BW - Willow River 81(D)A

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GULF CANADA RESOURCES INC.

WILLOW RIVER COAL PROJECT GEOLOGICAL REPORT

1981

COAL LICENCE NUMBERS 6431 to 6491 INCLUSIVE

AND 6866, 6867

NTS MAP NO. 93G/9, G/16

LATITUDES BETWEEN 53° 30 AND 54° 00 N

LONGITUDES BETWEEN 128° 24 AND 128° 39 N

GULF CANADA RESOURCES INC.

- AND -

G.W. JACKSON

CONSULTING GEOLOGIST

JUNE 1981

WILLOW RIVER PROJECT

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GULF CANADA RESOURCES INC.

WILLOW RIVER COAL PROSPECT

1.0 SUMMARY

1.1 LOCATION

The Willow River Prospect is comprised of three non-contiguous blocks of Coal Licences centered approximately 50 km southeast of Prince George, B.C., lying between 53° 30′ & 54° 00′ north latitude and 122° 00′ & 122° 30′ west longitude (see location map, Figure 1, overleaf). In total, 63 coal licences encompassing some 15,759 hectares are controlled by Gulf Canada Resources Inc., with licence renewal anniversary dates of July 1 for coal licences, 6431 to 6491, inclusive and 6866, 6867.

1.2 GEOLOGY & LICENCING STRATEGY

The licences comprising this prospect were acquired during 1980 largely owing to their proximity to the Bowron River coal deposit. Available literature concerning the Bowron River deposit suggests that the Tertiary coal basin is preserved by pre-glacial structural conditions and the Gulf licences were acquired because of the possibility for the existence of heretofore undiscovered extensions to the Bowron River deposit or isolated structures of similar origin.

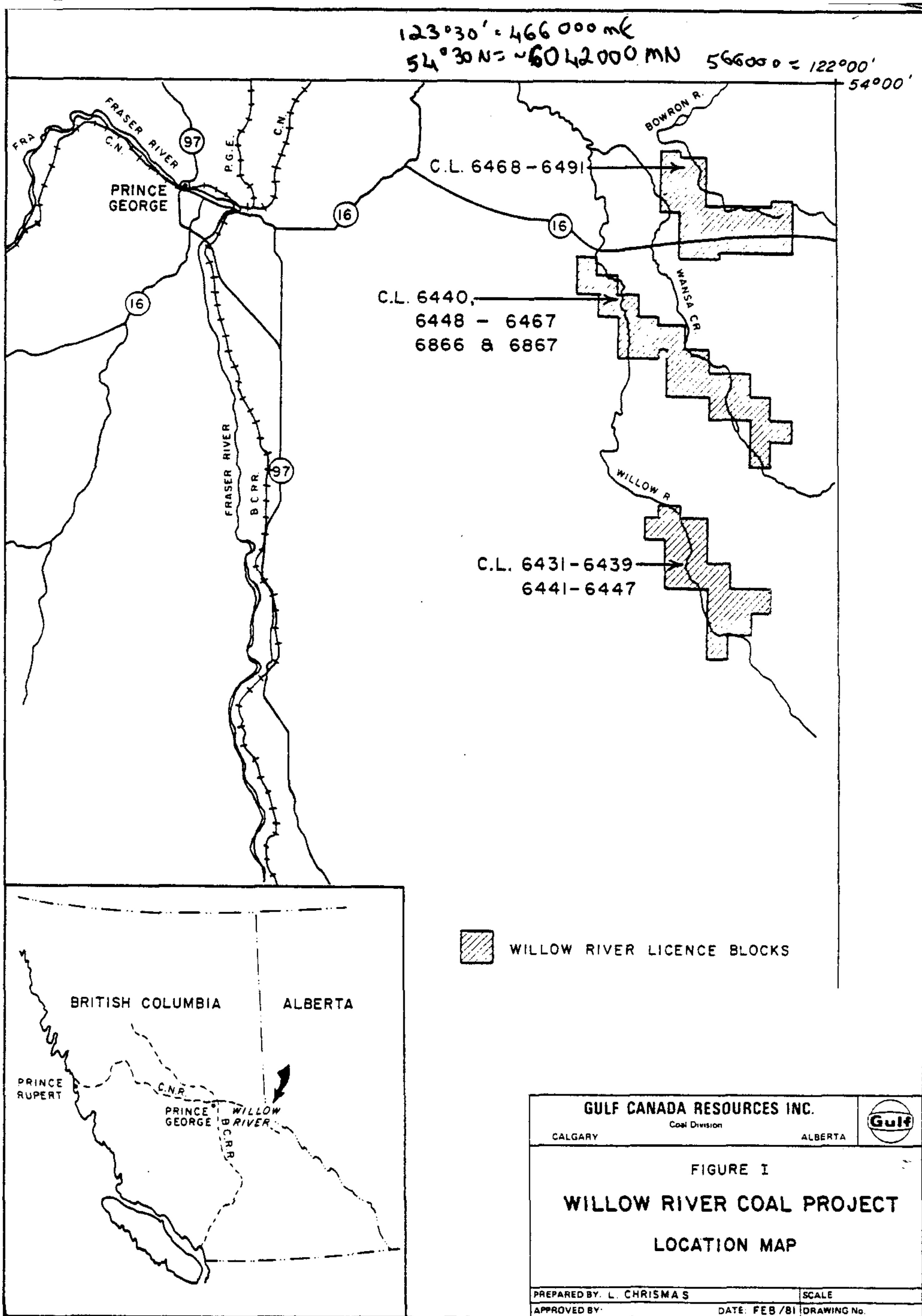


FIGURE I

WILLOW RIVER COAL PROJECT

LOCATION MAP

Bedrock within the licenced areas is usually obscured by a thick mantle of Pleistocene to Recent glacial deposits comprised largely of gravels and sands with minor lacustrine clays and silts. Preliminary field reconnaissance of the area prior to acquisition eliminated from licencing those locations where bedrock older than the coal bearing sediments could positively be identified. Field mapping during 1980 further defined those areas most favorable for coal exploration.

A simple reconnaissance gravity survey was conducted by Ager, Barretta and Associates Inc. at the direction of Gulf Canada Resources Inc., across five lines within the two southerly licence blocks, during February, 1981. This survey defined the limits of an alluvial basin in one instance and the eastern limit of an apparent basin in a second instance. The models developed for the gravity anomalies showed a possibility for coal seam development beneath glacial deposits and three of five drill holes were targeted for these potential seams. No gravity survey was performed across the northernmost licence block, but its proximity to the western limit of known coal bearing licences and the presence of a regional trending topographic low through its centre made it the target for the two remaining drill holes.

1.3 1981 EXPLORATION RESULTS

During nineteen days commencing May 4, 1981, exploration drilling accompanied by field mapping was carried out on the Willow River Coal Property. In total, five holes totalling 1015.62 metres were successfully completed with one hole totalling 67.05 metres having to be abandoned and re-located because of severe gravel conditions. Two 1.5 metre bedrock cores were taken at two separate locations. Geophysical logging was attempted for all holes, with the successfully logged intervals totalling 728 metres.

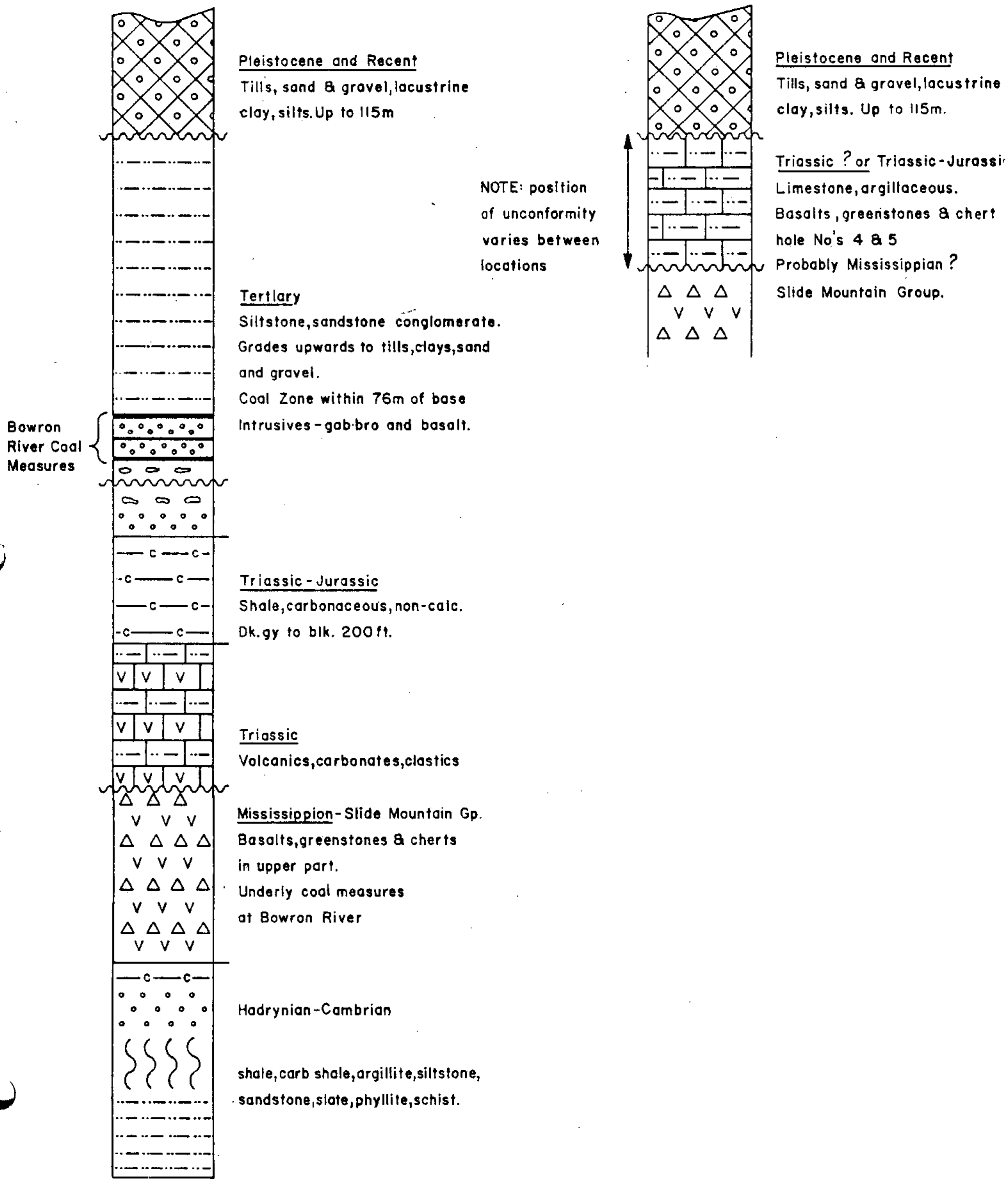
No coal occurrences were encountered during the exploration program. The low gravity anomalies were determined to have resulted from thick accumulations of unconsolidated gravels and sands of probable Pleistocene to Recent age. Up to 115 metres of such deposits were intersected. Bedrock below the gravels consisted largely of argillaceous, carbonaceous limestone, and dark grey to green grey basalts, tentatively correlated with the Mississippian Slide Mountain Group, and older than the prospect Bowron beds.

The 1981 Exploration Program was of insufficient detail to absolutely eliminate the existence of coal within the Gulf Willow River licences. Drill hole placement was such that the potential for coal tonnages sufficient to substantiate economic exploitation is virtually non-existant.

FIGURE II

GENERALIZED STRATIGRAPHIC COLUMN

WILLOW RIVER COAL LICENCES FROM 1981 EXPLORATION



2.0 INTRODUCTION

2.1 OBJECTIVES

The Gulf Willow River Coal Licences were acquired in 1980, on a speculative basis, with the intent of possibly discovering an extension or a structurally preserved correlative to the Bowron River Coal Field. Field mapping was undertaken during July, 1980, under the direction of Dr. J. Hughes, Consulting Geologist, and with operational personnel of John Innis, Gulf Geologist in charge, and John Stockwell, Consulting Geologist. Management of the Willow River Project has been the responsibility of B.P. Flynn, Supervisor Regional Exploration.

The 1980 field mapping program identified the two most southerly licence blocks as those most favorable for preservation of the Bowron Beds. A gravity survey, commissioned to Ager Barretta and Associates Inc., was undertaken across five lines within the two southern blocks during February, 1981. This survey defined the limits of an alluvial basin in one instance and the eastern extent of an apparent basin in a second instance. The models developed from the survey showed the possibility for thick coal accumulations underlying the drift mantle (see Appendix IV - Gravity Survey - for details).

The objectives of the 1981 Exploration Program were to assess, by drilling, the potential for economic coal seam development within the Gulf Licences. Particular emphasis was placed in those areas where the gravity survey had indicated alluvial basin potential. Additionally, field mapping was to be continued.

2.2 LOCATION

The Gulf Willow River Coal Licences are comprised of three non-contiguous licence blocks, totalling 63 individual licences covering 15,759 hectares, and located within approximately sixty kilometres south and east of Prince George, B.C., and within twelve kilometres west of the Norco Resources Ltd. Bowron River Coal Licences. (See 1:250 000 Location Map, Appendix VI).

2.3 COAL LICENCES

The 63 coal licences are numbered 6431 to 6491 inclusive and 6866, 6867. Annual licence renewal dates of July 1 apply in all cases.

2.4 OWNERSHIP

G.C.R.I. - 95%
Dr. J. Hughes - 5%

2.5 ACCESS

Access to the Gulf licences is via gravelled logging haul roads emanating from Highways 16 and 97. Highway 16 transects the northern licence block approximately 45 km east of Prince George, and access to the licences is gained along logging haul roads emanating south from the Highway at about 50 km and north of the Highway at about 52 km. Drill site 3 is about 0.5 km south of Highway 16 at 50 km. One logging haul road originating at Giscome, emanating south from highway 16 immediately east of the Bowron River Bridge crossing and turning north at the underpass, approximately parallels the Bowron River and provides access to drill site 4 and that portion of the licence block lying north of the river via an overgrown dirt-haul road at km 58 from Giscome. A washed out creek crossing prohibited access to the northwest portion of this licence block during the course of 1981 exploration. The central and southern licence blocks are most readily accessed by following highway 97 south from Prince George to the amber flashing light at approximately 14 km marking the intersection of the highway with the Willow Forest Road. Access then proceeds east and slightly south along the Forest Road to the Willow River bridge crossing at km 41.5. The central licence block is accessed by crossing the bridge and continuing to km 49 where the east fork leads to drill sites 1, 2 and 2 . Access to the southern licence block continues south from km 41.5 to about km 46 then east across the Willow River. Drill site 5 is at km 54 along this southerly route.

The Forestry roads within the Gulf Licences serve as haul roads for timbering operations centered at Prince George and are well maintained during those periods when logging is active. The roads are constructed of packed gravels and sands so are well drained and passable even during extremely wet periods.

3.0 EXPLORATION

3.1 INTRODUCTION

Exploration of the Willow River Coal Licences has taken place in three distinct phases:

i) field mapping during 1980;
ii) gravity survey during Feb., 1981;
iii) 1981 drill program.

The results of phases i) and ii) are briefly summarized in section 3.2 - Geological Mapping and 3.3. - Gravity Survey. More detailed accounts can be found in Appendix III - J.E. Hughes Reports and Appendix IV - Gravity Survey Details of the 1981 drill program are included as Section 3.4 - Exploration.

3.2 GEOLOGICAL MAPPING

The results from field mapping carried out during July, 1980 were enough to eliminate areas of little or no promise for coal development. The geological map produced from this reconnaissance serves as the Geological Base Map appended to the present report, and helped in selecting those areas most favorable for the gravity survey and for exploration drilling. Complete details of the program are included as Appendix III.

No changes to the 1980 field program resulted from mapping carried out in conjunction with the 1981 exploration program, but two bedrock exposures additional to those previously mapped were found and have been added to the Geological Base Map.

3.3 GRAVITY SURVEY

The 1980 field mapping program indicated a lesser likelihood for the northern licence block to be underlain by Bowron Beds than for the central and southern licence blocks. The gravity survey, commissioned to Ager Barretta and Associates Inc., and performed during February, 1981, was therefore confined to the central and southern blocks. In total, five survey lines were run across the two licence blocks with spacing between the lines of two to two and one half kilometres for the three lines within the central block and two kilometres for the two lines within the southern block. Station intervals of 50 metres were used throughout and a total of 583 stations along 28,950 line kilometres were recorded.

Interpretation of the gravity data identified the limits of an alluvial basin within the central licence block. Within the southern block, the eastern limit of a possible alluvial basin was identified. Several models were developed to explain the gravity profiles recorded, based on average rock densities of 2.8 grams per cc for country rock, 2.0 grams per cc for alluvial material and assumed density of 1.65 grams per cc for coal.

The most favorable model showed 50 - 60 metres of alluvial *material overlying up to 60 metres of coal near station* 2800 on the centre line through the central licence block. An alternate model for this same locale showed 150 - 200 metres of alluvial material. It was suggested that drilling in this locale "... would yield sufficient information to explain the gravity response and further evaluate the probability of a significant coal deposit in the area....."

3.4 1981 EXPLORATION

The 1981 Exploration Program was undertaken to investigate, by drilling, the potential for economic coal deposits within the Willow River Licences. Approximate drilling locations were selected within those areas where the previous field mapping and gravity survey had indicated most favorable targets. Additionally, the use of the gravity survey as a method of initial reconnaissance for helping to locate potentially coal-bearing sedimentary basins was to be checked. Actual drill locations were slightly modified within the northern lease block in response to available surface access conditions and to rumors as to the most favorable areas for locating an extension to the Bowron River coalfield.

Concurrent with the drilling operations, geological reconnaissance for bedrock outcrops additional to those previously mapped was undertaken to further refine the geological map.

3.4.1 EXPLORATION EQUIPMENT

A model TH-60 Cyclone drill, equipped with a casing hammer and capable of operating with either air or water, was rented from Can-West Drilling Inc. of Box 1209, Prince George, B.C. The drill was operated on 2-12 hour shifts per day and used the following as associated and support equipment:

i) 1500 ft. (457 m) 3-1/8" o.d. drill rods in 20 ft. lengths;
ii) downhole hammer;
iii) 6" o.d. surface casing with wall thicknesses of 188,280 and 377 mm, in 20 ft. lengths;
iv) 2 - 4 wheel drive 3/4 ton pickups;
v) combination water/service truck with approximately 500 gallon capacity;
vi) all necessary bits, subs, tools and equipment.

Century Geophysical Corporation, Calgary, was employed to provide logging services consisting of Natural Gamma, Gamma-Density, Resistivity and Caliper. A five foot diamond triple-tube core barrel, yielding approximatley 2-7/8" diameter core was rented for a portion of the program. Gulf personnel rented two - 4 wheel drive 3/4 ton pickups, for daily transportation to the program and employed a Bell 206 Jet Ranger helicopter for three hours reconnaissance.

3.4.2 EXPLORATION PERSONNEL

The program was carried out under the supervision of Mr. B.P. Flynn, Supervisor Regional Exploration, Gulf Canada Resource Inc. Field personnel included:

G.W. Jackson	-	Consulting Geologist and Field Manager.
Ali Rahmani	-	Geologist, Gulf Canada Resources Inc.
Ajit Vora	-	Project Accountant, Gulf Canada Resources Inc.
Dr. J.E. Hughes	-	Consulting Geologist

Accommodation for all out of town personnel was obtained at motels within Prince George.

3.4.3 RESULTS OF 1981 EXPLORATION

A total of six holes were attempted at five different sites (see Drill Hole Location Map, Appendix IV for hole locations). One hole, 2', had to be abandoned at 107.9 metres depth when the 0.188 mm wall thickness casing collapsed due to excessive gravels. This hole was skidded to location 2 and successfully completed using 0.280 and 0.377 mm casing. In total 1082.67 metres of drilling was completed, including two 1.5 metre cored intervals.

Drill cuttings, representative of each twenty foot interval, were collected and retained for each hole. The cuttings were visually described by on-site geologists and form the basis for the drill litho-logs included as Appendix I. Additionally, interpretative descriptions of the drill cuttings and cores have been prepared by Dr. J.E. Hughes for those drill sites visited by himself. Dr. Hughes notes are included as Appendix II.

The two cores were also retained and visually described by the on-site geologists. Positive age identification of the rocks could not be made on the basis of visual description, but pre-Tertiary ages are interpreted in all cases. Micropaleontological studies of the core from WR-RDH-2 might positively identify the age, if such determination is deemed necessary. All cores and drill cuttings samples were shipped to Calgary and are temporarily stored at Gulf's facilities.

Attempts to geophysically log the drill holes encountered difficulties at locations 1 and 2. At location 1, severe sloughing conditions in weakly consolidated (Recent?) siltstones were encountered by the drill immediately below the surface casing. Attempts to log beyond this point were unsuccessful, even after reaming and heavy foam injection. The logging unit was not equipped with a slimline tool, so no log could be run through the drill stem. After six hours reaming and attempting to log, the hole was abandoned. At location 2, bridging of the hole had occurred at 128 metres. Attempt to ream through the bridge and open-hole log were not successful. The slimline tool was ordered after hole 1, and was run inside the drill stem for all but the bottom 19 metre interval at hole 2. Open hole logs were obtained to the bridge. No logging was attempted at hole 2' because it had been abandoned prior to reaching the overburden/bedrock interface. No logging problems were encountered for the remaining three drill holes.

Helicopter reconnaissance of the licences was undertaken to check access, particularly in the southern block, to check for bedrock outcrop additional to those previously mapped and to investigate the trend of drilling patterns on licences adjacent to Gulf's as a possible aid in locating an extension to the Bowron River Field. Access routes spotted from the air were ground-checked and proved to be impassible by exploration equipment. One area of outcrop was spotted between the northern and central licence blocks. Ground-checks showed this to be of basaltic composition (Mississippian - Slide Mtn.). The drilling pattern of Norco Resource Limited was difficult to trace through numerous logged over areas, but appeared to follow a northwest - southwest grid pattern with no obvious correlation to the Gulf Licences.

Field traverses undertaken while drilling was in progress yielded only one new outcrop (limestone, tentatively Jurassic) within the central block.

No coal was encountered during the course of 1981 exploration. Unconsolidated overburden deposits up to 115 metres were penetrated and are considered to be the probable cause for the anomalously low gravity responses. Whereas this exploration program could not verify the accuracy of reconnaissance gravity surveys as an aid to locating coal deposits, the gravity method was proven to be useful in locating areas yielding low gravity responses by virtue of abnormally thickened alluvial deposition. This use could be beneficial in eliminating areas of non-coal potential from further programs. The use for detecting coal-bearing areas will be hampered whenever thick drift deposits are present.

3.5 RECLAMATION

The six drill sites were left with approximately 0.5 metres of casing protruding from the ground, and with drill cuttings stacked to about the same height. Reclamation will consist of cutting off the casing below ground level, capping the hole, spreading the cuttings and possibly seeding the areas. No clearing was performed in conjunction with this program nor was any extensive environmental damage apparent to the field exploration personnel.

4.0 GEOLOGY

The heavy cover of alluvium and drift, with only scattered outcrop occurrences, makes structural and stratigraphic correlations across the Gulf licences virtually impossible. As previously noted, micropaleontological evaluation of the drill cores might allow positive age identification. The geological *map produced in conjunction with previous exploration* is considered occurate and has been updated with the results of 1981 field work. All bedrock encountered by drilling is tentatively described as pre-Tertiary.

The stratigraphic column constructed for this report (Figure II) was accumulated from a study of various other reports, papers etc., and shows both the regional stratigraphy and that interpreted from 1981 drilling.

5.0 RECOMMENDATIONS

The drilling pattern, together with bedrock determinations virtually eliminate the possibility for economically exploitable coal deposits within the Willow River Licence area. It is therefore recommended that these licences numbered 6431 to 6491 inclusive and 6866 & 6867 not be renewed at the next anniversary date of July 1, 1981. The appropriate B.C. Provincial Government officials in Victoria should be notified.

APPENDIX I

DRILL CUTTINGS & CORE DESCRIPTION
LITHOLOGY LOGS

Coal licence 6440

DRILL HOLE: WR-RDH-1

PROPERTY: Willow River

LOCATION: Lat. 53° 45-

Long. 122° 06

ELEVATION: 839 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: No logs run. Hole badly caved at 73 m. No slimline tool with logging unit.

LOG INTERVAL:

"FROM"	"TO"	DESCRIPTION
0	42.5	(OB) sand and gravel increasing grain size with depth from med-sand to coarse sand-pebble >1/16 -1/2" color dark green when wet.
42.5	55.	Clay, dark grey. Color dark green when wet.
55	67	Fine silt and clay, dark grey and green grey. Color tan when wet.
67	73	Silty clay with quartz veins well oxidized. Dry grey siltstone white quartz
73	103.5	Dark grey siltstone, slightly calcareous, less quartz than above more calcareous, no quartz with depth.
103.5	213	Siltstone, dark grey. Calcareous - partly calcareous with depth. Siltstone medium grey with calcite veins preent calcite decreases with depth.
213	238	Interbedded siltstone and claystone. Siltstone-medium grey, reacts with HCL Claystone well oxidized, rusty color. With depth, interbedded claystone and fine sandstone, weakly calcareous. claystone, oxidized. sandstone medium grey

DRILL HOLE: WR-RDH-1

PROPERTY: Willow River

LOCATION: Lat. 53° 45-
Long. 122° 06

ELEVATION: 839 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: No logs run. Hole badly caved at 73 m.
No slimline tool with logging unit.

LOG INTERVAL:

"FROM"	"TO"	DESCRIPTION
238	262 (TD)	Limestone, argillaceous, medium grey, fine grained, strongly calcareous. Minor ironstone and sandstone, fine grained.

Coal licence 6451

DRILL HOLE: WR-RDH-2

PROPERTY: Willow River

LOCATION: Lat. 53° 46+
Long. 122° 87-

ELEVATION: 854 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: Gamma, Density, Caliper, Resistivity, Gamma-Resistivity.

LOG INTERVAL: 261.2 m

"FROM"	"TO"	DESCRIPTION
0	71.5	Gravel and sand 6" pipe 300/gal/min.
71.5	79	Siltstone medium reaction with HCL Graphite present (carbonaceous)
79	100.5	Siltstone, carbonaceous, excessive amount of graphite present
100.5	134	Limestone, Argillaceous, carbonaceous. Light grey. Graphite content decreases from 100.5 - 134 m, reaction with HCL is medium.
134.0	280.5 (TD)	As above, limestone with minor shale. Shale is micaceous platey, fissile, dark grey and shows no reaction with HCL, slightly graphitic. Calcite veins present and increases with depth.

Coal licence 6451

DRILL HOLE: WR-RDH-2

PROPERTY: Willow River

LOCATION: Lat. 53° 46+

Long. 122° 07+

ELEVATION: 838 m

DATE: May, 1981

HOLE SIZE MAX.:

INCLINATION: Vertical

GEOPHYSICAL LOGS: Not run, hole abandoned

LOG INTERVAL:

"FROM"	"TO"	DESCRIPTION
0	107.9 m (TD)	Gravel and sand. Casing collapsed from excessive pounding. Hole abandoned, skid to location 2.

Coal Licence 6476

DRILL HOLE: WR-RDH-3

PROPERTY: Willow River

LOCATION: Lat. 53° 62+
Long. 122° 06-

ELEVATION: 762 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: Gamma, Density, Caliper, Resistivity
Gamma-Density

LOG INTERVAL: 245 m

"FROM"	"TO"	DESCRIPTION
0	3.5	Overburden gravel and sand
3.5	79	Limestone, argillaceous, dark grey, hard, carbonaceous streaks
79	201	As above, limestone with calcite content increasing about 15-20% Occasional pyrite *See core description 85.5-87 m*
201	245 (TD)	aa limestone, light grey, carbon content decreasing
		Core Description
85.5	87	Recovery 100%
		Limestone, argillaceous, dark grey to black Broken stick with 1.2 cm to 10 cm. pcs., average about 5 cm Calcite infilling both vertical and sub-parallel to bedding About 50% calcite in crystalline form at 71.12 cm to 83.82 cm. Vertical calcite joint about 3 mm thick at 124 to 142 cm. Very carbonaceous to graphitic along fracture planes

Coal Licence 6481

DRILL HOLE: WR-RDH-4

PROPERTY: Willow River

LOCATION: Lat. 53° 64+
Long. 122° 03

ELEVATION: 717 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: Gamma, Density, Caliper, Resistivity

LOG INTERVAL: 69.6 m

"FROM"	"TO"	DESCRIPTION
0	6	Clay & rocks, brown
6	24.5	Sand or finely ground bedrock, chips of dark grey, finely crystalline non calcareous rock (basalt)
24.5	36.5	Dark grey, finely crystalline basalt, Fragments of black (aphanitic) shale Trace amounts of calcite
36.5	67	Grey-green basalt, finely crystalline, minor calcite probably veining.
		CORE DESCRIPTION
67	69.6 (TD)	Recovery 100% Very fine crystalline basalt, calcite veined, minor black fragments, aphanitic inclusions (possibly silicified shales). Minor pyrite along shear planes.

Coal licence 6435

DRILL HOLE: WR-RDH-5

PROPERTY: Willow River

LOCATION: Lat. 53° 40-

Long. 122° 09+

ELEVATION: 899 m

DATE: May, 1981

HOLE SIZE MAX.: 13.3 cm

INCLINATION: Vertical

GEOPHYSICAL LOGS: Gamma, Density, Caliper, Resistivity, Gamma-Density

LOG INTERVAL: 152.2 m

"FROM"	"TO"	DESCRIPTION
0	109.5	Gravel and sand Abundant pyrite
109.5	122	Dray grey limestone Non-carbonaceous Minor pyrite and quartz
122	134	Grey shale, slightly carbonaceous Non-calc. except in calcite veins
134	152.5 (TD)	Basalt, dark green & black. Quartz & chert cutting. Chert Quartz-white to milky. Chert-green and tan?

APPENDIX II

NOTES ON DRILLING AND EXPLORATION,

J.E. HUGHES

WILLOW PROJECT: DRILLING

Note on Drilling and Exploration: May 1981: A summary of observations from field visits

Drill Hole 1

Cuttings of bedrock available for inspection, include shales - argilites, siltstones, sandstones, - and (?) some calcareous shales and limestones. No cores; and coring tools not available. Drilled section is pre-Tertiary.

Drill Hole 2

Cuttings of bedrock: argillites, siltstones, sandstones very fine grained, dark grey; calcareous shales, and limestones, black, and graphitic shales (or ? schists) notable, forming much of the lower part. No cores obtainable; two attempts failed to reach bottom. Caving and bridging in lower part of the hole can be referred to a low density zone recorded on the gamma-density log. This and other similar record, probably and represents a fault with graphitic, and carbonaceous gouge developed from the black limestones and shales. The drilled section is Pre-Tertiary.

Drill Hole 4: Vama Coal Licences

Drill cuttings of bedrock of greenstone. The core from the basal 5 feet, is similar and representative of the drilled section.

Core No. 1. Altered basalt (- greenstone or basalt of this aspect): aphanitic and partly very fine crystalline (? with fresh recrystallized felspars); core broken, some shears with chlorite surfaces, some calcareous veining.

The drilled section belongs to the Antler Formation, Slide Mountain Group; Mississippian & ? part Devonian.

Drill Hole 3

Drill cuttings from the lower part, includes shales - argillites, siltstones, calcareous shales and limestones very dark grey to black. Core No. 1, - 5 feet: limestone, black aphanitic, very carbonaceous, sooty; core broken some shears with graphitic streaks; tension gashes filled with calcite veining. The drilled section is Pre-Tertiary.

Stratigraphic references for Drill Holes 1, 2 and 3 are generalized. Similar lithic types are reported from the Hadrynian - Cambrian, Devonian (?) - Mississippian, and Triassic sequences, Micropalaeoutology may be useful for datings.

The basalt (greenstone) of Drill Hole 3, of the Slide Mountain group, Drill Hole 3 is part of the major trend of this outcrop, in Cariboo Mountains.

J.E. Hughes

APPENDIX III

PROGRESS REPORTS I & II,

J.E. HUGHES

WILLOW PROJECT

REPORT OF PROGRESS I : 1980

SUMMARY OF FIELD WORK, JULY 1980

J.E. HUGHES

AUGUST 3, 1980

Revised April, May, 1981

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FIELD SUMMARY REPORT: JULY, 1980

FOREWORD

The Willow project comprehends the search and exploration for Lower Tertiary coals, – the correlatives of the Bowron coalfield.

The field work for the project, July 3rd to 20th was directed to the geology of Ispah, Wansa, and Vama coal licences, and to stratigraphy, prospecting, and reconnaissance of the Pitoney Lake and Wansa Creek, Map Areas 93C/9 and 16, Figures 1 and 2. The report describes the results of field work in summary form to introduce a basis for the design of exploration and drilling.

This second edition of the Report of Progress 1980, has been edited with few revisions. There is one change in the stratigraphic placement of volcanic beds of the westerly outcrops.

All stratigraphic references are tentative, subject to confirmation by further studies.

TERRAIN

The Wansa and Pitoney areas include the northwest termination of the Cariboo Mountains, and its surrounding uplands and plains which make a transition to the lowlands of the Fraser Valley on the north and east. The Cariboo Mountains are reduced to hill ranges of broken forms, represented by outliers of Mount Bowron and Spring Mountain on the west, and the hills grouped about Mount George on the east. The uplands of low hills, plateau and valley forms occupy the middle ground, to elevations of 3 500 feet. They decline northward to a plain of 2 500 feet elevation with few low hills, and merge with the valley plains of the Fraser River.

Extensive glacial deposits cover the uplands and plains. The drainage was superimposed on the glacial drift, and collected by the Bowron and Willow Rivers which follow incised valleys 100 to 250 feet deep. The terrain is thickly forested, the northern plain more diversified by open scrub and muskeg on low ground and swamps.

Much of the areas of the coal licences are logged by open cuts, mostly of the last five years. Forestry and logging roads provide good access and a network of trails. The prevalent subsoil of sands and gravels are well drained and allow use in wet weather. Muskeg and swamps lack roads and trails, and may impede working in parts of the Vama group of coal licences. The roads and trails and the terrain should allow economies in first and subsequent exploration and drilling in most of the area under coal licences.

STRATIGRAPHY

Bedrock of the Wansa and Pitoney areas can be assigned a stratigraphic range, Hadryinian to Triassic; the subsequent intrusions were emplaced probably in the Jurassic – Cretaceous.

Lower Tertiary beds, the Bowron coal measures, the objective of exploration have not been found. Upper Tertiary units (G.S.C., Map 49 – 1950, 93G) are in question, and require confirmation. Pleistocene deposits cover most of the bedrock in the coal licences and surroundings.

Exposures of bedrock are few, and dispersed along parts of the Willow and Bowron Rivers, and in road cuts. They are not enough to obtain a comprehensive view of the stratigraphy or to determine structure. This limitation is more complicated by similar sequences of clastics and carbonates in the Hydrynian, Mississippian and Triassic succession, and repeated volcanism of the Missippian and Triassic. No fossil sequences have been found.

Field work allows stratigraphic assignments of only generalized nature, depending on judgement, and descriptions of published reports.

HADRYNIAN - CAMBRIAN: KAZA and CARIBOO GROUPS

The observed lithic types include shales, carbonaceous shales, argillites, siltstones, sandstones, slates, phyllites and schists. Phyllites and clastics occur together in interbedded sequences. The schists include light coloured, green or brownish types of recrystallized muscovite and quartz, and lesser graphitic, micaceous schists, and few chlorite-talc schists. One trend of phyllites with graphitic, and mica schists and carbonaceous shales can be followed along the west slopes of the Willow Valley from George to Jerry Creek.

MISSISSIPPIAN: SLIDE MOUNTAIN GROUP

This unit is identified by the basalts, greenstones, and cherts of the Antler Formation. The basalts outcrop in Box Canyon in the north part of the Vama group of coal licences, and the slopes of Mount Bowron. To the southeast, they underlie the Bowron coal measures.

The basalts are dark green, aphanitic or fine crystalline; and massive or brecciated in parts. They tend to be altered; some degree of chloritization with epidote and calcite is common; autobrecciation is frequent in places; a few pillow structures are noted. Other lighter coloured lavas of felsic, whitish, microcrystalline alteration and aspect are referred to the Mississippian, (localities, – Willow River, Lat. 53°53' – Wansa Creek, Lat. 53°49'): but a possible Triassic age may be noted.

Greenstones of adjacent areas show a felted matrix of chlorite and feldspars. The chert is massive, structureless and unbedded, of uniform grey colour and texture. Some shales, sandstones, and conglomerates in proximity with volcanics have been included in the Slide Mountain group.

TRIASSIC: TAKLA GROUP

The sequence of rocks ascribed to the Triassic of the Cariboo region includes volcanics, carbonates, and clastics. Takla beds outcrop in areas west of the Willow River (Tipper 1960).

Exposure of phyllites, and shales, siltstones and sandstones east of the Willow River, described as Pre-Cretaceous without stratal assignments, may belong to the Takla Group. Some of this ground was shown as Triassic (Tipper 1960). Other Triassic outcrops are shown along the Bowron River in the area of the Vama coal licences (ibid.).

TRIASSIC - JURASSIC (?)

Shales found northeast of Wansa Lake are regarded as possible Upper Triassic - Jurassic in age. They are very dark grey to black, of dull appearance. The shales are of uniform type, notably carbonaceous without any plant debris, and non-calcareous. They weather in fissile plates of dark olive colour. They show cleavage in small folds, but lack any definite foliation or metamorphism. The shales probably amount to 200 feet stratigraphic measure in the several exposures. Nearby float of argillaceous, carbonaceous limestone of similar, dull black appearance probably belongs to the shale sequence.

TERTIARY

Units of Miocene (?) and Palaeocene-Miocene sediments, and one of Late Tertiary volcanics are recorded in the Wansa, Pitoney, and Giscome areas (G.S.C., Map 49 - 1960, G.S.C., Map 2 - 1962).

Investigations do not confirm these stratigraphic assignments, by observations of lithology and field relations in areas of the coal licences and surroundings.

Exposures in ground formerly mapped as Late Tertiary units can be described as follows: (1) along the northerly and middle reaches of the Willow River, clays with pebbles, and clays grading upwards to glacial lake silts, and tills, apparently of Pleistocene age; (2) the mapped unit three miles south of the village of Willow River, glacial lake clays; (3) along the southerly reaches of the Willow, bedded and gravels regarded as probable Pleistocene or Recent deposits; (4) the mapped unit northwest of Wansa Lake, a thick sequence of gravelly tills, and some bedded reddish sands and gravels of which the contact and field relations are obscure. Similar sands and gravels are commonplace along the Willow River and surroundings are otherwise shown as Pleistocene and Recent.

A mapped unit of Tertiary on Jerry Creek (west fork) is in doubt for lack of positive identification. Tertiary volcanics shown west of Wansa Lake (G.S.C. Map 49 - 1960) were not found, but may well require another search. Jerry Creek (east fork), exposes about 15 feet of greenish sands, one lignitized tree trunk, and few thin interbeds with plant debris; a bed of alluvial gravels overlies the sands: observations here allow a possible Tertiary age. (Note different names of east and west forks, NTS 93G, 1:50 000 and 1:250 000 series.)

INTRUSIVES

Intrusives outcrop along the west side of the Willow River and along its course in the area and surroundings of the Ispah coal licences.

Granites of George and Hurtubrise Creeks are identical; a light coloured biotite granite with much quartz, about 30%, interstitial, and in aggregates resembling greisens. The granite may be referred to the Topley Intrusives (G.S.C., Map 49 - 1960).

Basic intrusives consist of similar, dark green pyroxene gabbros, of colour index 50 to 60. Basalts occur close by in separate exposures, in the west bank of the Willow River north of Hurtubrise Creek. The northern group of basic intrusives are linked by a moderate, and well-defined magnetic trend, a dyke extending from a northern plug. The basalts represent chilled margins or a feeder channel. The Willow gabbros probably belong to Topley magmatism, though a Tertiary age is not excluded.

PLEISTOCENE

Pleistocene deposits in the Ispah, Wansa, and Vama coal licences are lacustrine clays and silts, sands and gravels of littorals and outwash, and tills of englacial and lateral moraines. The tills have rounded water-worn gravels, and commonly in the southern parts, matrices of fine gravels, sand, and silts with lesser clay.

The Pleistocene deposits have various distributions though they conform to general pattern; north of Latitude 53° 49', lacustrine clays and silts, and clay tills are most abundant: on the south, sands and gravels, and gravel tills. The subsoil, roads, exposures and river banks in the uplands south of Latitude 53° 49' show this great accumulation of sands and gravels, of dull grey colours, and bright rusty colours. They probably derive from Late Tertiary fluvial and littoral beds. The boundary of the northern and southern glacial facies seemingly coincides with a still stand of the glacial retreat from south to north.

Remnants of the ice contact face (inferred), occur west and southwest of Beaver Lake near the divide of Taspai and Wansa Creeks. Here, the isolated hill elevation of 2 940 feet reveals sands and gravels in a section of 430 feet, base unseen; logging roads on the east face have left exposures from the top to the valley floor at Taspai Creek, elevation 2 510 feet. The sands and gravels are interpreted as deposits of glacial outwash. Their 430 feet section indicate a measure of the Pleistocene fill in the pre-glacial lake. A core of bedrock may underlie the hill and should be checked by detailed mapping.

Estimates for thickness of Pleistocene drifts are subject to some uncertainties, the relief of the bedrock surface, the depth of pre-glacial valleys. In the areas of the Ispah and Wansa coal licences, it seems the thickness of drift in the uplands can range to 250 feet. Drifts in intervals of 200 to 350 feet alongside the Willow River probably reflect the fill of its Late Tertiary pre-glacial valley. Relief of the bedrock in the Ispah and Wansa coal licences attain 600 feet, about comparable to the existing relief at surface.

Similar conditions probably apply to the Vama coal licences, a drift cover in the range to 200 feet; the bedrock relief is probably less, in the range to 300 feet. The course of the Bowron River here may not be related to a major pre-glacial valley.

Pleistocene deposits are mapped in preliminary order and grouped in units, which incorporate features of terrain. The map unit, - sg; "sands and gravels", combine materials of several origins, englacial and lateral moraines, outwash, littoral and lacustrine deposits, alluvium, reworked material and recent deposits and subsoil derived from the Pleistocene floor, and as such, the term serves a convenience in place of long term investigations. This unit tends to represent thicker drifts. Areas of relatively thin drift, less than about 65 feet are drawn from submask patterns, but this mapping is interpretative and lacks enough bedrock exposure for calibration.

STRUCTURE

A lack of exposures and definite stratigraphic references handicap work on structure of areas under coal licences.

On a regional scale there are structural features of note: the absence of the Slide Mountain Group (or its characteristic basalts) in outcrops west of the Wansa and Willow valleys and plains; the prevailing southwest dips and foliation in the area of the Wansa and Ispah coal licences. The structure has the general form - reading northeast from the Willow River: Hadrynian and Cambrian in anticline, syncline and ascending limb; fault limb of prevailing southeast dips, with structure modified by subordinate disharmonic folding in Triassic beds, folding and faulting or uplift, bounded on the east by a fault, or downfold along the Willow River: the footwall or syncline on the east, and a west dipping limb, modified by minor faults and folds: the major compound anticline along the trend of Spring Mountain.

Structures of interest for exploration can be indicated: the possible syncline or footwall, alongside the Willow River, on the east: a possible synclinal or down faulted trend along the west flank of Spring Mountain.

REVIEW OF EXPLORATION

There is not enough information to predict specific structures for exploration drilling.

Exposures along the Willow and Bowron Rivers allow projections of bedrock geology for much of the Ispah, Wansa and Vama coal licences, which exposures, if regarded as representative samples of the bedrock, exclude much of the area under coal licences from testing and drilling.

Some trends can be considered for prospecting, (See under STRUCTURE): the Willow trend, - the footwall or syncline east of the River: the Wansa trend, northeast of Wansa Lake and along the flank of Spring Mountain. The latter can be interpreted from beds regarded as (?) Triassic - Jurassic: if representative of the youngest pre-orogenic strata, they may be followed downdip in search of Bowron beds.*

* See: Memoranda and Notes, Willow Project; November, December, 1980

Outcrops of the Late Tertiary (G.S.C., Map 2 - 1962, G.S.C., Map 49 - 1960) are doubtful and some are likely to be discredited. Therefore, we cannot depend on the concept of Late Tertiary beds as a guide to synclines which may preserve the pre-orogenic Bowron coal measures of Early Tertiary age.

Selected References

Campbell, R.B., et al: Geology of McBride Map Area, B.C. (93H): G.S.C., Pages 72 - 85.

Tipper, W.H.: Prince George (93G): G.S.C., Map 49 - 1960)

Muller, J.E. and Tipper, H.W.: McLeod Lake, G.S.C., Map 1204 A

Willow Project

Report of Progress I : 1980

Summary of Field Work, July 1980

EXPLANATION AND LEGEND

FOR

FIGURES I AND 2

EXPLANATION AND LEGEND

MAP UNITS

U	Bedrock: Pre-Cretaceous, no stratal units assigned
Y	(? possible) Late Tertiary, post-orogenic
L	(? possible) Jurassic - Late Triassic
T	Triassic; Takla Group
M	Mississippian, and (? part) Devonian; Slide Mountain Group
W	Cambian and Hadrynian; Cariboo Group and (? part) Kaza Group

Intrusives

A	Granite; probably Topley intrusives, Jurassic
B	Gabbro, associated basalt and diabase; probably Topley intrusives, Jurassic; may include some Tertiary basic intrusives

RECENT AND PLEISTOCENE DEPOSITS

	<u>Recent</u>
ra	alluvium; overlying Pleistocene deposits, or bedrock
	<u>Recent or Pleistocene</u>
cb	thin drift cover; mostly ground moraine, concealed
sg	sands and gravels, in places sands and gravels with lesser interstitial clays: includes bedded sands and gravels, some (?) original glacial tills and reworked tills, fluvio glacial outwash; in places may include some alluvium
dr	drift unclassified
	<u>Pleistocene</u>
mr	moraine forms with tills: various
tl	tills (? interpretative)
pt	glacial deposits of lowlands: tills, clays, lacustrine clays and silts, minor sands
lk	lacustrine clays; clays; and clays with lesser or minor silt and sand layers, some random pebbles in places; - reserved for specific localities and observations

MAP SYMBOLS

Bedrock observed; representative exposure

x — Bedrock exposure; - records of field staff

Formational, or unit boundary, indicated, inferred, probable

Drift boundary; unconsolidated, Recent and Pleistocene deposits; indicated, inferred, probable

Fault: inferred, possible

Strike and dip, degrees: vertical beds

Approximate dip, degrees: undulant dip

30/60 — Variation and range of dips (degrees)

Drag fold

Foliation, direction, and dip (degrees): foliation vertical

anticline

syncline

plunge

bedrock, with thin or partial drift cover; enclosure

bedrock of major area, unmapped; enclosure

J.E. Hughes

Willow Project / Aug 3 / 1980.

WILLOW PROJECT

SUMMARY OF PROGRESS II : 1981

J.E. HUGHES

MAY 6, 1981

SUMMARY OF PROGRESS II

The report summarises activities and findings of the Willow Project. It supplements previous writings and offers a commentary on geology and exploration.

INTRODUCTION

The project entails a search for a concealed coalfield(s) for which the determinants are: coal measure sediments of pre-orogenic age, Cretaceous-Tertiary contained and preserved in synclines or down faulted structures, now covered by glacial and recent drifts, and perhaps in places post orogenic deposits of Later Tertiary age. The Bowron coalfield serves as example, and from this can be deduced an exploration model, a structure of 1.6 X 12.8 km, and the objective, a potential to about 30 million tons workable coal in place. The Bowron coals are ranked Bituminous High Volatile B/C: they have notable content of resins and some partial concentrations of germanium.

The exploration can be simplified by interpretations of structures, and of post-orogenic and recent relief. Previous information on the geology is introductory, and published mapping of reconnaissance order (G.S.C., Maps: 49/1960; 2/1962; 1356 A).

EXPLORATION

The design and progress of exploration can be indicated by the sequence of work:

1) reconnoitre and map geology as far as exposures, terrain, schedules and economics allow

2) identify and select prospective structures

3) geophysical surveys to delineate subsurface structure and drilling targets

4) drilling where appropriate to the results (3)

WORK COMPLETED

Field work July 3 to 20/80, was applied to geology mapping and prospecting. This was organised in two parties led by J. Innis, and G. Johnson, to cover the Vama, Wansa, and Ispah groups of coal licences. J.E. Hughes provided guidance and support to the work on the coal licences, and undertook the geology of the intervening and surrounding areas. Field operations were based in Prince George and serviced by helicoptor, J. Currie pilot. (<u>See</u> Willow Project Report of Progress I : 1980 : Summary of Field Work, July 1980, (August 3/80)).

The results were enough to eliminate areas of little or no promise, according to exposures of older beds and their probable, and projected subcrops. These included most of the Vama coal licences. In parts of the Wansa and Ispah coal licences, two trends were regarded as possible structures of interest: a syncline (?) partly inferred, trend 145°, parallel and along the southwest flank of Spring Mountain – reference Lat 53°46', Long 122°05'; the east front, or footwall of a downfold or fault, inferred alongside the Willow River, trend 160°, – reference Lat 53°36', Long 122°05' (<u>See</u>: Notes on Exploration & Memoranda, November 1980).

Gravity surveys to examine these trends may be confirmatory. Interpretation of the surveys depend on different densities for unconsolidated drift, bedrock, and that projected for Tertiary beds and coal measures: it is subject to a variable factor, unknown depth to bedrock.

GEOLOGY AND EXPLORATION

The following commentary relates to geological work to date.

The extensive drift cover restricts work, especially in the lowlands and the intermontane areas, and it limits mapping and determinations of stratigraphy and structure. This difficulty is made worse by similar and repeated lithologies in more than 10 000 m of geosynclinal succession, Hadrynian to Triassic. Fossil sequences are uncommon. Other factors indicate cautions for stratigraphic work: regional unconformities of the sub-Mississippian and sub-Triassic intervals, and the extent of regional metamorphism. Vertical and stratal ranges of metamorphism may seem obscure and arguments of its origin pre-Mississippian or Laramide, unsettled (See: Campbell et al, 1973). These limitations on geological work in folded and faulted terrain were recognized in advance, and the dependence on subsurface methods of search as a committment to the project.

Most of the bedrock belongs to the two sedimentary sequences, the Slide Mountain, and the Cariboo-Kaza Groups.

The Slide Mountain Group (Mississippian and (?) Devonian) is identified by the massive cherts, and the ophiolite association, greenstones, tuffs, basalts, and ? other volcanics - though similar volcanics with andesites are noted from descriptions of the Takla Group (Triassic, - ? Jurassic). The area east of the Willow River contains outcrops of the Slide Mountain Group. Other beds exposed here are left unnamed at present.

A generalized Kaza-Cariboo sequence can be assigned to schists, phyllites, and clastics with differential foliation, on the west of the Willow River.

These distributions, together with prevalent westerly dips and foliations, may indicate a fault or down fold, of trend 160° along the line of the Willow River.

Stratigraphic assignments of field work 1980, are provisional and subject to revision from further studies.

Late Tertiary beds shown in mapping (G.S.C., Map 49 - 1960, Map 1204 A) were regarded as post-orogenic fills in synclines and downfaulted structures, and thereby possible indicators to subcrops of Bowron coal measures. Fieldwork 1980, questions these assignments. Several of their locations are occupied by glacial lake clays: some by sands or gravels of remnant marginal terraces which may well have a history of multiple Quaternary processes. The possibility of one Late Tertiary outcrop, at Jerry Creek, is suggested by field relationships.

The drift cover has been mapped in provisional status to accommodate applications to geophysical work and drilling, and available time in the field. Sands and gravels in subsoil and cut banks south of Highway 16 cover the largest area. They are separable into two units, with estimates of thickness to 20 or 30 m, and (?) 60 or 80 m. River courses are incised, and the Willow valley is overdeepened.

REFERENCES

Ager, Berretta & Assoc. (1981): Gulf Coal Gravity Survey; Willow River

Campbell, R.B., et al (1973): Geology of McBride Map-Area, British Columbia; G.S.C. Paper 72-35

Hughes, J.E. (1980): Willow Project Report of Progress, I : 1980 : Summary of Field Work, July, 1980

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Tipper, H.W. (1961): Prince George, British Columbia; G.S.C., Map 49 - 1960

APPENDIX IV

WILLOW RIVER AREA GRAVITY SURVEY

AGER BARRETTA & ASSOC. INC.

GULF COAL GRAVITY SURVEY

WILLOW RIVER

AGER BERRETTA & ASSOCIATES INC.
March 1981

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GULF COAL GRAVITY SURVEY - WILLOW RIVER

Summary

A reconnaissance gravity survey has been completed over potential coal bearing areas in the vicinity of Willow River near Prince George B. C. The gravity data has defined the limits of an alluvial basin in one instance and the eastern extent of an apparent basin in a second region. Geological models have examined some of the possible sources of the gravity response obtained and drill hole locations have been specified.

This report outlines the survey procedures and includes a brief description of the fundamentals of the gravity data reduction process.

Respectfully submitted,

Gordon Ellis
Geophysicist,

31 March, 1981

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LIST OF FIGURES

Table 1

Gulf Coal

Willow River

INTRODUCTION

At the request of Gulf Canada Resources Inc., Ager, Berretta & Associates Inc. have conducted a reconnaissance gravity survey in the Willow River area of British Columbia - (Figure 1). The purpose of the work was to examine the possibility of the existance of a significant sedimentary basin within the survey area (Figure 2).

The survey was completed during February 1981. The grid area is primarily heavy forest with some logged off areas. Access is via a number of logging roads. Crews stayed on-site in a mobile home.

SURVEY PROCEDURES & INSTRUMENTATION

Five survey lines were completed in two areas (Figure 2). All lines run at approximately 50 degrees. Lines one, two and three are between 2 to 2.5 kilometres apart. Lines four and five are two kilometres apart and approximately twelve kilometres south of the first three lines. No survey lines were cut and there is no base line between grid lines. Survey lines were established using compass and chain. The station interval is 50 metres throughout. On lines one, two and three, the south west end of the line is designated zero and the lines each cross the main road at 1200 (1.2 Kilometres) north east. On lines four and five, the station on the road is designated zero and the lines run north east and south west from the road. Line lengths are as follows:

Line one	0.0 to 5000 Northeast	101 stations
Line two	0.0 to 5250 Northeast	106 stations
Line three	0.0 to 6300 Northeast	127 stations
Line four	2400 Southwest to 2000 Northeast	89 stations
Line Five	4000 Southwest 4000 Northeast	160 stations
Total		583 stations

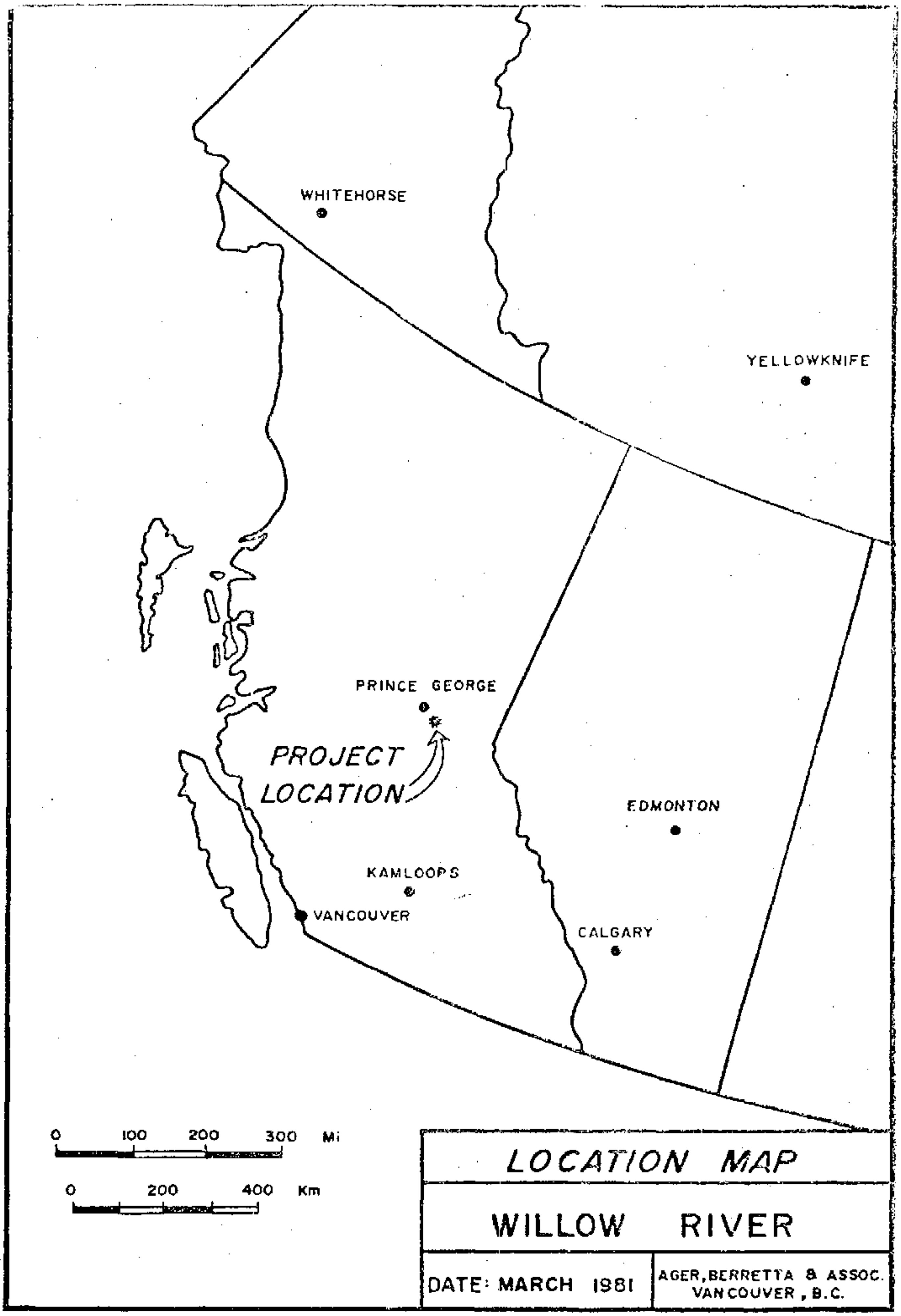
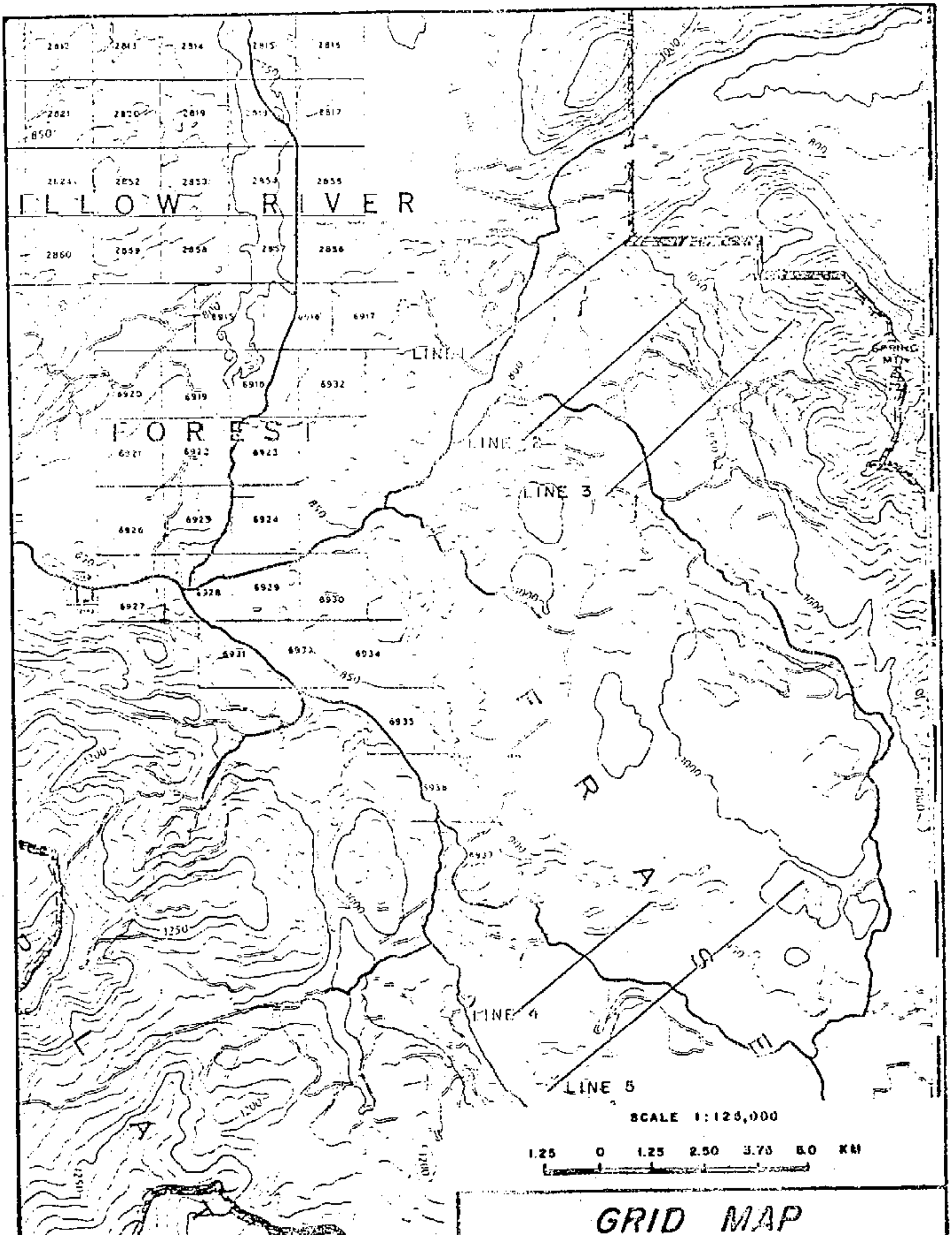

WHITEHORSE
YELLOWKNIFE
PRINCE GEORGE
PROJECT LOCATION
EDMONTON
KAMLOOPS
VANCOUVER
CALGARY
0 100 200 300 Mi
0 200 400 Km
LOCATION MAP
WILLOW RIVER
DATE: MARCH 1981
AGER, BERRETTA & ASSOC.
VANCOUVER, B.C.

FIGURE 1



GRID MAP

WILLOW RIVER

NTS: 93 G/NE

DATE: MARCH 1981

AGER, BERRETTA & ASSOC.
VANCOUVER, B.C.

FIGURE 2

Gravity observations were made using a LaCoste & Romberg Model G gravity meter (Serial No. 199) with reading accuracy of ± 0.01 mgals. Instrument and diurnal drift were accounted for by periodically tying into know base stations. All gravity observations were within the dial range 4300-4400 for which the instrument constant is 1.05908 milligals per division. Gravity base stations were established on the east side of Wansa Lake and in the campsite on the northeast corner of Pitoney Lake. Station elevations were determined from standard levelling and survey closure methods using an electronic level developed in-house by the consultant. Station elevations were determined to a relative accuracy of ± 0.10 feet or better.

For a brief discription of gravity fundamentals, see appendix I.

GEOLOGICAL BACKGROUND

The target is a sedimentary basin in which there may be coal. On the first three lines, outcrop to the northeast and southwest determines the limits of the potential target area. Between the higher elevations on either ends of the lines is an alluvial area under which may lie coal bearing sediments.

Lack of outcrop in the region of lines four and five limits the amount of background geological information available. The target remains a sedimentary basin in which coal may be present. A sedimentary basin would be indicated by a significantly low gravity response.

Samples were taken from locations throughout the survey area. Specific gravities of the samples are given in table 1.

INTERPRETATION

Simple Bouguer contour maps are given as Figures 3 and 4. Figure 3 covers the northern three lines. Gravity highs of approximately the same amplitude can be seen along the southwest and northeast sides of the survey area. These highs indicate near-surface rock. Between these highs is the alluvial basin. On line one, the gravity data yields a flat response suggesting a flat bottom to the alluvial basin.

On lines two and three, the magnitude of the gravity low increases considerably and looses its flat characteristic in the basin area. This may be due to either a deepening of the alluvial material (an old valley bottom or lake bed) or the presence of other less dense material such as coal. Models can be developed to approximate geological possibilities. A model from which to start assumes that the base of the alluvial material is everywhere approximately the same elevation as indicated on line one, and that further gravity deficiencies are due to additional volumes of less dense mass.

Necessary parameters have been derived as follows:

- density of country rock calculated from gravity/elevation correlation and from rock sample density measurements (Table 1) =2.8 grams per c.c.
- density of alluvial material calculated from gravity/elevation correlation in alluvial regions =2.0grams per c.c.
- density of coal approximately 1.65 grams per c.c.

Using the above parameters, alluvial material is calculated to be in the order of 50 to 60 metres thick on line one(Fig.5). If this thickness is assumed to be constant over the survey area, then the additional gravity deficiency on line two could be accounted for by a body of coal varying from 30 to 60 metres in thickness, as in Figure 5a.

A more likely model assumes that the depth of the alluvial material increases between lines one and two and that the alluvial basin depth is indicated by the flat gravity regions centered at 2200 and 3500 northeast on line two. To accommodate these parameters, the alluvial basin would have to be in the order of 100 metres thick. The residual gravity low (magnitude 1.5 milligals) could be accounted for by coal or other similarly dense material in the order of 30 metres

Table 1
Specific Gravity Results

Sample #	S. G.
1	2.74
2	2.73
3	2.82
4	2.67
5	2.69
6	2.68
7	2.93
8	2.75
9	2.80
10	2.83
11	3.00
12	2.73
13	2.63
14	2.70
15	2.99
16	3.01
17	2.65
18	2.59
	Average= 2.77

GEOLOGICAL MODELS

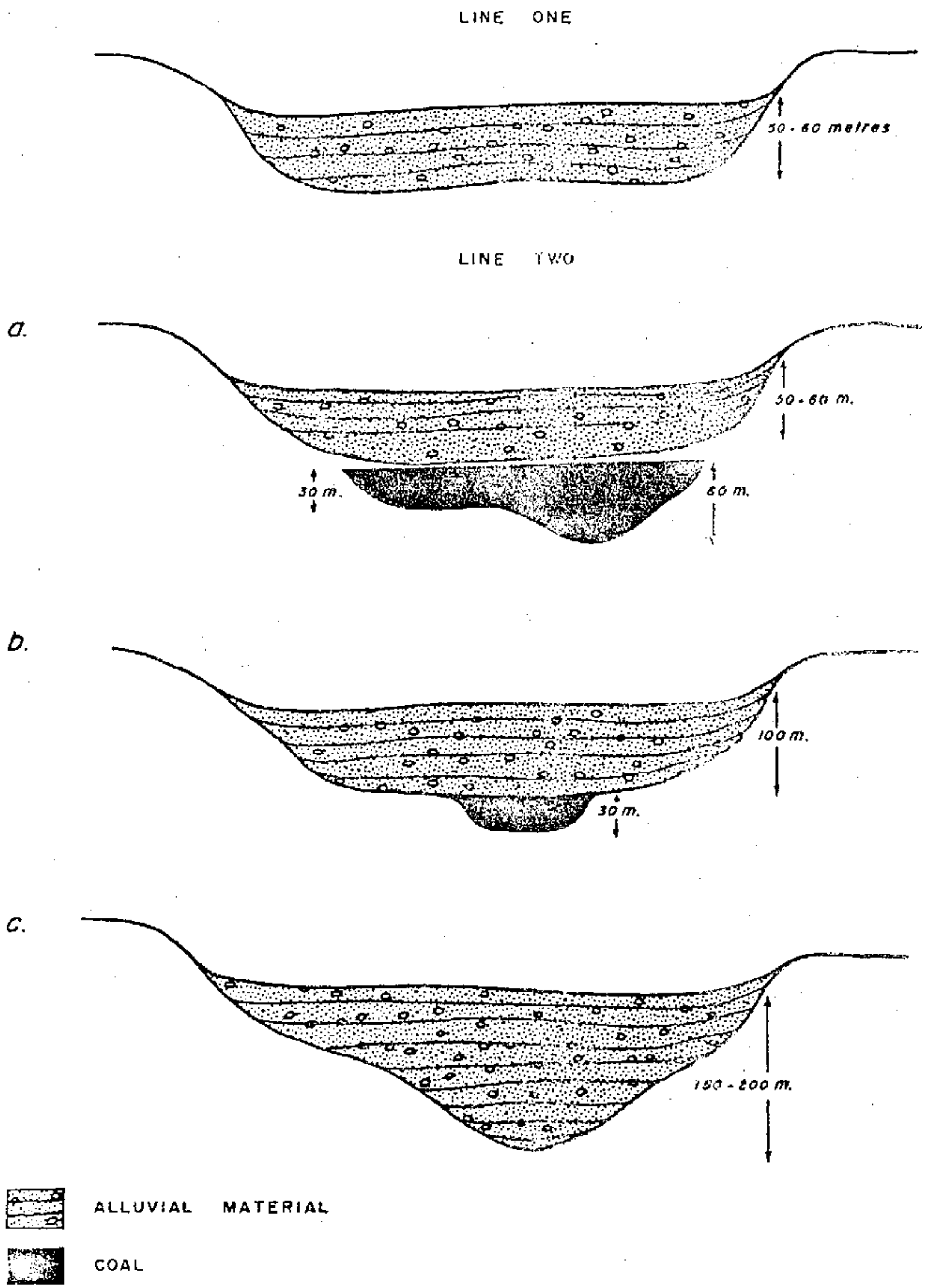


FIGURE 5

in thickness, as in Figure 5b.

A third model assumes that the entire gravity anomaly is caused by increasing thickness of alluvial material. This would be the case if we are dealing with a former lake bottom or valley. As indicated in Figure 5c, 150 to 200 metres of alluvial material would be required in the vicinity of 3000 north east on line two to justify the gravity response obtained. Figure 3 indicates that this gravity low feature extends south to a lesser extent through line three.

The most probable model is a broad flat valley at line one deepening toward lines two and three with a valley or lake bed near 3000 north east on line two. The most favourable target for a significant coal deposit is below the gravity feature centered at 2800 north east on line two.

Lines four and five did not yield a well defined basin similar to that found in the northern region.Most of the area covered by lines four and five appears to be geologically similar to the higher regions on the flanks of lines one, two and three. The steep gravity gradient running north south along the south west side of the southern region is of the same magnitude and slope as the gradients on either side of the gravity low in the northern survey area. The gradient in the southern region drops off into the Willow River suggesting that the river basin may be the source of the gravity response. Unfortunately, the gravity survey was not extended across the river to determine whether or not the gravity values increased again to the south west. The potential target zone is therefore on the edge of the survey area and is not well defined. Geological models for this region would be similar in magnitude to those for the northern region.

CONCLUSION

An alluvial basin under which may lie a coal deposit has been defined within the region of lines one, two and three. A number of models which could produce the obtained gravity have been presented. One drill hole in the vicinity of 2800 north east on line two would yield sufficient information to explain the gravity response and further evaluate the probability of a significant coal deposit in the area. The gravity response centered at 2800 north east on line two could be caused by a coal deposit 30 or more metres in thickness and is therefore a prime drill target.

A second gravity low response has been noted to the south west end of lines four and five. This low is not as well defined as the one outlined above, but it does indicate the eastern extent of a second probable basin and possible coal bearing zone.

APPENDIX I

GRAVITY FUNDAMENTALS

There are a number of steps required in order to obtain meaningful, relative gravity values from raw field data. The final values are referred to as Complete Bouguer Gravity and are derived from the following components;

g_o = observed gravity = field observations corrected for drift and adjusted to National Grid Base.

g_{fa} = free air effect = correction for the relative distance of observation points from the center of mass (earth). This calculation moves all stations to a common elevation and corrects for relative differences in distance from the source mass.

g_{bs} = bouguer slab effect = correction for the relative differences in amounts of surface rock below gravity stations. This calculation requires that a mean density or rock type between the lowest and highest grid elevations be established. All stations are shifted to a common datum as in the free air effect except that the vertical change is through an assumed slab of the derived density.

g_l = latitude correction - correction for change of observed gravity with change in latitude - due primarily to the difference in the earth's radius between the poles and equator.

g_t = terrain correction = correction for variations caused by local terrain. The vertical component of the gravitional effect exerted by nearby hills, or not exerted by valleys or gullys, will effect the net reading obtained at any one station. The overall effect on a given line profile or grid area will be a function of the station spacing relative to the frequency of the terrain correction.

Accurate and appropriate application of the above corrections yields Complete Bouguer Gravity values which are in theory, free from all effects excepts those caused by realtive changes in density within rock units below the survey area.

$G_{cb} = g_o - (g_{fa} + g_{bs} + g_l + g_t)$ = Complete Bouguer Gravity.

Changes in relative gravity values which may result in "anomalous" readings are a function of;

- the difference in densities between rock units.
- the sizes of rock units relative to each other and relative to the grid spacing or "target" size.
- the distance from the area of density contrast to the observation points.

For example; steeply dipping, near surface massive sulphide deposits or coal seams will give sharp featured gravity anomalies, the former greater than background, the latter less than background. Density contrasts at depth, such as slopes or changes in basement stratigraphy, will result in very low frequency changes, often referred to as gradients.

APPENDIX II

Listing of Simple Bouger gravity values. Bouger correction factor based on a density of 2.77 grams per cubic centimetre.

Gravity datum as printed; arbitrary

Elevation datum; approximated from 1:50,000 contour map

WILLOW RIVER LINE ONE

DENSITY 2.770 ELEVATION FACTOR 0.192509

STATION COORD	ELEV(M)	ELEV(FT)	OBS G	LAT G	TER G	CB GRAV
0.0	777.1	2549.7	109.48	10.00	0.0	269.09
50.0	778.9	2555.5	109.32	9.97	0.0	269.23
100.0	783.4	2570.1	108.50	9.93	0.0	269.24
150.0	788.4	2586.7	107.58	9.90	0.0	269.26
200.0	793.9	2604.6	106.61	9.87	0.0	269.31
250.0	796.4	2612.8	106.16	9.83	0.0	269.31
300.0	793.8	2604.2	106.73	9.80	0.0	269.34
350.0	794.6	2606.8	106.75	9.77	0.0	269.48
400.0	802.8	2633.9	105.03	9.74	0.0	269.31
450.0	802.2	2631.8	105.19	9.70	0.0	269.32
500.0	806.7	2646.7	104.42	9.67	0.0	269.39
550.0	810.4	2658.7	103.69	9.64	0.0	269.33
600.0	813.3	2668.2	102.97	9.60	0.0	269.14
650.0	818.1	2684.1	101.90	9.57	0.0	268.97
700.0	823.0	2700.0	100.83	9.54	0.0	268.79
750.0	821.6	2695.5	100.90	9.50	0.0	268.57
800.0	819.5	2688.6	101.36	9.47	0.0	268.59
850.0	815.5	2675.7	102.06	9.44	0.0	268.50
900.0	806.4	2645.6	103.73	9.41	0.0	268.37
950.0	792.3	2599.3	106.15	9.37	0.0	268.04
1000.0	774.8	2541.9	109.34	9.34	0.0	267.83
1050.0	756.9	2483.2	112.59	9.31	0.0	267.60
1100.0	756.5	2481.9	112.33	9.27	0.0	267.23
1150.0	754.9	2476.8	112.66	9.24	0.0	267.23
1200.0	760.8	2495.9	111.44	9.21	0.0	267.10
1250.0	756.4	2481.7	112.41	9.17	0.0	267.20
1300.0	753.1	2471.0	113.13	9.14	0.0	267.26
1350.0	750.6	2462.7	113.61	9.11	0.0	267.22
1400.0	749.2	[illegible]	113.77	9.07	0.0	267.18

1450.0	749.2	2458.1	113.85	9.04	0.0	267.12
1500.0	748.2	2454.7	114.05	9.01	0.0	267.09
1550.0	747.9	2453.4	114.01	8.98	0.0	266.94
1600.0	747.4	2452.0	114.13	8.94	0.0	266.95
1650.0	747.1	2451.1	114.20	8.91	0.0	266.93
1700.0	746.3	2448.6	114.44	8.88	0.0	266.99
1750.0	745.3	2446.8	114.33	8.84	0.0	266.75
1800.0	745.5	2446.3	114.41	8.81	0.0	266.76
1850.0	745.3	2445.2	114.48	8.78	0.0	266.73
1900.0	744.8	2443.6	114.63	8.74	0.0	266.75
1950.0	744.7	2443.2	114.70	8.71	0.0	266.77
2000.0	744.3	2441.9	114.86	8.68	0.0	266.82
2050.0	744.3	2442.0	114.97	8.65	0.0	266.90
2100.0	744.3	2441.8	115.07	8.61	0.0	266.96
2150.0	744.4	2442.4	115.05	8.58	0.0	266.94
2200.0	744.3	2443.6	114.91	8.55	0.0	266.84
2250.0	751.5	2465.5	113.76	8.51	0.0	266.94
2300.0	760.9	2496.2	111.82	8.48	0.0	266.78
2350.0	779.5	2557.4	108.05	8.45	0.0	266.56
2400.0	782.2	2566.3	107.81	8.41	0.0	266.81
2450.0	788.4	2586.6	106.31	8.38	0.0	266.96
2500.0	793.4	2602.9	105.97	8.35	0.0	267.05
2550.0	797.2	2615.5	105.30	8.31	0.0	267.08
2600.0	796.1	2611.8	105.59	8.28	0.0	267.12
2650.0	797.5	2616.6	105.28	8.25	0.0	267.06
2700.0	794.9	2607.9	105.73	8.22	0.0	266.97
2750.0	786.4	2580.0	107.28	8.18	0.0	266.85
2800.0	782.3	2566.6	108.07	8.15	0.0	266.82
2850.0	776.5	2547.6	109.21	8.12	0.0	266.80
2900.0	776.2	2546.7	109.31	8.08	0.0	266.83
2950.0	784.3	2573.1	107.89	8.05	0.0	266.92
3000.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	266.72

3050.0	782.4	2566.9	108.11	7.98	0.0	266.71
3100.0	773.2	2536.7	109.93	7.95	0.0	266.73
3250.0	751.8	2466.5	114.34	7.92	0.0	266.98
3200.0	751.1	2464.2	114.47	7.89	0.0	266.95
3250.0	751.1	2464.1	114.46	7.85	0.0	266.90
3300.0	750.6	2462.6	114.53	7.82	0.0	266.84
3350.0	749.1	2457.8	114.71	7.79	0.0	266.71
3400.0	749.3	2458.2	114.58	7.75	0.0	266.57
3450.0	748.6	2456.2	114.71	7.72	0.0	266.55
3500.0	748.6	2455.9	114.98	7.69	0.0	266.77
3550.0	748.9	2456.9	115.26	7.65	0.0	267.07
3600.0	754.2	2474.3	114.53	7.62	0.0	267.33
3650.0	759.5	2491.8	113.81	7.59	0.0	267.61
3700.0	763.8	2505.9	113.16	7.55	0.0	267.75
3750.0	771.4	2530.8	112.13	7.52	0.0	268.15
3800.0	771.9	2532.6	112.33	7.49	0.0	268.43
3850.0	778.3	2553.3	111.55	7.45	0.0	268.83
3900.0	787.2	2582.8	109.87	7.42	0.0	268.84
3950.0	799.8	2624.1	107.64	7.39	0.0	269.01
4000.0	810.7	2660.6	105.60	7.36	0.0	269.07
4050.0	806.8	2646.9	106.51	7.32	0.0	269.14
4100.0	810.3	2660.1	105.79	7.29	0.0	269.16
4150.0	816.2	2677.7	104.78	7.26	0.0	269.15
4200.0	816.4	2678.5	104.48	7.22	0.0	268.87
4250.0	821.2	2694.1	103.72	7.19	0.0	268.99
4300.0	837.0	2746.1	100.62	7.16	0.0	268.91
4350.0	836.4	2744.2	100.71	7.13	0.0	268.85
4400.0	844.4	2770.4	99.02	7.09	0.0	268.67
4450.0	850.6	2790.7	97.67	7.06	0.0	268.48
4500.0	856.0	2808.5	96.65	7.03	0.0	268.47
4550.0	869.5	2852.7	94.06	6.99	0.0	268.44
4600.0	872.8	2863.6	93.33	6.96	0.0	268.32
4650.0	883.1	2897.4	91.48	6.93	0.0	268.42
4700.0	887.9	2913.0	90.52	6.89	0.0	268.34
4750.0	899.2	2950.3	88.39	6.86	0.0	268.36
4800.0	908.0	2979.0	86.82	6.83	0.0	268.45
4850.0	912.9	2995.1	85.99	6.79	[illegible]	[illegible]

4950.0	916.1	3005.7	82.52	6.73	0.0	265.61
5000.0	921.6	3023.8	30.14	6.70	0.0	264.26

ELEV FT 2441	2525	2608	2691	2775	2858	2941	3025	3108	3191
ELEV M 744	769	795	820	845	871	896	922	947	972
MGAL 263.5	264.0	264.5	265.0	265.5	266.0	265.5	267.0	267.5	268.0
1	1	1	1	1	1	1	1	1	1

0.- E

50.- E

100.- E

150.- E

WILLOW RIVER LINE TWO

DENSITY 2.770 ELEVATION FACTOR 0.192509

STATION COORD	ELEV(M)	ELEV(FT)	OBS G	LAT G	TER G	CB GRAV
0.0	834.5	2737.8	87.18	11.07	0.0	258.90
50.0	833.6	2734.8	87.69	11.04	0.0	259.20
100.0	833.8	2735.5	88.84	11.01	0.0	260.36
150.0	828.1	2716.9	90.16	10.98	0.0	260.56
200.0	819.7	2689.2	91.24	10.95	0.0	259.98
250.0	814.1	2670.8	92.10	10.92	0.0	259.73
300.0	809.4	2655.4	93.02	10.89	0.0	259.72
350.0	804.0	2637.9	94.09	10.85	0.0	259.73
400.0	799.0	2621.3	95.11	10.82	0.0	259.74
450.0	794.4	2606.3	96.05	10.79	0.0	259.77
500.0	786.8	2581.5	97.43	10.76	0.0	259.67
550.0	781.4	2563.6	98.40	10.73	0.0	259.55
600.0	773.6	2538.0	100.09	10.70	0.0	259.71
650.0	771.8	2532.2	100.42	10.67	0.0	259.67
700.0	769.8	2525.4	100.60	10.64	0.0	259.42
750.0	769.2	2523.5	100.70	10.60	0.0	259.37
800.0	768.5	2521.4	100.68	10.57	0.0	259.20
850.0	768.7	2522.1	100.42	10.54	0.0	258.95
900.0	768.6	2521.7	100.29	10.51	0.0	258.77
950.0	768.7	2522.1	100.29	10.48	0.0	258.76
1000.0	768.9	2522.7	100.27	10.45	0.0	258.74
1050.0	770.9	2529.2	100.09	10.42	0.0	258.91
1100.0	768.8	2522.4	100.55	10.39	0.0	258.94
1150.0	769.4	2524.2	100.48	10.35	0.0	258.95
1200.0	772.0	2533.0	99.86	10.32	0.0	258.81
1250.0	768.9	2522.5	100.38	10.29	0.0	258.63
1300.0	768.7	2522.0	100.05	10.26	0.0	258.30
1350.0	768.9	2522.5	99.65	10.23	0.0	257.89
1400.0	770.5	2527.7	98.96	10.20	0.0	257.48

1450.0	774.1	2539.8	98.03	10.17	0.0	257.22
1500.0	776.6	2547.8	97.41	10.13	0.0	257.04
1550.0	777.6	2551.2	97.10	10.10	0.0	256.90
1600.0	778.5	2554.1	96.80	10.07	0.0	256.74
1650.0	777.5	2550.8	96.91	10.04	0.0	256.62
1700.0	775.0	2542.5	97.23	10.01	0.0	256.43
1750.0	773.2	2536.8	97.55	9.98	0.0	256.38
1800.0	770.1	2526.7	98.08	9.95	0.0	256.29
1850.0	767.0	2516.5	98.60	9.92	0.0	256.18
1900.0	758.6	2489.0	99.94	9.88	0.0	255.87
1950.0	749.6	2459.4	101.77	9.85	0.0	255.93
2000.0	746.0	2447.6	102.41	9.82	0.0	255.85
2050.0	743.8	2440.3	102.84	9.79	0.0	255.82
2100.0	750.7	2463.0	101.52	9.76	0.0	255.80
2150.0	758.6	2488.9	99.97	9.73	0.0	255.74
2200.0	761.2	2497.4	99.50	9.70	0.0	255.74
2250.0	763.2	2504.1	99.27	9.67	0.0	255.87
2300.0	760.9	2496.5	99.76	9.63	0.0	255.88
2350.0	761.9	2499.6	99.57	9.60	0.0	255.84
2400.0	762.2	2500.8	99.46	9.57	0.0	255.77
2450.0	762.0	2500.0	99.34	9.54	0.0	255.57
2500.0	763.4	2504.5	98.94	9.51	0.0	255.40
2550.0	759.6	2492.1	99.46	9.48	0.0	255.17
2600.0	756.2	2480.9	100.05	9.45	0.0	255.07
2650.0	747.4	2452.2	101.57	9.42	0.0	254.87
2700.0	743.4	2438.9	102.25	9.38	0.0	254.74
2750.0	741.1	2431.4	102.66	9.35	0.0	254.63
2800.0	738.4	2422.7	103.18	9.32	0.0	254.66
2850.0	740.8	2430.6	102.48	9.29	0.0	254.39
2900.0	742.3	2435.4	102.21	9.26	0.0	254.37
2950.0	743.2	2438.2	102.13	9.23	0.0	254.43
[illegible]	[illegible]	[illegible]	[illegible]	9.20	0.0	254.62

3100.0	746.8	2450.3	101.71	9.13	0.0	254.62
3150.0	747.1	2451.3	101.86	9.10	0.0	254.79
3200.0	747.4	2451.9	101.99	9.07	0.0	254.93
3250.0	748.2	2454.7	102.06	9.04	0.0	255.14
3300.0	749.3	2458.3	101.93	9.01	0.0	255.18
3350.0	750.7	2463.0	101.81	8.98	0.0	255.31
3400.0	752.5	2468.8	101.57	8.95	0.0	255.38
3450.0	753.7	2472.7	101.49	8.91	0.0	255.50
3500.0	755.5	2478.5	101.11	8.88	0.0	255.43
3550.0	756.5	2482.3	100.98	8.85	0.0	255.49
3600.0	757.6	2485.4	100.85	8.82	0.0	255.51
3650.0	759.0	2490.0	100.60	8.79	0.0	255.50
3700.0	761.4	2498.1	100.28	8.76	0.0	255.62
3750.0	762.5	2501.8	100.08	8.73	0.0	255.60
3800.0	763.7	2505.7	100.05	8.70	0.0	255.77
3850.0	763.3	2504.4	100.15	8.66	0.0	255.76
3900.0	765.6	2511.7	99.75	8.63	0.0	255.77
3950.0	777.8	2551.9	97.33	8.60	0.0	255.67
4000.0	776.1	2546.2	97.90	8.57	0.0	255.88
4050.0	773.5	2537.7	98.53	8.54	0.0	255.97
4100.0	780.9	2562.1	97.18	8.51	0.0	256.03
4150.0	786.8	2581.4	96.26	8.48	0.0	256.21
4200.0	792.1	2598.6	95.55	8.45	0.0	256.47
4250.0	792.4	2599.6	95.78	8.41	0.0	256.73
4300.0	793.7	2604.0	95.75	8.38	0.0	256.93
4350.0	793.4	2603.1	96.10	8.35	0.0	257.19
4400.0	794.9	2607.9	96.12	8.32	0.0	257.46
4450.0	802.6	2633.3	94.91	8.29	0.0	257.71
4500.0	811.0	2660.9	93.67	8.26	0.0	258.06
4550.0	821.0	2693.6	92.02	8.23	0.0	258.30
4600.0	836.0	2742.9	89.23	8.19	0.0	258.37
4650.0	849.8	2787.9	86.99	8.16	0.0	258.74
4700.0	854.5	2803.6	86.42	8.13	0.0	259.07
4750.0	866.3	2842.1	84.37	8.10	0.0	259.23
4800.0	870.5	2856.0	83.79	8.07	0.0	259.44
4850.0	875.2	2871.3	83.17	8.04	0.0	259.69
4900.0	881.8	2893.0	81.83	8.01	0.0	259.59
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

5000.0	898.7	2943.5	78.94	7.94	0.0	259.90
5050.0	892.0	2925.5	79.99	7.91	0.0	259.62
5100.0	898.6	2940.2	78.82	7.88	0.0	259.69
5150.0	910.2	2986.3	76.76	7.85	0.0	259.84
5200.0	926.6	3040.1	73.35	7.82	0.0	259.55
5250.0	930.7	3053.4	72.88	7.79	0.0	259.83

ELEV FT	2422	2505	2589	2672	2756	2839	2922	3006	3089	3172
ELEV M	738	763	789	814	840	865	890	916	941	967
MGAL	254.6	255.1	255.6	256.1	256.6	257.1	257.6	258.1	258.6	259.1
	1	1	1	1	1	1	1	1	1	1

0.- E G

50.- E

100.- E

150.- E

WILLOW RIVER LINE THREE

DENSITY 2.770 ELEVATION FACTOR 0.192509

STATION COORD	ELEV(M)	ELEV(FT)	OBS G	LAT G	TER G	CB GRAV
0.0	771.5	2531.0	96.20	12.65	0.0	257.36
50.0	770.6	2528.2	95.93	12.62	0.0	256.90
100.0	769.5	2524.8	95.68	12.59	0.0	256.41
150.0	771.2	2530.3	95.31	12.56	0.0	256.34
200.0	771.3	2530.6	95.14	12.53	0.0	256.16
250.0	769.8	2525.7	95.28	12.50	0.0	255.98
300.0	768.3	2520.7	95.34	12.47	0.0	255.71
350.0	764.8	2509.3	95.72	12.44	0.0	255.40
400.0	761.5	2498.4	96.94	12.41	0.0	255.95
450.0	761.6	2498.8	96.63	12.38	0.0	255.69
500.0	761.3	2497.8	96.69	12.35	0.0	255.60
550.0	760.8	2495.9	96.66	12.32	0.0	255.43
600.0	759.7	2492.3	96.92	12.28	0.0	255.45
650.0	760.0	2493.6	96.82	12.25	0.0	255.39
700.0	761.4	2498.1	96.77	12.22	0.0	255.57
750.0	761.3	2497.7	96.70	12.19	0.0	255.45
800.0	761.0	2496.8	96.69	12.16	0.0	255.36
850.0	760.7	2495.8	96.70	12.13	0.0	255.28
900.0	760.7	2495.6	96.64	12.10	0.0	255.18
950.0	760.5	2495.2	96.55	12.07	0.0	255.03
1000.0	761.0	2496.8	96.53	12.04	0.0	255.08
1050.0	760.9	2496.3	96.60	12.01	0.0	255.09
1100.0	761.2	2497.5	96.65	11.98	0.0	255.18
1150.0	763.1	2503.8	96.20	11.95	0.0	255.06
1200.0	765.8	2512.6	95.64	11.92	0.0	254.99
1250.0	770.3	2527.2	94.66	11.89	0.0	254.84
1300.0	772.5	2534.6	94.15	11.86	0.0	(254.73)
1350.0	781.3	2563.3	92.51	11.83	0.0	254.75
1400.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1450.0	794.0	2608.0	89.94	11.77	0.0	254.74
1500.0	798.4	2619.5	89.42	11.74	0.0	254.86
1550.0	805.2	2641.8	88.27	11.71	0.0	254.99
1600.0	811.9	2663.6	86.99	11.68	0.0	254.96
1650.0	818.7	2686.2	85.78	11.65	0.0	255.04
1700.0	829.1	2720.2	83.80	11.62	0.0	255.03
1750.0	831.0	2726.5	83.61	11.59	0.0	255.13
1800.0	830.9	2725.9	83.57	11.56	0.0	255.07
1850.0	822.6	2698.8	85.01	11.53	0.0	254.89
1900.0	826.8	2712.5	84.31	11.50	0.0	254.97
1950.0	833.2	2733.6	83.10	11.47	0.0	254.97
2000.0	835.7	2741.9	82.64	11.43	0.0	254.96
2050.0	841.9	2762.2	81.36	11.40	0.0	254.84
2100.0	852.2	2796.1	79.38	11.37	0.0	254.82
2150.0	861.2	2825.4	77.69	11.34	0.0	254.82
2200.0	867.1	2844.7	76.64	11.31	0.0	254.87
2250.0	871.3	2858.8	76.00	11.28	0.0	255.03
2300.0	876.9	2876.9	74.90	11.25	0.0	254.96
2350.0	876.2	2874.8	75.25	11.22	0.0	255.16
2400.0	874.9	2870.3	75.67	11.19	0.0	255.28
2450.0	873.0	2864.1	75.98	11.16	0.0	255.20
2500.0	890.1	2920.3	72.76	11.13	0.0	255.24
2550.0	891.1	2923.7	72.90	11.10	0.0	255.46
2600.0	894.0	2933.0	72.48	11.07	0.0	255.65
2650.0	888.6	2915.3	73.69	11.04	0.0	255.79
2700.0	886.7	2909.2	74.26	11.01	0.0	255.97
2750.0	886.3	2907.6	74.36	10.98	0.0	255.95
2800.0	888.5	2914.9	73.93	10.95	0.0	255.92
2850.0	886.8	2909.6	74.49	10.92	0.0	256.13
2900.0	883.2	2897.9	75.29	10.89	0.0	256.21
2950.0	882.3	2895.8	75.63	10.86	0.0	256.35

3100.0	878.4	2831.7	76.71	10.77	0.0	256.57
3150.0	875.9	2873.8	77.31	10.74	0.0	256.67
3200.0	882.1	2894.1	76.29	10.71	0.0	256.81
3250.0	888.3	2914.5	75.27	10.68	0.0	256.96
3300.0	889.2	2917.4	75.28	10.65	0.0	257.11
3350.0	885.7	2905.9	75.87	10.62	0.0	257.00
3400.0	890.9	2922.9	74.85	10.58	0.0	256.94
3450.0	889.5	2918.3	75.42	10.55	0.0	257.21
3500.0	892.0	2926.7	75.21	10.52	0.0	257.46
3550.0	894.0	2933.1	75.00	10.49	0.0	257.60
3600.0	897.9	2945.8	74.34	10.46	0.0	257.65
3650.0	904.1	2966.1	73.24	10.43	0.0	257.71
3700.0	910.4	2986.8	72.17	10.40	0.0	257.83
3750.0	915.7	3004.3	71.30	10.37	0.0	257.96
3800.0	918.4	3013.1	71.14	10.34	0.0	258.28
3850.0	920.0	3018.5	70.96	10.31	0.0	258.39
3900.0	923.2	3029.0	70.44	10.28	0.0	258.45
3950.0	925.9	3037.6	70.04	10.25	0.0	258.53
4000.0	929.3	3048.8	69.48	10.22	0.0	258.60
4050.0	934.4	3065.5	68.81	10.19	0.0	258.87
4100.0	940.5	3085.5	67.92	10.16	0.0	259.13
4150.0	946.0	3103.6	67.19	10.13	0.0	259.43
4200.0	952.0	3123.5	66.53	10.10	0.0	259.69
4250.0	957.2	3140.4	65.74	10.07	0.0	260.08
4300.0	959.4	3147.7	65.63	10.04	0.0	260.37
4350.0	963.0	3159.5	64.73	10.01	0.0	260.18
4400.0	966.6	3171.1	63.83	9.98	0.0	259.88
4450.0	969.5	3180.9	63.33	9.95	0.0	259.92
4500.0	973.8	3194.9	62.43	9.92	0.0	259.81
4550.0	978.9	3211.8	61.55	9.89	0.0	259.89
4600.0	984.7	3230.8	60.66	9.85	0.0	260.09
4650.0	989.5	3246.4	60.05	9.83	0.0	260.37
4700.0	992.8	3257.4	59.03	9.80	0.0	259.96
4750.0	997.1	3271.4	58.01	9.77	0.0	259.73
4800.0	1003.3	3291.8	56.78	9.74	0.0	259.67
4850.0	1008.4	3308.3	55.75	9.70	0.0	259.58
4900.0	1013.7	3325.7	54.79	9.67	0.0	259.61
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

5000.0	1023.5	3358.0	52.94	9.61	0.0	259.59
5050.0	1027.4	3370.6	52.25	9.58	0.0	259.62
5100.0	1029.7	3378.1	51.94	9.55	0.0	259.71
5150.0	1031.7	3384.7	51.77	9.52	0.0	259.90
5200.0	1032.4	3387.1	51.83	9.49	0.0	260.06
5250.0	1033.8	3391.8	51.66	9.46	0.0	260.14
5300.0	1034.3	3393.3	51.76	9.43	0.0	260.30
5350.0	1036.8	3401.6	51.31	9.40	0.0	260.31
5400.0	1038.7	3408.0	50.93	9.37	0.0	260.27
5450.0	1040.8	3414.6	50.50	9.34	0.0	260.20
5500.0	1042.9	3421.6	50.15	9.31	0.0	260.23
5550.0	1043.9	3424.9	49.95	9.26	0.0	260.19
5600.0	1046.5	3433.2	49.47	9.25	0.0	260.17
5650.0	1045.9	3431.4	49.61	9.22	0.0	260.17
5700.0	1046.2	3432.4	49.56	9.19	0.0	260.15
5750.0	1050.1	3445.1	48.81	9.16	0.0	260.11
5800.0	1057.0	3467.9	48.20	9.13	0.0	260.81
5850.0	1062.5	3486.0	47.55	9.10	0.0	261.19
5900.0	1068.3	3504.9	46.58	9.07	0.0	261.30
5950.0	1075.0	3526.9	45.53	9.04	0.0	261.51
6000.0	1080.9	3546.3	44.29	9.01	0.0	261.38
6050.0	1087.8	3568.8	43.30	8.98	0.0	261.68
6100.0	1094.9	3592.1	42.17	8.95	0.0	261.84
6150.0	1099.7	3607.9	40.95	8.92	0.0	261.57
6200.0	1103.4	3620.0	40.19	8.89	0.0	261.49
6250.0	1108.7	3637.6	39.56	8.85	0.0	261.86
6300.0	1114.9	3657.9	38.60	8.82	0.0	262.06

WILLOW RIVER LINE FOUR

DENSITY 2.770 ELEVATION FACTOR 0.192509

STATION COORD	ELEV(M)	ELEV(FT)	OBS G	LAT G	TER G	CB GRAV
2400.0	685.7	2249.7	77.48	23.49	0.0	232.98
2350.0	685.9	2250.2	77.46	23.46	0.0	232.96
2300.0	685.6	2249.4	77.55	23.43	0.0	232.97
2250.0	685.7	2249.8	77.52	23.40	0.0	232.93
2200.0	685.8	2249.9	77.60	23.37	0.0	232.99
2150.0	686.0	2250.7	77.65	23.34	0.0	233.05
2100.0	686.4	2252.0	77.81	23.31	0.0	233.26
2050.0	685.9	2250.5	78.03	23.28	0.0	233.36
2000.0	686.5	2252.1	78.01	23.25	0.0	233.41
1950.0	686.0	2250.6	78.32	23.22	0.0	233.59
1900.0	685.9	2250.3	78.50	23.19	0.0	233.73
1850.0	686.0	2250.6	78.56	23.16	0.0	233.78
1800.0	700.7	2248.7	75.90	23.13	0.0	233.91
1750.0	715.2	2346.5	73.45	23.10	0.0	234.23
1700.0	725.1	2378.9	71.58	23.07	0.0	234.23
1650.0	735.3	2412.3	70.02	23.04	0.0	234.60
1600.0	738.3	2422.1	69.56	23.01	0.0	234.69
1550.0	739.5	2426.1	69.54	22.98	0.0	234.87
1500.0	735.9	2414.5	70.44	22.95	0.0	235.06
1450.0	736.1	2415.0	70.61	22.91	0.0	235.23
1400.0	742.9	2437.3	69.34	22.88	0.0	235.24
1350.0	749.6	2459.4	68.26	22.85	0.0	235.42
1300.0	756.9	2483.3	66.97	22.82	0.0	235.51
1250.0	763.0	2503.4	65.97	22.79	0.0	235.65
1200.0	767.9	2519.4	65.20	22.76	0.0	235.79
1150.0	771.9	2532.6	64.63	22.73	0.0	235.97
1100.0	773.6	2538.0	64.57	22.70	0.0	236.19
1050.0	774.4	2540.7	64.50	22.67	0.0	236.25
1000.0	774.3	2540.3	64.67	22.64	0.0	236.37
950.0	772.2	2533.3	65.25	22.61	0.0	236.51
900.0	768.2	2520.3	66.26	22.58	0.0	236.72

850.0	763.1	2503.7	67.32	22.55	0.0	236.78
800.0	756.9	2483.3	68.77	22.52	0.0	237.00
750.0	754.9	2476.6	69.25	22.49	0.0	237.06
700.0	754.4	2475.0	69.30	22.46	0.0	236.98
650.0	753.9	2473.3	69.46	22.43	0.0	237.01
600.0	753.5	2472.0	69.82	22.40	0.0	237.27
550.0	753.6	2472.5	70.31	22.37	0.0	237.76
500.0	759.8	2492.7	69.22	22.34	0.0	237.82
450.0	763.3	2504.1	68.74	22.31	0.0	237.98
400.0	764.9	2509.4	68.40	22.28	0.0	237.92
350.0	765.7	2512.1	68.22	22.25	0.0	237.87
300.0	765.5	2511.5	68.21	22.22	0.0	237.79
250.0	764.9	2509.6	68.17	22.19	0.0	237.61
200.0	756.3	2481.4	69.67	22.16	0.0	237.43
150.0	749.6	2459.2	71.11	22.13	0.0	237.53
100.0	752.4	2468.5	70.66	22.09	0.0	237.60
50.0	758.3	2489.6	69.24	22.06	0.0	237.39
0.0	762.0	2500.0	0.0	22.03	0.0	168.73
0.0	762.0	2500.0	63.62	22.00	0.0	237.32
50.0	766.8	2515.9	67.66	21.97	0.0	237.26
100.0	770.9	2529.1	66.88	21.94	0.0	237.22
150.0	773.4	2537.3	66.47	21.91	0.0	237.27
200.0	776.0	2546.1	65.97	21.88	0.0	237.25
250.0	777.7	2551.6	65.67	21.85	0.0	237.19
300.0	778.0	2552.6	65.53	21.82	0.0	237.13
350.0	778.8	2555.1	65.42	21.79	0.0	237.14
400.0	779.5	2557.4	65.33	21.76	0.0	237.15
450.0	779.9	2558.7	65.24	21.73	0.0	237.11
500.0	781.3	2563.2	64.94	21.70	0.0	237.04
550.0	782.7	2568.0	64.45	21.67	0.0	236.80
600.0	778.3	2553.5	65.13	21.64	0.0	236.60
650.0	766.9	2516.1	67.15	21.61	0.0	236.40
700.0	751.8	2466.5	70.22	21.58	0.0	236.52
750.0	737.1	2418.3	73.07	21.55	0.0	236.52
800.0	736.2	2415.5	73.35	21.52	0.0	236.60
850.0	739.0	2424.7	72.[illegible]	21.49	0.0	236.66
900.0	746.9	2450.3	71.30	21.46	0.0	236.5[illegible]
950.0	757.4	2484.8	69.29	21.43	0.0	236.52
1000.0	769.0	2522.8	66.94	21.40	0.0	236.37
1050.0	780.3	2561.7	64.70	21.37	0.0	236.38

1050.0	780.8	2561.7	64.70	21.37	0.0	236.38
1100.0	778.6	2554.3	65.20	21.34	0.0	236.41
1150.0	781.0	2562.2	64.75	21.31	0.0	236.40
1200.0	781.8	2565.1	64.50	21.27	0.0	236.29
1250.0	782.9	2568.6	64.33	21.24	0.0	236.29
1300.0	783.7	2571.2	64.10	21.21	0.0	236.18
1350.0	784.3	2573.1	63.98	21.18	0.0	236.15
1400.0	783.4	2570.2	64.23	21.15	0.0	236.19
1450.0	781.3	2563.3	64.62	21.12	0.0	236.15
1500.0	781.2	2563.1	64.62	21.09	0.0	236.10
1550.0	780.6	2561.0	64.68	21.06	0.0	236.02
1600.0	779.3	2556.8	64.94	21.03	0.0	236.00
1650.0	778.2	2553.3	65.24	21.00	0.0	236.06
1700.0	776.7	2548.1	65.61	20.97	0.0	236.10
1750.0	774.7	2541.7	66.04	20.94	0.0	236.12
1800.0	772.5	2534.3	66.55	20.91	0.0	236.16
1850.0	772.4	2534.3	66.50	20.88	0.0	236.08
1900.0	768.3	2520.6	67.37	20.85	0.0	236.12
1950.0	763.8	2506.0	68.20	20.82	0.0	236.06
2000.0	759.7	2492.5	69.04	20.79	0.0	236.03

WILLOW RIVER   LINE FIVE

DENSITY 2.770   ELEVATION FACTOR   0.192509

STATION COORD		ELEV(M)		ELEV(FT)	OBS G	LAT G	TER G	CB GRAV	
4000.0	658.80	0.0	2161.30	0.0	75.70	24.89	0.0	100.59	227.48
3950.0	658.70	662.1	2161.00	2172.3	75.65	24.83	0.0	227.94	227.28
3900.0	659.80	662.0	2164.66	2172.0	75.54	24.77	0.0	227.75	227.33
3850.0	659.12	663.2	2162.47	2175.7	75.65	24.70	0.0	228.01	227.24
3800.0	671.80	663.8	2204.22	2177.9	73.07	24.64	0.0	225.50	227.05
3750.0	684.28	676.5	2245.02	2219.5	70.94	24.58	0.0	225.75	227.25
3700.0	685.30	686.3	2248.35	2251.6	70.95	24.51	0.0	227.58	227.39
3650.0	688.13	687.3	2257.6	2254.9	70.63	24.45	0.0	227.39	227.55
3600.0		690.1		2264.2	70.34	24.39	0.0	227.59	
3550.0		689.7		2262.9	70.59	24.32	0.0	227.69	
3500.0		692.1		2270.8	70.30	24.26	0.0	227.80	
3450.0		694.1		2277.3	70.06	24.19	0.0	227.88	
3400.0		694.0		2277.0	70.26	24.13	0.0	228.00	
3350.0		694.5		2278.6	70.52	24.07	0.0	228.29	
3300.0		694.4		2278.1	70.70	24.00	0.0	228.38	
3250.0		694.1		2277.3	70.95	23.94	0.0	228.52	
3200.0		693.9		2276.5	71.29	23.88	0.0	228.74	
3150.0		693.4		2275.0	71.54	23.81	0.0	228.84	
3100.0		693.5		2275.4	71.89	23.75	0.0	229.15	
3050.0		693.5		2275.2	71.94	23.69	0.0	229.13	
3000.0		693.6		2275.7	72.05	23.62	0.0	229.20	
2950.0		694.0		2276.8	71.87	23.56	0.0	229.03	
2900.0		682.7		2239.7	74.01	23.50	0.0	228.93	
2850.0		683.3		2241.7	73.71	23.43	0.0	228.68	
2800.0		683.7		2243.1	73.57	23.37	0.0	228.56	
2750.0		684.1		2244.6	73.43	23.31	0.0	228.44	
2700.0		684.3		2245.1	73.42	23.24	0.0	228.40	
2650.0		684.9		2247.2	73.27	23.18	0.0	228.31	
2600.0		685.7		2249.7	73.15	23.12	0.0	228.27	
2550.0		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

2500.0	686.4	2251.9	72.97	22.99	0.0	228.09
2450.0	686.8	2253.2	72.95	22.93	0.0	228.09
2400.0	687.2	2254.6	73.01	22.86	0.0	228.17
2350.0	687.7	2256.3	72.92	22.80	0.0	228.11
2300.0	688.5	2259.0	72.79	22.74	0.0	228.08
2250.0	688.6	2259.3	72.87	22.67	0.0	228.11
2200.0	693.0	2273.6	71.93	22.61	0.0	227.95
2150.0	713.0	2339.4	68.08	22.55	0.0	227.89
2100.0	717.3	2353.2	67.52	22.48	0.0	228.06
2050.0	721.5	2367.2	66.76	22.42	0.0	228.03
2000.0	724.4	2376.8	66.21	22.36	0.0	228.03
1950.0	727.3	2386.1	65.74	22.29	0.0	228.04
1900.0	729.2	2392.4	65.42	22.23	0.0	228.03
1850.0	729.6	2393.6	65.58	22.17	0.0	228.19
1800.0	731.0	2398.2	65.32	22.10	0.0	228.14
1750.0	733.0	2404.9	65.11	22.04	0.0	228.26
1700.0	733.2	2405.4	65.26	21.98	0.0	228.37
1650.0	732.9	2404.6	65.35	21.91	0.0	228.36
1600.0	733.8	2407.4	65.33	21.85	0.0	228.44
1550.0	734.5	2409.7	65.28	21.79	0.0	228.46
1500.0	731.0	2398.1	66.24	21.72	0.0	228.68
1450.0	730.1	2395.4	66.45	21.66	0.0	228.67
1400.0	730.2	2395.6	66.48	21.59	0.0	228.64
1350.0	730.4	2396.4	66.63	21.53	0.0	228.77
1300.0	730.3	2396.1	66.67	21.47	0.0	228.73
1250.0	730.3	2396.0	66.72	21.40	0.0	228.71
1200.0	730.9	2397.8	66.79	21.34	0.0	228.83
1150.0	734.4	2409.3	66.21	21.28	0.0	228.86
1100.0	735.3	2412.4	66.23	21.21	0.0	229.00
1050.0	736.0	2414.6	66.16	21.15	0.0	228.99
1000.0	735.5	2412.9	66.00	21.09	0.0	228.67
950.0	738.4	2422.5	65.81	21.02	0.0	228.98
900.0	740.1	2428.1	65.70	20.96	0.0	229.14
850.0	741.3	2432.1	65.47	20.90	0.0	[illegible]

800.0	743.4	2438.9	65.13	20.83	0.0	229.07
750.0	744.6	2442.6	64.92	20.77	0.0	229.03
700.0	737.8	2420.7	66.14	20.71	0.0	228.89
650.0	717.9	2355.4	70.54	20.64	0.0	229.39
600.0	705.1	2313.4	73.34	20.58	0.0	229.66
550.0	700.3	2297.6	74.35	20.52	0.0	229.69
500.0	702.5	2304.8	74.06	20.45	0.0	229.75
450.0	703.4	2307.9	73.89	20.39	0.0	229.70
400.0	704.2	2310.5	73.72	20.33	0.0	229.62
350.0	712.3	2336.9	71.97	20.26	0.0	229.35
300.0	732.0	2401.7	67.91	20.20	0.0	229.04
250.0	745.0	2444.2	65.18	20.14	0.0	228.74
200.0	756.5	2481.9	63.13	20.07	0.0	228.84
150.0	758.5	2488.4	62.68	20.01	0.0	228.70
100.0	756.7	2482.8	62.74	19.95	0.0	228.37
50.0	757.7	2486.0	62.85	19.88	0.0	228.60
0.0	762.0	2500.0	62.28	19.82	0.0	228.79
50.0	761.8	2499.2	62.21	19.76	0.0	228.61
100.0	762.1	2500.2	62.28	19.69	0.0	228.63
150.0	761.5	2498.3	62.44	19.63	0.0	228.66
200.0	760.2	2494.0	62.55	19.57	0.0	228.46
250.0	760.1	2493.6	62.56	19.50	0.0	228.39
300.0	760.1	2493.6	62.52	19.44	0.0	228.28
350.0	760.3	2494.4	62.50	19.38	0.0	228.24
400.0	760.2	2494.2	62.55	19.31	0.0	228.21
450.0	760.9	2496.3	62.48	19.25	0.0	228.20
500.0	761.0	2496.8	62.42	19.18	0.0	228.11
550.0	761.7	2499.0	62.34	19.12	0.0	228.10
600.0	762.0	2500.1	62.42	19.06	0.0	228.18
650.0	760.5	2494.9	62.64	18.99	0.0	228.03
700.0	760.1	2493.8	62.74	18.93	0.0	228.00
750.0	760.0	2493.4	62.82	18.87	0.0	227.99
800.0	760.6	2495.4	62.68	18.80	0.0	227.91
850.0	761.1	2496.9	62.67	18.74	0.0	227.92
900.0	762.0	2500.1	62.56	18.68	0.0	227.94
950.0	762.4	2501.4	62.34	18.61	0.0	227.73
1000.0	763.2	2503.9	62.31	18.55	0.0	227.78
1050.0	764.0	2506.7	62.30	18.49	0.0	227.87
1100.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

1100.0	764.3	2507.4	62.41	18.42	0.0	227.96
1150.0	763.3	2504.2	62.83	18.36	0.0	228.13
1200.0	761.4	2497.9	63.14	18.30	0.0	228.01
1250.0	759.7	2492.4	63.50	18.23	0.0	227.98
1300.0	756.5	2481.9	64.21	18.17	0.0	228.01
1350.0	748.2	2454.8	65.90	18.11	0.0	228.04
1400.0	744.4	2442.2	66.70	18.04	0.0	228.04
1450.0	723.9	2407.8	68.71	17.98	0.0	227.97
1500.0	733.7	2407.3	68.91	17.92	0.0	228.08
1550.0	750.7	2463.1	65.95	17.85	0.0	228.33
1600.0	758.2	2487.5	64.93	17.79	0.0	228.68
1650.0	760.5	2495.2	64.62	17.73	0.0	228.76
1700.0	764.6	2508.4	63.76	17.66	0.0	228.61
1750.0	768.3	2520.8	63.15	17.60	0.0	228.66
1800.0	772.6	2534.7	62.57	17.54	0.0	228.83
1850.0	776.1	2546.1	61.92	17.47	0.0	228.79
1900.0	778.8	2555.2	61.37	17.41	0.0	228.71
1950.0	781.6	2564.2	61.05	17.35	0.0	228.86
2000.0	783.4	2570.3	60.87	17.28	0.0	228.97
2050.0	784.1	2572.5	60.85	17.22	0.0	229.01
2100.0	785.0	2575.5	60.81	17.16	0.0	229.09
2150.0	785.5	2577.1	60.77	17.09	0.0	229.08
2200.0	789.4	2589.9	60.19	17.03	0.0	229.18
2250.0	786.4	2580.1	60.90	16.97	0.0	229.26
2300.0	780.2	2559.9	62.21	16.90	0.0	229.32
2350.0	766.4	2514.3	65.06	16.84	0.0	229.43
2400.0	766.0	2513.2	65.34	16.78	0.0	229.58
2450.0	766.3	2514.2	65.26	16.71	0.0	229.49
2500.0	766.9	2515.9	65.19	16.65	0.0	229.47
2550.0	767.2	2517.2	65.14	16.58	0.0	229.42
2600.0	767.4	2517.7	65.11	16.52	0.0	229.36
2650.0	767.7	2518.8	65.05	16.46	0.0	229.31
2700.0	768.9	2522.5	64.98	16.39	0.0	229.39

2800.0	793.1	2618.4	59.72	16.27	0.0	229.62
2850.0	815.9	2676.9	56.60	16.20	0.0	229.88
2900.0	819.6	2689.1	56.21	16.14	0.0	230.14
2950.0	0.0	0.0	0.0	16.08	0.0	16.08
3000.0	826.5	2711.7	55.30	16.01	0.0	230.43
3050.0	828.5	2718.1	55.06	15.95	0.0	230.50
3100.0	830.4	2724.3	54.91	15.89	0.0	230.65
3150.0	830.0	2723.0	54.98	15.82	0.0	230.58
3200.0	834.3	2737.1	54.28	15.76	0.0	230.65
3250.0	837.3	2747.1	53.74	15.70	0.0	230.63
3300.0	839.0	2752.7	53.53	15.63	0.0	230.68
3350.0	842.9	2765.5	52.82	15.57	0.0	230.66
3400.0	846.6	2777.6	52.11	15.51	0.0	230.60
3450.0	851.6	2794.1	51.21	15.44	0.0	230.60
3500.0	856.4	2809.7	50.42	15.38	0.0	230.66
3550.0	860.9	2824.5	49.59	15.32	0.0	230.64
3600.0	862.5	2829.6	49.45	15.25	0.0	230.73
3650.0	862.7	2830.5	49.57	15.19	0.0	230.84
3700.0	861.4	2826.0	49.84	15.13	0.0	230.79
3750.0	860.1	2821.7	50.06	15.06	0.0	230.69
3800.0	858.3	2815.9	50.53	15.00	0.0	230.76
3850.0	858.4	2816.3	50.50	14.94	0.0	230.69
3900.0	858.1	2815.4	50.61	14.87	0.0	230.68
3950.0	856.7	2810.6	50.94	14.81	0.0	230.67
4000.0	857.0	2811.7	50.92	14.75	0.0	230.65

APPENDIX V

LEGEND TO ACCOMPANY GEOLOGICAL MAP

APPENDIX

July 1980

WILLOW RIVER EXPLORATION

LEGEND TO ACCOMPANY GEOLOGY MAP

PLEISTOCENE AND RECENT DEPOSITS

RECENT

va alluvium

Pleistocene and Recent

deposits with thin drift cover

sg sands and gravels, - origins various:
bedded sands and gravels, reworked and
original tills, glacial outwash, and alluvium
in places

dr drift, - unclassified

Pleistocene

m moraine forms with tills

t tills (?) interpretative

pt glacial deposits of lowlands; tills, clays,
laucustrine clays and silts, minor sands

MAP UNITS, BEDROCK

y (?) Tertiary

u (?) Triassic/Jurassic

T Triassic

M Mississippian: Slide Mountain Group

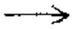
W Hadryniam - Cambrian: Cariboo Group

A Granite: Topley intrusions; Jurassic

B Gabbro, and associated basalts: Jurassic, (Poss. Tertiary)

(Formations and map units, provisional, and subject to revision)

SYMBOLS

	bedrock exposures
	observations of bedrock (part)
	bedding: strike, dip in degrees: vertical
	dip; approximate, undulant
	drag fold, minor flexure
	plunge
	foliation, inclined, vertical
	fault

BW-Willow River 81(3)*A #2
WR-RDH-2 RDH #2

CENTURY GEOPHYSICAL CORPORATION
Tulsa, Oklahoma

22

BOREHOLE	W.R. (RDH).C.
DATE	05-15-81
UNIT/OPERATOR	D. FERGUSON
FIELD OFFICE	CALGARY

COMPANY	GULF RESOURCES
BOREHOLE	W.R. (RDH).C.=2
AREA	WILLOW RIVER AREA
ELEVATION	
COUNTY	
STATE	BRITISH COLUMBIA.
SECTION	
TOWNSHIP	
RANGE	

HOLE DATA

TOTAL DEPTH — DRILLER	277.3 m.	BIT SIZE	13.3 cm.
TOTAL DEPTH — LOGGER	261.2 m.	CASING — TYPE & SIZE	STEEL
TOTAL FOOTAGE LOGGED	261.2 m.	CASING DEPTH	76.2 m.
LOGGING SPEED	8 m/min.	BOREHOLE FLUID	WATER.
REFERENCE LEVEL	DRILLERS TABLE	FLUID RESISTIVITY	@ °F
PROBE NO.	9068 - 642	SOFTWARE LEVEL	8.1 * A
TAPE # 1		SCALE SELECTION	☒ OPERATOR ☐ CLIENT
TRACK # 2			

REMARKS: SCALES USED - VERTICAL SCALE 2.5 m/div.
- GAMMA 25 cps/div.
- RELATIVE DENSITY .5/6
DID NOT LOG PASS 261 m BECAUSE OF DRILLERS HAMMER BIT.
ATEMPT LOG WITH 9030A TOOL BRIDGED AT 128.15 m. ABORT LOG.
WILL LOG AGAIN WHEN CORE BARREL ARRIVES
5-16-81

EQUIPMENT DATA

		9010	9030	9050/55	9080	9068
PROBE MODEL		9010	9030	9050/55	9080	9068
PROBE DIAMETER		1.87"	2.0"	1.87"	1.4"	1.4"
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI	NAL
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"	.5x3.0"
	STD. K-FACTOR	1.59 x 10⁻⁵	—	.558 x 10⁻⁵	1.62 x 10⁻⁵	1.62x10⁻⁵
	STD. DEADTIME	1 μsec	—	1.18 μsec	1 μsec	1 μsec
	CALIB. MODEL LOC.		—			
	CALIB DATE		—			
	K-FACTOR x 10⁻⁶		—			
	DEADTIME μsec		—			
	TEST READING		—			
	WATER FACTOR		—			
	CASING FACTOR		—			
	SCALE					25cps/d
DENSITY	DETECTOR TYPE	—	NaI	—	NaI	NAL
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"	.5x3.0"
	SOURCE TYPE	—	Cs137	—	Cs137	Cs137
	SOURCE NO.	—		—		VL-1-40
	SOURCE STRENGTH	—		—		125mCi
	SOURCE SPACING	—		—		
	CAL. STD					2283
	CAL. RUN					9970
	SCALE					.5/6
NEUTRON	DETECTOR TYPE	—	—	He³	—	
	DETECTOR SIZE	—	—	1.0" x 8.0"	—	
	SOURCE TYPE	—	—	AmBe	—	
	SOURCE NO.	—	—		—	
	SOURCE STRENGTH	—	—		—	
	SOURCE SPACING	—	—		—	
SNGL. PT RESISTANCE		1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L	
RESISTIVITY		—	6" FOCUSED	—	—	
SELF POTENTIAL		YES	—	YES	YES	
TEMPERATURE		—	—	YES	—	
DEVIATION		—	—	NO / YES	—	
CALIPER		—	YES	—	—	

CT-112 REV. 2/11/80

COMPU-LOG V8LO PLOT 05-15-81

W.R.C.
GULF RESOURCES
WILLOW RIVER AREA
HOLE DIAMETER : 13.3
PROBE # 9068 - 642
CAL STD CPS = 2283 CAL RUN CPS = 9970
PROBE CAL BIAS = 0
DATA V8L1 TRUCK # 7921
D. FERGUSON APPL.#518 I

COMPUPLOT® OMNIGRAPHIC® HOUSTON INSTRUMENT

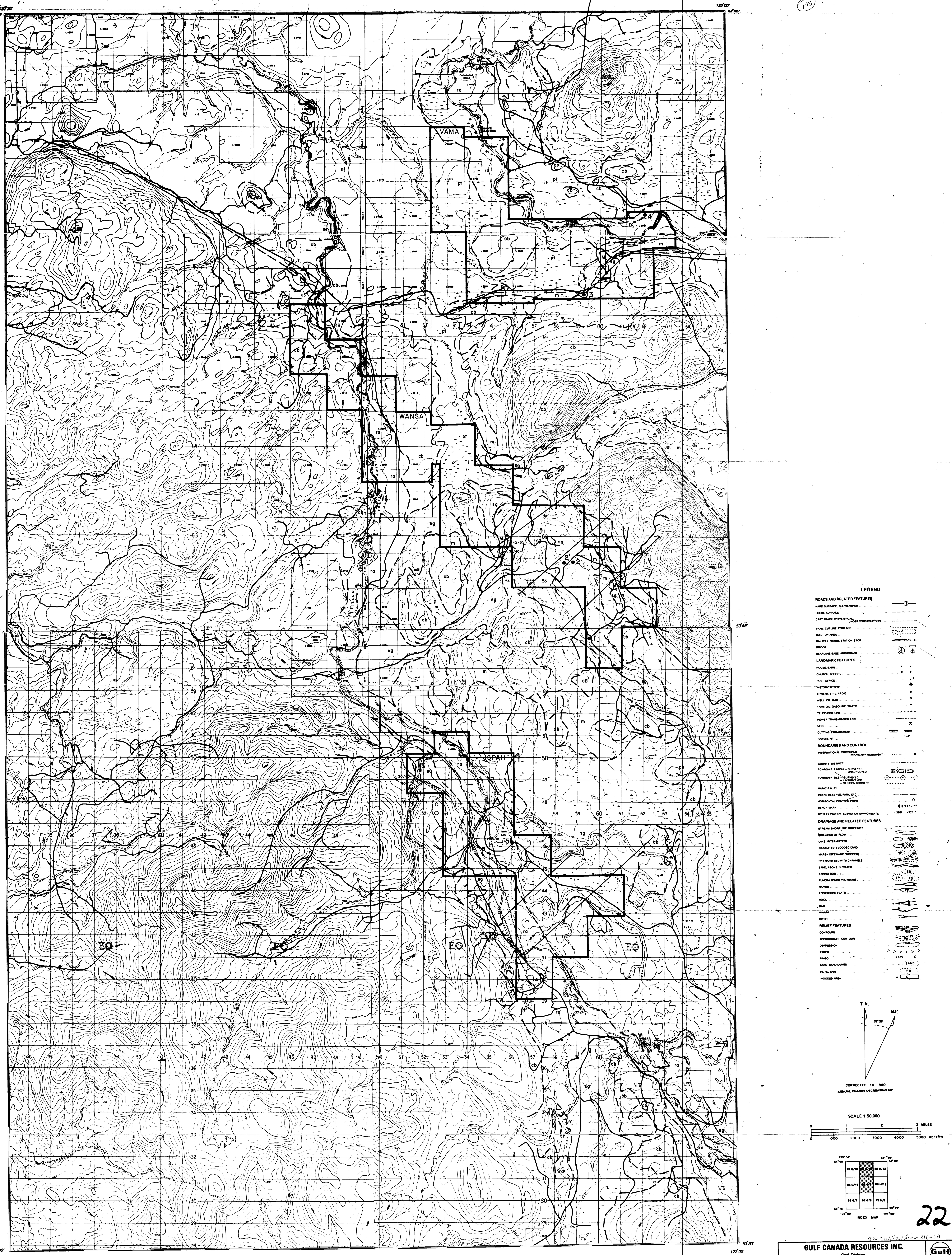
TO ACCOMPANY REPORT TITLED:
GRAVITY SURVEY
GULF COAL (WILLOW RIVER PROJECT)
DATED: MARCH, 1981

GULF COAL WILLOW RIVER PROJECT		
SIMPLE BOUGUER GRAVITY MAP CONTOUR INTERVAL: 0.2 MGAL.		
Ager, Berretta & Associates Vancouver, B.C.	DWN. BY: CHK. BY: DATE: MARCH 198	FIG. NO. 4

EXCLUSIVE DRAFTING SERVICES LTD

BW - Willow River 8(2)A

22



LEGEND

- LICENCE BOUNDARY
- GRAVITY LINES
- ROADS
- GEOLOGICAL CONTACT
- ● 3 1981 DRILL HOLE & NUMBER

22

BW - Willow River 81(2)A

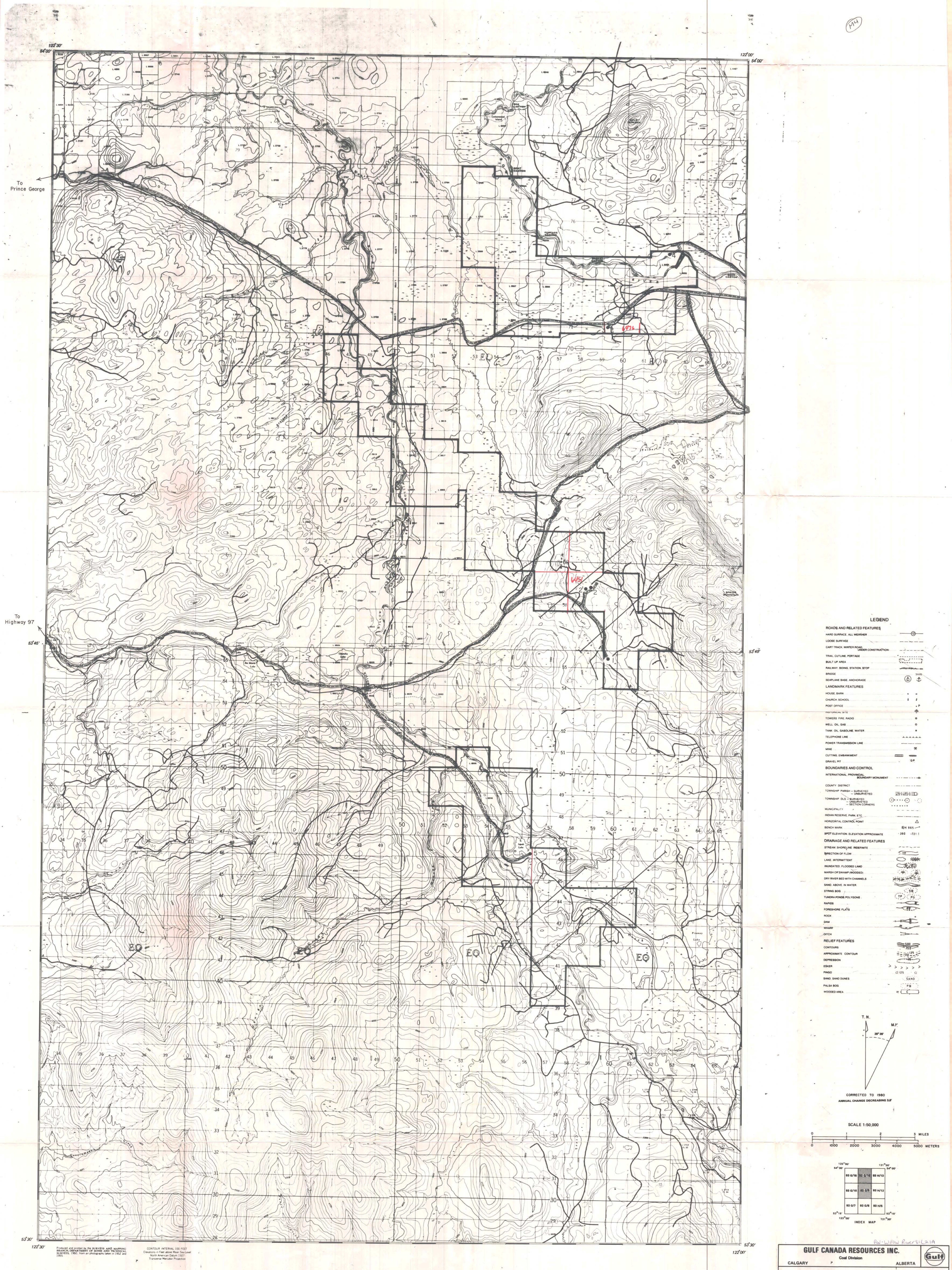
GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Gulf

93 G/9 & G/16

WILLOW RIVER COAL PROJECT
GEOLOGY & 1981 DRILL LOCATIONS

PREPARED BY:		DRAWING No.
APPROVED BY:	DATE: DEC. 80	



BW-Willow River 81L21A

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

Gulf

93 G/9 & G/16

WILLOW RIVER COAL LICENCES

COMPLETED DRILL HOLE LOCATIONS
& ACCESS FOR 1981 EXPLORATION

PREPARED BY: DRAWING No.
APPROVED BY: DATE: DEC. 80

LEGEND
- COMPLETED DRILL HOLE
- LICENCE BOUNDARY
- GRAVITY LINE
- ACCESS ROADS USED

Bw-Willow River 81(3)*A *2
WR-RDH-2 RDH

CGC

CENTURY GEOPHYSICAL CORPORATION

Tulsa, Oklahoma

22

BOREHOLE	W.R. (RDH).C.
DATE	05-15-81
UNIT/OPERATOR	D. FERGUSON
FIELD OFFICE	CALGARY

COMPANY: GULF RESOURCES
BOREHOLE: W.R. (RDH).C.=2
AREA: WILLOW RIVER AREA
ELEVATION:
COUNTY:
STATE: BRITISH COLUMBIA.
SECTION: TOWNSHIP: RANGE:

HOLE DATA

TOTAL DEPTH — DRILLER	277.3 m.	BIT SIZE	13.3 cm.
TOTAL DEPTH — LOGGER	261.2 m.	CASING — TYPE & SIZE	STEEL
TOTAL FOOTAGE LOGGED	261.2 m.	CASING DEPTH	76.2 m.
LOGGING SPEED	8 m/min.	BOREHOLE FLUID	WATER.
REFERENCE LEVEL	DRILLERS TABLE	FLUID RESISTIVITY	@ °F
PROBE NO.	9068 - 642	SOFTWARE LEVEL	8.1 * A
TAPE # 1		SCALE SELECTION	☑ OPERATOR ☐ CLIENT
TRACK # 2			

REMARKS: SCALES USED - VERTICAL SCALE 2.5 m/div.
- GAMMA 25 cps/div.
- RELATIVE DENSITY .5/6
DID NOT LOG PASS 261 m BECAUSE OF DRILLERS HAMMER BIT.
ATEMPT LOG WITH 9030A TOOL BRIDGED AT 128.15 m.
ABORT LOG.
WILL LOG AGAIN WHEN CORE BARREL ARRIVES
5-16-81

EQUIPMENT DATA

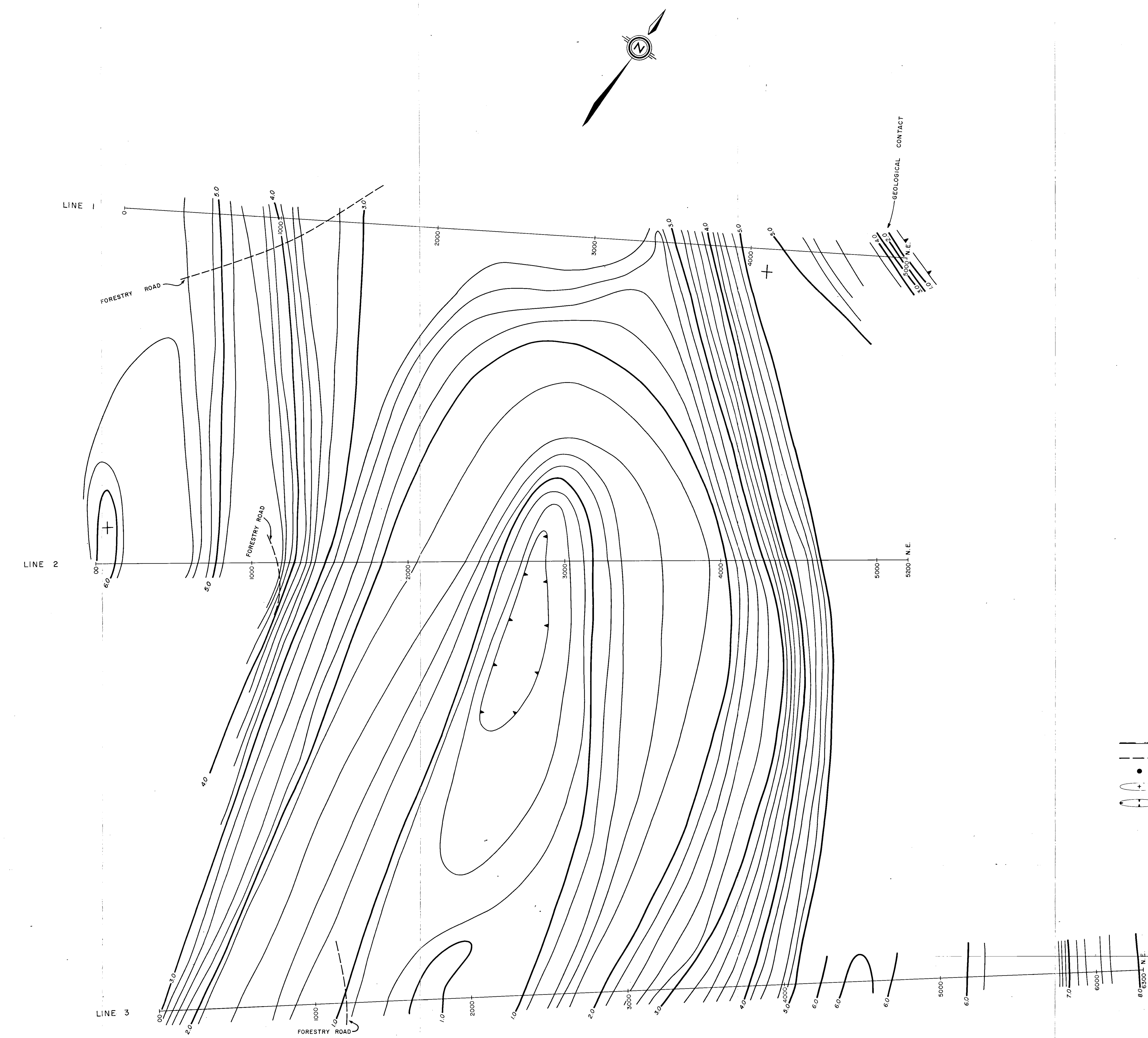
		9010	9030	9050/55	9080	9068
PROBE MODEL		9010	9030	9050/55	9080	9068
PROBE DIAMETER		1.87"	2.0"	1.87"	1.4"	1.4"
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI	NAL
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"	.5x3.0"
	STD. K-FACTOR	1.59 x 10^-6	—	.558 x 10^-6	1.62 x 10^-6	1.62x10^-6
	STD. DEADTIME	1 μsec	—	1.18 μsec	1 μsec	1 μsec
	CALIB. MODEL LOC.		—			
	CALIB DATE		—			
	K-FACTOR x 10^-6		—			
	DEADTIME μsec		—			
	TEST READING		—			
	WATER FACTOR		—			
	CASING FACTOR		—			
	SCALE					25cps/div
DENSITY	DETECTOR TYPE	—	NaI	—	NaI	NAL
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"	.5x3.0"
	SOURCE TYPE	—	Cs137	—	Cs137	Cs137
	SOURCE NO.	—		—		VL1-40
	SOURCE STRENGTH	—		—		125mCi.
	SOURCE SPACING	—		—		
	CAL. STD					2283
	CAL. RUN					9970
	SCALE					.5/6
NEUTRON	DETECTOR TYPE	—	—	He3	—	
	DETECTOR SIZE	—	—	1.0" x 8.0"	—	
	SOURCE TYPE	—	—	AmBe	—	
	SOURCE NO.	—	—		—	
	SOURCE STRENGTH	—	—		—	
	SOURCE SPACING	—	—		—	
SNGL. PT RESISTANCE		1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L	
RESISTIVITY		—	8" FOCUSED	—	—	
SELF POTENTIAL		YES	—	YES	YES	
TEMPERATURE		—	—	YES	—	
DEVIATION		—	—	NO / YES	—	
CALIPER		—	YES	—	—	

CT-112 REV. 2/11/80

COMPU-LOG V8LO PLOT 05-15-81

W.R.C.
GULF RESOURCES
WILLOW RIVER AREA
HOLE DIAMETER : 13.3
PROBE # 9068 - 642
CAL STD CPS = 2283 CAL RUN CPS = 9970
PROBE CAL BIAS = 0
DATA V8L1 TRUCK # 7921
D. FERGUSON APPL.#518 I

(M6)



LEGEND

- RIVER
- ROADS
- GRAVITY BASE STATION
- GRAVITY HIGH
- GRAVITY LOW
- CONTOUR INTERVAL 0.2 MILLIGALS
- GRAVITY DATUM ARBITRARY

NOTE
Gravity Datum Arbitrary

SCALE 1:10,000

200 100 0 200 400 600 800 Metres

TO ACCOMPANY REPORT TITLED:
GRAVITY SURVEY
GULF COAL (WILLOW RIVER PROJECT)
DATED: MARCH, 1981

GULF COAL
WILLOW RIVER PROJECT

SIMPLE BOUGUER GRAVITY MAP

CONTOUR INTERVAL: 0.2 MGAL.

Ager, Berretta & Associates Vancouver, B.C.	DWN. BY: CHK. BY: DATE: MARCH 1981	FIG. NO. 3

EXCLUSIVE DRAFTING SERVICES LTD.

(M6) BW-Willow River 81(2)A

22

BW · Willow River 81 (3 FA) *2
WR-RDH-3

CENTURY GEOPHYSICAL CORPORATION
Tulsa, Oklahoma

22

BOREHOLE	W.R. (RDH). B.
DATE	05-18-81
UNIT/OPERATOR	D. FERGUSON
FIELD OFFICE	CALGARY.

COMPANY	GULF RESOURCES
BOREHOLE	W.R. (RDH). B. =30
AREA	WILLOW RIVER AREA
ELEVATION	
COUNTY	
STATE	
SECTION	
TOWNSHIP	
RANGE	

HOLE DATA

TOTAL DEPTH — DRILLER	234 m.	BIT SIZE	13.3
TOTAL DEPTH — LOGGER	234 m.	CASING — TYPE & SIZE	STEEL
TOTAL FOOTAGE LOGGED	234 m.	CASING DEPTH	3.3 m.
LOGGING SPEED	8 m/min.	BOREHOLE FLUID	WATER
REFERENCE LEVEL	DRILLERS TABLE	FLUID RESISTIVITY	@ °F
PROBE NO.	9068-642	SOFTWARE LEVEL	8.1 * A
TAPE # 3 TRACK # 1		SCALE SELECTION	☑ OPERATOR ☐ CLIENT

REMARKS: SCALES USED - VERTICAL 2m/div.
NATURAL GAMMA 25CPS
RELATIVE DENSITY .5/8
TAPE #2 TRACK # 4 TAPE CLICHED RE LOGGED HOLE TAPE # 3 TRACK # 1
DRILLING CO. USED CAN. WEST DRILLING.
LOGGED 234. m BECAUSE HAMMER BIT AT END OF RODS.

EQUIPMENT DATA

		9010	9030	9050/55	9060	9068
PROBE MODEL		9010	9030	9050/55	9060	9068
PROBE DIAMETER		1.87"	2.0"	1.87"	1.4"	1.4"
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI	NAI
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"	.5"x3.0"
	STD. K-FACTOR	1.59 x 10⁻⁶	—	.558 x 10⁻⁶	1.62 x 10⁻⁶	1.62x10⁻⁶
	STD. DEADTIME	1 µsec	—	1.18 µsec	1 µsec	1 µsec
	CALIB. MODEL LOC.		—			
	CALIB DATE		—			
	K-FACTOR x 10⁻⁶		—			
	DEADTIME µsec		—			
	TEST READING		—			
	WATER FACTOR		—			
	CASING FACTOR		—			
	SCALE					25CPS.
DENSITY	DETECTOR TYPE	—	NaI	—	NaI	
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"	
	SOURCE TYPE	—	Cs137	—	Cs137	Cs 137
	SOURCE NO.	—		—		VL-1-480
	SOURCE STRENGTH	—		—		125mCi
	SOURCE SPACING	—		—		
	SCALE					5/8
	CAL STD					2283
	CAL RUN					9970
NEUTRON	DETECTOR TYPE	—	—	He3	—	
	DETECTOR SIZE	—	—	1.0" x 6.0"	—	
	SOURCE TYPE	—	—	AmBe	—	
	SOURCE NO.	—	—		—	
	SOURCE STRENGTH	—	—		—	
	SOURCE SPACING	—	—		—	
SNGL PT RESISTANCE		1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L	
RESISTIVITY		—	8" FOCUSED	—	—	
SELF POTENTIAL		YES	—	YES	YES	
TEMPERATURE		—	—	YES	—	
DEVIATION		—	—	NO / YES	—	
CALIPER		—	YES	—	—	

CT-112 REV. 2/11/80

COMPU-LOG V8L0 PLOT 05-18-81

W.R.(RDH).B.
GULF RESOURCES
WILLOW RIVER AREA

HOLE DIAMETER : 13.3
PROBE # 9068 - 642
CAL STD CPS = 2283 CAL RUN CPS = 9970
PROBE CAL BIAS = 0
DATA V8L1 TRUCK # 7921
D. FERGUSON APPL.#518 I

BW-Willow River 81(3)#A #2 RDH(3)
WR-RDH-3

CENTURY GEOPHYSICAL CORPORATION

Tulsa, Oklahoma

22

BOREHOLE	W.R.(RDH).B.
DATE	05-18-81
UNIT/OPERATOR	D. FERGUSON
FIELD OFFICE	CALGARY
COMPANY	GULF RESOURCES
BOREHOLE	W.R. (RDH) B. = 3
AREA	WILLOW RIVER AREA.
ELEVATION	
COUNTY	
STATE	
SECTION	
TOWNSHIP	
RANGE	

HOLE DATA

TOTAL DEPTH — DRILLER	245m.	BIT SIZE	13.3 cm.
TOTAL DEPTH — LOGGER	245m.	CASING — TYPE & SIZE	STEEL
TOTAL FOOTAGE LOGGED	245m.	CASING DEPTH	3.3m.
LOGGING SPEED	8m/min	BOREHOLE FLUID	WATER
REFERENCE LEVEL	GROUND	FLUID RESISTIVITY	@ °F
PROBE NO.	9030A-414	SOFTWARE LEVEL	8.1* A.
TAPE # 3		SCALE SELECTION	☑ OPERATOR ☐ CLIENT
TRACK #2			

REMARKS: SCALES USED - VERTICAL 2m/div.
- NATURAL GAMMA 100 API
- RESISTIVITY .5K/.2K
- APPARENT DENSITY .5/-1
- CALIPER 5/-10

DRILLING CO. CAN WEST DRILLING.

EQUIPMENT DATA (M8)

		9010	9030	9050/55	9060
	PROBE MODEL	9010	9030	9050/55	9060
	PROBE DIAMETER	1.87"	2.0"	1.87"	1.4"
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"
	STD. K-FACTOR	1.59 x 10⁻⁵	—	.558 x 10⁻⁵	1.82 x 10⁻⁵
	STD. DEADTIME	1 μsec	—	1.18 μsec	1 μsec
	CALIB. MODEL LOC.		—		
	CALIB DATE		—		
	K-FACTOR x 10⁻⁵		—		
	DEADTIME μsec		—		
	TEST READING		—		
	WATER FACTOR		—		
	CASING FACTOR		—		
	SCALE		100 API.		
DENSITY	DETECTOR TYPE	—	NaI	—	NaI
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"
	SOURCE TYPE	—	Cs137	—	Cs137
	SOURCE NO.	—	VL-1-480	—	
	SOURCE STRENGTH	—	125mCi	—	
	SOURCE SPACING	—		—	
	SCALE		.5/-1		
	CAL STD.		6588		
	CAL RUN.		5033		
NEUTRON	DETECTOR TYPE	—	—	He3	—
	DETECTOR SIZE	—	—	1.0" x 6.0"	—
	SOURCE TYPE	—	—	AmBe	—
	SOURCE NO.	—	—		—
	SOURCE STRENGTH	—	—		—
	SOURCE SPACING	—	—		—
	SNGL. PT RESISTANCE	1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L
	RESISTIVITY	—	8" FOCUSED	—	—
	SELF POTENTIAL	YES	—	YES	YES
	TEMPERATURE	—	—	YES	—
	DEVIATION	—	—	NO / YES	—
	CALIPER	—	YES	—	—

CT-112 REV. 2/11/80

.COMPU-LOG V8LO PLOT 05-18-81

W.R.(RDH).B.
GULF RESOURCES
WILLOW RIVER AREA

HOLE DIAMETER : 13.3
PROBE # 9030A - 414
CAL STD CPS = 6588 CAL RUN CPS = 5033
PROBE CAL BIAS = 27
DATA V8L1 TRUCK # 7921
D. FERGUSON APPL.#530 I

BW-Willow River 81(3)A #2
WR-RDH-4
(4)

CENTURY GEOPHYSICAL CORPORATION
Tulsa, Oklahoma

22

COMPANY	GULF RESOURCES
BOREHOLE	W.R. (RDH). A. = 4
AREA	WILLOW RIVER AREA.
ELEVATION	
COUNTY	
STATE	
SECTION	
TOWNSHIP	
RANGE	

BOREHOLE	DATE
W.R. (RDH). A.	05-20-81
UNIT/OPERATOR	**FIELD OFFICE**
D. FERGUSON	CALGARY

HOLE DATA

TOTAL DEPTH — DRILLER	69.6 m.	BIT SIZE	13.3 cm.
TOTAL DEPTH — LOGGER	69.6 m.	CASING — TYPE & SIZE	STEEL
TOTAL FOOTAGE LOGGED	69.6 m.	CASING DEPTH	10.6 m.
LOGGING SPEED	8m/div.	BOREHOLE FLUID	WATER
REFERENCE LEVEL	GROUND	FLUID RESISTIVITY	@ °F
PROBE NO.	9030A- 414	SOFTWARE LEVEL	8.1 * A
TAPE # 3		SCALE SELECTION	☑ OPERATOR ☐ CLIENT
TRACK # 3			

REMARKS: SCALES USED - VERTICAL 2m/div.
- APPARENT DENSITY .5/1
- RESISTIVITY .5K/÷2K
- CALIPER 5/-10
- NATURAL GAMMA 100 API.

DRILLING CO. CAN WEST DRILLING.

EQUIPMENT DATA (M9)

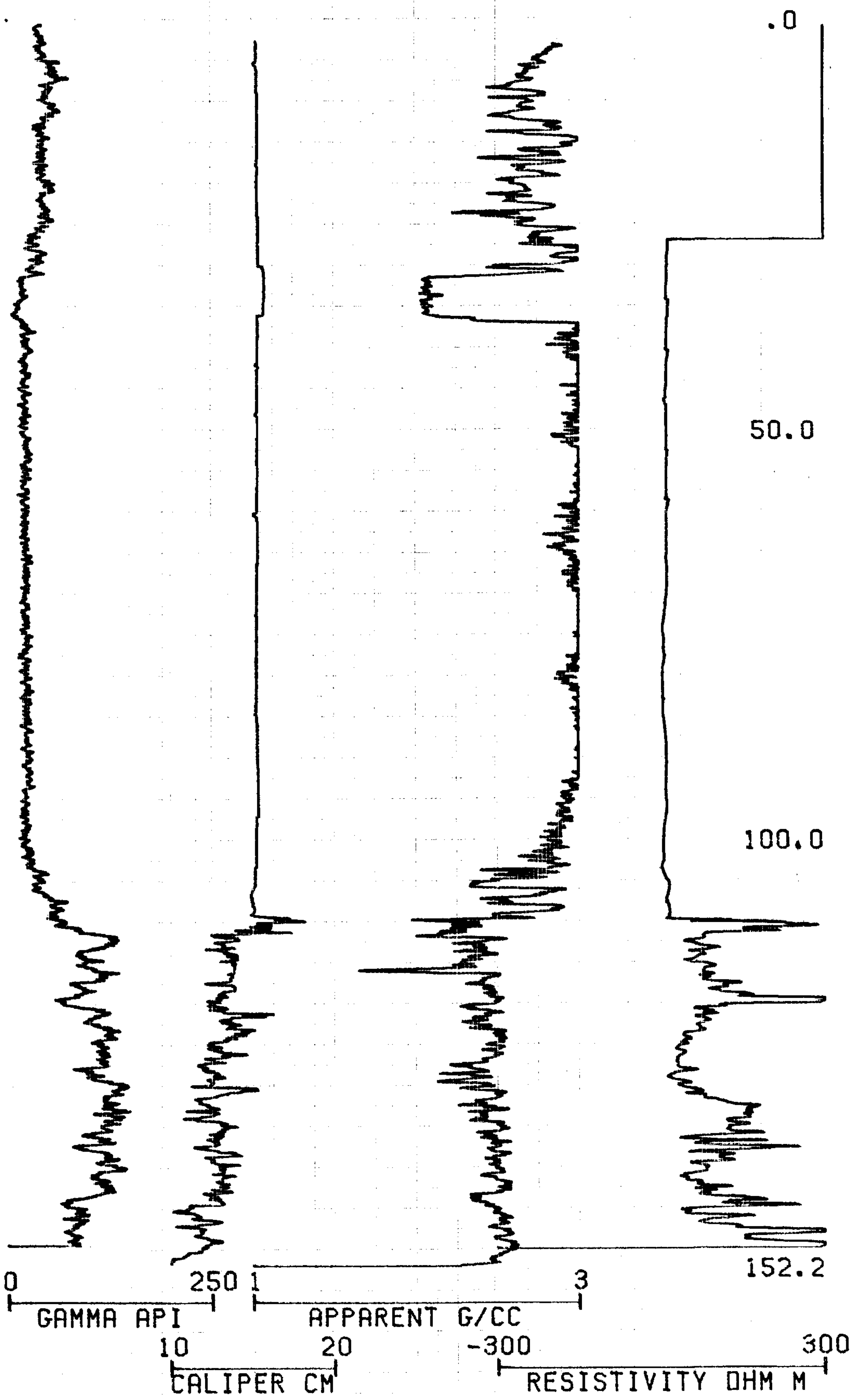
		9010	9030 A	9050/55	9080	
PROBE MODEL		9010	9030 A	9050/55	9080	
PROBE DIAMETER		1.87"	2.0"	1.87"	1.4"	
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI	
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"	
	STD. K-FACTOR	1.59×10^{-5}	—	$.558 \times 10^{-5}$	1.82×10^{-5}	
	STD. DEADTIME	1 μsec	—	1.18 μsec	1 μsec	
	CALIB. MODEL LOC.		—			
	CALIB DATE		—			
	K-FACTOR $\times 10^{-5}$		—			
	DEADTIME μsec		—			
	TEST READING		—			
	WATER FACTOR		—			
	CASING FACTOR		—			
	SCALE		100 API.			
DENSITY	DETECTOR TYPE	—	NaI	—	NaI	
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"	
	SOURCE TYPE	—	Cs^{137}	—	Cs^{137}	
	SOURCE NO.	—	VL-1-480	—		
	SOURCE STRENGTH	—	125mCi.	—		
	SOURCE SPACING	—		—		
	SCALE		.5k/.2k			
	CAL STD.		6588			
	CAL. RUN.		5033			
NEUTRON	DETECTOR TYPE	—	—	He^3	—	
	DETECTOR SIZE	—	—	1.0" x 6.0"	—	
	SOURCE TYPE	—	—	AmBe	—	
	SOURCE NO.	—	—		—	
	SOURCE STRENGTH	—	—		—	
	SOURCE SPACING	—	—		—	
SNGL. PT RESISTANCE		1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L	
RESISTIVITY		—	6" FOCUSED	—	—	
SELF POTENTIAL		YES	—	YES	YES	
TEMPERATURE		—	—	YES	—	
DEVIATION		—	—	NO / YES	—	
CALIPER		—	YES	—	—	

CT-112 REV. 2/11/80

COMPU-LOG V8L0 PLOT 05-20-81

W.R.(RDH).A.
GULF RESOURCES
WILLOW RIVER AREA
HOLE DIAMETER : 13.3
PROBE # 9030A - 414
CAL STD CPS = 6588 CAL RUN CPS = 5033
PROBE CAL BIAS = 27
DATA V8L1 TRUCK # 7921
D.FERGUSON APPL.#530 I

M10



BW-Willow River 81(3)*A *2

COMPU-LOG V8LO PLOT 05-22-81

W.R.(RDH).E. =5 WR-RDH-5

GULF RESOURCES

WILLOW RIVER AREA

HOLE DIAMETER : 13.3

PROBE # 9030A - 414

CAL STD CPS = 6588 CAL RUN CPS = 5033

PROBE CAL BIAS = 27

DATA V8L1 TRUCK # 7921

D. FERGUSON APPL.#530 I

COMPU-LOG V8LO PLOT 05-22-81

W.R.(RDH).E. WR-RDH-5

GULF RESOURCES

WILLOW RIVER AREA

HOLE DIAMETER : 13.3

PROBE # 9030A - 414

CAL STD CPS = 6588 CAL RUN CPS = 5033

PROBE CAL BIAS = 27

DATA V8L1 TRUCK # 7921

D. FERGUSON APPL.#530 I

55

BW-Willow River 51(3)A #2

WR-RDH-2

CENTURY GEOPHYSICAL CORPORATION

CGC

Tulsa, Oklahoma

M12

22

BOREHOLE	DATE
W.R.(RDH).C.	05-16-81
UNIT/OPERATOR	FIELD OFFICE
D. FERGUSON	CALGARY ALB.

COMPANY	GULF RESOURCES
BOREHOLE	W.R.(RDH).C.#2
AREA	WILLOW RIVER AREA
ELEVATION	
COUNTY	
STATE	BRITISH COLUMBIA.
SECTION	
TOWNSHIP	
RANGE	

HOLE DATA

TOTAL DEPTH — DRILLER	: 277.3m	BIT SIZE	: 13.3
TOTAL DEPTH — LOGGER	: 130.9 m.	CASING — TYPE & SIZE	: STEEL
TOTAL FOOTAGE LOGGED	: 130.9 m.	CASING DEPTH	: 76.2m
LOGGING SPEED	: 8m/min	BOREHOLE FLUID	: WATER
REFERENCE LEVEL	: GROUND	FLUID RESISTIVITY	: @ °F
PROBE NO.	: 9030A-642	SOFTWARE LEVEL	: 8.1*A
TAPE # 2		SCALE SELECTION	: ☑ OPERATOR ☐ CLIENT
TRACK # 3			

REMARKS: SCALES USED - VERTICAL 2m/div.
- NATURAL GAMMA 100 API.
- CALIPER 5/-10
- RESISTIVITY 150/300
- APPARENT DENSITY .5/-1

TAPE DRIVE MALFUNCTION TRACK #1 RELOG.
BAD HEADER #2 ONLY LOGGED 130.7m BRIDGED AT SAID DEPTH. GEOLOGIST REQUESTED LOG FOR 130.9 m.

EQUIPMENT DATA

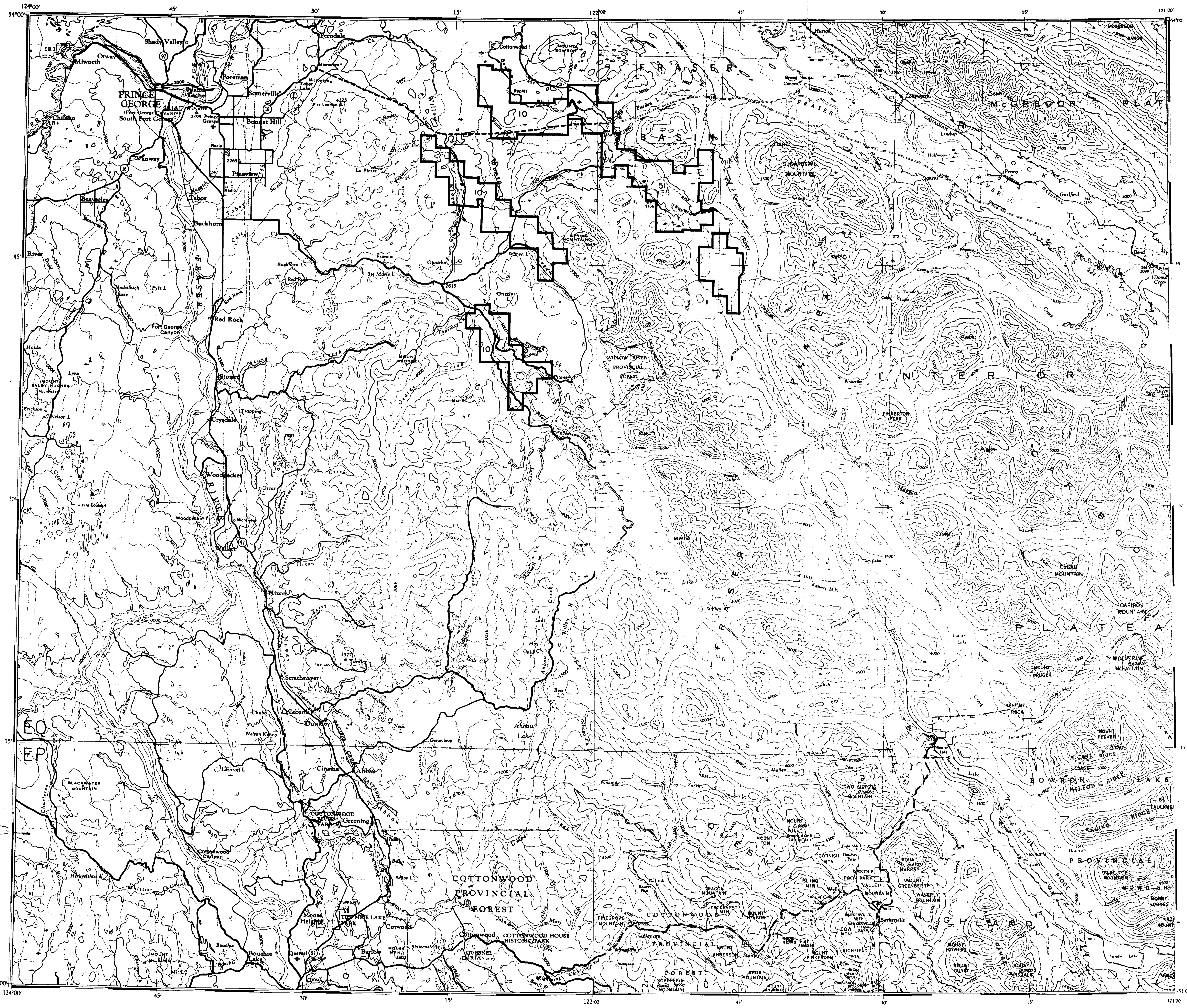
		9010	9030	9050/55	9060
PROBE MODEL		9010	9030	9050/55	9060
PROBE DIAMETER		1.87"	2.0"	1.87"	1.4"
NATURAL GAMMA	DETECTOR TYPE	NaI	NaI	NaI	NaI
	DETECTOR SIZE	.875" x 1.25"	1.125" x 4.5"	.875" x 4.0"	.5" x 3.0"
	STD. K-FACTOR	1.59 x 10⁻⁵	—	.558 x 10⁻⁵	1.62 x 10⁻⁵
	STD. DEADTIME	1 μsec	—	1.18 μsec	1 μsec
	CALIB. MODEL LOC.		—		
	CALIB DATE		—		
	K-FACTOR x 10⁻⁵		—		
	DEADTIME μsec		—		
	TEST READING		—		
	WATER FACTOR		—		
	CASING FACTOR		—		
	SCALE		100 API		
DENSITY	DETECTOR TYPE	—	NaI	—	NaI
	DETECTOR SIZE	—	.5" x 1.5"	—	.5" x 3.0"
	SOURCE TYPE	—	Cs137	—	Cs137
	SOURCE NO.	—	VL-1-480	—	
	SOURCE STRENGTH	—	125 mCi	—	
	SOURCE SPACING	—		—	
	CAL. STD		6588		
	CAL. RUN		5033		
	SCALE		.5/-10		
NEUTRON	DETECTOR TYPE	—	—	He3	—
	DETECTOR SIZE	—	—	1.0" x 6.0"	—
	SOURCE TYPE	—	—	AmBe	—
	SOURCE NO.	—	—		—
	SOURCE STRENGTH	—	—		—
	SOURCE SPACING	—	—		—
SNGL. PT RESISTANCE		1.4"D x 2.5"L	—	1.4"D x 2.5"L	1.1"D x 2.5"L
RESISTIVITY		—	6" FOCUSED	—	—
SELF POTENTIAL		YES	—	YES	YES
TEMPERATURE		—	—	YES	—
DEVIATION		—	—	NO / YES	—
CALIPER		—	YES	—	—

CT-112 REV. 2/11/80

COMPU-LOG V8L0 PLOT 05-16-81

W.R.(RDH).C.
GULF RESOURCES
WILLOW RIVER AREA

HOLE DIAMETER : 13.3
PROBE # 9030A - 414
CAL STD CPS = 6588 CAL RUN CPS = 5033
PROBE CAL BIAS = 27
DATA V8L1 TRUCK # 7921
D. FERGUSON APPL.#530 I



LEGEND

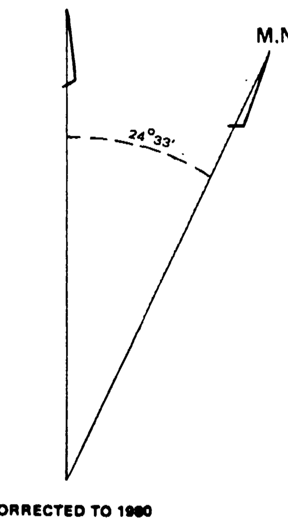
ROADS AND RELATED FEATURES
- HARD SURFACE, ALL WEATHER
- LOOSE SURFACE
- CART TRACK, WINTER ROAD
- TRAIL, CUT LINE, PORTAGE
- BUILT-UP AREA
- RAILWAY, SIDING, STATION, STOP
- BRIDGE
- SEAPLANE BASE, ANCHORAGE

LANDMARK FEATURES
- HOUSE, BARN
- CHURCH, SCHOOL
- POST OFFICE
- HISTORICAL SITE
- TOWERS: FIRE, RADIO
- WELL: OIL, GAS
- TANK: OIL, GASOLINE, WATER
- TELEPHONE LINE
- POWER TRANSMISSION LINE
- MINE
- CUTTING, EMBANKMENT
- GRAVEL PIT

BOUNDARIES AND SURVEY CONTROL
- INTERNATIONAL, PROVINCIAL, BOUNDARY MONUMENT
- COUNTY, DISTRICT
- TOWNSHIP, PARISH-SURVEYED -UNSURVEYED
- TOWNSHIP, DLS - SURVEYED, UNSURVEYED
- SECTION CORNERS
- MUNICIPALITY
- INDIAN RESERVE, PARK, ETC
- HORIZONTAL SURVEY POINT
- BENCH MARK WITH ELEVATION
- SPOT ELEVATION, PRECISE: LAND, WATER

DRAINAGE AND RELATED FEATURES
- STREAM, SHORELINE: INDEFINITE
- DIRECTION OF FLOW
- LAKE, INTERMITTENT LAKE
- FLOODED LAND
- MARSH, SWAMP (WOODED)
- DRY RIVER BED WITH CHANNELS
- SAND: ABOVE, IN WATER
- STRING BOG
- TUNDRA: PONDS, POLYGONS
- RAPIDS, FALLS, RAPIDS
- FORESHORE FLATS
- ROCK
- DAM
- WHARF
- DITCH

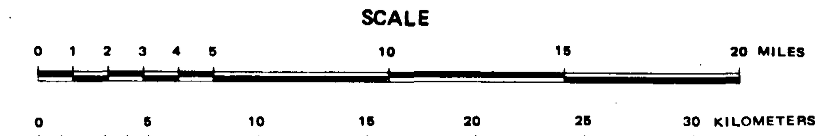
RELIEF FEATURES
- CONTOURS
- APPROXIMATE CONTOURS
- DEPRESSION CONTOUR
- SPOT ELEVATION, APPROXIMATE: LAND, WATER
- ESKER
- PINGO
- SAND, SAND DUNES
- PALSA BOG
- WOODED AREA
- CLEARED AREA



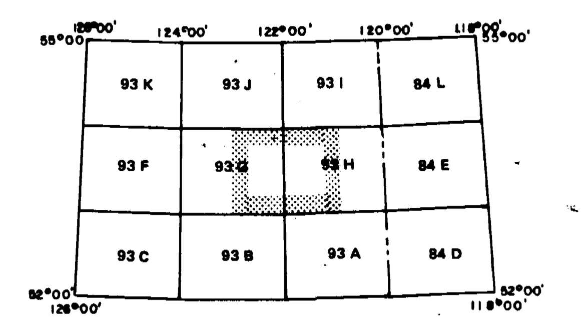
CORRECTED TO 1980

MAGNETIC DECLINATION DECREASING 3.5 WEST ANNUALLY

SCALE



INDEX TO ADJOINING MAPS



COMPANY CODE/DATE LICENCE APPLICATION WITHDRAWN:
COMPANY CODE/DATE LICENCE SURRENDERED:

10 COAL LICENCES

LICENCE HOLDERS
10 GULF CANADA RESOURCES INC.
51 NORCO RESOURCES LTD.

SYMBOLS
- AREA UNDER LICENCE
- AREA UNDER LICENCE - SURRENDERED
- AREA UNDER LICENCE APPLICATION
- AREA UNDER LICENCE APPLICATION - WITHDRAWN
- AREA UNDER FREEHOLD COAL RIGHTS
- OUTLINE OF COAL RESERVE

GULF CANADA RESOURCES INC.
Coal Division
CALGARY ALBERTA

93G/E & 93H/W
WILLOW RIVER AREA

UPDATED TO: FEB. 20, 1981		
DRAWN BY:	DATE:	SCALE 1 : 250 000
PREPARED BY:		DRAWING No.
APPROVED BY:	DATE:	
		FILE No.

M13

22

BW-Bowron River 81(2)A