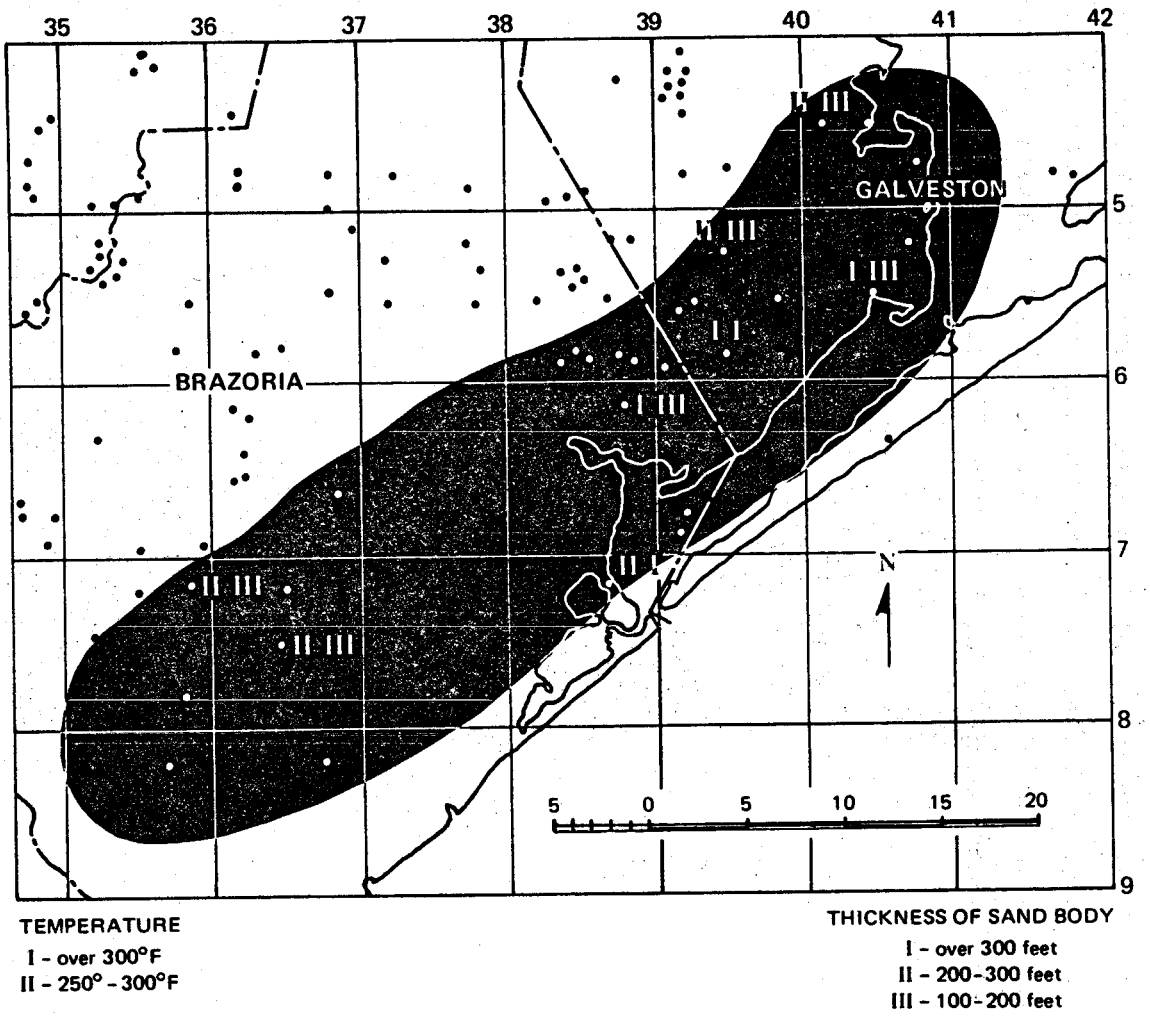



Figure 1. GEOTHERMAL AREA OF INTEREST IN THE UPPER TEXAS GULF COAST - BRAZORIA FAIRWAY.

6. Possibilities of reservoir compaction and/or surface subsidence.

C. Well Location

The test well, GCO-DOE Pleasant Bayou No. 1, will be located on a five-acre test site 40 miles south of Houston, Texas, in Perry and Austin Survey Abstract A-107, Brazoria County, 1,097.4 feet from the north line and 11,744.9 feet from the east line, also located on the east bank of Chocolate Bayou on General Crude Oil Company's Martin Ranch property near Alvin, Texas (see Figures 2, 3, and 4).

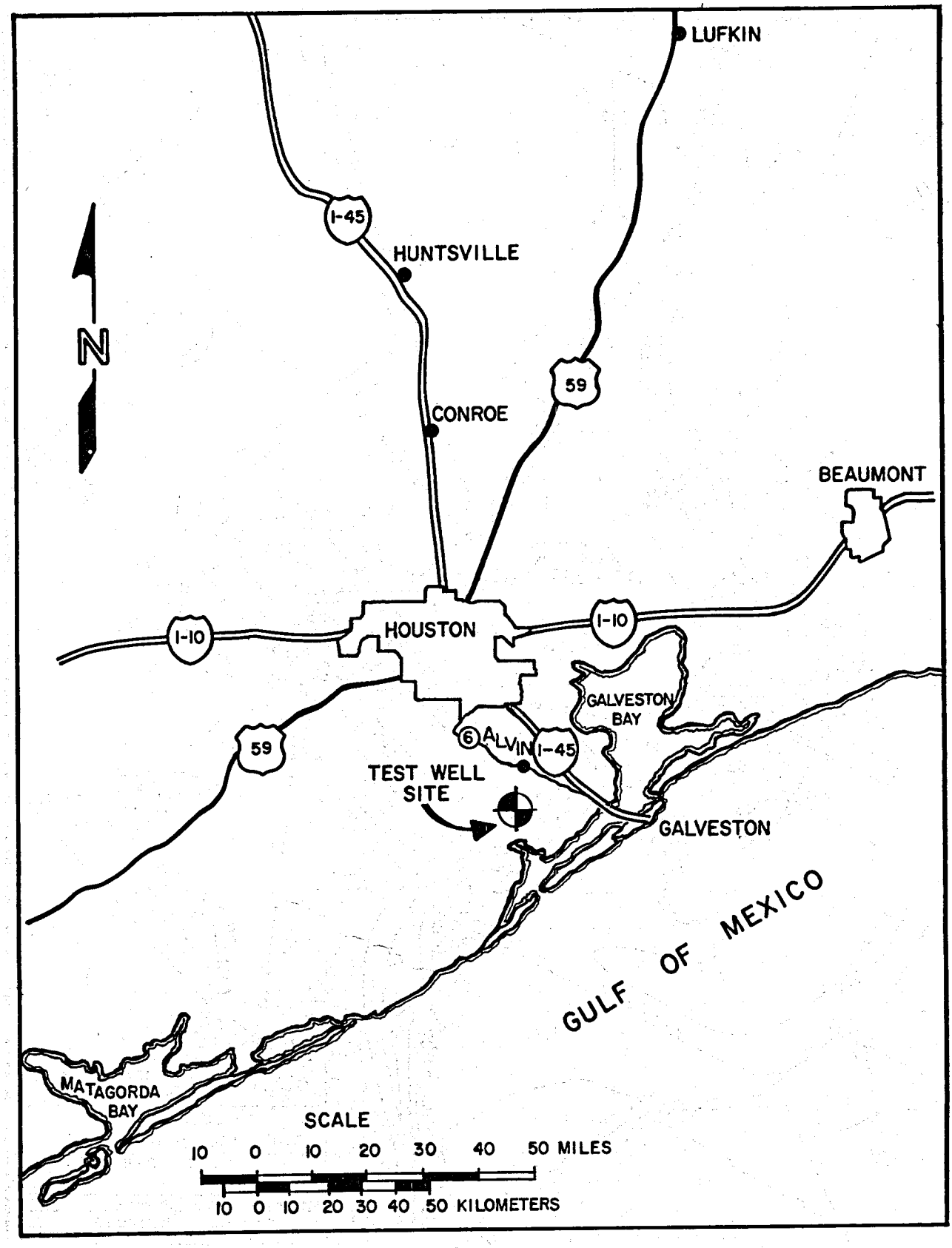



Figure 2. TEXAS GULF COAST AREA SHOWING WELL LOCATION.

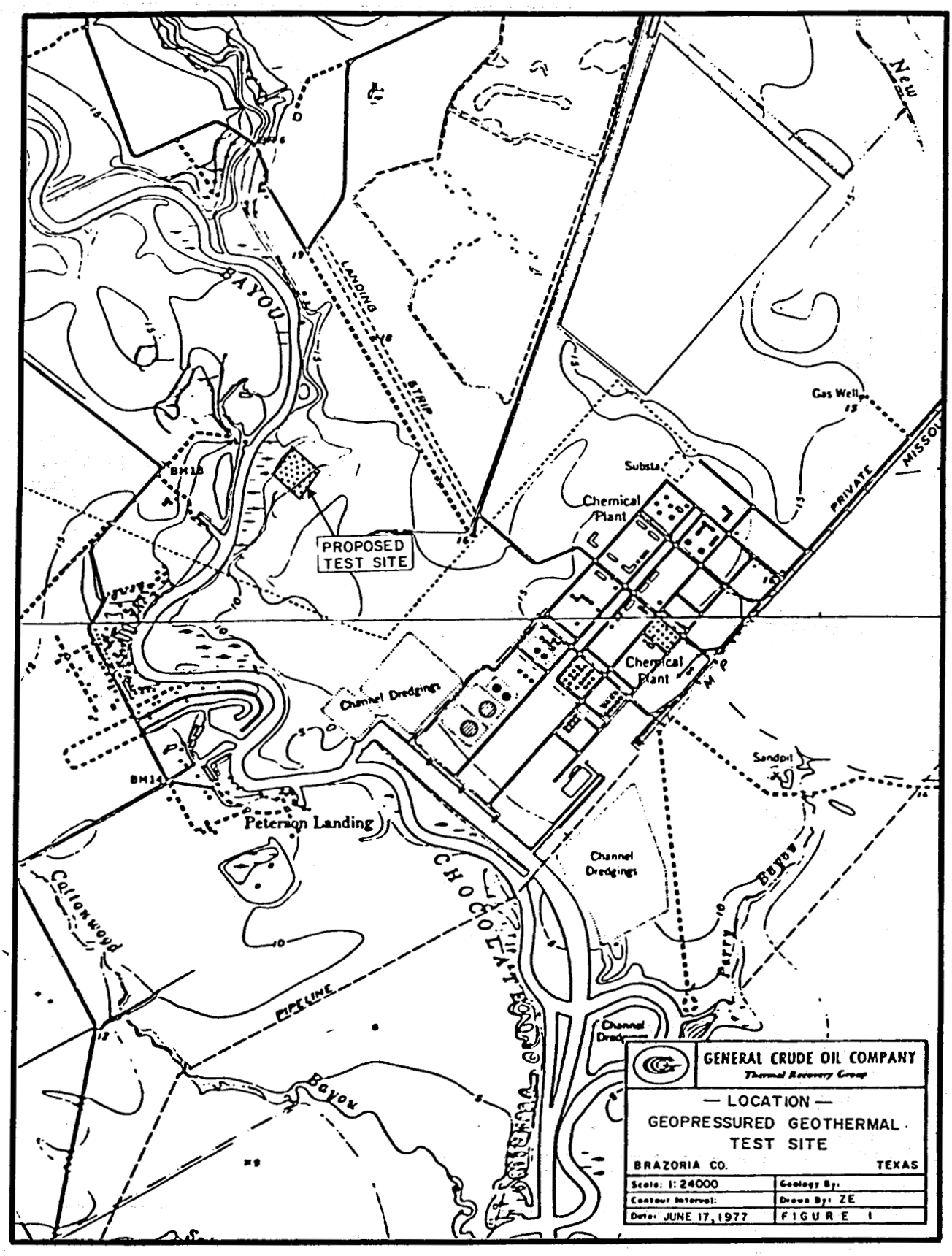
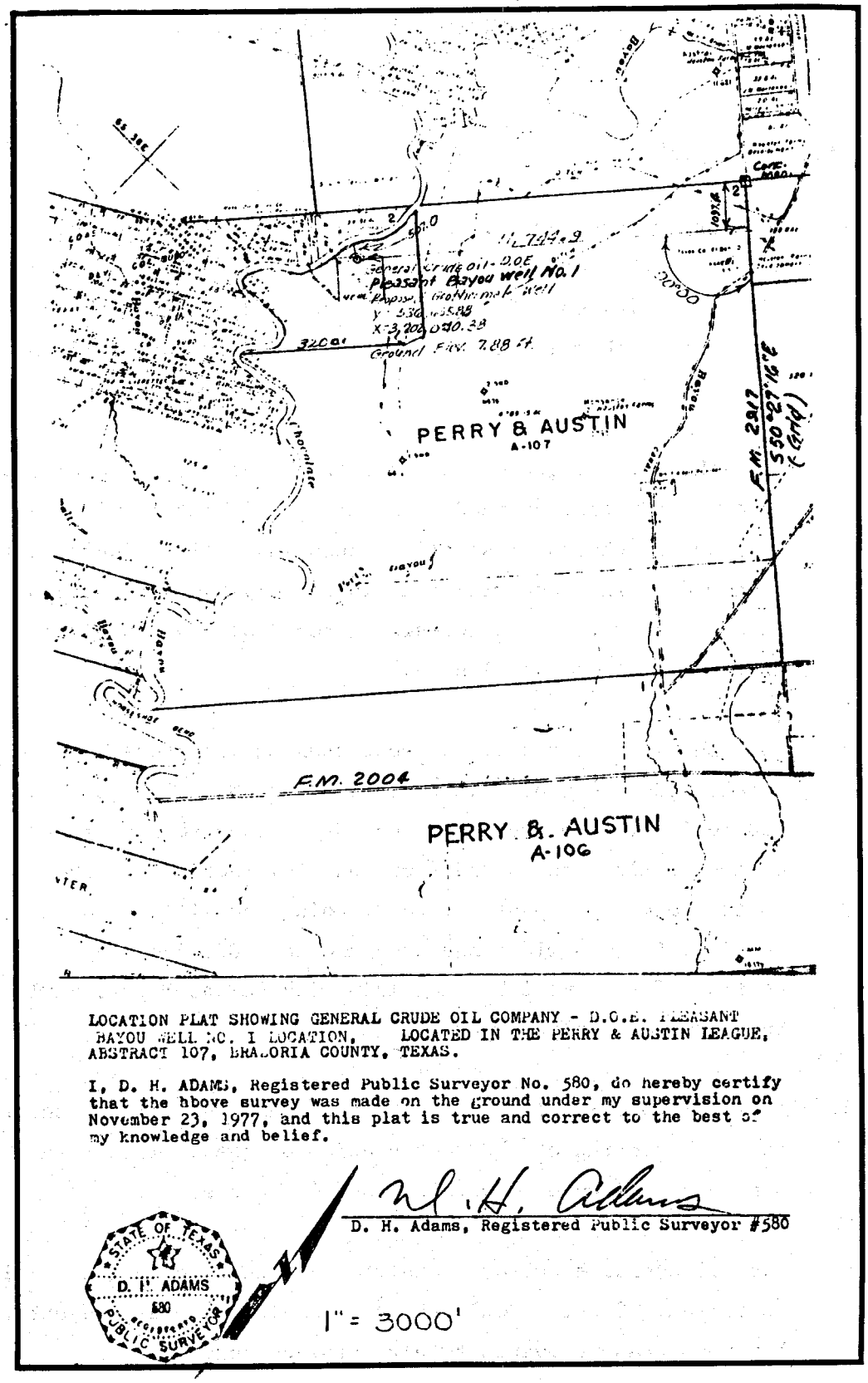



Figure 3 WELL SITE LOCATION.




LOCATION PLAT SHOWING GENERAL CRUDE OIL COMPANY - D.C.E. PLEASANT BAYOU WELL NO. 1 LOCATION, LOCATED IN THE PERRY & AUSTIN LEAGUE, ABSTRACT 107, BRAZORIA COUNTY, TEXAS.

I, D. H. ADAMS, Registered Public Surveyor No. 580, do hereby certify that the above survey was made on the ground under my supervision on November 23, 1977, and this plat is true and correct to the best of my knowledge and belief.

D. H. Adams, Registered Public Surveyor #580

Figure 4 WELL LOCATION PLAT.

## II. GENERALIZED SITE ACTIVITIES

### A. Site Preparation

1. Furnish, spread, grade, and roll crushed limestone over approximately 13,200 feet of road. The crushed limestone will be to a finished thickness of four (4) inches and will be twenty (20) feet wide. This is the entry road from Farm Road 2917 to the property.

2. Furnish, spread, grade, and roll crushed limestone over approximately 2,800 feet of road. The crushed limestone will be to a finished thickness of six (6) inches and will be fourteen (14) feet wide. The road will contain one (1) bypass at the midway point which will be an additional ten (10) feet in width and one hundred (100) feet in length.

3. Furnish, spread, grade, and roll crushed limestone over approximately 2,200 feet of unimproved road which will require shaping and rolling. The crushed limestone will be to a finished thickness of twelve (12) inches and fourteen (14) feet wide. The road will contain one (1) bypass at the midpoint and will be an additional ten (10) feet in width and one hundred (100) feet long. This section of road will be underlain with DuPont Typar, Style 3401, Spun, Bonded, Polypropylene.

4. A wide turn suitable for trucks and trailers will be constructed at the beginning of the last section of road. This turn will be completed and covered with crushed limestone.

5. Two (2) concrete culverts, thirty (30) feet in length, will be installed. Concrete culverts are in place at the present time; however, these culverts require replacement.

6. Five cattle guards twenty (20) feet long by eight (8) feet wide will be fabricated and installed. The cattle guards will be constructed of 5 1/2-inch casing and 2 7/8-inch tubing. When the cattle guards are installed, the fences will be tightened and securely fastened to the cattle guards. A wire gate will be placed at one side of each cattle guard, as required.

7. The turnaround (board drilling pad) will be constructed of rough finish, new boards, three (3) ply with the bottom layer solid, and the foundation beneath the substructure will be four (4) ply solid. The entire turnaround will be underlain with DuPont Typar, Type 3401, Spun Bonded Polypropylene. The turnaround will be approximately 225 feet by 150 feet and the space beneath the substructure will be approximately 65 feet by 45 feet.

8. A dirt levee will be placed around the entire drilling site area to prevent any water runoff from the rig operations, and to prevent any flooding to the location from inclement rains, drainage, etc. The dirt levee will be constructed by removing earth from the inside of the levee. The levee will be approximately 5 feet in height from the ground level with a berm of 1 foot and a base of 5 feet.

9. A reserve pit measuring approximately 200 feet by 200 feet by 8 feet (capacity of approximately 57,000 bbls) will be constructed by removing the earth from the inside of the enclosure. A "ducks nest" measuring approximately 30 feet by 30 feet will be constructed within the confines of the reserve pit.

10. See Figure 5, Drill Site Layout.

B. Trailers

One on-site office trailer will be provided for DOE and University of Texas personnel. Other trailers on site provided by their respective

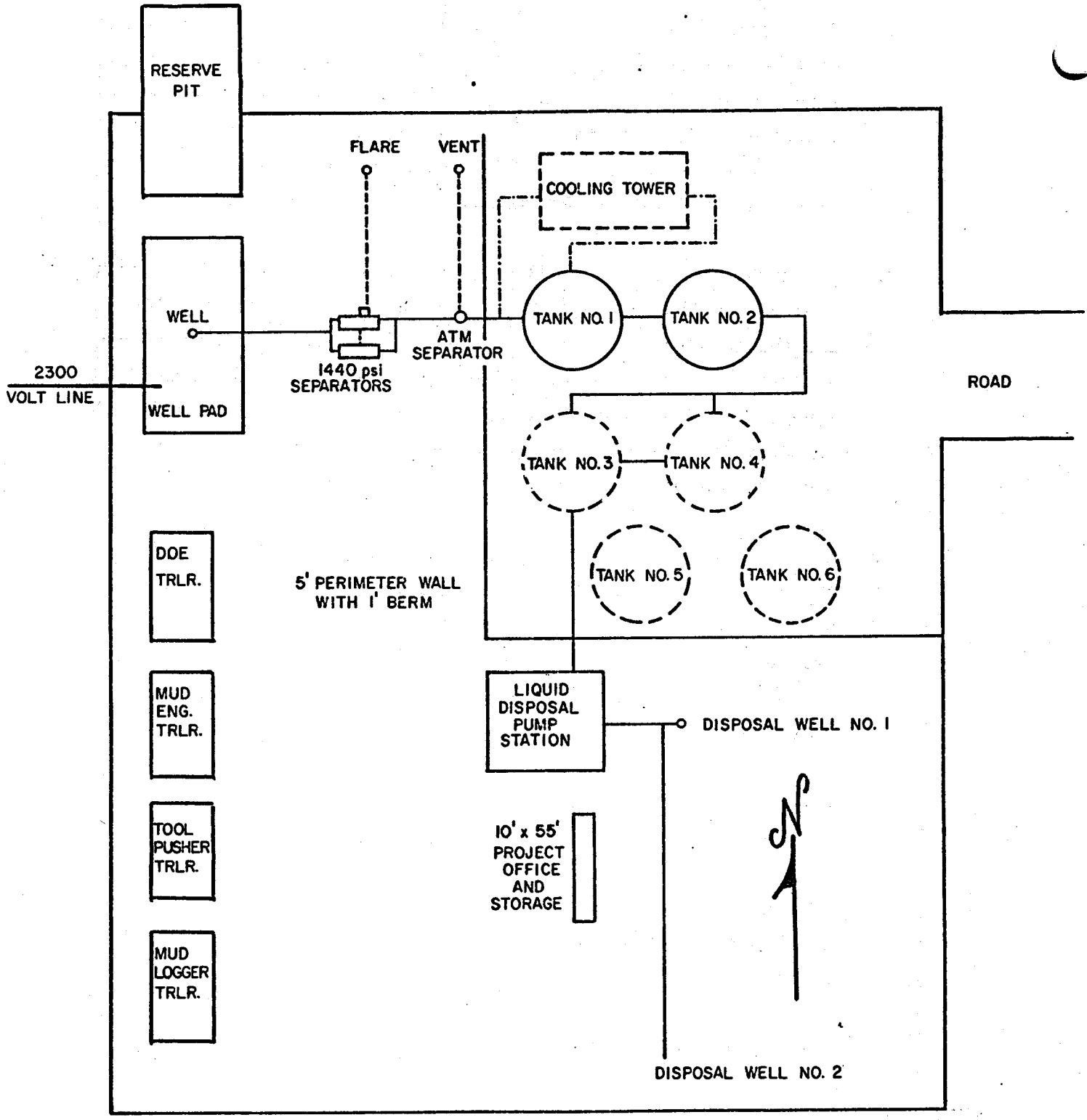



Figure 5. DRILL SITE LAYOUT

firms will be (1) the tool pusher's trailer, (2) the mud logger's trailer, and (3) the mud engineer's trailer.

C. Communications

Two telephone lines, if possible, with additional extension telephones in the DOE office trailer will be provided.

D. Power

The well location will be serviced by a 2,300 volt line. A pole and transformer will be at the well site for electrical power when needed.

E. Drilling Rig Engines

Drill rig engines will be placed on the northeast side of the rig substructure to mitigate noise.

F. Site Cleanup and Restoration

At the completion of the project, all mud pits, both steel and earthen, will be emptied by vacuum truck, and all reusable drilling fluid will be sold. The board mat will be removed and the boards returned to the lessor. After this work is accomplished, earthworking machines will move in and level the reserve and shale pit areas, smooth and level the well site which was covered by the mat, and if operations are to continue, the area will be covered with crushed limestone for a working pad. If the project is to be abandoned completely, the well may be turned over to the operator (GCO) or plugged and abandoned in compliance with state requirements. The entire area of the well site will be smoothly finished and the surface returned to its original appearance. The roads and cattle guards will remain in place. All water disposal drill sites may be turned over to GCO and restored in a like manner.

G. Water Supply

A water supply well for the drilling operation will be drilled at the east edge of the turnaround to a depth of about 400 feet. This well is expected to produce at a rate of about 400 bbls per hour.

# III. OCCUPATIONAL HEALTH AND SAFETY

## A. General

All drilling operations and other site activities will be conducted in accordance with standards of the Occupational Safety and Health Act of 1970 (OSHA).

All participating organizations are responsible for the health and safety of their own personnel and for conducting all activities in accordance with procedures that assure:

1. A safe and healthful environment for the employees.

2. Control and minimization of hazards to the public and to personnel of other participants.

3. Minimization of the accidental damage or loss of equipment, materials, and property.

## B. Site Access

Because of the hazardous nature of geopressure-geothermal well drilling and testing operations, GCO will control access to the test site and will arrange all visits of nonproject personnel.

## C. Fire Protection

Hand-operated fire extinguishers for the drill rig and other surface equipment will be provided. Extinguishers will be available for control of Class A, B, and C fires.

D. Industrial Hygiene

Potable water and chemical or standard toilets will be provided at all areas where personnel are stationed on a full-time basis. The chemical toilets will be serviced on a regular basis. Solid wastes will be disposed of appropriately.

E. Safety Hazards

1. Hydrogen Sulfide

None expected. Normal precautions will be taken by placing $H_2S$ detectors in the drilling fluid pit areas and monitoring same with the mud logging unit.

2. Blowouts

a. Refer to Section IV.

b. Should severe "well kick" develop, the Hydril will be closed and the choke line opened. Circulation will continue while slowly increasing the weight of the drilling fluid. After sufficient weight material (Barite) has been added, the Hydril will be opened. Circulation will continue for a length of time necessary to completely stabilize the mud at the new weight. The pump will be shut down and the well observed. If the drilling fluid is stable, normal operations will be continued.

During the course of the well killing procedure with the Hydril closed, the drill pipe is periodically moved to lessen the chance for the drill pipe to become stuck in the hole. Should the Hydril fail, the upper preventer is closed and circulation continues, but the drill pipe is no longer moved.

# IV. DRILLING OPERATIONS

## A. Disposal Wells

### 1. General

Two disposal well sites will be prepared, as described in Section II.A, prior to moving in the drill rig. No cellar will be excavated and no conductor pipe will be run.

A 14 3/4-inch hole will be drilled with mud to a depth of approximately 1,300 feet (see Figure 6) and 10 3/4-inch surface pipe will be set and cemented to the surface. A 9 7/8-inch hole will then be drilled from the bottom of the 10 3/4-inch surface casing to a depth of approximately 7,000 feet, or until a suitable injection zone is located, as determined by logging. The well will then be completed by setting and cementing 7-inch casing from surface to T.D., perforating, and installing 4 1/2-inch tubing to injection depth.

After completion of the well, injection will be conducted at maximum flow rates and at 1,000 psi utilizing separator pressure or 1,995 psi using pump pressure.

### 2. Estimated Formation Tops

All drilling, casing, and any other depth measurements will be references to the Kelly bushing (KB). Logging and formation tops will be referenced to KB.

| Formation | Depth (Ft.) |
|---|---|
| Base of Miocene | 7,500 ± |

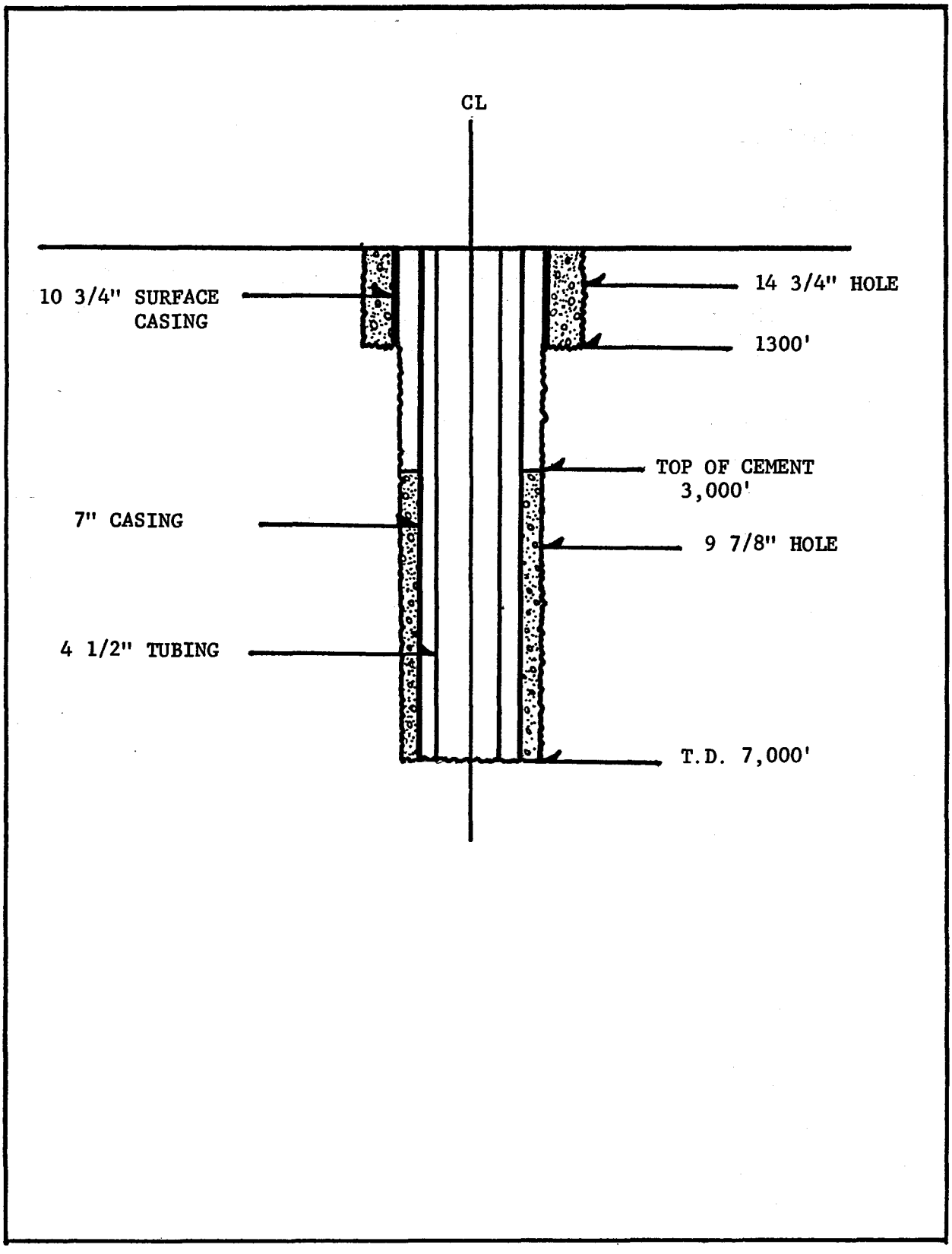



Figure 6 DISPOSAL WELL COMPLETION

3. Drilling Procedure for the Water Injection Wells

a. Move in a drilling rig capable of efficient drilling to 8,000 feet and rig up on prepared location.

b. Spud and drill a 14 3/4-inch hole with mud to approximately 1,300 feet. Condition hole and drilling fluid by circulating.

c. Pull out of hole, rig up, and run 10 3/4-inch casing to 1,300 feet. (Casing should be equipped with four standard centralizers spaced appropriately, float collar, and float shoe with tack-welded joints.)

d. Nipple up and test blowout preventers to 1,500 psi and the casing to 1,000 psi. Utilize fresh water when testing the blowout preventers. To test casing, close blowout preventer rams on the drill pipe and apply 1,000 psi pressure through drill pipe.

e. Drill out float collar and float shoe with caution to minimize thread damage or pipe back-off downhole.

f. Drill ahead with mud to approximately 7,000 feet. Record drill torque, drill rate, depth, and penetration rate by utilizing well-maintained geolograph.

g. Condition hole and drilling fluid. Pull out of hole. Obtain suite of electric logs.

h. Where ample sand for disposal is present, go in hole to condition. Pull out of hole laying down drill pipe. Rig up and run 7-inch casing to total depth. The casing is to be equipped with centralizers and scratchers throughout the prospective injection zone spaced at appropriate distances.

A float collar and float shoe will be utilized. When cementing the 7-inch casing, use sufficient cement to cover the bottom 4,000 feet of casing.

i. After allowing sufficient time for the cement to set go in hole with bit and wash to float collar. Displace the drilling fluid with inhibited brine water, close the blowout preventer, test casing to 1,500 psi, and pull out of hole. Lay down bit.

j. Rig up wireline and obtain a cement bond log (CBL), and gamma ray-neutron log of zones of interest. Correlate the gamma ray-neutron log with the induction electrical survey, and perforate injection zone or zones. Go in hole and set permanent-type production packer above injection zones.

k. Pick up and go in hole with 4 1/2-inch, 12.6 pounds per foot, N-80 grade tubing with expansion joint and Atlas-Bradford DSS-HT connections containing corrosion barrier rings. Utilize stabbing guide when tubing is being installed and 20 feet of seal rings. Land tubing in packer, close rams, and apply 1,000 psi pressure to 4 1/2-inch tubing-7-inch casing annulus. Open rams, pick up tubing from packer, and nipple down blowout preventer equipment. Install Christmas tree and nipple up.

l. Install and connect flow line. Commence water injection, recording continuously the rate in barrels per day and the injection pressure at the wellhead.

m. Release rig and move to second injection well site and repeat above program.

## 4. Surface Equipment and Services

### a. Wellhead

The wellhead equipment will consist of a 7-inch x 10 3/4-inch casing head. This equipment will be installed when the 10 3/4-inch casing is run. The blowout preventers will be nippled up on the top of the casing head. When the well has been drilled and it is determined that the casing will be set, the 7-inch casing will be suspended from the 7-inch x 10 3/4-inch casing head by a slip and seal assembly. After the casing has been suspended from the casing head, the casing will be tested by closing the blowout preventer rams and applying pressure to the 7-inch casing. If a leak is apparent, find and squeeze cement. If the casing is satisfactory, install the tubing and nipple up the Christmas tree. The Christmas tree will consist of a tubing head spool with two 2-inch side outlets and one pressure gauge, two 4 1/2-inch masters, a tubing hanger, tubing head adapter, one flanged master valve, and a blind flange at the top (see Figure 7). The flow line will be connected to the well with a long radius bend, smoothly curved pipe to mitigate the friction. Both disposal well wellheads will be similar.

### b. Blowout Prevention Equipment

The rig will be equipped with a ram-type, hydraulic double Shaffer pipe blowout preventer, and one Type GK Hydril. Both pieces of equipment are 3,000 psi test (see Figure 8).

### c. Drill Rig

The drilling rig to be used will be a Cardwell Hevi-Duty rig equipped with two WAK Waukesha engines, one Gardner-Denver PZ7 pump powered by a Cat D-379 TA, and one Emsco D-300 powered by a Cat D-375, or the equivalent.

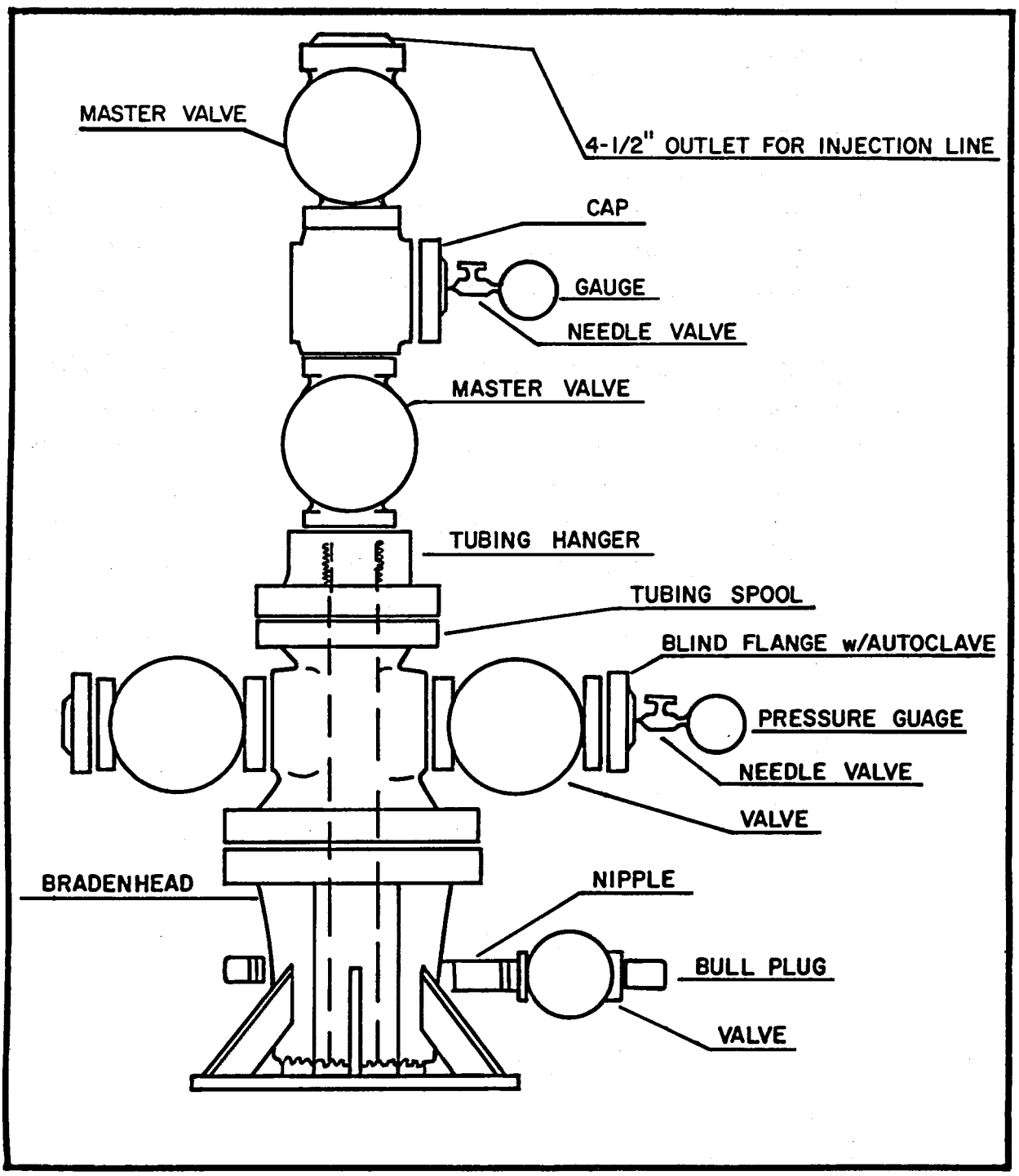



Figure 7. DISPOSAL WELL — WELLHEAD

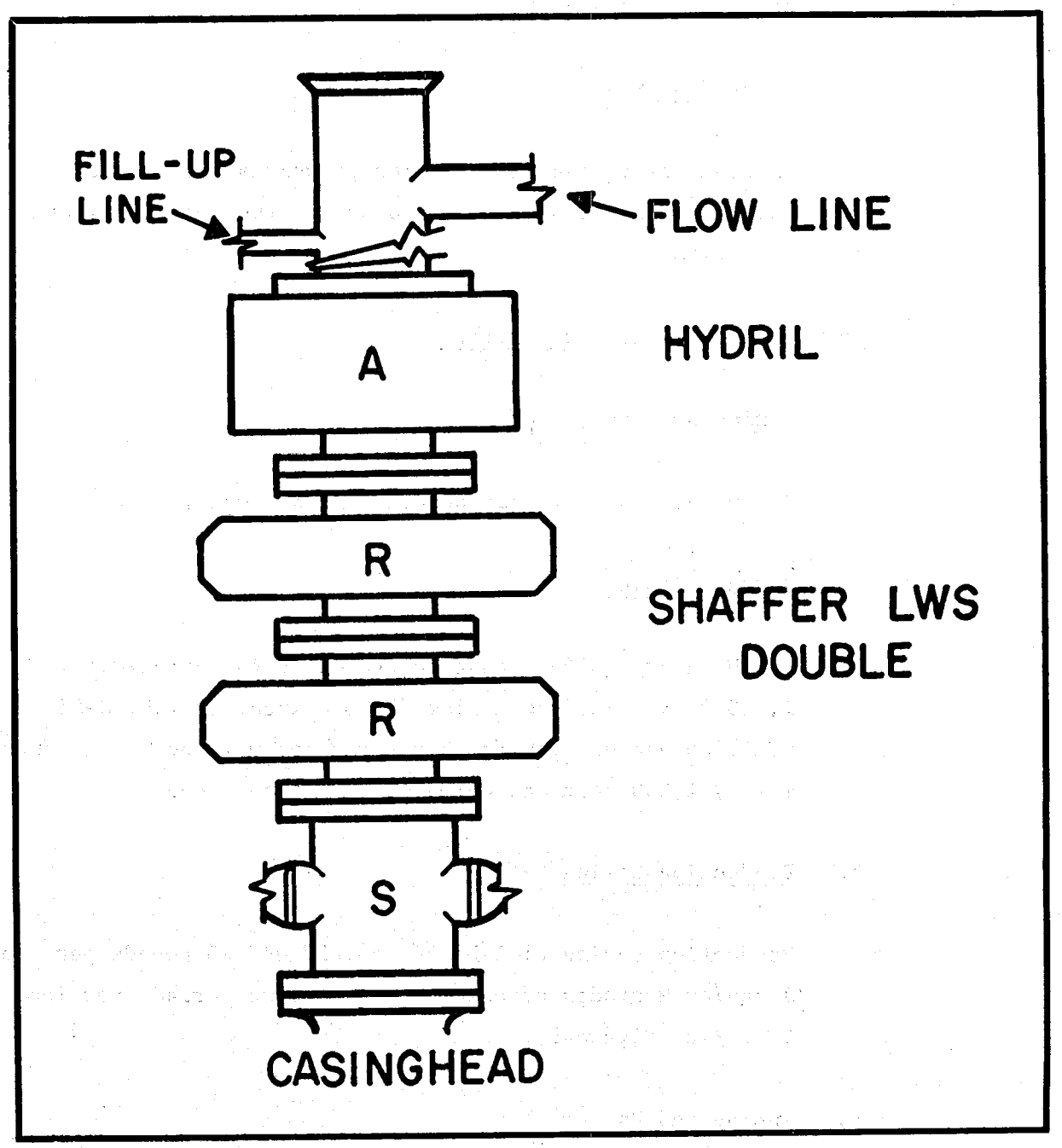



Figure 8. DISPOSAL WELL BLOWOUT PREVENTOR.

d. Drilling Recording Instrument

The only drilling recording unit to be used while drilling the water disposal wells is a Geolograph, which records the drilling rate and depth.

e. Other Equipment

Instruments to record injection pressures and volumes injected will also be utilized during the entire injection operation.

5. Downhole Equipment and Services

a. Conductor Pipe

Conductor pipe will not be used on this well.

b. Surface Casing

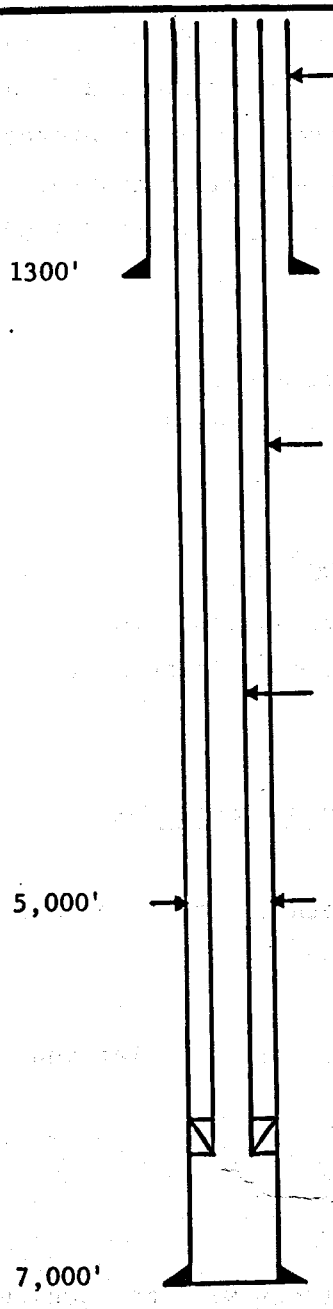
Fresh water aquifers must be protected to approximately 1,200 feet. Surface casing (10 3/4-inch, 405 lb. J-55 ST&C) to protect the fresh water zones will be set at approximately 1,300 feet and cemented to the surface.

c. Production Casing

Production casing will be 7-inch, 23 and 26 pounds per foot, J and/or N grades of casing with 8 round threads per inch ST&C (see Figure 9).

d. Tubing and Packer

Tubing for the injection well will be 4 1/2-inch, 12.6 pounds per foot, N-80 grade casing utilizing Atlas-Bradford DSS-HT connections with corrosion barrier rings, and a




10 3/4" SURFACE CASING, 40.5#,,J-55, ST&C @ 1300'

SAFETY FACTORS:

| COLLAPSE | BURST | TENSION |
|---|---|---|
| 2.78 | 5.03 | 8.5 |

7" PRODUCTION CASING, 23#, J-55, ST&C- 0 – 5,000'

SAFETY FACTORS:

| COLLAPSE | BURST | TENSION |
|---|---|---|
| 1.20 | 2.61 | 1.60 |

4 1/2" PRODUCTION TUBING, 12.6#, N-80, DSS-NTCR-0- 7,000'

SAFETY FACTORS:

| COLLAPSE | BURST | TENSION |
|---|---|---|
| 1.96 | 4.22 | 3.27 |

7" PRODUCTION CASING, 26#, J-55, ST&C 5,000' – 7,000'

SAFETY FACTORS:

| COLLAPSE | BURST | TENSION |
|---|---|---|
| 1.13 | 1.3 | 2.07 |

SURFACE PIPE DESIGN FACTORS BASED ON USING 9.2 lbs. PER GALLON DRILLING FLUID INSIDE FOR BURST AND OUTSIDE FOR COLLAPSE.

PRODUCTION PIPE DESIGN FACTORS BASED ON USING 10.5 lbs. PER GALLON FLUID INSIDE FOR BURST AND OUTSIDE FOR COLLAPSE.

INJECTION TUBING DESIGN FACTORS BASED ON USING 10.5 lbs. PER GALLON FLUID OUTSIDE FOR COLLAPSE AND 2,000 PSI FOR BURST AT THE UNSUPPORTED TOP.

Figure 9 DISPOSAL WELL – CASING DIAGRAM AND SPECIFICATIONS

permanent-type wireline set packer with opening through the packer equal to or larger than the tubing. Surface pipe is set at approximately 1,300 feet in accordance with the Texas Water Quality Board requirements that fresh water be protected by cementing casing below the deepest fresh water aquifer. Fresh water does not occur below an estimated depth of 1,000 feet in this area.

The production string of casing is being set through a massive sand zone which should contain ample sand volume for disposal purposes.

The injected water should not exceed 300° F., and production and surface casings will not be affected at these temperatures. The tubing will contain an expansion joint at the packer.

e. Float and Guide Equipment for the Water Disposal Well

(1) The surface casing will utilize both float collar and float shoe.

(2) Production casing will utilize both float collar and float shoe.

f. Centralizers

(1) Four appropriately spaced centralizers will be used on the surface pipe.

(2) Centralizers will be utilized on the production pipe, the number and placement to be determined in the field.

g. Cementing

(1) Surface Casing--1,326 sacks of cement will be used.

(2) Production Casing--1,000 sacks of cement will be used.

| Cement Type | Water Gals./sx. | Salt #/sx. | Slurry Wt. | Slurry Vol. CF/sx. | Thickening Time-Hrs. Mins. @ 6,000' | Comp. Strength, psi, 110° F.-1,600 psi 24 hrs. | 72 |
|---|---|---|---|---|---|---|---|
| | | | | Surface Casing | | | |
| Light Wate | 10.9 | -- | 12.4 | 1.97 | 4:00 | 225 | 485 |
| Class H | 5.2 | -- | 15.6 | 1.18 | 1:25 | 3,550 | |
| | | | | Production Casing | | | |
| Poz "A" Class H | 5.75 | 4.8 | 14.4 | 1.28 | 3:00 | 750 | 1,790 |
| Class H | 5.2 | 7.8 | 15.9 | 1.22 | 3:06 | 3,100 | |

h. Other Downhole Equipment

A 4 1/2-inch x 7-inch permanent packer will be used.

i. Pressure Testing

Surface casing will be tested to 1,000 psi and production casing to 1,500 psi.

j. Bit Program

14 3/4-inch rock bits to 1,300 feet and 9 7/8-inch rock bits to 7,000 feet will be used.

k. Mud Program

| Depth | Weight | Viscosity | Fluid Loss |
|---|---|---|---|
| 0-1,300' | 8.8 to 9.5 | 35 to 50 | 20 |
| 1,300-7,000' | 9.5 to 10.5 | 4 to 45 | 20 to 3 |

l. Logging Program

All logging depths will be relative to the Kelly Bushing.

(1) Run 2- and 5-inch-spaced open hole logs.

Open hole caliper survey from 7,000 feet to surface. No temperature survey.

(2) Run 2- and 5-inch-spaced cased hole logs.

(3) Run velocity survey.

m. Directional Survey and Deviation Control

Surveys will be run each 500 feet with a maximum deviation from vertical of 2 degrees at total depth, and maximum deviation allowed between surveys of 2 degrees.

n. Completion

The disposal wells will be completed by perforating ample sections in the Miocene sand. A packer will be set above

the perforated interval and injection will be accomplished through tubing below the packer.

o. Water Sample Collection and Analysis

As far as possible, water samples will be collected from adjacent producing wells and near the same depth. Compatibility tests will be made between the injected water and the formation water.

p. Injection Tests

Injection tests, as such, will not be conducted. Disposal pressure and volumes will be determined after actual disposal of water begins.

B. Test Well

1. General

The site will be prepared as specified in Section II, prior to moving the drill rig on, which will include construction and installation of supports for the substructure mat.

A 26-inch conductor pipe will be driven to 100 feet. A 24-inch hole will be drilled to approximately 1,300 feet and 20-inch surface casing will be set and cemented to surface. A 17 1/2-inch hole will then be drilled to approximately 8,000 feet, and 13 3/8-inch casing set and cemented from 8,000 feet to approximately 4,800 feet. Using a multiple-stage cementing tool set at 3,000 feet, the 13 3/8-inch casing will be cemented to the surface. A 12 1/4-inch hole will be drilled to 15,000 feet and 9 5/8-inch casing set from T.D. to the surface. The 9 5/8-inch casing will be cemented from T.D. to 11,000 feet. An 8 1/2-inch hole will be drilled to 16,500 feet and 7-inch casing liner set and cemented

from T.D. to 14,800 feet. The well will be completed with 5 1/2-inch production tubing perforated opposite the test zones. (See Figure 10.)

2. Estimated Formation Tops

All drilling, casing, and other depth measurements will be referenced to the Kelly Bushing. Logging and formation tops (which will be identified by palentology) will be referenced to the Kelly Bushing.

| Formation | Depths (ft.) |
|---|---|
| T1 | 9,200 |
| T2 | 9,900 |
| T3 | 10,300 |
| T4 | 11,500 |
| T5 | 12,700 |

3. Drilling Procedure

a. Stake location and file required Railroad Commission forms.

b. Prepare location. Install supports beneath the substructure mat--eight (8) piles minimum.

c. Move in and rig up a drilling rig capable of safely handling 1,000,000 pounds air weight.

d. Drive a 26-inch conductor pipe to 100 feet.

e. Drill a 24-inch hole to approximately 1,300 feet. Set 20-inch casing to 1,300 feet and use sufficient cement to fill the annulus between the casing and the open hole. Be certain that cement returns to the surface of the ground.

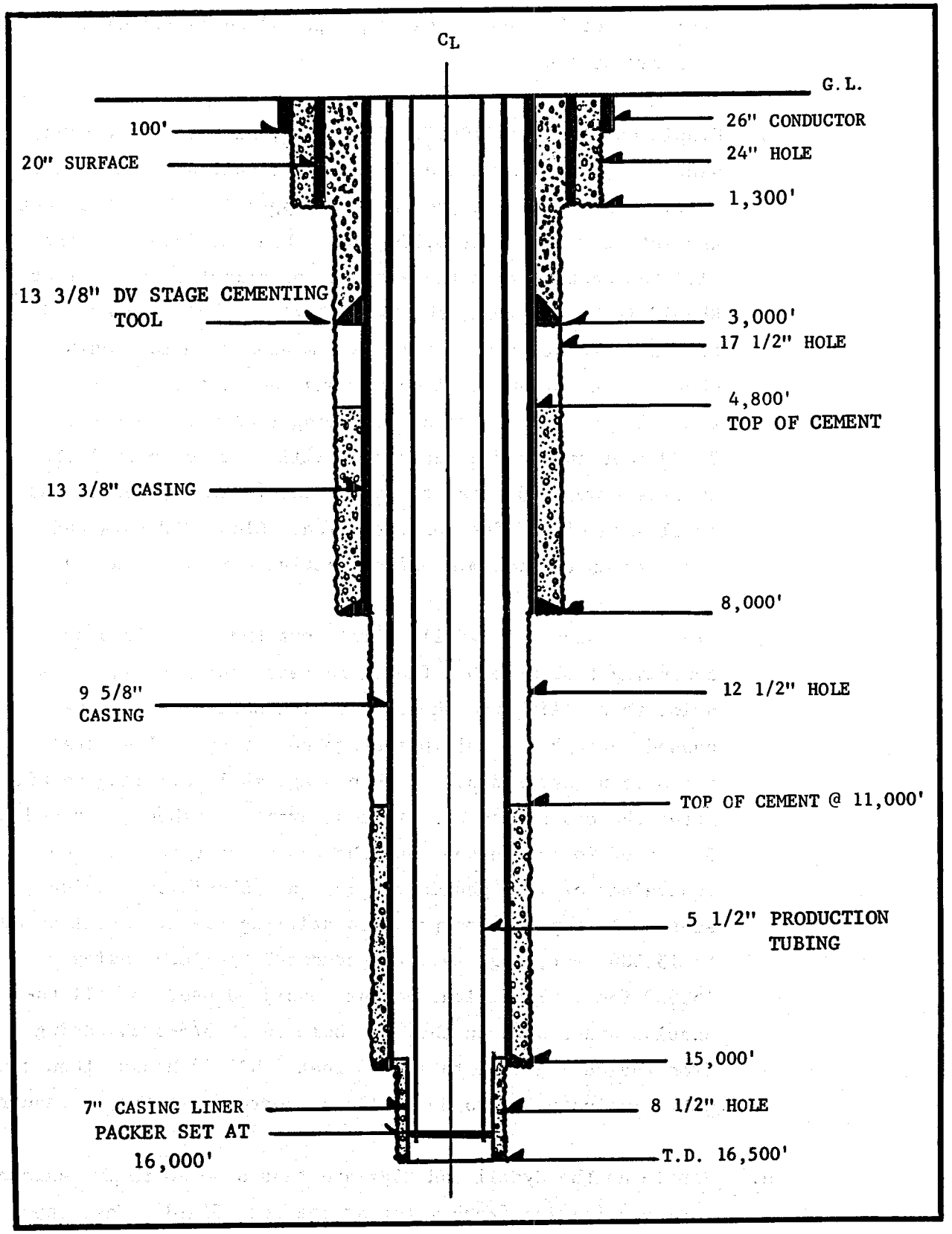



Figure 10. COMPLETED GCO - DOE PLEASANT BAYOU NO. 1 WELL.

(TEST WELL)

A small-diameter pipe may be required to circulate the mud from the top 50 feet of the annulus and to refill with a good cement slurry.

f. Nipple up BOPs and Hydril. Drill out and test the casing seat at 1,300 feet with a 10-pound-per-gallon weight equivalent. Drill a 17 1/2-inch hole to approximately 8,000 feet and set 13 3/8-inch at 8,000 feet. Use sufficient cement to fill the annulus from the shoe to approximately 4,800 feet. Should it be feasible, the DV tool will be eliminated and the intermediate casing will be cemented from the casing shoe to the surface in a continuous operation. If it is not feasible, a multiple-stage cementing tool will be set at 3,000 feet and sufficient cement will be used to fill the annulus from 3,000 feet to the surface. WOC 24 hours, and drill shoe plug 5 feet of formation. Close BOP rams and pressure up to determine if corrective work is required.

g. Nipple up BOPs and Hydril. Drill out the multiple-stage cementing tool at 3,000 feet, and test casing to 1,500 psi prior to drilling the shoe. A casing scraper should be passed through the multiple-stage cementing tool several times to be assured of smooth passage while drilling ahead. After the casing has been tested, drill the shoe joint and 5 feet of formation and test the casing seat to a mud weight equivalent of 16.5 pounds per gallon. Should the casing seat fail, repair same prior to drilling ahead. Drill ahead to 15,000 feet, log, set, and cement 9 5/8-inch casing at 15,000 feet. Sufficient cement should be used to fill the annulus space between the open hole and 9 5/8-inch casing from the casing shoe to 11,000 feet. WOC 12 hours, then run CBL. Evaluate log to determine if corrective work is required.

h. Nipple up the Hydril and BOPs and test same to their maximum rating utilizing fresh water as the test fluid. Test the

9 5/8-inch casing to 2,500 psi. Drill the shoe and 10 feet of formation, and test the casing seat to an 18.5-pound-per-gallon mud weight equivalent. Should the casing seat fail, repair same by squeeze cementing prior to drilling ahead. Drill an 8 1/2-inch hole to 16,500 feet and conduct electrical log suite and velocity surveys. If warranted, set a 7-inch, Spiraline casing liner from 14,800 feet to 16,500 feet and use sufficient cement to fill the annular space between the open hole and the 7-inch liner to a height of 14,800 feet. This is the top of the liner. WOC sufficient time, then run CBL and evaluate for adequacy of cement job.

i. If cement job is satisfactory, run in the hole with a bit and clean out to the top of the liner and test same. Should the liner top fail to hold pressure, squeeze the top with cement, redress, and retest. When the liner top has been repaired, go in the hole with a bit and clean out to the shoe joint. Circulate hole and condition the mud for a packer fluid. Test casing and pull out of the hole. Conduct the desired electrical surveys.

j. Run in the hole with a 7-inch x 5 1/2-inch hydraulically set packer on 5 1/2-inch tubing. Set the packer at 16,000 feet and nipple up the Christmas tree.

k. Rig up perforating company's equipment and perforate the previously selected zones. Flow the well to clean up.

NOTE: Should cement channeling occur behind the 7-inch liner as shown by Cement Bond Logs, perform all squeeze work prior to completing.

## 4. Surface Equipment and Services

### a. Wellhead

The wellhead will be rated at 15,000 psi working pressure and include dual master valves and one swab valve. The flow line outlet will be a 45-degree tee. The swab valve will be above this tee.

### b. Blowout Prevention Equipment

The blowout preventers will be 10,000 psi working pressure, ram-type, hydraulic-controlled equipment. Dependent on the drilling rig selected, the preventers will be either stacked singles or a double. An annular-type preventer will be above the ram preventers, and it also will be 10,000 psi working pressure (see Figure 11).

### c. Drill Rig

The drilling rig will be a Mid-Continent 914U diesel electric, powered by three (3) 1,000-HP Caterpillar engines with General Electric SCR control package. The derrick will be a Pyramid and will be 148 feet tall and with a 1,250,000-pound rating. The floor is on a 29-foot-high substructure with 41- x 70-foot dimensions. Both of the mud pumps are Gardner-Denver PZ9 (1,350-HP) pump. The rig is equipped with 4 1/2-inch drill pipe and ample drill collars.

### d. Drilling Recording Instruments

Drilling recording instruments consisting of pump stroke counters, continuous mud weight recorders, pit volume totalers, pit level floats, rate of penetration gauges, etc., will be utilized on the drilling rig and by the mud loggers.

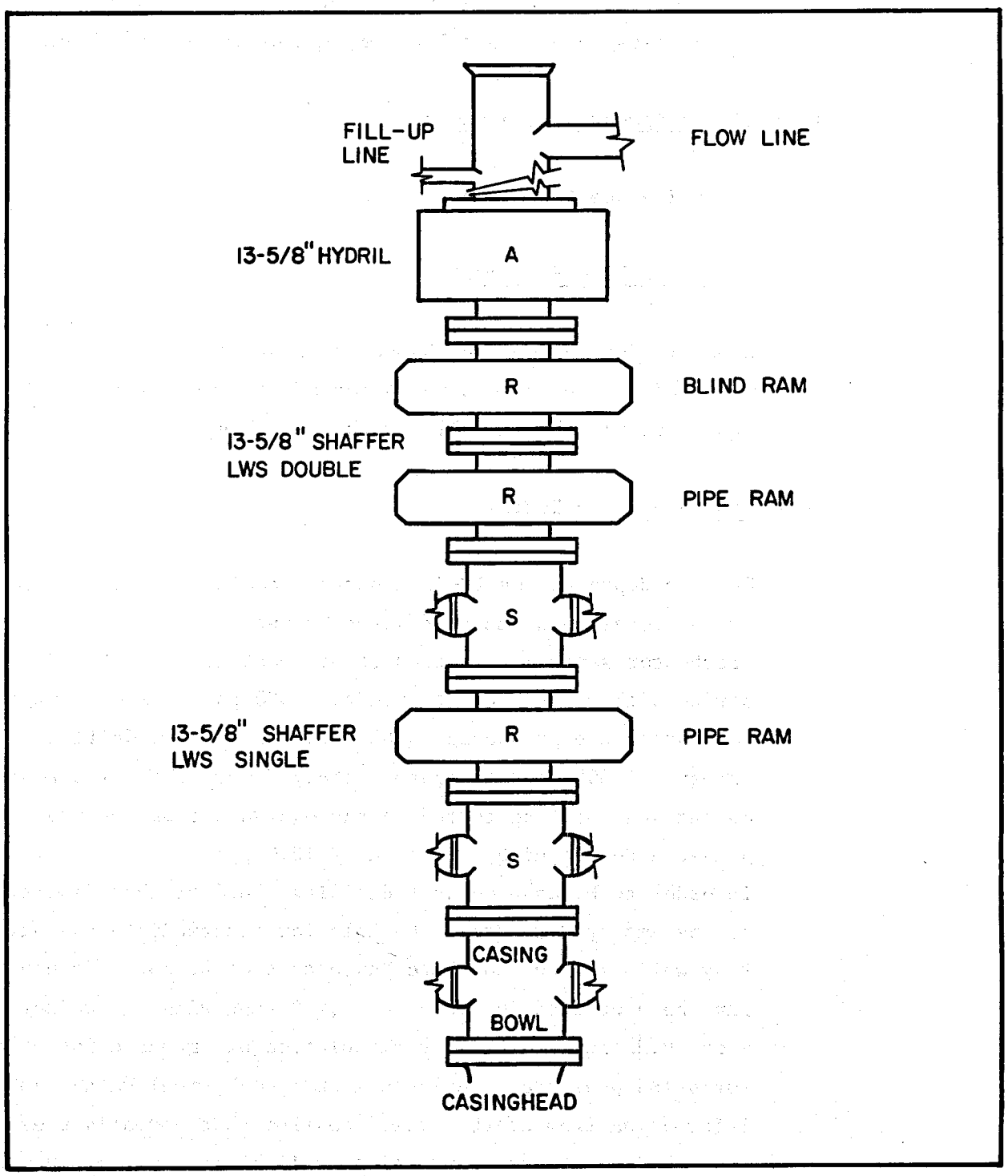



Figure 11. TEST WELL BLOWOUT PREVENTOR GCO-DOE PLEASANT BAYOU NO. 1 WELL.

e. Other Equipment

Desilters, desanders, degassers, shale shakers, and all normal plus some abnormal rig equipment may be utilized.

5. Downhole Equipment and Services

a. through i.--See tabulation.

1. Other Downhole Equipment

A Sperry-Sun Concentric Chamber-type pressure gauge is a means of obtaining continuous bottom-hole pressures. This equipment will be installed with the tubing.

m. Casing Setting Depths

Setting depth of the 20-inch surface casing as established by the Texas Department of Water Resources for protection of freshwater sands is expected to be about 1,300 feet. This string will be pressure tested to 1,000 psi, which is ample to contain the pressures to be encountered when drilling the interval 1,300 feet to approximately 8,000 feet. The 20-inch casing seat will be tested to the equivalent of the hydrostatic pressure developed by a column of 10.0 ppg mud, e.g., 675 psi, in order to be assured that drilling fluid of that density can be employed to drill the hole for intermediate casing. Many wells in the Chocolate Bayou area of Brazoria County have been drilled to depths of 7,500 feet with mud weight of about 9.3 ppg without lost circulation or encountering high formation pressure. Geological and geophysical data, plus information from nearby wells, confirm that normally pressured, i.e., hydropressured, formations will be present to a depth of 7,500 feet in the general area of the proposed well. Fluid pressures in these formations can be contained with

5. Downhole Equipment and Services

Casing Description

| Casing | Size, in. | Depth From, ft. | Depth To, ft. | Weight, lbs./ft. | Grade | Thread | Hole Size, in. |
|---|---|---|---|---|---|---|---|
| a. Conductor | 26 | Surface | 100 | 267 | Hevi-Wall | Drive | Driven |
| b. Surface | 20 | Surface | 900 | 94 | H-40 | ST&C | 24 |
| | | 900 | 1,300 | 106.5 | K-55 | ST&C | |
| c. Intermediate | 13 3/8 | Surface | 300 | 72 | N-80 | Buttress | 17 1/2 |
| | 13 3/8 | 300 | 4,250 | 72 | N-80 | ST&C | 17 1/2 |
| | 13 3/8 | 4,250 | 8,000 | 72 | S-95 | ST&C | 17 1/2 |
| d. Protection | 9 5/8 | Surface | 1,950 | 53.5 | S-95 | Buttress | 12 1/4 |
| | 9 5/8 | 1,950 | 5,900 | 47.0 | S-95 | Buttress | 12 1/4 |
| | 9 5/8 | 5,900 | 8,100 | 53.5 | S-95 | LT&C | 12 1/4 |
| | 9 3/4 | 8,100 | 10,100 | 59.2 | S-105 | LT&C | 12 1/4 |
| | 9 7/8 | 10,100 | 15,000 | 62.8 | S-105 | LT&C | 12 1/4 |
| e. Liner | 7 | 14,800 | 16,500 | 38.0 | P-110 | FL-4S | 8 1/2 |
| f. Tubing | 5 1/2 | Surface | 1,000 | 23.0 | P-110 | Buttress | Csg. |
| | | 1,000 | 8,400 | 23.0 | P-110 | LT&C | Csg. |
| | | 8,400 | 16,500 | 23.0 | P-110 | SFJ | Csg. |

| g. Float Equipment | Size, in. | Casing Design Factors: Casing | Collapse | Tension | Burst | Scratchers |
|---|---|---|---|---|---|---|
| Drive Shoe | 26 | Conductor | --- | --- | --- | --- |
| Float Shoe | 20 | Surface | 1.14 | 5.49 | 2.78 | --- |
| Float Collar | 20 | Surface | 1.40 | 45.07 | 4.38 | --- |
| Float Shoe | 13 3/8 | Intermediate | 14.60 | 2.84 | 1.30 | Yes |
| Float Collar | 13 3/8 | Intermediate | 1.14 | 1.81 | 1.30 | --- |
| DV Tool | 13 3/8 | Intermediate | 0.83 | 4.17 | 1.54 | --- |
| Float Shoe | 9 5/8 | Protection | 3.97 | 1.80 | 1.81 | Yes |
| Float Collar | 9 5/8 | Protection | 1.13 | 1.80 | 1.45 | --- |
| Float Collar | 9 5/8 | Protection | 1.13 | 2.27 | 1.61 | --- |
| Float Collar | 9 5/8 | Protection | 1.13 | 3.04 | 1.68 | --- |
| Float Collar | 9 5/8 | Protection | 0.86 | 3.92 | 1.60 | --- |
| Liner Eq't. | 7 | Liner | 0.95 | 16.83 | 0.80 | No |
| None | 5 1/2 | TBG | 10.01 | 1.92 | 1.08 | No |
| None | 5 1/2 | TBG | 1.53 | 1.80 | 1.00 | |
| None | 5 1/2 | TBG | 0.92 | 2.76 | 0.92 | |

h. Centralizers

| Casing | Size | Centralizers |
|---|---|---|
| Conductor | 26 | No |
| Surface | 20 | Yes |
| Intermediate | 13 3/8 | Yes |
| Protection | 9 5/8 | Yes |
| Liner | 7 | No |
| Tubing | 5 1/2 | No |

i. Liner will be suspended using hydraulic hanger and will be equipped with a tie-back.

j. Cement

| Casing | Size | No. Sacks | Type | $H_2O$ Per Sack-Gals. | Slurry Wt. lbs./sack | Slurry Vol. $ft^3$/sack | Thickening Time | | Compressive Strength | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Hrs. | Mins. | 24 Hrs. | 72 Hrs. |
| Surface | 20" | 800 | 50-50 Poz | 5.75 | 14.4 | 1.28 | 4 | 0 | 350 | 750 |
| Surface | 20 | 1005 | Class H | 5.20 | 15.6 | 1.18 | 7 | 5 | 1,300 | --- |
| Intermediate | 13 3/8 | 800 | HOWCO Lt. | 9.9 | 12.7 | 1.84 | 4 | 0 | 235 | 485* |
| Intermediate | 13 3/8 | 1600 | 50-50 Poz | 5.75 | 14.4 | 1.28 | 4 | 0 | 350 | 750* |
| Intermediate | 13 3/8 | 2400 | Class H | 5.2 | 15.6 | 1.18 | 3 | 58 | 4,025 | --- |
| Protection | 9 5/8 | 2500 | Class H Sil. Fl. | 5.4 | 16.4 | 1.40 | 2 | 40 | 10,750 | --- |
| Liner | 7 | 376 | Class H Sil. Fl. | 5.6 | 18.0 | 1.54 | 3 | 19 | 10,000 | --- |

*DV tool at 3000.

k. Pressure Tests

| Casing | Press. Test--psi |
|---|---|
| Surface | 1000 |
| Intermediate | 1500 |
| Protection | 2500 |
| Liner | 2500 |

drilling fluid of 9.0 ppg density. Mud weight of 10.5 ppg can be carried in open hole from 1,300-8,000 feet without trouble; several operators have experienced lost circulation with higher mud weight in that interval.

A hole with a diameter of 17 1/2 inches will be drilled into the transition zone of the geopressured Anahuac shale. Intermediate or protection casing (13 3/8-inch) will be set into the top of this formation at about 8,000 feet. The nearest well, Monsanto Chemical Houston Farms No. 2, 1.4 miles east of the proposed drill site, topped the Anahuac at 7,500-foot depth. Texaco-Ft. Bend Oil Houston Farms No. 2, 1.6 miles northeast, found the Anahuac at 7,400-foot depth. General Crude Oil Persimmon Bayou Tr. 151, Well No. 1, 5 miles east-northeast of the proposed well, reached the Anahuac at 7,300-foot depth; intermediate casing was set at 7,500 feet in that well.

After setting 13 3/8-inch casing at approximately 8,000 feet and drilling out the shoe, the intermediate casing seat will be tested to the equivalent of 16.5 ppg drilling fluid. Although it may not be possible to reach 15,000-foot depth using that mud density without formation fracture, testing of the casing shoe will ensure that the cement behind the 13 3/8-inch will hold that mud weight. From available well information in the area, it appears that the lower portion of the Anahuac shale and geopressured formations to about 15,000 feet will support 15.0 ppg mud without lost circulation due to formation fracture. Note the following wells:

Texaco-Hou. Farms Dev. No. 2 (1.6 miles NE)

16" @ 1,514' using 9.0 ppg mud
10 3/4" @ 7,334' using 10.1 ppg mud

* 7 5/8" @ 12,346' using 14.9 ppg mud
Drld to 15,507' using 17.8 ppg mud

*Equivalent to 14,100 in the proposed well.

General Crude Oil, Persimmon Bayou Tr. 151, No. 1 (5 miles ENE)

16" @ 325'
10 3/4" @ 7,550' using 9.3 ppg mud
Drld to 12,330' using 15.2 ppg mud

Monsanto Chemical, Houston Farms No. 2 (1.4 miles E)

16" @ 1,547'
10 3/4" @ 7,497' using 9.3 ppg mud
Drld to 12,750' using 14.6 ppg mud

The setting depth of the 9 5/8-inch production casing will be determined by the depth to which 12 1/4-inch hole can be drilled without lost circulation. The mud weight required to control formation pressure will be determined by the actual pressures encountered when drilling. From available well data, it is believed 15,000-foot depth can be reached using 16.5 ppg mud weight. If 15,000 feet can be reached with mud weight less than 16.5 ppg, drilling will continue until a 16.5 ppg gradient is reached, then the 9 5/8-inch casing will be set at that depth. If the formations in the geopressured section contain pressures exceeding 16.5 ppg gradient, the 9 5/8-inch casing will be set at less than 15,000 feet. The attached correlation chart between two deep wells in the area (Figure 12) shows the geopressured zones to be encountered below 15,000 feet in the proposed well. If the equivalent section is reached at shallower depth than indicated, final depth of the proposed well will be less than 16,500 feet. The Exxon Skrabanek well reached 15,000 feet with fairly light mud, as follows:

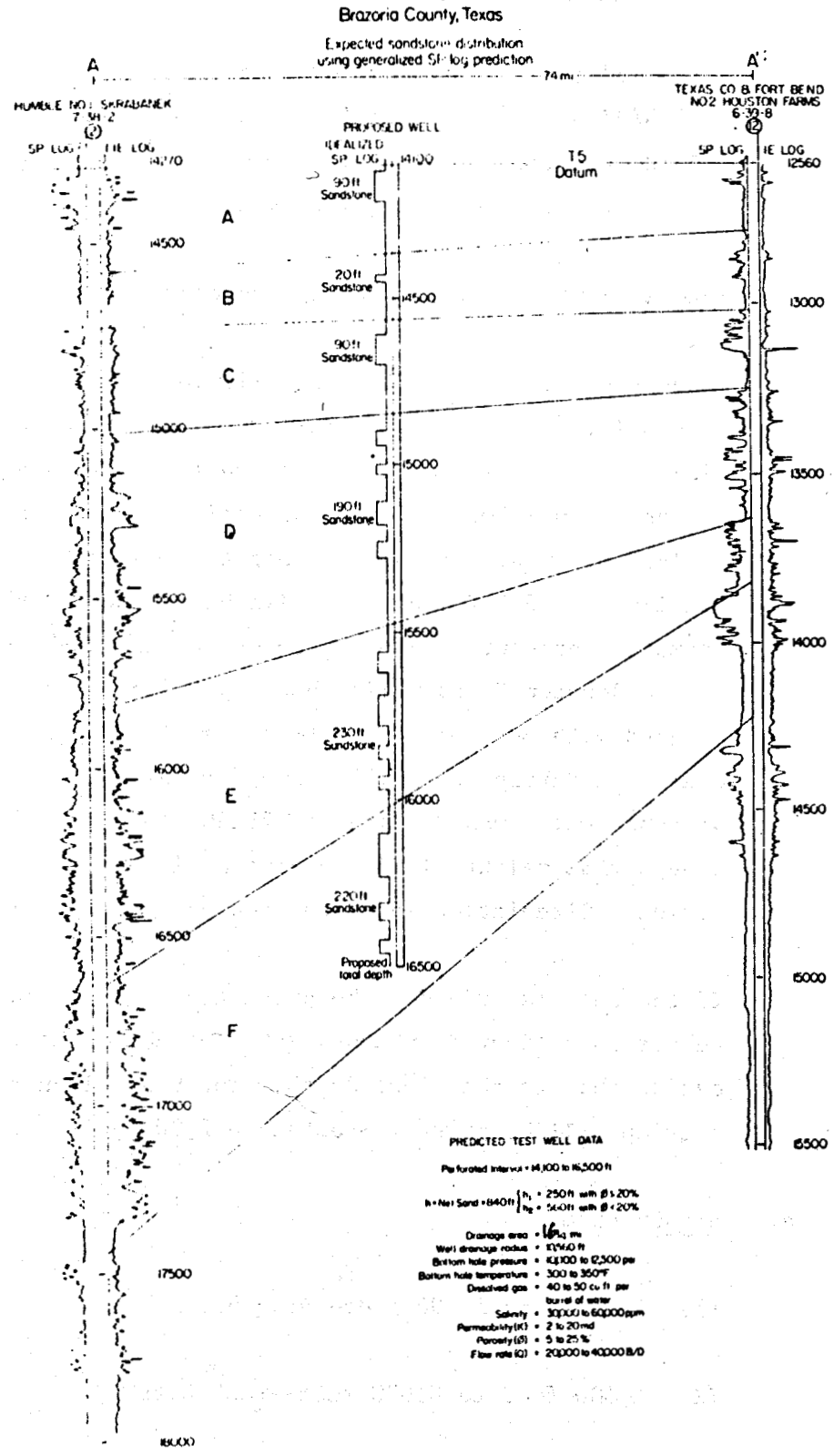



Figure 12. TEST WELL CORRELATION.

Exxon Skrabanek No. 1 (6 miles SW)

13 3/8" @ 9,500' using 10.6 mud
9 5/8" @ 13,797' using 13.9 mud
**Drld to 15,028' using 15.1 mud
Drld to 17,000' using 15.9 mud

**Equivalent to 14,800' in the proposed well.

Production casing (9 5/8-inch) will be set in the interval 14,000-15,000 feet, and 8 1/2-inch hole will be drilled to final depth, estimated to be 16,500 feet. This string will be tested to 2,500 psi, and the casing seat to the equivalent of 18.5 ppg mud. Actual mud weight to be employed while drilling the 8 1/2-inch hole will be as necessary to contain formation pressure. Experience on the Exxon-Skrabanek and Texaco-Houston Farms wells shows that final depth can be reached with mud weight not to exceed 17.8 ppg. General Crude Oil Martin Fee No. 2, some 5 miles southeast of the proposed well, was drilled to 17,140 feet with 17.3 ppg mud, though that weight fluid was lost at 16,588 feet for a short period. Circulation was recovered using 17.2 ppg mud.

If the well is judged to be productive, 7-inch casing will be set as a liner from about 200 feet above the 9 5/8-inch casing shoe to the final depth. The 9 5/8-inch x 7-inch overlap will be pressure-tested to 2,500 psi.

n. Bit Program

(1) Surface to 1,300 feet--drag bit

(2) 1,300 feet to 8,000 feet--rock bits

(3) 8,000 feet to 15,000 feet--rock bits

(4) 15,000 feet to 16,500 feet--rock bits and diamond drill bits

o. Drilling Fluid

| From | To | Type | Weight, ppg | Viscosity | Water Loss |
|---|---|---|---|---|---|
| Surface | 1,300' | Native | 8.8- 9.2 | 35-45 | -- |
| 1,300' | 8,000' | Low Solids | 9.2-10 | 35-45 | 15-20 |
| 8,000' | 15,000' | Dispersed Low Solids | 10 -16.5 | 43-48 | 15- 3 |
| 15,000' | 16,500' | Dispersed Low Solids | 16.5-18.5 | 48-53 | 1- 2 |

p. Logging Program

Open Hole Logging (To Be Coordinated By UTA/CES and BEG):

8,000 feet

Dual Induction Laterolog
Borehole Compensated Sonic With Transit Time Integration
Compensated Neutron Log With Gamma Ray
Formation Density Log Compensated for Borehole Effects
Caliper Log
High-Resolution Thermometer
Sidewall Cores
Radioactive Bullet Placement
Long Spaced Sonic Log Plus Variable Density Log
Directional Survey

15,000 feet — In addition to the above, a High-Resolution Dipmeter will be obtained, plus a Velocity Survey. A Directional Survey will not be required.

16,500 feet — The same suite of logs obtained at 15,000 feet will be run at 16,500 feet plus a Velocity Survey, a computed Saraband log in the zones of interest, and a computed Mechanical Properties log in the zones of interest.

Cased Hole Logs:

Gamma Ray-Neutron
Cement Bond Log With Variable Density/Wave Train
Cased Hole Reservoir Analysis
Spinner Surveys

q. Mud Logging Program (To Be Coordinated by GCO)

A conventional mud logger will be installed at 5,000 feet and employed to a depth of 9,500 feet. A fully manned DATA unit (a sophisticated mud logging unit) will be installed at 9,500 feet and continued to 16,500 feet or total depth.

r. Cuttings and Palentological Analysis (To Be Coordinated By UTA/BEG)

Three sets of sample cuttings will be obtained from approximately 1,300 feet to total depth. They will be analyzed at the site, and washed samples will be packed, labeled, and distributed or stored as required. The University of Texas

will receive two of the sets, and the third set remains at the well site.

s. Coring (To Be Coordinated By UTA/BEG)

Sidewall cores will be obtained, prepared, and preserved from each logging depth. Diamond cores will be obtained where needed, not to exceed a total of 500 feet.

t. Directional Surveys and Deviation Control

The hole will be maintained as straight as possible, within reasonable limits of economics. Permissible deviation at 8,000 feet is 2 degrees, and maximum permissible at 16,500 feet is 5 degrees. The deviation cannot vary in excess of 2 degrees between surveys. Surveys will be obtained each 500 feet of depth or more often if required. A directional survey will be obtained at T.D.

u. Completion

The well will be completed as follows:

A permanent-type packer will be set in the 7-inch liner and above the uppermost zone of interest. The tubing, consisting of 5 1/2-inch, 23-pound-per-foot casing will be installed and spaced out. The blowout preventers will be removed and the Christmas tree connected to the tubing. At this time, the 18.5 ppg drilling fluid will be displaced by circulation with 15.5 ppg treated packer fluid. The fluid will contain an inhibitor to oppose corrosion and a bacteriacide. The 15.5 ppg fluid in the tubing will then be displaced with water containing calcium chloride. When the fluid has been displaced, the packer will be engaged with the tubing and the wellhead or Christmas tree will be nippled up. The zone or zones of

interest will be perforated utilizing shaped charges and at a density of four holes per foot. Only 20 feet of the zone will be perforated on each trip into the well. The perforating will continue as per Table I, page 47, until sufficient zone is perforated to obtain the required objective of 40,000 barrels of water per day. Several zones may be perforated, but since only one packer will be set, this will be a multizone commingled completion.

# V. PRODUCTION TESTING

## A. General

The primary purpose of drilling the Brazoria geopressured-geothermal well is to enable industry and the Government to assess the feasibility and potential of an energy source from a deep hot geopressured brine. To accomplish this experiment will involve the comprehensive, long-term testing of the well both at the surface and in the reservoir.

## B. Site Layout for Testing

Figure 13 is a schematic of the surface well testing equipment. It includes the wellhead, flow lines, samplers, separators, scrubbers, condensors, compressors, and meter runs.

## C. Surface Testing Facilities

The wellhead assembly for the geopressure-geothermal well is shown in Figure 14. This is the normal combination of casing head and intermediate casing head equipment designed to accommodate 15,000 psi well pressures. The flow will pass through the tubing head and master valves before entering a large-radius pipe bend to direct the flow to the high-pressure separator without passing through a 90-degree tee. Each casing annulus will be equipped with a pressure gauge to detect tubing leaks or a breakdown in the completion integrity.

Surface equipment required to reduce the well pressure to atmospheric pressure and flare the gas is also shown in Figure 11. A flow-through liquid sampler will be located near the wellhead to collect high-pressure samples by isolation of the split stream. Continuous pressure and temperature will be recorded near the wellhead. A Willis M3F choke will be used to reduce the flow pressure to 1,000 psi just before entering two high-pressure separators. Gas released from

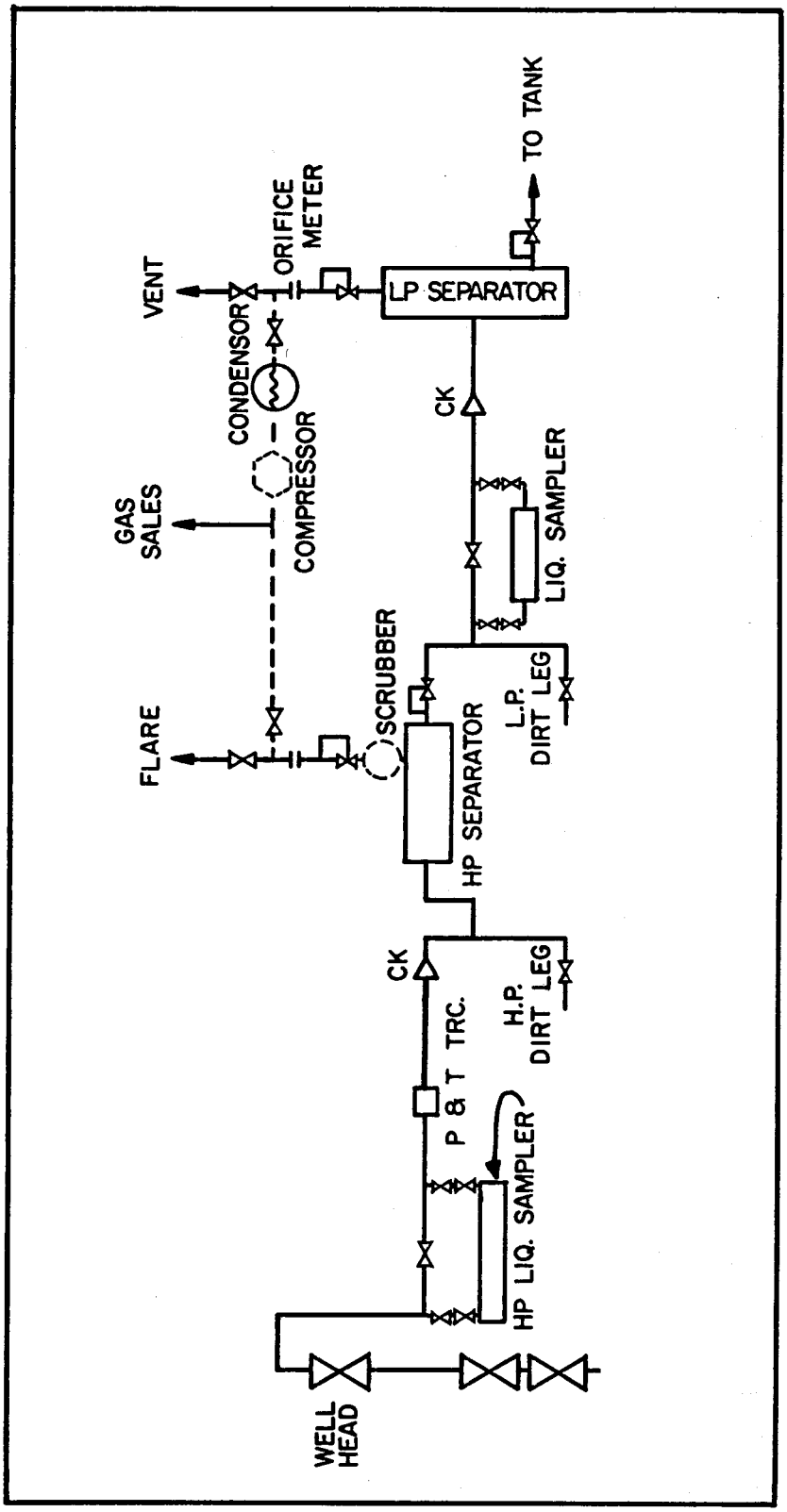



Figure 13. SURFACE TESTING EQUIPMENT.

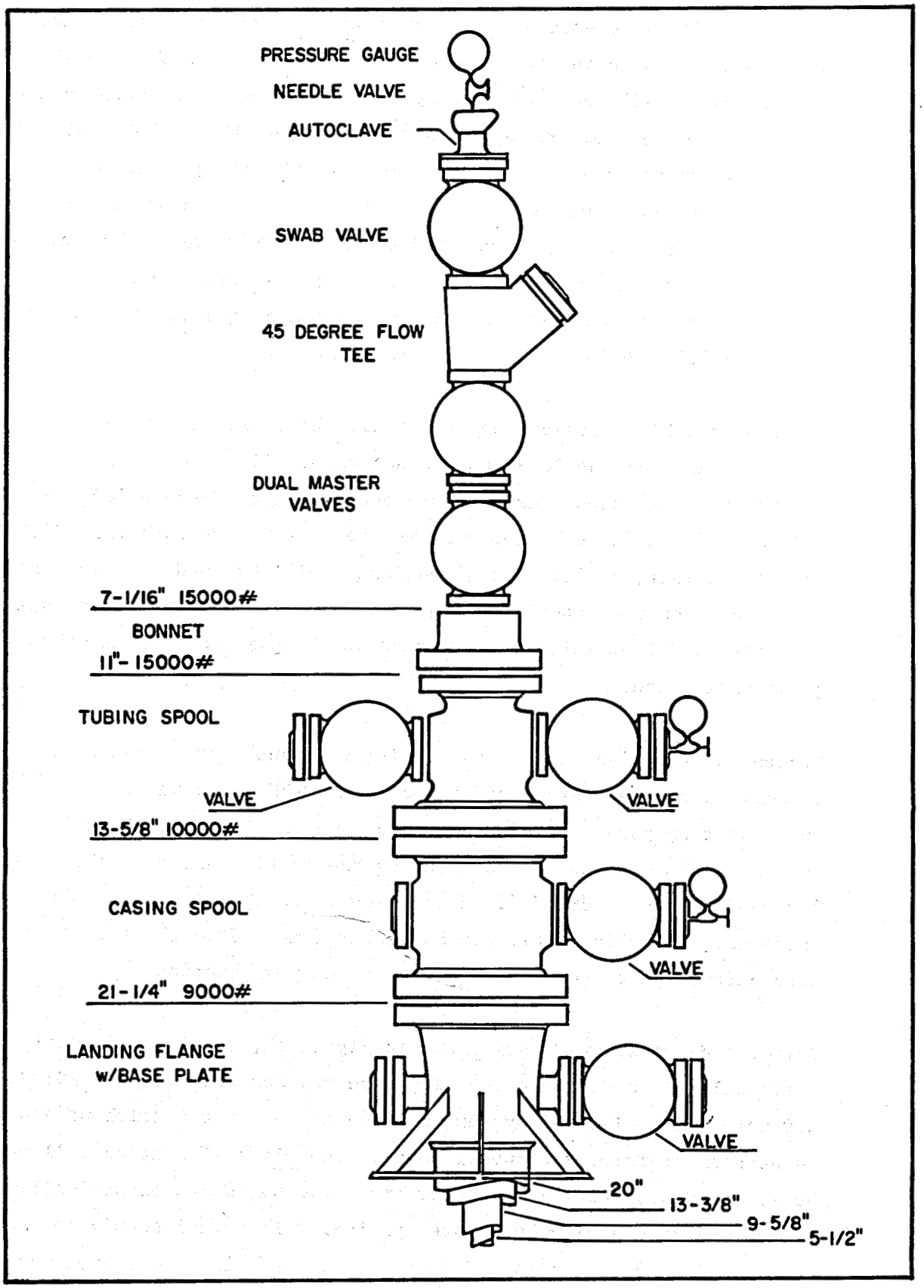



Figure 14. TEST WELL – WELLHEAD GCO-DOE PLEASANT BAYOU NO. 1 WELL

solution will be metered and sold or flared through an orifice meter. Downstream of the high-pressure separators, a second flow-through liquid sampler will be used to compare chemical analysis between the high-pressure and low-pressure lines. A second Willis choke will reduce the stream pressure to approximately 50 psig just before entering a low-pressure separator. Any gas production at this point will be either vented or dehydrated to remove the water and sold. Gas contract negotiations will have to be completed before estimates on gas sales may be obtained. Presently, estimated gas sales will amount to 1.6 MMSCF per day from both separators.

Gas from the high-pressure separator will be cooled to between 100 and 120° F. Gas from the low-pressure separator will be compressed to 800 psi to meet sales line pressure and cooled to between 100 and 120° F. If the gas contains a sulfur content higher than that dictated by the contract, sulfur removal equipment will be used to bring the gas within contract specifications. This additional investment will be determined from initial tests made on the gas recovered from the geothermal brine.

Figure 15 is a plan view of the facility layout showing the separators as well as the tank area used to cool the production before it enters the injection pumps for disposal. The two to six 10,000-barrel holding tanks will be adequate during the initial phase of the project for cooling the produced fluids. However, as the flow rates are increased, a cooling tower may be required to reduce the flow temperature before the disposal stream enters the pump station.

Only two disposal wells are shown in Figure 15, but four disposal wells will be needed when the flow rate reaches the designed 40,000 BPD rate. The disposal system will consist of four Aldrich or Ajax Quintuplex or Triplex disposal pumps. The disposal station will be housed to protect it from weather since the pumps are electrically driven and have a high horsepower rating. Electrical supply to these pumps will be 2,300 volts and each pump motor will draw approximately 100 amps.

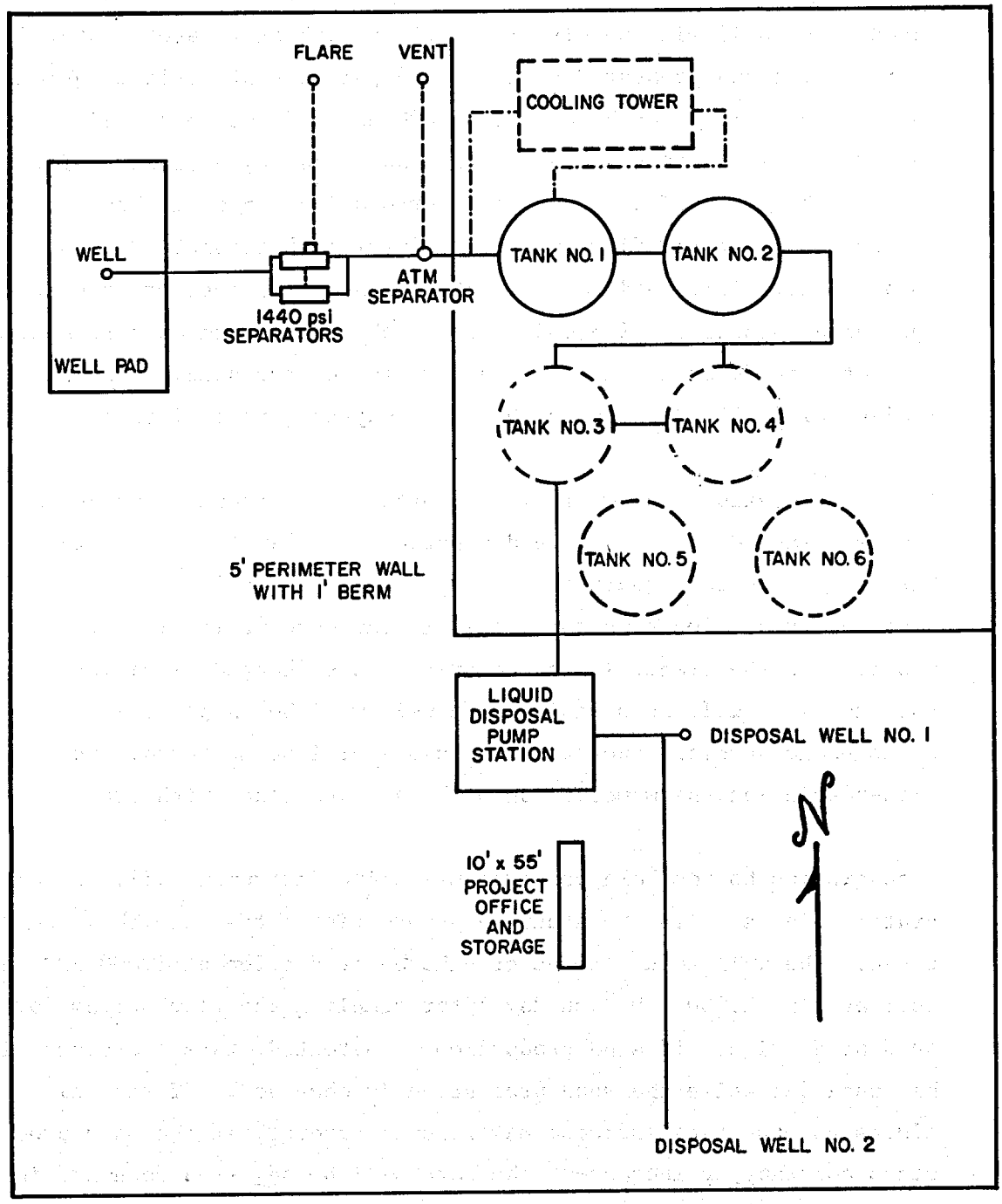



Figure 15. TEST WELL SURFACE FACILITY.

D. Reservoir Testing Procedure

A well test schedule has been formulated as shown in Table I. The initial test will be a static pressure test after the well is perforated. The well will be circulated clean with salt water containing a tracer ion and pressured up to 10,000 psi to test surface equipment. The pressure will then be bled to 5,000 psi and the hole will be logged for perforating depth control and gamma ray activity before running the Hyper II Jet gun. The perforating gun will then be lowered to shoot the first permeable interval between 16,000 and 16,500 feet. Perforation will continue until 125 feet of zone are open or a Kh product of 5,000 md-ft is obtained based on core analysis. The total perforated interval may have to be increased to obtain a minimum of 5,000 md-ft or another zone may have to be located.

After perforation, the well will be brought on stream in steps of 250 BWPD each day over a five-day period to clean the well bore. During this period, quart samples will be taken daily and checked for sand and tracer ion concentration. If sand production is not a problem and the tracer ion concentration has changed significantly, then the well will be shut in. The well will be sampled with a bottom-hole sampler, the static pressure will be measured, and a high-resolution thermometer log will be taken along with other logs.

A continuous bottom-hole pressure measuring instrument will be calibrated to agree with the static pressure test obtained with an Amerada gauge. The well then will be brought on production at 1,000 BPD and increased by 1,000 BPD each day after sampling the flow stream for sand production. If sand production is detected, rate increases will be suspended while the sand production is observed. If the well cleans up, the rate increase may resume; however, if the sand production stays constant or increases, the rate will be adjusted downward in 500-BPD increments until the sand production stops.

Table I

TEST SCHEDULE
GCO-DOE PLEASANT BAYOU NO. 1

| Test Period | Test Duration | Cumulative Test Time at End of Period | Test Rate BPD | Cumulative Fluid Prod. MBbl |
|---|---|---|---|---|
| Initial Static | 3 Days | 3 Days | 0 | 0 |
| Initial Dynamic | | | | |
| Phase 1a | 63 days | 69 days | 0-10,000 | 315 |
| Phase 1b | 40 days | 116 days | 10,000 | 715 |
| Phase 2a | 28 days | 134 days | 10,000-20,000 | 1,135 |
| Phase 2b | 40 days | 174 days | 20,000 | 1,935 |
| Second Static | 3 days | 177 days | 0 | 1,935 |
| Second Dynamic | | | | |
| Phase 1a | 22 days | 199 days | 0-30,000 | 2,346 |
| Phase 1b | 30 days | 229 days | 30,000 | 3,246 |
| Phase 2a | 12 days | 241 days | 30,000-40,000 | 3,626 |
| Phase 2b | 30 days | 271 days | 40,000 | 4,826 |
| Final Static | 3 days | 274 days | 0 | 4,826 |

When a rate has been established with less than 1/2 percent volume sand production at or below 10,000 BPD, the well's producing pressure will be recorded for an indefinite period not to exceed 40 days. The bottom-hole pressure and surface pressure should stabilize and be recorded. The well's productivity index can then be calculated. Resuming step size increases in the well production rate at 2,000-BPD increments each day up to a total rate of 20,000 BPD and checking the flow stream for sand, a second dynamic test period will be run. This test period will also last for 40 days and the productivity index for the zone will be calculated at each rate.

At the end of the second test period, the well will be shut in and the pressure allowed to stabilize while measuring the bottom-hole pressure. A second set of cased hole logs will be run at this time. At this point, it may be desirable to open twice as much permeable sand and test the potential of the combined zones in the same manner. Ultimately, if sand production is not a problem, the well's final flow rate should be 40,000 BPD sustained for a 30-day period to allow stabilization as determined from pressure measurements and calculation of the Productivity Index. At the end of this flow test, the well should be shut in for a second buildup to test static pressure.

Productivity Index (PI) calculations at the 10,000- 20,000- and 40,000-BPD rates are based on the equation:

$$J = \frac{q}{Pws - Pw}$$

Where J is the Productivity Index for a well producing "q" barrels of fluid per day at a stabilized producing pressure Pw. The well's static pressure, Pws, is used as a basis for comparison. If one divides the PI equation by the perforated thickness h, the Specific Productivity Index (SPI) is obtained. The Productivity Index should be constant and the stabilization period short to indicate favorable reservoir conditions. If gas breaks out of solution in the reservoir near the well bore or the sand becomes plugged near the well, the

stabilization period will take several hours or even days and be reflected by a continuous decrease in the PI. If the well bore is being cleaned up as a result of the production, the PI should increase with time. At the temperatures and pressures expected, the PI should remain fairly constant over the test periods. If the reservoir permeability is low and excessive drawdown pressures are required to produce the selected rate, then low well bore pressures will result in gas separation in the sands near the well. This results in a direct drop in PI caused by a decrease in the relative permeability to liquid.

The Productivity Index can be used in the following equation to indicate the average formation permeability adjacent to the well bore:

$$k = 325\ Js\ \mu\beta\ \log \frac{re}{rw}$$

Pressure buildup periods at the end of the dynamic flow test will also be utilized to determine the reservoir permeability. Theory presented by Muskat and Miller, Dyer, and Hutchinson are used to estimate oil and gas well permeabilities. They may also be applied to geopressure-geothermal wells. Ultimately, these tests will indicate several reservoir properties which cannot be obtained from core analysis. These tests can be used to determine the economic viability of the well.

## E. Surface Testing

During the dynamic test on reservoir production, surface samples of the produced fluid will be collected bimonthly and analyzed for the standard API ion analysis as shown in Table II. The static bottom-hole samples will be checked by a laboratory and the API ion analysis in addition to selected heavy metal determination with the spectrograph will be performed. Gas analysis for $CO_2$, $C_1$, $C_2$, and $C_3$ may be run routinely at the test site on a weekly basis. Each month, a gas sample will be submitted to a laboratory for $C_1$-$C_6$, and $CO_2$ and total sulfur. These analyses may be reduced in frequency if they are determined to be consistent and repetitive. Ions and heavy metals that are

Table II

GENERAL CRUDE OIL COMPANY AND DOE
PLEASANT BAYOU NO. 1 WELL

Chemical Test

I. API Ion Analysis

| | | |
|---|---|---|
| Cations | Sodium | Magnesium |
| | Potassium | Barium |
| | Calcium | Iron |
| Anions | Chlorides | Bicarbonates |
| | Sulfates | Hydroxides |
| | Carbonates | |
| Other Tests | pH | Sp. Gr. |
| | T.D.S. | Resistivity |
| | Total Hardness | Conductance |

II. Special Tests

Dissolved Silicate
Viscosity (Surface)
Solids by Millipore Filtration
Viscosity (at Reservoir Conditions)
Compressibility

III. Select Heavy Metal Analysis

| | | |
|---|---|---|
| Copper | Boron | Zinc |
| Mercury | Chrome | Arsenic |
| Lead | Barium | Cadmium |

IV. Gas Analysis

| | |
|---|---|
| Chromatograph | $CO_2$, $N_2$, $C_1$ through $C_5$, $C_6+$ |
| | SpG, BTU (Dry and Wet) |
| Special | Sulfur Total |
| | Sulfur Breakdown (COS, $H_2S$, $CS_2$, $SO_2$) |

not present in the produced fluids will not be included in subsequent tests. Correspondingly, gas components that are not present in the initial test will be dropped from remaining tests.

Scaling is a typical problem with mineral-laden waters from the Frio formation. Barium sulfate creates the scaling problem by precipitating in the well's tubing, flow line, and surface equipment. Regular chemical tests will be made to determine the severity of, and to control the expected scaling problem.

F. Fluid Sampling and Analysis

General Crude Oil Company will obtain all fluid samples from both the subsurface and the surface of the well. All requests for fluid samples by other organizations will be cleared through and approved by GCO.

G. Gas Sampling and Analysis

General Crude Oil Company will obtain all gas samples from the surface and subsurface as required. All requests for gas samples by other organizations will be cleared and approved by GCO. GCO will also provide analysis of gas samples.

H. Reservoir Analysis

Following the well's completion, cased hole logs will be run in the completion fluid, which will be clean salt water or a treated water. The main objectives of the cased hole logs are to:

1. Record initial temperature profiles.

2. Correlate porosities and saturation interpretation between cased hole logs, open hole logs, and core analysis.

3. Locate radioactive tracer bullets with respect to casing collars.

4. Identify and correlate perforation depths.

Following cased hole logging, the selected interval based on log, drilling, and core information will be perforated while the well is pressured to approximately 75 percent of the expected formation pressure. This is, of course, subsequent to complete testing of surface and well equipment for its highest working pressure integrity. After perforation and a five-day cleanup period, a conventional bottom hole (BH) pressure and temperature recording device, fully calibrated, will be run to (1) determine BH static pressure, (2) determine BH temperature, and (3) calibrate the continuous BH pressure recording equipment. BH samples at static conditions and surface samples will be collected and analyzed for chemical composition.

After completion of the initial test, the well will be flowed at varying rates below 10,000 BPD. It is planned to use several test rates and apply a two-rate flow test analysis at each rate change. Throughout the flow period, the productivity index will be determined to keep a daily record in the changes in the well's productivity. After 63 days, a longer 40-day flow period will be utilized to stabilize well flow condition just prior to a buildup test. Typical Horner buildup analysis and multirate flow theory will be utilized to determine the reservoir's flow behavior and average reservoir properties in the drawdown region. A complete set of cased hole logs will be rerun following the static test period just prior to continuation of the dynamic rate tests.

After the first phase tests up to 10,000 barrels, a second phase is planned which will take the well's flow rate up to 20,000 BPD. At any time, these flow tests may be interrupted due to:

1. Sand production.

2. Indications of formation damage.

3. Indications of interference with offsetting fields.

4. Indications of environmental damage.

If the test schedule is not interrupted for one of these reasons, it is planned to continue the rate increase schedule with static buildup studies up to 40,000 BPD.

The entire rate test schedule includes surface fluid sampling, gas, and water for extensive chemical tests. Samples will be examined daily (more often immediately following rate changes) for sand production. Presently, rate increase schedules will be abandoned if significant sand production is detected. Continuous bottom-hole pressures, surface pressures, surface temperatures, and surface flow volumes will be measured and recorded. Surface examination of equipment for corrosion, erosion, or scaling will be regularly performed.

Results from the reservoir test period will give indications of formation permeability and size. Hopefully, the test phase will show little to no decrease in static reservoir pressure over the test period. This will then open the study schedule to a second year, which will include long-term reservoir limits test, power generation, and heat utilization of the geothermal source. If the zone being tested is found to be too small or exceedingly unproductive, considerations to abandoning this first test zone and opening a second test zone will be in order. Correspondingly, if this first test zone meets expectations, other wells will be considered to develop a sufficient energy source to operate a 10- to 25-megawatt power plant.

Testing will be in four periods; buildup to 20,000 barrels per day with constant rate and shut-ins for evaluation of boundaries, kh, ps.

All test data and results from reservoir analysis will be provided to UTA/CES for use and further analysis by appropriate researchers.

# VI. ENVIRONMENTAL ASSESSMENT AND MONITORING PROGRAM

## A. Environmental Assessment

The well drilling and testing program associated with the GCO-DOE Pleasant Bayou No. 1 Well will be conducted within the scope of an Environmental Impact Assessment (EIA) prepared by DOE/Division of Geothermal Energy and identified as follows:

Environmental Impact Assessment--
Geothermal Well Test
Brazoria County, Texas
1978
Division of Geothermal Energy, DOE

## B. Environmental Monitoring Program

The Bureau of Economic Geology (BEG), through its Land Resources Laboratory and through service contractual agreements with private firms, will undertake management of environmental baseline studies and monitoring studies of the GCO-DOE Pleasant Bayou No. 1 geopressured-geothermal resource test well site in Brazoria County, Texas. Baseline studies will include: air quality monitoring, water quality monitoring, repeated first-order leveling surveys (subsidence), continuous microseismic survey (seismicity), and noise surveys. BEG will provide for contractual arrangements with firms to undertake specific baseline studies (air quality, leveling, microseismic). BEG will also be responsible for assuring that: (1) data collection formats are compatible with federal and state requirements; (2) data is compiled, analyzed, and reported to DOE on a quarterly basis or more frequently if needed; and (3) if air or water quality standards are exceeded as a result of geothermal fluid production or if subsidence appears to have resulted from fluid production, DOE, as well as the appropriate federal, state, and local agencies, will be notified immediately.

BEG will be responsible for increasing or decreasing requirements for baseline data collection if they are clearly warranted by naturally occurring environmental changes on the test well site or by significant environmental factors recognized during early phases of measurement. However, BEG will be obligated to demonstrate the inadequacy of the existing data collection program to DOE when seeking additional requirements.

## 1. Scope of Work

The purpose of collecting environmental data is to secure a baseline of physical and chemical conditions prior to disturbances by geothermal test well operations in Brazoria County (Figures 16 and 17). The scope of these studies will include air quality, water quality, microseismic, first-order leveling, and archaeological studies.

### a. Air Quality

Because geopressured fluids contain hydrocarbons, and possibly some locally $H_2S$, they can, if released to the atmosphere, contribute to air quality degradation. The purpose of the air quality baseline studies is to: (1) characterize ambient air quality prior to test well operations, (2) identify any substance potentially derived from geopressured fluid that may have an adverse effect and establish baseline concentrations for these substances, (3) collect locally available meteorological data necessary for understanding dispersion and conversion patterns, and (4) provide baseline data compatible with later measurements needed to assure compliance with state or federal air quality standards. The Houston-Galveston Air Quality Control Region, which includes the Brazoria test site, is presently a nonattainment area with respect to total suspended solids and ozone. The region is potentially a nonattainment area for $SO_2$.

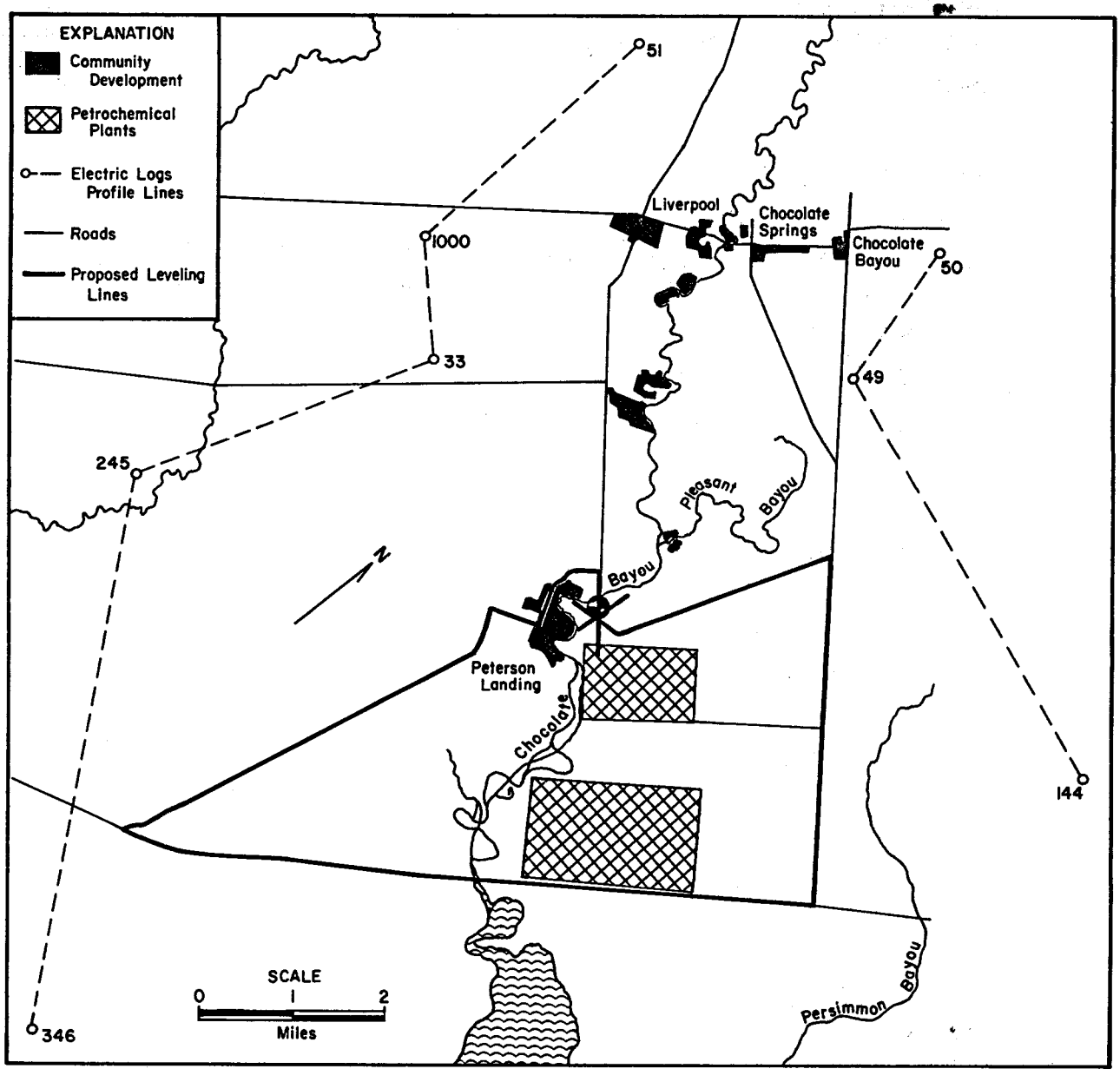



Figure 16. BASELINE PHYSICAL CONDITIONS PLAT — 1.

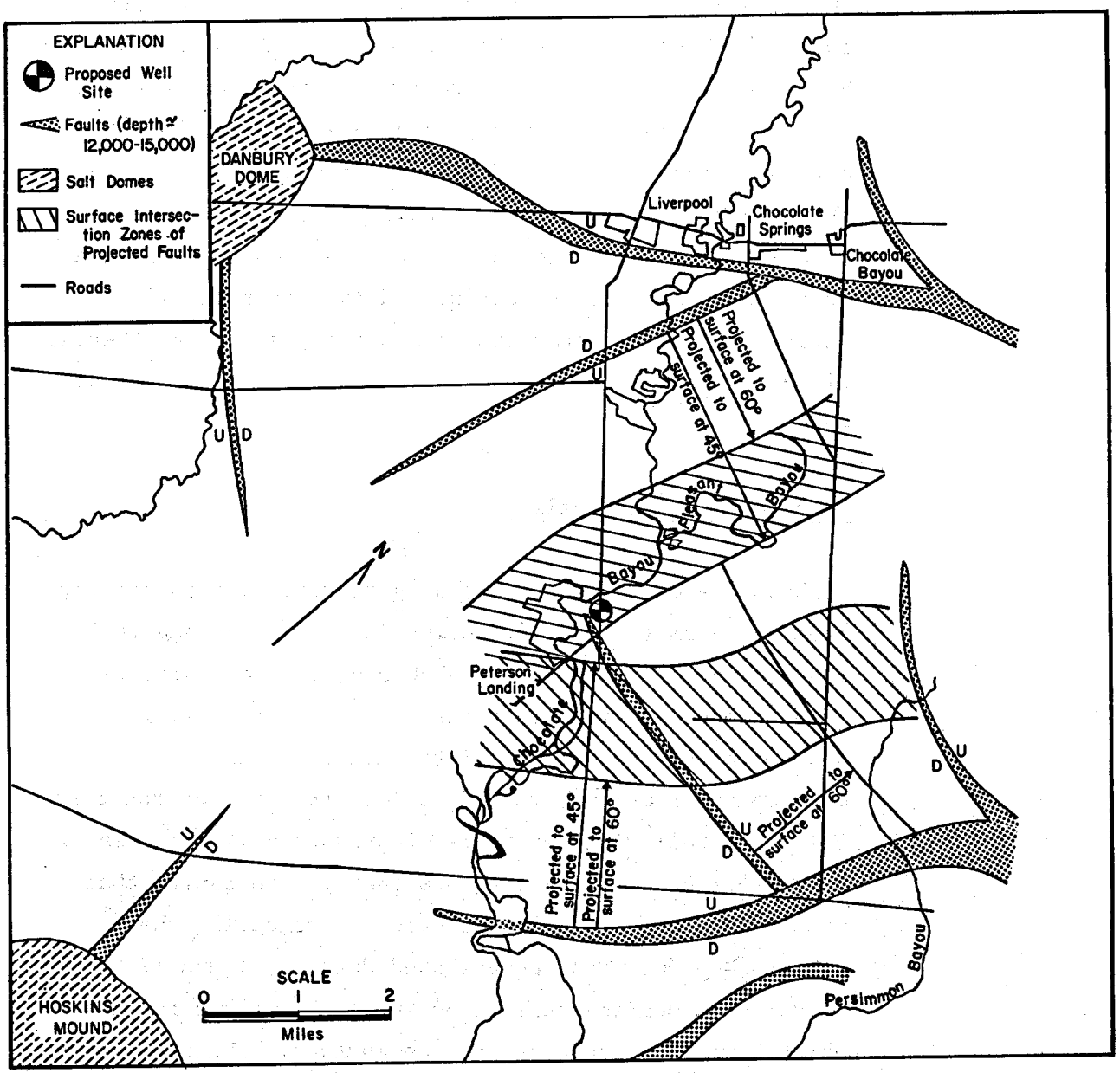



Figure 17. BASELINE PHYSICAL CONDITIONS PLAT — 2.

b. Water Quality

Two sources of water will be sampled: surface water from Chocolate Bayou and local shallow groundwater.

The purposes of the water quality baseline studies are to: (1) characterize ambient water conditions in Chocolate Bayou and in local shallow groundwater prior to test well operations, (2) identify any substance that may have an adverse effect and establish baseline concentrations for these substances, (3) provide baseline data compatible with later measurements needed to assure compliance with state water quality standards, and (4) determine if, during test well operations, temporarily stored geothermal fluids have leaked into the Bayou or into shallow groundwater.

c. Microseismic and Leveling

Perhaps one of the most serious potential impacts arising from geothermal fluid production is subsidence and faulting. Calculations by BEG geologists based on currently understood conditions in reservoir rocks which will be penetrated by the geothermal test well suggest that subsidence of as much as .54 feet is possible at the test well site following two years of production. Analysis of electric logs strongly suggests that growth faults that pass near the test well site were active during the Pleistocene (Guevara, unpublished data). Figure 17 illustrates surface strikes of known subsurface faults which have been projected to the surface. The projections roughly coincide with the positions of growth faults. Furthermore, the projected faults roughly coincide with the linear elements that have been shown by Kreitler (1976) to be, in selected cases, the surface expression

of growth faults. Stream patterns and sand percentage maps also suggest that a growth fault may intersect the surface approximately 3/4 of a mile south of the test well site (Kreitler, in press).

First-order leveling surveys, repeated at 12-month intervals throughout the operation of the well, will be conducted to document the occurrence, if any, of surface subsidence near the well site or of differential surface movement along reactivated faults. A microseismicity survey of the area containing the Brazoria test well site will be undertaken to determine first the background levels of microseismicity near the test well site and second to test for microseismicity associated with current movements along growth faults prior to and during test well production.

2. Tasks

a. Task One--Air Quality

Ambient air quality will be monitored prior to and during the production of geothermal fluids. Measurement standards and equipment will conform to Environmental Protection Agency Quality Assurance procedures. The baseline data gathering program for ambient air includes analysis of hazardous substances anticipated from geothermal operation and pollutants for which there are federal or state standards. Analyses will include $SO_2$, $H_2S$, total hydrocarbons and methane, and particulates. Meteorological data will include wind speed and direction.

Sampling and analysis for hazardous substances will be from a fixed, automated monitoring unit located adjacent to and north of the test well site (prevailing winds are from the south and southeast). Monitoring will be continuous for one year.

The following specifications will be required for analysis:

(1) Methane, Total Hydrocarbons, Nonmethane Hydrocarbons

| | |
|---|---|
| Ranges | 1, 2, 5, 10, 20, 50, 100 ppm |
| Minimum Detectable Sensitivity | .005 ppm |
| Precision | ± 1% |
| Linearity | ± 0.5% |
| Operating Temperature | 5-40° C. |

(2) Sulfur Dioxide

The specifications are as follows:

| | |
|---|---|
| Range | 0 to 1 ppm |
| Noise | ± 0.5% (full scale) |
| Minimum Detectable Concentration | .005 ppm |
| Zero Drift (With Temperature Control) | ± 1% per day<br>± 2% per 3 days |
| Span Drift (With Temperature Control) | ± 2% per day |
| Linearity | ± 3% per day<br>± 1% full scale |

| | |
|---|---|
| Precision | ± 1% |
| Operation Temperature Range | $10^{o}$ C. to $40^{o}$ C. |
| Interference Equivalent | .01 ppm |

(3) Hi-Vol Samplers

Particulates will be collected daily using computer-controlled High-Volume Particulate samplers. These samplers will follow guidelines recommended by EPA and they will meet or exceed all federal performance and dimensional specifications including those in Federal Register, Vol. 36, No. 84, dated April 30, 1971.

b. Task Two--Water Quality

Surface water samples will be collected from Chocolate Bayou upstream of the test well site but below all known outfalls. Water samples will be collected monthly and stream discharge will be recorded when samples are collected. Water samples will be depth integrated. Baseline water sampling is to be initiated prior to production of geothermal fluids. Water samples from Chocolate Bayou will be collected downstream from the test well site but above all known outfalls on a monthly basis.

Parameters to be measured include stream discharge, temperature, pH, specific conductance, turbidity, Na, K, $NH_3$, Mg, Ca, Mn, Cl, $SO_4$, $SiO_2$, B, Pb, As, Cd, Ba, and Hg (detection limits in Table III). If specific conductance does not increase by 10 percent after three (3) samplings, repeat analyses may be made at longer intervals--3 to 6 months.

Table III

Detection Limits

| | |
|---|---|
| N | .1 ppm |
| K | .1 ppm |
| Mg | .1 ppm |
| Ca | .1 ppm |
| Cl | 10 ppm |
| $SO_4$ | 5 ppm |
| Si | .1 ppm |
| B | .2 ppm |
| Mn | .030 ppm |
| Pb | .040 ppm |
| Cd | .001 ppm |
| Ba | .1 ppm |
| $A_3$ | .05 ppm |
| $NH_3$ | .1 ppm |
| Hg | .001 ppm |
| TDS | 8 ppm |
| Temp. | $\pm.5^{o}$ C. |

Ions that are not present in the first three samplings will not be tested for until surface storage is initiated.

Four shallow water wells will be installed for geothermal fluids. One will be placed on each side of the emergency surface storage pit. Wells will be drilled to a least 10 feet below the groundwater table following the construction of the pits. Wells will be perforated in mud sections or screened in sandy units. A portable pump will be used to collect monthly samples for baseline analyses.

Following the establishment of baseline groundwater quality, groundwater samples will be taken every 6 months until use of temporary storage ponds is initiated. When and if surface storage pits are used, a monthly groundwater sampling program will be reinstituted. Groundwater samples will be given the same analyses as surface waters.

Collection and analysis of water samples will be done according to current methods published by EPA and USGS and summarized in "Recommended Methods of Water-Data Acquisition." Analyses of water samples will be reported within one calendar month following collection.

c. Task Three--First-Order Leveling Survey

First-order leveling surveys will be run over the lines shown in Figure 16. The initial leveling survey should be completed prior to production of geothermal fluids. Subsequent surveys will be at 12-month intervals. Level lines shall be double run using Wild N-3 precise levels and Invar rods with an attached level, or equipment capable of similar precision. U.S. Coast and Geodetic Survey procedures will be used and leveling profiles will be tied to available bench marks. Level lines will have first-order closure.

d. Task Four--Microseismic Survey

This study fills the need for an initial baseline microseismicity study at the test well site. Survey results will provide estimates of RMS noise levels observed in the test well area. Tabulations of location and estimated magnitudes of microearthquakes will be made and specific recommendations will be given concerning the development and deployment of a seismic monitoring system which will be used to collect additional baseline data. The task outlined in this proposal (Phase 1 of Task 5) is necessary to provide preliminary baseline microseismic data as well as a foundation for later baseline studies. Continuous monitoring of microseismic activity (Phase 2) will follow the preliminary reconnaissance study. A six-element array of sensors will be deployed to monitor microseismic events in the vicinity of the test well site. Microseismic data will be continuously collected for the 9-month duration of Phase 2. Data taps will be processed to locate hypocenters of microearthquakes and determine earthquake magnitudes. Data analyses reports will be submitted monthly.

e. Task Five-A

BEG will subcontract to private consultants for analyses of air quality, first-order leveling surveys, microseismic surveys, and for noise surveys.

BEG will provide leadership in assuring that data from consultants is compiled, analyzed, and reported in an orderly manner. Furthermore, BEG will provide monthly reviews of environmental baseline data to DOE to assure that collected data and analyses are relevant. BEG will recommend to increase or to decrease requirements for baseline data collection and analysis at any time if clearly warranted by

naturally occurring environmental changes on the test well site or by significant environmental factors recognized during measurement. BEG will demonstrate data collection program inadequacies to DOE when seeking additional requirements.

f. Task Five-B

BEG will prepare quarterly status reports (including data summaries) and an annual report summarizing air quality, water quality, and microseismic and leveling data for the test well site. Based on analyses of the data and on the development of the test well and federal, state, and local regulations, BEG will evaluate the need of continuing air quality, water quality, and microseismic monitoring and leveling surveys. If continued monitoring is necessary, BEG will evaluate and recommend whether or not it can be accomplished at a reduced level, for example, increasing the interval between water samples or reducing the number of ions being analyzed.

## VII. PERMITS

The attached permits are applicable to the drilling of the GCO-DOE Pleasant Bayou No. 1 Well in Brazoria County, Texas.

| | | | |
|---|---|---|---|
| 1. | Railroad Commission Oil and Gas | GT-4 | Certificate of Compliance and Authorization to Transport Geothermal Energy |
| 2. | Ibid. | W-1 | Application for Permit to Drill |
| 3. | Ibid. | P-5 | Organization Report |
| 4. | Ibid. | W-2 | Oil Well Potential Test or Recompletion Report and Log |
| 5. | Ibid. | GT-2 | Producer's Monthly Report of Geothermal Wells |
| 6. | Ibid. | GT-3 | Monthly Geothermal Gatherer's Report |
| 7. | Texas Department of Water Resources | --- | Water-Bearing Strata Protection |
| 8. | Railroad Commission Oil and Gas | --- | Permit to Drill, Deepen, or Plug Back on Regular Location |

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

FORM W-1
(6-8-77)

API Well No. 42
Instruction (7a & b) on back side.

Directional Well ___ Amended or Corrected Permit ___

RRC Permit Number, if previously assigned.

# APPLICATION FOR PERMIT TO DRILL, DEEPEN, OR PLUG BACK

Check one: [X] DRILL [ ] DEEPEN (Below Casing) [ ] DEEPEN (Within Casing) [ ] PLUG BACK [ ] OTHER (Specify) _____

If Amended Application, explain fully in Remarks or Attach Separate Page.

7. RRC District: 3

8. County: Brazoria

1. Operator: General Crude Oil Company

4. Lease Name and RRC Lease or ID No. If Assigned: Pleasant Bayou

9. Well Number: 1

2. Address (Including City and Zip Code): P. O. Box 2252, Houston, Texas 77001

5. Location (Sec., Blk., Survey): Abstract 107, Perry & Austin Survey

10. Number of Acres in Lease: 320

6. This well is to be located 11 miles south Direction from Alvin, Texas. Nearest Post Office or Town.

11. Distance from Proposed Location to Nearest Property or Lease Line (ft.): 507

3. Is Form P-5 (Organization Report) in Exact Operator Name Filed? YES [ ] NO [ ] (Instruction (2) on back side.)

12. Total Depth: 16,500

## EACH PROPOSED COMPLETION

**REFER TO INSTRUCTIONS ON BACK SIDE. READ CAREFULLY AND FURNISH COMPLETE DATA.**

| 13. FIELD NAME (Exactly as shown on R.R.C. Proration Schedule including Reservoir if applicable.) If Wildcat, so state below. | 14. Completion Depth | 15. All Prior Rule 37 Case Numbers for this wellbore. If none, State None. | 16. Applicable Field Rules Spacing Pattern. If no Rules, State 467-1200. (ft.) | 17. Applicable Field Rules Density Pattern. If no Rules, State 40. (acres) | 18. Number of Acres in Drilling Unit for this Well AND DESIGNATE ON PLAT. | 19. Is this acreage presently assigned to another well in same field? (Yes or No. If yes explain in remarks.) | 20. Distance from proposed location to nearest drilling completed or applied for well in same reservoir on same lease (ft.) | 21. Is this a 1. Regular or 2. Rule 37 Location? Check the appropriate box. | 22. Oil, Gas, or other Type Well (Specify) | 23. Number of Wells or Permitted locations on this Lease in same Reservoir for which this Permit is Requested? OIL | GAS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wildcat | 16,500 | None | 467-1200 | 40 | 40 | No | None | Regular 1 [X] Rule 37 2 [ ] | Geopressure Geo-thermal | None | None |
| | | | | | | | | Regular 1 [ ] Rule 37 2 [ ] | | | |
| | | | | | | | | Regular 1 [ ] Rule 37 2 [ ] | | | |
| | | | | | | | | Regular 1 [ ] Rule 37 2 [ ] | | | |

24. PERPENDICULAR LOCATION FROM TWO DESIGNATED:
A. Lease Lines 507' SE of the NW lease line & 1900' SW of the NE lease line.
B. Survey Lines 11,744.9' SW of the NE line & 1079.4' SE of the NW line, Abstract 107, Perry & Austin Survey, Brazoria County, Texas

25. DISTANCE AND DIRECTION TO NEAREST WELL IN THE SAME FIELD ON THIS LEASE.
None

**NOTICE**
NO ALLOWABLE WILL BE ASSIGNED to any well which does not have sufficient surface casing to protect all fresh water sands. Where Commission rules do not specify surface casing requirements, it will be necessary to contact Texas Water Development Board, Austin, Texas, to ascertain the depth to which fresh water sands must be protected.

REMARKS: This Application for Permit to Drill is for the drilling of a Geopressure Geothermal prospect in Brazoria County, Texas.

**CERTIFICATE**
I declare under penalties prescribed in Article 6036c, R. C. S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

R. L. Draper
Signature

Vice President
Title

February 13, 1978
Date

Telephone: Area Code 713 651-9261

READ INSTRUCTIONS ON BACK SIDE AND FURNISH COMPLETE DATA.

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# RAILROAD COMMISSION OF TEXAS
## OIL AND GAS DIVISION

Form No. P-5
(Rev. 11/76)

# ORGANIZATION REPORT

This is the initial and principal instrument that identifies an organization to the Commission. It is imperative that it be fully and correctly executed and filed before an organization initiates operations.

1. Full Name of the Company or Organization.

2. Post-office Address (Box or Street Address, City, State and Zip Code)

3. (a) Plan of Organization (State whether organization is a corporation, joint stock association, firm or partnership, limited partnership, joint venture, individual, or trust)

3. (b) Type of Operation (Oil and gas operator, transporter by pipeline and/or truck, directional surveyors, cycling plant, gasoline plant, salt water haulers, reclamation treating plant, carbon black plant, etc.)

4. If a reorganization, give name and address of previous organization.

5. If a corporation or limited partnership, give: State where incorporated or registered

| 6A. If foreign corporation or limited partnership, give: | 6B. If foreign corporation, give: |
|---|---|
| Date of permit or registration to do business in Texas | Name and post-office address of Texas agent |

7. Officers, Directors, Trustees, Partners, Joint Venturers, and General Partners* (Required for all organizations except individuals)

| TITLE | NAME | POST-OFFICE ADDRESS |
|---|---|---|

*If separate Form P-5's are on file for each partner or joint venturer, clearly refer to complete organization names on file in this section.

I declare under penalties prescribed in Article 6036c, R.C.S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Date _____ Signature _____

Company _____ Name of Person (type or print) _____

Street Address (ONLY) _____ Title of Person (If agent, attach certificate of authority signed by operator. See Section 3 on reverse side.)

City, State _____ Zip Code _____ Telephone: Area Code _____ Number _____



(REQUIREMENTS ON REVERSE SIDE)

## RULE 1. ORGANIZATION NAME TO BE FILED AND RECORDS TO BE KEPT

(A) (1) Any person, firm, joint venture, partnership, joint stock association, corporation, or other organization, domestic or foreign, operating wholly or partially within this state, acting as principal or agent for another, or transporting or refining crude oil, gas and products, shall file an Organization Report with the Commission reflecting the name of the company or organization, giving the name and post-office address of the organization, the plan under which it was organized, and the names and post-office addresses of the trustees thereof, the names and post-office addresses of the officers and directors of a corporation, and the names and addresses of the partners of a general partnership, and the general partners of a limited partnership.

(2) Each operator who is required to file an Organization Report is also required to file annually, no later than January 15th of each succeeding year, a revised Organization Report showing the required information at that filing date; provided, that if no change has occurred in the required information, a letter certification to this effect shall be filed in lieu of the refiling of the entire form.

(3) Form must be executed by an individual of authority in the organization; if executed by an agent, certificate of agency authority from operator must accompany Form P-5.

RAILROAD COMMISSION OF TEXAS
OIL AND GAS DIVISION

Form W-2
Rev. 6/30/75

# OIL WELL POTENTIAL TEST
# COMPLETION OR RECOMPLETION REPORT AND LOG

| | | |
|---|---|---|
| 1. FIELD NAME (as per RRC Records or Wildcat) | 2. LEASE NAME | 7. RRC District<br>8. RRC Lease Number<br>9. Well Number |
| 3. OPERATOR | | 10. County |
| 4. ADDRESS | | 11. Purpose of Test<br>Initial Potential ☐<br>Retest ☐<br>Reclass ☐ |
| 5 If Operator has changed within last 60 Days -- Give former Operator | | |
| 6a. LOCATION (Section, Block, and Survey) | 6b. Distance and Direction to nearest town in this county. | |
| 12. If Workover --Give former Field (with Reservoir) | 13. Type of Electric or other Log run | 14. Completion Date |

## Section I — POTENTIAL TEST DATA

| | | | | | |
|---|---|---|---|---|---|
| 15. Date of Test | 16. No. of Hours Tested | 17. Production Method (Flowing, Gas Lift, Jetting, Pumping - Size & Type of Pump) | | | 18. Choke Size |
| 19. Production During Test Period ///// | Oil - BBLS | Gas - MCF | Water - BBLS | Gas - Oil Ratio | Flowing Tubing Pressure PSI |
| 20. Calculated 24 //// Hour Rate ////// | Oil - BBLS | Gas - MCF | Water - BBLS | Oil Gravity - API - 60° | Casing Pressure PSI |
| 21. Was Swab or Artificial Flowing Device Used During this Test? Yes ☐ No ☐ | | 22. Oil Produced Prior to Test (New & Reworked Wells) | | | 23. Injection Gas-Oil Ratio |

NOTE: TEST SHOULD BE FOR 24 HOURS UNLESS OTHERWISE SPECIFIED IN FIELD RULES

INSTRUCTIONS: All potential test Forms, with all information requested thereon filled in, shall be filed in the District Office of the Railroad Commission not later than ten (10) days after the test is completed and, should the operator fail to file potential test in an acceptable Form within the ten (10) days as specified, then the effective date of the allowable resulting from such test shall not extend back more than ten (10) days prior to receipt and acceptance of the potential test Form in the District Office. This Ten-Day provision shall govern regardless of whether the potential test is taken during the month in which it is received in the District Office or any prior month. Fill in only the front of this Form when reporting only a potential test; if well is newly completed or recompleted, fill in reverse side also.

EACH WITNESS MUST PERSONALLY SIGN.

We, the undersigned, witnessed this test, by observation of meter readings, or the top and bottom gauges of each tank, whichever is applicable, into which production was run during duration of this test.

Signature: REPRESENTATIVE OF COMPANY MAKING TEST
List of Offset Operators Notified and Date Notified:

Signature: REPRESENTATIVE OF RAILROAD COMMISSION
List of Offset Operators Notified and Date Notified:

An inclination survey has been run in accordance with Statewide Rule 11 and the results are available upon request. Maximum horizontal displacement was _____ feet at a measured depth of _____ feet.

Signature of Authorized Representative

Name of Company Conducting Survey

All casing was cemented in accordance with Statewide Rule 13 or a written exception thereto. Cementing tickets and/or other data are available upon request.

Signature of Cementer or Authorized Representative

Name of Cementing Company

CERTIFICATE:
I declare under penalties prescribed in Article 6036c, R.C.S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

REPRESENTATIVE OF COMPANY | TITLE | DATE

SECTION II — DATA ON WELL COMPLETION AND LOG (Not Required on Retest)

24. Type of Completion: New Well ☐ Deepening ☐ Plug Back ☐ Other ☐

25. Date Permit Issued

26. Notice of Intention to Drill this Well was filed in Name of

27. If Special Permit, Give Permit Number

28. Number of Producing Wells on this Lease in This Field (Reservoir) including this Well

29. Total Number of Acres in this Lease

30. Date Plug Back, Deepening, Work Over or Drilling Operations: Commenced | Completed

31. Distance to Nearest Well, Same Lease & Reservoir

32. Location of Well, Relative to Nearest Lease Boundaries of Lease on which this Well is Located — Feet From Line of The Line And Feet From Lease

33. Elevation (DF, RKB, RT, GR, ETC)

34. Was Directional Survey Made Yes ☐ No ☐

35. Top of Pay | 36. Total Depth | 37. P.B. Depth | 38. Surface Casing Determined By: Recommendation of Texas Water Development Board ☐ Field Rules ☐ Railroad Commission (Special) ☐

39. Is Well Multiple Completion? Yes ☐ No ☐

40. If Multiple Completion List All Reservoir Names (Completions in this Well)

41. Intervals Drilled By: Rotary Tools | Cable Tools

42. Name of Drilling Contractor

43. Is Cementing Affidavit Attached? Yes ☐ No ☐

44. CASING RECORD (Report All Strings Set in Well)

| CASING SIZE | WT #/ FT. | DEPTH SET | MULTI STAGE TOOL DEPTH | TYPE & AMOUNT CEMENT (Sacks) | HOLE SIZE | TOP OF CEMENT | SLURRY VOL. cu. ft. |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

45. LINER RECORD

| Size | Top | Bottom | Sacks Cement | Screen |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

46. TUBING RECORD

| Size | Depth Set | Packer Set |
|---|---|---|
| | | |
| | | |
| | | |

47. Producing Interval (this completion) indicate Depth of Perforations or Open Hole

| | |
|---|---|
| From | To |
| From | To |
| From | To |
| From | To |

48. ACID, SHOT, FRACTURE, CEMENT SQUEEZE, ETC.

| Depth Interval | Amount and Kind of Material Used |
|---|---|
| | |
| | |
| | |
| | |
| | |

49. FORMATION RECORD (LIST DEPTHS OF PRINCIPAL GEOLOGICAL MARKERS AND FORMATION TOPS)

| Formations | Depth | Formations | Depth |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

REMARKS

PRODUCER'S MONTHLY REPORT
OF GEOTHERMAL WELLS.

# RAILROAD COMMISSION OF TEXAS
## OIL AND GAS DIVISION

CORRECTED REPORT ☐

FORM GT – 2

Operator _____

Address _____

Month _____, 19____

Page Number _____

| 1 RAILROAD COMMISSION DISTRICT / FIELD / LEASE | 2 Well Number A. or N. | 3 RRC Identification Number | 4 Flowing | 4 Pump or Gas Lift | 5 Total mass produced (Lbs x $10^6$) | 6 Dry steam produced (Lbs x $10^6$) | 7 Flow temp. (°F) | 8 Flow pres. (psi) | 9 Water produced (acre-feet) | 10 Minerals produced Gas – MCF Other – Tons | 11 Purchaser of Geothermal Energy |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

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CERTIFICATE:

I declare under penalties prescribed in Article 6036c, R.C.S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature _____

Date _____ Title _____

Telephone No. _____ _____
Area Code Number

# PRODUCER's MONTHLY REPORT OF GEOTHERMAL WELLS, FORM GT-2
## OFFICIAL INSTRUCTIONS

A. Time and Place of Filing – One copy of this report shall be filed with the Railroad Commission at Austin, Texas, on or before the last day of the calendar month following the month covered by the report and one copy shall be sent to each gatherer moving the geothermal water or steam from the wells reported.

B. Volumes – All volumes of geothermal water or steam shall be reported in pounds x $10^6$ at well head temperature °F and pressure PSIA.

All volumes of natural gas shall be reported in MCF (thousand cubic feet) at a base pressure of 14.65 PSIA and a base temperature of 60° F, and computed by Commission approved methods of measurement. Do not use fractional ~~bases~~ units on this report.

C. All volumes of solid minerals shall be reported in short tons (2000 pounds).

D. Remarks – Remarks may be shown in the body of your report on the line following the reported volume the remark refers to. Place appropriate symbol next to any volume explained with a remark.

E. Totals – District totals of the reported volumes of materials (geothermal water or steam, natural gas, minerals) are required to be shown.

F. Order of the Report – This report shall be a report on one operator and shall be in the order indicated by the headings in Column 1, that is, by Railroad Commission district, alphabetically by field, and numerically by identification number. The signature and title of the person authorized to sign need appear only on the last page of the report provided the report pages are numbered and attached. You may file one continuous form reporting all your geothermal well production in the state.

G. Specific Columns

1. Column 1 shall contain Railroad Commission district number, field name, and lease name.
2. Column 2 shall contain six position well designation as per RRC Schedule. Well Number limitations:

| POSITION | REQUIREMENT | PURPOSE | EXAMPLE |
|---|---|---|---|
| 1 | Alphabetic or Numeric | Tract designation or high Well Number | A 1 2 9 6 |
| 2, 3, & 4 | Numeric only | Basic Well Number | 1 4 6 |
| 5 | Alphabetic only | Replacement Well Code | 1 A<br>1 R |
| 6 | Alphabetic only | Multiple completion designation as per RRC Schedule or Coding System | 1 0 - T<br>1 2 9 - C |

3. Column 3 shall contain Railroad Commission assigned geothermal identification number. (4 digit number)

MONTHLY GEOTHERMAL
GATHERER'S REPORT

# RAILROAD COMMISSION OF TEXAS
## OIL AND GAS DIVISION

CORRECTED REPORT ☐

FORM GT-3

Gatherer Name _____

Address _____ City _____ State _____ Zip Code _____

Month _____, 19 _____

Page Number _____

| 1 RAILROAD COMMISSION DISTRICT<br>FIELD<br>OPERATOR<br>LEASE | 2 RRC Lease Number | 3 No. of Prod. Wells | 4 Product* Purchased | 5 Total Mass, Lbs. X $10^6$ | 6 Total Volume Acre Feet | 7 Total Volume Gallons † | 8 Temp. °F. | 9 Pressure psi |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

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| | | | |
|---|---|---|---|
| Residual Water | Acre Feet | Gallons † | Disposition of Water |
| Type and Weight of Minerals Extracted | | | Disposition of Minerals |

* *State type of product: Dry Steam, Geothermal Water, Low-Temp. Thermal Water, etc.*

† *Total Volume in Gallons for Low-Temp. Thermal Wells Only*

**CERTIFICATE:**

I declare under penalties prescribed in Article 6036c, R.C.S., that I am authorized to make this report, that this report was prepared by me or under my supervision and direction, and that data and facts stated therein are true, correct, and complete, to the best of my knowledge.

Signature _____

Date _____ Title _____

Telephone No. _____ (Area Code) _____ (Number)

2147

TEXAS DEPARTMENT OF WATER RESOURCES
1700 N. Congress Avenue
Austin, Texas

TEXAS WATER DEVELOPMENT BOARD
A. L. Black, Chairman
Robert B. Gilmore, Vice Chairman
Milton T. Potts
John H. Garrett
George W. McCleskey
Glen L. Roney

Harvey Davis
Executive Director

TEXAS WATER COMMISSION
Joe D. Carter, Chairman
Dorsey B. Hardeman
Joe R. Carroll

February 9, 1978

IN REPLY REFER TO:
SC-2147

General Crude Oil Company
P. O. Box 2252
Houston, Texas 77001

Re: GCO DOE Pleasant Bayou, Well #1,
Perry & Austin Sur., A-107,
Brazoria County, Texas

Gentlemen:

Reference is made to your inquiry of February 3, 1978 regarding the protection of usable-quality water strata in your above named well.

Water-bearing strata must be protected down to a depth of 1,200 feet.

Please send an electrical log of this well when it is available.

NOTE: The depth to which we recommend that usable-quality water strata should be protected is intended to apply only to the subject well. Approval of the well-completion methods for protection of this ground water falls under the jurisdiction of the Railroad Commission of Texas. This recommendation is intended for normal drilling and production operations only and does not apply to salt water disposal operations. It should not be used as a recommendation for fieldwide usable-quality water protection rules.

Very truly yours,

Gail L. Duffin
Geologist, Surface Casing

GLD/dh
cc: RRC, Austin
RRC, District Office #3

GEJ 2-17-78
REC 2/17/78

# RAILROAD COMMISSION OF TEXAS
## PERMIT TO DRILL, DEEPEN OR PLUG BACK ON REGULAR LOCATION

| PERMIT NUMBER | DATE OF PERMIT | DISTRICT |
|---|---|---|
| 018397 | 2/16/78 | 03 |
| **API NUMBER** | **FORM W-1 (dated)** | **COUNTY** |
| 42 039 31236 | 2/13/78 | BRAZORIA |
| **TYPE OF OPERATION** | | **ACRES** |
| DRILL | | 120 |

**OPERATOR** 299710

GENERAL CRUDE OIL CO.
BOX 2252
HOUSTON TX 77001

**NOTICE**
NO ALLOWABLE WILL BE ASSIGNED unless well protects all fresh water sands with sufficient surface casing. Where Commission rules do not specify surface casing requirements, contact the Texas Water Development Board for depth to which fresh water sands must be protected.
PERMIT SUBJECT TO CONDITIONS ON BACK OF FORM
*District Office Telephone No.:* AC 713 688-3461

| LEASE NAME | WELL NUMBER |
|---|---|
| PLEASANT BAYOU | 1 |
| **LOCATION** | **TOTAL DEPTH** |
| 11 MILES SOUTH FROM ALVIN | 16,500 |

**SECTION, BLOCK and/or SURVEY**
ABST. 107, PERRY & AUSTIN SURVEY

| DISTANCE -- LEASE LINES | -- SURVEY LINES | -- NEAREST WELL ON LEASE |
|---|---|---|
| 507 SE/NWL & 1000 SW/NEL | 11744.9 SW/NE-1079.4 SE/NW | NONE |

**FIELD(S)**
WILDCAT

**** LIMITATIONS ****

WILDCAT ABOVE 16,500.
REGULAR FOR GEOPRESSURE GEOTHERMAL.

Based upon the representations made on the above FORM W-1 and those made on any plat or plats filed therewith, it is believed that the operation indicated, when carried out at that point which you have represented to be the location of the above designated Well, complies as of the date thereof, with the provisions of the applicable spacing rule SUBJECT TO THE LIMITATIONS, IF ANY, SET OUT ABOVE. Compliance with the applicable Commission spacing rule renders it unnecessary that you secure a special Commission permit to cover this indicated operation at the location shown, the same being classed as regular.

If there are outstanding permits covering operations which have not actually been started as of the date of filing of FORM W-1 above described and which, if started, would impair the regularity of this operation, then the permit covering that location on which the actual operation is first begun shall prevail, and all other such outstanding permits shall be nullified.

PHONE
(512) 475-2458

DIRECT INQUIRIES TO: ADMINISTRATIVE SERVICES DIVISION
DRILLING PERMIT SECTION

MAIL
Capitol Station-P. O. Drawer 12967
Austin, Texas 78711

# VIII. PROGRAM MANAGEMENT

## A. General

This section describes the basic authorities and responsibilities of the principal organizations and responsible officials participating in this well drilling and testing program. The principal organizations and individuals include:

1. Department of Energy, Division of Geothermal Energy, Washington, D.C.

   a. Geopressure Program Manager (GPM)--Mr. Keith Westhusing.

   b. Drilling and Testing Program Manager (DTPM)--Mr. Bennie G. DiBona.

   c. Environmental Program Manager (EPM)--Mr. Ronald Loose.

2. Department of Energy, Nevada Operations Office, Las Vegas, Nevada.

   Nevada Operations Office Project Manager (NVPM)--Mr. Ronald T. Stearns.

3. General Crude Oil Company, Houston, Texas.

   a. Contractor Program Manager--Mr. Robert L. Draper.

   b. Contractor Operations Engineer--Mr. Charles E. Jones.

   c. Contractor Reservoir Engineer--Dr. Gilbert V. Cady.

4. University of Texas, Center for Energy Studies, and the Bureau of Economic Geology, Austin, Texas.

   a. UTA/CES Program Manager--Dr. Myron Dorfman.

   b. UTA/CES Technical Support Coordinator--Mr. William Boyd.

   c. UTA/CES Compaction Study Manager--Dr. K. E. Gray.

   d. UTA/BEG Sandstone Consolidation Study Manager--Dr. Don Bebout.

   e. UTA/CES Aquifer Simulator Study Manager--Dr. Roy Knapp.

   f. UTA/CES Subsurface Environmental Effects (Elastic Properties) Study Manager--Dr. Myron Dorfman.

   g. UTA/BEG Environmental Study Manager--Dr. Tom Gustavson.

5. All statewide permitting will be approved by the Texas Railroad Commission.

B. Programmatic Responsibilities

1. DGE Geopressure Program Manager (GPM)

Responsible for overall programmatic aspects of the DGE geothermal-geopressure program. The GPM will be continuously informed of contract activities through informal and formal communications with the DTPM and also by communication with the NVPM, the Contractor, and UTA/CES study managers as may be required. The GPM will approve any proposed contract modifications which affect the project objectives (as stated in the contract statement of work) or increase level of funding.

2. DGE Drilling and Testing Program Manager (DTPM)

The DTPM will continuously inform the GPM of contract activities through formal and informal communications.

The DTPM will be responsible for approving this drilling and testing plan.

The DTPM will be available to the field operation when necessary. He will maintain communication with the UTA/CES study managers, the Contractor, the NVPM, and other individuals and organizations as required, but will receive formal communications from the Contractor through the NV Project Manager. He will further be advised of current activity by daily, weekly, and monthly reports sent to him on a timely basis and will communicate frequently with the NV Project Manager (NVPM).

The DTPM will be responsible for approving all major changes to the approved drilling and testing plan unless hole conditions or safety considerations require immediate action. Such approval may be obtained by the Contractor through the NVPM via telephone, but shall be followed by submission of a written memorandum by the Contractor through the NVPM to the DTPM. In the event that any approved plans are modified by the DTPM, NVPM, or the Contractor, the party issuing such directives shall document it by the channels as set forth in this plan.

The DTPM will organize and chair a Testing Review Committee consisting of the GPM, EPM, NVPM, and technical advisors. The committee will meet at times to be specified by the DTPM during the course of the testing phase of the program. The committee will review the test data obtained to date and testing procedures and provide comments and recommendations.

3. DGE Environmental Program Manager (EPM)

The EPM will be responsible for preparing an approved Environmental Impact Assessment for the drilling and testing program. The EPM will also be responsible for monitoring progress of the studies conducted by the UTA/BEG environmental study team. The EPM will inform the GPM, DTPM, and NVPM of environmental activities through formal and informal communications.

4. NV Project Manager (NVPM)

All formal lines of communication and directives between the Division of Geothermal Energy and the Contractor will be directed through the NVPM. There will, of course, be informal communication between the GPM, DTPM, EPM, Contractor, and UTA/CES study managers.

The NVPM will be primarily responsible for project coordination between the Contractor and DGE and the Contractor and NV Administrative Services. He will assist the Contractor in expediting and coordinating procurement approvals and other administrative tasks as well as being available to monitor all critical drilling and testing phases in the field. Whether at the well location or otherwise, the NVPM will maintain a close surveillance of the project and be able to discuss comprehensively both technical and administrative aspects of such with the GPM, the DTPM, and the EPM.

The NVPM will be a member of the Testing Review Committee.

Specifically, the NVPM will be in continuous contact with the Contractor and the operation by periodic reports, telephone, or personal visits, if necessary, to monitor the Contractor's progress.

The NVPM will assume responsibility for all press releases pertaining to the project and coordinate such releases with the NV Office of Public Affairs, the Contractor, the DTPM, and the UTA/CES Program Manager.

Finally, the NVPM, together with the DTPM, will review all Contractor reports before release. Notification of reports approved for release will be the responsibility of the NVPM.

5. Contractor Program Manager (CPM)

The CPM will be the principal Contractor contact for the project. He will direct all aspects of the project in accordance with the contract and this plan. He will communicate with the GPM, DTPM, and TAs on an informal basis, but all formal actions will go through the NVPM. During the field operation, no major change in the plan will be implemented without approval of the NVPM (who will obtain approval from the DTPM) unless hole conditions or safety considerations require immediate action.

The CPM will designate such other individuals (i.e., Operating Engineer, Reservoir Engineer, and others as required) to facilitate communications or other technical and administrative functions.

The CPM or his designee will coordinate all research activities conducted by UTA/CES (as described in the contract and Appendix C to this plan) with the UTA/CES Technical Support Coordinator and will assure that the UTA/CES investigators have adequate logistical and other support.

The CPM will also be responsible for preparing a completion report or well and testing report. The report will be a composite of work performed by all investigators directly related to the drilling and testing program.

## 6. UTA/CES Technical Support Coordinator

The UTA/CES Technical Support Coordinator will be responsible for project coordination between the Contractor and the UTA/CES study managers. The Technical Support Coordinator will be in continuous contact with the Contractor's Operating Engineer and the operation by periodic reports, telephone, or personal visits, if necessary, to monitor the Contractor's progress as it relates to the UTA/CES investigations. He will also be responsible for providing the results of UTA/CES investigations to the Contractor for incorporation in project reports.

Figure 18 indicates the interrelationship between the participants and the channels of funding and communications.

GENERAL CRUDE OIL COMPANY
BRAZORIA WELL
PROGRAM MANAGEMENT

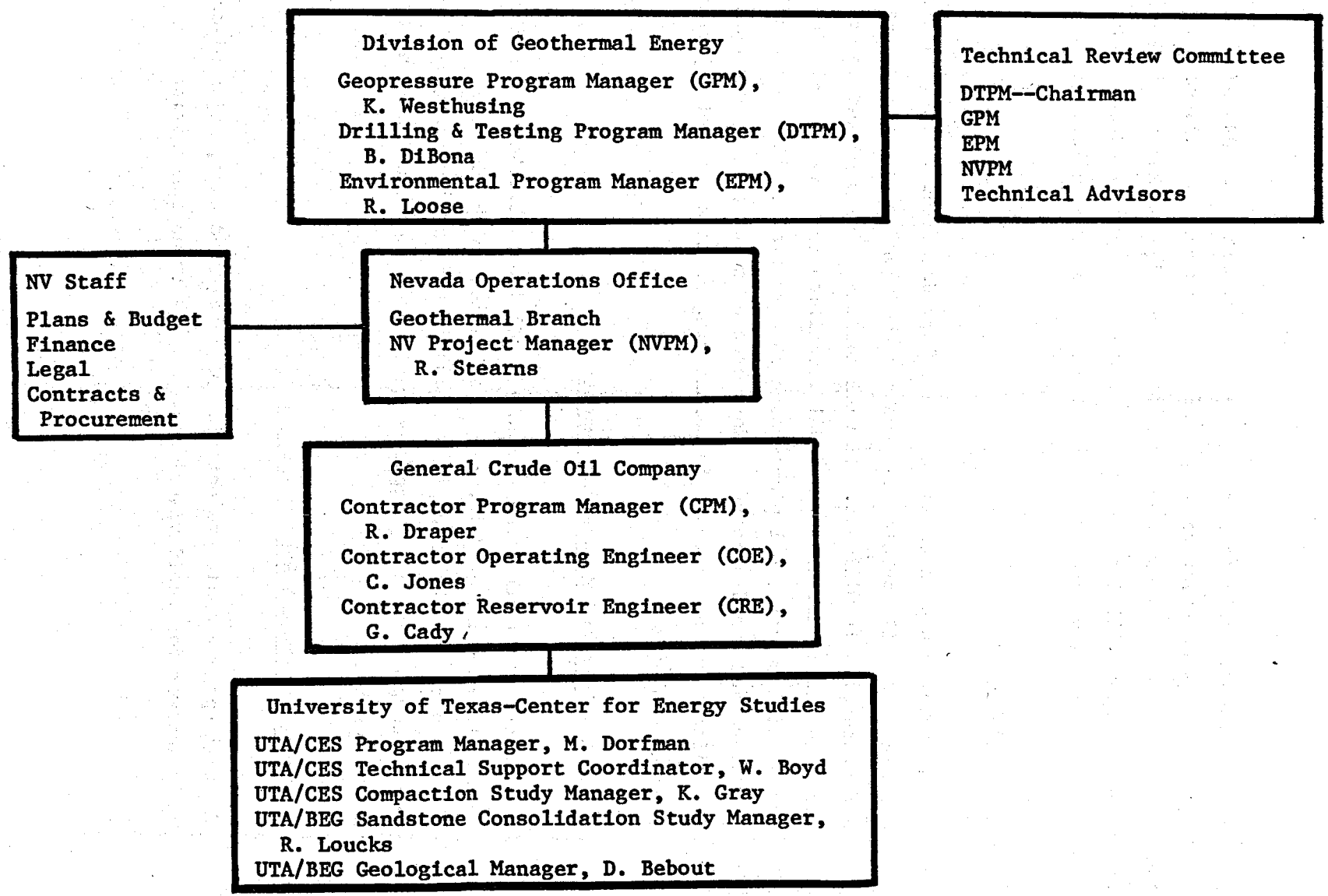



Figure 18

# IX. REPORTING

All reports (except daily and monthly) will be submitted to DOE/NV by the Contractor for review prior to publication in accordance with specific instructions to be provided by the DOE/NV Technical Information Officer. These instructions will include format, number of copies, and submittal schedules. In summary, the reports will consist of the following:

A. Management Plan

The Contractor's plan to manage the effort described in the statement of work. It will contain management methodologies, control systems, and procedures it will use. It will include milestones and other planning schedules, organizational identifications and descriptions, and special and critical plans, such as test plans, plans for handling of Government-owned property. Work breakdown structures, key personnel identification, and methods for monitoring progress toward objectives will be required.

B. Milestone Plan and Management Report

The Contractor's milestone schedule for all work breakdown structure items, line items, or deliverables specified in the Contract. To be updated periodically (usually monthly) to show status, progress toward completion, and percent completion of each line item and on the total Contract.

C. Contract Management Summary Report

A single-page graphic presentation of integrated cost, major milestones, and manpower for rapid visual analysis and trend forecasting.

D. Major Milestone Status Plot

A periodic graphic presentation of events, deliverables, or major milestones and associated dates plotted in an expected performance envelope for rapid visual analysis and trend forecasting.

E. Cost Management Report

A periodic report of the status of costs compared to the Cost Plan. Data will be used to report actual and projected accrued costs, evaluate performance against plan, identify actual and potential problem areas, construct cost experience for projects and budgeting efforts, and to verify the reasonableness of Contractor's invoices.

F. Technical Progress Report

1. Daily Drilling Report

An informal activity report submitted daily throughout the drilling and testing phase. These reports will be phoned in directly to the Nevada Operations Office for subsequent transmittal to other interested parties.

2. Monthly Technical Progress Report

A technical letter report submitted one week after the end of each month describing accomplishments made to date and providing a brief outline of the planned work schedule for the succeeding period. Problems that have occurred will be discussed along with the method of solution. Test measurement results and analytical data will be presented.

## G. Final Reports

These written reports will correlate findings of flow tests, analyses, and will include a summarization of the operational aspects of well activities, including a review of the research work done by the University of Texas in support of the Contractor's DOE Pleasant Bayou No. 1 Well. The reports will also include the evaluation of the completion technique and production strategy, the result of sand stability investigations including the maximum and reasonable rates at which the well and the reservoir will safely operate, the determinations concerning corrosion and scaling properties of the produced fluid and any treating methods that can be used to control corrosion or scaling problems, evaluation of the reservoir deliverability and depletion including appropriate material-energy balance equations of use, determination of reservoir size as indicated from test data, reservoir fluid characteristics including salinity, formation compaction related to any detected surface subsidence, and discussion of the heterogeneity of the reservoir if detected.

### 1. Yearly Technical Report

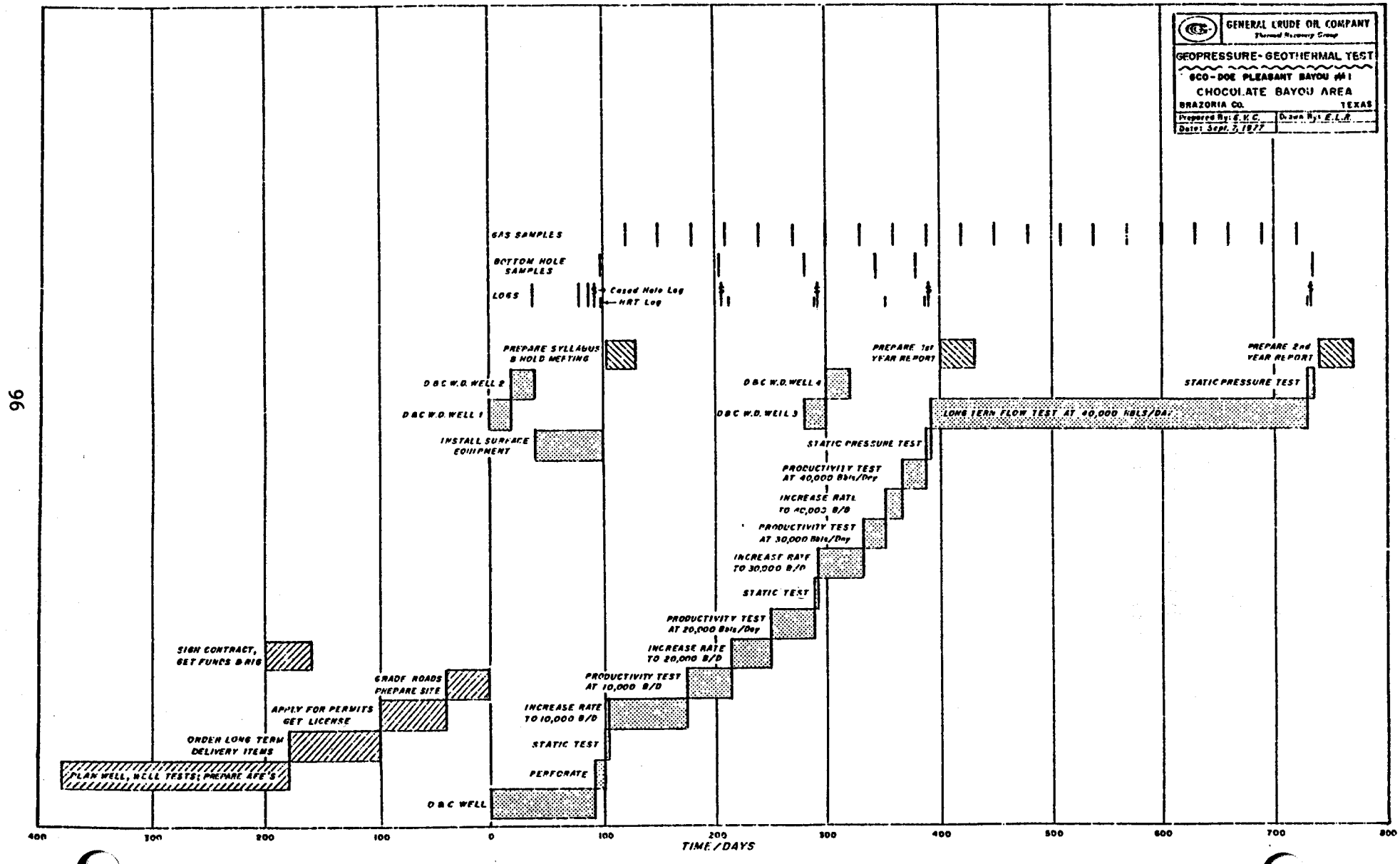
A technical report will be submitted in draft form upon completion of each contract year. It will describe operational procedures followed, drilling completion and testing methods employed, and it will provide measurement and test information with all necessary illustrations, graphs, and tabulations required to show significant results. Descriptive text will be used to explain all illustrations. Results of all related research work performed by the University of Texas or others will be attached to the report as appendices.

### 2. Final Technical Report

A report will be submitted at the conclusion of the program presenting a summary of overall program results. It will be a

complete report on all significant data obtained and will be a composite of work performed by all investigators directly related to the drilling and testing of the production well, drilling and utilization of the disposal well(s), and operation of the surface facility.

# X SCHEDULE


GENERAL CRUDE OIL COMPANY
Thermal Recovery Group
GEOPRESSURE-GEOTHERMAL TEST
ECO-DOE PLEASANT BAYOU #1
CHOCOLATE BAYOU AREA
BRAZORIA CO. TEXAS
Prepared By: E.V.C.
Drawn By: E.L.R.
Date: Sept. 3, 1977
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GAS SAMPLES
BOTTOM HOLE SAMPLES
LOGS
Cased Hole Log
HRT Log
PREPARE SYLLABUS & HOLD MEETING
D & C W.O. WELL 2
D & C W.O. WELL 1
INSTALL SURFACE EQUIPMENT
PREPARE 1st YEAR REPORT
D & C W.O. WELL 4
D & C W.O. WELL 3
PREPARE 2nd YEAR REPORT
STATIC PRESSURE TEST
LONG TERM FLOW TEST AT 40,000 KBLS/DAY
STATIC PRESSURE TEST
PRODUCTIVITY TEST AT 40,000 Bbls/Day
INCREASE RATE TO 40,000 B/D
PRODUCTIVITY TEST AT 30,000 Bbls/Day
INCREASE RATE TO 30,000 B/D
STATIC TEST
PRODUCTIVITY TEST AT 20,000 Bbls/Day
INCREASE RATE TO 20,000 B/D
PRODUCTIVITY TEST AT 10,000 B/D
INCREASE RATE TO 10,000 B/D
STATIC TEST
PERFORATE
D & C WELL
SIGN CONTRACT, GET FUNDS & RIG
GRADE ROADS PREPARE SITE
APPLY FOR PERMITS GET LICENSE
ORDER LONG TERM DELIVERY ITEMS
PLAN WELL, WELL TESTS; PREPARE AFE'S
-400
-300
-200
-100
0
100
200
300
400
500
600
700
800
TIME/DAYS

## XI. REFERENCES


1. Kruger, Paul, and Carl Otte: Geothermal Energy, Stanford University Press, Stanford, California, 1973.

2. Berman, Edward R.: Geothermal Energy, Noyes Data Corp., Park Ridge, New Jersey, 1975.

3. Herrin, E.: "Development of Geothermal Reservoirs From Over-Pressured Areas Beneath the Gulf Coast Plain of Texas," Report AD-766 855, Air Force Office of Scientific Research.

4. Dorfman, M. H., and R. W. Deller: "Proceedings First Geopressured Geothermal Energy Conference," University of Texas at Austin, Center for Energy Research, June 2-4, 1975.

5. Dorfman, M. H., and R. W. Deller: "Summary and Future Projections," Volume I, Proceedings Second Geopressure Geothermal Energy Conference, University of Texas at Austin, February 23-25, 1976.

6. Podio, A. L., et al.: "Reservoir Research and Technology," Volume III, Proceedings Second Geopressure Geothermal Energy Conference, University of Texas at Austin, February 23-25, 1976.

7. Underhill, G. K., et al.: "Surface Technology and Resource Utilization," Volume IV, Proceedings Second Geopressure Geothermal Energy Conference, University of Texas at Austin, February 23-25, 1976.

8. Vanston, J. H., et al.: "Legal Institutional and Environmental," Volumn V, Proceedings Second Geopressure Geothermal Energy Conference, University of Texas at Austin, February 23-25, 1976.

9. Whiting, R. L., and H. J. Ramey: "Applications of Material Energy Balances to Geothermal Steam Production," J. Pet. Tech. V21, 1969, pp. 893-900.

10. Cady, G. V.: "Model Studies of Geothermal Fluid Production," Ph.D. Dissertation, Stanford University, 1969.

11. Bebout et al.: Geopressured-Geothermal Fairway Evaluation and Test-Well Site Location--Frio Formation, Texas Gulf Coast, University of Texas, Bureau of Economic Geology Report for the U.S. DOE, Division of Geothermal Energy. 1978.

# APPENDIX A

## WORK STATEMENTS
## for
## The University of Texas at Austin

## Contracts Supporting
## General Crude Oil Company
## Well Test,
## Brazoria County, Texas

Six contracts at the University of Texas at Austin allow complementary research work to be performed to support the drilling, completion, and testing of the GCO DOE Martin Ranch No. 1 Well in Brazoria County, Texas. These contracts are:

1. Special Studies and Coordination Assistance (EY-76-5-05-5243), Principal Investigators: Dr. Myron Dorfman, Dr. Don Bebout.

2. Sandstone Consolidation Analysis, Principal Investigator: Dr. Don Bebout.

3. Compaction Measurements (EG-77-5-05-5437), Principal Investigator: Dr. K. E. Gray.

4. Geopressured Aquifer Simulator (EY-76-C-05-5040), Principal Investigator: Dr. Roy Knapp.

5. Subsurface Environment Effects on Elastic Properties (contract planned for award FY 78), Principal Investigator: Dr. Myron Dorfman.

6. Environmental Characteristics and Guidelines for Site Selection Methodology and Environmental Site Monitoring (EY-76-5-05-5401), Principal Investigator: Dr. T. Gustavson.

Summaries of the work statements for these contracts are provided in the following pages.

1. CONTRACT: SPECIAL STUDIES AND COORDINATION ASSISTANCE

The Center for Energy Studies will provide for:

a. Technical Assistance and Coordination for the Brazoria County Geopressure Geothermal Test Well.

(1) Technical assistance for planning of the test well, data collection, system, data evaluation, and determination of appropriate completion and testing program.

(2) Technical evaluation and dissemination of results obtained.

b. Technical Assistance, Coordination, and Planning of Surface Component Test Facilities and Pilot Plant.

c. Legal Research in Geopressure Geothermal Resource Development and Support to the Appropriate Management Staff Sections.

d. Operation of Geopressure Geothermal Information Service.

(1) Supply information on well test activities and results.

(2) Digitize logs and develop and refine methods for geological, engineering, and resource applications.

e. Utilization of Test Well Data and Results.

Coordinate all research activities of the University with test, measurement, and collection activities at the well site.

f. Report preparation, formal and informal, written and verbal to DOE and GCO.

2. CONTRACT: SANDSTONE CONSOLIDATION ANALYSIS

The sandstone consolidation analysis effort has seven major tasks to support the well drilling and testing of the Brazoria County Well to determine effects of diagenetic alteration on porosity and permeability for use in mapping optimum reservoir areas. These seven tasks are:

a. Acquisition of cores and core analysis.

b. Processing of core data.

c. Acquisition of petrophysical logs from the cored well.

d. Processing of petrophysical logs.

e. Assimilation of data and analysis.

f. Interpretation of data and mapping of optimum reservoir area.

g. Report preparation and submission to GCO and DOE.

3. CONTRACT: COMPACTION MEASUREMENTS

Compaction measurements will provide the basis for understanding compaction drive mechanisms, of permeability variations, and of potential subsidence.

Twelve tasks are associated with making these determinations for the Brazoria County Well:

a. Core specimen selection and preparation.

b. Performing modified triaxial tests.

c. Evaluating techniques for estimating the uniaxial compaction coefficient.

d. Performing hydrostatic tests.

e. Evaluating rock bulk and matrix compressibilities and their dependence on stress.

f. Development, test, and calibration of high-pressure pore volume change measurement equipment.

g. Performing further triaxial testing.

h. Evaluating rock deformation mechanisms.

i. Development of advanced core testing program.

j. Integration of state-of-the-art measurment techniques.

k. Determination of parameters for input to computer simulator for reservoir productivity and subsidence predictions.

l. Reporting to GCO and DOE.

## 4. GEOPRESSURED GEOTHERMAL AQUIFER SIMULATOR

The developed computer simulator of the University of Texas at Austin will be modified to incorporate wellbore flow effects to accomplish predictions of the performance of the Brazoria County geopressure reservoir using well test results from the DOE Pleasant Bayou No. 1 Well.

Five tasks are to be accomplished in support of the well tests:

a. Incorporation of wellbore flow subroutine into the computer simulator.

b. Develop improved well test methods to determine in situ reservoir properties governing reservoir productivity.

c. Perform reservoir performance predictions for the Brazoria reservoir considering various production and reinjection strategies.

d. Evaluate potential land surface subsidence and movement, both horizontal and vertical.

e. Prepare monthly progress reports and the final technical report to be submitted to GCO and DOE.

5. CONTRACT: SUBSURFACE ENVIRONMENT EFFECTS ON ELASTIC PROPERTIES

The part of this Contract that supports the work on the GCO DOE Pleasant Bayou No. 1 Well test consists of well log and laboratory core velocity work and velocity survey work to better understand the effect of the geopressure environment on elastic properties of sandstone-shale sequences in test wells to be drilled in the Brazoria County area. Better correlation of well acoustic log data with seismic survey information will lead to improved resolution of geopressured formations by seismic survey exploration methods where performed without well control. In addition, measured parameters related to the physical properties of rocks will be useful in understanding deformation mechanics and how they affect well and reservoir productivity. Eight tasks are involved in supporting the General Crude Oil Company work on the Pleasant Bayou No. 1 Well:

a. Determine the physical properties of geopressured formations using cores from the Pleasant Bayou No. 1 Well and other available geopressure cores and compare with similar normally pressured formations.

b. Perform analysis of complete wave forms from vertical seismic profiling including the Pleasant Bayou No. 1 Well site area to obtain seismic wave velocities and attenuation.

c. Perform analysis of sonic logs.

d. Design and fabricate necessary acoustic velocity and attenuation measurement apparatus to operate under uniform confining pressures to 15,000 psi, axial pressures to 27,500 psi, pore pressures to 15,000 psi, and temperatures to 500° F.

e. Measure elastic properties of 10 to 30 cores from shales and sandstones including Pleasant Bayou No. 1 Well cores in the laboratory under simulated subsurface temperatures and pressures equal to those encountered in the Pleasant Bayou No. 1 Well.

6. CONTRACT: ENVIRONMENTAL CHARACTERISTICS, DESIGN CRITERIA GUIDELINES, AND SITE SELECTION METHODOLOGY FOR THE BRAZORIA COUNTY AREA

The University of Texas Bureau of Economic Geology is to perform an environmental comparative analysis of candidate sites for geopressured geothermal resource well tests within the Brazoria and Kenedy Counties prospect areas. Available environmental information on candidate test well sites within the prospect areas will be compiled and the methodology for selecting the optimum environmentally acceptable site will be developed.

A planned additional phase of work of providing site environmental monitoring at the Pleasant Bayou No. 1 Well area prior to and during the drilling and long-duration flow testing will require contracting for microseismicity monitoring, first-order leveling, and air and water quality monitoring. The plan and work statement for this monitoring is presently being developed.

The Brazoria and Kenedy Counties analysis effort consists of (1) specifying which environmental characteristics will be analyzed, (2) establishing criteria to determine the impact potential of given characteristics, (3) establishing criteria to decide the relative importance of different characteristics for each candidate well site, (4) compiling data on environmental characteristics for each candidate well site, and (5) applying the decision criteria of Items (1) and (3) to determine the

optimum sites for well tests. Seven tasks are involved in the determination of the optimum environmentally acceptable well site.

a. Determine important environmental characteristics in the areas of interest.

b. Develop site selection methodology using important environmental characteristics.

c. Perform environmental studies of the two county prospect areas.

   (1) Prepare environmental geologic maps.

   (2) Tabulate water quality data.

   (3) Tabulate air quality data.

   (4) Prepare current land use maps.

   (5) Prepare biologic assemblage maps.

   (6) Prepare transparent maps of the above.

d. Perform Site Ranking Analysis.

e. Document Federal and Texas State Agency Regulations concerning the environment.

f. Prepare the final report on environmental assessment and maps for the two selected prospect areas. Designate the optimum environmentally acceptable well site.

g. Prepare and submit the monthly progress reports and the final report and maps to General Crude Oil Company and the DOE.

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