HOLE HISTORY
ROTARY HOLE DC-3
HANFORD, WASHINGTON
OCTOBER, 1977

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INTRODUCTION

Borehole DC-3 was drilled by Century Drilling Company, Shelby, Montana, under subcontract to Fenix & Scisson, Inc. The hole was drilled for the U. S. Department of Energy and the Rockwell Hanford Operations' Department of Waste Isolation. Fenix & Scisson, Inc. furnished the engineering and daily supervision of the drilling activities.

The purpose of hole DC-3 was to drill into the Umtanum basalt flow using both conventional rotary and core drilling methods. The borehole is to be utilized for geophysical logging, future hydrological testing, and the future installation of a borehole laboratory for long-term pressure, seismic, and moisture migration or accumulation recording in the Umtanum basalt flow in support of the Basalt Waste Isolation Program.

Hole DC-3 is located east of the 200 West barricaded area on the Hanford reservation. The Hanford reservation coordinates for hole DC-3 are North 43,802 feet and West 70,156 feet. The location is depicted on the site map, Figure 1.

Drilling commenced August 6, 1977 and the total depth, 3,635 feet, and final geophysical logging suite were completed October 4, 1977. The drilling progress curve for DC-3 is shown in Figure 2.

As-built, 9-5/8-inch outside diameter casing extends from surface ground level to 3,575 feet. The open hole section extends from 3,575 feet to 3,635 feet and is an 8-5/8-inch diameter hole. Figure 3 is the as-built diagram of hole DC-3.

SUMMARY

Century Drilling Company utilized rotary Rig Number 1 - Brewster Model N-4A for drilling and construction of borehole DC-3. Mobilization of the rig onto the Hanford reservation began August 1, 1977. A 26-inch diameter conductor hole was spudded August 6, 1977. The conductor hole was drilled to 34 feet (all depths recorded in this report are those measured from surface ground level) and 29 feet of 20-inch outside diameter conductor casing was set and cemented. The casing was cemented with 100 cubic feet of Type II neat cement. The cement was poured into the annulus around the conductor casing.

A 17-1/2-inch surface hole was drilled from the conductor hole to 1,460 feet. The deviation of the borehole from vertical at 1,460 feet was zero. Table I lists the various depths of deviation surveys performed during the drilling of DC-3.

Several minor hole problems or drilling obstacles occurred while drilling from 34 feet to 1,460 feet. At a drill depth of 1,207 feet, 82 feet of sand fill was encountered after making a bit trip. Then at 1,403 feet, lost circulation occurred and sand from an interbed caved in around the bottom hole assembly causing a stuck drill string. Diesel oil, 2,800 gallons, was circulated and the drill string was worked free. After tripping out of the hole, a sand bridge was encountered from 1,075 feet to 1,115 feet. The bridge and last 70 feet of hole were reamed out and the caving sand was circulated from the hole.

A non-dispersed polymer mud system was utilized for the drilling mud. The caving sand problems occurred immediately after lost circulation and after a bit trip. Both lost circulation and a trip from the hole caused reduction in hydrostatic pressure due to a decrease in the length of the annular or open hole mud fluid columns, respectively. The sands penetrated by the borehole are highly porous water-bearing interbeds with an approximate normal pore pressure. When the borehole hydrostatic pressure is reduced due to lack of normal mud fluid level, the pore pressure from the sands overbalances that exerted within the borehole causing the sand to flow into the annular or borehole space. The record of the daily mud properties analyzed is presented in Table II.

Surface casing, 13-3/8-inch outside diameter, was run to 1,450 feet. The as-built tally for the surface casing is presented in Table III. The design criteria for the surface casing are shown in Table IV. The casing was cemented to surface with 1,400 cubic feet of Class G-Pozzolan (1 to 1 ratio) salt saturated cement containing 2 percent bentonite. Furthermore, the last 200 cubic feet of cement contained 2 percent calcium chloride. Approximately 300 cubic feet of cement slurry was circulated from the casing annulus to the reserve pit. The cementing details are presented in Table V.

A 12-1/4-inch diameter hole was drilled from the surface casing on August 28, 1977. The 12-1/4-inch hole was drilled from 1,460 feet to 3,300 feet. No hole problems were encountered. Tungsten carbide chisel tooth insert tri-cone bits were utilized for all rotary drilling below the conductor casing. The

performance for each bit used is recorded in the bit record, Table VI. The average footage drilled by the tri-cone bits used for rotary drilling borehole DC-3 exceeded 390 feet.

While drilling from 1,460 feet to 3,300 feet, two suites of geophysical logs were run. The first suite was run at a total drilled depth of 2,580 feet and the second suite at 3,094 feet. The two suites consisted of the same logging runs. The details of the type of logs and depth intervals of measurement are presented in the geophysical logging record, Table VII.

At a depth of 3,300 feet, core drilling of an 8-5/8-inch diameter hole commenced. Core drilling continued to 3,479 feet. An 8-5/8-inch diameter tri-cone bit was used to conventionally drill from 3,479 feet to 3,490 feet. Core drilling reconvened for 2 more feet to 3,492 feet. The hole was rotary drilled from 3,492 feet to 3,573 feet. The hole was then core drilled to 3,575 feet.

From 3,300 feet to 3,575 feet, the 8-5/8-inch hole was opened to 12-1/4-inch diameter using tri-cone bits. Another suite of logs was run after opening the hole to 12-1/4-inches. The list of logs run is presented in Table VII under the date of operation, September 28, 1977.

Casing, 9-5/8-inch outside diameter, was then run into the 12-1/4-inch hole to 3,575 feet. The as-built tally for the longstring casing is presented in Table VIII. The design criteria for the 9-5/8-inch casing are shown in Table IX. The casing was cemented to surface with 1,554 cubic feet of cement. The cementing details are presented in Table V. Approximately 150 cubic feet of excess cement was circulated into the reserve pit.

The float collar, shoe cement, and guide shoe of the 9-5/8-inch casing were drilled out using an 8-5/8-inch tri-cone bit. Core drilling of new formation from 3,575 feet commenced September 30, 1977. The 8-5/8-inch diameter core hole progressed to a depth of 3,602 feet. A conventional tri-cone 8-5/8-inch bit was then used to drill to 3,630 feet. The final 5 feet of hole was core drilled. The total depth of borehole DC-3 is 3,635 feet.

The vacillation from core drilling to rotary drilling during the final 335 feet of hole was due to time deadline compliance. The hole was scheduled to be complete September 30, 1977. Due to unanticipated stratigraphy changes, the depth of hole DC-3 was 135 below preliminary contract estimates. Core drilling progress proved to be much slower than that of conventional drilling. With these

factors considered, formation intervals of prime interest were core drilled. The record of the coring runs is presented in Table X. The percentage of core recovery was 93 percent. A total footage of 205 feet was core drilled.

Following the drilling of DC-3, a final suite of geophysical logs was run over the open hole interval from 3,575 feet to 3,635 feet. The list of the final logging suite appears in Table VII under the date of operation, October 4, 1977.

Those companies supplying service and equipment for the successful completion of borehole DC-3 are listed in Table XI.

The rig operations ceased October 5, 1977.

DRILLING CHRONOLOGY

- 8-01-77 - Mobilized rig to DC-3 from Montana.
- 8-02-77 - Mobilization completed.
- 8-03-77 - Rigging up; held safety meeting with all drill crews.
- 8-04-77 - Completed rig-up of special equipment.
- 8-05-77 - Mix mud and spud rat hole.
- 8-06-77 - Drilled rat hole, mouse hole, and 26-inch conductor hole to 34 feet; set one joint (29.4 feet) of 20-inch conductor casing and cemented with 100 cubic feet of Type II neat cement.
- 8-07-77 - Wait on cement; drilled 17-1/2-inch hole to 56 feet.
- 8-08-77 - Drilled 17-1/2-inch hole to 199 feet; survey at 196 feet = 3/4 degree.
- 8-09-77 - Drilled 17-1/2-inch hole to 304 feet; survey at 258 feet = 1/2 degree.
- 8-10-77 - Drilled 17-1/2-inch hole to 425 feet; survey at 415 feet = 1/2 degree.
- 8-11-77 - Drilled 17-1/2-inch hole to 538 feet; survey at 478 feet = 1/2 degree.
- 8-12-77 - Drilled 17-1/2-inch hole to 595 feet; survey at 572 feet = 1/4 degree.
- 8-13-77 - Drilled 17-1/2-inch hole to 643 feet; bit trip/ survey at 636 feet = 1 degree.
- 8-14-77 - Drilled 17-1/2-inch hole to 747 feet; survey at 730 feet = 1 degree.
- 8-15-77 - Drilled 17-1/2-inch hole to 800 feet; survey at 793 feet = 1 degree.

- 8-16-77 - Drilled 17-1/2-inch hole to 870 feet; survey at 857 feet = 1 degree.
- 8-17-77 - Drilled 17-1/2-inch hole to 977 feet; survey at 919 feet = 3/4 degree.
- 8-18-77 - Drilled 17-1/2-inch hole to 1,102 feet; survey at 1,043 feet = 1/4 degree.
- 8-19-77 - Drilled 17-1/2-inch hole to 1,160 feet; survey at 1,106 feet = 1/4 degree.
- 8-20-77 - Drilled 17-1/2-inch hole to 1,207 feet; bit trip; 82 feet of bottom hole fill; reamed to total depth; survey at 1,169 feet = 1/4 degree.
- 8-21-77 - Drilled 17-1/2-inch hole to 1,297 feet; survey at 1,292 feet = 1/4 degree.
- 8-22-77 - Drilled 17-1/2-inch hole to 1,403 feet; lost circulation at 1,403 feet; short trip 5 stands; pipe stuck; spotted 2,800 gallons of diesel; work pipe; trip out of hole, mix lost circulation material; survey at 1,354 feet = 1/4 degree.
- 8-23-77 - Trip in hole; reamed through bridge from 1,075 feet to 1,115 feet; reamed through bottom hole fill from 1,333 feet to 1,403 feet; drilled 17-1/2-inch hole to 1,412 feet.
- 8-24-77 - Drilled 17-1/2-inch hole to 1,460 feet; intermittent lost circulation; survey at 1,447 feet = 0 degree.
- 8-25-77 - Circulated to condition hole; short trip; trip out; ran 13-3/8-inch casing to 1,450 feet; pumped 1,400 cubic feet of API Class G 50:50 Pozzolan salt (sodium chloride) saturated cement with 2 percent bentonite (2 percent calcium chloride was added to the last 200 cubic feet); displaced cement with 1,200 cubic feet of mud and 90 cubic feet of water; cement in place at 2100 hours; waited on cement to set.
- 8-26-77 - Waited on cement to set.
- 8-27-77 - Waited on cement; nipped up blowout preventer; test blowout preventer; trip in hole; drilled wiper plug, float collar, shoe cement, and guide shoe.
- 8-28-77 - Drilled 12-1/4-inch hole to 1,512 feet; survey at 1,493 feet = 1 degree.

- 8-29-77 - Drilled 12-1/4-inch hole to 1,542 feet; survey at 1,520 feet = 1 degree; placed 30 cubic feet of cement at surface between conductor casing and 13-3/8-inch casing.
- 8-30-77 - Drilled 12-1/4-inch hole to 1,654 feet; survey at 1,627 feet = 1 degree.
- 8-31-77 - Drilled 12-1/4-inch hole to 1,846 feet; survey at 1,784 feet = 1 degree.
- 9-01-77 - Drilled 12-1/4-inch hole to 1,990 feet; survey at 1,937 feet = 1 degree.
- 9-02-77 - Drilled 12-1/4-inch hole to 2,137 feet; survey at 2,095 feet = 1 degree.
- 9-03-77 - Drilled 12-1/4-inch hole to 2,200 feet; survey at 2,189 feet = 3/4 degree; bit trip.
- 9-04-77 - Drilled 12-1/4-inch hole to 2,375 feet; survey at 2,284 feet = 1 degree.
- 9-05-77 - Drilled 12-1/4-inch hole to 2,559 feet; survey at 2,473 feet = 1 degree.
- 9-06-77 - Drilled 12-1/4-inch hole to 2,580 feet; survey at 2,568 feet = 1/2 degree; trip out of hole, rigged up Schlumberger Well Services, Inc. and ran the following logs: induction electric with spontaneous potential; compensated neutron with formation density; temperature; borehole-compensated sonic with caliper and gamma ray. Tripped in with new bit and drilled 12-1/4-inch hole to 2,585 feet.
- 9-07-77 - Drilled 12-1/4-inch hole to 2,758 feet; survey at 2,757 feet = 1/4 degree.
- 9-08-77 - Drilled 12-1/4-inch hole to 2,897 feet; survey at 2,852 feet = 1/4 degree.
- 9-09-77 - Drilled 12-1/4-inch hole to 3,046 feet; survey at 2,978 feet = 3/4 degree.
- 9-10-77 - Drilled 12-1/4-inch hole to 3,094 feet; trip out; rigged up Schlumberger Well Services, Inc. and ran the following logs: induction electric with spontaneous potential; compensated neutron with formation density; temperature; borehole-compensated sonic with caliper; and gamma ray.

- 9-11-77 - Completed logging; trip in with new bit; drilled 12-1/4-inch hole to 3,173 feet; survey at 3,133 feet = 1/4 degree.
- 9-12-77 - Drilled 12-1/4-inch hole to 3,196 feet; repaired pump; trip out to change shock sub.
- 9-13-77 - Drilled 12-1/4-inch hole to 3,293 feet; survey at 3,272 feet = 1/2 degree; trip out.
- 9-14-77 - Trip in with new bit; drilled 12-1/4-inch hole to 3,300 feet; trip out and layed down 8-inch drill collars; picked up core barrel and tripped in hole; cored 8-5/8-inch hole to 3,308 feet; survey at 3,300 feet = 1/4 degree.
- 9-15-77 - Core drilled 8-5/8-inch hole to 3,328 feet; bit trip; core recovery trip.
- 9-16-77 - Core drilled 8-5/8-inch hole to 3,354 feet; core recovery and bit trip.
- 9-17-77 - Core drilled 8-5/8-inch hole to 3,392 feet; core recovery and bit trip.
- 9-18-77 - Core drilled 8-5/8-inch hole to 3,410 feet; core recovery and bit trip; core recovery trip.
- 9-19-77 - Trip in with new core bit; core drilled 8-5/8-inch hole to 3,423 feet.
- 9-20-77 - Bit trip and core recovery; trip in with new core bit; core drilled 8-5/8-inch hole to 3,434 feet; core recovery and bit trip.
- 9-21-77 - Core drilled 8-5/8-inch hole to 3,449 feet; core recovery and bit trip.
- 9-22-77 - Core drilled 8-5/8-inch hole to 3,466 feet; core recovery and bit trip.
- 9-23-77 - Core drilled 8-5/8-inch hole to 3,479 feet; core recovery trip; layed down core barrel assembly; trip in with 8-5/8-inch tri-cone bit; drilled 8-5/8-inch hole to 3,490 feet; survey at 3,460 feet = 1/4 degree; trip out.
- 9-24-77 - Trip in with core barrel assembly; core drilled 8-5/8-inch hole to 3,492 feet; trip out and layed down core barrel; trip in with tri-cone bit; drilled 8-5/8-inch hole to 3,575 feet; trip out; picked up core barrel assembly and trip in.

- 9-25-77 - Core drilled 8-5/8-inch hole to 3,577 feet; trip out and layed down core barrel assembly; trip in with 12-1/4-inch tri-cone bit; began opening 8-5/8-inch hole to 12-1/4 inches at 3,300 feet.
- 9-26-77 - Reamed 8-5/8-inch hole to 12-1/4 inches; round trip to pick up shock sub.
- 9-27-77 - Completed reaming 8-5/8-inch hole to 12-1/4 inches to 3,577 feet; circulated to condition hole; depth corrected to 3,575 feet from 3,577 feet due to driller tally error; trip out; rig up Birdwell Division of S.S.C.; logging tool hit bridge at 3,555 feet; trip in hole with 12-1/4-inch tri-cone bit; reamed to total depth; trip out to log hole.
- 9-28-77 - Ran continuous dipmeter, seisviewer, induction electric with spontaneous potential, density with gamma ray and caliper, temperature, velocity (3-D), and neutron logs; removed blowout preventer; ran 9-5/8-inch casing.
- 9-29-77 - Completed casing run to 3,575 feet; cemented casing with 1,500 cubic feet of API Class G 50:50 Pozzolan salt saturated cement with 2 percent bentonite (2 percent calcium chloride was added to the last 150 cubic feet); displaced cement 1,554 cubic feet of water; cement in place at 0840 hours; waited on cement to set.
- 9-30-77 - Waited on cement to set; trip in hole; drilled float collar, shoe cement and guide shoe; trip out; pick up core barrel assembly; core drilled 8-5/8-inch hole to 3,578 feet.
- 10-01-77 - Core drilled 8-5/8-inch hole to 3,590 feet; core recovery and bit trip.
- 10-02-77 - Worked on core barrel assembly; core drilled 8-5/8-inch hole to 3,594 feet.
- 10-03-77 - Core drilled 8-5/8-inch hole to 3,602 feet; two trips for core recovery and bit change; trip in with 8-5/8-inch tri-cone bit; drilled 8-5/8-inch hole to 3,630 feet.
- 10-04-77 - Trip out; pick up core barrel assembly; core drilled 8-5/8-inch hole to 3,635 feet; trip out; rig up Birdwell Division of S.S.C.; ran seisviewer, induction electric with spontaneous potential, density with gamma ray and caliper, temperature, velocity (3-D), and neutron logs; rig down loggers.
- 10-05-77 - Operation secured; crews dismissed.

FIGURE 1
SITE MAP FOR HOLE DC-3

FIGURE 2

DRILLING PROGRESS CURVE HOLE DC-3

FIGURE 3

AS-BUILT DIAGRAM HOLE DC-3

TABLE I
DEVIATION SURVEYS

<u>DEPTH</u> <u>(feet)</u>	<u>DEVIATION</u> <u>FROM</u> <u>VERTICAL</u>	<u>DATE</u>	<u>DEPTH</u> <u>(feet)</u>	<u>DEVIATION</u> <u>FROM</u> <u>VERTICAL</u>	<u>DATE</u>
133	1/4°	8/08/77	2,284	1°	9/04/77
196	3/4°	8/08/77	2,378	1/2°	9/05/77
258	1/2°	8/09/77	2,473	1°	9/05/77
321	1/2°	8/10/77	2,568	1/2°	9/06/77
415	1/2°	8/10/77	2,663	1°	9/07/77
478	1/2°	8/11/77	2,757	1/4°	9/07/77
540	3/4°	8/12/77	2,852	1°	9/08/77
572	1/4°	8/12/77	2,978	3/4°	9/09/77
636	1°	8/13/77	3,133	1/4°	9/11/77
667	3/4°	8/14/77	3,272	1/2°	9/13/77
730	1°	8/14/77	3,300	1/4°	9/14/77
793	1°	8/15/77	3,460	1/4°	9/23/77
857	1°	8/16/77			
919	3/4°	8/17/77			
981	1/2°	8/18/77			
1,043	1/4°	8/18/77			
1,106	1/4°	8/19/77			
1,169	1/4°	8/20/77			
1,231	1/4°	8/21/77			
1,292	1/4°	8/21/77			
1,354	1/4°	8/22/77			
1,447	0°	8/24/77			
1,493	1°	8/28/77			
1,520	1°	8/29/77			
1,564	1°	8/30/77			
1,627	1°	8/30/77			
1,689	1/2°	8/31/77			
1,784	1°	8/31/77			
1,846	3/4°	9/01/77			
1,937	1°	9/01/77			
2,001	1°	9/02/77			
2,095	1°	9/02/77			
2,189	3/4°	9/03/77			

TABLE II
MUD RECORD

DATE	DEPTH	WEIGHT	VISCOSITY		YP	GELS	pH	FILTRATION	ANALYSIS		SAND	RETORT		CED	
1977	feet.	lb/gal	Sec API	PV		10 s. 10 m.	ml API	Cake 32nds	pf Mf	Cl ppm	Ca ppm	%	Solids %	Water %	Mud me/ml
8-5	Spud	8.7	115	13	62	44/45	7.0 15.4	4	.05 .35	400		tr.	3	97	
		Drilling - unconsolidated gravel beds.													
8-6	Spud	8.7	100	13	57	35/50	8.0 11.4	3	.05 .20	400		.25	3	97	
		Losing fluid over shaker - bypassed.													
8-7	30	8.5	60	11	14	6/14	7.5 18	3	.1 .2	500		tr.	2	98	
		Jetted pits - buildup of drilled solids.													
8-8	102	8.7	30	3	7	2/4	8.0 61	5	.3 .4	200 40	1.0		2	98	
		Low on materials - adding lime for viscosity													
8-9	240	9.2	48	30	13	3/9	8.0 10.8	3	.1 .2	250		9.0	8	92	
		Drilling ahead with shaker bypassed.													
8-10	320	9.2	48	15	23	2/5	8.0 8.6	3	.5 1.5	250		1.5	6	94	
		Moderate hole fill between connections.													
8-11	470	9.5	48	26	15	3/12	7.0 10.2	3	.05 .15	250					
		Drilling ahead in basalt.													
8-12	550	9.2	45	14	18	2/4	7.0 11.4	2	.0 .15	200		2.5	6	94	
		Drilling ahead in basalt.													
8-13	608	9.2	46	22	11	2/4	7.0 10.2	2	.0 .1	150		1.5	6	94	
		Pull out of hole and change bit.													
8-14	681	9.3	46	20	15	2/5	7.0 12	3	.0 .15	150		2.5	7	93	
		Drilling ahead with shaker partially bypassed.													
8-15	761	9.0	41	14	8	2/3	7.0 11.4	2	.0 .2	150 20		tr.	5	95	
		Drilling ahead with desilter running.													
8-16	816	9.0	47	20	20	4/8	7.0 11.4	2	.0 .2	100 20		.25	5	95	
		Drilling ahead with shaker partially bypassed.													
8-17	924	8.9	40	12	13	3/7	7.5 12.9	2	.1 .25	100 20		.75	4	96	
		Drilling ahead with shaker bypassed.													
8-18	997	8.9	44	19	8	1/3	8.0 11.4	3	.05 .25	150 15		tr.	4	96	
		Drilling ahead with shaker partially bypassed.													
8-19	1117	8.9	46	18	11	2/4	7.0 10.8	2	.0 .15	150 30		.25	4	96	
		Drilling ahead, increasing viscosity.													
8-20	1180	8.9	47	20	22	3/6	7.0 10.4	3	.0 .25	150		.25	4	96	
		Drilling ahead.													
8-21	1228	8.8	50	23	18	3/6	7.0 11.4	2	.0 .15	125		tr.	3.5	96.5	
		Trip to change bit. Viscosity cut by formation water.													

TABLE II - MUD RECORD (Continued)

DATE	DEPTH	WEIGHT	VISCOSITY	YP	GELS	pH	FILTRATION	FILTRATE ANALYSIS	SAND	RETORT	CEC		
8-22	1373	8.9	52	22	25	8/13	7.0 10.5	3	.0 .2	150	.25	4	96
		Drilling ahead in sand & clay - need shaker.											
8-23	1406	8.9	120	24	54	18/31	7.0 9	3	.0 .3	100	9.0	6 6	88
		Lost circulation, add L.C.M.; tight hole, add diesel.											
8-24	1440	9.1	84	32	36	10/22	7.0 9	3	.0 .25	125	5.0	6 4	90
		Drilling ahead with periodic lost circulation.											
8-25	1460	9.0	85	22	39	9/15	7.0 9.2	3	.0 .15	125	5.0	5 4	91
		Circulate and condition hole for casing.											
8-26	1460	8.4	30	4	3	2/2	9.0 32	3	.6 .9	150	tr.	1	99
		Mix mud.											
8-27	1460	8.4	30	4	3	2/2	9.0 32	3	.6 .9	150	tr.	1	99
		Waiting for cement to set up.											
8-28	1466	8.4	38	7	33	10/10	12.5 36	6	1.1 1.3	200	tr.	1	99
		Drilling cement, add Soda Ash.											
8-29	1530	8.6	32	5	10	7/8	12.0 36	5	.7 .9	175	.75	2 1	97
		Drilling ahead.											
8-30	1560	8.6	30	5	5	5/6	11.5 34.5	5	.6 .7	150	.25	2 1	97
		Pull out of hole and re-cement. Run in hole and ream 10' to bottom.											
8-31	1705	8.7	32	10	3	0/2	9.0 17	3	2.5 .35	150	.25	3	97
		Drilling ahead.											
9-1	1904	8.8	30	6	3	0/1	9.0 12.6	3	.1 .2	100	tr.	3	97
		Drilling ahead.											
9-2	2035	8.8	32	8	2	0/1	9.0 12	3	.05 .2	100	tr.	3	97
		Drilling ahead.											
9-3	2165	8.9	33	9	2	0/1	7.5 10.2	2	.05 .25	100	re.	4	96
		Drilling ahead, possible fluid loss to formation.											
9-4	2253	8.9	34	15	3	0/2	7.0 10.5	3	.0 .25	100	tr.	4	96
		Pull out of hole, change to bit #6. Run in hole & ream.											
9-5	2432	8.9	41	21	6	2/2	7.0 11.4	3	.0 .2	100	20 tr.	4	96
		Increased viscosity, condition mud for logging.											
9-6	2580	Tripping - Logging.											
9-7	2640	8.9	37	16	6	1/2	7.0 9.3	2	.0 .25	100	14 tr.	4	96
		Change to bit #7 and maintain viscosity at 34-36.											
9-8	2789	9.0	37	20	5	0/2	7.0 9.0	2	.0 .2	100	15 tr.	6	94
		Drilling ahead; operate desilter all times.											
9-9	2935	9.0	33	11	2	0/1	7.0 9.0	2	.0 .25	100	10 tr.	5	95
		Drilling ahead.											
9-10	3076	9.0	38	16	8	1/2	7.0 8.4	2	.0 .2	100	15 tr.	5	95
		Seepage, viscosity increased, drilling ahead.											

Seepage, viscosity increased, drilling ahead.

TABLE II - MUD RECORD (Continued)

DATE	DEPTH	WEIGHT	VISCOSITY	YP	GELS	pH	FILTRATION	FILTRATE ANALYSIS	SAND	RETORT	CEC					
9-11	3094	8.8	40	17	8	2/3	7.5	10.8	3	.0	.2	100	20	tr.	4	96
		Pull out of hole, log, change to bit #8. Run in hole and drilling ahead.														
9-12	3194	8.9	39	17	8	2/2	7.5	9.0	2	.0	.2	100	40	tr.	4	96
		Fluid loss stopped.														
9-13	3218	8.8	37	14	6	1/2	7.5	10.2	2	.0	.15	100	20	.25	4	96
		Drilling ahead.														
9-14	3300	8.9	42	21	10	2/3	7.5	9.6	2	.0	.2	100	30	.25	4	96
		Pull out of hole, change to bit #9. Run in hole with 8-5/8" bit.														
9-15	3309	8.9	47	20	13	2/3	7.5	9.3	2	.0	.2	100	30	.25	4	96
		Coring with 8 5/8".														
9-16	3332	8.8	38	16	9	1/2	7.5	9.6	3	.0	.25	100	30	tr.	4	96
		Change to bit #12, coring.														
9-17	3358	8.8	38	15	8	1/2	7.5	9.6	3	.0	.25	100	30	tr.	4	96
		Pull out of hole, change bit, and run in hole & core.														
9-18	3397	8.8	36	14	4	1/2	7.5	9.3	2	.0	.2	100	20	tr.	4	96
		Pull out of hole, change bit, and run in hole & core.														
9-19	3414	8.8	37	16	5	1/2	7.5	9.3	2	.0	.25	100	20	tr.	4	96
		Coring, lost fluid to formation.														
9-20	3426	8.8	38	15	6	1/2	7.5	9.0	2	.0	.2	75	20	tr.	4	96
		Coring, no apparent fluid loss.														
9-21	3436	8.8	39	17	10	2/3	8.0	9.0	2	.0	.25	75	20	tr.	4	96
		Coring.														
9-22	3454	8.8	35	12	6	1/1	8.0	9.3	3	.0	.2	75	20	tr.	4	96
		Coring.														
9-23	3474	8.8	38	14	6	1/2	8.0	9.0	2	.0	.2	75	20	tr.	4	96
		Pull out of hole, service core bbl. Run in hole with core bbl.														
9-24	3493	8.8	40	18	10	2/3	8.0	9.0	2	.0	.2	75	15	tr.	4	96
		Pull out of hole, service core bbl. Run in hole with core bbl. and ream.														
9-25	3577	8.8	34	9	5	1/1	8.0	9.6	2	.0	.2	50	15	tr.	4	96
		Pull out of hole. Run in hole with 12 1/4" bit and ream to 3577'.														
9-26	3435	8.7	35	12	4	0/1	8.0	9.6	2	.0	.25	50	15	tr.	3	97
		Reaming with 12 1/4" bit to 3577.														
9-27	3577	8.8	41	19	15	2/3	8.0	9	3	.0	.2	50	20	.25	4	96
		Condition mud and hole for logs.														
9-28	3577	Logging.														
9-29	3577	Run in hole with 9-5/8" casing and cement.														

TABLE III

CASING TALLY - AS-BUILT 13-3/8-INCH SURFACE CASING

<u>JOINT NUMBER</u>	<u>LENGTH (feet)</u>	<u>STRING EQUIPMENT</u>	<u>JOINT NUMBER</u>	<u>LENGTH (feet)</u>	<u>STRING EQUIPMENT</u>
-	1.34	Guide Shoe	22	30.90	-
1	32.71	Centralizer	23	30.61	-
-	1.63	Float Collar	24	27.76	-
2	30.57	-	25	43.08	-
3	29.67	-	26	29.29	-
4	26.96	-	27	41.07	-
5	32.86	-	28	42.55	-
6	29.67	-	29	43.80	-
7	31.80	Centralized	30	32.09	-
8	42.29	-	31	44.49	-
9	31.76	-	32	27.42	-
10	31.26	-	33	32.15	-
11	32.47	-	34	30.17	-
12	26.91	-	35	32.49	-
13	28.63	-	36	27.17	-
14	32.15	-	37	32.41	-
15	30.55	-	38	42.44	-
16	30.45	-	39	40.64	-
17	45.99	-	40	30.42	-
18	42.27	-	41	43.97	-
19	45.48	-	42	32.47	-
20	25.04	-	43	31.94	-
21	28.98	-			

-20.77 up on #43

TOTAL 1450.00

Joint Numbers 1 through 39 are 54.5 lb, Grade K-55

Joint Numbers 40 through 43 are 48 lb, Grade H-40

TABLE IV

DESIGN CRITERIA FOR 13-3/8-INCH SURFACE CASING

	<u>2ND SECTION</u>	<u>1ST SECTION</u>
WEIGHT AND GRADE	48-H-40 ST&C	54.5-K-55 ST&C
EFFECTIVE COLLAPSE RESISTANCE *.	735 psi	674 psi
DEPTH OF BOTTOM OF SECTION	111 ft.	1,450 ft.
LENGTH OF SECTION	111 ft.	1,349 ft.
CUMULATIVE EFFECTIVE WEIGHT TO TOP OF SECTION	79,849 lbs.	73,521 lbs.
USABLE JOINT STRENGTH IN TENSION	243,151 lbs.	473,480 lbs.
DEPTH TO TOP OF SECTION	0 ft.	111 ft.
BIAXIAL STRESS-COLLAPSE SLOPE	-78.62 lb/psi	-89.32 lb/psi

* Design criteria to resist collapse from 15 ppg cement.

TABLE V
CEMENTING DETAILS

	<u>8/25/77</u>	<u>9/29/77</u>
CASING SIZE (in.)	13-3/8	9-5/8
CASING DEPTH (ft.)	1,450	3,575
CEMENT UTILIZED	Class G 50:50 Pozzolan	Class G 50:50 Pozzolan
CEMENT VOLUME (cu.ft.)	1,400	1,500
DISPLACEMENT VOLUME (cu.ft.)	1,290	1,554
SLURRY YIELD (cu.ft/sack)	1.34	1.34
ADMIXTURES	18% NaCl (2% CaCl last 200 cu.ft.)	18% NaCl (2% CaCl last 150 cu.ft.)
CEMENT METHOD	Positive Displacement Plug Bump	Positive Displacement Plug Bump
CEMENT STAGES	1	1
WAIT ON CEMENT TIME (hr.)	48	24

TABLE VI
BIT RECORD

NO.	SIZE	MAKE	TYPE	JET 32nd IN	DEPTH OUT	FEET	HOURS	ACCUM. DRLG. HRS.	WT. 1000 LBS.	RPM	PUMP PRESS	WT. VIS.	MUD VIS.	W.L.	DULL. T	COND. 8	COND. G
1	26	HTC.	OSC-3	-	34	34	7-1/4	7-1/4	-	-	-	-	-	-	-	-	-
2	17-1/2	Reed	S-62	-	609	575	121-1/2	128-3/4	4/30	60	100	9.2	45	10.2	6	4	I
3	17-1/2	Reed	S-62	-	1207	598	159-1/2	288-1/4	10/20	60	200	8.8	50	11.4	8	4	I
4	17-1/2	Reed	S-62	-	1460	253	54-3/4	343	10/40	60	200	9.0	85	9.2	7	4	I
5	12-1/4	Reed	FP-62	16/13/13	2167	717	123-1/4	466-1/4	10/40	60	550	8.9	33	10.2	8	8	I
6	12-1/4	Reed	FP-62	13	2580	413	52-1/2	518-3/4	10/40	60	700	8.9	34	11.4	6	6	I
7	12-1/4	Reed	FP-62	12	3094	514	86-1/2	605-1/4	10/40	60	950	8.8	40	10.8	6	6	I
8	12-1/4	Reed	FP-62	12	3293	199	36-1/2	641-3/4	10/40	60	900	8.9	42	9.6	4	4	I
9a	8-5/8	Reed	FP-62	12	3300	7	1-3/4	643-1/2	30	60		8.9	42	9.6	2	2	I
10	8-5/8	Chris.	MC21	.40	3308	8	6-1/2	650	20	45	600	8.9	47	9.3	-	-	-
11	8-5/8	Chris.	MC23	.40	3328	20	11	661	20	46	700	8.8	32	9.6	-	-	-
12	8-5/8	Chris.	MC23	.40	3354	26	15-1/4	676-1/4	15	44	850	8.8	36	9.3	-	-	-
13	8-5/8	Chris.	MC23	.40	3396	42	21-3/4	698	25	60	800	8.8	36	9.3	-	-	-
14	8-5/8	Chris.	MC20	.40	3410	14	12-3/4	710-3/4	25	60	825	8.8	37	9.0	-	-	-
15	8-5/8	Chris.	MC20	.40	3423	13	18-1/2	729-1/4	20	45	1000	8.8	38	9.0	-	-	-
16	8-5/8	Chris.	MC20	.40	3427	4	4-1/2	733-3/4	25	45	1000	8.8	38	9.0	-	-	-
17a	8-5/8	Chris.	MC23	.40	3435	8	12	743-3/4	30	60	800	8.8	39	9.0	-	-	-
17b	8-5/8	Chris.	MC23	.40	3454	19	23-3/4	769-1/2	30	60	900	8.8	35	9.3	-	-	-
18a	8-5/8	Chris.	MC201	.40	3479	25	23-1/4	792-3/4	30	60	1100	8.8	38	9.0	-	-	-
9b	8-5/8	Reed	FP-62	12	3490	11	3/4	793-1/2	25	45	950	8.7	35	9.6	2	2	I
18b	8-5/8	Chris.	MC201	.40	3493	3	3/4	794-1/4	30	60	1000	8.7	35	9.6	-	-	-
9c	8-5/8	Reed	FP-62	12	3573	80	8-3/4	803	30	60	1000	8.7	35	9.6	4	4	I
18c	8-5/8	Chris.	MC201	.40	3575	2	2-3/4	805-3/4	25	60	900	8.8	37	9.0	-	-	-
19	12-1/4	Reed	FP-62	12	3575	282	39	844-3/4	20	60	1300	8.8	37	9.0	4	6	I
20	8-5/8	Reed	Y-13J	12	3576	1	1/2	845-1/4	20	60	950				1	1	I
21	8-5/8	Chris.	MC23	.40	3589	13	19-1/2	864-3/4	25	45	1000				-	-	-
22	8-5/8	Chris.	MC23	.40	3590	1	2-3/4	867-1/2	25	45	900				-	-	-
23	8-5/8	Chris.	MC23	.40	3596	5	8-1/4	875-3/4	25	45	900				-	-	-
24a	8-5/8	Chris.	MC23	.40	3602	6	8-3/4		25	50	800				-	-	-
9d	8-5/8	Reed	FP-62		3630	28	3-1/2		30	65	850				6	6	I
24b	8-5/8	Chris.			3635	5	8		20	55	900				-	-	-

TABLE VII
GEOPHYSICAL LOGGING DETAILS

9-6-77

<u>Log Run</u>	<u>Depth Interval</u>
Induction Electric with Spontaneous Potential	2,580' to 1,450'
Compensated Neutron Formation Density	2,580' to 1,450'
Temperature	2,580' to 1,420'
Borehole-Compensated Sonic with Caliper and Gamma Ray	2,580' to 1,450'

9-10-77

Induction Electric with Spontaneous Potential	3,094' to 2,377'
Compensated Neutron Formation Density	3,094' to 2,380'
Temperature	3,094' to 2,380'
Borehole Compensated Sonic with Caliper and Gamma Ray	3,094' to 2,380'

9-28-77

Continuous Dipmeter Survey	3,575' to 1,450'
Seisviewer	3,575' to 2,740'
Induction Electric with Spontaneous Potential	3,575' to 3,000'
Compensated Density with Gamma Ray and Caliper	3,575' to 3,000'
Caliper Log with Temperature	3,575' to 3,000'
3-D Velocity Log	3,575' to 3,000'
Compensated Neutron with Gamma Ray	3,575' to 3,000'

10-04-77

Seisviewer	3,635' to 3,570'
Induction Electric with Spontaneous Potential	3,635' to 3,575'
Compensated Density with Gamma Ray and Caliper	3,635' to 3,550'
Caliper Log with Temperature	3,635' to 3,500'
3-D Velocity Log	3,635' to 3,500'
Compensated Neutron with Gamma Ray	3,635' to 3,550'

TABLE VIII
CASING TALLY - AS-BUILT 9-5/8-INCH LONGSTRING CASING

<u>JOINT NUMBER</u>	<u>LENGTH (feet)</u>	<u>STRING EQUIPMENT</u>	<u>JOINT NUMBER</u>	<u>LENGTH (feet)</u>	<u>STRING EQUIPMENT</u>
-	1.22	Guide Shoe	43	37.68	-
1	45.87	External Casing	44	38.62	-
		Packer	45	42.27	-
-	1.65	Float Collar	46	45.22	-
2	45.60	Centralizer	47	40.60	-
3	44.86	-	48	42.90	-
4	45.10	-	49	38.02	-
5	45.54	Centralizer	50	42.65	-
6	41.67	-	51	45.58	-
7	44.65	-	52	45.92	-
8	42.08	-	53	42.50	-
9	40.20	-	54	41.88	-
10	46.15	-	55	42.68	-
11	45.80	-	56	46.32	-
12	45.78	-	57	43.27	-
13	41.95	-	58	41.97	-
14	46.62	-	59	41.73	-
15	42.30	-	60	39.48	-
16	45.71	-	61	44.18	-
17	45.45	-	62	41.00	-
18	38.58	-	63	42.05	-
19	42.89	-	64	45.82	-
20	43.89	-	65	41.85	-
21	44.49	-	66	44.88	-
22	38.10	-	67	42.35	-
23	37.57	-	68	43.63	-
24	45.10	-	69	42.20	-
25	42.00	-	70	42.74	-
26	44.19	-	71	39.72	-
27	44.90	-	72	45.05	-
28	43.11	-	73	41.98	-
29	44.18	-	74	42.73	-
30	42.97	-	75	42.58	-
31	40.30	-	76	45.50	-
32	41.88	-	77	40.36	-
33	42.70	-	78	41.15	-
34	45.30	-	79	40.78	-
35	45.85	-	80	40.25	-
36	42.71	-	81	38.36	-
37	45.95	-	82	40.28	-
38	42.70	-	83	38.90	-
39	39.80	-	84	40.00	-
40	43.13	-			
41	45.40	-			
42	43.10	-			
				-25.22 up on #84	
			TOTAL	3575.00	

Joint Numbers 1 through 76 are 40 lb, Grade K-55

Joint Numbers 77 through 84 are 36 lb, Grade K-55

TABLE IX

DESIGN CRITERIA FOR 9-5/8-INCH LONGSTRING CASING.

	<u>2ND SECTION</u>	<u>1ST SECTION</u>
WEIGHT AND GRADE	36-K-55 ST&C	40-K-55 ST&C
EFFECTIVE COLLAPSE RESISTANCE*	1,930 psi	1,455 psi
DEPTH OF BOTTOM OF SECTION	287 ft.	3,575 ft.
LENGTH OF SECTION	287 ft.	3,288 ft.
CUMULATIVE EFFECTIVE WEIGHT TO TOP OF SECTION	141,852 lbs.	131,520 lbs.
USABLE JOINT STRENGTH IN TENSION	347,148 lbs.	354,480 lbs.
DEPTH TO TOP OF SECTION	0 ft.	287 ft.
BIAXIAL STRESS-COLLAPSE SLOPE	-58.96 lb/psi	-61.51 lb/psi

* Design criteria to resist collapse from 15 ppg cement.

HOLE: DC-3
CONTRACTOR: Century Drilling Company
CORE SIZE: 4-1/2-inch diameter

[illegible]

TABLE XI

SERVICE COMPANIES AND EQUIPMENT SUPPLIERS

ACME Tool Company, Casper, Wyoming - string tools
Bariod Petroleum Services, Denver Colorado - mud products and services
Bill's Casing Tong Service, Marysville, California - tong service
Birdwell Division of S.S.C., Tulsa, Oklahoma - logging services
B.J. Hughes, Inc., Signal Hill, California - cement products and services
Century Drilling Company, Shelby, Montana - rig
Christensen Diamond Products, U.S.A., Denver, Colorado - core drilling services
and equipment
Dahlory, Inc., Fullerton, California - shale shaker
Lynes, Inc., Bakersfield, California - external casing packer
National Supply Company, Craig, Colorado - casing
Otwell Tool Company, Fairfield, California - rental equipment
Quadco, Farmington, New Mexico - torque gauge
Reed Tool Company, Fullerton, California - bits
Redman Pipe and Supply Company, Tulsa, Oklahoma - casing and well head
Schlumberger Well Services, Inc., Cut Bank, Montana - logging services
Sooner Pipe and Supply, Tulsa, Oklahoma - casing

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