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DATE PERFORMED: September 9, 1986 - March 28, 1987 DATE FILED: March 31, 1987

LOCATION: LAT.: 60°29'W AREA: Mt. Granger

LONG.: 135°16'W VALUE $:

CLAIM NAME & NO.: CML 2989 - 2991

CEL 30

WORK DONE BY: J.H. Perry

WORK DONE FOR: Whitehorse Coal Corporation

DATE TO GOOD STANDING | REMARKS: #41 WHITEHORSE COAL

092024

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# WHITEHORSE COAL PROPERTY:

# SUMMARY REPORT ON THE

# 1986 TEST PIT - BULK SAMPLING PROGRAM

PROGRAM DESIGNATION NO:
EIP 86-031

COAL MINING LEASES:
2989, 2990, 2991 and Coal Exploration License 30

CLAIM SHEET NO'S:
105 D/6 and 105 D/11

LATITUDE: 60° 29'N / LONGITUDE: 135° 16'W

WORK PERIOD:
September 9th, 1986 - March 28th, 1987

REPORT PREPARED FOR:
WHITEHORSE COAL CORP.

MINING SUPERVISED BY:
JHP COAL-EX CONSULTING LTD.

REPORT AUTHOR:
J.H. PERRY, P. GEOL. (COAL-EX)

DATE SUBMITTED:
March 31st, 1987

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March 31, 1987

Whitehorse Coal Corporation
P.O. Box 5478
Whitehorse, Yukon
Y1A 5H4

Attention: Mr. P. Poggenburg, President

Dear Sirs:

Re: Whitehorse Coal Property Report

We are pleased to submit herewith two copies of our report entitled "Whitehorse Coal Property: Summary Report on the 1986 Test Pit - Bulk Sampling Program."

The report discusses the activities undertaken during the 1986 work program and summarizes the results obtained from geological observations and coal testing and analysis.

We urge Whitehorse Coal Corporation to continue the work initiated on coal testing and analysis to further evaluate the practicalities of selective mining.

Should you have any questions concerning our report, we will be available to discuss them with you.

Yours sincerely,
**JHP Coal-Ex Consulting Ltd.**

J.H. Perry
President

0 2 0 2 4

## SUMMARY

Explöration on the Whitehorse Coal Property during 1986 consisted of test mining and bulk sampling. A test pit was located on coal mining lease 2989, in the northwest corner of the property. Prevous drilling (in 1985) defined coal reserves along the southwest flank of West Hill. The pit was located down-hill from these holes, between hole 85-3 and 86-6.

Stripping (Phase I) began on October 1st, 1986 and was completed by October 19th with the removal of 16,109 cubic metres of material. Subsequent to this, during the coal mining (Phase II) portion of the program, an additional 750 cubic metres of material was removed from atop the seam and along the front of the pit. In-situ coal reserves within the pit were estimated at 7,450 tonnes; 5,250 tonnes of potential product coal and 2,200 tonnes of oxidized coal mixed with soil. Coal mining began on October 20th at the western end of the pit. This area was quickly abandoned due to large amounts of residual rock above the seam and a second face was established in the east central portions of the pit, downhill from hole 85-4. Subsequent coal mining proceeded towards the west. Mineable coal was restricted to the back half of the pit due to the presence of a deep permafrost zone along the front. This created certain difficulties due to the size of the backhoe in relation to the mining area. These difficulties were also compounded by unexpected geological structures.

The seam stratigraphy in the pit correlates well with the drill holes. Most of the variations can be explained by the presence, or absence, of igneous intrusions (present as sills). It was these rock bands that the selective mining process concentrated on removing from the "product" coal. In the eastern parts of the mined area the geology is complicated by the presence of a sharp roll, or anticlinal fold, which results in a drastic steepening of the dip along the highwall. It was fortuitous that the sills present in this area were found at the top of the seam and were therefore, relatively easy to remove. Otherwise, the seam had to be bulk mined. In the central and western portions of the mined area the geologic structure was more uniform, with dips commonly 20° to 25° to the northwest. Throughout these areas the sills were found at the top, middle and in the lower


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parts of the seam. Selective mining was employed in these situations. While success was achieved in the removal of the orange-coloured, altered igneous bands it was at the expense of coal loss. This mining was also time consuming. Where possible loose coal from atop the permafrost zone was also recovered.

Coal and mixtures of coal and rock were stockpiled adjacent to the pit. Approximately 3,290 tonnes are contained within five stockpiles; two of these (Stockpiles #1 and #2) contain an estimated 1,885 tonnes of "product" coal. The quality of this coal is, as yet, undetermined. It is anticipated that stockpile #1 (845 tonnes) may be higher in ash than stockpile #2 (1,040 tonnes) and so better suited for use in the planned fluidized bed combustor at the Yukon College than for more conventional industrial or domestic uses. In-situ reserves remaining within the pit are estimated at 2,150 tonnes potential "product" and 3,650 tonnes of coal within the permafrost zone.

Samples of the coal seam were taken from several locations within the mined area and from the stockpiles. A 14-tonne "bulk" sample was also taken and shipped to Calgary for testing. To date, only a few of the samples have been subjected to preliminary analysis. The "bulk" sample has undergone screening and washability testing in addition to other coal analyses. The "bulk" sample represents an entire seam composite and includes all rock bands. Preliminary results from this sample indicate that the raw coal is relatively high in ash (45.4%). It is unlikely that the ash content can be significantly reduced by crushing and screening. Washability results indicate that only very small recoveries of low-ash coal can be anticipated; at a 1.9 S.G. cut the yield is approximately 50% with 27% ash. The total seam raw ash in some parts of the area may be as low as 34%. More analyses are necessary before predictions can be made regarding the ash contents of selectively mined coal.

Recommendations for further work within and adjacent to the stripped area include: completion of the testing and analyses for all the samples, additional geological mapping and drilling and the evaluation of the thin coal "seam" which underlies the main seam. It is further recommended that detailed exploration be conducted throughout the areas held under coal mining lease.

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## 1.0 INTRODUCTION AND TERMS OF REFERENCE

In early September, 1986 Coal-Ex Consulting Ltd. was retained by Whitehorse Coal Corp. (W.C.C.) to supply geological and supervisory services for a test pit - bulk sample program on the Whitehorse Coal Property. Primary tasks to be handled by Coal-Ex included:

- pre-program data review
- selection of pit location
- pit design
- supervision of mining activities (both waste rock removal and coal mining)
- sampling and geological data gathering
- co-ordination of coal testing
- final report preparation

Coal-Ex was assisted in the pit design and in the supervision of some of the mining activities by Terra Scan Technical Consultants. Terra Scan were also responsible for topographic and in-pit surveying (see Section 4.3).

This report summarizes the activities undertaken during the mining of the bulk sample. Topics discussed include program logistics, monitoring and supervision as well as data collection. Reviews of the pit and coal seam geology are presented but no detailed data handling has been undertaken. Preliminary results from the testing and analysis of various coal samples are also reviewed.

## 2.0 EXPLORATION FRAMEWORK

The Whitehorse Coal Property is located in southwestern Yukon, approximately 30 kilometres southwest of Whitehorse. The property comprises three Coal Mining Leases and one Coal Exploration Licence for a total of 19,987 hectares. Apart from some volcanics and meta-volcanics of uncertain age, rocks contained within the property boundaries belong to the Mesozoic period. Coal is found within the Upper Jurassic - Lower Cretaceous Tantalus Formation.

Between 1981 and 1984 W.C.C. conducted several reconnaissance exploration programs comprising prospecting, trenching and road construction. This work identified two laterally continuous coal zones within the coal leases in the northwestern portions of the property. These coal occurrances were named Coal Zones A and B (see Perry, 1984). Exploration during 1985 incorporated cat-trenching, road construction and open-hole, rotary drilling. All the drill holes were positioned along the southern slopes of West Hill and targetted Coal Zone B. Of the six holes drilled, five intersected this coal zone. A report on the 1985 exploration program, which includes geological interpretations and reserve calculations, was prepared by L.W. Carlyle, P. Geol (1985). Based upon the results of this work, W.C.C. proceeded with plans for coal mining which culminated in the 1986 bulk sample program.

## 3.0 PROGRAM OBJECTIVES

The 1986 test pit - bulk sample program had four primary objectives. They were:

1) by the use of selective mining techniques, provide approximately 2,000 tons of run-of-mine coal for sample product distribution to potential customers;

2) provide sufficiently large and representative samples for comprehensive analysis on a variety of sized coals in both raw and cleaned states. Such coals would approximate potential products gained from selective mining and bulk mining techniques;

3) examine the suitability of selective mining for future bulk sample extraction or small-scale production scenarios; and,

4) obtain data on the mined coal seam with respect to seam thickness, rock band distribution, coal quality and geologic structure.

# 4.0 LOGISTICS

## 4.1 Introduction

The program consisted of two contiguous work phases; Phase I involved removal of the majority of overburden (waste rock) from the pit while Phase II incorporated the removal of the residual overburden and selective coal mining. The entire program, including pre-mobilization road maintenance, covered a period of approximately 8 weeks from September 9th to November 5th, 1986. Phase I began on September 30th and Phase II started on October 20th, 1986.

Access to the pit site was via the main exploration road that extends from the premises of Whitehorse Copper to the northern portion of the property. This road passes within a few metres of the pit. The larger pieces of mining equipment were mobilized by low-boy trailer to Whitehorse Copper from whence they made their way to the pit area under their own power. The D-8 Caterpillar operated by W.C.C. had to assist the scraper on some of the steeper slopes. A fuel wagon was hauled into the property by the mining contractor's bulldozer.

The majority of the mined coal was stockpiled on site in three main and two secondary piles. Approximately 300 tonnes were trucked to a stockpile located near the Whitehorse end of the property access road, for near-term distribution to potential customers. A 14-tonne "bulk" sample was trucked to Calgary for detailed coal testing.

Mining concluded on November 5th and the demobilization of all equipment was completed by November 6th, 1986.

### 4.2 Road Maintenance

Some early maintenance of the main access road was undertaken in August with the repair of a wash-out and associated culvert installation near kilometre six. This work was conducted using a bulldozer and loader contracted from Melberg Verrico Contracting Ltd.

The main phase of road maintenance began on September 9th, prior to the mobilization of mining equipment, and continued until the end of the bulk sampling program. Tasks undertaken during this period included:

- reduction of grades on the steeper slopes;
- elimination of one switchback;
- widening of corners; and,
- construction of passing zones.

This work was necessary for easier trucking of coal from the pit area to Whitehorse Copper. The road maintenance was carried out by W.C.C. using their own Wabco grader and a Caterpillar D-8 rented from Gunrunner Trucking Ltd. Other activities utilizing this equipment included snow removal and assistance with the mobilization and demobilization of the mining equipment.

### 4.3 Surveying

Surveying duties were contracted to Terra Scan Technical Consultants and were performed by Mr. D. Clark. The pit area was surveyed prior to stripping and a topographic map was produced at a scale of 1:500. Further surveys were carried out during the early stages of stripping to control the pit limits and slope of the highwall. A final survey of the pit floor was undertaken at the end of Phase I. Additional Terra Scan responsibilities included the final calculations of waste rock/overburden volumes removed during Phase I and the detailed reporting of all Phase I mining activities with associated pit maps and cross-sections. The reader is, therefore, referred to the report authored by Mr. Clark entitled "Construction Summary, Excavation for Exploration of Pit No. 1". Terra Scan also provided advice on the pit design and Mr. Clark assisted in the supervision of the overburden removal.

### 4.4 Mining

The contractor for the mining was Melberg Verrico Contracting Ltd. of Whitehorse, Yukon. Phase I, overburden/waste rock removal, was achieved using an International TD-25 bulldozer with ripper and a Caterpillar 631-B scraper. Phase II, overburden clean-up and coal mining, utilized a Caterpillar 235 backhoe with a 3/4 cubic yard toothed bucket and 2 cubic yard clean-up bucket and a gravel truck (trimed capacity, 8.9 cubic metres).

The activities relating to the waste rock stripping have been reported by Clark (1986). A description of the coal mining stage (Phase II) is presented below, in Section 5.0.

### 4.5 Trucking

The transfer of coal from the stockpiles at the pit to a smaller stockpile near Whitehorse Copper was carried out by two gravel trucks supplied by Carcross Indian Band Construction Ltd. Trucking began on November 1st and finished on November 5th. A total of 20.5 loads were hauled, totalling approximately 300 tonnes. The last load shipped from the pit area comprised a 14 - tonne "bulk" sample which was subsequently sent to Calgary for detailed testing.

### 4.6 Project Management and Primary Contractors

Geological services, pit planning and supervision of all pit activities were provided by Mr. J. Perry, P. Geol. (Coal-Ex Consulting Ltd.). Overall program control and supervision of road maintenance was conducted by P. Poggenburg (W.C.C.).

The personnel and primary contractors who contributed to the 1986 program are listed below:

**Whitehorse Coal Corp.**

| | |
|---|---|
| P. Poggenburg | Project Manager |

**Consultant**

| | |
|---|---|
| J.H. Perry, P. Geol. | Coal-Ex Consulting Ltd.<br>Suite 806 - 402 West Pender Street<br>Vancouver, B.C.<br>V6B 1T6 |

**Contracting Companies**

| | |
|---|---|
| Terra Scan Technical Consultants<br>302 Jarvis, Whitehorse<br>Yukon<br>Y1A 1A3 | Surveying, waste rock volumes, consultation on pit design, assistance with supervision of stripping, reporting of phase I activities. |
| Melberg Verrico Contracting Ltd.<br>P.O. Box 4332<br>Whitehorse, Yukon | Mining contractor; minor road maintenance. |
| Gunrunner Trucking Ltd.<br>Whitehorse, Yukon | Caterpillar D-8 for road maintenance. Operator provided by W.C.C. |
| Carcross Indian Band Construction Ltd.<br>Carcross, Yukon | Hauling of coal from pit area to Whitehorse Copper and Calgary, Alberta. |
| Birtley Coal and Minerals Testing<br>505 - 50th Avenue, S.E.<br>Calgary, Alberta | Coal testing: 14-tonne "bulk sample" |
| Chemex Labs Ltd.<br>212, Brooksbank Avenue<br>North Vancouver, B.C.<br>V7J 2C1 | Coal testing: channel samples |

## 5.0 MINING

### 5.1 Site Selection and Pit Design

The general site for the test pit was pre-determined by Whitehorse Coal Corp. prior to the 1985 drill program. This location was selected based upon results obtained from a large bulldozer cut on the eastern nose of West Hill which exposed a significant section of Coal Zone B. Other major factors which determined the general pit location were:

- access;
- ease of excavation; and,
- proximity to suitable areas for waste disposal.

The 1985 drill program was designed to provide a coal reserve for future mining by establishing geological control over the seam stratigraphy and by determining the coal quality from fresh coal samples.

Prior to the 1986 field program, the data provided by Carlyle (1985) was reviewed by Coal-Ex. In conversations with Mr. P. Poggenburg during the review period it was concluded that, subject to field confirmation, the primary location for the pit was between holes 85-3 and 85-6. Factors influencing this conclusion included:

i) the correlation of the seam stratigraphy between holes 85-3, 4, 5 and 6 and the lack of the main seam in hole 85-1;
ii) the steeper topographic slope east of hole 85-3;
iii) the presence of thicker conglomerate east of hole 85-3.

Field examination of the drilled area by J.H. Perry and P. Poggenburg confirmed the final pit location; namely, that the headwall be centered between holes 85-4 and 85-5 and the eastern and western wing walls extend towards holes 85-3 and 85-6, respectively.

Prior to the field program, Whitehorse Coal Corp. outlined the broad scale and scope of the project. Prelimiary pit design was then undertaken by Coal-Ex using the data supplied by Carlyle (1985). Initial waste rock volumes were estimated at 14,250 cubic metres, based upon a 60° highwall slope. In-situ coal reserves were estimated at 7,600 tonnes using a coal seam thickness of 2.5 metres and a specific gravity of 1.8.

Additional design was carried out subsequent to the topographic survey of the pit area. Waste volumes and in-situ coal tonnages calculated at this stage were 13,650 cubic metres and 7,300 tonnes, respectively. Adjustments to this pit plan were necessary once the initial phase of highwall development had been carried out. A bench was added along the deepest section of the highwall to reduce the volume of waste rock and for safety considerations. Final estimates for ultimate waste rock and in-situ coal resources were calculated at 16,600 cubic metres and 7,450 tonnes respectively. The waste rock volumes were considered to be accurate to ± 20%, depending upon the dip of the coal seam. Coal reserves were based upon a 2.5 metre seam thickness and an estimated specific gravity of 1.8; 2,200 tonnes were estimated to be oxidized and/or mixed with soil leaving a potential 5,250 tonnes of "product" coal. No assumptions of coal quality were made.

### 5.2 Overburden/Waste Rock Removal (Phase I)

Stripping of the overburden/waste rock formed Phase I of the pit development. As this portion of the program has been described by Clark (op. cit.) it is not dealt with here. At the end of Phase I the amount of overburden removed was calculated by Terra Scan to be 16,109 cubic metres. Further discussion of residual overburden volumes removed subsequent to Phase I are presented in Section 5.3.

### 5.3 Coal Mining (Phase II)

Phase II consisted of three components:

i) exposure of the coal seam along the lip, or outer limit, of the pit;
ii) removal of residual overburden/waste rock; and,
iii) coal mining.

Prior to coal extraction some time was spent in completing the "facing up" of the coal seam along the front, or lip, of the pit. An approximate length of 65 metres had been excavated at the western end of the pit during the final stages of Phase I. Intermittent work by the backhoe over a period of several days completed this work for all but the easternmost 20 metres of the pit front. Initially, all the loose waste material piled over the coal subcrop by the Phase I stripping was removed. This was followed by the removal of the original soil and till horizons which overlay the coal. Most of this material was sidecast away from the pit, although some was hauled away by dump truck. Approximately 400 cubic metres of overburden were removed during this operation.

The removal of residual overburden/waste rock was carried out in conjunction with the coal mining. The original plans called for mining to begin at the west end of the pit and then proceed towards the east. The floor of the resulting excavation would have sloped towards the highwall and also towards the western end, providing natural drainage for surface run-off and snow melt. Work in this area was quickly abandoned, however, primarily due to the relatively large amount of waste rock which remained above the main seam. The Phase I stripping was planned to stop at or just above the first showing of coal once a certain depth had been reached. At the west end of the pit, this point was subsequently found to represent a thin coal and coaly shale zone which lay approximately one to 1.5 metres above the main seam. Other geological factors, such as the presence of many intrusive bodies and possible structural complexities, combined with time constraints to precipitate a change in the mining plans. The work at the western end of the pit resulted in the removal of some 150 cubic metres of material;

approximately 50 cubic metres of this represented the coal and coaly shale band. This material was kept to provide a base for the product coal stockpiles.

Prior to the excavation of a new coal face, the backhoe removed some 60 cubic metres of rock from the back of the western half of the pit. This rock "wedge" abutted against the highwall making it impossible for the scrapper to mine.

The new production face was excavated downhill from drill hole 85-4. A cut was established across the width of the pit and subsequent mining proceeded by face retreat towards the west. This was to have been achieved by having the bucket of the backhoe work in an up-dip and/or down-dip direction. Such a method would have provided an optimum combination of control and productivity, resulting in a minimum of coal loss and rock contamination. Two factors prevented this approach, however, and the hoe was obliged to dig along the general strike of the coal seam. These factors were:

- the presence of a 5 metre wide permafrost zone along the front of the pit; and,
- the presence of a sharp "roll" or fold within the coal seam near the back of the pit. The trend of this structure was sub-parallel to the highwall and as a result the roll stayed within the pit for some distance.

As the permafrost zone significantly reduced the recoverable coal within this part of the pit, it was necessary to mine right back to the highwall. This entailed mining the area affected by the structural roll; a situation that would have otherwise been avoided during this program. The mining proceeded with great care to avoid rock contamination particularly by orange-coloured rock bands encountered at the top and, later, near the bottom of the coal seam. However, mining in this fashion was time consuming.

Throughout most of the mining the backhoe sat above the working face and loaded into the dump truck which was either positioned in the pit bottom or behind the hoe, on top of the coal seam. The sequence of mining involved the following steps:

a) removal of residual overburden and waste rock with little or no intermixed coal to the dump;

b) removal of intermixed coal and waste rock to stockpile #3 for base material and/or for later beneficiation;

c) coal and orange coloured rock bands stockpiled for later coal beneficiation (stockpile #4);

d) loose coal obtained from atop the permafrost zone, coal obtained from the initial cut area, downhill from hole 85-4, and any coal with relatively large amounts of intermixed carbonaceous claystone to stockpile #1 as "high-ash product";

e) the main portion of the coal seam to stockpile #2 as product;

f) large lumps of permafrost material to stockpile #5. This was mainly intermixed coal and carbonaceous shale, saved for later addition to stockpile #1.

The mining of coal from the second face began on October 25th and concluded November 4th; a period of 11 days. A total of 239 truck loads were hauled to the various stockpiles; loads of waste rock taken to the dump were not tallied. The daily range in stockpiled loads was quite variable (from 12 to 27) due, primarily, to the amount of residual waste material removed and to equipment problems. An estimate of the various tonnages present in each stockpile is presented in Table 5.1. Approximately 3,290 tonnes were stockpiled; some 1,885 tonnes comprise "product" coals contained within stockpiles 1 and 2. Stockpile #1 is anticipated to have a higher ash content than stockpile #2 and, consequently, may be better suited for use within the fluidized bed combustor planned for the Yukon College than for other, more conventional, industrial or domestic uses.

**TABLE 5.1**

**Estimates of Stockpiled Tonnages**

| Stockpile No. | Loads | Est. Volume (cu. m.) | Estimated Tonnage |
|---|---|---|---|
| 1. (product) | 66 | 470 | 845* |
| 2. (product) | 81 | 577 | 1,040* |
| 3. | 12 | 85 | 185** |
| 4. | 77 | 548 | 1,180** |
| 5. | 3 | 21 | 40* |

Note: i) all volume estimates are based upon a full load, trimmed to the top of the gravel box (8.9 cu. m), factored by 0.8.

ii) * estimated specific gravity = 1.8

iii) ** estimated specific gravity = 2.15

The volume of waste rock removed from above the coal over the mined area was approximately 140 cubic metres. Therefore, the total overburden/waste rock removed from the pit during phase II was 750 cubic metres.

# 6.0 GEOLOGY

## 6.1 Introduction

Prior to the 1986 field program, data on the coal seam stratigraphy of the West Hill area came from six rotary drill holes and several cat-trenches. No detailed seam descriptions were available and, as no cores had been taken, the most reliable information was provided by the down-hole geophysical logs.

The seam targetted for the trial mining was fully defined in four of the drill holes (85-3 to 85-6); it was not present in hole 85-1 and hole 85-2 was collared at or near the seam floor. Seam thicknesses in holes 85-3 to 85-6 varied from 3.35 metres (hole 85-5) to 4.27 metres (hole 85-3). These are apparent thicknesses; Carlyle (1985) assigned dips of 30° and 32° to the seam, across the proposed pit area. True thicknesses were, therefore, projected to range between 2.90 and 3.62 metres. Variations in the character of the coal seam, as portrayed by the "density" geophysical logs, were due to differences in the number and thicknesses of in-seam rock bands. These bands were estimated to range in true thickness from a few centimetres to 0.80 metres.

No data was available on the geologic structure of the area except for occasional beddings obtained from outcrops over the southwestern flanks of West Hill.

## 6.2 General Pit Geology

Before stripping commenced outcrops and road cuts in and around the pit area were examined. The surface distributions and thicknesses of the major lithologies were found to be in broad agreement with those projected from the geophysical logs. No folds or faults were noted. Bedding orientations were, however, quite variable with dips ranging from 10° to 48° to the west, northwest, north and northeast. Some of this variability was due to the presence of cross-bedding within the conglomerates, sandstones and siltstones. In addition, irregular bedding surfaces were common within the finer grained (siltstone and shale) lithologies. These strata exhibited a high degree of jointing and fracturing; some of the latter was undoubtedly cleavage. The siltstones and shales also showed a marked tendency for concentric weathering. All of these factors made structural observations difficult. Several patches of orange-coloured rocks were noted. These represented weathered, highly-altered igneous intrusions. The relationships of these bodies to the bedding was not always visible; in two cases they appeared to be dykes.

Coal is exposed in the side and floor of a large excavation east of the pit area at the location of drill hole 85-2. Detailed examination of this coal-bearing sequence was prevented by a heavy snowfall. Preliminary observations indicated that the sequence had been subjected to strong deformation as evidenced by large amounts of shearing, small-scale disharmonic folding and the presence of a strong, penetrative cleavage. Interestingly, not all of the strata were affected by the small-scale folds. Some layers of hard coal and several orange-coloured rock bands appeared relatively planar, exhibiting only minor warps.

Geological observations were made during Phase I, as time permitted. No detailed mapping of the pit was undertaken, however. The stratigraphic sequence exposed in the highwall above Coal Zone B was composed of lenticular siltstones and arkosic sandstones with thin interbeds of shale, carbonaceous shale and coaly shale. These were overlain by a thick channel conglomerate which formed the highest rock unit exposed within the pit. The orange-weathering igneous rocks originally exposed in road cuts across the hillside, were found to represent thin (0.25 to 2.0 metre) dykes. Other thin, discontinuous sill-like bodies were occasionally located along the bottom half of the highwall. Sills were commonly found immediately above, within and below the main coal seam (see Section 6.3). Some of these may have been fed by shallow dipping dykes similar to those exposed in the permafrost zone along the front of the pit, approximately 30 metres from the pit's western end. Alternatively, these shallow dipping intrusions may represent discordant "steps" which take the sills from one stratigraphic horizon to another.

Bedding measurements on strata exposed within the highwall were variable, similar to those already described. They were generally shallow (10° to 30°) and many dipped towards the northwest. Cross-bedding and/or poorly developed bedding again presented difficulties in obtaining many reliable readings. A zone of highly disturbed and fractured rock is found within the pit. This zone extends across the western pit floor and intersects the highwall near the centre of the pit, rising across the highwall to the east. Preliminary examination of this zone suggests that it probably represents a fault or sharp structural roll which dips into the highwall at 50° to 65°. The disturbed zone is approximately 5.5 metres wide; the central 1.5 metres are highly tectonized with much soft, white, "chalky" secondary mineralization (calcite?) or the fracture surfaces. This zone of deformation and the general variability in bedding undoubtedly reflect structures similar to, or the same as, those later exposed within the coal seam (see Section 6.3.3).

### 6.3 Coal Seam Geology

This section briefly summarizes some of the more important aspects of the coal seam geology as observed within the test pit.

#### 6.3.1 Seam Stratigraphy

The opening of the coal face below hole 85-4 presented the first opportunity to examine the full coal section in any detail. Observations within the "coal-mining" area (that portion of the pit from which coal was mined) and from atop the main seam at the pit's western end, indicate that the character of the coal seam closely reflects the patterns presented by the drill holes. In other words, while there is considerable seam vâriation in an east-west direction there is little variation in a north-south direction. Seam sections in the pit correspond relatively well to those presented by the geophysical logs of holes 85-4 and 85-5. A measured section located 17 metres west of the east wall of the "coal-mining" area was 3.24 metres thick compared to 3.81 metres for the seam in 85-4. Most of the difference in thickness is probably due to two factors: i) the top of the measured section may correspond to a rock band located within the uppermost parts of the coal seam in 85-4 (possibly at a depth of 97 feet), and is not, therefore, the seam roof sensu-stricto, and ii) the measured section recorded true thickness while the drilled section most probably represents apparent thickness. A seam section located 36 metres from the east wall, southeast of hole 85-5, was slightly thicker than the drilled section (3.81 metres compared to 3.35 metres). In this portion of the pit the seam characteristics are transitional between those exhibited by hole 85-4 and those of hole 85-5. Precise correlation of the seam roof between measured sections and the drill holes is difficult. It should be noted that correlations of the coal seam are hindered by the lack of detailed-scale (1:40) geophysical logs; only general-scale (1:100) logs were run in 1985. At the westernmost limit of the "coal-mining" area rock band distribution within the seam is similar to that exhibited by hole 85-5; no measured section was obtained from this point due to the rapid termination of activities. At the western end of the pit, the characteristics of the seam roof correspond closely to those portrayed by the "density" log of drill hole 85-6. It is to be supposed that the full coal seam would also show characteristics similar to those presented by this geophysical log.

Coal within the main seam ranges from being very hard, forming large lumps or slabs, to extremely friable and highly sheared, forming small pieces and powder. These physical characteristics exist at various horizons within the seam and are mirrored by some of the rock bands. The coal varies in appearance between dull-grey, shiny steel-grey and black. It generally increases in "blackness" with depth of cover; where the seam lay closest to the original topography most of the coal was grey. At the western end of the "mining" area, however, a thin coal split below the main seam possessed a steel-grey tone while most of the overlying coal was black. In most high rank coal seams, a very hard, grey coal typifies boney (high-ash) coal. While this type of coal is present within the main seam, unsheared slabs and lumps of ordinary coal also exhibit these features. The hardness is typical of anthracite and the grey-colour may be due to oxidation and/or the effects of permafrost. From the measured sections, boney, stoney and baked coals make up about 18% of the seam, lower ash coal comprises 55% to 62% and rock bands form 20% to 27% (see Appendix I).

Rock bands contained within the main seam are composed of a variety of shaley claystones and altered igneous instrusives (as sills). The claystones are commonly carbonaceous but sometimes contain little or no carbonaceous material; they may also be silty. Thicknesses range from less than one centimeter to 0.22 metres. The intrusive igneous bodies are sills; they are conformable to bedding and have baked the coal and/or claystone adjacent to both their upper and lower surfaces. These sills range in thickness from several centimetres to 0.40 metres; they are relatively continuous and terminate abruptly. As a result of post-emplacement tectonics, they may form en-echelon strips and exhibit boudinage. They are typically orange to buff coloured along their upper and lower surfaces (or throughout, where very thin) and along major joint surfaces. On freshly broken surfaces, particularly within the thicker bands, they are whitish to light grey. The sills within the main seam were all altered to fine clays and quartz with occasional rusty, weathered pyrite. At the western end of the pit in a thick sill immediately above the main seam, large round boulders of light coloured, fine-grained igneous rock (possibly rhyolitic) are contained within an altered clay-rich matrix similar to that found in the thinner sills.

It is important to understand the distribution and lateral extent of the sills as they probably account for most of the variation exhibited by the main seam (as portrayed on the geophysical logs). In the "coal-mining" area below 85-4 a sill is located at or near the top of the main seam. Precise correlation is difficult but it probably represents the rock band present at 97.5 feet on the log of 85-4. A few metres to the west another sill is present above the first; this may be equivalent to the rock band at 96.5 feet in 85-4. Towards the west the lower of these two sills disappears after approximately 7 metres. The upper sill continues across most of the coal mining area and effectively forms the roof of the seam, although a thin coaly band usually overlies it. This sill is probably equivalent to the rock band at 117 feet within 85-5; the rock band at 121.5 feet in 85-5 also includes a sill. Within the mined area this latter sill first appeared approximately 43.5 metres west of the initial cut. At that point it lay approximately 0.3 metres below the upper sill; this widened to 0.75 metres at the western limit of the mined area. A lower sill, equivalent to part of the rock band between 124.5 and 127 feet in hole 85-5, was first encountered some 18 metres west of the initial cut. This sill persisted at this horizon the remaining length of the "coal-mining" area. It should be noted that the sills often lie in contact with or in close proximity to claystone and boney/stoney coal bands. Consequently, the rock bands indicated on the geophysical log of hole 85-5 are not solely composed of altered igneous rock. The lithologies in contact with the sills have been baked along both the upper and lower contacts. These baked zones are commonly 0.05 to 0.12 metres thick but the thermal effects may extend to slightly greater thicknesses. This alteration results in ubiquitous columnar jointing and leaves the various lithologies somewhat brittle. While baked claystones can be differentiated from coal, the thermal alteration masks the true character of the coal which makes it difficult to distinguish one coal type from another. The sills within the uppermost portions of the main seam can be seen at the site of hole 85-2 approximately 120 metres east of the "coal mining" area. They are somewhat thinner at this location. Throughout the "coal-mining" area the floor of the main seam consists of a shaley claystone. Below this are other thin sills and claystones with interbeds of coal.

### 6.3.2 Structure

From south to north across the "coal mining" area the main structural features are:

i) along the front of the pit the beds exhibit a shallow dip (less than 10°) towards the south;

ii) they are gently folded to dip between 12° and 18° to the northwest. The fold axis plunges approximately 10° to N.075;

iii) dips steepen, ranging from 20° to 25° with localized warps of 40° to 46°; the direction of dip varies from west-northwest to north-northwest;

iv) the beds are sharply folded about an axis which plunges at approximately 10° to N.255° to 265°. Beds north of this axis dip steeply (65-72°) to the northeast. This fold trends into the headwall and its effects are not evident in the western two-thirds of the "coal-mining" area.

The shallow southerly dips and most of the shallow northwesterly dips lie within the permafrost zone. Most of the pit covers the moderately (20°-25°) northwest dipping portions of the seam. The steep northeastern dipping section of the coal seam is mainly restricted to the eastern third of the mined area; the axial trend of this anticlinal fold intersects the highwall approximately 18 metres from the start of mining. As a result, the zone of steeper dip disappears into the highwall.

Other structures contained within the coal seam included: zones of heavy shearing and disharmonic folding, low-amplitude short-wavelength warps, several joint sets, cleavage and boudinage of the sills. No detailed study of these structures was undertaken.

### 6.4 Remaining Coal Reserves - Pit Area

No detailed calculations have been made to determine the coal reserves that remain within the pit. A quick approximation based upon the same assumptions that were made in Section 5.1 suggests that a potential 2,150 tonnes of "product" (selectively mined raw coal) may be available. The original estimate of 2,200 tonnes for oxidized coal and coal mixed with soil has been increased to 3,650 tonnes to take the permafrost zone into account. These figures have been adjusted for the area already mined. No comparison between theoretical tonnage estimates and recovered tonnages has been carried out.

## 7.0 SAMPLING AND TESTING

A number of samples were taken during the program. The different sample types are discussed in Section 7.1 while the results of the testing are discussed in Section 7.2.

### 7.1 Samples

The test mining - bulk sample program produced approximately 1,885 tonnes of "product" coal. While this coal can be considered a bulk sample for supply to potential customers a number of other samples (including a smaller "bulk" sample) were taken for geological and control purposes. These samples were obtained as channel and grab samples from within the pit and as random samples from the main stockpiles. They are described in Appendix I.

The main objectives in sampling the coal seam within the "coal-mining" area were:

a) to provide independent "check" samples of the coal going to the product stockpiles (that is, stockpile #1 and #2);

b) to provide independent check samples of the coal going to form the 14-tonne "bulk" sample; and,

c) to determine the variability of coal quality within the seam, both laterally and vertically, and to ascertain the character of the seam as a whole.

Objective a) was not successful for stockpile #1 due to the erratic thicknesses and poor definition of the material which overlay the permafrost zone. Some of this material went to stockpile #1 while some went to stockpiles 3, 4 and 5. Sample 13 may have to suffice for stockpile #1 although samples 1 and 2 characterize a lot of the coal sent to this stockpile during the early stages of coal mining. Most of the material sent to stockpile #2 is characterized by samples 5 to

12 (one-third) and samples 16 and 16A (two-thirds) (item b), as well as by the stockpile sample (14).

At the end of the program a "bulk" sample of approximately 14 tonnes was obtained from coal set-aside for this purpose. This sample was intended to undergo detailed analysis and pilot-plant washing. As a result, the sample was required to reflect the run-of-mine coal that would be obtained from taking the whole seam (inclusive of rock bands) as opposed to coal obtained from selective mining. The resulting sample was collected from two sets of material, namely:

i) the coal taken from the section described by samples 5 to 12;

ii) coal taken from the section described by samples 16, 17 and 18.

The former material (i) was stored at one corner of stockpile #2 while the latter material (ii) was stored alongside stockpile #1. To reflect the general distribution of tonnage within the mined area the "bulk" sample was composed of one-third (i) and two-thirds (ii).

The samples, 1 to 4 and 19, were taken for geological purposes (item c) while sample 15 represents stockpile #4. Four additional samples (A to D) were taken from some of the sills and baked margins of the host coal and/or claystone. These samples were obtained to test for anomalous elements such as precious metals.

### 7.2 Results of Coal Testing

Prior to the end of mining, it was intendend that most of the samples would undergo comprehensive testing and analysis. However, budget constraints shortened this part of the program. Consequently, only a few of the samples were examined; the scope of the laboratory work was also reduced. The results of the testing are discussed below; certificates of analysis are presented in Appendix II.

Samples 1 to 12 were sent to Chemex Laboratories Ltd., Vancouver for preliminary analysis whilst coal mining continued. Samples 1 to 4 were intended to provide quick data on ash, moisture and heat contents. The higher moisture levels observed in sample 1 (total moisture = 19.1%, residual moisture = 8.01% a.d.b.) probably reflect incipient permafrost in the top portions of the seam at this location. The ash contents of samples 2 and 3 are incongruous; sample 3 should contain less ash than sample 2 as the latter included a thick claystone band which was omitted in the former. Sample 4 was taken from part of the coal seam which contained several claystone and boney coal bands. It is possible that the results from samples 3 and 4 were interchanged; Chemex believes this to be unlikely.

Slightly more detailed analyses were undertaken on samples 5 to 12. These represent incremental (or ply) samples taken across the entire seam. They were submitted for preliminary proximate analysis, sulphur and heat content determinations. Residual moisture contents range from 2.12% to 4.56% (a.d.b.); it is interesting to note that moisture contents show a marked decrease from the seam top to floor. Ash contents range widely, from 20.35% to 61.51%, (a.d.b.), and correspond to the predominant material (coal or rock) which make up the ply samples. Volatile contents are consistent with coal of anthracite rank although samples 5 and 6 are slightly high. Sulphur content is very low, varying between 0.31% and 0.54% (a.d.b.). Heat contents are reasonably high considering the ash contents and reach 14,000 Btu/lb. on a moist, mineral matter-free basis (sample 8). Not all the samples burned to completion during the heat content determinations. Samples 5 and 7 were re-run using benzoic acid to aid the combustion process. This resulted in an increase in Btu's for each sample; sample 5 increased from 10,116 to 10,297 Btu/lb. and sample 7 from 7,525 to 8,017 Btu/lb. (a.d.b.). If the air-dried heat content of sample 8 is increased by approximately 180 But's/lb., similar to sample 5, then the moist, mineral-matter free Btu's increase to 14,250 per lb.

The determination of specific gravities for samples 5 to 12 would allow weighted averages to be made for each of the various analyses thus providing data for the seam as a whole at this particular sample location. An estimated composite of samples 5 to 12 indicates that the full seam section could have a raw ash content of approximately 34% (a.d.b.). No further analyses have been carried out on these samples, however, and samples 13 to 19 and A to D have not yet been tested.

The "bulk" sample sent to Calgary went to Birtley Coal and Minerals Testing. The sample was homogenized and large lumps were broken by hand to 8 inches. Representative sub-samples were taken for raw head analysis and screening. The raw head sub-sample was crushed to 3/4" and analyzed for proximate, sulphur and heat content. The results indicate that this raw, run-of-mine coal has a residual moisture of 1.9% and 45.4% ash, 8.4% volatiles, 44.3% fixed carbon and 0.36% sulphur (a.d.b.). The heat content is reported at 5,735 Btu/lb. (3,186 cal/gm) or, with benzoic acid, 6,904 Btu/lb. (3,836 cal/gm) on an air dried basis.

The sub-sample for screening filled six 45-gallon barrels. This material was crushed to pass 4" and then screened into nine fractions between 4" x 0. The results are fairly uniform throughout the various size fractions. Recoveries (by weight) varied from 6.2% (4" x 2") to 19.7% (1/2" x 1/4") although five of the size fractions ranged between 10.4% and 12.9%. Only 7.8% of the material passed 28 mesh while 17.3% fell between 4" x 1".

Residual moistures are all less than 1.8% except for the 1/16" x 28 mesh and 28 mesh x 0 with 11.5% and 13.2% (a.d.b.), respectively. These high values are probably due to either incomplete drying or the presence of clays that retain water molecules within their lattice structure. The ash contents of the various size fractions vary only slightly, from 42.5% (4" x 2") to 47.3% (2" x 1"). There are no trends towards lower ash contents in either the coarser or finer sizes. There are only small ranges in sulphur and heat contents.

Upon review of the screening data three composites were formed and readied for further testing. Three composites were made from the 4" x 28 mesh fractions these were; 4" x 1" (17.3% by weight), 1" x 1/4" (39.6%) and 1/4" x 28 mesh (35.3%). These composites were subjected to float: sink testing at specific gravity cut points of 1.50, 1.60, 1.70, 1.80 and 1.90. The 28 mesh x 0 fraction underwent froth flotation testing. The detailed results of this work are presented in Appendix II. These results indicate that the "bulk" sample provides very little coal of less than 20% ash. Theoretical values of ash and yield at a 1.8 S.G. cut are 22% and 33.6%, respectively. At a 1.9 S.G. cut, the values are ash = 27.08%, yield

= 49.6%. The results of the froth flotation indicate there is very little recoverable coal within the 28 mesh x 0 fraction.

Two samples were composited from the floats of the preceeding tests; one sample was from coal that reported to the floats at 1.8 S.G. and the other from coal floating at a 1.9 S.G. cut. These samples underwent proximate analysis, and sulphur and heat content determinations. On an air-dried basis the results from the 1.8 S.G. composite were: residual moisture = 1.9%, ash = 22.7%, heat content = 10,590 Btu/lb. (5,882 cal/gm). The 1.9 S.G. composite results were: residual moisture = 2.0%, ash = 27.0%, heat content = 9,810 Btu/lb. (5,448 cal/gm). The heat contents were determined using benzoic acid as an aid to combustion. As a prelude to more detailed analyses these two samples were tested for their ash fusion temperatures. The purpose of this was to see if there were potential slagging problems associated with the higher ash sample. Both samples show high initial deformation temperatures under reducing conditions (1.8 S.G. composite = 1349°C; 1.9 S.G. composite = 1393°C); the 1.9 composite always exhibits the higher temperatures. No further testing has been performed on the "bulk" sample.

It should be remembered that these tests were performed upon a sample that included all in-seam rock bands. Similar tests on selectively mined coal or blends of selectively mined and bulk mined coal may product significantly better washability results.

## 8.0 SELECTIVE MINING - DISCUSSION

One of the primary objectives of the test mining program was to provide a sample coal product to potential customers. As no coal washing plant was available, it was decided to utilize selective mining for "in-pit" cleaning. It was hoped that the removal of some of the thicker rock bands from the coal seam would lower the ash content significantly. Until the appropriate analyses have been performed it will not be possible to precisely determine how successful the mining was in this goal.

Some of the main factors that affected the efficiency of the selective mining during the 1986 program were:

(a) the presence of deep permafrost along the front of the pit;

(b) structural complexities within the coal seam;

(c) rock band recognition by the hoe operator;

(d) rock band hardness and the presence of permafrost bands within the seam; and,

(e) equipment suitability.

Some of the difficulties associated with items a) and b) have been discussed in Section 5.3. One additional point is that while the pit floor over the first 18 metres of coal mining was relatively flat once mining advanced beyond that, to the western flank of the anticlinal fold, the roof and floor of the seam pitched to the northwest. Consequently, the hoe had to shift its position constantly to obtain a relatively level surface from which to mine. Quite often the backhoe had to build its own operating pad.

Rock band recognition by the hoe operator (item c) was relatively straightforward for the orange-coloured sill rock. Without the aid of the geologist in the pit, however, it would have been impossible for the operator to have distinguished grey coal from grey claystone or black coal from dark grey to black claystone. The hardness of the rock bands and two permafrost bands within the coal seam (item d) provided more difficulties for the backhoe. Almost all of the coal mining was done using the 2 cubic yard clean-up bucket. Usually, it took several attempts to break the rock bands away from the coal face. Once the rock band broke the residual pull on the bucket often resulted in several cubic decimetres of good coal being taken with the rock (which is why this material as sent to stockpile #4). This was also the case for a permafrost band present within the top layer of coal, immediately below the seam roof. Also, it was never possible to selectively mine the lowermost coal band (below the lower sill), equivalent to sample 18. This was due to three reasons: i) permafrost in the coal, ii) lack of room, and iii) the difficulty in removing the lower sill (which often resulted in taking most of the lower coal band with it).

With regard to item e), it is unlikely that any one piece of equipment would be entirely suitable for mining under the conditions experienced within the test pit. However, if only one piece can be had, the Catepillar 235 backhoe is probably the best suited for operations of similar scale and scope in areas of similar geological complexity to that of the 1986 test pit. The use of the straight-edged clean-up bucket for selective mining is preferred over the toothed bucket if control over rock contamination is paramount. However, the clean-up bucket was slow in removing the main rock bands. If larger areas of just rock or coal were to be mined then bucket changes could be utilized; these take time by hand, and are not easy. To increase speed, teeth could be added to both sides of the clean-up bucket. The 3/4 cu. yd. toothed bucket can be used when coal loss and/or rock contamination are within acceptable limits, or are not of primary importance. The use of this bucket would result in higher face productivity.

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## 9.0 CONCLUSIONS

From the preceeding sections of this report, the following conclusions are drawn:

- The main coal seam present within Coal Zone B in the West Hill area is laterally continuous over several hundred metres.
- The seam stratigraphy within the test pit correlates with the drill holes.
- Most of the in-seam variations shown on the geophysical logs of the 1985 drill holes are due to igenous intrusions (as sills).
- Further mining within the stripped area will probably be restricted to the back half of the pit because of a permafrost zone along the front.
- Selective mining in the central portions of the pit, downhill from hole 85-5, will be difficult due to the thinner coal splits.
- Conditions for selective mining should improve towards the western end of the pit, but more rock will have to be removed to expose the main seam.
- Selective mining can be employed east of presently mined area. Permafrost may prevent mining in the far eastern corner of the pit.
- Additional reserves are available between the highwall and the drill holes. Further work will be necessary to evaluate the feasibility of their recovery.

Conclusions drawn from the preliminary coal analyses should be treated with caution due to the limited data available. The few analyses performed to date indicate that:

- Coal that has not been selectively mined but which includes all the rock bands, is relatively high in raw ash (45.4%). The raw ash in any one part of the mined area may be as low as 34%.

- It is unlikely that crushing and screening of such raw coal would significantly reduce the ash content.

- Float-sink analyses on this sample yield very low recoveries of coal with less than 20% ash; at 27% ash theoretical recoveries are approximately 50%.

- In order to obtain a lower ash product and higher wash plant recoveries it may be necessary for operations in the West Hill area to wash selectively mined coal only or to blend bulk mined and selectively mined coals.

- Predictions of possible ash contents for product coal(s) obtained solely by selective mining must await additional coal testing and analysis.

## 10.0 RECOMMENDATIONS

If W.C.C. intends to continue mining along the West Hill area, we recommend that:

- All samples that have not yet been examined should undergo preliminary testing.

- Based upon the preliminary test results additional, comprehensive analyses should be undertaken. These analyses should determine the coal and ash characteristics for washed, screened and raw coal at various size fractions. Such data will enable decisions to be made regarding selective and/or bulk mining, crushing and screening or washing to produce a saleable product.

- The testing of the 14-tonne bulk sample should continue. Pilot plant coal washing should await the results of the preliminary analyses.

- Geological mapping be carried out within and adjacent to the pit, with particular emphasis on structural geology.

- Further drilling should be conducted both within the existing stripped area and to the west, north and east to confirm the amounts of additional reserves and to provide data which will aid the mining plan. Such a drilling program should be capable of providing cored holes; all holes should be geophysically logged.

- The coal "seam" immediately below the main seam should be evaluated with respect to its reserve potential and coal quality. This should form part of an overall search for nearby low-ash coal for possible blending purposes with the product coal from the existing pit.

It is further recommended that:

- Detailed surface geological mapping be undertaken across all of the northern coal mining leases.
- This mapping should be followed up by trenching and drilling.

**Submitted by:** **JHP COAL-EX CONSULTING LTD.**

J.H. Perrry, P. Geol, F.G.A.C., F.G.S.

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# APPENDICES

# APPENDIX I

## SAMPLE DESCRIPTIONS

## SAMPLES 1 TO 3

Most of this coal section is composed of rubbly coal and claystone and powdered coal. Slabs and lumps representing more coherent strata are present near the base of the section.

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| | | Top of section lies several centimetres below projected base of upper sill. |
| | 0.23 | Coal - powdered. |
| | 0.08 | Coaly Claystone and Coal - mixed pieces and powder. |
| | 0.54 | Coal - pieces and powder; some carbonaceous claystone pieces. |
| | 0.20 | Coal - powder. |
| #1 (1.99m) | 0.10 | Coal - pieces, with some stoney coal pieces. |
| | 0.27 | Coal - powder and pieces. |
| | 0.09 | Coal - heavily sheared, listric surfaces. |
| | 0.09 | Coal - powder. |
| | 0.10 | Claystone - light-bluish grey, broken. |
| | 0.10 | Coal - sheared, powdered. |
| | 0.09 | Carbonaceous Claystone - brown weathering, dark grey when fresh. |
| | 0.10 | Coal - powdered. |
| | 0.16 | Stoney Coal - fissile, highly sheared pieces. |
| #3 (1.07m) | 0.15 | Carbonaceous Claystone - pieces, sheared. |
| | 0.15 | Coal - pieces, sheared. |
| | 0.13 | Coal - lumps. |
| #2 (1.66m) | 0.05 | Coal - powdered. |
| | 0.10 | Claystone - bluish-grey |
| | 0.02 | Coal - powdered. |

Samples 1 to 3 Continued

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| #3 (1.07m) | 0.07 | Claystone - bluish-grey. |
| | 0.11 | Coal - powdered. |
| | 0.13 | Coal - lump. |
| | | ----- Floor or main seam ----- |
| #2 (1.66m) | 0.10 | Claystone - bluish-grey |
| | 0.05 | Coal. |
| | 0.09 | Claystone - bluish-grey |
| | 0.06 | Coal. |
| | 0.22 | Claystone - bluish-grey. |
| | 0.07 | Coal - lump. |

**Samples #1, #2 and #3** are channel samples across the seam. Sample #2 extends into the floor of the main seam. The seam floor (base of Sample #3) is believed to correlate with the depth of 107.5 ft. on the densilog of hole 85-4. These samples were taken from the centre of the excavation approximately 3 metres west of the east face of the "coal-mining" area.

## SAMPLE #4

This is a grab sample taken horizontally across a 2.4 metre section of disharmonically folded coal seam. This sample was taken to determine the gross coal quality of a section of blocky and slab-forming coal and claystone. The location of this sample is approximately 10 metres west of the east face of the "coal-mining" area.

## SAMPLES 5 TO 12

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| | | Roof: Sill - altered igneous rocks. |
| #5 (0.27m) | 0.10 | Baked Coal - shows columnar jointing. |
| | 0.04 | Stoney Coal. |
| | 0.08 | Boney Coal. |
| | 0.05 | Stoney Coal. |
| #6 (0.56m) | 0.31 | Coal - hard. |
| | 0.04 | Stoney Coal. |
| | 0.21 | Coal - lump. |
| #7 (0.49m) | 0.09 | Carbonaceous Claystone - some stoney coal. |
| | 0.05 | Stoney Coal. |
| | 0.22 | Claystone - blocky, some carbonaceous and coaly bands. |
| | 0.05 | Coal - hard. |
| | 0.08 | Stoney Coal - large lumps. |
| #8 (0.24m) | 0.24 | Coal - with several thin claystone laminae near top. |
| #9 (0.26m) | 0.04 | Claystone. |
| | 0.04 | Sheared Claystone - with coal laminae. |
| | 0.07 | Coal. |
| | 0.07 | Claystone. |
| | 0.04 | Stoney Coal. |
| #10 (0.41m) | 0.17 | Coal - lump. |
| | 0.05 | Coal - thin claystone band near base and several claystone laminae throughout. |
| | 0.19 | Coal - many listric surfaces. |

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## Samples 5 TO 12 Continued

| Sample No. | True Thickness ( m ) | Description |
|---|---|---|
| | 0.03 | Stoney Coal. |
| #11 (0.19m) | 0.05 | Coal. |
| | 0.11 | Silty Claystone - sheared in bottom 0.03 m. |
| | 0.09 | Coal - lump |
| | 0.16 | Coal - heavily sheared |
| #12 (0.82m) | 0.07 | Stoney Coal. |
| | 0.13 | Coal. |
| | 0.09 | Claystone - dark grey. |
| | 0.28 | Coal - hard, occasional claystone and boney laminations. |
| | | -- Floor of seam -- |
| | | Claystone - same as base of Sample #3 |

These samples represent channel samples taken across the full thickness of the main coal seam. This section was located in the centre of the excavated area approximately 17 metres west of the east wall.

## SAMPLES 13 TO 15

These samples were taken from the main stockpiles. Each sample comprises several large bags which were taken at various intervals during the mining period.

| | | | |
|---|---|---|---|
| Sample 13 | (4 bags) | - | Stockpile #1 |
| Sample 14 | (6 bags) | - | Stockpile #2 |
| Sample 15 | (5 bags) | - | Stockpile #4 |

## SAMPLES 16 TO 18

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| | | Roof - altered igneous sill. |
| #16 (2.20m) | 0.12 | Baked Coal - indeterminate types; hard, columnar jointing. |
| | 0.10 | Boney Coal - grey, very hard. Could be lower ash coal baked by intrusion. |
| | 0.06 | Coal - grey, hard. |
| | 0.12 | Boney Coal - grey, very hard. |
| | 0.21 | Coal - black and grey, mixed with rusty coloured, weathered surfaces. |
| | 0.02 | Claystone. |
| | 0.06 | Coal - as above. |
| | 0.02 | Claystone. |
| | 0.25 | Coal - black, friable, sheared. |
| | 0.52 | Coal - black, very heavily sheared, listric surfaces. Could have interlayered carbonaceous claystone laminae in top third. |
| | 0.05 | Carbonaceous Claystone - soft, highly sheared. |
| | 0.19 | Coal - black, friable, sheared. |
| | 0.03 | Carbonaceous Claystone - as above. |
| | 0.29 | Coal - hard, friable. |
| | 0.16 | Coal - very hard; could be boney. |
| #16A (0.28m) / #17 (1.21m) | 0.05 | Coaly Claystone - dark grey |
| | 0.11 | Carbonaceous Claystone. |
| | 0.08 | Coal - grey, hard, could be boney. |
| | 0.04 | Baked Coal. |
| | 0.17 | Altered igneous rock (Sill). |
| | 0.11 | Baked Contact - indeterminate, probably carbonaceous claystone. |

92024

## Samples 16 TO 18 Continued

| Sample No. | True Thickness ( m ) | Description |
|---|---|---|
| | 0.15 | Carbonaceous Claystone. |
| | 0.19 | Stoney Coal - grey, very hard |
| #17 (1.21m) | 0.08 | Carbonaceous Claystone. |
| | 0.10 | Coaly Claystone - grey. |
| | 0.13 | Carbonaceous Claystone. |
| | 0.06 | Boney Coal. |
| | 0.05 | Coal. |
| #18 (0.40m) | 0.05 | Boney Coal. |
| | 0.24 | Coal. |
| | | --- Floor of Seam --- |
| | | Carbonaceous Claystone. |

These samples represent channel samples taken across the full thickness of the main coal seam. This section was located in the centre of the excavated area approximately 36 metres west of the east wall.

## SAMPLE 19

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| | | Roof - altered igneous rock (Sill). |
| #19 (0.75m) | 0.09 | Baked Claystone. |
| | 0.08 | Carbonaceous Claystone. |
| | 0.03 | Boney Coal. |
| | 0.03 | Coal - hard. |
| | 0.13 | Coaly Claystone. |
| | 0.34 | Coal. |
| | 0.05 | Boney Coal. |
| | | Altered igneous rock (Sill). |

This sample is a channel sample taken across the coal and claystone band that lies between the middle sill and the sill that forms the roof of the seam. The coal in this section is equivalent to the peak on the densilog of hole 85-5 centred about the 120 ft. depth. This sample was obtained from the centre of the excavated area approximately 47.5 metres west of the east wall.

## 14-TONNE "BULK" SAMPLE

Formed by coal characterized by samples 5 to 12 (one-third) and coal characterized by samples 16, 17 and 18 (two-thirds).

## SAMPLES A, B, C AND D

These samples were obtained for ICP analysis and fire assay purposes primarily to test their metals content.

**Sample A** : Channel sample across the first sill above the seam floor approximately 36 metres west of the east wall.

**Sample B** : Channel sample across the uppermost sill (seam roof) taken from the highwall approximately 15 metres west of the east wall.

**Sample C** : Sample of the baked rock/coal below the sill (B, above).

**Sample D** : Channel sample across a zone containing two sills projected to lie below the main coal seam. Taken from a trench excavated along the front of the pit approximately 20 metres from the western end of the pit.

| Sample No. | True Thickness (m) | Description |
|---|---|---|
| #D (1.48m) | 0.06 | Baked carbonaceous claystone. |
| | 0.55 | Altered igneous rock (Sill). |
| | 0.62 | Baked carbonaceous claystone, coal and unbaked carb. claystone and coal. |
| | 0.25 | Altered igneous rock (Sill). |

# APPENDIX II

## RESULTS OF COAL TESTING AND COAL QUALITY ANALYSES

Chemex Labs Ltd.

Analytical Chemists • Geochemists • Registered Assayers

212 Brooksbank Ave.
North Vancouver, B.C.
Canada V7J 2C1
Phone: (604) 984-0221
Telex: 043-52597

# CERTIFICATE OF ASSAY

TO : WHITEHORSE COAL CORPORATION

BOX 5478
WHITEHORSE, YUKON
Y1A 5H4

** CERT. # : A8620334-001-
INVOICE # : I8620334
DATE : 1-DEC-86
P.O. # : NONE
WHITEHORSE

| Sample description | BASIS | T.M. % | R.M. % | ASH % | V.M. % | F.C. % | SULFUR % | C.V. BTU/LB |
|---|---|---|---|---|---|---|---|---|
| SAMPLE #1 | AR | 19.1 | -- | -- | -- | -- | -- | -- |
| | A.D. | -- | 8.01 | 50.15 | -- | -- | -- | 3851 |
| | DRY | -- | -- | 54.51 | -- | -- | -- | 4186 |
| SAMPLE #2 | AR | 12.8 | -- | -- | -- | -- | -- | -- |
| | A.D. | -- | 4.47 | 50.76 | -- | -- | -- | 4823 |
| | DRY | -- | -- | 53.14 | -- | -- | -- | 5048 |
| SAMPLE #3 | A.D. | -- | 4.74 | 51.91 | -- | -- | -- | -- |
| | DRY | -- | -- | 54.50 | -- | -- | -- | -- |
| SAMPLE #4 | A.D. | -- | 4.38 | 39.63 | -- | -- | -- | 6830 |
| | DRY | -- | -- | 41.44 | -- | -- | -- | 7143 |
| SAMPLE #5 | A.D. | -- | 4.56 | 20.35 | 10.48 | 64.61 | 0.42 | 10297 |
| | DRY | -- | -- | 21.32 | 10.98 | 67.70 | 0.44 | 10789 |
| SAMPLE #6 | A.D. | -- | 4.16 | 24.64 | 10.29 | 60.91 | 0.53 | 9341 |
| | DRY | -- | -- | 25.71 | 10.74 | 63.55 | 0.56 | 9746 |
| SAMPLE #7 | A.D. | -- | 3.12 | 37.83 | 7.18 | 51.87 | 0.44 | 8017 |
| | DRY | -- | -- | 39.05 | 7.41 | 53.54 | 0.45 | 8275 |
| SAMPLE #8 | A.D. | -- | 3.00 | 23.77 | 5.89 | 67.34 | 0.54 | 10397 |
| | DRY | -- | -- | 24.51 | 6.08 | 69.41 | 0.56 | 10719 |
| SAMPLE #9 | A.D. | -- | 3.01 | 48.52 | 7.66 | 40.81 | 0.36 | 6207 |
| | DRY | -- | -- | 50.02 | 7.89 | 42.09 | 0.37 | 6399 |
| SAMPLE #10 | A.D. | -- | 2.88 | 31.17 | 5.82 | 60.13 | 0.48 | 9325 |
| | DRY | -- | -- | 32.09 | 5.99 | 61.92 | 0.49 | 9602 |
| SAMPLE #11 | A.D. | -- | 2.12 | 61.51 | 5.50 | 30.87 | 0.31 | 4409 |
| | DRY | -- | -- | 62.84 | 5.62 | 31.54 | 0.32 | 4504 |
| SAMPLE #12 | A.D. | -- | 2.73 | 34.71 | 6.56 | 56.00 | 0.45 | 8544 |
| | DRY | -- | -- | 35.69 | 6.75 | 57.56 | 0.46 | 8784 |

NOTE: Calorific values on samples 5, 7, 9, and 11 were done with benzoic acid as requested.

092024 VO! rev.

........................................
Registered Assayer, Province of British Columbi

CLIENT: WHITEHORSE COAL CORPORATION
PROJECT: BULK SAMPLE RECEIVED NOV. 20, 1986
LAB NO: 2694
DATE: DECEMBER 1, 1986

HEAD RAW ANALYSIS, air dried basis

| ADM% | MOIST% | ASH% | VOL% | F.C.% | S% | CV CAL/GM | BASIS |
|---|---|---|---|---|---|---|---|
| 11.80 | 1.90 | 45.40 | 8.40 | 44.30 | 0.36 | 3186 | adb |
| | 13.48 | 40.04 | 7.41 | 39.07 | 0.32 | 2810 | arb |
| | | 46.28 | 8.56 | 45.16 | 0.37 | 3248 | db |

ZE AND RAW ANALYSIS, air dried basis

| SIZE FRACTION | WT% | RM% | ASH% | VOL% | FC% | S% | CV CAL/GM | CUMULATIVE WT% | CUMULATIVE ASH% |
|---|---|---|---|---|---|---|---|---|---|
| 4" X 2" | 6.20 | 1.10 | 42.50 | 6.40 | 50.00 | 0.38 | 3820 | 6.20 | 42.50 |
| " X 1" | 11.10 | 1.60 | 47.30 | 7.10 | 44.00 | 0.34 | 3088 | 17.30 | 45.58 |
| " X 3/4" | 7.30 | 1.80 | 45.70 | 7.10 | 45.40 | 0.33 | 3396 | 24.60 | 45.62 |
| 3/4" X 1/2" | 12.60 | 1.30 | 46.70 | 7.80 | 44.20 | 0.34 | 2936 | 37.20 | 45.98 |
| 2" X 1/4" | 19.70 | 1.80 | 45.80 | 7.80 | 44.60 | 0.33 | 3256 | 56.90 | 45.92 |
| 4" X 1/8" | 12.90 | 1.70 | 46.80 | 8.30 | 43.20 | 0.34 | 2933 | 69.80 | 46.08 |
| 1/8" X 1/16 | 12.00 | 1.80 | 45.40 | 8.60 | 44.20 | 0.35 | 3064 | 81.80 | 45.98 |
| 16"X 28M | 10.40 | 11.50 | 44.70 | 9.50 | 34.30 | 0.35 | 3369 | 92.20 | 45.84 |
| 8M X 0 | 7.80 | 13.20 | 45.10 | 10.80 | 30.90 | 0.35 | 3353 | 100.00 | 45.78 |

Birtley Coal
& Minerals Testing

CLIENT: WHITEHORSE COAL CORPORATION
PROJECT: BULK SAMPLE RECEIVED NOV. 20, 1986
HEAD RAW - SIZE & RAW ANALYSIS
LAB NO: 2694
DATE: DECEMBER 4, 1986

HEAD RAW ANALYSIS, air dried basis

| ADM% | MOIST% | ASH% | VOL% | F.C.% | S% | CV CAL/GM (USUAL) | CV CAL/GM (BENZOIC) | BASIS |
|---|---|---|---|---|---|---|---|---|
| 11.80 | 1.90 | 45.40 | 8.40 | 44.30 | 0.36 | 3186 | 3836 | adb |
| | 13.48 | 40.04 | 7.41 | 39.07 | 0.32 | 2810 | 3383 | arb |
| | | 46.28 | 8.56 | 45.16 | 0.37 | 3248 | 3910 | db |

SIZE AND RAW ANALYSIS

| SIZE FRACTION | AIR DRIED BASIS CV CAL/GM (USUAL) RUN #1 | AIR DRIED BASIS CV CAL/GM (BENZOIC) RUN #2 | DRY BASIS CV CAL/GM (USUAL) RUN #1 | DRY BASIS CV CAL/GM (BENZOIC) RUN #2 |
|---|---|---|---|---|
| 4" X 2" | 3820 | 4339 | 3862 | 4387 |
| 2" X 1" | 3088 | 3798 | 3138 | 3860 |
| 1" X 3/4" | 3396 | 3934 | 3458 | 4006 |
| 3/4" X 1/2" | 2936 | 3791 | 2975 | 3841 |
| 1/2" X 1/4" | 3256 | 3736 | 3316 | 3804 |
| 1/4" X 1/8" | 2933 | 3736 | 2984 | 3801 |
| 1/8" X 1/16 | 3064 | 3709 | 3121 | 3777 |
| 1/16 X 28M | 3369 | 3813 | 3807 | 4314 |
| 28M X 0 | 3353 | 3735 | 3863 | 4303 |

NOTE: RUN #1 - USUAL METHOD
RUN #2 - BENZOIC ACID ADDITIVE METHOD

CLIENT: WHITEHORSE COAL CORPORATION
PROJECT: BULK SAMPLE RECEIVED NOVEMBER 20, 1986
LAB NO: 2694
DATE: DECEMBER 10, 1986

FLOAT-SINK ANALYSIS, air dried basis: 4" X 1" (WT% = 17.3)

| S.G. FRACTION | WT% | RM% | ASH% | CUMULATIVE WT% | CUMULATIVE ASH% |
|---|---|---|---|---|---|
| FLOAT - 1.50 | 0.10 | 0.90 | 5.40 | 0.10 | 5.40 |
| 1.50 - 1.60 | 6.40 | 1.70 | 13.00 | 6.50 | 12.88 |
| 1.60 - 1.70 | 20.60 | 2.10 | 22.70 | 27.10 | 20.35 |
| 1.70 - 1.80 | 16.00 | 2.30 | 32.30 | 43.10 | 24.78 |
| 1.80 - 1.90 | 16.10 | 2.00 | 41.30 | 59.20 | 29.28 |
| 1.90 - SINK | 40.80 | 1.60 | 69.60 | 100.00 | 45.73 |

FLOAT-SINK ANALYSIS, air dried basis: 1" X 1/4" (WT% = 39.6)

| S.G. FRACTION | WT% | RM% | ASH% | CUMULATIVE WT% | CUMULATIVE ASH% |
|---|---|---|---|---|---|
| FLOAT - 1.50 | 0.50 | 0.50 | 7.90 | 0.50 | 7.90 |
| 1.50 - 1.60 | 7.60 | 0.90 | 12.70 | 8.10 | 12.40 |
| 1.60 - 1.70 | 16.50 | 1.40 | 21.40 | 24.60 | 18.44 |
| 1.70 - 1.80 | 14.90 | 1.60 | 31.00 | 39.50 | 23.18 |
| 1.80 - 1.90 | 12.30 | 1.70 | 39.00 | 51.80 | 26.93 |
| 1.90 - SINK | 48.20 | 1.10 | 68.70 | 100.00 | 47.07 |

FLOAT-SINK ANALYSIS, air dried basis: 1/4" X 28 MESH (WT% = 35.3)

| S.G. FRACTION | WT% | RM% | ASH% | CUMULATIVE WT% | CUMULATIVE ASH% |
|---|---|---|---|---|---|
| FLOAT - 1.50 | 0.70 | 0.80 | 5.50 | 0.70 | 5.50 |
| 1.50 - 1.60 | 7.50 | 0.80 | 10.80 | 8.20 | 10.35 |
| 1.60 - 1.70 | 14.00 | 1.50 | 19.50 | 22.20 | 16.12 |
| 1.70 - 1.80 | 15.40 | 2.20 | 28.30 | 37.60 | 21.11 |
| 1.80 - 1.90 | 15.70 | 2.10 | 37.90 | 53.30 | 26.05 |
| 1.90 - SINK | 46.70 | 1.40 | 68.70 | 100.00 | 45.97 |

092024

CLIENT: WHITEHORSE COAL CORPORATION
PROJECT: BULK SAMPLE RECEIVED NOVEMBER 20, 1986
LAB NO: 2694
DATE: DECEMBER 10, 1986

FROTH FLOTATION TEST, air dried basis: 28 MESH X 0 (WT% = 7.8)

| PRODUCT | WT% | RM% | ASH% | CUMULATIVE WT% | CUMULATIVE ASH% |
|---|---|---|---|---|---|
| STAGE I | 7.80 | 2.30 | 34.30 | 7.80 | 34.30 |
| STAGE II | 8.40 | 2.60 | 41.80 | 16.20 | 38.19 |
| TAILINGS | 83.80 | 2.00 | 46.50 | 100.00 | 45.15 |

PULP DENSITY = 10%
REAGENT = 4:1 = KEROSENE:MIBC
DOSAGE = 0.5 LBS/TONNE
CONDITIONING = 60 SECONDS
STAGE I = FIRST MINUTE FROTH
STAGE II = SECOND MINUTE FROTH

CLIENT: WHITEHORSE COAL LIMITED
PROJECT: BULK SAMPLE RECEIVED NOV. 20, 1986
LAB NO: 2694
DATE: JANUARY 8, 1986

ANALYSIS OF COAL

| LAB NO: | SAMPLE ID: | MOIST% | ASH% | VOL% | F.C.% | S% | CV CAL/GM | BASIS | CV* Cal/Gm |
|---|---|---|---|---|---|---|---|---|---|
| 2694 | 1.80 COMP. | 1.90 | 22.70 | 8.30 | 67.10 | 0.54 | 5522 | adb | 5882 |
| | CC #1 | | 23.14 | 8.46 | 68.40 | 0.55 | 5629 | db | 5996 |
| 2694 | 1.90 COMP. | 2.00 | 27.00 | 8.30 | 62.70 | 0.47 | 5172 | adb | 5448 |
| | CC #2 | | 27.55 | 8.47 | 63.98 | 0.48 | 5278 | db | 5559 |

ASH FUSION TEMPERATURES (DEG. F)

| | | REDUCING | | | |
|---|---|---|---|---|---|
| LAB NO. | SAMPLE ID: | IDT | ST | HT | FT |
| 2694 | CC #1 | 2460 | 2710 | 2800 | 2800+ |
| 2694 | CC #2 | 2540 | 2790 | 2800+ | — |

* (with Benzoic Acid)

092024

Birtley Coal
& Minerals Testing