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APPENDIX 3-1

WOLF MOUNTAIN GEOLOGY AND RESERVES

(From The Roberts Consulting Corp.
Feasibility Study)

Nanaimo Coal Project
Prepared by: Norecol Environmental Consultants
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2.1.3 GEOLOGY

A comprehensive exploration program of the Wolf Mountain property was undertaken in 1982 by JHP Coal-Ex Consulting Limited. This programme included the drilling of 16 rotary holes, with four sections cored through the Wellington seam. The exploration also included extensive geologic mapping. A comprehensive report on the geology of the Wolf Mountain property based on this exploration was prepared by Mr. J. Perry, consulting coal geologist, (see Perry (1983)). The description of the geology of the Wolf Mountain property below attempts to summarise this report, and contains a number of excerpts.

Stratigraphy

The rock strata of the Wolf Mountain property is part of the coal bearing strata of the Upper Cretaceous Nanaimo Group. Six coal seams are found within the Extension-Protection formation, located just above the base of the Nanaimo Group. Strata of this Group unconformably overlies the metasediments and igneous rocks of the Sicker and Vancouver Groups, and the Island Intrusions. Figure 4 shows the regional geology in the Wolf Mountain property area.

The sediments that comprise the Nanaimo Group represent five sedimentary cycles. Four of the cycles are transgressive, each grading upwards from fluvial to deltaic and/or lagoonal, through nearshore to offshore marine. The fifth cycle is deltaic only. Each of the first four

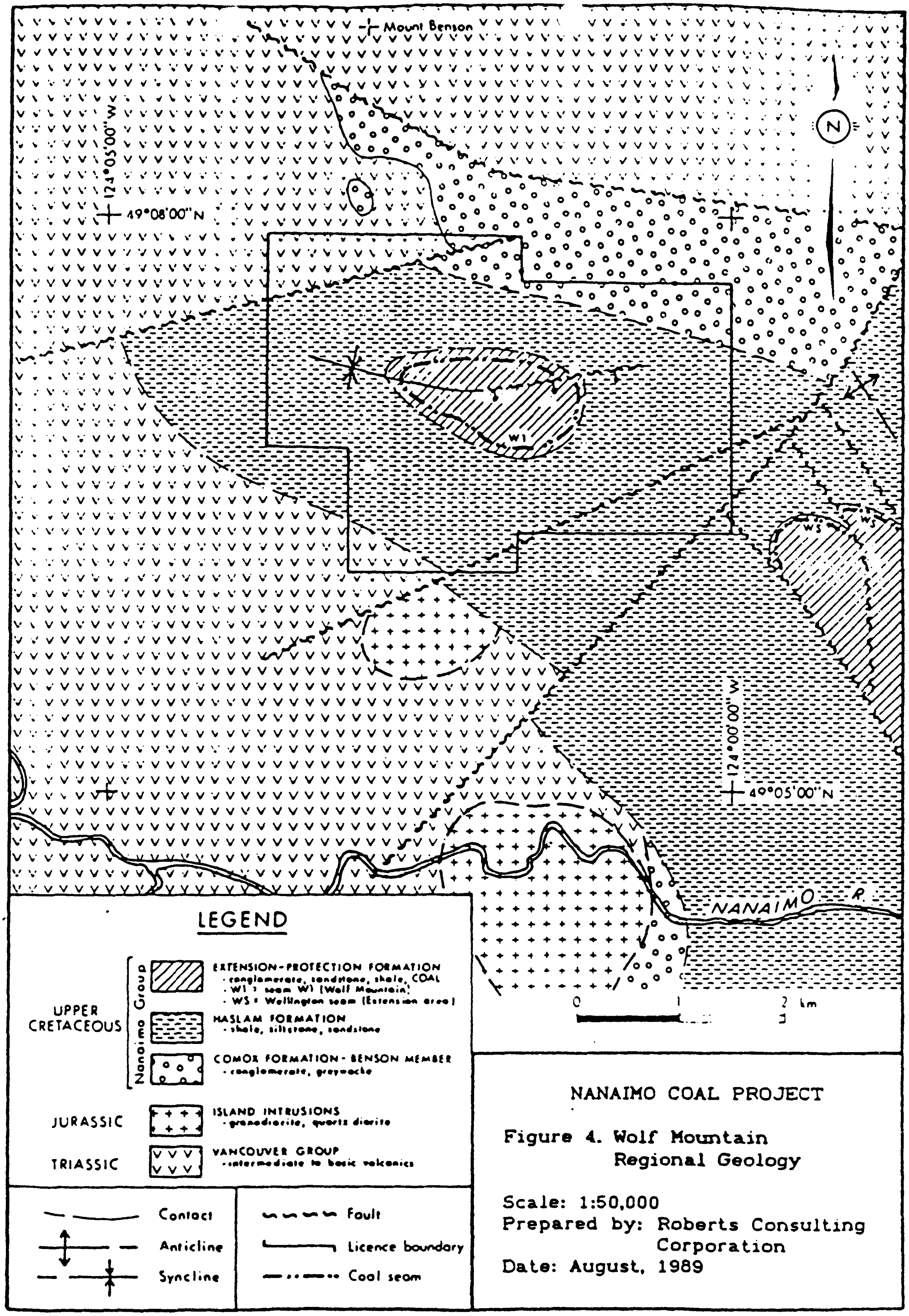

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Figure 4. Wolf Mountain Regional Geology

Scale: 1:50,000
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cycles is comprised of two formations: the first is a non-marine sandstone conglomerate sequence which may contain lagoonal shale and coal; the second is an overlying, mainly marine, siltstone-shale sequence. Within the Nanaimo region, only the lagoonal Extension-Protection Formation is coal bearing. Of the Nanaimo Group, only sediments of the Comox, Haslam and Extension-Protection Formations are present within the Wolf Mountain property.

The Extension-Protection Formation

The Extension-Protection Formation conformably overlies the Haslam Formation and represents the lower part of the second depositional cycle. The lower half of the Extension-Protection Formation contains the Wellington, Newcastle, and Douglas seams, the only coal seams of economic interest in the Nanaimo region. These three seams were extensively mined between 1852 and 1953. At the base of the Extension-Protection Formation is a thick sandstone referred to as the East Wellington member. This sandstone is approximately 40 meters thick, and commonly forms the floor of the Wellington seam.

Coal Seam Stratigraphy

Only the lowermost portions of the Extension-Protection Formation are represented on the Wolf Mountain property. Consequently, only the Wellington and associated minor seams are present. In addition to the Wellington seam, five other minor coal seams have been identified on the Wolf Mountain property. Because of thickness and quality considerations, these other seams are not currently considered to be of economic interest. Throughout most of the Wolf Mountain area, the Wellington seam is the lowermost coal seam. The Wellington seam is referred to as W.1, and the other minor coal seams are numbered in ascending order (see the W.1 projected outcrop trace on Figure 4).

The Wellington seam has an average thickness of approximately 2.4 meters, but this thickness varies considerably over the property. The average elevation of the seam is approximately 600 meters above sea level. The floor of the Wellington seam is usually a medium to coarse grained sandstone. Roof lithologies range from carbonaceous claystone through interbedded shale and siltstone to medium grained silty sandstone. Some old mine workings to the east exhibit a similar lithology in the roof, but in the Extension area the roof of the Wellington seam is conglomerate. The floor in these old workings is usually reported to be sandstone. Clapp (1914) reports the existence of sharp "rolls", "pinches" and "swells" within the coal seams of the Nanaimo Basin. Within the Wellington seam, most of the disturbances are found in the roof.

Structural Geology

The general geological structure of the region is illustrated in Figure 4. Sediments within the western portions of the Nanaimo Coalfield are characterised by gentle, mainly easterly dipping strata within a number of gently warped and tilted fault blocks.

The projected structure of the Wellington seam over the Wolf Mountain property is presented in Figure 5. While the WMCLP operation showed that this structure is disrupted by a series of small displacement faults and roof rolls, this figure nevertheless represents a good approximation of the overall seam structure.

The 1982 exploration data indicated that the coal bearing strata of the Wolf Mountain property is contained within a faulted syncline (see Figure 5). The axis of this syncline trends approximately east-west. The south limb of this faulted syncline dips gently to the north, while the north limb dips on average 23 degrees to the south. The Wolf Mountain reserves are thus divided into two main areas, each requiring a different mining method. Mining plans for extracting these reserves are presented in Sections 2.3 and 2.4 of this report.

The syncline is thought to be disrupted by a high angle reverse fault contained within the hinge zone of the fold. The full extent and displacement of this fault is not known, and this zone will be explored as the south flank section of the Wolf Mountain mine is developed. The

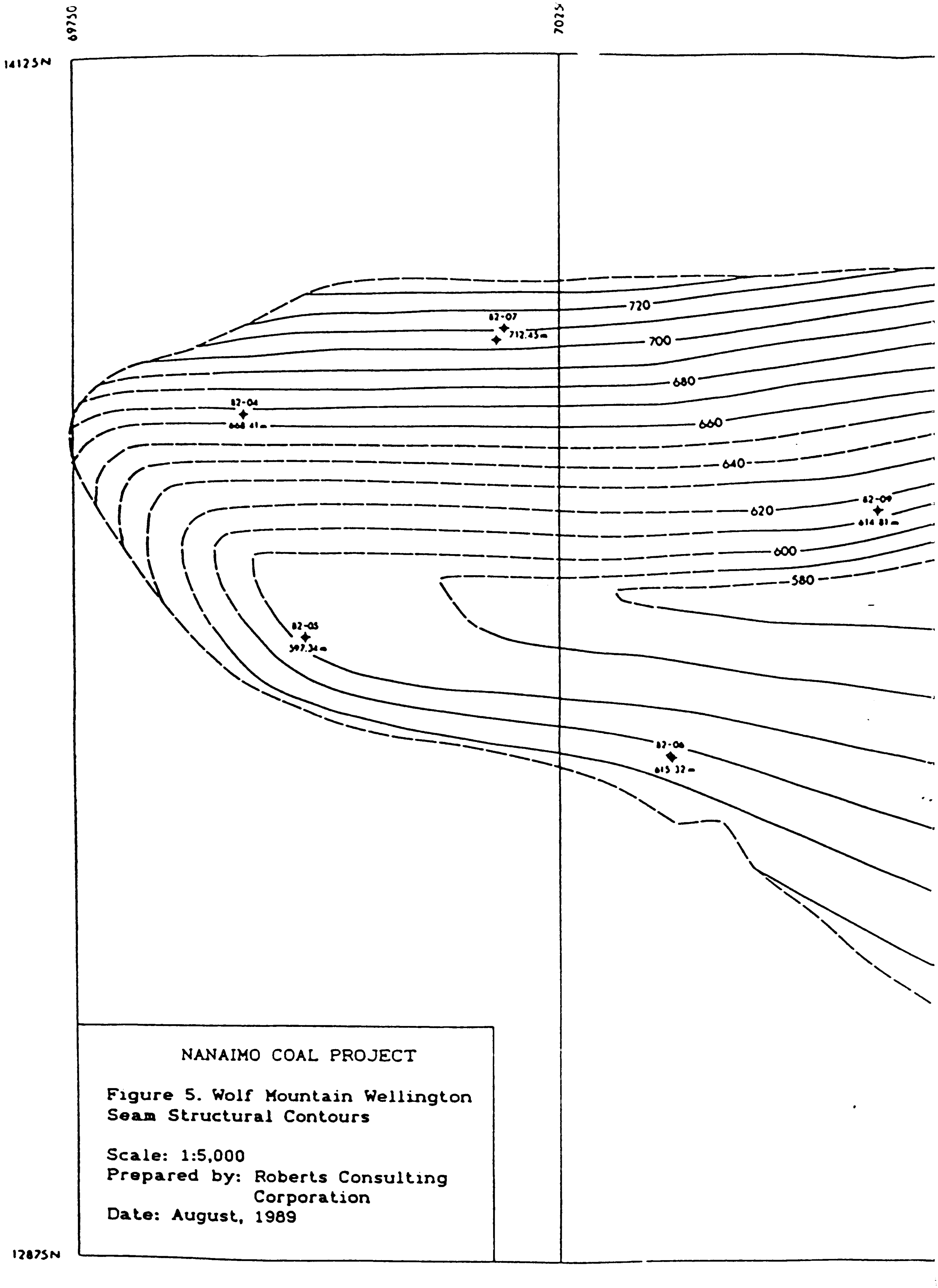

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Figure 5. Wolf Mountain Wellington Seam Structural Contours

Scale: 1:5,000
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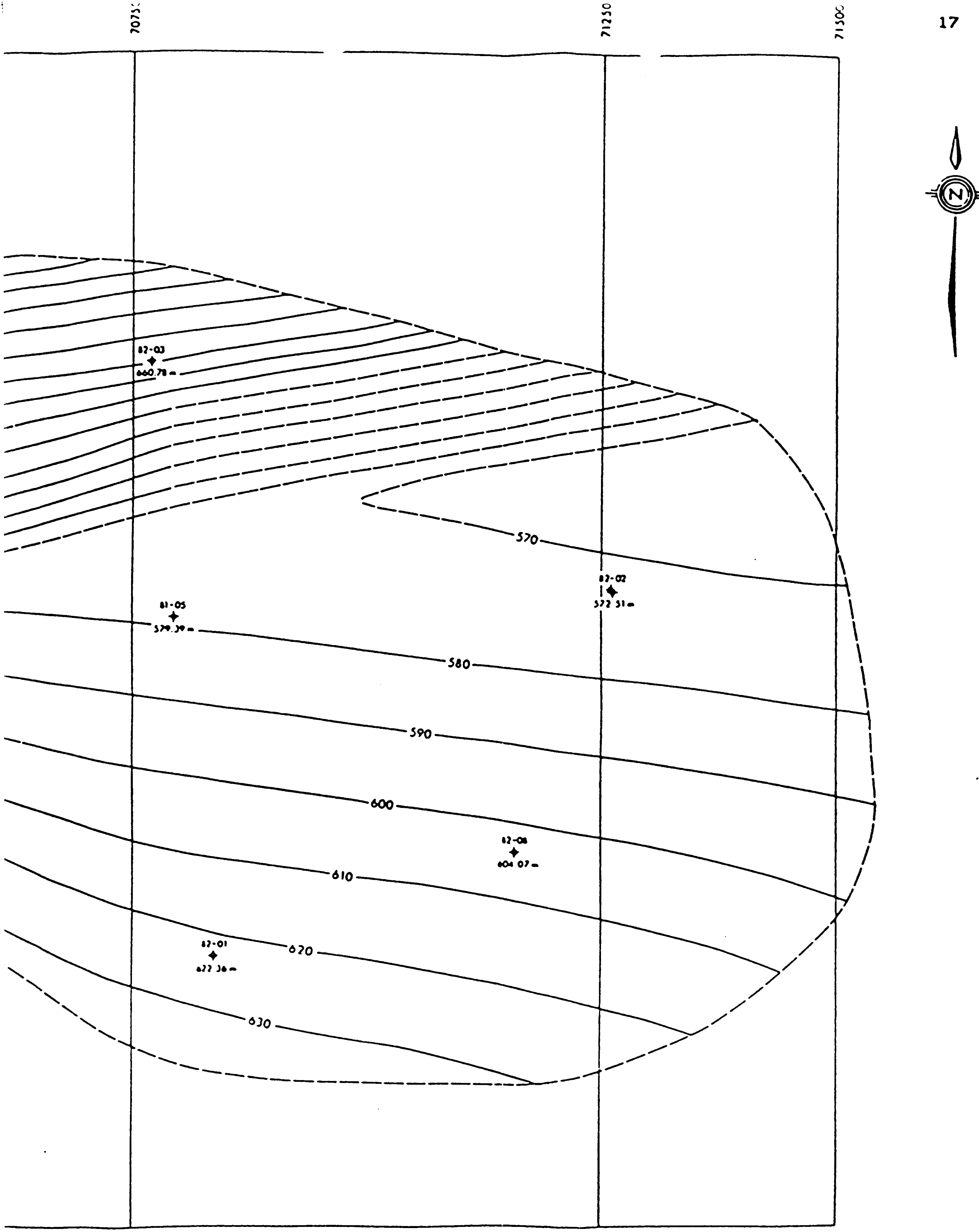
70750
71250
71500
82-03
660.78 m
82-02
572.51 m
81-05
579.39 m
82-08
604.07 m
82-01
622.36 m
570
580
590
600
610
620
630
N

Wolf Mountain mine has been designed to avoid any potential mining problems in this zone.

2.1.4 RESERVES

Perry (1983) estimates the Wolf Mountain insitu reserves as 2.02 million metric tonnes in the south flank, and 1.14 million metric tonnes in the north flank, giving a total for the property of 3.16 million metric tonnes. Subtracting 80,000 tonnes for the coal mined from the south flank between 1982 and 1986, the south flank insitu reserves are estimated to be 1.94 million tonnes, and the total reserves as 3.08 million tonnes. As is discussed in Section 2.2 of this report, approximately 20,000 tonnes of the south flank reserves will be accessed from the north flank workings. Thus for the purpose of this mining feasibility, the south flank and north flank insitu reserves are taken to be 1.92 and 1.16 million metric tonnes respectively.

Based on a mining recovery in the south flank of 70 percent (see Section 2.3 of this report), recoverable reserves from the south flank are estimated to be 1.34 million tonnes. Recoverable reserves in the north flank are estimated to be .942 million metric tonnes (see Section 2.4 of this report), giving a calculated recovery of approximately 81 percent for the north flank. Total recoverable reserves from the Wolf Mountain property are thus estimated to be 2.28 million metric tonnes of run of mine (ROM) coal, thus giving an overall mining recovery for the property of 74 percent.

2.1.5 COAL QUALITY

Run of Mine Coal

A typical proximate analysis for run of mine coal from the Wolf Mountain property is presented below (as received basis):

Fixed Carbon	38%
Volatiles	34%
Ash	22%
Total Moisture	6%

The sulphur content is low, typically .6 percent. The Wellington seam coal has an ASTM D-388 classification of High Volatile Bituminous A. In estimating the heat content, coal from the Wolf Mountain mine has been found to conform approximately to the relationship:

BTU's per lb = 14,953 - (164 x % Ash) - (148 x % Moisture)

Thus a run of mine sample with the analysis provided above would have a heat content:

= 14,953 - 164 x (22) - 148 x (6) = 10,457 BTU/lb

Due to considerable variation in the Wellington seam characteristics, the run on mine coal from Wolf Mountain can be expected to vary greatly in quality, from a minimum of approximately 15 percent ash to a maximum of approximately 40 percent ash (at, say, 6 percent moisture). Based on past experience at the Wolf Mountain mine, an average of approximately 25 percent ash would appear reasonable. It is important to note that the washability testing done by Birtley Coal & Minerals Testing (June 16, 1987) was on a sample from one of the better areas in the existing Wolf Mountain workings, and is probably not typical of the ROM coal that can be expected from future mining at Wolf Mountain. There is, however, a thinning of the shale bands within the seam towards the west which supports the estimate of 25 percent (average) ash within the run of mine coal. The estimates of the preparation plant yield have been adjusted to reflect this estimated feed ash content.

Washed Coal

Figure 6 shows the estimated coal quality of washed coal from the Nanaimo Coal Project. This table was prepared by Mr. R. Kynoch, a consulting coal preparation engineer. Note that these specifications were prepared for a smaller scale operation, and the annual volumes of Wolf Mountain and waste pile coal do not match the volumes projected in this study. Nevertheless, these numbers closely approximate the anticipated clean coal specifications.

	Wolf Mountain	Waste Piles	Approx Blend
Volume (tonnes per year)	235,260	112,828	348,088
Size range	50 x 0 mm	50 x 0.5 mm	50 x 0 mm
Ash content	12.55 %	13.7 %	12.92 %
Inherent moisture (A.D.B.)	1.5 %	2.8 %	2.0 %
Total moisture (as received)	10 %	10 %	10 %
Gross calorie value Kcal/kg	6,500	6,657	6,550
Volatile matter	39.1 %	34.6 %	37.48 %
Fixed carbon	51.8 %	48.9 %	51.2 %
Total sulphur	0.49 %	0.55 %	0.51 %
Nitrogen (A.D.B.)			1.34 %
Hardgrove index	60	65	-
F.S.I.	4½	1½	3
Ash Fusion (oxidizing)		2320-2590°C	2310-2570°C
" " (reducing)		2290-2520°C	2270-2510°C
Ash analysis (approx)			
SiO_2	-	46.2 %	40.21 %
Al_2O_3	-	23.7 %	23.83 %
TiO_2	-	1.38 %	1.18 %
Fe_2O_3	-	5.83 %	5.43 %
CaO	-	9.91 %	14.39 %
MgO	-	2.5 %	3.05 %
Na_2O	-	0.31 %	0.42 %
K_2O	-	1.12 %	0.86 %
P_2O_5	-	1.02 %	0.98 %
SO_3	-	6.24 %	7.29 %

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Figure 6. Wolf Mountain and Waste Pile Estimated Clean Coal Specifications

Prepared by: Aries Pacific Developments Inc.
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