680841

GROUNDHOG COAL PROPERTY

GEOLOGICAL REPORT

DECEMBER, 1984

Coal Licence Numbers
4395, 4400, 4406, 7540-42

Cassiar Land District
NTS Map Number 104A/16

Latitude between 56°50'N and 56°55'N
Longitude between 128°20'N and 128°10'N

Prepared by

J.M. DUFORD CONSULTING SERVICES LTD.

For

GROUNDHOG COAL LTD.

1.0 SUMMARY

The Groundhog Coal Ltd. licences are located on the west side of the Skeena River Valley of northwestern British Columbia, 180 kilometres north of Hazelton, B.C. and 150 kilometres northeast of Stewart, B.C. Access is currently limited to helicopter and fixed-wing aircraft utilizing a local airstrip. Vehicular access from the north is possible to within 15 kilometres of the property along a B.C.R. right-of-way.

The 1984 Groundhog Coal Exploration Program geologically mapped the licence area, documented seam thicknesses and characteristics, collected representative samples for rank, quality and washability analyses and compiled all data collected to date into one interpretation.

The coal is contained in the Upper Jurassic Currier unit. The composite stratigraphic section contains 15 coal seams averaging 1.08 metres in thickness with maximum measured seam thicknesses approaching two metres. Structure on most of the property consists of a broad plunging synclinal structure with excellent mining potential.

The total in-situ resource on the property is calculated to be 221.4 million tonnes and is composed of an indicated resource of 11.5 million tonnes and an inferred resource of 209.9 million tonnes.

Coal quality and washability analyses indicate that the Groundhog Coal licences are capable of producing a multi-product anthracite coal with product coal ash values as low as 5 percent. Clean coal calorific

values for the medium and low ash products would be 31.4 and 33.4 (MJ/kg) respectively. The hard, coarse nature of the extracted coal suggests an excellent anthracite product.

Based on the 1984 Exploration Program an additional drilling program is recommended to increase the geologic level of confidence. The acquisition of the two licences south of the property is also recommended to cover the extension of the two main seams.

7.0 QUALITY

7.1 PROCEDURES AND PARAMETERS

Rigid coal sampling procedures were followed in order to obtain as representative a surface sample as possible. Where conditions allowed, trenches were dug deep enough into the seams to reach solid, relatively unweathered coal. The exposed seams were logged in detail (Appendix B) and seam sub-samples determined where required. Sub-samples conformed to stratigraphic controls and were taken where total seam thickness exceeded one metre and where the seam roof and/or floor contact was gradational. Prior to sampling, the seam face was spray painted with two parallel lines outlining the sample channel for a representative sample.

The analytical flow sheet (Figure 7.1) can be subdivided into five general procedures: component analyses; compositing; size analyses; detailed washability; and product analyses.

The component analyses were completed on each individual sample to provide data for later compositing and data on the general quality of the thinner seams. Based on the component analyses three seams were selected for more complete analysis. The compositing of the three seams involved the weight averaging of the component results by length and specific gravity. If a gradational contact sample contributed too much rock to the total seam ash it was excluded from the composite sample. Following the compositing the samples were screened at +28 and 100 mesh to produce three size fractions:

COAL ANALYSIS FLOW SHEET

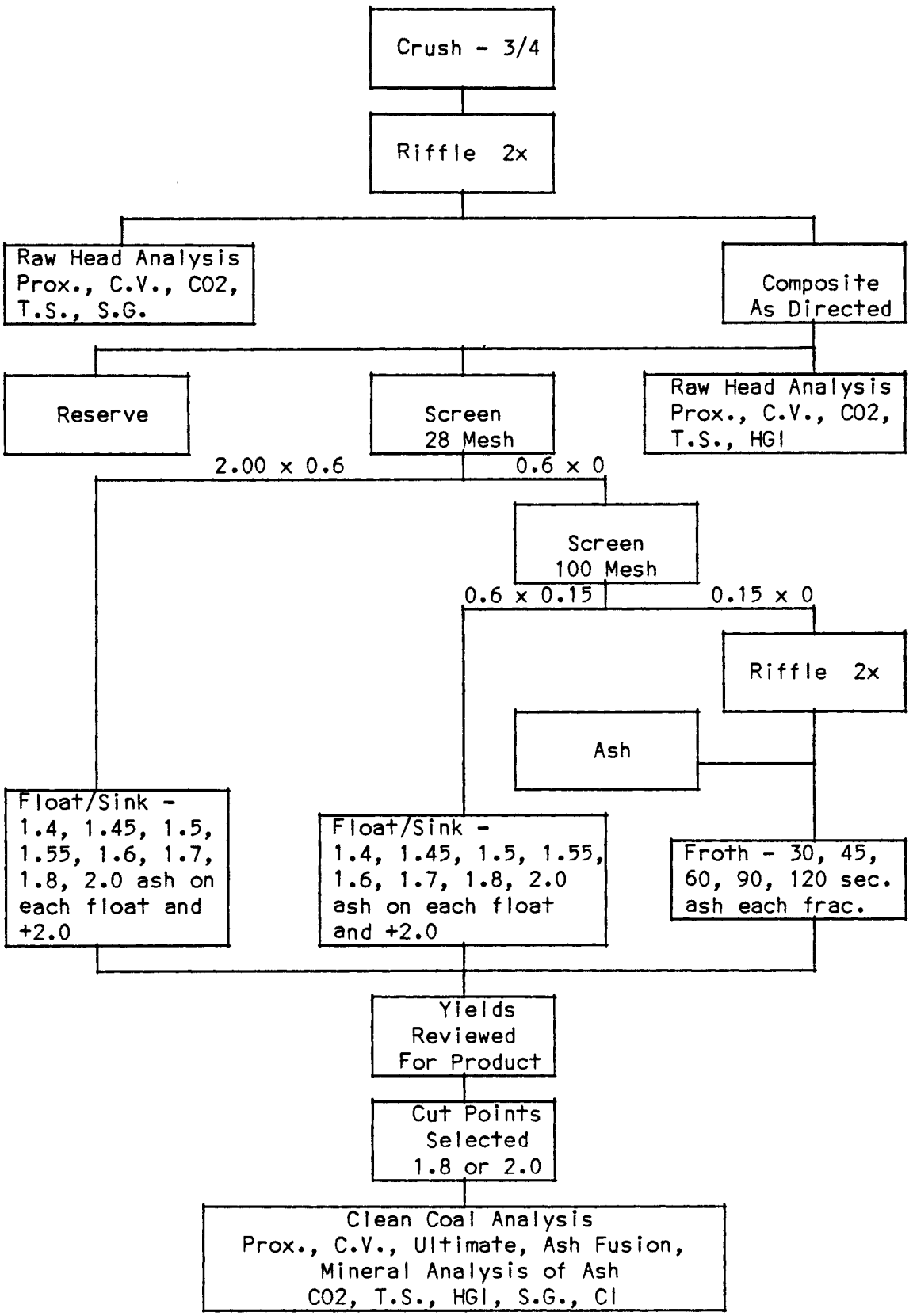

FIGURE 7.1

2.0x0.6 mm; 0.6x0.15 mm; and 0.15x0 mm. The two coarser fractions underwent detailed washability at 8 specific gravity intervals. Based on the results of the washability analyses specific gravity cut points were selected to produce a product coal with an ash of approximately 10% while maximizing the yield. The product sample was then formed from the float portions of the two coarser size fractions and subjected to a complete range of analyses. Preliminary froth flotation of the fine size fraction indicated that a minimal increase in yield was possible when a cleaned portion of this fraction was included in the product. This was due to the relatively high ash content of the fine fraction and the oxidized nature of the surface sample which inhibited the flotation of the fine particles. On the basis of this preliminary froth flotation, further flotation tests were eliminated from the analyses and the fine size fraction was eliminated from the product analyses.

7.2 RESULTS

Results of all analyses are found in Appendix F organized according to sample number. A trench sample summary is also located in Appendix F.

7.2.1 Coal Rank

The coal of the Groundhóg licence area is an anthracite. The mean maximum reflectance ($R\bar{o}max$) ranges from 3.47 to 4.21 (Appendix C); the DMMF (dry, mineral matter free) volatiles (drill core samples) range from 3.5% to 8.0% (Appendix D); and the fuel ratio (fixed carbon/ volatile matter) ranges from 9 to over 19 where the ash is less than 30%. According to various classification schemes, coals are ranked as anthracites where $R\bar{o}max$ exceeds 2.5, the DMMF volatiles are between 2 and 8 percent or the fuel ratio is greater than 9.

Previous workers have identified the Groundhog coal as a bituminous coal usually based on surface samples. Most likely this rank was due to the relatively high volatile values of proximate analyses. The inherent ash and rock partings can contain some carbonates which release carbon dioxide. The gas is reported as part of the total volatiles. The carbon dioxide can significantly affect the total volatiles of anthracite coal when carbon dioxide exceeds one percent. Since the carbonates are part of the ash material the effect is greatest in higher ash coal.

Oxidation or weathering of surface coal also affects the volatile content as well as the moisture content. A comparison of trench data (Appendix F) and drill hole data (Appendix D) illustrates the increase in volatiles and moisture for surface samples.

7.2.2 1984 Raw Coal Quality

The trench samples collected during the 1984 exploration program indicate a range of coal quality. Table 7.1 summarizes the average coal quality for the trench seam composite data. Raw coal ash ranges from 18.6% to 47.9% with an average of 35.5% (dry basis). The average volatile content of 11.0% (dry basis) is not indicative of the true coal quality due to the moisture in the weathered sample. Air dried moisture values averaged 4.6% whereas moisture values from 1970 drill core were well below 1%.

Sulphur values are remarkably low, averaging 0.42% and ranging from 0.28 to 0.70%.

Size analyses demonstrate the hard nature of Groundhog coal. The average size consist (Table 7.2) shows almost 85% of the coal greater than 28 mesh with only 5% reporting to the fine fraction.

TRENCH SAMPLE COAL QUALITY SUMMARY

Dry Basis

Trench	Sample Numbers	Ash (%)	Volatile Matter (%)	Fixed Carbon (%)	Calorific Value (MJ/kg)	S (%)	CO_2 (%)	S.G. (g/cc)
TRC8401	9551-9553	38.82	11.15	50.03	19.35	0.28	0.19	1.76
TRC8402	9556	47.87	11.65	40.48	15.37	0.27	0.09	1.87
TRC8403	9557-9560	31.05	11.21	57.74	21.76	0.40	0.16	1.77
TRC8404	9564+9565	28.23	19.81	51.96	20.38	0.31	0.15	1.77
TRC8405	not analyzed							
TRC8406*	9568	62.71	12.49	24.80	9.83	0.22	0.22	2.11
TRC8407	9569	44.02	7.86	48.12	17.53	0.54	1.65	1.87
TRC8408	9570	18.57	10.08	71.35	27.63	0.50	0.26	1.57
TRC8409	9571	41.43	8.10	50.47	18.411	0.34	0.49	1.71
TRC8410	9572	34.08	8.47	57.45	21.95	0.70	0.75	1.68
Average		35.51	11.04	53.45	20.30	0.42	0.47	1.75

* Ash value exceeds 50% therefore excluded from all seam calculations.

TABLE 7.1

AVERAGE SIZE CONSIST

Size	Weight %	Ash %
3/4 " x 28 m	84.50	
28 m x 100 m	10.46	
100 mesh x 0	5.04	35.37

TABLE 7.2

A relationship between raw coal ash and specific gravity was determined based on a linear regression (Figure 7.2). The derived formula was:

$$\text{Specific Gravity (g/cc)} = 1.38 + (\text{Ash} \times 0.01)$$

The correlation coefficient for the equation is .95, however, a limited number of data points were available and more are needed to further refine this relationship.

7.2.3 Washability

The washability data (Appendix F) indicates that the Groundhog coal property would be capable of producing a multi-product coal. Although a 10% ash product was generated for product coal analyses the data indicates that a 5% ash product is feasible. Producing a 5% ash product would result in a yield exceeding 40% on the one product. Reject material from a low ash product would contribute to a medium or high ash product.

Cut points ranging from 1.8 g/cc to 2.0 g/cc were used for the product coal, producing an average product ash of 9.72% (dry basis) with an average total yield of 68.3%. Yields were as high as 76.6% despite the exclusion of the fine size fraction. Contribution of clean coal from the fine size fraction will increase the yield.

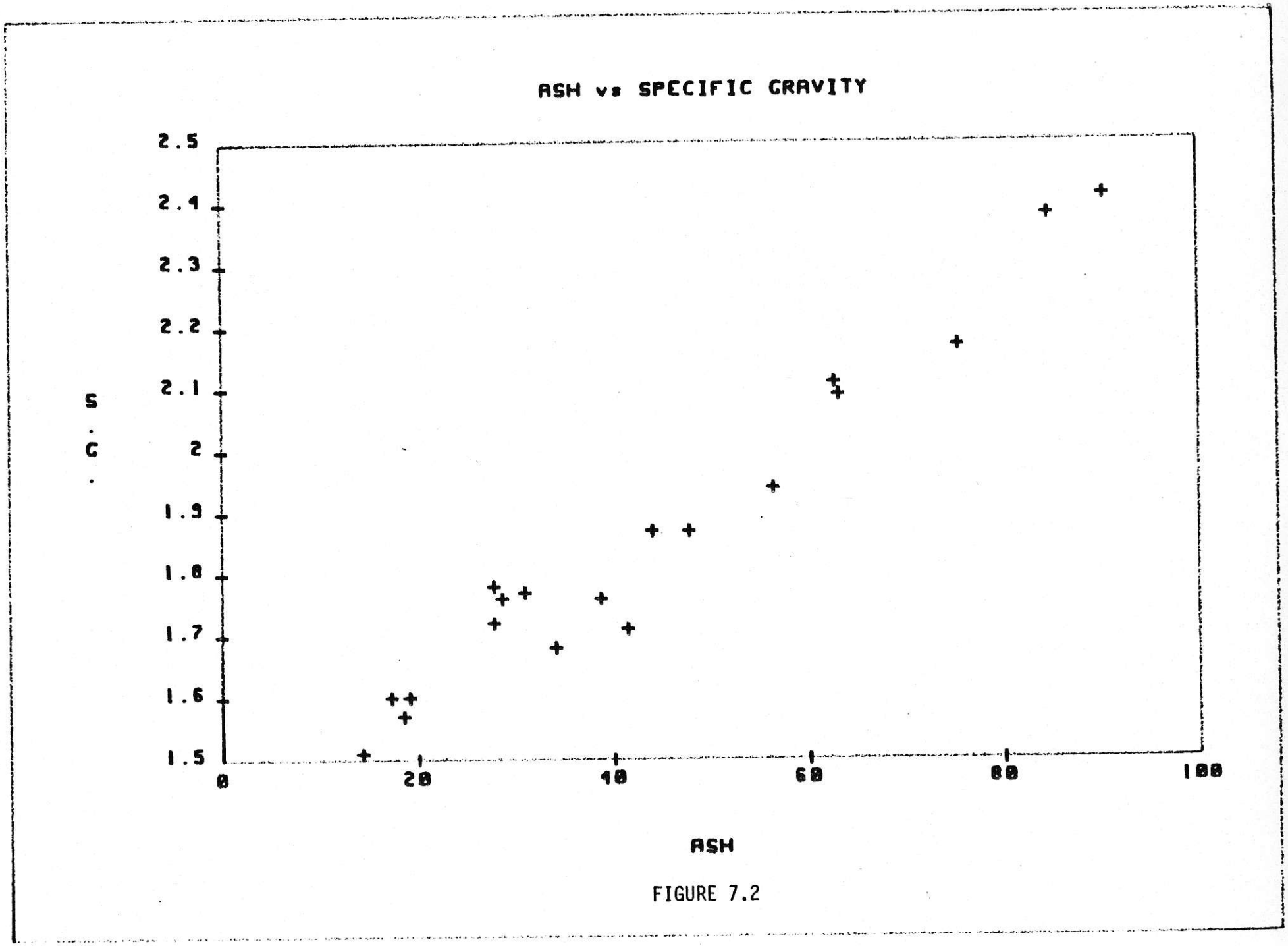
ASH vs SPECIFIC GRAVITY
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
S
.
G
.
0
20
40
60
80
100
ASH

FIGURE 7.2

The washability data indicates that most of the ash is contained in rock partings rather than disseminated throughout the entire seam. This coal characteristic limits the near gravity material and improves the washability particularly at the cut points used.

As previously discussed, extensive froth flotation tests of the fine size fraction were eliminated from the analysis due to the oxidized nature of the coal and the relatively small quantities involved.

7.2.4 Product Coal

A medium ash level was selected for the product coal since washability data suggested that a 10% ash product would represent most of the coal in the three main seams. Specific gravity cut points ranging from 1.8 to 2.0 g/cc were used providing a yield of over 68% with an average ash of 9.5% (air dried basis). A low ash product (5%) is also possible at cut points between 1.45 and 1.5 g/cc. As previously stated theoretical yields should exceed 40%. Undoubtably the property is capable of producing a high ash product, however, data from additional seams is required for an indication of the product quality.

The average medium ash product coal quality from the three composited samples, representing coal from the Pond seam, Lower Discovery Creek seam and Upper Discovery Creek seam, is presented in Table 7.3. The weathered nature of the

AVERAGE PRODUCT COAL QUALITY

	Air-Dry Basis	Dry Basis
Yield	68.32 %	-
Proximate - Ash	9.50 %	9.72 %
- Moisture	2.22 %	-
- Volatile Matter	9.73 %	9.95 %
- Fixed Carbon	78.55 %	80.33 %
Ultimate - Carbon	79.57 %	81.37 %
- Hydrogen	2.71 %	2.52 %
- Nitrogen	0.97 %	0.99 %
- Sulphur	0.44 %	0.45 %
- Oxygen	6.80 %	5.87 %
Calorific Value (MJ/kg)	29.97	30.65
Specific Gravity (g/cc)	1.43	1.44
Hardgrove Grindability Index	35.7	-
Chlorine	0.03 %	

TABLE 7.3

AVERAGE PRODUCT COAL QUALITY
(cont'd.)

Ash Fusibility	Reducing Atmosphere (°C)	Oxidizing Atmosphere (°C)
Initial Deformation Temperature	1180	1243
Softening Temperature	1217	1262
Hemispherical Temperature	1233	1273
Fluid Temperature	1265	1293

Mineral Analysis of Ash	Weight (%)
SiO_2	41.26
Al_2O_3	24.13
Fe_2O_3	9.31
CaO	8.85
MgO	2.24
Na_2O	1.04
K_2O	1.13
P_2O_5	8.26
TiO_2	0.71
SO_3	3.73

TABLE 7.3 (cont'd.)

samples has contributed to the high moisture and volatile values. Drill core data (Appendix D) demonstrates that moisture levels for unweathered samples average just over 0.5% while volatile matter would range from 4 to 6% (dry basis).

The average calorific value (30.65 MJ/kg, dry basis) for the 10% ash product is approximately 13200 BTU and reflects the weathered nature of the coal. Utilizing the calorific values generated from a linear regression of ash and calorific values of all available Groundhog licence area data (Figure 7.3), a more representative calorific value can be obtained. The derived formula is:

Dry Basis Calorific Value (MJ/kg)
= 35.36 - (Ash x 0.40)

Utilizing the regression equation a calorific value of 31.36 MJ/kg (13482 BTU) can be obtained from a 10% ash (dry basis) product while a calorific value of 33.36 MJ/kg (14342 BTU) is possible from a 5% ash (dry basis) product.

The average hardgrove grindability index of 35.7 demonstrates the hardness of the coal which correlates well with the high percentage of coarse material. Hard, coarse coal is a desired anthracite characteristic.

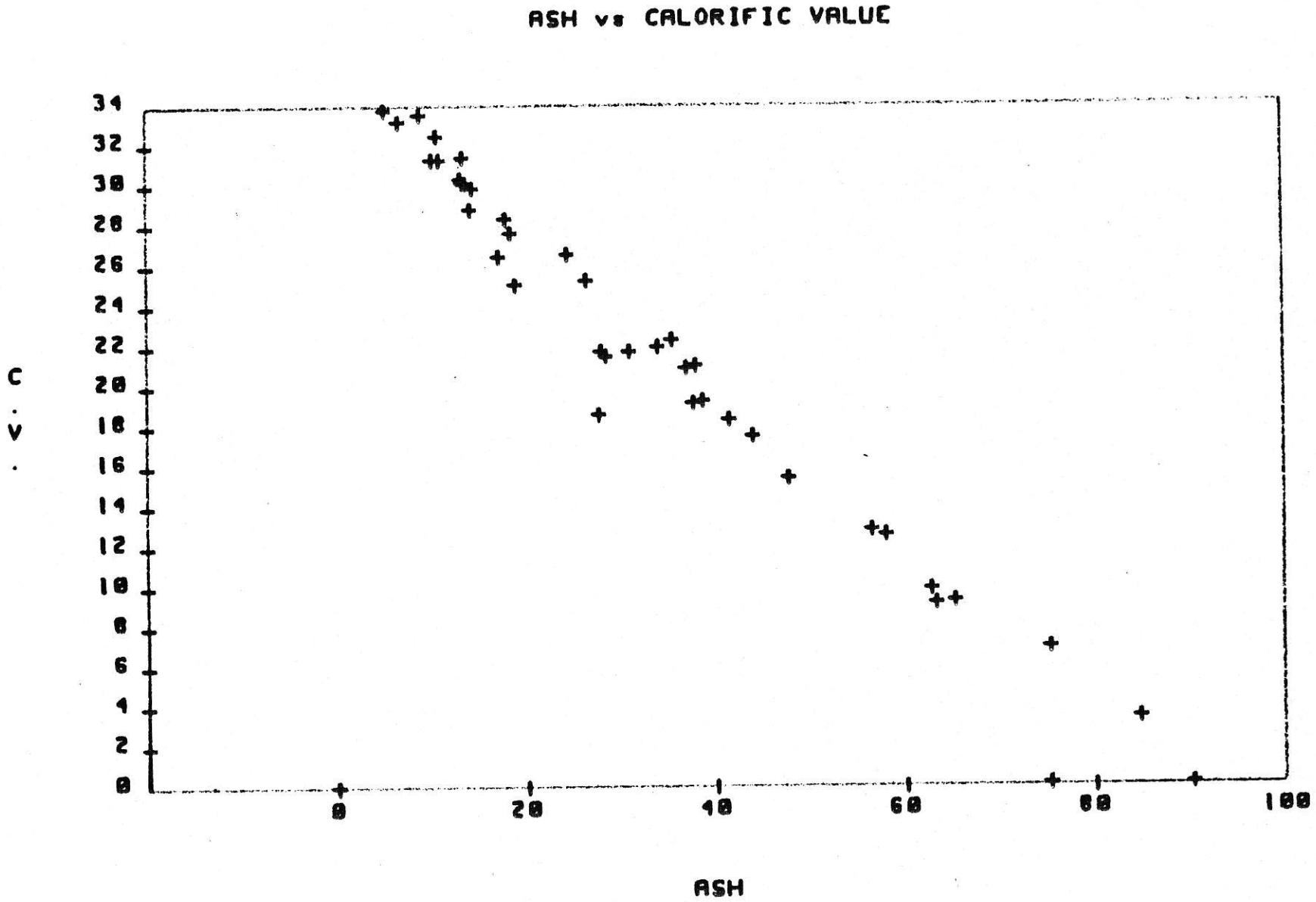
ASH vs CALORIFIC VALUE
C.V.
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
20
40
60
80
100
ASH

FIGURE 7.3

The average ash fusion, ultimate and ash analyses are illustrated in Table 7.3. Ash fusion temperatures indicate a medium slagging tendency while the base/acid ratio shows low-medium fouling tendency. The average chlorine content also shows a medium fouling tendency (Vaninetti and Busch, 1981).