GL00532

SALTON SEA SCIENTIFIC DRILLING PROGRAM

Report of the Fourth Quarter
(July Through September)
FY 1985

December 1985

U.S. DEPARTMENT OF ENERGY
Office of Renewable Energy Technologies
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EXECUTIVE SUMMARY

During the fourth quarter of FY-1985, plans for the Salton Sea Scientific Drilling Program (SSSDP) received final revisions prior to drilling. Due to an earlier reduction in scope, the SSSDP schedule was modified and, in conjunction, management responsibilities reorganized. Accordingly the project is proceeding on a new schedule.

At the beginning of the fourth quarter (FY-1985), the SSSDP engineering design was complete and site preparation was underway. Site preparation and equipment procurement were primary objectives in the fourth quarter. Final well design and drilling plans were developed and approved. The drilling permit was issued by the State of California, Division of Oil and Gas. Dikes were repaired, the site dewatered, and the mud pit and brine pond were excavated. Procurements included: electrical and telephone lines, office and work trailers, a drilling contractor, casing, a wellhead, and scientific instrumentation. The drilling contract was awarded to the Cleveland Drilling Company. Also a drilling supervisor was selected.

Scientific instruments were tested and procedures outlined. The objectives and requirements of all participants involved in the SSSDP were considered in the development of a comprehensive scientific plan, a General Logging Plan, and a Quality Assurance Plan.

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INTRODUCTION

The Salton Sea Scientific Drilling Program (SSSDP) is a scientific research effort of the U.S. Department of Energy (DOE), the U.S. Geological Survey (USGS) and the National Science Foundation (NSF). The intent of the program is to integrate selected scientific and engineering studies of the Salton Sea hydrothermal system into an overall comprehensive investigation of an active continental spreading zone located in southern California's Imperial Valley. Scientific experiments to be performed in the SSSDP wellbore, and upon samples collected during the drilling phase of the program, can be broadly categorized in areas of geochemistry, petrology, geophysics, and bio-organic studies. Engineering studies have been significantly reduced (for required cost savings) to three short-term flow tests, due to elimination of the brine injection well and large-scale flow test facility. The 30 or more planned studies to be carried out will assist in determining relationships within the hydrothermal system between fluid chemistry, mineralogy, and micro-organisms.

PROGRAM PLAN

Current Program

As discussed in previous quarterly reports, the SSSDP has been considerably down-scaled from the original concept because of the escalation of estimated costs. Cost reduction was achieved by elimination of certain elements of the program relating to reservoir engineering, including a brine disposal well, a large-scale flow test facility and a long-term flow test. However, the project has been on schedule since May 5, 1985 and, given the forecast cost of the project, is currently within budget. With the changes incorporated into the project plan, the revised total cost estimate for the overall drilling, engineering and data gathering parts of the project has been established at 6.2 million. Bechtel's cost estimates have been based on overall project costs for a unique venture. Project costs related directly to drilling compare favorably to costs of other wells in the vicinity.

As a result of the scaling down of the SSSDP and other factors, changes were made in management positions. Figure 1 shows the present management positions. Changes of particular note were made in the positions of DOE/SAN Operations project manager and Chairman of the Science Coordinating Committee (SCC).

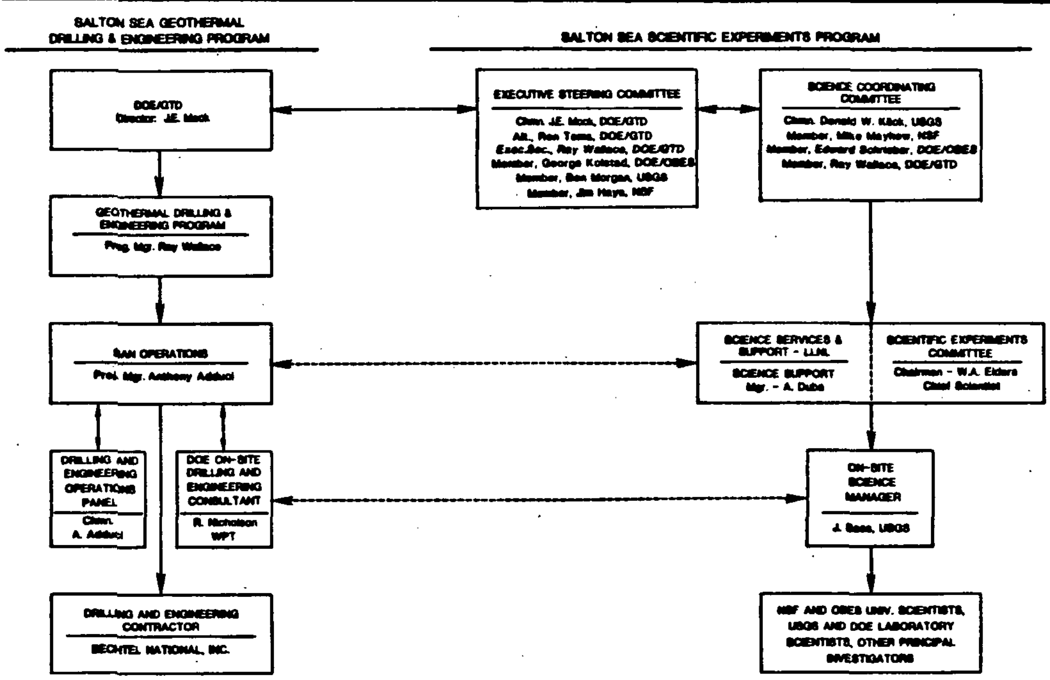

Figure 1: SSSDP MANAGEMENT PLAN

The revised engineering program design and site preparation work were completed, and drilling was scheduled to begin in mid-October. The SSSDP site lay-out is presented in Figure 2. Above ground piping from the wellhead through the test facility are shown in the diagram. With the site plan approved, site preparation and equipment procurement were the focus of the project for the reporting period. The locations of facilities for use in supporting the scientific and drilling activities were also planned. Due to delays in surface facilities fabrication and equipment procurement, the SSSDP spud date was extended to October 23, 1985.

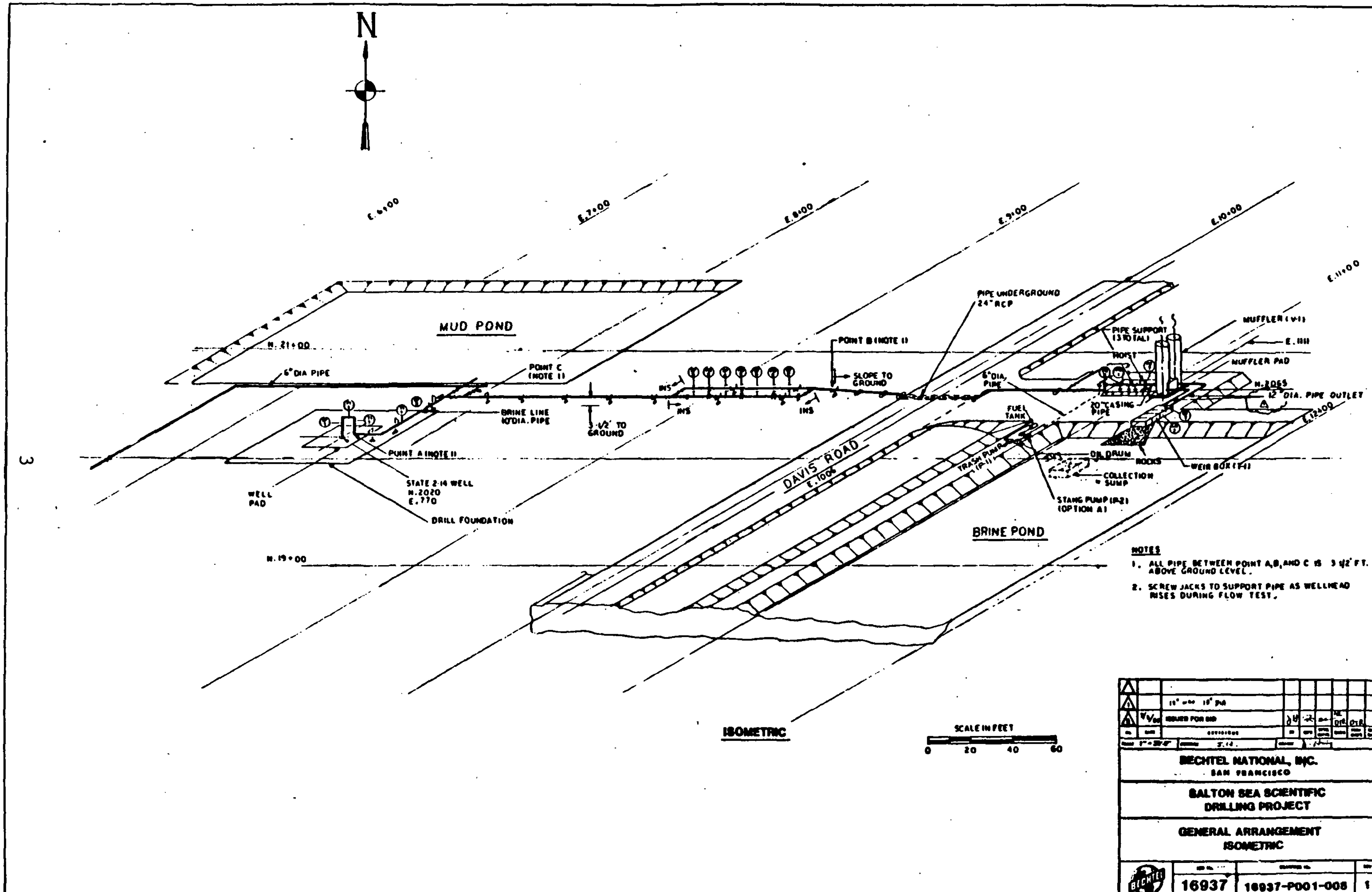

FIGURE 2: Isometric Site Plan

The revised SSSDP is summarized below:

1. Drill to a target depth of 10,000 ft. The first production casing will be set at 3,000 ft and the second at 6,000 ft;

2. Collect drill cuttings at 30 ft intervals above 3,000 ft, at every 20 ft interval to 6,000 ft; and at every 10 ft interval to total depth. It is anticipated that about 800 ft of 5.25-inch core will be obtained above 6,000 ft and that 900 ft of 4-inch core will be obtained below 6,000 ft;

3. Flow test and sample the fluids from the first production zones encountered below the 3,000 ft and 6,000 ft casing points; and flow test and sample fluids from the open interval below 6,000 ft to total depth through a slotted 7-inch liner;

4. Carry out a comprehensive program of open-hole wireline logging using high temperature tools and cables, including measurement of temperature;

5. Make repeated pressure/temperature logs during a period of quiescence until the well reaches thermal equilibrium;

6. Keep the well available for other downhole studies for a period of at least six months (quiescent period) after completion.

Drilling and Engineering Program

Through the reporting period, site preparation and procurement of services, supplies, materials, and equipment were the main emphases of the SSSDP's drilling and engineering program. Surface site preparation work was completed during this time as the mud pit and brine pond were excavated following dike repair and dewatering. Electrical and telephone communication lines were installed in addition to the office and work trailers. Procurement items included subcontracts for excavation, drilling rig, casing, wellhead, and a drilling supervisor. Other items in various stages of procurement include construction of flow-test facilities; tool and equipment rentals; and cementing, mud logging, and commercial geophysical logging services.

Drilling Preparation and Services

The final well design (Figure 3) was approved and a drilling permit issued by the California Division of Oil and Gas (CDOG) in August. Casing design changes requested by the CDOG were to increase the 30" surface string from 100 to 150 feet and to reduce the 20" casing requirement from 1,500 to 1,000 feet: The net result of these changes required that a large capacity drilling rig be used to install the longer (150') surface casing (30") string.

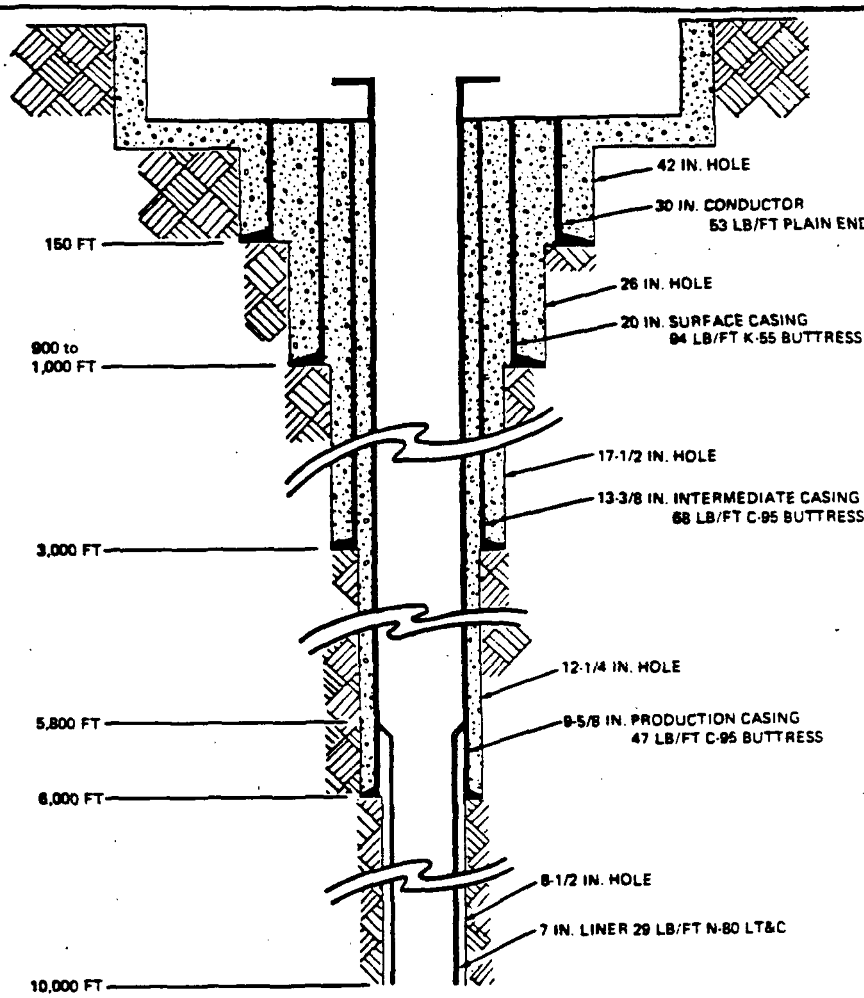

FIGURE 3: Final Well Design

The actual drilling services contract for the SSSDP was approved by DOE/SAN and let by Bechtel. The contract, amounting to approximately $1,150,000, was awarded to Cleveland Drilling Company. Another contract was let for the purchase of high-temperature logging cable, which was scheduled for delivery by mid- to late-October. The contract was awarded to Vector Cable Company of Sugarland, Texas.

Bids were also received for construction of the flow test facilities. The successful bid was submitted by Mustang Engineering for $274,365 with a proposed construction schedule of 5 1/2 weeks from the date of award. The Chief Scientist, through NSF funding, retained Dr. D.E. Michels to review and advise on the final design of these facilities. Several modifications were incorporated as a result.

Coring costs continued to be of concern in overall planning of the drilling phase of the project. In an effort to track and control costs, a cost-of-coring methodology, based upon various scenarios, was devised by Bechtel. The pertinent equations for deriving costs for coring in 30-foot and 60-foot lengths are listed in Table 1. A summary "cost-to-core" graph for quickly estimating coring cost at any depth is presented on Figure 4.

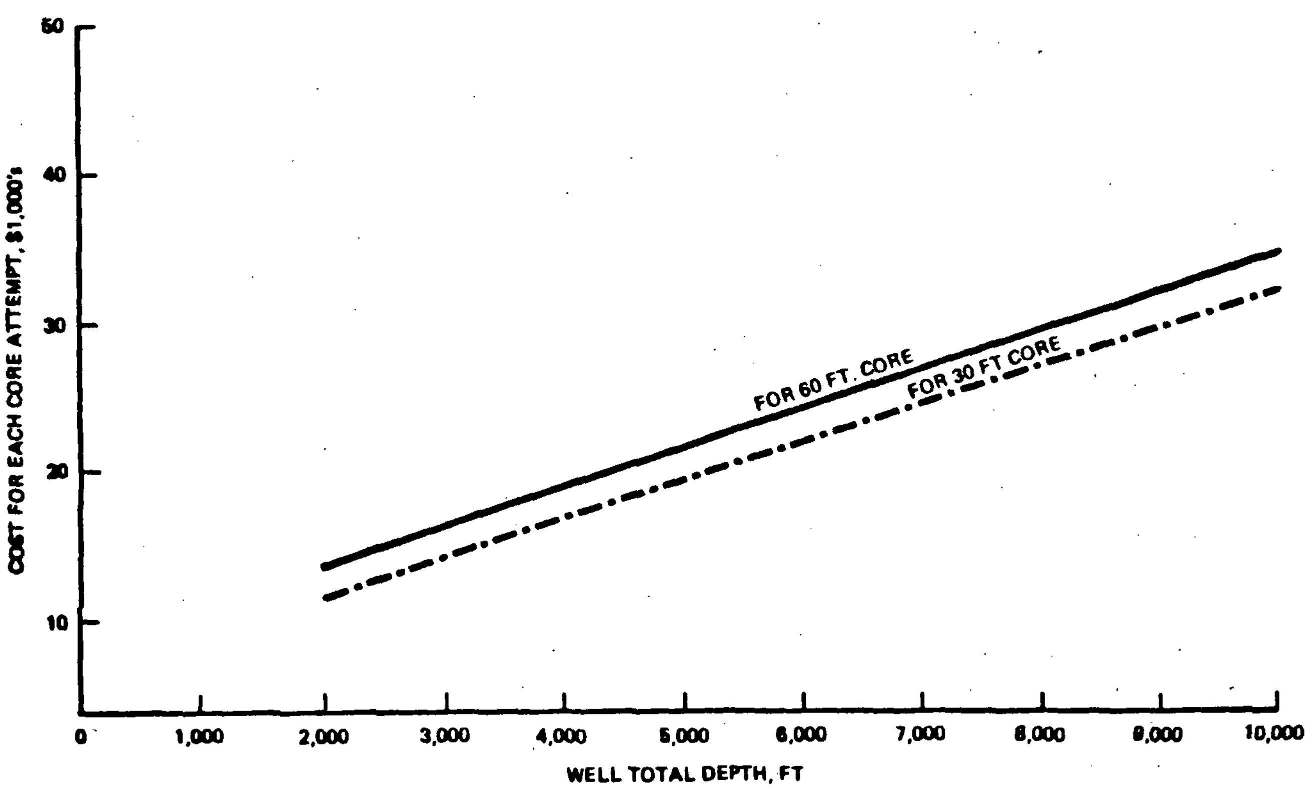

FIGURE 4: Estimated Coring Cost Per Attempt vs. Well Depth

Table 1: Cost-to-Core Summary of Pertinent Equations for 30 and 60 Foot Cores (after Bechtel).

Basis:	1,500 ft/hr trip time 40 min/1,000 ft. circulation time 8 ft/hr coring rate

THIRTY FOOT CORES:

Coring time (alone; no logging or bit change)

$$C.T._{A(30)} = 6.75\ hr + (5.333 \times 10^{-3}\ hr/ft)\ (depth - ft) \quad 1$$

Coring time (when bit change or well logging occurs)

$$C.T._{B(30)} = 5.75\ hr + (2.667 \times 10^{-3}\ hr/ft)\ (depth - ft) \quad 2$$

Cost Per core f(time)

$$CC_{(30)} = 2{,}954 + \$496.5/hr\ (CT)$$

where CT = hours associated with coring sequence

Cost per core(A) f(depth) (alone; no logging or bit change)

$$CC_{A(30)} = \$6{,}305 + (\$2.65/ft)\ (depth - ft) \quad 4$$

Cost per core(B) f(depth) (when bit change or well logging occurs)

$$C.C._{B(30)} = \$5{,}809 + (\$1.32/ft)\ (depth - ft) \quad 5$$

SIXTY FOOT CORES:

Coring time (alone; no logging or bit change)

$$C.T._{A(60)} = 10.5\ hr + (5.333 \times 10^{-3}\ hr/ft)\ (depth - ft) \quad 6$$

Coring time (when bit change or well logging occurs)

$$C.T._{B(60)} = 9.5\ hr + (2.667 \times 10^{-3}\ hr/ft)\ (depth - ft) \quad 7$$

Cost per core f(time)

$$C.C._{(60)} = \$3{,}282 + (\$496.5/hr\ (CT))$$

CT = hours associated with coring sequence

Cost per core(A) f(depth) (alone; no logging or bit change)

$$C.C._{A(60)} = \$8{,}495 + (\$2.65/ft)\ (depth - ft) \quad 9$$

Cost per core(B) f(depth) (when bit change or well logging occurs)

$$C.C._{B(60)} = \$7{,}999 + \$1.32\ (depth - ft) \quad 10$$

Equipment and Materials

Dewared temperature and pressure tools, obtained through Sandia National Laboratories and developed by the Kuster Company, were fabricated and tested. A schematic diagram of the pressure tool is shown on Figure 5. Initial downhole measurements using bare Kuster tools will be made during shallow drilling operations. As the drilling progresses and higher temperatures are achieved in the well, the dewared tools run on "slickline" will be the only means for obtaining downhole measurements.

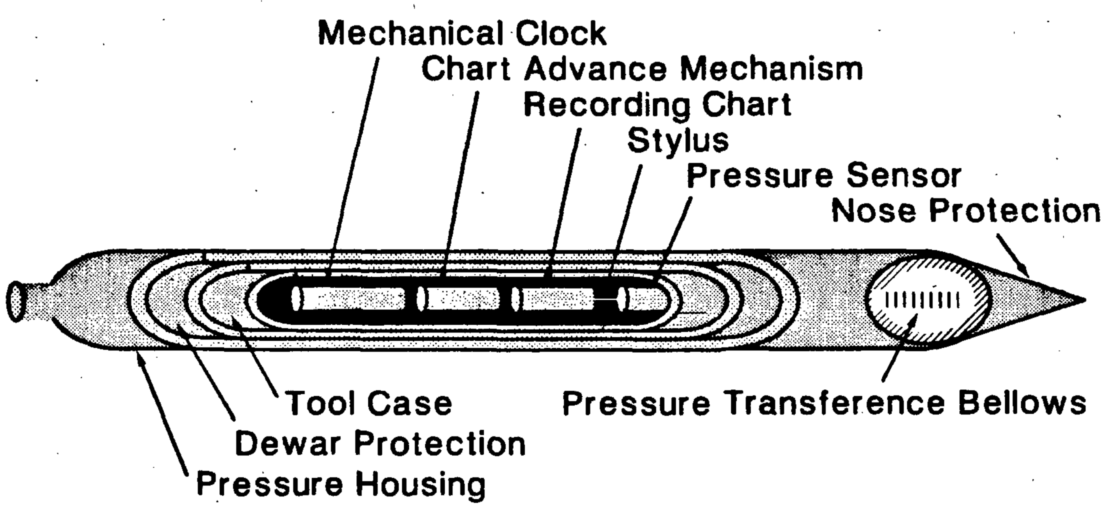

FIGURE 5: Schematic Representation of a Mechanical Pressure Tool

Battery packs for two downhole fluid samplers, provided by Los Alamos National Laboratory (LANL), were assembled by Sandia National Laboratory (SNL) and scheduled for final testing in October (Figure 6). The power packs were designed to operate the fluid samplers under high-temperature, high pressure, corrosive conditions. The sampling devices are designed to be lowered on either conducting or nonconducting cable to obtain critical fluid samples at selected depths within the scientific well. The battery packs will not be used to power the fluid samplers while the samplers can be successfully operated from signal-conducting wireline. Therefore, the power packs will probably not be used until early spring, when fluid samples are required from depths close to the total depth of the well.

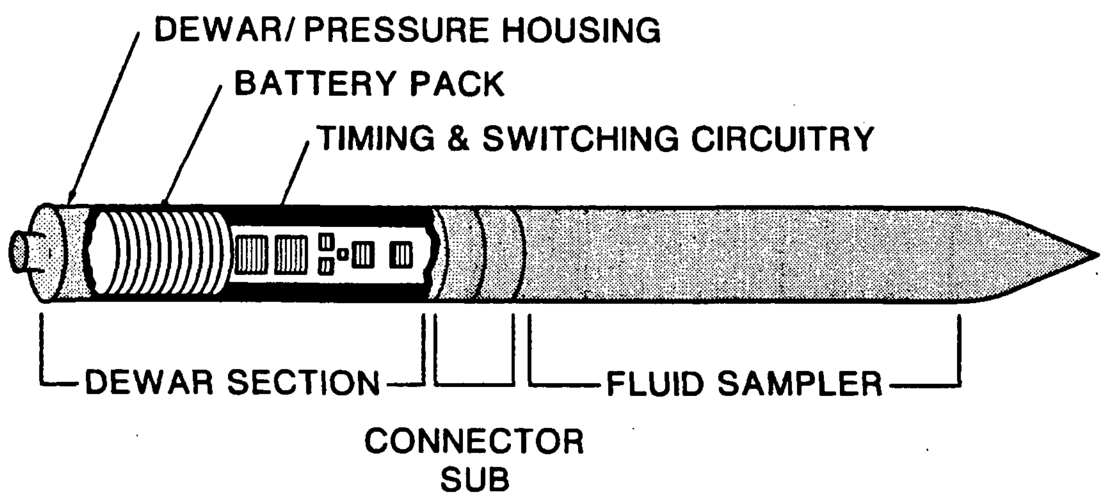

FIGURE 6: Schematic Diagram of the Sandia/LANL Downhole Fluid Sampler

The cementing program, including equipment, materials, procedures and possible cementing alternatives depending upon downhole conditions, were discussed at preliminary meetings with Halliburton well service company. The cementing program will use the types of additives dictated by temperature and depth. The program calls for Halliburton to perform laboratory tests to determine the properties of various types of cement with respect to temperature prior to performing cementing operations in the well.

Scientific Experiments Program

Logging and Downhole Experiments

A General Logging Plan was developed for the SSSDP, and logging and downhole scientific experiments were scheduled by the On-site Science Manager (Table 2). Downhole experiments will use a single conductor, TFE-insulated, MP35N-armored and sheathed cable. Tools will be deployed in the well with the well shut-in and the wellhead cool. Downhole experiments to be run during flow testing will be deployed on a slickline by a contractor. A geothermal logging truck, on location, for those occasions requiring the Vector 7-conductor, TFE-insulated, MP35N armored and sheathed cable (up to 315°C), will be provided by the USGS Water Resources Division.

TABLE 2: General Logging Plan

Approx. Date	Depth	Log	Operator
Oct. 10		spud date	
Oct. 28	3000′ ±	production logs	Contractor
		USGS geophysical logs	Morin
		CASING (13 3/8")	
		cement bond logs	Contractor
Nov. 4	3500′ ±	Temperature log	WRD hoist - Morin or Sass
Nov. 11		FLOW TEST	T, P, F - dewared Kuster tools in drill pipe - Contractor
		fluid sampling	post-flow test, WRD or GD hoist - Sass, F. Goff
		borehole televiewer (?)	Morin
	4000′ ±	BHT	WRD or bare Kuster in drill pipe or dewared
	5000′ ±	BHT	Kuster in open hole (depends on temp.) - Sass
Dec. 15	6000′ ±	BHT	dewared Kuster, slickline, openhole - Sass
		production logs	Contractor
		USGS geophysical logs	Morin
		CASING (9 5/8")	
		cement bond logs	Contractor
Dec. 25	6500′ ±	temperature log	dewared Kuster tools, - Sass
Jan. 1		FLOW TEST	T, P, F - dewared Kuster, open hole, slickline - Contractor
		fluid sampling	post-flow test, GD hoist - Sass
		borehole televiewer (?)	Morin
	7000′ ±	BHT	dewared Kuster, openhole, GD hoist - Sass
	8000′ ±	BHT	dewared Kuster, openhole, GD hoist - Sass
	9000′ ±	BHT	dewared Kuster, openhole, GD hoist - Sass
Mar. 20	TD (10000′)	USGS geophysical logs (?)	Morin, (depends on temp.)
		set 7" liner	
		release rig	
		T log	electronic temperature tool - Sass
		FLOW TEST	T, P, F dewared Kuster, openhole, slickline - Contractor
		fluid sampling	post flow test, GD hoist - Sass, F. Goff
		VSP	McEvilly
		gravity	Hearst
		fluid inclusion sampling	GD hoist, Bethke, Sass
		serial T logs	electronic temperature tool, - Sass

Also at the site, a science lab trailer and a ramada will be accessible. The science lab trailer will be used for on site experiments that require a certain degree of urgency, but uncomplicated equipment. The ramada is designed primarily for processing, examining, and boxing core samples, and has available electricity and running water (non-potable). The ramada is suitable for assembling and disassembling water samplers, Kuster tools, etc.

The locations of the different facilities are diagrammed on Figure 7. The ramada and the science lab trailers are located near the mud logger's trailer, adjacent to the rig substructure and the mud pit. Slightly further off-site are located the offices and the Science Headquarters Trailer. The Science Headquarters Trailer houses a small workshop, kitchen and living facilities.

Sample and Data Acquisition Procedures

Conflicting requirements of the various scientific experiments regarding samples and data led to the issuance of general guidelines by the Science Experiments Committee (SEC) to "harmonize interaction between the participants." The procedures outlined by the Science Experiments Committee were:

A. On-site Scheduling

Dr. John Sass is the On-site Science Manager. He and his staff are responsible for scheduling and overseeing all on-site science activities and communications between the drilling program and the science program. A DOE-approved On-site Procedures Manual has been prepared by Bechtel. All on-site investigators will be required to read it and abide by the procedures.

B. Downhole Logging

In addition to commercial logging, Dr. Fred Paillet and other USGS personnel will coordinate and run multiple downhole logs. An attempt will be made to process digital log data on site.

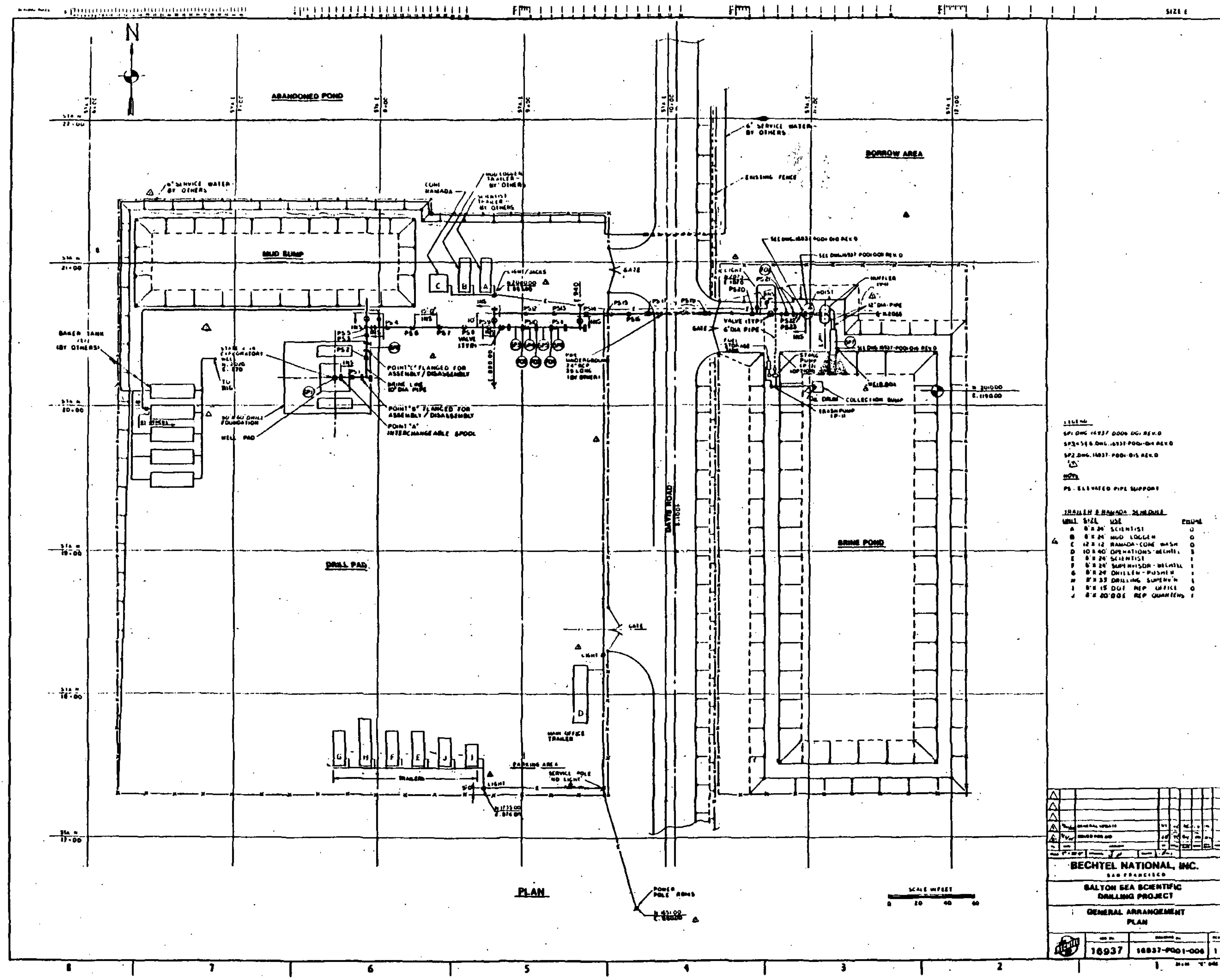

FIGURE 7: Block Site Plan

C. Fluid Sampling

During flow tests Dr. Donald E. Michels will be responsible for coordinating fluid sampling and acquisition of the ancillary data necessary to assist the geochemistry program.

D. Lithologic Sampling

A mud-logging service company will take cuttings samples and prepare a preliminary running lithologic log. These, together with the cores, will be curated at the University of California by Dr. Wilfred A. Elders, who will be responsible for preparing lithologic descriptions and providing sample splits to approved investigators, as requested.

E. On-site Records

Lawrence Livermore National Laboratory (LLNL) will install a well-log computer system on-site. This system will maintain composite geophysical logs and store relevant geological, geochemical, and scientific data in addition to information from other wells in the field. Analog copies of well logs, lithologic logs, and geochemical analyses will be available on-site, to appropriate technical and scientific personnel.

F. Release of Preliminary Records

In all such cases, the records generated on-site will be labeled "Preliminary SSSDP Data; not for reproduction or public inspection." Similarly, preliminary laboratory data may be made available to guide field operations with the same restrictions. Such data may be cited or released publicly only with the written consent of the Chief Scientist and the principal investigators concerned.

G. Initial Reports

Principal investigators will forward "letter reports" of their preliminary findings to the Chief Scientist within 6-months of completion of the drilling of the well. The Chief Scientist will distribute these informal reports among the investigators, for their mutual benefit, subject to the same restrictions on publication and citation outlined in F above.

H. Conference Proceedings

Within 12 months of the completion of the well, an initial SSSDP conference will be held. In return for the opportunity of participating in the SSSDP, it is expected that investigators will make the initial publication of their results in the proceedings volume arising from this conference.

I. Archiving

At the conclusion of the initial phase of the project, following DOE protocols, samples and records will be archived at a DOE facility in Grand Junction, Colorado.

J. Coordination and Mediation

The Chief Scientist is responsible for overall coordination and implementation of these policies of the Science Experiments Committee. In this role, he will act as an intermediary between investigators, but may elect to refer sensitive decisions to the committee.

In addition to the protocol for scientific data, an On-site Procedures Manual has been prepared by Bechtel that describes safety requirements, on-site responsibilities, and coordination of activities. Daily reports distributed to the On-site Science Manager, project scientist, and DOE representative will include:

1. Tower report
2. Drilling report
3. Morning report
4. Afternoon report
5. Mud logger report
6. Mud log
7. Daily mud company's report
8. Wireline and slickline logs
9. Flow test report
10. Coring report
11. Drill pipe inspection report
12. Casing inspection report
13. Casing talley report
14. Drill pipe talley
15. Deviation survey
16. Final bit record
17. Other special reports

Project Schedule

The schedule has been modified due to the overall project down-scaling and revisions. The current project schedule is illustrated in Figure 8. The major SSSDP activities for the reporting period were procurement of services and site preparation that included: trailers, mud logging services, casing, excavation, electrical lines, and trailer hook-ups among others. The spud date was expected to be October 23, 1985.

The integration of scientific experiments into the overall drilling plan is underway. As of mid-August more than 30 proposals had been approved by the Science Coordinating Committee (SCC) and funded by the participating agencies. Several engineering and scientific plans, including the On-site Procedures Plan, Site Safety Plan, Quality Assurance Plan and General Logging Plan for SSSDP were in final preparation stages. Dissemination of scientific information and releases of both preliminary and primary results are anticipated, and being organized.

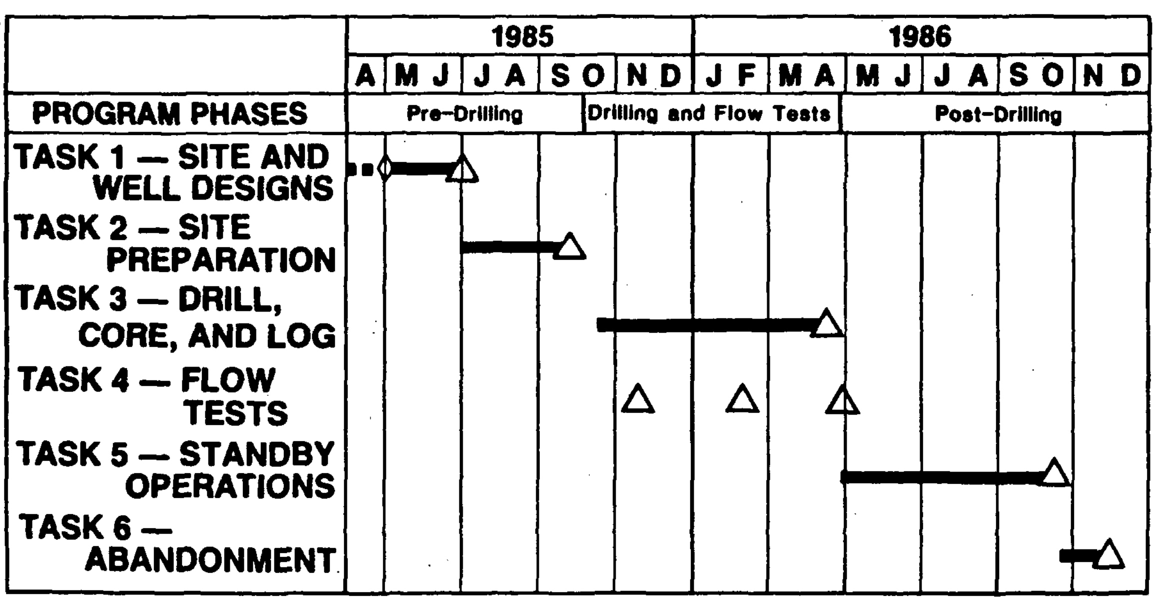

FIGURE 8: Overall Project Plan

SIGNIFICANT MEETINGS

Executive Steering Committee (ESC) Seventh Meeting; July 10, 1985

The meeting was convened at DOE Headquarters in Washington D.C., and covered revisions in the SSSDP plan that resulted from the overall reduction in project scope. At the conclusion of the meeting, the ESC endorsed two major recommendations: 1) modify the schedule to include the original requirement that the well remain accessible for scientific activities for approximately one year after completion, and 2) ask the SEC to prepare a priority matrix for possible scientific trade-offs.

Scientific Experiments Committee (SEC) Meeting; July 22, 1985

A meeting was held at DOE/SAN offices with representatives from DOE and the SEC. At the meeting, the decision was made not to further delay the project for the delivery of high-temperature logging cable. The collection of fluid samples from the first lost-circulation zone below 3000 feet and below 6000 feet from interim flow tests was approved by the SEC at the meeting, even though certain risks were involved. Other business discussed included core bits and equipment, which were acceptable to the attendees, and extension of the projected post-completion standby time from 4 to 6 months.

DOE/SAN Meeting; July 24, 1985

Site responsibilities were discussed and agreed to be divided between: 1) John Sass-coring & instrumentation; and 2) Wilfred Elders - flow tests. Other decisions made during the meeting were to:

- reinvest surplus money into the scientific program;
- perform flow tests and take fluid samples at lost-circulation zones below 3000 and 6000 feet; and
- reserve a minimum of 250 hours of rig time for running downhole scientific instrumentation.

The meeting attendees agreed that:

- o the drilling period should be 5 to 6 months,
- o the high-temperature cable delivery would not delay the spud date, and
- o the site lay-out was satisfactory.