PR. PEACE RIVER CANYON
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TERRACON GEOTECHNIQUE LTD.
Consulting Engineers and Geologists

CINNABAR PEAK MINES LTD.
A REPORT ON THE 1983 COAL RESERVE DRILLING AND PLANT SITE INVESTIGATION PROGRAM
PEACE RIVER CANYON PROPERTY

Licences: 3407, 3409, 3410, 3415, 3424, 3429, 3430, 3431, 3433, 3434, 3435, 3437, 3438, 3440, 3441

Land District: Peace River

NTS: 93-0/16

Latitude: 55°55'N

Longitude: 122°05'W

Owner/Operator: Cinnabar Peak Mines Ltd.

Consultant: Terracon Geotechnique Ltd.

Authors: L. Nichols, P. Eng.; D. Watson, E.I.T.

Date of Field Work: October - November, 1983

Submission Date: February 10, 1984

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February 18, 1984

Mr. E. Lipsett
Vice-President, Technical Projects
Cinnabar Peak Mines Ltd.
505 - 707 W. Broadway
Vancouver, B.C.
V5Z 1J5

Dear Mr. Lipsett:

Re: Report of 1983 Activities on Cinnabar's Peace River Canyon Property

I trust that you will find the attached report on the above subject to your satisfaction.

I would be pleased to review the details of the report with you at any time.

Yours sincerely,

L. Nichols, P. Eng.
Principal

LCGN/smc

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1.0 INTRODUCTION

1.1 Terms of Reference

Terracon Geotechnique was commissioned by Cinnabar Peak Mines Ltd. to supervise the drilling, logging and site investigation study on its Peace River Canyon Property near Hudson Hope, British Columbia. The drilling program included both rotary/down-the-hole hammer for the coal reserve holes and rotary and solid stem auger for the site investigation program.

The ore reserve drilling was planned as a development "fill-in" pattern of holes between existing core holes. The holes were located on selected leases on the proposed open pit area as defined by others.

The plant site investigations have been designed to be of a general nature. This portion of the program was intended to examine potential waste dump areas, plant site location, conveyor, load out and transfer points and mine site service facilities. The local geology, foundation conditions and water tables have been described. Selected samples were collected from the drilling program for laboratory index testing.

The field study was completed by the end of November, 1983 with all activities being executed on licences held by Cinnabar Peak Mines Ltd. at its Peace River Canyon Property. Local contractors were utilized whenever possible.

1.2 Program Objectives

The program had four objectives:

- Provide a better definition of the continuity, thickness and coal quality for the coal seams in the proposed open pit areas.
- Place Casagrande type piezometers as permanent installations in selected holes for long term monitoring of the groundwater tables in both the coal seams and associated rocks and the overburden materials.

- Identify, describe and classify the materials underlying the various proposed plant and dump sites as listed in the scope section.
- Summarize the general foundation conditions at each site.

1.3 Contractors

The drilling was undertaken by Wonowon Oil Contracting Ltd. of Hudson Hope and BPB Instruments (Canada) Ltd. of Calgary conducted the geophysical logging and reduction of the log data. All surface preparation, road construction, snow removal and reclamation efforts were undertaken by D. Ragan of Dawson Creek.

1.4 Historical Background of the Peace River Canyon Area

The coal along the Peace River in northeastern British Columbia is believed to be the first coal discovered in Western Canada. In 1793, Sir Alexander MacKenzie noted the presence of exposed coal seams in the Peace River Canyon.

Among those most persistent in their efforts to mine coal from this region was the Gething family of Fraser Lake and Hudson Hope, B.C. and their name has been given to this extensive coal formation. Recent exploration has discovered that the Gething Formation has an enormously large potential over an area 56 km wide by 322 km long. This area stretches from the Sukunka River to the Sikanni Chief River. The centre of this block is approximately 145 km southwest of Fort St. John.

Coal mining in the canyon dates from 1923. At one time or another, production came from five mines located on or adjacent to the property now held by Cinnabar Peak Mines Ltd. Although this initial mining phase lasted more than 40 years, production was carried out on a small scale. Throughout the entire period, less than 55,000 tonnes of coal was produced and half of this production came from the Gething No. 3 mine.

The Gething family mined coal from the property until 1947 but with railways converting to diesel fuel from coal there was no longer a ready market and the mine was closed.

In 1969 Cinnabar Peak Mines Ltd. began a coal land acquisition program with an option to purchase agreement of Crown granted freehold lands of 648 ha owned by the Gething-Green estate. This option was exercised in 1979 with the said coal rights of the freehold lands now wholly owned by Cinnabar.

In addition to the freehold lands, Cinnabar applied to the B.C. Government and received coal removal licences covering approximately 8,094 ha surrounding the freehold property.

Since that time the company has carried out a detailed exploration program of mapping, trenching, drilling and site investigations, including the current program.

1.5 Status of Coal Mining Properties

The Peace River Canyon Coal property consists of 3512 ha of B.C. coal licences (15 total) as shown on Figure 1 in Appendix A. These licences are located approximately nineteen road miles southwest of the town of Hudson Hope, B.C. The coal property also includes 648 ha of freehold lands in the Peace River Land District described as follows:

Northwest Quarter of District Lot 1039
South Half of District Lot 1050
Fractional West Half of District Lot 1054
District Lot 276
District Lot 1055

These properties are shown on Figure 1 in Appendix A.

1.6 List of Licences With Work Performed

List of licences with each type of performed work.

Lic 3429: Holes: 83-1 - Coal Investigation Hole
Geophysically Logged and Piezometer Installed
83-3 - Coal Investigation Hole
83-2 - Coal Investigation Hole
Geophysically Logged
Road Work Reclamation
83-4 - Overburden Investigation Hole
Geophysically Logged, Piezometer Installed
83-6 - Overburden Investigation Hole

Lic 3424: Hole: 83-5 - Overburden Investigation Hole

Lic 3409: Holes: 83-7 - Overburden Investigation Hole
Piezometer Installed
83-11 - Overburden Investigation Hole
Geophysically Logged, Piezometer Installed

Lic 3415: Holes: 83-8 - Overburden Investigation Hole
Geophysically Logged, Piezometer Installed
83-9 - Overburden Investigation Hole
Geophysically Logged, Piezometer Installed
83-10 - Overburden Investigation Hole
Geophysically Logged, Piezometer Installed

2.0 SURFACE PROGRAM

2.1 Road Construction

A minimal amount of road work was required to upgrade certain sections of the drill site access roads. In addition, snow removal was required for some of the roads towards the end of the program.

2.2 Reclamation Activities

At three separate locations, tree "leaners" were cut to conform to environmental requirements. Seeding of selected areas was intended using a grass seed mix recommended by government staff. Because the drilling was completed after significant snow falls, seeding was not carried out. Seeding is now expected to be completed in the spring of 1984.

Erosion bars were placed on several road segments where gradients warranted such activity. This included the roads on the slopes of Coalbed Creek valley and at mid elevations of Mt. Johnson.

All work was completed within published government guidelines for coal exploration. Local government inspectors approved these activities. However, due to snowfall conditions, the work will be re-inspected in the spring for final approval.

2.3 Borehole Location Checks

The collars of the three deep coal reserve holes were checked for correct location by chain and compass traversing. These three holes, 83-1, 83-2 and 83-3, were tied into one another as well as adjacent holes drilled previously. Collar elevations, as in previous programs, have been estimated from contour maps.

3.0 COAL RESERVE DRILLING AND BOREHOLE LOGGING PROCEDURES

3.1 Drilling and Sampling Method

The drilling program was initiated October 11, 1983 with the three deep reserve development holes 83-1, 83-2 and 83-3 being completed on December 1, 1983. A DSI Quick Drill, (hydraulic top-drive rotary rig), was utilized in the program. This rig has a rated depth of 300 m. An initial rotary rate of .6 m/hour average was attained for the first 61 m of drilling. Thereafter, a down-the-hole hammer bit was used. This improved the penetration rate to approximately 3 m/hour. However, hole depths were limited by the air compressor pressure capacity when the down-the-hole hammer assembly was being utilized. The hole depth limit depended on the volume of water flow and the water head. In holes 83-1, 83-2 and 83-3 this depth limit was approximately 130 m.

For the coal reserve holes 83-1, 83-2 and 83-3, grab samples of the drill cuttings were taken from the mud tank (or air return line when air was used), on a 3 m (10 ft) increment basis. These were taken to obtain a general description of the various lithologies but no attempt was made to identify the detailed stratigraphy.

3.2 Geophysical Logging Procedures

A standard suite of geophysical logs were completed in holes 83-1 and 83-2. The geophysical logging suite consisted of caliper, gamma, focussed resistivity, long spaced density, bed resolution density and neutron porosity. Hole 83-3 was not geophysically logged due to a blockage at the 21.3 m depth. This blockage was caused by continual caving which could not be controlled by the driller.

Holes 83-4 and 83-7 to 83-11 were geophysically logged with the caliper and gamma logs. A long spaced density log was also performed on hole 83-8. The remaining two holes 83-5 and 83-6 were not geophysically logged due to caving conditions.

Tables 1 and 2 in Appendix B summarize the geophysical logs that were completed. The geophysical logs are included in Appendix D.

3.3 Interpretation of Coal Seam Thicknesses

Coal seams were interpreted from the geophysical logs for 83-1 and 83-2. For hole 83-3, the coal seam intersections have been estimated from the drill sample cuttings which were taken at regular intervals. Intersections for the coal seams for this hole (83-3) are therefore approximate.

The total coal intersections for each hole are presented in Table 3, Appendix B. Figure 2 in Appendix A shows cross-section 'A-A' with hole 83-3 projected onto the section. Figure 3 in Appendix A shows cross-section B-B' with holes 83-1 and 83-2 projected onto the section.

4.0 PLANT, WASTE DUMP AND GENERAL SITE INVESTIGATIONS

4.1 Hole Pattern

Map 1 in Appendix E shows the layout of drill holes for the 1983 program. Three coal reserve holes are located on licence 3429. Holes 83-4 and 83-5 were drilled in the vicinity of proposed waste dump locations. Hole 83-6 lies in the proximity of a coal transfer or load out point at the proposed pit. Holes 83-7 through to 83-11 were drilled to give broad coverage to the general plant site areas.

4.2 Drilling, Logging and Sampling Procedures

Total coal reserve drilling amounted to 349 metres.

The foundation site investigation holes drilled with air, (83-4 through to 83-7), were sampled at 0.3 m increments for the purposes of obtaining a general description of the overburden stratigraphy. In the remaining holes (83-8 through to 83-11) samples were taken at 1 metre intervals from the flites of the solid stem auger.

A total of 70.7 metres of drilling were completed in the foundation investigation holes. Borehole geological logs are presented in Appendix C.

4.3 Laboratory Data

Selected samples from eight boreholes were utilized in the laboratory testing program. Index tests were completed to obtain a preliminary classification of the overburden (unconsolidated) materials, principally Pleistocene materials, at the various sites. Table 4 (Appendix B) summarizes this laboratory data which includes moistures, densities and Atterberg Limits. Grain size data are also given in Figures 2 to 5 inclusive in Appendix A.

5.0 PIEZOMETER INSTALLATIONS

5.1 Installation Procedures and Configurations

All piezometers which were installed are of the Casagrande type. These are 1" diameter tubing (Schedule 80 PVC) with flush joint buttress threads. Piezometer tips 1.5 m in length were set at the base of the holes. Frac-sand, (14-20 grade), was used to provide a filter around the piezometer tip and the filter was then sealed off at the top of the sand filter with bentonite prills. Details of the piezometer construction including piezometer tip locations are shown to scale on the borehole geological logs in Appendix C.

Piezometers were installed in the following holes; 83-1, 83-4 and 83-7 to 83-11 inclusive.

5.2 Water Level Readings

Piezometers were installed at the completion of the drilling program and water level readings were not taken as insufficient time had elapsed for water levels to reach equilibrium. Water levels in these holes should be taken in the spring of 1984.

Map 1 in Appendix E displays a full table summary of all piezometer readings taken to date.

5.3 Preliminary Interpretation of Groundwater Data

Air drilling indicates that an active groundwater flow regime, which is manifested by high flows, exists in the coal seams. Based on water returns during the drilling, flows of 45 to 60 litres per minute are present in the thicker coal seams. Most of the overburden is a lacustrine silty clay or clay silt which has a relatively low permeability estimated at 10^{-6} or 10^{-7} cm/sec. This material is, however, generally saturated with the water table being located within one metre of the present topographic surface.

6.0 SITE FOUNDATION CONDITIONS

6.1 Location of Proposed Facilities

Boreholes 83-4 and 83-5 were placed in the vicinity of proposed waste disposal areas for mine overburden. Boreholes were also drilled in the proposed plant site and load out areas including holes 83-6, 83-7, 83-9 and 83-10. Boreholes 83-7, 83-8 and 83-11 were included in the program to provide additional broad coverage of the general plant area in terms of the surficial geology and the local groundwater conditions.

6.2 Local Surficial Geology

There is a mantle of lacustrine clayey-silt covering the proposed dump site and plant site areas. The material is generally thicker than 10 metres. Two clayey-silt units have been defined, one has an olive gray hue and the other a very dark gray hue. The former unit overlies the latter unit. The olive gray clay-silt generally has a thickness of 6 to 7 metres. Both units have very similar grain size characteristics as shown in the grain size gradation curves, Figures 2 to 5 inclusive in Appendix A.

This material is quite distinct from the coarser colluvial till-like material which mantles most of the slopes of Mt. Johnson.

6.3 Foundation Bearing Criteria

The low Liquid Limit and Plastic Limit data would indicate that the two clay silt units which overlie the proposed plant site areas are relatively competent and would offer reasonable bearing strengths. However, more detailed testing of specific sites in the form of consolidation tests and standard penetration tests must be completed in order to provide bearing limits for these soils.

Furthermore, special precautions will have to be taken when setting foundations on this clayey-silt material because it is quite frost susceptible. Hence, subgrade excavation, backfilling with clean gravel to provide good foundation drainage will be important design factors for shallow footing design, irrespective of the loads that the foundations will be required to carry.

Drainage, carried out with preloading, may also be an appropriate construction method.

6.4 Recommendations for Further Site Investigations

Specific foundation sites must be checked to determine bearing limits of these clayey silt units. For this purpose, SPT and consolidation tests must be conducted.

For the purposes of slope stability analysis for waste dump design as well as for the design of any required cut slopes, triaxial tests to determine shear strength design parameters must also be completed.

7.0 SUMMARY AND CONCLUSIONS

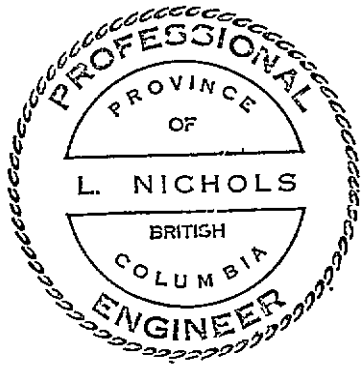
The 1983 field program can be summarized as follows:

- o A total of 349 metres of rotary drilling was conducted in three boreholes at the Peace River Canyon Property in the fall of 1983 for coal reserve calculations.
- o A total of 70.7 metres in 8 holes of rotary and auger drilling was conducted for the purpose of foundation, plant and dump site investigations.
- o A grand total of 419.7 metres of drilling was completed.
- o Geophysical logging amounted to 265.9 metres in 8 holes.
- o Laboratory index tests were conducted on a selected number of samples from the foundation site investigation program to classify the surficial geology materials which are common to those areas.
- o Eight Casagrande type piezometers, to enhance information on the groundwater regime(s), were installed. There are now 11 operating piezometers on the property.

Respectfully submitted,

L. Nichols

L. Nichols, P. Eng., P. Geol.
Principal



Expiry Date May 5, 1984

8.0 COST STATEMENT

See addendum submitted under separate cover by Cinnabar Peak Mines Ltd.

9.0 BIBLIOGRAPHY

Appleby, P.J. and Lipsett, E. (1980). 1979 Exploration of Peace River Canyon Coal Properties, Northeastern British Columbia; 13 pp, 26 Figures, Cinnabar Peak Mines Ltd., Company Report.

Appleby, P.J. and Lipsett, E. (1981). 1980 Property Evaluation, Peace River Canyon Coal Properties, Northeastern British Columbia; 29 pp, 7 Figures, Cinnabar Peak Mines Ltd., Company Report.

Checklin, G.A. and Halferdahl, L.B. (1971). 1971 Geological Exploration of Peace River Canyon Coal Properties, Northeastern British Columbia; 37 pp, 9 Appendices, 12 Figures, 5 Tables, Cinnabar Peak Mines Ltd., Company Report.

Halferdahl, L.B. (1976). 1976 Exploration of Peace River Canyon Coal Properties, Northeastern British Columbia; 29 pp, 4 Appendices, 49 Figures, 5 Tables, Cinnabar Peak Mines Ltd., Company Report.

Haslett, G.A., Checklin, G.A. and Halferdahl, L.B. (1974). 1973 Preliminary Feasibility Study and Drilling on Peace River Canyon Coal Properties, Northeastern British Columbia; 21 pp, 4 Appendices, 33 Figures, 2 Tables, Cinnabar Peak Mines Ltd., Company Report.

Nichols, L.C.G. and Ricker, J. (1981). Mine Development Drilling Program, 1980. Peace River Canyon Coal Property, Northeastern British Columbia; 9 pp, 3 Appendices, 2 Figures, Cinnabar Peak Mines Ltd., Company Report.

Nichols, L.C.G. (1984). Annual Reclamation Report for 1983. Peace River Canyon Coal Property, Northeastern British Columbia; 2 pp, 1 Figure, 1 Table, Cinnabar Peak Mines Ltd., Company Report.

Stogran, S.W. and Jones, D.J. (1981). Preliminary Environmental Assessment of the Peace River Canyon Coal Project. Peace River Canyon Coal Property, Northeastern British Columbia; 135 pp, 4 Appendices, 33 Figures, 42 Tables, Cinnabar Peak Mines Ltd., Company Report.

Van Dyck, G.A. (1972). 1972 Winter Drilling Project on Peace River Canyon Coal Properties, Northeastern British Columbia; 16 pp, 3 Appendices, 5 Figures, 4 Tables, Cinnabar Peak Mines Ltd., Company Report.

Van Dyck, G.A. and Riddell, K.P. (1972). 1972 Summer Exploration of Peace River Canyon Coal Properties, Northeastern British Columbia; 10 pp, 3 Appendices, 6 Figures, Cinnabar Peak Mines Ltd., Company Report.

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January 6, 1984