

5.4 Testing

Two drill stem tests, DST No. 1 and No. 1A, were performed in the oil-bearing section of the Ness Formation, both over the same interval. The original plan called for one test only, however, the well produced oil at a 50 percent water cut, strongly indicating that the water was channeling up from the underlying water zone. A squeeze cement job was carried out to isolate this zone, and the well was reperforated.

The perforated interval was:

DST Nos. 1 and 1A: 2502.5 - 2512.5 m RKB

(The depths refer to the CDL - CNL log of February 13, 1985 with the 3.5 m log depth correction applied.)

The test objectives were:

- to sample reservoir fluid
- to estimate reservoir pressure and temperature
- to evaluate reservoir properties and the productivity of the zone
- to detect possible lateral heterogenities in the sand

The test string consisted of

- a GeoVann tubing conveyed perforating system, (12 spf, 6" OD)
- two bundle carriers, one with Flopetrol SDP gauges and one with four Sperry Sun MRPG gauges, 40 and 50 metres respectively above the middle of the perforations at 2507.5 mRKB
- a Halliburton DST-string with an annular pressure operated tester valve and a retrievable packer
- tubing, 5" OD
- Flopetrol subsea safety valve (EZ-tree), lubricator valve and a surface test tree

A standard 1440 psi Flopetrol separator was used to separate gas and liquids.

DST No. 1

The well was perforated against a 9.5 mm fixed choke at 50 bar underbalance to the formation.

During the 10 minutes initial flow period, 2.4 m³ cushion was flowed back. The well was then shut in for a two hour pressure build up to obtain the reservoir pressure.

During the 12 hours main flow period, the well produced oil at a rate of 200 Sm³/d with a 50% water cut, through a 6.5 mm fixed choke. The wellhead pressure was 95 bar. The well was then shut in for a 3 hour main pressure build up period.

The separator GOR was 120 Sm³/Sm³ at separator conditions of 25 bar and 36° C.

The well produced 1 to 5% sand throughout the test.

The reservoir pressure was estimated to 361 bar and the maximum temperature recorded was 88° C.

The main events of DST No. 1 are listed in table 5.4 and the oil rates and bottom hole pressures are shown in fig. 5.3. The oil rates and the pressure data from the main build up are listed in table 5.5.

DST No. 1A

The leak behind the casing was squeezed off and the well was reperforated against a closed choke.

The initial flow period lasted for 13 minutes and 2.0 m³ cushion was flowed back. The well was then shut in for a two hour pressure build up. During the 24 hour main flow period the well produced clean oil at a rate declining from 320 to 260 Sm³/d and a well head pressure declining from 90 to 72 bar. The choke size was 9.5 mm.

The gas oil ratio was $150 \text{ Sm}^3/\text{Sm}^3$ at separator conditions of 12 bar and 43° C .

Oil and gas samples were taken at the separator during the flow period.

The reservoir pressure was estimated to 345 bar i.e., 7 bar less than in DST No. 1. The maximum temperature recorded was 88° C .

The well was shut in for a 36 hours main pressure build up period.

The main events of DST No. 1A are listed in table 5.6 and the oil rates and the bottom hole pressures are shown in fig. 5.4. The oil rates and the pressure data from the main build up are listed in table 5.7.

After the main build up, the well was opened for a bottom hole sampling flow. Due to plugging of the string the sampling was aborted and the well was killed.

5.5 Fluid Analysis

During DST No. 1, one set of separator samples (gas and oil) were collected. These could not be used for further analysis since the water content was too high. However, six sets of separator samples (gas and oil) were collected during DST No. 1A. In addition to the gas and oil samples, formation water was collected from the separator during both tests. Bottom hole samples were not obtained due to plugging of the test string.

Preliminary data for well stream composition are presented in table 5.8. Water analyses for DST Nos. 1 and 1A are presented in table 5.9.



DEPTH (m RKB)	HYDROSTATIC MUD PRESSURE (psig)	MEASURED FORMATION PRESSURE (psig)	TEMPERATURE CORRECTED FORMATION PRESSURE (psia)	TEMPERATURE CORRECTED FORMATION PRESSURE (bar)	EQUIVALENT PRESSURE GRADIENT (MSL) (g/cm ³)	PRETEST PERMEABILITY (mD)
Run 3A Strain Gauge 13.02.85 73°C						
2506.0	6075	Leaking	-	-	-	-
2506.5	6083	5205	5219	359.84	1.48	31
2511.0	6096	5234	5248	361.84	1.48	71
2510.5	6090	5233	5247	361.77	1.48	1.2
2519.5	6113	5358	5373	370.45	supercharged	
2522.5	6116	5272	5286	364.40	1.49	>1000
2523.0	6119	5273	5287	364.53	1.49	34
2525.0	6126	5278	5292	364.87	1.49	>1000
2529.5	6139	5274	5288	364.59	1.48	>1000
2547.0	6182	5300	5315	366.46	1.48	139
2570.5	6238	5333	5348	368.73	1.48	685
2605.0	6318	5661	5678	391.48	supercharged	
2717.0	6608	Leaking	-	-	-	-
2715.0	6590	Leaking	-	-	-	-
2589.5	6288	5368	5383	371.14	1.49	537
2506.5	6083	5216	5230	360.60	1.49	16

Run 4B Strain Gauge 24.02.85 68°C						
2502.5	-	Lost seal	-	-	-	-
2503.0	5849	5093	5106	352.05	1.45	881
2506.5	5856	5199	5213	359.42	1.48	8
2510.5	5866	5228	5242	361.42	1.49	1.1
2519.8	5888	5271	5286	364.46	1.49	0.2
2522.5	5896	5269	5384	364.32	1.49	33
2533.0	5921	5272	5287	364.53	1.49	5
2547.0	5953	5291	5306	365.84	1.48	>1000
2576.0	6020	5333	5348	368.73	1.48	411
2587.5	6049	5351	5366	369.97	1.48	>1000
2590.0	6054	5355	5370	370.25	1.48	123
2605.0	6090	5376	5391	371.70	1.47	49
2894.5	6759	6059	6080	419.20	1.49	47
2900.0	6775	6067	6088	419.75	1.49	>1000
2905.5	6789	6074	6095	420.23	1.49	0.9
2919.0	6821	6092	6113	421.48	1.49	822
2930.5	6850	6114	6135	422.99	1.49	8
2937.0	6866	6121	6142	423.48	1.49	4
2965.5	6931	6160	6181	426.16	1.48	184
2981.5	6972	6186	6208	428.03	1.48	3
3006.5	7028	6218	6240	430.23	1.48	18
3063.5	7162	6303	6325	436.09	1.47	129
3067.5	7173	6310	6332	436.58	1.47	8

CONVERSIONS

1 bar 14.5038 psi
 1 g/cc 8.34523 ppg
 1 kg/cm³ 14.2233 psi

KB = 26 m

Remarks : All depths are corrected depths

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REF			



TABLE 5.4 MAIN EVENTS, DST NO. 1

EVENT	Initial flow	Initial build up	Main flow*	Main build up
DURATION (hrs)	0.17	2	12	3
CHOKE SIZE (mm)	9.5	-	6.4	-
OIL RATE (Sm ³ /d)	345*	-	100	-
BOTTOM HOLE PRESSURE (bar)	326	357	310	341
WELL HEAD PRESSURE (bar)	26	-	95	-

REMARKS

50 % water cut

* Cushion rate

The GOR was 120 Sm³/Sm³ at separator conditions 25 bar and 36 °C

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OIL RATES, MAIN FLOW PERIOD, AND BUILD UP
PRESSURES, MAIN BUILD UP, DST no. 1

DATE	TIME	RATE (Sm ³ /d)
3/3	04:10:00	206.7003
	08:00:00	206.7003
	08:00:00	0.0159
	09:20:00	0.0159
	09:20:00	208.2903
	11:30:00	208.2903
	11:30:00	101.7601
	16:12:35	101.7601
	16:12:35	0.0000

DATE	TIME	PRESSURE (BAR)
3/3	16:12:30	309.7807
	16:13:00	316.6338
	16:13:30	318.9876
	16:14:00	320.1655
	16:14:30	320.9400
	16:15:00	321.5414
	16:15:30	322.0166
	16:16:00	322.4021
	16:17:00	323.0407
	16:18:00	323.5869
	16:20:00	324.4917
	16:24:00	325.9538
	16:28:00	327.1207
	16:33:00	328.3048
	16:37:00	329.0896
	16:45:00	330.3904
	16:57:00	332.0634
	17:13:00	333.8724
	17:29:00	335.3469
	17:45:00	336.6035
	18:01:00	337.6931
	18:33:00	339.5696
	19:21:00	341.8041
	19:24:00	341.9538

LAST FLOWING PRESSURE

FINAL BUILD UP PRESSURE

DATE JULI 85	AUTH. ØHø
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EVENT	Initial flow	Initial build-up	Main flow flow	Main build-up
DURATION (hrs)	0.22	2	24	36
CHOKE SIZE (mm)	9.5	-	9.5	-
OIL RATE (Sm ³ /d)	220*	-	260	-
BOTTOM HOLE PRESSURE (bar)	310	348	220	322
WELL HEAD PRESSURE (bar)	8	-	72	-

REMARKS

Sand face flow consists of invasion water and oil

Clean oil after 9 hours flow.

* Cushion rate

The GOR was 150 Sm³/Sm³ at separator conditions 12 bar and 43 °C

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REF 34/7-5			



DATE	TIME	RATE (Sm ³ /d)
7/3	18:39:30	270.3004
	21:00:00	270.3004
	21:00:00	318.0004
8/3	01:01:30	318.0004
	01:01:30	302.1004
	08:02:00	302.1004
	08:02:00	278.2504
	14:00:00	278.2504
	14:00:00	266.3253
	16:58:00	266.3253
	16:58:00	262.3503
	18:40:00	262.3503
	18:40:00	0.0000

DATE	TIME	PRESSURE (bar)
8/3	18:40:00	220.0096
	18:40:30	229.7076
	18:41:00	234.3517
	18:41:30	236.6276
	18:42:00	238.1441
	18:43:00	240.1993
	18:43:30	240.9786
	18:44:00	241.6628
	18:44:30	242.2862
	18:45:30	243.3869
	18:46:00	243.8821
	18:46:30	244.3524
	18:47:00	244.7972
	18:49:00	246.3938
	18:50:00	247.1041
	18:51:00	247.7669
	18:53:00	248.9724
	18:54:00	249.5257
	18:55:00	250.0517
	18:57:00	251.0317
	18:59:00	251.9241
	19:01:00	252.7414
	19:07:00	254.0724
	19:13:00	256.6517
	19:21:00	258.6655
	19:33:00	261.2007
	19:37:00	261.9531
	19:41:00	262.6703
	19:49:00	264.0179
	20:05:00	266.4379
	20:13:00	267.5441
	20:21:00	268.5897
	20:29:00	269.5855
	20:53:00	272.3338
	21:09:00	274.0021
	21:25:00	275.5683
	22:05:00	279.1221
	22:39:00	281.0221
	22:56:00	283.1110
	23:44:00	286.3704
9/3	00:32:30	289.2683
	01:04:30	291.0290
	02:24:00	294.9172
	03:12:00	296.9510
	04:16:00	299.3704
	06:24:00	303.4228
	11:44:30	310.5931
	14:56:30	313.6421
	17:04:30	315.3490
	22:24:30	318.9131
10/3	00:32:30	320.1262
	02:40:30	320.5414
	05:52:30	322.7276

LAST FLOWING PRESSURE

FINAL BUILD-UP PRESSURE

DATE	JULI 85	AUTH.	ØH0
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<u>Component</u>	<u>Mol %</u>
CO ₂	0.50
N ₂	0.45
C ₁	43.02
C ₂	7.53
C ₃	6.63
i-C ₄	1.14
n-C ₄	3.17
i-C ₅	1.19
n-C ₅	1.92
C ₆	2.93
C ₇₊	<u>31.52</u>
	100.00

Density C₇₊ fraction (kg/m³): 863.4
Molecular weight C₇₊ fraction : 225

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WELL:

DISSOLVED SOLIDS (mg/l)	DST no. 1	DST no. 1A
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Cations

Sodium	9 200	9 800
Calcium	360	330
Magnesium	72	90
Barium	23	1.37
Iron	1	0.84
Potassium	4.45	5.96
Strontium	50	36
Aluminium	<1	<1
Manganese	0.36	0.78

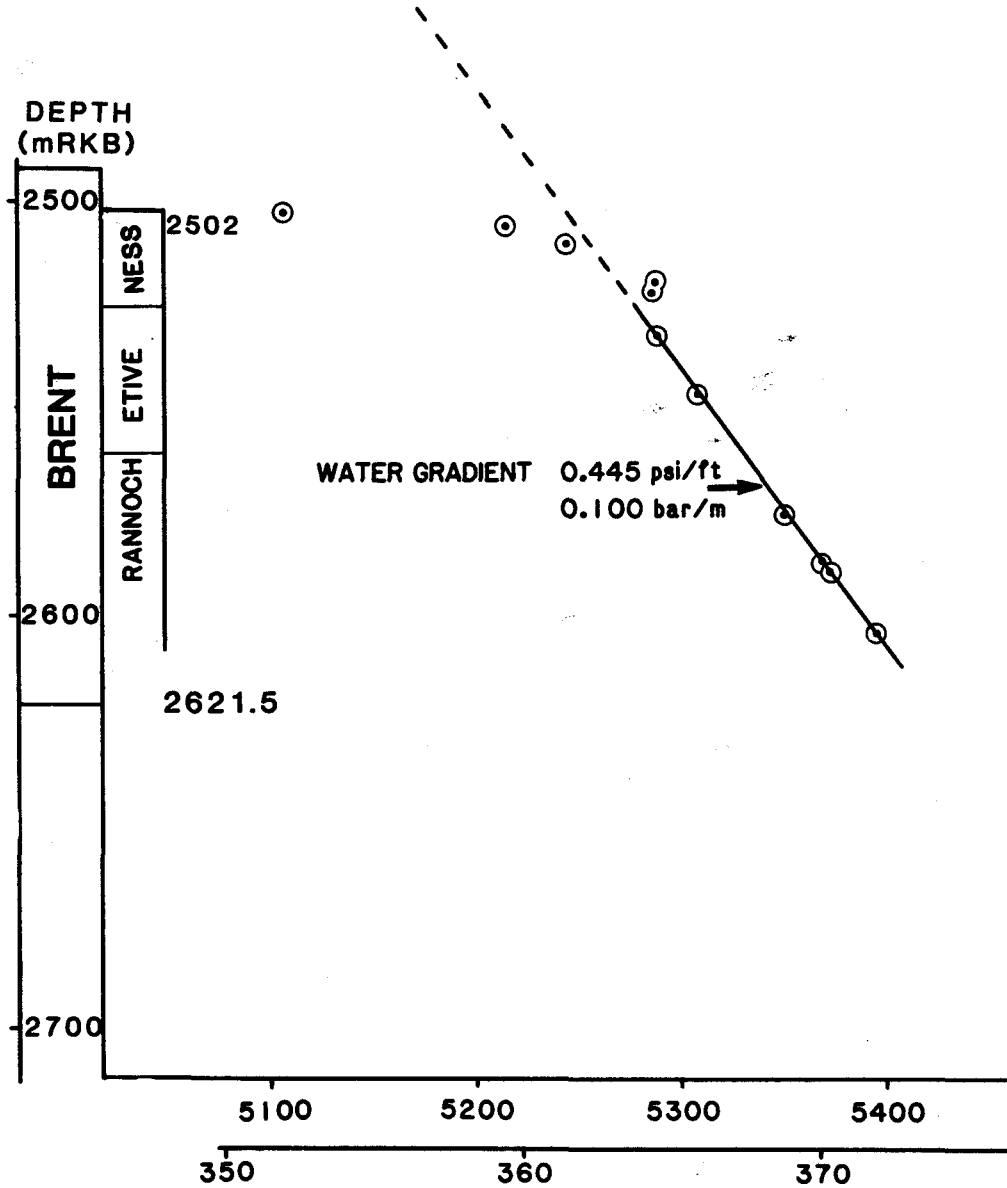
Anions

Chloride	14 700	15 400
Sulfate	20	97
Carbonate	0	0
Bicarbonate	884	827

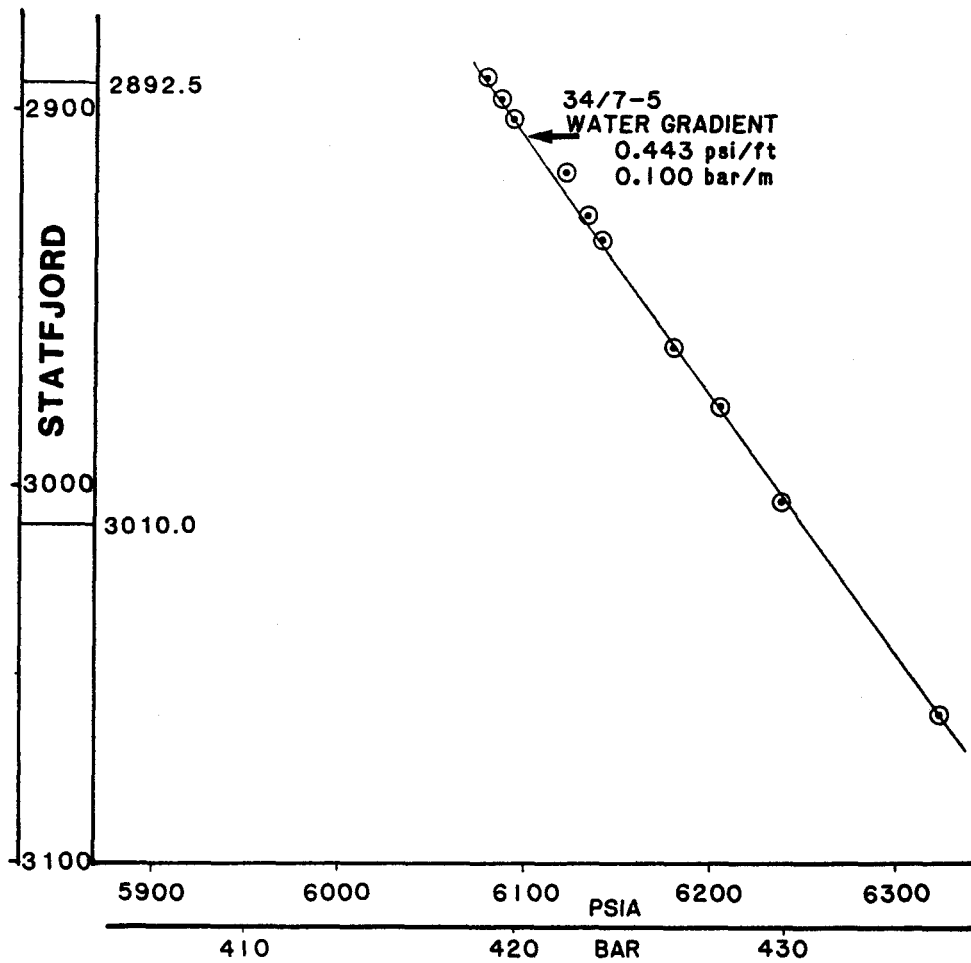
Other properties

pH	7.96	7.36
Specific gravity	1.0188	1.0269
Resistivity (ohm-m) at 15 °C	0.303	0.328
Iron total (mg/l)	39.6	31.0

DATE	JULI 85	AUTH	B&B
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REF			



DATE	July 85	AUTH.	PS
DRAW. BY	SBN	APPR.	
REF			



DATE Jul 85	AUTH. PS
DRAW. BY SBN	APPR.
REF 34/7-5	

6.2.1 Mud Properties, Daily Report

Well no: 34/7-5



DATE 1985	HOLE SIZE INCHES	DEPTH METERS	MUD WEIGHT PPG	P.V.	Y.P.	GEL STRENGHT	n	K	WATER LOSS	PH	ALKALINITY PF/MF	Ca+ ppm	CL- ppm	SAND %	SOLIDS %	COMMENTS
17.1.	36"	385							SPUD	MUD						Drl'd 36" hole
18.1.	36"	384	1.04						"	"						Cmt. csg. Run riser
19.1.	17 1/2"	800	1.10						"	"						Run riser, 17 1/2" pilot hole
20.1.	17 1/2"	447	1.12													Drlg-logg-reaming
21.1.	26"	930	1.22													Reaming
22.1.	26"	913							Mixing gyp-polymer mud							
23.1.	17 1/2"	913	1.04	7	15	4/4	0.39	1.94	10.0	9.5	0.05/.1	2300	20500			Drlg. cmt w/S.W.
24.1.	17 1/2"	1170	1.1	10	17	3/4	0.45	1.64	7.0	9.2	.1/.2	2000	22000	TR	4	Drlg.
25.1.	17 1/2"	1490	1.22	17	13	3/4	0.64	0.56	7.0	9.2	.1/1.0	2200	22000	TR	9	Drlg.
26.1.	17 1/2"	1788	1.40	20	22	5/12	0.56	1.28	7.0	9.4	.1/.5	1800	20000	TR	14	Drlg.
27.1.	17 1/2"	1865	1.43	19	18	9/21	0.59	0.94	7.0	9.4	.1/.5	1920	21000	TR	14	Logging
28.1.	17 1/2"	1865	1.43	18	18	11/26	0.58	0.97	11.5	9.5	.2/.5	2240	22000	TR	16	Reaming + logging
29.1.	17 1/2"	1865	1.43	20	19	5/12	0.59	0.99	7.0	9.3	.2/.5	2200	21500	TR	16	Cmt. 13 3/8" csg.
30.1.	12 1/4"	1985	1.52	24	18	5/24	0.65	0.73	6.0	10.6	.2/.5	2000	22000	TR	19	Drl cmt & 12 1/4" hole
31.1.	12 1/4"	2138	1.62	25	16	10/33	0.68	0.59	6.0	10.4	.2/.6	2200	22000	TR	21	Drl. trip
1.2.	12 1/4"	2325	1.66	22	20	15/32	0.61	0.93	6.5	10.3	.2/.7	2200	21000	TR	24	Drlg.
2.2.	12 1/4"	2434	1.69	24	15	6/30	0.69	0.52	4.0	10.2	.2/.7	1600	20000	TR	24	Drlg.
3.2.	12 1/4"	2454	1.69	24	15	6/32	0.69	0.52	4.5	10.2	.2/.7	2160	21000	TR	25	Drlg. trip
4.2.	12 1/4"	2507	1.69	24	16	7/30	0.68	0.58	5.0	10.1	.2/.8	1280	21000	TR	24	Drlg. trip
5.2.	12 1/4"	2521	1.68	23	15	7/31	0.68	0.55	6.0	10.1	.2/.7	1600	21000	0.5	24	Coring
6.2.	12 1/4"	2536	1.68	23	16	7/32	0.67	0.60	4.8	10.5	.2/.8	1560	21000	.25	24	Coring
7.2.	12 1/4"	2542	1.68	23	16	7/33	0.67	0.60	5.0	10.1	.2/.7	1500	21000	TR	24	Coring test BOP
8.2.	12 1/4"	2573	1.68	24	15	6/32	0.69	0.53	4.6	10.1	.2/.7	1560	21000	TR	24	Coring
9.2.	12 1/4"	2609	1.68	24	14	6/30	0.71	0.45	5.5	10.5	.2/.8	1400	21000	TR	23	Coring
10.2.	12 1/4"	2626	1.68	25	15	5/28	0.70	0.51	4.8	10.3	.2/.7	1360	20000	.25	23	Coring
11.2.	12 1/4"	2672	1.68	25	16	7/32	0.69	0.55	5.0	10.3	.2/.8	1440	20000	.5	23	Coring, drl 12 1/4" hole
12.2.	12 1/4"	2750	1.68	27	17	7/32	0.69	0.60	6.0	10.2	.2/.8	1240	20000	.5	24	Drl.POCH for logging
13.2.	12 1/4"	2750	1.68	25	13	5/26	0.73	0.40	5.0	10.2	.2/.7	1240	20000	.5	24	Logging
14.2.	12 1/4"	2794	1.63	22	18	9/38	0.63	0.79	6.5	10.0	.2/.4	1000	18000	.5	23	Built 250 BBLs gel mud

SAGA PETROLEUM A.S.

6.2.2 MUD MATERIALS USED

Well no: 34/7-5

Materials	Unit	36 in hole	26 in hole	17-1/2 hole	12-1/4 hole	8-1/2 hole	Total
BARITE	M/T	0	48	331	1125	0	1504
BICARBONATE	50 KG	0	0	0	22	0	22
CAUSTIC SODA	50 KG	9	23	74	284	0	390
DRISPAC REG	50 LB	0	0	90	0	0	90
DRISPAC S/L	50 LB	0	0	0	164	0	164
GYPSUM	50 KG	0	0	552	140	0	692
LD-8	5 GAL	0	0	5	15	0	20
LIGCO	25 KG	0	0	0	17	0	17
LIGCON	50 LB	0	0	0	15	0	15
LIME	40 KG	4	0	0	0	0	4
MD	200 L	0	0	0	12	0	12
MILBIO	55 GA	0	0	6	1	0	7
MILPOL 302	25 KG	0	0	143	19	0	162
PERMALOSE	25 KG	0	0	260	0	0	260
UNI-CAL	25 KG	0	0	0	392	0	392
W.O.21	25 KG	0	0	0	1	0	1
BENTONITE	M/T	14	32	0	21	0	67
BENTONITE	50 KG	0	0	32	0	0	32
AL-STEARAT	25 KG	0	0	1	0	0	1
PROPOL S/L	25 KG	0	0	0	25	0	25
PRO-THIN	25 KG	0	0	0	474	0	474
CACL2	25 KG	0	0	0	1343	0	1343