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= PR - WAPITI PROJ. - 1960 B =

EXPERIMENTAL TESTS TO DRIVE A SMALL DIAMETER CHANNEL IN A COAL SEAM

September 25, 1979

GULF CANADA RESOURCES INC.

EXPERIMENTAL TEST TO DRIVE A SMALL DIAMETER CHANNEL IN A COAL SEAM

Summary:

Gulf Canada Resources Inc. proposes to test the capabilities of a patented device to drive a small diameter channel in a coal bed. The site is a shallow flat-lying seam in northeastern British Columbia on Gulf Canada Resources' Wapiti coal project. A conventional slim-hole rig will drill and case a vertical hole or holes to the coal seam at a depth of about 8 metres (25 feet). A special rig will then burn consecutively two horizontal channels in selected directions to outcrop locations of the coal. The first channel will be about 50 metres (165 feet) long. The second channel will be directed approximately at right angles to the first, and will be 120 metres (400 feet) in length. The test should be conducted within a two to four week period, commencing October 15, 1979. The site will subsequently be vacated and reclaimed.

Introduction:

Fluid connection (porosity and permeability) between two points, namely intake and production wells, is essential in underground coal gasification (UCG) to provide the supply of air to support combustion and to collect the product gases. Known methods of improving the permeability by induced fracturing, high pressure air injection, and known directional drilling methods, etc., are limited in scope and direction. If channels could be created between widely spaced wells, then production costs would be greatly reduced by requiring fewer wells, the scope of production patterns would be varied, and applications of UCG could be increased. The proposed experiment will test the channel-creating capabilities and directional control of a new device for a distance of 120 metres (400 feet). This would be significantly greater than any known achievement to date.

Location:

The test site is 50 km (30 miles) southwest of Dawson Creek adjacent to the Fellers - Puggins road, map area 93-P-7 (Figure 1). The

Murray River is 12 km west, and Muskeg Lake is 5 km southwest. A support camp will be located at a vacated geophysical campsite by the road just north of Muskeg Lake. The campsite will be the same as that being used for Gulf's coal exploration project which has already been approved.

The test site is on the southwest slope of a south-trending pine covered ridge, at an elevation of 1000 m (3300 feet). The slope of the terrain is twelve percent or 7^{o} to the southwest.

Coal Licences:

Gulf Canada Resources Inc. acquired on January 30, 1979, 399 licences containing 177 879 ha of coal rights in the area known as the Wapiti project. An additional 85 licences containing 25 101 ha were applied for in June, 1979. The actual test site is on the west edge of the Wapiti project area on coal licence #4982, comprised of units 63, 64, 73, 74, Block F, map sheet 93-P-7, containing 296 hectares (Figure 2).

Geology:

A flat-lying coal seam 2 metres thick is exposed for about 150 metres along a road cut on the Fellers - Puggins road. The seam is at the base of the Wapiti formation of Upper Cretaceous age. The seam overlies the Chungo sandstone, the upper member of the Puskwaskau formation. At the road cut, the seam is overlain by thin beds of shale and sandstone, and covered by a mantle of regolith and soil. The coal seam is essentially flat, but minor flexures can be expected. A 2 metre drop is noted in the two easternmost survey locations of the seam.

A number of measurements of vertical cleats (fractures) of the coal seam indicate a main cleat pattern in the direction of 037^{o}T (N37^{o}E) and a minor cleat direct pattern running 121^{o}T (S59^{o}E). The channelling device will be directed along these cleat directions.

Test Site:

Figures 3 and 4 show the proposed test site and access road. A drill site approximately 90 metres square will be cleared. An access road

150 metres in length and 20 metres wide will connect with the main road north of the coal outcrop.

Operations:

Vertical Hole (V)

A narrow trench will be dug by a backhoe machine to a depth of 3 metres at the wellsite, and sloping from the surface at an angle of 45^{o}. This trench will accomodate a pipe to convey product gases away from the well to the flare stack, as shown in Figure 5.

A slim-hole rotary rig or rat-hole rig will drill a large diameter hole (45 cm) through the coal seam into the underlying sandstone, a depth of about 12 metres. Casing (30 cm inside diameter) will then be cemented in the well bore. Prior to directionally setting the casing, slots will be cut in the casing to facilitate the directional channel device, and a branch pipe will be fitted near the top to remove product gases as mentioned above.

Special equipment and mechanism will be installed within the casing. This equipment will include, but will not necessarily be limited to a blow-out preventor, a support and turn-table for a directional elbow, and a support or feed pipe for the channelling device.

The rotary rig will then be removed and a special tower will be placed in position over the test hole. Other surface equipment will include an air compressor, electrical generator, drum to store flexible coil, hydraulic motor, and a personnel trailer.

Channelling Operations

The coal seam will be ignited by an electrical heating rod through pre-cut slots in the casing. Compressed air will be fed to support combustion through a flexible steel coil approximately 4 cm in diameter. The coil is sheathed by links of heat resistant steel which allows the coil to bend and be wound in one direction. After passing through the directional elbow, the links are locked to form a rigid pipe. The coil will be fed through the casing as the channel progresses. The air pressure and feed rate will be controlled to limit the size of channel burned in the coal.

The product gases will travel with the return air stream back to the casing, through the "Y" trap to be burned at the flare stack. The penetration rate is expected to be 15 metres per twenty-four hour period. The cross-sectional area of the channel will be from 0.1 to 0.3 square metres. Consequently, the burn will consume from 2.5 to 6.0 tonnes of coal per twenty-four hour period (100 to 240 kilograms per hour).

Short Channel V-S

The first channel will be directed along the line V-S in the direction of the major cleat to the coal outcrop at "S", a distance of 50 metres (165 feet). After the channel has reached the outcrop, the air supply will be shut off and the coil and nozzle returned to the directional elbow. After examination, the channel at "S" will be plugged. It is anticipated that sealing the channel and stopping the air flow will terminate the burn. If not, then water will be pumped down the return air vent to quench the burn. Water for this operation will be obtained from Salt Creek, two kilometres west.

Long Channel V-L

When the burn at the short channel has been extinguished, the channelling device will be rotated to the second slot, and the procedure repeated to create a channel in the direction of V-L. To expose the coal seam at point "L", a trench would have to be cut into the hill. This trench would be approximately 65 metres long, 10 metres wide, and 10 metres deep at the uphill side, requiring the removal of approximately 3700 cubic metres (4800 cubic yards) of material. The trench will be excavated by a backhoe and/or bulldozer. An area will be cleared for the excavated material. This material will be returned to the trench in the order excavated at the completion of the test.

Endurance Test

Upon the completion of the two channels V-S and V-L mentioned above, an extended endurance test will be conducted to measure the "wear-and-tear" of the nozzle and coil. A series of channels will be

driven southeast of the test hole V, in the area between V-S and V-L. This test will also determine the ability of the device to channel obliquely to the fracture or cleat pattern.

Alternate Plan

The initial plan as described above is to drive both horizontal channels from one vertical hole, requiring a trench at point "L". It is recognized that for various reasons, this may not be practical or desirable, in which case two alternate vertical holes may be required as shown on Figure 3. The short channel would be directed westward from "A" to the coal outcrop along the minor cleat direction. The long channel would be burned southward from "B" along the major cleat direction. Depth to the coal seam at "A" and "B" would be 7 and 18 metres respectively.

Coal Quality and Product Gas

The Wapiti coal at the test site is Subbituminous A in rank. Analysis of the coal is shown on the following page. The sulphur content is 0.50% on a raw coal basis. The product gases produced by the channelling method are expected to be mainly from the combustion zone in front of the nozzle, but some gasification gases will be generated in the return flow area. An anlysis of the product gas will probably be as follows:

Nitrogen	50 - 65%
Hydrogen	10 - 20%
Carbon Dioxide	10 - 15%
Carbon Monoxide	5 - 10%
Methane	1 - 3%
Hydrogen Sulphide	0.10 - 0.15%
Other	1 - 2%

As mentioned previously, these gases will be flared and it can, therefore, be expected that the resulting gases that are emitted to the atmosphere will be nitrogen, carbon dioxide, water, and small amounts of sulphur dioxide.

WAPITI COAL ANALYSIS

Road Outcrop, Northeast of Muskeg Lake

	Raw Coal	Clean Coal*
As Analyzed Basis		
Moisture % (Inherent)	6.5	5.8
Ash %	22.8	15.6
Volatile Matter %	33.5	36.7
Fixed Carbon %	37.2	41.9
TOTAL	100.0	100.0
Sulphur %	0.50	0.55
BTU/lb.	8,517	9,562
Dry Basis		
Ash %	24.4	16.6
Volatile Matter %	35.9	39.0
BTU/lb.	9,106	10,148
Dry, Ash - Free Basis		
Volatile Matter %	47.4	46.7
BTU/lb.	12,040	12,167

* Yield 78.7%

Safety Aspects

Prior to the field test, the operation will be planned in consultation with personnel experienced in various Gulf Canada Resources Inc. operations, namely drilling, gas plants, oil sands, in-situ projects, and the environmental group. Personnel from these departments will be "on call" throughout the test program.

In addition, Norwest Resource Consultants Ltd. and Shawinigan Engineering Ltd. will be retained to observe and independently prepare a joint report on the experimental test.

As previously mentioned, it is anticipated that each burn will extinguish as the air supply is withdrawn. However, there is always the possibility that air may reach the coal seam through surface fractures in the overburden. Consequently, water may be pumped down the vertical holes to extinguish the fire. If necessary, additional vertical holes may be drilled to flood the coal seam.

The experimental test and a coal drilling program will be conducted in the area at the same time. Consequently, a caterpillar, a drilling rig, and a water truck will be available at short notice to contain any combustion or to drill additional holes to flood the coal seam. The area will be monitored for gas leaks, particularly for sulphur dioxide, hydrogen sulphide and carbon monoxide. A first aid attendant will be stationed at the camp. Six gas masks will be available -four at the test site and two at the camp as back-up.

As previously mentioned, we believe the channelling procedure by coal combustion can be controlled by regulating the air supply, and that any pocket of combustion can be extinguished by water flooding the coal seam. However, if combustion spreads to a larger area and is not responding to water flood, then the contingency plan is to remove the overburden from the suspect area, isolate the coal, and extinguish the fire. In such a case, the existing pit adjacent to the test site will be used for temporary storage of overburden.

Costs

The total cost for the experimental test is estimated at $300,000 as follows:

Site Preparation		
Road and Drill Site	$10,000	
Trench	20,000	
Vertical Hole (drill, log, casing)	8,000	
Equipment - Rentals	50,000	$88,000
Air Compressor, Generator, Flare Stack, Piping, Valves, Propane Tank, Water Truck, Caterpillar, Hydraulics		
Special Equipment (patented)	150,000	238,000
Tower Coil, Design Engineering	25,000	263,000
Mobilization and Demobilization	10,000	273,000
Camp Costs	15,000	288,000
Reclamation	30,000	318,000
Contingency - Excavate Burning Coal Seam	50,000	368,000
	$368,000	

BIOPHYSICAL DESCRIPTION:

Although no Gulf environmental field studies have been conducted in the proposed test area, extensive biophysical information is available from reports prepared as part of the Northeast Coal Study under direction of the Environment and Land Use Sub-Committee on northeast coal development (ELUSC). In addition to published or available data, Gulf biologists viewed the proposed test area during May, 1979. The following description is drawn largely from available biophysical data.

Physiography and Soils

The proposed test site is located 50 km southwest of Dawson Creek on the east slopes of the Rocky Mountains. This area is included in

the Alberta Plateau Benchlands physiographic region, characterized by rolling upland topography and underlain by conglomerates and carbonaceous sandstones and shales (ELUSC 1977).

The test site occurs on the southwest slope of a ridge adjacent to the Salt Creek valley. Fellers and Zonnebecke soil associations are present on this slope, having developed over fine-textured morainal and variable colluvial deposits respectively (Vold et al 1977). The site is moderately to steeply sloped to the southwest, and drains into Salt Creek approximately 750 metres away. Salt Creek feeds the Murray River 12 km west of the ridge.

These soils have moderate to severe engineering restrictions related mainly to slope and frost heave (Vold et al 1977). Fine-textured Fellers soils may be particularly susceptible to erosion if exposed on steep slopes.

Climate

The mountains exert a major climatic effect on the area, resulting in lower annual temperatures and precipitation than areas to the west. June is normally the wettest month, while July has the warmest average temperature. Near the test site, normal spring snow depth is less than one metre (ELUSC 1977).

At the Lower Moose meteorological station situated approximately 35 km to the southwest, moderate winds from the west dominated during May, June and July, 1976 (ELUSC 1977).

Vegetation

The test site is located in the boreal white spruce zone of the boreal forest region. Due to the presence of well drained surficial deposits, seral lodgepole pine and trembling aspen are the dominant tree species; understory species and diversity vary with soil type and aspect (Harcombe 1978).

The area has nil to low potential for agriculture (CLI Class 5 - 7), and moderate to low potential for forestry production (CLI Class 4 - 5).

Agriculture and forestry capability are limited by low moisture holding capacity and a shallow rooting zone.

Wildlife

Ungulate habitat capability ratings and actual ground observations from the test site area are contradictory. Capability mapping suggests that the test site has moderate potential (CLI Class 3) for ungulate production due to excessive snow depth. However, observations conducted for ELUSC (1977) indicate that the area has high year-round capability for moose and elk, and B. Churchill, Regional Habitat Protection Technician (pers. comm.), believes the Salt Creek drainage to be an important moose wintering area. Moose, black bear, elk, mountain caribou and mule deer have been observed in this region (ELUSC 1977).

Beaver, marten, fisher, mink, weasel, wolverine, lynx and squirrel are abundant in the Northeast Coal Study area (ELUSC 1977).

Muskeg Lake, 5 km to the southwest, is the only suitable waterfowl habitat in the area (Trenholme, 1978). This lake has moderate potential for waterfowl production (CLI Class 4), but does not appear to be important for staging. Trumpeter swans use and nest in lakes of the Redwillow River drainage, 30 to 40 km to the south, but have not been observed on Muskeg Lake (Trenholme, 1978). The test site has no waterfowl production capability, and impact on waterfowl resources will be negligible.

Aquatic Systems

The test site is located in the watershed of Salt Creek, a tributary of the Murray River. No water quality data are available from Salt Creek, but surface waters in the area are generally alkaline, moderately hard, brownish coloured and turbid (ELUSC 1977). Measured levels of turbidity and colour in the Murray River exceed recommended drinking water criteria and are largely attributed to natural erosion and mass wasting (Water Investigations Branch 1976). It is expected that the water quality of Salt Creek is similar to other streams in the region.

Downstream of the test site, Salt Creek passes over one 8 metre waterfall and a 5 m high chute. Non-game fish (burbot, longnose sucker and slimy sculpin) are present above the falls, but game fish are restricted to the area below the falls (Resource Analysis Branch, Map 93P/7). The waterfall presumably prevents movement to and from the Murray River. Near the confluence of Salt Creek and the Murray River, indigenous sport fish capability is very high (ELUSC 1977). Arctic grayling, Dolly Varden and mountain whitefish are known to occur in the Murray River and lower portions of Salt Creek below the cascade.

Recreation

The area adjacent to the test site has low to moderately low (CLI Class 5 & 6) capability for outdoor recreation. All recreation potential in this area is based on the opportunity of viewing wildlife and/or waterfowl. It is expected that the proposed test will have negligible impact on recreation opportunities.

POTENTIAL IMPACTS AND MITIGATION:

Certain potential environmental impacts are associated with the proposed test, but proper planning, construction, operation and reclamation procedures will minimize these impacts to an acceptable level. All necessary licences and approvals will be obtained prior to commencement of field operations and operations will be conducted according to procedures outlined in the Guidelines for Coal and Mineral Exploration (1977).

During the construction phase, merchantable timber, as designated by Dawson Creek Forest Service personnel, will be stockpiled and made available to commercial operations in the area. Leaning timber will be felled. All slash will be collected and burned in accordance with Forest Service requirements. Slope stabilization will be conducted to prevent erosion on access roads, test site and trenching locations, and to direct run-off onto adjacent vegetated land. During trenching operations, topsoil and overburden will be stockpiled separately upslope to facilitate reclamation after backfilling.

When drilling and testing, all waste products will be pitted and later backfilled. Product gases will be flared; sulphur dioxide concentrations are expected to be low and should not adversely affect nearby vegetative cover.

Due to the shallow rooting zone and thickness of overburden, little or no impact on plants is expected due to combustion of the coal seam. Although unlikely, an uncontrolled burn in the seam presents more serious potential impacts. Rooting zone damage and/or surface fire may result if combustion occurs upwards through a fracture. Some subsidence may accompany a major uncontrolled burn, but is not expected to be significant.

After testing, the outcrop channel exits will be filled in to prevent leaching from the channel, and to allow cutoff of the oxygen supply. The drilling inlet will be cemented.

All access corridors and clearings will be reclaimed using the reclamation mix and procedures recommended by the Dawson Creek Forest Service. Seeding will take place prior to snowfall during 1979. If operations terminate after first snowfall, slope stabilization procedures will prevent erosion until the areas can be seeded in 1980.

It is expected that no significant impact on ungulate or furbearer populations will occur as a result of this test. The presence of the existing Fellers Heights Tumbler Ridge road has undoubtedly impacted local populations, and the proximity of the test site and access road to this corridor is expected to impose little additional impact. Some short term movement away from the test site may occur, but the short duration of the test will not result in permanent displacement. Timing of the project coincides with no critical period for wildlife.

No significant impact on Salt Creek water quality or biota is expected. Water withdrawal will occur at a rate low enough to prevent habitat disruption. Sediment input will be minimized by slope stabilization and by directing runoff to the natural vegetative buffer zone between the site and creek.

LITERATURE CITED:

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Guidelines for Coal and Mineral Exloration. 1977. Ministry of Mines and Petroleum Resources, Inspection and Engineering Division. Province of British Columbia. 63 p.

Harcombe, A. 1978. Vegetation Resources of the Northeast Coal Study Area. Ministry of the Environment, Province of British Columbia. 46 p plus appendices.

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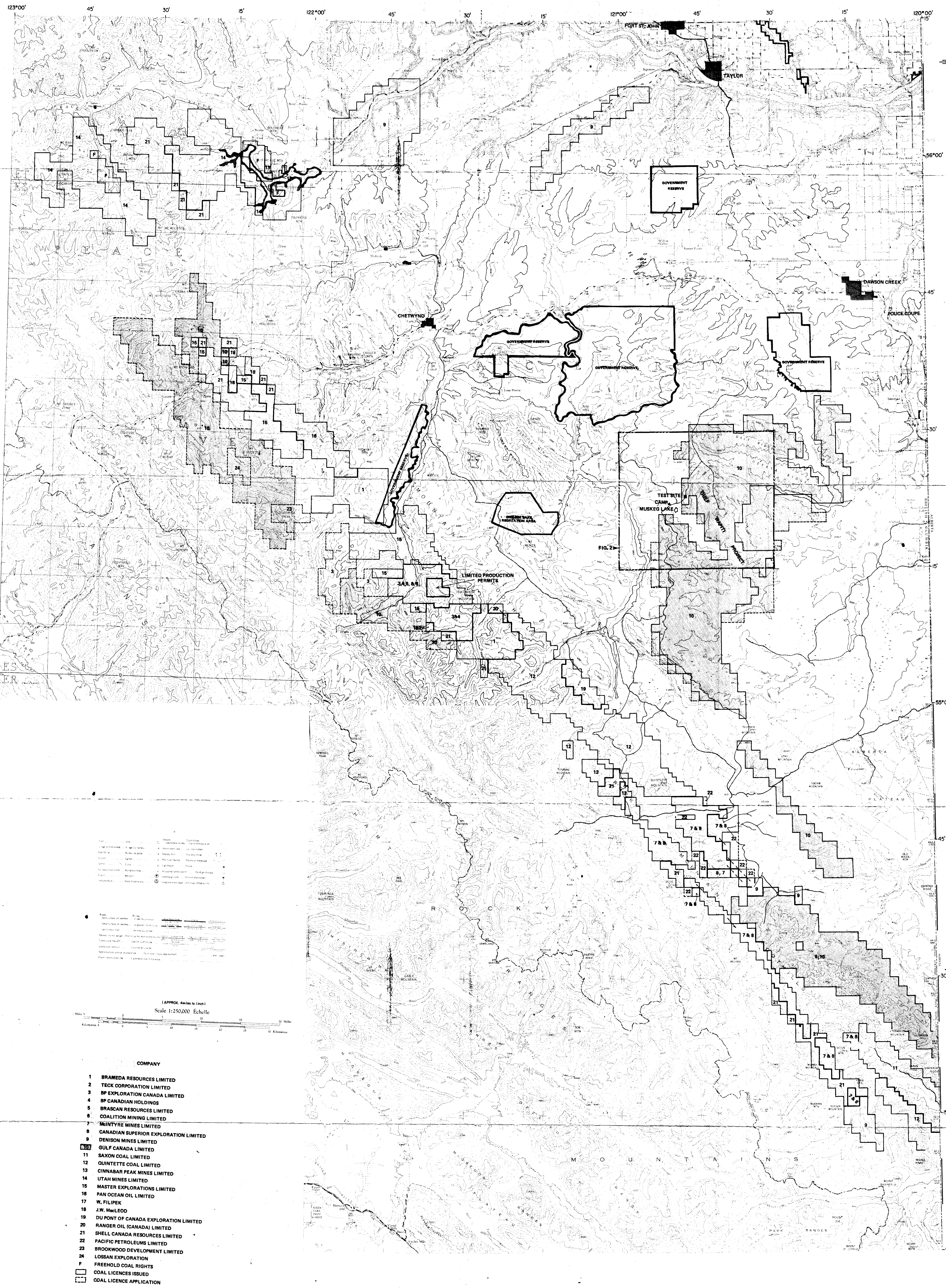
PERSONAL COMMUNICATIONS:

Churchill, B. 1979. Regional Habitat Protection Technician. B.C. Fish and Wildlife, Prince George region. 9711 - 100 Avenue, Fort St. John, British Columbia. Telephone conversation.



WAPITI PROJECT

Experimental Test

Figure 1.

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GULF CANADA RESOURCES
COAL DIVISION

(1)

TITLE	DEPARTMENT
NORTH EASTERN BRITISH COLUMBIA	AREA NO.
PEACE RIVER COAL PROPERTIES	CLASS NO.
	PROJ. NO.
	DATE
DRAWN BY / CHECKED CH. DRAFT / SECTION HD.	SCALE
DRAWN AT / CHECKED ENGINEER / APPROVED BY	DWG. NO.

FILE NO. 79338

SUNDOWN CREEK

PEACE RIVER DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Surveyed and compiled by the SURVEYS AND MAPPING BRANCH, BRITISH COLUMBIA. Produced by the MAPPING AND CHARTING ESTABLISHMENT, DEPARTMENT OF NATIONAL DEFENCE.

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- PHASE I HOLE DRILLED
- PHASE II PROPOSED ROTARY
- PHASE III PROPOSED DIAMOND DRILL HOLE
- EXISTING LICENSE
- LICENSES APPLIED FOR

GULF CANADA RESOURCES INC.

WAPITI PROJECT

PROPOSED EXPERIMENTAL TEST PROGRAM (2)

Fig. 2 SEPT. 1979

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SHEET 93P/7

639,800 E

640,400 E

6,140,400 N

6,140,000 N

6,139,600 N

HV 1 = 40,477.35 N 40,155.13 E
Elev. = 1011.00

I.P. 455 40,407.33 N 40,173.91 E
Elev. = 1012.51

I.P. 457 40,203.95 N 40,234.73 E
Elev. = 1017.31

40,088.41 N 39,804.33 I.P. 452
Elev. = 1003.83

39,980.54 N 39,837.6 O.T.H "D.D.H. 258" O
Elev. = 1001.03

39,726.10 N 39,938.82 E I.P. 448
Elev. = 985.79

39,568.17 N 40,100.09 E I.P. 443 HV 2
Elev. = 994

HV 4 39,835.00 N 40,345.00 E
Elev. = 999.14

I.P. 447 39,821.72 N 40,340.03 E
Elev. = 999.71

FELLENS HEIGHTS ROAD

DAWSON CREEK

Gravel Road

Dirt Road

Seismic Line

Seismic Lines

LIMIT OF A GROUND SURVEY

ALTERNATE A

ALTERNATE B

TEST SITE

TRENCH

ROGERS

PUGGINS MTN

Top of Cut

Base of Cut

OUTLINE - DETAIL MAP
SEE FILE NO. 79397-1B FIG. 4

TRUE NORTH

MAJOR CLEAT 052°

MINOR CLEAT 322°

LEGEND:

Galvanized iron bar ..... ●

Nail or spike ..... ○

SURVEY NOTE:
Ground survey by D. WATSON B.C.L.S. 1979. Survey based on assumed U.T.M. zone 10 coordinates of HV1: 6,140,477.35N 640,155.13E Elevation 1011.0m.

FIGURE 3

GULF CANADA RESOURCES INC.

WAPITI PROJECT

EXPERIMENTAL TEST PROGRAM

NORTHEAST BRITISH COLUMBIA

SCALE 1:2000

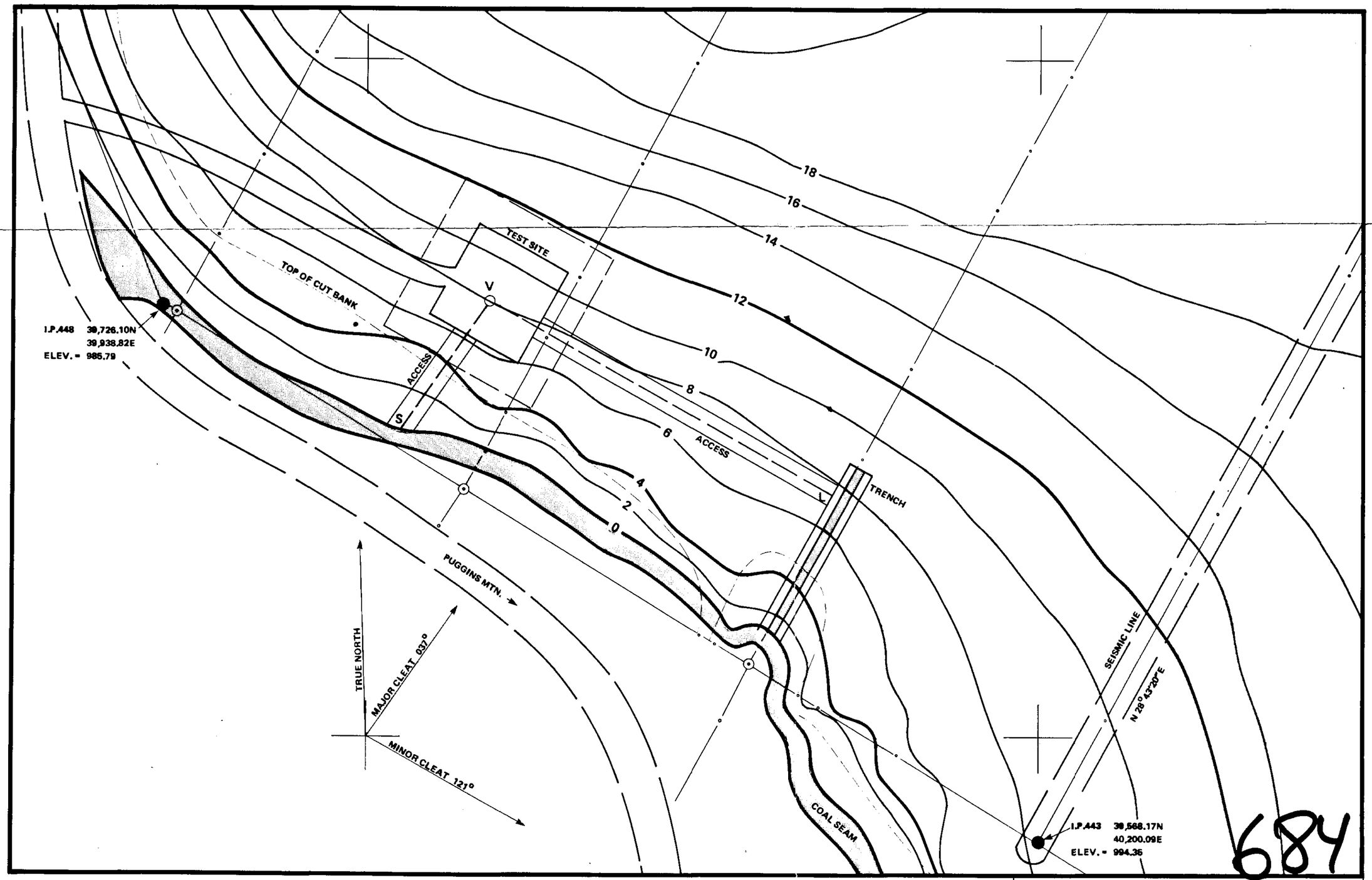
50 40 30 20 10 0 50 100 150 200 250 300 METRES

2 metre contours

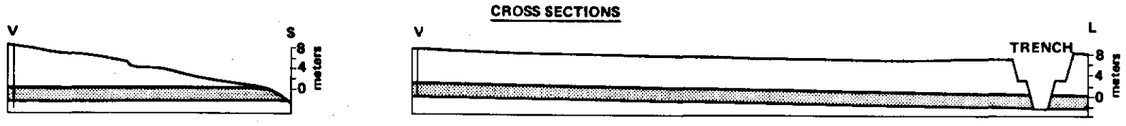
FIGURE 3
GULF WAPITI PROJECT

(3) 684

FILE NO. 79397-3C



CROSS SECTIONS



SCALE

0 10 20 30 40 50 meters

GULF CANADA RESOURCES INC. FIGURE 4

WAPITI PROJECT (DETAIL)

OVERBURDEN ABOVE COAL SEAM

NORTHEAST BRITISH COLUMBIA

CONTOUR INTERVAL – 2 meters

(4)

FILE NO. 79397-18

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