OPEN FILE REPORT 1984-22

JUDITH RIVER COAL, BROOKS AREA

DRILLING REPORT, 1983

by

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1983

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INTRODUCTION

The Alberta Geological Survey, presently in its final year of a second five-year contract with Alberta Energy and Natural Resources (AENR) to evaluate plains coal resources (Fig. 1), investigated the Judith River Formation in the Brooks area of south-central Alberta during 1983. The program was also to provide sub-surface information to ongoing outcrop studies in the Dinosaur Provincial Park situated about 35 km northeast from the town of Brooks (Fig. 2).

This report discusses methods of preparation and operation (drilling, coring, geophysical logging and drillsite reclamation), and presents a program evaluation with recommendations. A cost analysis and drilling statistics are also included.

Drilling operations started on June 6, and were completed on July 18. During this period twenty-four test holes were drilled and four other test holes cored in twenty-nine 12-hour shifts. Drilling of test holes went well, but some coring problems were experienced in three core holes. A logging tool was badly damaged on one drill location. Nevertheless, all program objectives were met within budget and within the projected time frame.

METHODS OF PREPARATIONS

SELECTION OF STUDY AREA

The Brooks area was selected as the 1983 program area for the following reasons:

(a) the area contains two established coal fields;

(b) they collectively contain 21% of in-place coal reserves and 79% of strippable reserves in the Judith River Formation, according to the Enery Resources Conservation Board (ERCB);

(c) according to the ARC Coal Department, they are potential sites for a mated power/pyrolysis industry with a suitable socio-economic infrastructure;

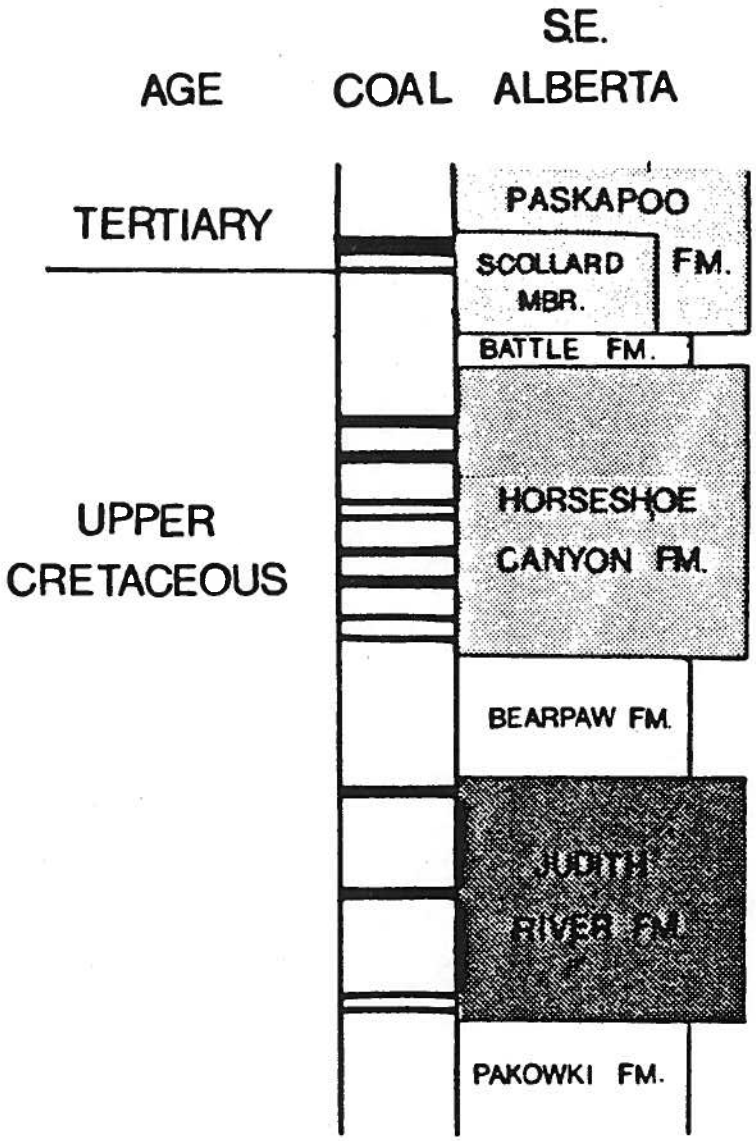


Figure 1

Geological formations of the coal bearing strata of the south-central Alberta Plains showing approximate position of major coal zones

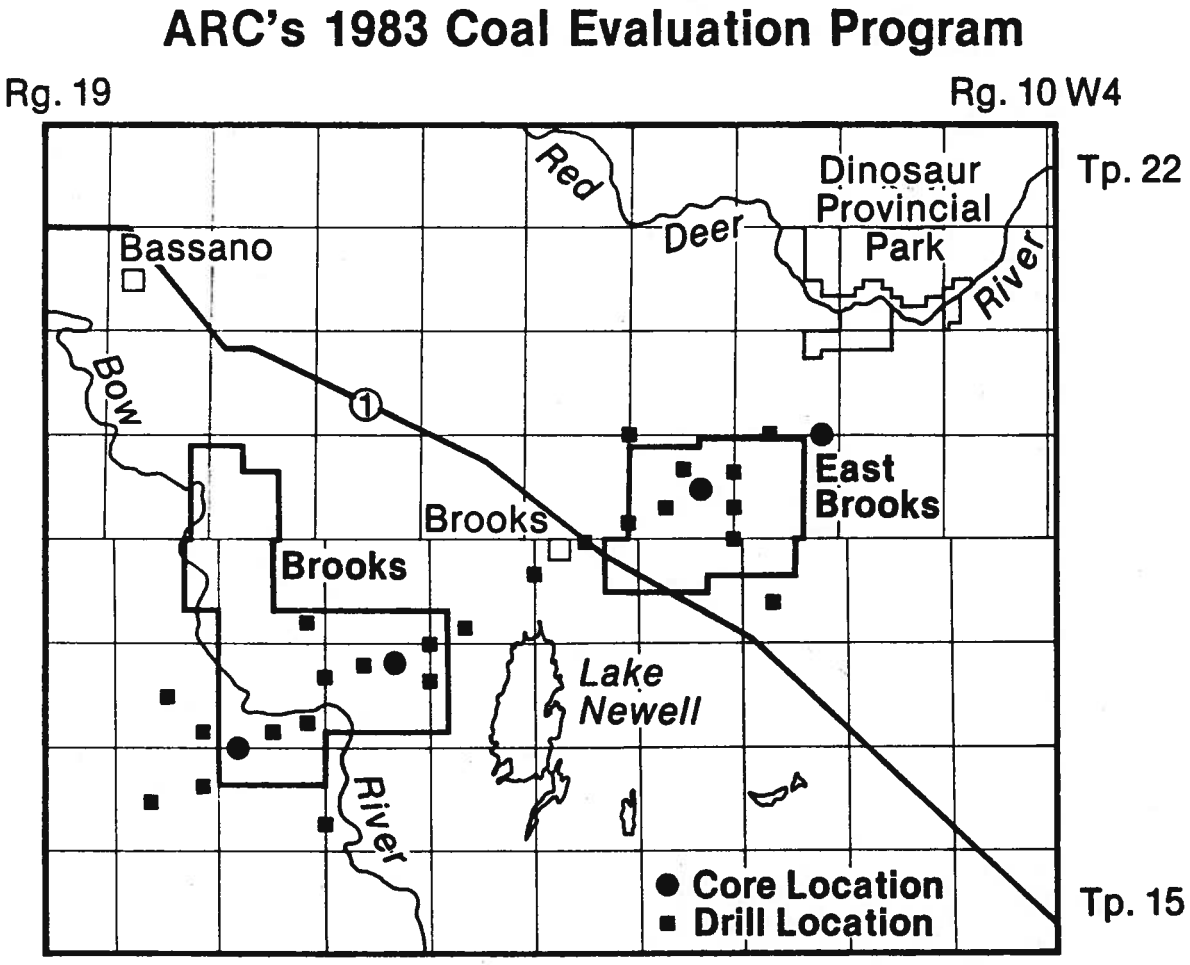


Figure 2

Area of Study and Testhole Locations

(d) they are the closest coal fields, as designated by the ERCB, to the Dinosaur Provincial Park and, therefore, knowledge of the subsurface geology setting benefits from the outcrop exposed nearby in the park, thereby enabling subsurface extension of outcrop-derived findings;

(e) apply the geological findings as a working model for the study of other ERCB-designated fields of the formation.

SELECTION OF DRILLING LOCATIONS

A background study of the area was undertaken during the winter of 1982-83. Based on the information obtained from about 140 oil and gas well logs, a structure contour map on the Pakowki Formation was constructed. In addition, 640 test hole records of coal companies, 60 water well records and 12 ARC 1976 test hole records were researched, to obtain a better understanding of the regional geology. The study formed the basis for selecting the actual locations of 24 drill holes and four core holes. The drill hole pattern which emerged consisted of 17 evenly spaced test holes (about three miles apart) along a northeast-southwest line (down dip), of which 13 holes were to be simply drilled and every fourth hole cored. This line was intersected by three short northwest-southeast lines (along strike) and on each line three holes were to be drilled. The farthest northeast hole on the long line was selected as the deep core hole (400 m); average depth for all other holes was 70 m (Fig. 2).

TENDERS

Tenders for drilling/coring and geophysical logging were invited through the Edmonton Journal and the Calgary Herald on April 8 and 9, 1983. The closing date for receipt of tenders was April 29, and the contracts were awarded on May 3 to Elgin Exploration Company Limited of Calgary for drilling and coring, and to Century Geophysical Corporation of Canada for geophysical logging. For details of contracts, see Appendices A, B and C.

GOVERNMENT CLEARANCE

Applications for an Exploration Approval and a Deep Drilling Permit were submitted to the ERCB, on February 25, 1983. The Approval, without any special terms or conditions attached was received on April 13, and the Permit, with several conditions appended was received on April 15. One of the more significant conditions specified was that the deep test hole was to be cored with blow-out prevention equipment (BOP) in place. On April 12, the counties of Newell and Vulcan in which drilling was to take place, were informed in writing regarding the work to be done.

A geophysical license and permit, required to conduct exploration work in the province of Alberta were in force during the 1983 program.

A permit allowing water to be taken from irrigation canals for the purpose of drilling was obtained from the Eastern Irrigation District at a cost of $200.00.

PERSONNEL

Two employees of ARC participated during the drilling phase of the program and a third employee joined the field party during the coring of the three shallow holes.

E.M. Koster	Project Manager (drilling and coring)
D. Macdonald	Geologist (coring)
A. Bosman	Operations Manager (drilling and coring)

Due to the diverse nature of the 1983 program, support personnel were employed as follows:

- one university geology student during drilling and logging of twenty-four holes (12-hour day shifts only)
- one geologist and one university geology student during coring of three shallow holes (12-hour day shift only)

- one university geology student and one local high school student (12-hour night shift) and one ARC technologist and one local high school student (12-hour day shift) during the coring of one deep hole.

VEHICLES AND COMMUNICATIONS

Three vehicles were obtained through the Alberta Government Central Vehicle Service Pool and used as follows:

- one suburban truck, used by the project manager
- one half ton truck, used by the operations manager
- one Econoline Van, used as a drillsite office unit.

Due to the short duration of the 1983 program, it was decided not to install mobile communication equipment in any of the vehicles.

METHODS OF OPERATIONS

DRILLING LOCATIONS

Because many road allowances are not developed in the Brooks region, hence providing ideal drillsites, it was possible to drill twenty-six test holes on road allowances. However, two test holes were drilled on privately owned land for which permission was obtained from the landowners prior to drilling.

DRILLING AND CORING

Fifteen bids were received for the 1983 program. Thirteen bids included drilling and coring services, one bid offered drilling services only and one bid coring services only. The bid of Elgin Exploration Company Limited of Calgary (lowest bid) was accepted. Contract terms provided that drilling be done at a footage rate and coring at an hourly rate.

The following equipment was provided for the program by the contractor:

One 1972 Failing drill rig model 1250, equipped with one Failing 5 x 6 1/2 inch mud pump, an Le Roi 715 cfm air compressor, a Bean Royal-25 injection pump and a G8-Geolograph drilling recorder. Additional drilling equipment included 100 metres of standard drill pipe, 100 metres of HQ core-pipe with two 5-foot HQ3 series splite-tube core barrels, a mud pit and a 1979-IHC-2500 gallon water truck. Intention was to use a larger drill rig (Failing model CF15) for coring the deep hole (CH 1-83).

The drill rig was operated by the driller and one helper. A "daily drilling report" and the Geolograph chart were maintained by the driller recording all events, times, and consumed "chargeable" items. The report, after being signed daily by the driller and the operations manager, became the basis for payment for all drilling and coring charges and other costs incurred by the contractor.

During the drilling phase of the program twenty-four test holes were completed. All test holes were 12 cm in diameter and water was used as the circulation medium. Sample cuttings taken from the mudstream every 3 m of hole depth were washed and described on site, to form the basis of a lithologic log. All samples were bagged and retained for future reference. Only one hole was abandoned due to gravel at 15 m. Another hole was later successfully completed at a nearby location.

The coring of the three shallow holes started as soon as the regular drilling program was completed. HQ3 series coring equipment was used for the first time on an ARC program. The wireline system included two 1.5 m split-tube core barrels with a 9.5 cm-o.d. core bit, which produced a 6.3 cm core in diameter.

Coring results were as follows:

hole no.	drilled(m)	cored(m)	recovered(m)	recovered(%)	total hours
CH2	15.6	37.9	35.5	93.7	23
CH3	17	48.2	45.1	93.6	41
CH4	21.3	39	34.9	89.5	22

Coring procedures were identical for each hole. After each hole was drilled and cased off to bedrock the hole was continuously cored to total depth. The first core bit used in the program was an HQ3 tungsten carbide two step insert bit. This bit, with eight relatively small fluid ports in the bit face, did not perform well; the total flow area was apparently too small. Coring through hard or coarse-grained materials presented no problem, but in shale (a common lithology in the upper Judith River Formation), the bit would "ball-up", resulting in plugged ports, high pump pressures and the core not being properly cut. This core bit was, at an early stage, replaced by an HQ3 flat-faced tungsten carbide bit with similar fluid ports. This bit performed only slightly better and some additional improvement was noticeable after quite large slots were cut in the bit face in an effort to increase the total flow area. Nevertheless, the problem of "balling-up" accompanied by increased pump pressure persisted, though to a lesser extent. Consequently, core quality of the shale intervals was inferior. After completion of the three core holes and before details for the deep core hole were finalized, this coring problem, as well as results and performance in general were evaluated. Based on this evaluation, it was decided to use large diameter coring equipment for the deep hole. This decision was also based on the fact that, with the mandatory use of BOP equipment, the total cost for coring this hole was known to be high and a successful operation was therefore imperative.

The contract with Elgin Exploration was, therefore, terminated on June 30. After re-examination of all bids submitted for the 1983 program, Hi-Rate Drilling Company Ltd. of Stettler was approached regarding the coring of the one remaining hole. Since Hi-Rate Drilling indicated that

they were willing to do the work, a contract based entirely on their original bid was prepared, and finalized on July 5, 1983.

Hi-Rate Drilling provided the following equipment. One Seismic rotary-top head drive drill rig, model 16R-1977 with one 5 1/2 x 8 inch Gardner-Denver pump, one Le Roi 560 cfm-250 psi air compressor, a Geolograph drilling recorder and 400 metres of Christensen Diamond Products (C.D.P.) wireline core pipe with two split-tube core barrels. Additional equipment consisted of a 2500 gallon water truck, one large mud tank with a mud-cement mixer, one auxiliary rotary pump to the main pump, a light plant, a welder and a parts-tool trailer. A daily working schedule of one day and one night shift was in effect, each shift consisting of one driller and two helpers with supervision provided by one tool push. A complete BOP system was rented for this hole from Lory Oilfields Rentals Ltd., in Edmonton (for details see Fig. 3). Work began on July 12 and was carried out in the following manner: a 25 cm hole was drilled to bedrock, after which eighteen metres of 18 cm casing, with two centralizers and one floatshoe attached was installed and cemented in. After a waiting period of 12 hours for the cement to set, the BOP equipment was installed and tested. Coring commenced at 18 metres and was terminated several metres into the Pakowki Formation at 345 metres. Coarse flat tooth insert bits, yielding 7.6 cm diameter core were used and core quality was very good. Water (mud) was used as circulation medium.

Coring progressed at a constant rate, except once, when operations were interrupted for a 29 hour period due to rain. BOP tests were conducted on a daily basis, and the equipment performed faultlessly throughout. No gas or water was detected from the hole at any time and after the hole was logged, it was cemented off its entire length. Work was completed on July 18 with the following results:

hole no.	drilled(m)	cored(m)	recovered(m)	recovered(%)	total hours
CH1	18	326.8	307.4	94	125

All core obtained from the three shallow holes was described on site by the geologist and useful logs are now available for further core interpretation. Core description of the deep hole during night shifts was not possible.

GEOPHYSICAL LOGGING

Six bids for geophysical logging services were received. The bid submitted by Century Geophysical Corporation of Canada was accepted. Gamma-density-caliper and focussed resistivity logs were obtained from each test hole (see Appendix F). In addition, a gamma-sp-single point resistance and neutron log was obtained from the deep core hole. All logs were recorded on tape and all final copies were recorded on the North American metric standard (i.e., metric numbers on inch divided paper).

All logs requested by ARC were obtained without any delay and the total logging time spent on each hole was indeed short. Unfortunately, one serious logging incident did occur. As has been the practice, as soon as a hole is drilled, the drill rig is left over the hole and a pulley is suspended from the mast to accommodate the wire line and attached logging tool during the logging process. When logging of TH 13-83 was completed but the tool was still hanging partly in the drill's rotary table and partly in the hole to allow the engineer time to close the caliper tool, the driller for no apparent reason, drove the drill rig forward. This caused (a) a very sharp bend in the tool, (b) a part of the tool to break off and, (c) the broken-off section to fall to the bottom of the hole (73 m). Because this section contained the radioactive source, it had to be retrieved. Because special fishing tools are required in such situations, N.L. McCullough (experts in this field) were consulted in their Brooks office. After all details were explained to their supervisor, an overshot type fishing tool was made up and brought out to the drillsite. The overshot was attached to the regular drill string and lowered down the hole. It was considered very fortunate that the broken tool section locked into the overshot on the first attempt. The total fishing job was completed in less than one hour. However, the damage to the logging tool

was severe. Century carried an extra logging tool in the truck, so that operations could continue without further interruptions.

After the drilling contract with Elgin Exploration was terminated, the contract with Century Geophysical was also temporarily suspended as well. It was agreed, however, that Century would log the deep hole on a "call out" basis whenever the hole was ready to be logged.

CEMENTING AND ABANDONMENT

All 1983 test holes were abandoned according to prescribed regulations. For cementing the deep hole, 13,000 pounds of ready mixed cement was brought out to the site by Newell Concrete Ltd. The cement was directly pumped down the hole through a string of regular drill pipe and a vacuum tank truck was on site to draw-up the replaced drilling mud.

For the reclamation of drillsites and agreement was reached with Mr. Don Elliott, a contractor from Brooks. With a front-end loader and a 12-yard dump truck all drill cuttings were removed from each drillsite. The cuttings were disposed of in an approved land-fill site.

SUBMISSION OF PROGRAM DATA

As required under the Coal Conservation Act, a complete report on the 1983 program and a map indicating each drill location were submitted to the ERCB on September 14, 1983. On November 2, 1983 a copy of each geophysical log was forwarded to the ERCB.

PROGRAM EVALUATION AND RECOMMENDATIONS

DRILLING LOCATIONS

The preliminary study made of the 1983 program area during the winter of 1982-83, formed the framework for establishing drill and core locations. In addition, it provided valuable information which was often referred to

during actual field work. It is considered essential that such studies be continued in future program preparations.

Favourable conditions in the field made it possible that all holes could be drilled close to their predetermined locations. For the drilling of two holes on privately owned land, full cooperation was received from the landowners, which was much appreciated.

DRILLING

Twenty-four drill holes (1609 metres) were successfully completed and except for the logging tool incident, no other drilling problems were encountered. Average hole depth was 67 metres and the average drilling time required to complete one hole was 3 1/2 hours. Only five insert type drill bits and twenty-one bags of mud were required to complete these holes. Conditions of lost circulation were not encountered at any time.

CORING

The problems associated with coring through shale intervals in the three shallow holes were not resolved. Because the mud pump had more than adequate capacity, the problem must have been that either the fluid ports in the core bit were too small, or that the fluid annulus in the core barrel itself was too small, or possibly a combination of both. The HQ3 coring system is undoubtedly suitable under proper conditions, and the fact that good quality core was obtained from the coarser lithologies, confirms its applicability. Materials used for the three core holes consisted of four HQ3 insert core bits, two core lifter shells, two core lifters and two bags of mud.

The only problem encountered during the coring of the deep hole was that on some occasions when retrieving a full core barrel, the core would not break off at the exact point where coring was discontinued. This problem was not new as it had been experienced in previous years. By not breaking off, some core would slide back out through the core retainer,

then break off at some weak point leaving a section of core in the bottom of the hole. Usually this section was picked up on the next run, but especially when the problem repeated itself it would confuse and frustrate the driller. By not knowing exactly how much core was left in the hole, it was difficult to determine how much core should be cut on the following run. In spite of this, however, overall coring results were not greatly affected by this problem.

Experienced drilling personnel and excellent drilling equipment as provided by the drilling contractor contributed greatly to the successful completion of this hole.

Materials consumed in this hole included: 18 metres of casing, 25 bags of cement, two centralizers, one floatshoe, one cement plug, three insert type core bits, 18 core retainers, 16 bags of mud, 18 litres of Poly 2000 (liquid mud) and 13,000 pounds of cement.

Coring Rates and Coring Costs/Comparison

	Elgin Exploration HQ3 Equipment	Hi-Rate Drilling CDP Equipment
Coring rate per hour including drilling setting casing and BOP, and logging time	1.45 m	2.63 m
Coring only, rate per hour	2.12 m	3.84 m
Core recovery rate	92.3 %	94 %
Coring cost per metre including drilling, setting casing and BOP, and logging time	$77.23	$46.20

A considerably higher penetration rate was obtained with CDP coring equipment, but the core recovery rate with this equipment was only slightly better.

Comparing coring costs between three shallow holes and one deep hole is more difficult. For instance, cementing in of the casing and BOP installation was not required on the shallow holes, yet these costs are included in the deep hole calculations. Furthermore, core obtained from a deep hole is inherently more costly than core obtained from a shallow hole.

In general, the core obtained with CDP equipment was of superior quality and in addition was 1.27 cm wider in diameter. As well, the 3 m long CDP core barrel has a definite advantage over the 1.5 m HQ3 core barrel, especially in deep core holes.

Based on the 1983 coring experiences, it is suggested that CDP coring equipment be used in any future ARC coring programs.

As a point of interest, the deep core hole represents the first hole in the Province of Alberta in which the entire Judith River Formation and part of the upper Pakowki Formation were cored continuously.

GEOPHYSICAL LOGGING

The Compu-Log logging system provided by Century Geophysical for the 1983 program performed very well, breakdowns did not occur and log quality was excellent. With Compu-Log, all information is recorded on magnetic tape in digital form, which makes it possible to produce reprints in various forms and on various scales right in the field.

Because all four parameters (gamma, density, caliper, resistivity) are recorded in one single pass with the Century "Coal Probe", the average total logging time was only 32 minutes for a 67-metre hole.

Century personnel provided very good service and their excellent cooperation in the field was much appreciated.

Regarding the damaged logging tool, the ARC was invoiced the sum of $13,436.71 by Century on June 24, 1983 for incurred damages. The ARC has since forwarded the invoice and all other relevant information to Risk Management and Insurance, a branch of the Provincial Treasury Department. Risk Management is presently engaged in negotiations with Elgin Exploration's insurance company in an effort to obtain a satisfactory settlement.

CEMENTING AND ABANDONMENT

Reclamation of all drillsites was effectively handled by Mr. Don Elliott and the work was completed in two days. On December 8 a Reclamation Certificate was received, indicating that all 1983 test sites were inspected and approved by officials of Alberta Environment.

APPENDIX A

DRILLING CONTRACT NO. 1

Fifteen drilling-coring bids were received for the 1983 program. The bid of Elgin Exploration Company Limited of Calgary, Alberta was accepted. The main terms of the contract read as follows:

Drilling rate per foot	$ 3.00
Coring rate per hour (with drill rig CF1250)	$ 95.00
Coring rate per hour (with drill rig CF15)	$110.00
Standby rate per hour	$ 70.00
Moving and cementing rate per hour	$ 95.00

Drilling and coring bits, cement, lost circulation and hole conditioning materials and casing were to be paid by the client, including transportation costs and a 10 percent handling charge.

Standby rates were in effect during third party geophysical logging, and during any delays not caused by the contractor.

The drilling contractor was to be responsible for the condition of the hole until the geophysical contractor reached the bottom of the hole for the first time.

The client agreed to pay the contractor $35.00 per working day per man towards living allowances. The working schedule was to consist of one twelve-hour shift per day during the drilling of 24 test holes and the coring of three shallow test holes. Two shifts of twelve hours per day were to apply during the coring of the one deep test hole.

Drilling and coring equipment to consist of the following:

1. One rotary type Failing drill, model CF1250, equipped with one 5 x 6 1/2 inch Failing mud pump, a Le Roi air compressor and a Geolograph drilling recorder.
2. 100 metres of regular drilling pipe and 400 metres HQ core pipe with two complete core barrels.

3. One 2500 gallon water truck.
4. One rotary type Failing drill, model CF15, equipped with one 5 x 6 1/2 inch Failing mud pump, a Gardner Denver air Compressor and a Geolograph drilling recorder; this drill rig to be used for one deep core hole only.

The contractor to provide and maintain adequate insurance including:

(a) Comprehensive General Liability insurance;
(b) Automobile insurance;
(c) Equipment insurance.

The contractor shall comply with the provisions of the Workers' Compensation Act and the Occupational Health and Safety Act.

Locating drilling sites was to be the responsibility of the client.

It was agreed to commence drilling on June 6, 1983.

APPENDIX B

DRILLING CONTRACT NO. 2

A contract for coring one deep hole was put into effect with Hi-Rate Drilling Company Ltd. of Stettler, Alberta, on July 5, 1983. The main terms of the contract read as follows:

Drilling rate per foot (including setting casing)	$ 17.00
Coring rate per foot to 500 feet depth	$ 17.00
Coring rate per foot 500 to 700 feet depth	$ 20.00
Coring rate per foot 700 to 900 feet depth	$ 24.00
Coring rate per foot 900 to 1100 feet depth	$ 30.00
Coring rate per foot 1100 to total depth	$ 36.00
Standby rate per hour	$140.00
Moving and cementing rate per hour	$150.00

The coring rates to include the cost of drilling bits, coring bits and core catchers. All hole conditioning materials were to be paid by the client, including transportation cost and a 10 percent handling charge. Core boxes were to be supplied by the client.

Standby rates were in effect during third party geophysical logging, and during any delays not caused by the contractor.

The drilling contractor was to be responsible for the condition of the hole until the geophysical contractor reached the bottom of the hole for the first time.

The client agreed to pay the contractor $40.00 per working day per man towards living allowances. The working schedule was to consist of two shifts of twelve hours each per day for the duration of the work. The number of men per rig-crew was to be three, plus one toolpush.

Drilling equipment to consist of the following:

1. One rotary type Seismic drill, model 16R, equipped with one 5 1/2 x 8 Gardner Denver mud pump, an air compressor, a hydraulic top drive rotary system and a Geolograph.
2. 400 metres of CDP, core pipe with two complete core barrels.
3. One 2500 gallon water truck.
4. One tool-parts trailer with a welder and light plant.

The contractor to provide and maintain adequate insurance including:

(a) Comprehensive General Liability insurance
(b) Automobile insurance
(c) Equipment insurance.

The contractor shall comply with the provisions of the Workers' Compensation Act and the Occupational Health and Safety Act.

It was agreed to commence drilling on July 12, 1983.

APPENDIX C

GEOPHYSICAL LOGGING CONTRACT

Six logging bids were received, and the bid submitted by Century Geophysical Corporation of Canada was accepted. The terms of the contract read as follows:

Century was to obtain one geophysical log from twenty-seven shallow test holes: gamma ray, density, caliper and resistivity. The logging unit and one man were to be available on 24-hour standby basis for twenty-seven holes at a contract price of $400.00 per day.

Two additional logs were required from one deep test hole. This hole was to be logged under "Call Out" services at the following rates:

gamma ray, density, caliper and resistivity at	$ 5.00 per metre
natural gamma, s.p., single point resistance and neutron	$ 2.00 per metre
sonic	$ 2.00 per metre

Additional charges under the contract included:

recording tapes	$24.00 each
fuel for truck	at cost
lodging	at cost
meals	$21.00 per day
mobilization and demobilization, 2 ways	$ 0.60 per km

Extra services such as reduced logs, coal quality analysis, digital printouts were available in the field, and additional logging tools would be available at an extra charge upon request.

APPENDIX D

DRILLING STATISTICS

Total number of test holes drilled	24 (1609 m)
Total number of test holes cored	4 (451.9 m)
Total metres of core recovered	422.9 (93 %)
Total dayrate hours	62
Total standby hours	31
Total coring hours	211

Materials used:

Insert drilling bits	5
Insert coring bits	7
Core retainers	20
Core shells	2
Casing	18 metres
Float shoe	1
Centralizers	2
Cement plug	1
Cement	25 bags
Cement, ready mixed	13,000 lbs
Drilling mud	39 bags
Poly 2000, liquid mud	18 litres

APPENDIX E

COST ANALYSIS

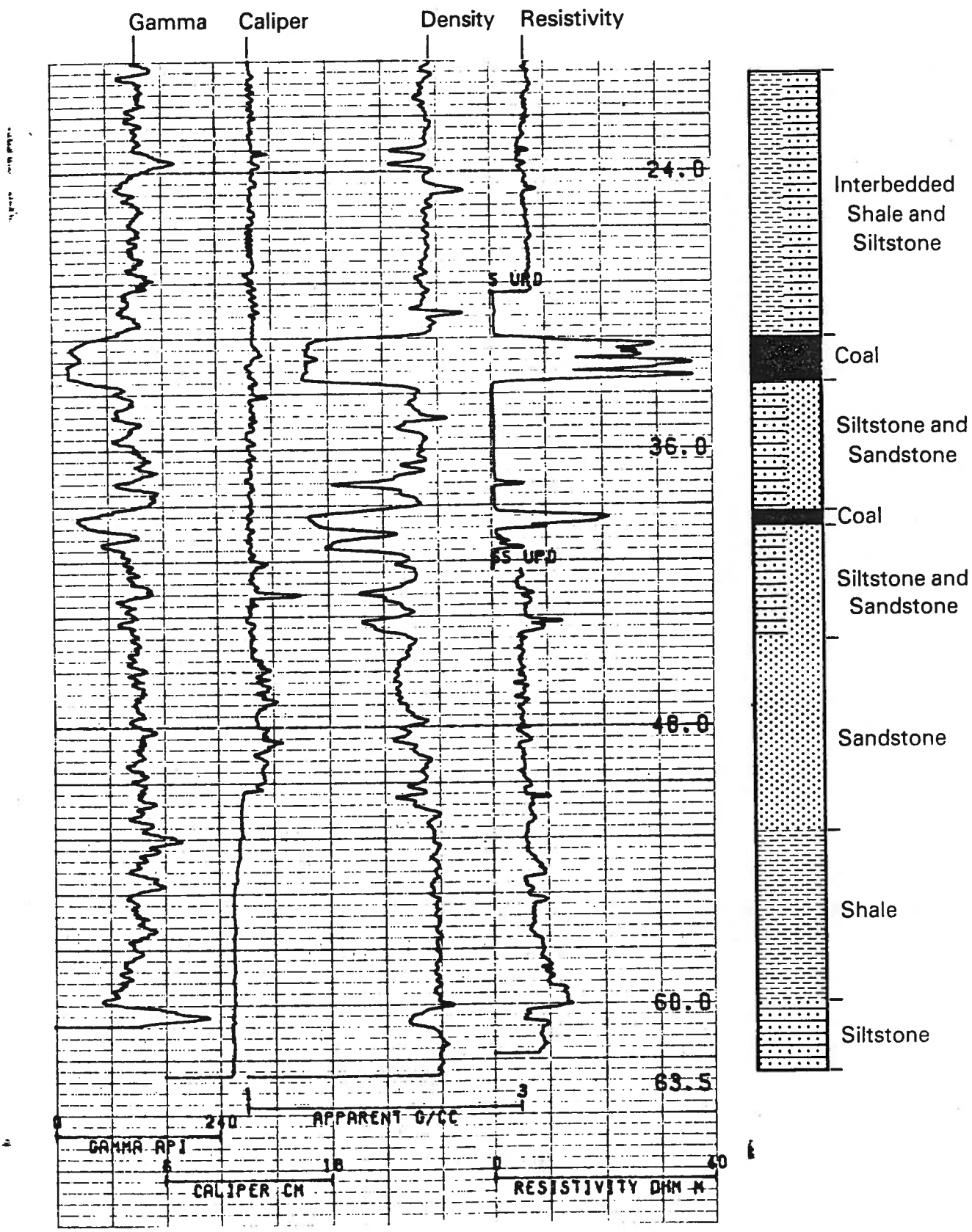
Elgin Exploration

Total feet drilled 5278 @ $ 3.00	= $15,834.00	
Total hours cored 87.25 @ $95.00	= $ 8,288.75	
Total dayrate hours 32.75 @ $95.00	= $ 3,111.25	
Total standby hours 13.50 @ $70.00	= $ 945.00	
Drilling and coring bits, lifters and shells	= $ 1,617.78	
Drilling materials	= $ 211.20	
Man days subsistence 45 @ $35.00	= $ 1,575.00	
Subtotal	$31,582.98	$31,582.98

Hi-Rate Drilling

Total feet cored 1073 (at various rates)	= $23,434.60	
Total dayrate hours 29.25 @ $150.00	= $ 4,387.50	
Total standby hours 17.50 @ $140.00	= $ 2,450.00	
Cement 25 bags @ $9.13	= $ 228.25	
Ready mixed cement 13.000 lbs	= $ 1,663.20	
Casing 58 feet, flareline pegs 8	= $ 532.40	
Vacuum truck (one trip)	= $ 296.45	
BOP trucking charges	= $ 1.306.25	
Man days subsistence 42 @ $40.00	= $ 1,680.00	
Subtotal	$35,978.65	$35,978.65
Total drilling and coring		$67,561.63

Century Geophysical	$12,772.30	
BOP rental	$ 1,984.10	
NL McCullough (fishing services)	$ 861.00	
Drilling permits land owners (2)	$ 175.00	
Water permit Eastern Irrigation District	$ 250.00	
Reclamation of drillsites	$ 1.540.00	
Wages, 2 high school students	$ 741.00	
Core storage rent (Brooks)	$ 400.00	
Vehicle rental and operational costs	$ 2,452.00	
Materials and supplies	$ 1,527.51	
Personal expenses, ARC personnel	$ 4,446.95	
Subtotal	$27,149.86	$27,149.86
Total cost of 1983 coal drilling program		$94,711.49



APPENDIX F

Geophysical Log

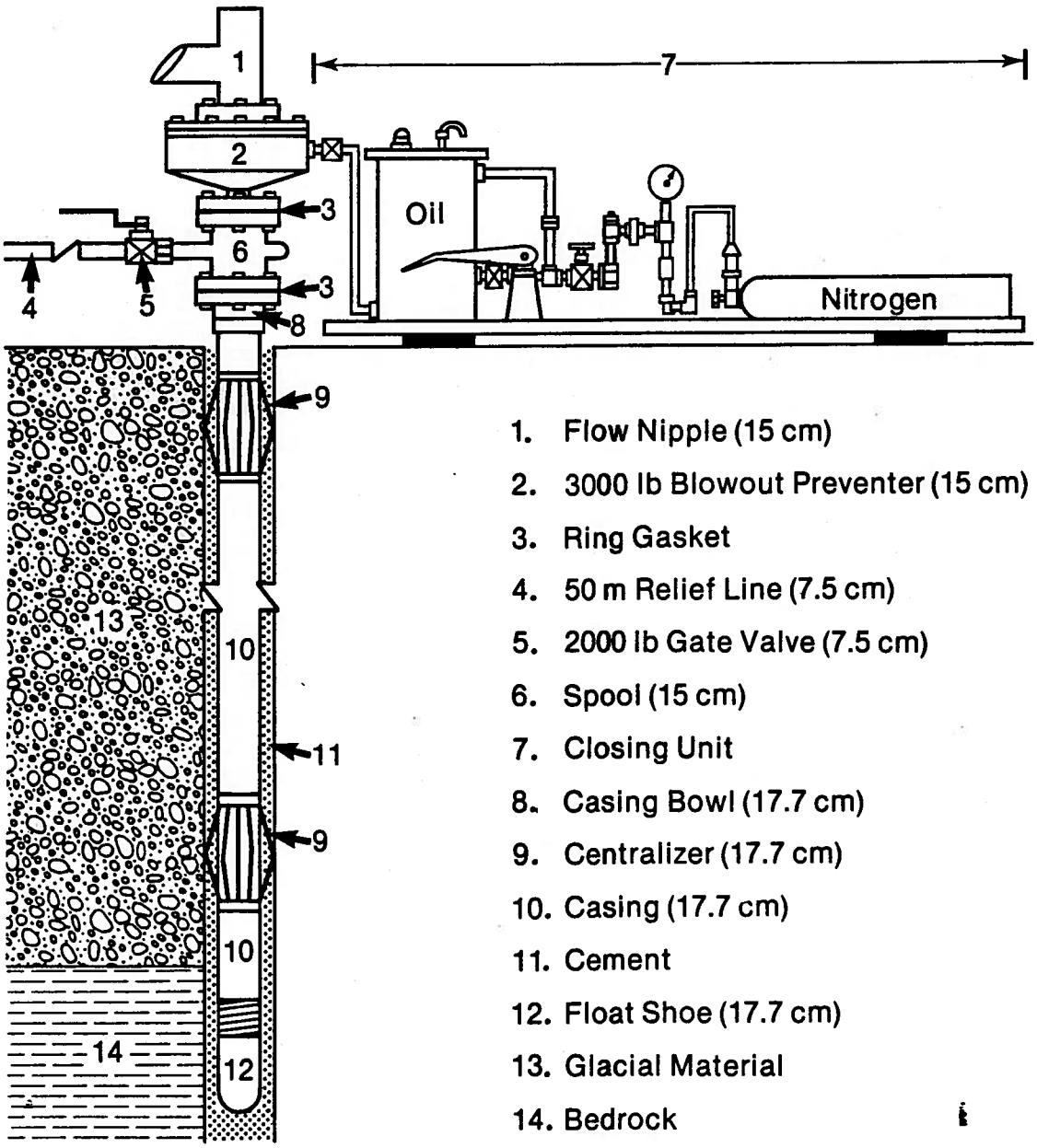


Figure 3

Diagram of Blowout Preventor Installation