REPORT ON
THE 1979/80 DEVELOPMENT WORK
CARRIED OUT ON THE
ELK RIVER COAL PROJECT
VOLUME I

ELCO MINING LIMITED

K Elk River BCIA

REPORT ON

THE 1979/80 DEVELOPMENT WORK

CARRIED OUT ON THE

ELK RIVER COAL PROJECT

VOLUME I

ELCO MINING LIMITED

Manager Elk River Coal Project

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March 5, 1981.

Ministry of Energy, Mines and
Petroleum Resources,
Parliament Buildings,
VICTORIA, British Columbia.

Attention: Mr. P. Hagen,
Coal Administrator

Dear Sir:

Re: Coal Licence No.s 64, 65, 421-434, 481-489, 515, 771-779 and 951-957 - Report on the 1979/80 Development Work Carried Out on the Elk River Coal Project

Pursuant to Section 18(1) and (2) of the Coal Act and in support of our schedule of expenditures for the 1979/80 reporting period (submitted December 3, 1980), enclosed herewith is the Report on the 1979/80 Development Work Carried Out on the Elk River Coal Project. This report has been submitted within the requested 90-day extension pursuant to Section 18(4) of the Coal Act.

A schedule of expenses upon which work credits are being applied for, is included under Section 5 of this report.

We trust you will find this report acceptable. Should you require further information, please contact the undersigned.

Yours truly,
ELCO MINING LIMITED,

G. F. Lawrence

G. F. Lawrence,
Chief Geologist.

Enclosure

GFL/ew

REPORT ON THE 1979/80 DEVELOPMENT WORK CARRIED OUT ON THE ELK RIVER COAL PROJECT

Coal Licence Numbers:	64, 65, 421-434 Incl., 481-489 Incl., 515, 771-779 Incl., 951-957 Incl.
Location:	East Kootenay Regional District of Southeastern British Columbia
NTS Map Designation:	Mount Head 82J/7W
Centre of Project:	50°, 24' North Latitude 114°, 56' West Longitude
Licence Owners:	Elco Mining Limited 50% Stelco Inc. 25% Home Oil Company Limited 15% Scurry-Rainbow Oil Limited 10% Coal Licences "Held in Trust" by Canada Permanent Trust Ltd.
Operator:	Elco Mining Limited
Author of this Report:	G.F. Lawrence
Work Performed From:	June 16 - October 15, 1980
Submitted to:	Ministry of Energy, Mines and Petroleum Resources [redacted]
Date:	March 3, 1981

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8.0	Volume VII	IECO Test Pit Logs
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10.0	Volume VII	Golder Drill Hole (Well) Logs

SECTION 1

INTRODUCTION

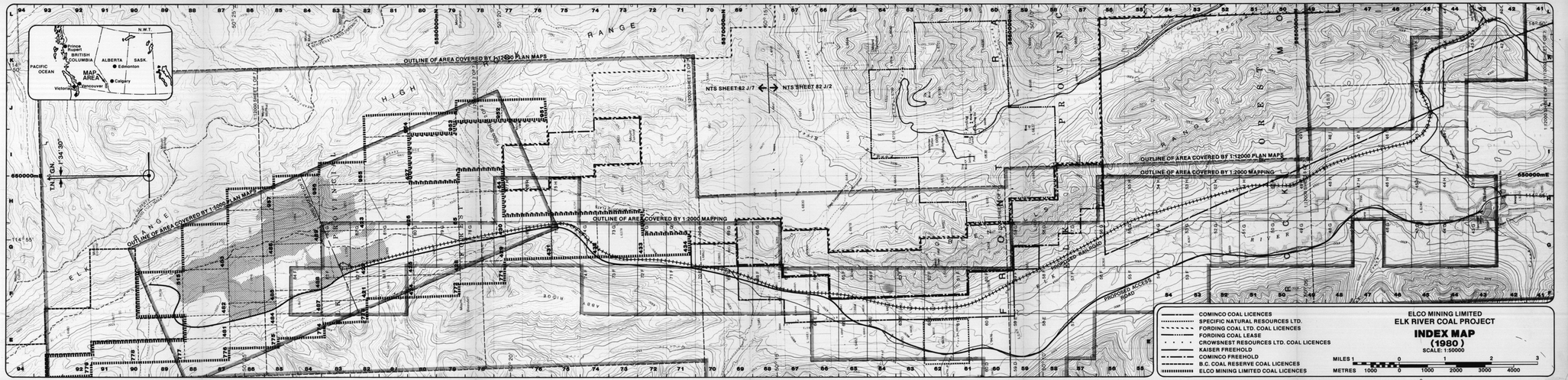
1.1 GENERAL GEOGRAPHIC AND PHYSIOGRAPHIC POSITION OF LICENCES

The Elk River Coal Project is located in the East Kootenay regional district of southeastern B.C. Approximate centre of the project area, which consists of 7,782 ha of coal licences on Elk Provincial Forest land, is 50^{o} 24' north latitude and 114^{o} 56' west longitude. The licence area roughly covers the upper part of the Elk River Valley between the confluence of Aldridge Creek and the Elk River in the south and Cadorna Creek and the Elk River in the north. This represents a section of the Elk River Valley approximately 12 km long and includes the eastern and western flanks of the valley. Access is gained to the area along approximately 44 km of B.C. Forest Service Road running northward from Elkford, (see Index Map, Page 2).

1.2 PROPERTY DEFINITION

1.21 Historical Background

The Elk River coal deposit has been known since 1883 when first examined by Dr. G.M. Dawson of the Canadian Geological Survey. As early as 1905 propectors had uncovered 22 seams


OUTLINE OF AREA COVERED BY 1:12000 PLAN MAPS
NTS SHEET 82 J/7
NTS SHEET 82 J/2
OUTLINE OF AREA COVERED BY 1:2000 MAPPING
PROPOSED ACCESS ROAD
PROPOSED RAILROAD
MAP AREA
PACIFIC OCEAN
BRITISH COLUMBIA
ALBERTA
SASK
N.W.T.
Prince Rupert
Edmonton
Calgary
Victoria
Vancouver
COMINCO COAL LICENCES
SPECIFIC NATURAL RESOURCES LTD.
FORDING COAL LTD. COAL LICENCES
FORDING COAL LEASE
CROWSNEST RESOURCES LTD. COAL LICENCES
KAISER FREEHOLD
COMINCO FREEHOLD
B.C. COAL RESERVE COAL LICENCES
ELCO MINING LIMITED COAL LICENCES
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
INDEX MAP
(1980)
SCALE: 1:50000
MILES 1 0 1 2 3
METRES 1000 0 1000 2000 3000 4000

1.2 PROPERTY DEFINITION Cont'd.

1.21 Historical Background Cont'd.

and by 1910 three coal companies had acquired leases in the area. The year 1920 saw the first attempt to explore the deposit in any systematic way, with the driving of a 650 foot adit (Aldridge Tunnel) into Big Weary Ridge, approximately one mile south of Weary Creek.

Interest in the Elk River deposit receded after 1920 and most licences were dropped. The area was idle until 1952 at which time West Canadian Collieries carried out sampling on the Big Weary Ridge exposures.

In 1967 Scurry-Rainbow Oil Ltd. began acquiring coal licences for this deposit and in 1968, North American Coal Corporation, under an option agreement with Scurry-Rainbow Oil Ltd. undertook an exploration program, primarily on Big Weary Ridge. When North American Coal Corporation did not exercise its option, Scurry-Rainbow Oil Ltd. independently extended exploration of the deposit north to include Little Weary Ridge.

In December 1969 Emkay Canada Natural Resources Ltd., a wholly owned Canadian subsidiary of Morrison-Knudsen Company, Inc.,

1.2 PROPERTY DEFINITION Cont'd.

1.21 Historical Background Cont'd.

acquired a 50% interest in the coal licences. Exploration of the licences by the joint owners resumed in July 1970 and continued through the spring of 1971. During this time additional coal licences were acquired bringing the total number of individual licences to 42 for a total area of 19,200 acres (7,782 ha).

In May 1975, Elco Mining Limited, acting on behalf of a group of European steel companies, acquired Emkay Canada Natural Resources Ltd.'s 50% interest in the coal licences. During 1975/76 Elco Mining Limited carried out a prefeasibility study which involved exploration in the Big Weary and Little Weary Ridge areas.

In October 1976, the Steel Company of Canada Ltd. and Home Oil Company Ltd. acquired 25% and 15% interests, respectively in the property from Scurry-Rainbow Oil Limited. A joint venture agreement was then concluded between the following partners with their respective interests:

Elco Mining Limited	50%
Stelco, Inc.	25%
Home Oil Company Limited	15%
Scurry Rainbow Oil Ltd.	10%

1.2 PROPERTY DEFINITION Cont'd.

1.22 Current Owner

Elco Mining Limited was appointed Project Manager and immediately undertook a feasibility study which involved the most extensive exploration program to date. This program, which extended from October 1976 to June 1977, was mainly concentrated on the northern half of the valley's east flank and included Little Weary Ridge and part of Big Weary Ridge. Also, detailed investigations were for the first time carried out on the vertical to overturned seams on the west flank of the valley. The feasibility study was completed January 1978 and preparation of the Stage II submissions were underway.

The Stage II report [1] for the Elk River Coal Project was submitted on August 28, 1978. Following this, a significant amount of additional work [2] was undertaken at the request of the government reviewing agencies.

On February 22, 1979, the Environment and Land Use Committee of the B.C. Cabinet gave approval-in-principle to the project, subject to, however, completing an additional program of Stage III work. [3]

1.2 PROPERTY DEFINITION Cont'd.

1.22 Current Owner Cont'd.

Elco Mining Limited currently remains Project Manager of the Elk River Coal Project and is continuing to carry out Stage III permit activities. The original pace of the project has somewhat decelerated due to the softening demand for steel products and metallurgical grade coal on the world markets, especially in Europe.

1.23 Brief Economic Assessment

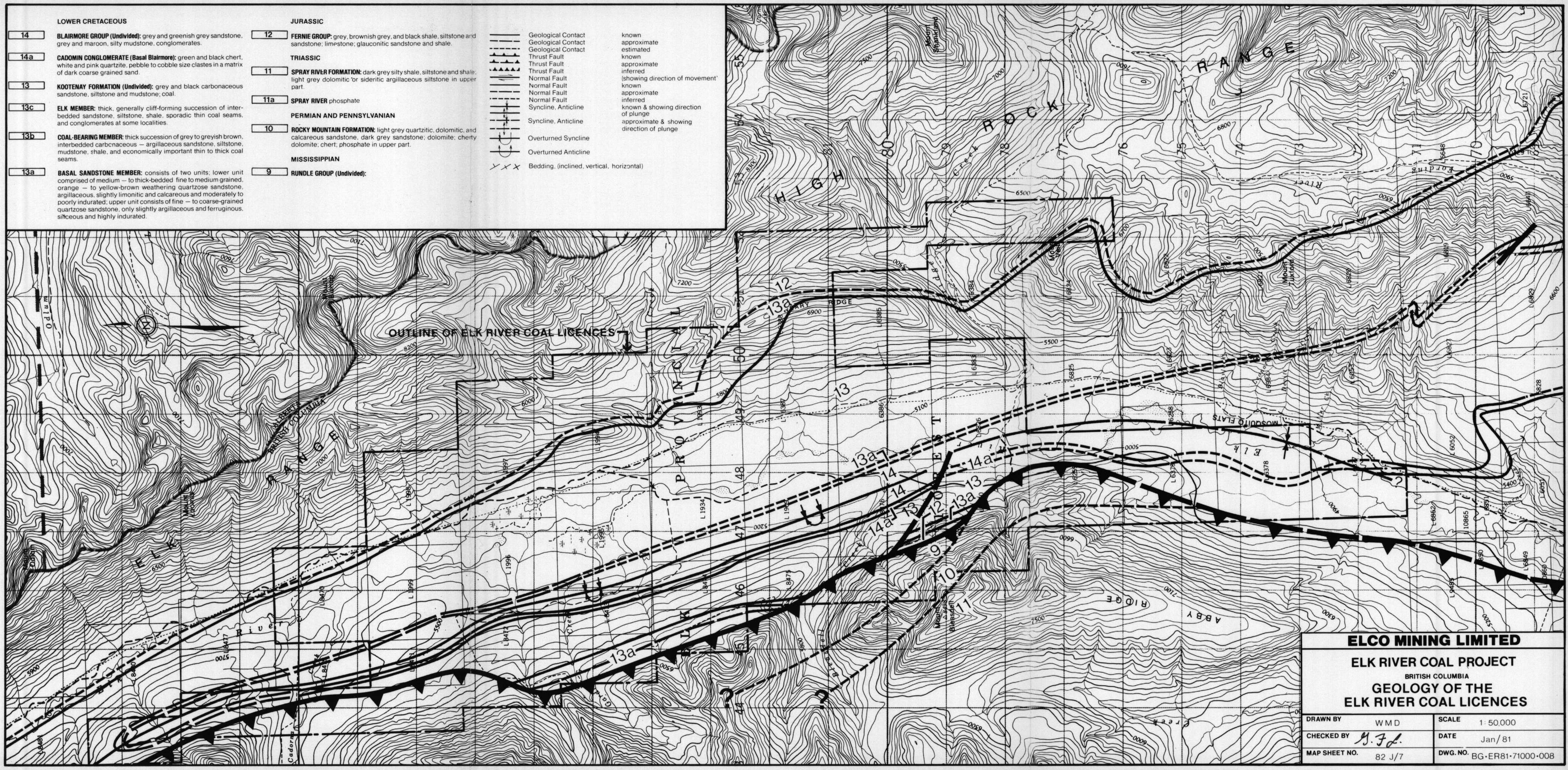
The Elk River Coal Project, however, remains to be a very viable project. A 36 year open pit mine plan has been developed which will produce 4.0 million tonnes of clean coal per year at an overall stripping ratio of 3.27 bm^3/t. This plan involves the mining and blending of more than 18 seams of varying quality to produce a low volatile, good cokeability product which will meet the requirements of most of the world's coking coal consumers. Furthermore, it has been proven that similar open pit reserves extend southwards onto Big Weary Ridge which would give at least an additional 20 years of mining at the above rate of production, however at a somewhat higher stripping ratio, (approximately 6.0 bm^3/t).

1.2 PROPERTY DEFINITION Cont'd.

1.23 Brief Economic Assessment Cont'd.

With the growing world wide demand for thermal coal the economic potential of the seams located on the west flank of the Elk River coal deposit, which investigations to date, have indicated to be a low cokeability high volatile coal, is rapidly increasing. Here there is an indicated open pit potential of 174 million tonnes of clean coal at an approximate stripping ratio of 7.0 bm^3/t.

Underground reserves of clean coal from within the total licence area are estimated to be in the order of 600 million tonnes for coking coal and 558 million tonnes for thermal coal (see Geological Map of the Elk River Coal Licences, page 8).


LOWER CRETACEOUS
14 BLAIRMORE GROUP (Undivided): grey and greenish grey sandstone, grey and maroon, silty mudstone, conglomerates.
14a CADOMIN CONGLOMERATE (Basal Blairmore): green and black chert, white and pink quartzite, pebble to cobble size clastes in a matrix of dark coarse grained sand.
13 KOOTENAY FORMATION (Undivided): grey and black carbonaceous sandstone, siltstone and mudstone; coal.
13c ELK MEMBER: thick, generally cliff-forming succession of inter-bedded sandstone, siltstone, shale, sporadic thin coal seams, and conglomerates at some localities.
13b COAL-BEARING MEMBER: thick succession of grey to greyish brown, interbedded carbcnaceous — argillaceous sandstone, siltstone, mudstone, shale, and economically important thin to thick coal seams.
13a BASAL SANDSTONE MEMBER: consists of two units; lower unit comprised of medium — to thick-bedded fine to medium grained, orange — to yellow-brown weathering quartzose sandstone, argillaceous, slightly limonitic and calcareous and moderately to poorly indurated; upper unit consists of fine — to coarse-grained quartzose sandstone, only slightly argillaceous and ferruginous, siliceous and highly indurated.
JURASSIC
12 FERNIE GROUP: grey, brownish grey, and black shale, siltstone and sandstone; limestone; glauconitic sandstone and shale.
TRIASSIC
11 SPRAY RIVER FORMATION: dark grey silty shale, siltstone and shale; light grey dolomitic or sideritic argillaceous siltstone in upper part.
11a SPRAY RIVER phosphate
PERMIAN AND PENNSYLVANIAN
10 ROCKY MOUNTAIN FORMATION: light grey quartzitic, dolomitic, and calcareous sandstone, dark grey sandstone; dolomite; cherty dolomite; chert; phosphate in upper part.
MISSISSIPPIAN
9 RUNDLE GROUP (Undivided):
Geological Contact known
Geological Contact approximate
Geological Contact estimated
Thrust Fault known
Thrust Fault approximate
Thrust Fault inferred
Normal Fault (showing direction of movement)
Normal Fault known
Normal Fault approximate
Normal Fault inferred
Syncline, Anticline known & showing direction of plunge
Syncline, Anticline approximate & showing direction of plunge
Overturned Syncline
Overturned Anticline
Bedding, (inclined, vertical, horizontal)
OUTLINE OF ELK RIVER COAL LICENCES
HIGH ROCK RANGE
PROVINCIAL FOREST
ELK RANGE
MOSQUITO FLATS
ABBY RIDGE
ALBERTA
BRITISH COLUMBIA
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
GEOLOGY OF THE ELK RIVER COAL LICENCES
DRAWN BY WMD
SCALE 1:50,000
CHECKED BY
DATE Jan/81
MAP SHEET NO. 82 J/7
DWG. NO. BG-ER81-71000-008

1.3 SUMMARY OF 1979/80 DEVELOPMENT WORK

During this term of licence, Elco's field activities or "on property" work increased over that of the two previous terms. Work was carried out during this term in the following program areas:

- Mine and Mine Facility Overburden Geotechnical Investigations;
- Mine Rock Slope Geotechnical Investigations;
- Railway Terrain Analysis Study;
- Railway and Access Road Corridor Topographic Mapping;
- Field Surveying.

(see Appendix 1.0-A, Sheets 1a & 2a of 7, and Appendix 1.0-B, Sheet 2-7 of 7.

1.31 Geophysical Surveying

Engineering seismic refraction surveys were carried out in support of the overburden geotechnical investigations. Thirty-five surveys were made at selected locations on the proposed haul road alignment, river diversion channel, access road, and Weary Creek waste dump area.

1.3 SUMMARY OF 1979/80 DEVELOPMENT Cont'd.

1.32 Drilling

Thirty nine overburden test holes, ranging in size from 114.3 mm to 177.80 mm were completed on the proposed diversion dam, river diversion channel, settling pond and haul road. In addition, a 203.2 mm pumping well was drilled in the overburden deposits at the proposed diversion dam and PVC type piezometers were installed in the overburden test holes.

A series of five bedrock pumping wells were drilled in both the proposed mine footwall and highwall/endwall areas for a total of 10 holes. Each pump test site consisted of one 200 mm diameter pump well and four 150 mm diameter observation wells, each completed with 3 PVC standpipe type piezometers.

1.33 Pump Testing

A 72 hour pump test was performed in the proposed diversion dam area to evaluate ground water conditions in the alluvium and seepage control measures that will be needed below the dam embankment.

1.3 SUMMARY OF 1979/80 DEVELOPMENT Cont'd.

1.33 Pump Testing Cont'd.

Twenty three-day and 33-day pump tests were carried out respectively in the proposed north endwall/highwall area and the proposed footwall area in order to evaluate the hydrogeology and define dewatering requirements for both slope stability and the handling of ground water inflows into the proposed open pit.

1.34 Geological Surveys

Detailed structural logging of selected drill cores, stored from earlier drill programs and structured field mapping of rock exposures within the approximate 2,600 hectare investigation area was carried out in conjunction with the rock slope stability studies.

Geological reconnaissance was carried out along the proposed alignments for the haul road, river diversion channel, diversion dams, west waste dump, settling pond, tailings pond, plant site, forestry by-pass road, northeast interceptor ditch and Weary Creek waste dump and diversion channel.

1.3 SUMMARY OF 1979/80 DEVELOPMENT Cont'd.

1.34 Geological Surveys Cont'd.

Terrain analysis and surfician geology mapping was carried out on approximately 9,800 hectares along Elco's proposed railway alignment.

1.35 Topographic Mapping

New 1:2000 scale topographic mapping was made for the proposed railway and access road corridors. A total of 6,360 hectares were mapped in both pencil manuscript and fairdrawn form.

1.36 Field Surveying

Two programs of field surveying, involving line cutting were carried out.

Program No. 1 entailed the layout of the proposed alignments for the haul road, haul road channel crossings, west waste dump toe line, northeast interceptor ditch, tailings pond dyke centre line, settling pond dyke centre line, river diversion cutoff dam centre lines, Bleasdell Creek railway crossing and impart, the forestry bypass road and the

1.3 SUMMARY OF 1979/80 DEVELOPMENT Cont'd.

1.36 Field Surveying Cont'd.

Weary Creek diversion channel. In total 23.3 kilometers of line cutting was carried out in this program. In addition to line cutting, field surveying in the second program also involved: the erection of permanent primary control signals; new permanent secondary control surveys; new road, drill site and test pit surveys, new bench mark surveys; and old adit and drill site surveys.

1.37 Test Pits

Seventy four test pits, each approximately measuring one meter by three meters were completed for: the proposed haul road; river diversion channel; west waste dump; forest bypass road; tailings pond; settling pond; and Weary Creek waste dump.

1.40 Summary of Work by Licences

See Table 1.4 - 1, "Summary of Work by Licences," Page 14.

1.3 SUMMARY OF 1979/80 DEVELOPMENT Cont'd.

1.40 Summary of Work by Licences Cont'd.

Licence No.	TYPE OF WORK						
	Geophy. Survey	Drilling	Pump Testing	Geolog. Surveys	Topo. Mapp.	Field Survey	Test Pits
64				X			
65				X			
421				X	X		X
422	X	X		X	X	X	X
423	X			X		X	
424				X		X	
425				X	X	X	X
426		X				X	X
427				X		X	
428				X	X	X	
429				X	X		
430				X	X		
431				X	X		
432				X	X		
433				X	X		
434				X	X		
481					X	X	
482	X	X		X	X	X	X
483				X		X	
484				X	X	X	X
485	X	X		X	X	X	X
486				X		X	
487				X	X	X	X
488	X	X		X	X	X	X
489		X	X	X		X	
515		X	X	X	X	X	X
773						X	
776						X	
956				X		X	X
957				X		X	X
Outside Licence Area				X	X	X	X

Table 1.4 - 1

SUMMARY OF WORK BY LICENCES

SECTION 2

WORK PROGRAMS

2.1 FIELD SURVEYING

Field surveying was divided into two work programs and each was let out under separate contract. McElhanney Surveying and Engineering Ltd. was responsible for the survey work under Program No. 1 while Kerr Wood Leidal and Associates Ltd. was responsible for Program No. 2 survey work.

2.11 Survey Program No. 1

This was the most extensive of the two survey programs completed. In total 554 man-days were worked in the field. This was accomplished by three 3-man crews and one supervisor. In general, the work consisted of the following:

- Using plans and data supplied by Elco, proposed alignments were located on the ground and control stations established along these alignments;

- Coordination of all control stations, drill holes and test pits was carried out upon completion of geotechnical field work;

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

- Plans were prepared of all surveys (including the river diversion survey described later under Survey Program No. 2) and profiles of certain alignments, as specified by Elco, were constructed.

The following surveys were completed:

- Horizontal Control
- Monumentation of Primary Control Points
- West Waste Dump
- Tailing Dike Alignment
- Settling Pond Dike Alignment
- Weary Valley Road Traverse
- Forestry Bypass Road
- Haul Road Alignment
- Haul Road Crossings
- Weary Creek Diversion Channel
- Bleasdell Creek Railway Crossing
- River Diversion
- Cutoff Dams
- Sewage Lagoon
- Northeast Interceptor Ditch

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

- Geotechnical Exploration Drill Holes and Test Pits - IECO
- Geotechnical Drill Holes - Golder
- Old Exploration Drill Holes and Adit Surveys

See Appendix 2.0 "Survey Station Reference Plan," McElhanney Surveying and Engineering Ltd., Sheets 1 and 2.

Previous work consisted of traverses along road and transmission corridors of the Elk Valley and trilateration between prominent locations in the valley. This work had been completed over a period of several years dating back to 1968. Bench marks had been located in 1976/1977 from the McElhanney level run carried out in 1970. Elevation datum is at Michel Creek near Sparwood.

The accuracy of this work is not documented so it was necessary to tie the horizontal control with remeasurements whenever it was intended to use any of the control points. It was decided to make control monument 3620 the origin of coordinates and the line 3620 to Bleasdell the origin of

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

bearings for all connections made during the program.

Distances were reduced to the 1500 meter datum. The radius of curvature used was 6378231.834 meters. The reduced distance was obtained by using the following relationship:

$$S_1 = (Cr/Cr + (\frac{hA + hB}{2} - 1500)) \times So$$

Where: S_1 = distance reduced to the 1500 meter datum

Cr = radius of curvature

h_A = elevation of Station A

h_B = elevation of Station B

So = distance between A and B reduced to the horizontal plane.

All traverse loops and control ties were adjusted using the compass rule.

All control connections were made using Wild T2 theodilites and an HP 3808 distance measuring instrument. Traverses were carried out using Wild T2 and 20" reading theodilites.

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

Other distance measuring instruments used for traversing were Sokkisha Red 1A and K & E Autoranger.

Profiles were carried out using the level and chain or by using the transit, rod and stadia intercepts. When using stadia intercepts the reductions were computed using the following relationships:

$$\text{Horizontal Distance} = \text{S.I.} \times \cos^2 a$$

Where: S.I. = difference between top and bottom intercepts times 100

a = slope angle

$$\text{Vertical Displacement} = \text{S.I.} \times \cos a \times \sin a$$

Levels were carried out to third order accuracies which require that the misclosure be less than 24 mm $\sqrt{K}$, where K is the distance between bench marks in kilometers. A network of level loops has been initiated and these are run both ways.

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

In order to preserve the survey information generated during the 1980 program the following procedures were carried out.

Traverse control stations consist of rebar set in concrete. Survey control data cards were prepared for each of these stations. Traverse stations were marked with 10" or 12" spikes and hubs or laths were placed near to the spike. Each station was marked with a metal tag stamped with a number. All references to each station in the field notes, plan and coordinate listings are to the number on the tag.

Seventeen signals were fabricated and erected at the following control stations:

3606	Riverside
3609	Underhill No. 5
3610	Underhill No. 6
3620	Underhill No. 7
3621	Underhill No. 8
4752	Underhill No. 9
4756	Underhill No. 11
4849	8006
Bleasdell	

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

The cost of constructing the signals was $167 per signal and including cost of labour and helicopter time the cost of constructing and erecting the signals was $580 per signal (see Figure 2-11-1, "Details of Survey Control Monument Signal," page 22).

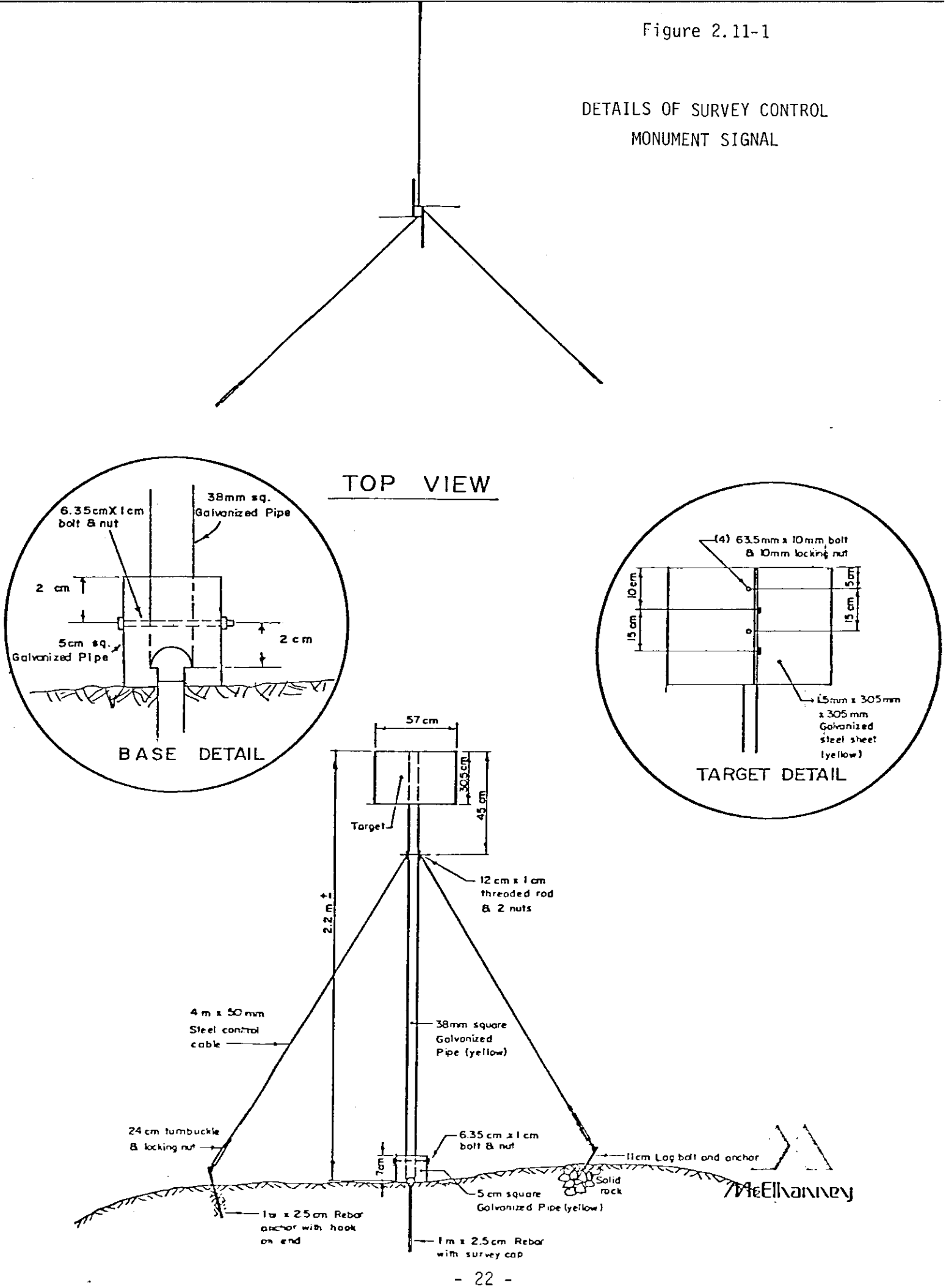
During the program, ties were made between various primary control monuments. The coordinate listings have been amended to the new values obtained. Two new stations were set and surveyed in. These were 8005 and 8006. Stations 4849 and 3609 were found to have had the survey monument removed. A new monument was established at each of these sites.

The following is a summary of the control work completed and the closures obtained:

3620 - 4849 - 8024 - 3620	1:79856
3620 - 3610 - 4849	1:185303
3620 - 3609 - 4849	1:76565
4849 - 8005 - Riverside - 8006 - 4849	1:73374
8005 - U658 - 4849	1:58282

Figure 2.11-1

DETAILS OF SURVEY CONTROL
MONUMENT SIGNAL



2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

To assist the geotechnical studies and provide data for future design work profiles were prepared on the following alignments, (see Appendix 3.0-A through 3.0-M).

- Haul Road (see Appendix No. 3.0-A, Sheets 1-14)
- Haul Road Crossing No. 1 (see Appendix No. 3.0-B, Sheets 1-2)
- Haul Road Crossing No. 2 (see Appendix No. 3.0-C, 1 sheet only)
- Haul Road Crossing No. 3 (see Appendix No. 3.0-D, Sheets 1-2)
- Settling Pond Dyke (see Appendix No. 3.0-E, Sheets 1-3)
- Tailings Pond Dyke (see Appendix No. 3.0-F, Sheets 1-7)
- River Diversion Cutoff Dam No. 1 (see Appendix No. 3.0-G, 1 sheet only)
- River Diversion Cutoff Dam No. 2 (see Appendix No. 3.0-H, 1 sheet only)
- River Diversion Cutoff Dam No. 3 (see Appendix No. 3.0-I, 1 sheet only)
- River Diversion Cutoff Dam No. 4 (see Appendix No. 3.0-J, 1 sheet only)

2.1 FIELD SURVEYING Cont'd.

2.11 Survey Program No. 1 Cont'd.

- River Diversion Cutoff Dam No. 5 (see Appendix No. 3.0-K, 1 sheet only)
- Bypass Road (see Appendix No. 3.0-L, Sheets 1-5)
- Bleasdell Creek Railway Crossing (see Appendix No. 3.0-M, Sheet)

2.12 Survey Program No. 2

Survey Program No. 2 involved surveying of the proposed river diversion channels for which there are three. These are known as the northern, middle and southern channel segments. Two 2-man survey crews completed the northern and middle segments between July 2 and July 31 while one 2-man crew completed the southern segment between July 31 and August 26. In general, the work consisted of the following:

- Using conceptual design plans developed by Kerr Wood Leidal (KWL) channel center lines were located on the ground;

- Cross-sections for the purpose of determining excavation quantities were run across the center line;

2.1 FIELD SURVEYING Cont'd.

2.12 Survey Program No. 2 Cont'd.

- Detailed topographical surveys of the inlet and outlets to each channel segment were completed;

- Coordination of all control stations;

- Preparation of plans of all surveys and profiles of cross-sections and center line sections.

Prior to KWL undertaking their surveys, McElhanney established control points on each channel segment as a basis for primary (EMGS) network control ties.

Survey procedures used are similar to those used by McElhanney and which have been described in Section 2.11.

To assist the geotechnical studies and provide data for future design work, plans and profiles were prepared. Plan views were transfered and are presented in Appendix 2.0, "Survey Station Reference Plan", McElhanney Surveying and Engineering Ltd. Profiles are presented in Appendices 4.0-A and 4.0-B.

2.2 TOPOGRAPHIC MAPPING

Pacific Survey Company Limited was contracted to carry out manuscript and fair drawn mapping of Elco's proposed railway and access road corridors. This mapping was a continuation of the work which had begun, and which has been reported on in the 1978/79 term of licence work report[4]. During that period the aerial photography and the ground control survey were completed.

This mapping was undertaken for the purpose of carrying out conceptual design work on Elco's proposed railway and access road. Mapping was produced at a scale of 1:2000 with a 2 meter contour interval and a 1 meter interpolated contour interval.

Mapping was confined to a 500 meter wide strip centered over the separate alignment center lines. For the railway, this began near the Fording Coal Ltd.'s spur line and the Fording River junction, (in the so-called Boivin Pass area) for the access road at the town of Elkford.

Both alignments run northward approximately 50 km to Elco's proposed mine site. The access road alignment becomes the forest bypass road at Elco's proposed plant site. It extends northwards on the west side of the mine area, then loops eastward over the proposed river diversion dam to rejoin the existing forestry road, a length of approximately 8 km.

2.2 TOPOGRAPHIC MAPPING Cont'd.

Where the railway alignment approaches the proposed Elk River crossing, mapping was extended to full valley bottom coverage. Where the railway and access road alignments converge, strip maps 750 meters wide were made. Also, map coverage was widened to include all Elco's proposed plant site area.

Fair drawn mapping was stopped at the plant site area, while manuscript mapping continued along the length of the forestry bypass road alignment. Topographic plans are presented in Appendix 5.0.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK

Elco undertook three separate geological/geotechnical field programs during the 1979/80 term of licence. These were as follows:

- Railway Corridor Geological/Geotechnical Investigations;
- Mine/Mine Facility Overburden Geological/Geotechnical Investigations;
- Mine Rock Slope Geological/Geotechnical Investigations.

These programs were carried out by three separate consulting firms. The mine related programs were field supported by Elco both directly and through separate contracts for the following:

- Permits, Administration and Coordination;
- Communications,
- Safety,
- Surveying,
- Labour and Construction (roads, test pits, drill sites);
- Drilling and Pump Testing,
- Laboratory Analysis,
- Camp and Catering,
- Archeological,
- Reclamation and Environmental Administration.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

McMeekin Construction Ltd. was retained to carry out road repair, road and drill site construction, test pit digging and timber slashing and cleanup. Two D6D, wide-track dozer tractors were used for road and drill site construction. A 0.76 cubic meter, model 2800 Linkbelt tracked backhoe was used to assist with the road building and to dig the test pits. A 2-man saw crew was used to slash cleared timber on roads and drill sites, to cut and remove any trees which had fallen into standing timber and to hand clear test sites located in areas designated as environmentally sensitive. See Appendix 1.0-A, "Plan of 1980 Field Work - Mine Site," for locations of completed roads, drill sites and test pits.

McMeekin Construction Ltd. was also under contract to Elco for the providing of camp and catering services. A 46-man camp consisting of a kitchen/diner, 5 sleeper units, one wash/laundry unit, two office units and a light plant was set up on Elco's former Weary Creek camp site, (see Appendix 1.0-A, Sheet 2A of 7 for camp site location).

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

All Kind Drilling Ltd. carried out overburden drilling and sampling and piezometer installations in the overburden test holes. To perform this work two drills were used, one, a Failing 1500, truck mounted rig set up for standard water/ mud drilling and coring, the second, a Boa M-60 track mounted drill set up for auger and core drilling.

Drillwell Enterprises Ltd. was contracted to carry out the large diameter well drilling for the pump test programs. This included pump tests in both overburden and bedrock. A truck mounted Bucyrus-Erie 12R rotary drill, equipped with air circulation, down-hole-hammer and casing hammer was used.

CPI Equipment Ltd. was contracted to carry out pump testing services in both the overburden and bedrock pump testing programs. Equipment included electric submersible pumps, well pipe, discharge pipe, monitoring equipment, electric generators, and a hoisting truck. A 2-man setup/takedown crew, and a monitoring technician were provided.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.31 Terrain Analysis and Surficial Geological Mapping of Railway Corridor

Thurber Consultants Ltd. were contracted to carry out a detailed terrain analysis and surficial geological study along Elco's proposed 47 kilometer railway corridor beginning from the CP Rail Fording Mine spur - Fording River junction and running northward along the Elk River Valley to Elco's proposed mine site.

The purpose of this study was to identify important geotechnical problems so that Elco could:

- Assess a proposed alignment and adjust to optimum locations;
- Develop preliminary cost estimates for construction, and
- Identify areas requiring further studies.

Seven days of field work for this study were completed in late June of 1980. The field work was preceded by a preliminary air photo interpretation which delineated areas for field investigations. Soil samples were collected and analyzed. Results are included in Table 2.31-1, page 32 and Figures 2.31-1 to 2.31-3, pages 33 to 35.

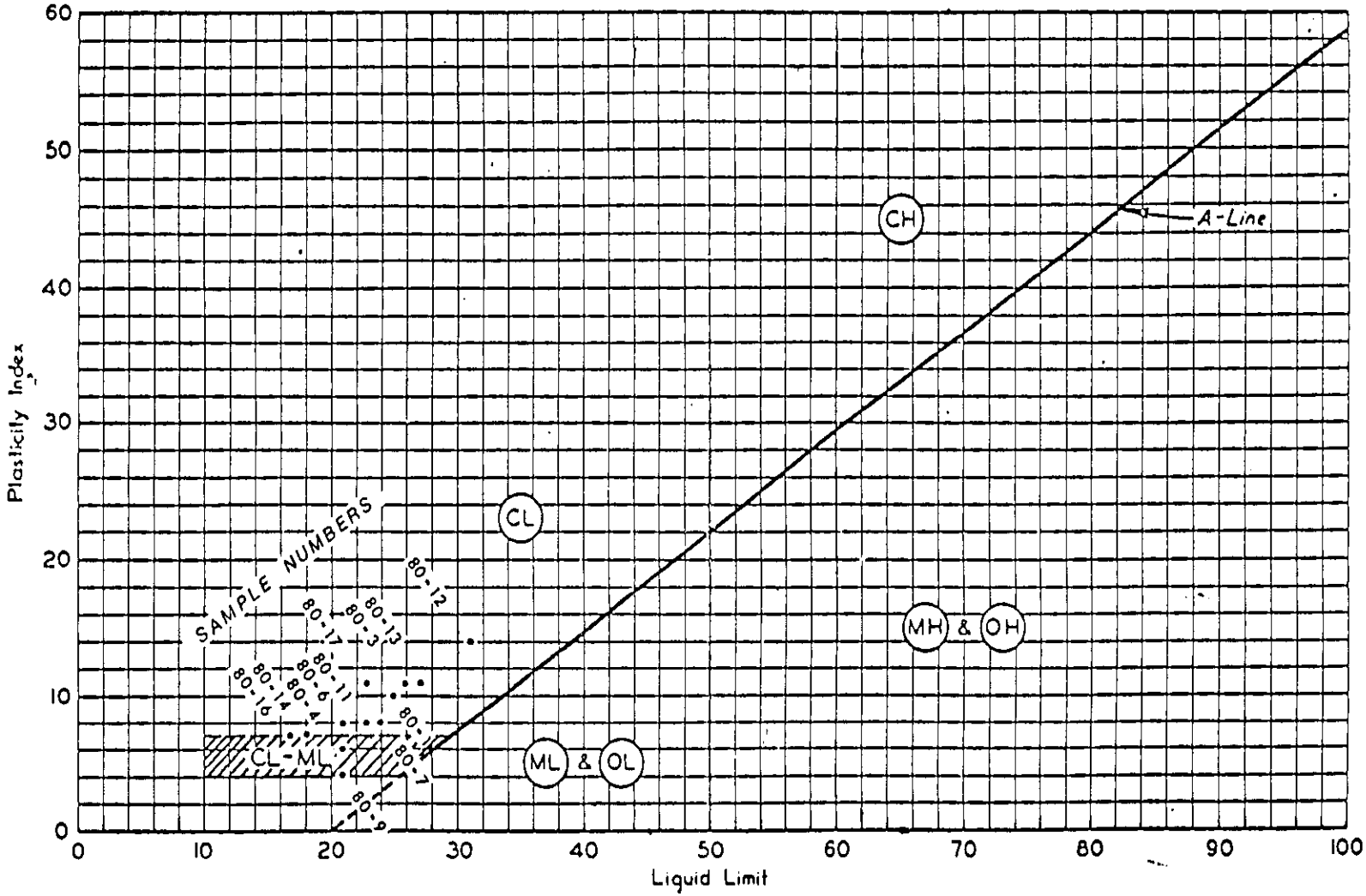
Table 2.31-1

DESCRIPTION OF SOIL SAMPLES

SAMPLE No.	CHAINAGE LOCATION	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION	MOISTURE % (w)	ATTERBERG LIMITS LL	PL	PI	GRAIN SIZE % Gravel	Sand	Silt	Clay	COMMENTS
80-1	Slide scarp near km 26.5	CL	Sandy silty clay fines.	2.3	25	15	10	-	-	-	-	Till.
80-2	Slide scarp near km 26.5	CL	Silty clay fines. Low plastic.	3.6	-	-	-	-	-	-	-	Fines interbedded in till.
80-3	Power line access road near km 26.8	CL	Silty clay, some sand, medium plastic.	2.2	26	15	11	-	-	-	-	Till.
80-4	Flowslide scarp near km 28.5	CL-ML	Slightly clayey sandy gravel. Well graded.	11.6	21	15	6	-	-	-	-	Till.
80-5	Stream cut face near km 3.4	GW-GM	Silty, sandy gravel.	-	-	-	-	41.3	49.9	8.8		Fan alluvium.
80-6	Slide scarp near km 25.7	CL	Silty clay with sand. Medium plastic fines.	6.7	20	12	8	19.2	28.2	34.6	18.0	Near preferred Elk River crossing alignment.
80-7	Slide scarp - access road near km 25.8	CL	Silty clay fines. Low - medium plastic.	13.4	24	16	8	-	-	-	-	Small recent failure near access road.
80-8	Slide scarp - access road near km 25.8	OH	Organic silty clay fines. High plastic.	-	-	-	-	-	-	-	-	Soft alluvial soil overlying till in scarp.
80-9	Slide scarp near km 17.9	ML	Sandy clayey silt fines.	3.1	21	17	4	19.0	34.8	37.2	9.0	Small shallow slide on large gully slope.
80-10	Carbonate pan from small slide near km 17.9	-	Cemented soil.	-	-	-	-	-	-	-	-	Carbonate pan from soil horizon. Forms continuous layers.
80-11	Slide scarp above rock canyon - km 11.4	CL	Silty clay fines with sand and gravel.	3.1	23	15	8	-	-	-	-	Till.
80-12	Access road north of line terminus near km 46.1	CL	Clayey silt and silty clay with organics.	15.8	31	17	14	19.1	24.8	37.1	19.0	Till.
80-13	Forestry road near km 43.8	CL	Silty clay. Medium plastic. Layered.	15.0	27	16	11	-	-	-	-	Glaciolacustrine material.
80-14	Borrow pit at km 41.6	CL-ML	Sandy silty clay. Very hard.	7.2	18	11	7	5.8	28.1	37.1	29.0	Till.
80-15	Terrace south of Birgay Creek opposite km 23.3	GM	Silty sandy gravel.	-	-	-	-	68.2	27.0	- 4.8 -		Terrace alluvium.
80-16	Drift exposure above Elk River near km 39.8	CL	Sandy silty clay fines.	0.9	17	10	7	-	-	-	-	Till.
80-17	Drift exposure above Elk River near km 39.8	CL	Layered silty clay. Seams of fine sand.	21.3	23	12	11	-	-	-	-	Glaciolacustrine material - water bearing in silt - sand horizons.
80-18	Bluff face near km 22.3	GP	Poorly graded sandy gravel.	-	-	-	-	77.1	21.0	1.9		Very dense carbonate

Figure 2.31-1

PLASTIC ANALYSIS OF FINE GRAINED SOILS



PLASTICITY CHART

Unified Soil Classification System & N.R.C. Field Description (Modified with clay size at 0.002 mm)

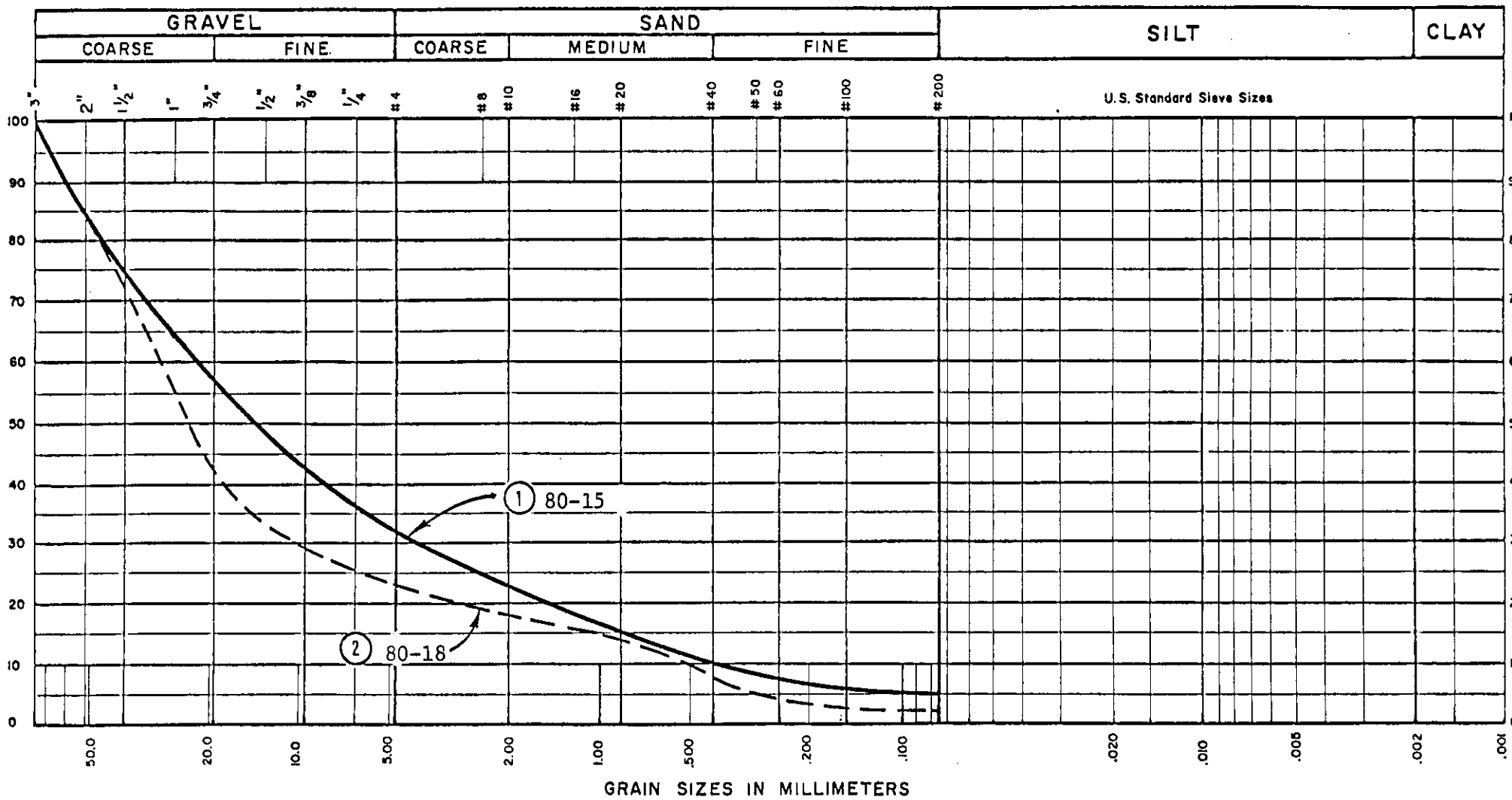


Figure 2.31-2
SIEVE ANALYSIS OF OUTWASH GRAVELS

Nat. Water Content		%
Liquid Limit		
Plastic Limit		
Plastic Index		

	①	②	
Clay	4.8	1.9	%
Silt			
Sand	27.0	21.0	
Gravel	68.2	77.1	

Classification _____

OUTWASH GRAVELS

CLIENT	Elco Mining Ltd.
PROJECT	Rail Extension
LOCATION	See Table 1
SAMPLE	
TEST DATE	August 26, 1980 FILE Nº 17-848-0

THURBER CONSULTANTS LTD., Geotechnical Engineers

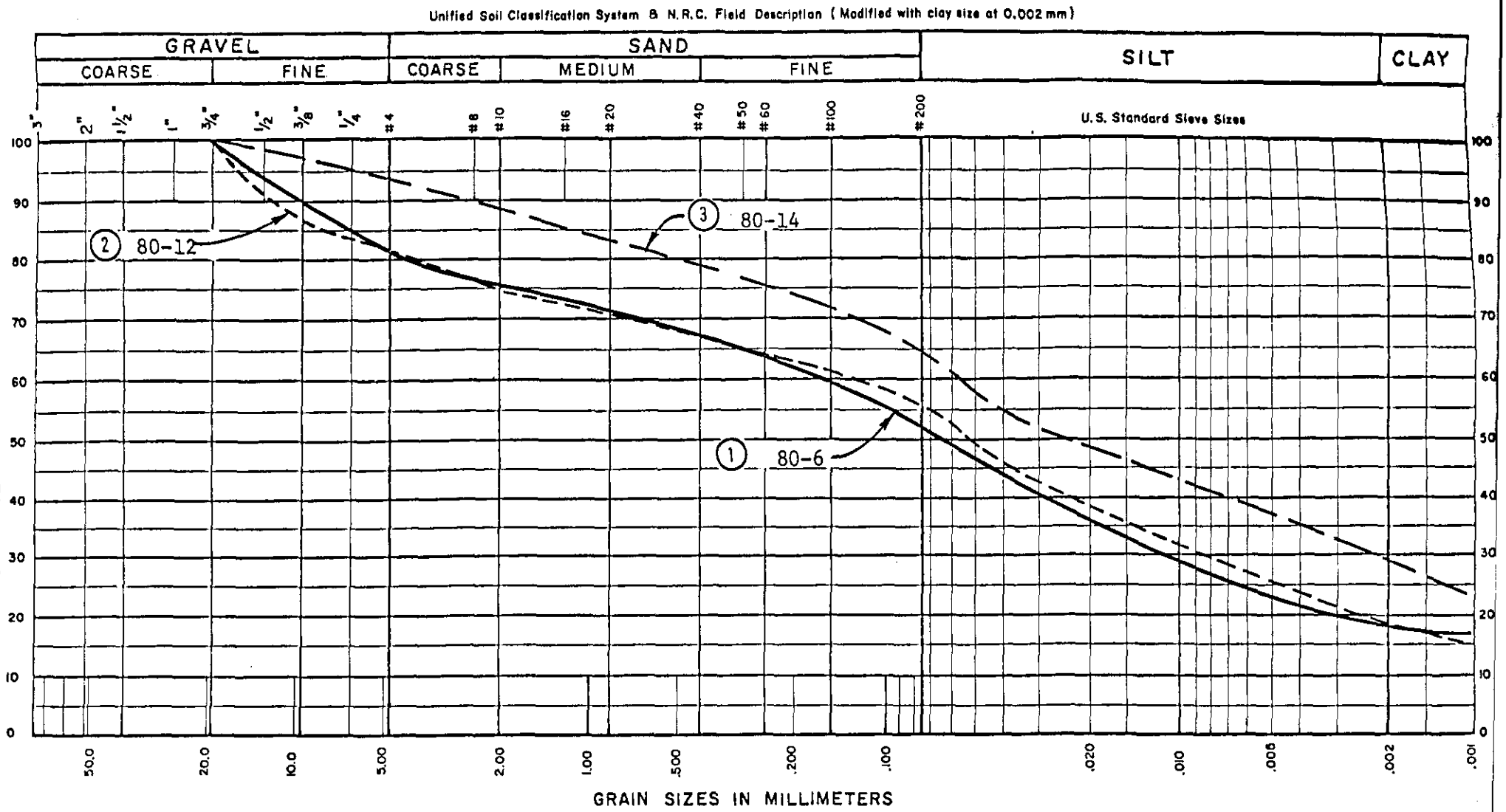


Figure 2.31-3
SIEVE ANALYSIS OF TYPICAL TILL SAMPLES

	①	②	③
Nat. Water Content			%
Liquid Limit			
Plastic Limit			
Plastic Index			
Clay	18.0	19.0	29.0%
Silt	34.6	37.1	37.1
Sand	28.2	24.8	28.1
Gravel	19.2	19.1	5.8

Classification _____

TYPICAL TILL SAMPLES

CLIENT	Elco Mining Ltd.
PROJECT	Rail Extension
LOCATION	See Table 1
SAMPLE	
TEST DATE	July 14-17, 1980 FILE Nº 17-848-0

THURBER CONSULTANTS LTD., Geotechnical Engineers

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.31 Terrain Analysis and Surficial Geological Mapping of Railway Corridor Cont'd.

The geotechnical evaluations are shown on the 1:12,000 scale maps (see Appendix 1.0-B, sheets 2-7) with descriptive geotechnical comments. Separate terrain mapping was also undertaken by Thurber. This is shown on the 1:12,000 scale mosaics, (see Figure 2.31-5, sheets 1-7, pages 38 to 44). Mapping units are described in the Terrain Mapping Legend, (see Figure 2.31-4, page 37).

TEXTURE DESCRIPTOR

(Particle sizes based upon Unified Soil Classification System and N.R.C. Field Description)

Specific Clastic Terms:

b	bouldery	203 mm plus
k	cobbly	76 – 203 mm
p	gravelly	5 – 76 mm
s	sandy	.075 – 5 mm
$	silty	.002 – .075 mm
c	clayey	minus .002 mm

Common (Grouped) Classes:

a	blocky	angular boulders
r	rubbly	angular gravel and cobbles
g	mixture of gravel and coarser	
-s-	silt and sand	mixture $ and s
f	fines	mixture $ and c

Organic Soils:

e fibric m mesic h humic

Well-sorted materials are described by the use of a single textural term; less well-sorted and poorly sorted materials are described using two textural terms with the subordinate textural term given first.

GENETIC MATERIALS

A	Anthropogenic*		
C	Colluvial*	O	Organic*
E	Eolian	R	Bedrock
F	Fluvial (Alluvial)	S	Saprolite*
I	Glacier Ice*	V	Volcanic
L	Lacustrine	W	Marine
M	Morainal (Till)		

U Undifferentiated

* (Marks materials for which formative processes are assumed active; others are assumed inactive).

In areas of air photo interpretation without field checking, textures of genetic materials are commonly not shown. Textures are then assumed to lie within a range which is defined for the Genetic Material within the E.L.U.C. publication.

SURFACE EXPRESSION DESCRIPTOR

a	apron	m	subdued
b	blanket	r	ridged
f	fan	s	steep
h	hummocky	t	terraced
l	level	v	veneer

The use of two (or rarely three) surface expressions together implies there is a mixing of discrete forms and not a combination of intermediate forms. Blanket indicates deposits greater than 1 metre thick; veneer indicates deposits less than 1 metre thick. The use of s is reserved for erosional slopes generally greater than 35° on both consolidated and unconsolidated materials.

QUALIFYING DESCRIPTOR

Qualifies genetic materials or modifying processes always as superscript following the term so qualified.

G	Glacial	
B	Bog	Reserved for organic Genetic Materials
F	Fen	
S	Swamp	
A	Active Process	
I	Inactive Process	

Active processes are those which give evidence for being recurrent or contemporary; inactive processes are those which are not recurrent and which have ceased. Modifying Processes and formative processes for Genetic Materials are assumed to be either active or inactive. A superscript modifier is shown only where a process state is contrary to the common assumption.

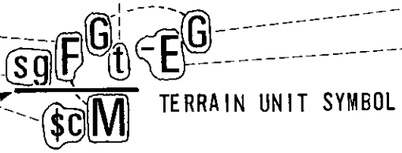
MODIFYING PROCESSES

-A	Avalanched*
-B	Bevelled
-C	Cryoturbated*
-D	Deflated
-E	Channelled
-F	Failing*
-H	Kettled
-K	Karst Modified*
-N	Nivated*
-P	Piping*
-S	Soliflucted*
-V	Gullied*
-W	Washed

* Marks processes assumed to be active; others are assumed inactive.

STRATIGRAPHIC DATA:

The horizontal bar indicates that the upper material overlies the lower material.



TERRAIN UNIT SYMBOL

EXAMPLE SHOWN:

Sandy gravelly and coarser fluvioglacial terrace deposits with channels eroded by glacial meltwater; the whole unit overlying silty clay till.

ON-SITE SYMBOLS: (These, and other, symbols may be used to show features or locations of special interest or limited areal extent).

- Drumlin, Crag-and-tail or Drumlinoid ridge
- Fluting
- Roche Moutonnée (stoss-and-lee)
- Glacial Striae, (ice direction known)
- Glacial Striae, (ice direction unknown)
- Moraine ridge (end moraine)
- Minor moraine ridges
- Eskers, direction of depositional flow known
- Eskers, direction of depositional flow unknown
- Kettle
- Large glacial meltwater channel
- Small glacial meltwater channel
- Abandoned shoreline
- Active dunes
- Inactive dunes
- Block fields
- Rock glaciers
- Escarpment
- Cirque
- Avalanched
- Failing: with outline of feature.
- Piping
- Gullied
- Erratic
- (F) Quaternary Fossil locality
- (H) Anthropogenic site
- Landslide scar
- (K) Karst
- Mine or Quarry
- Borrow Pit
- Unit boundary - broken line where approximate

COMPOSITE UNITS:

= components on either side of this symbol are approximately equal in area.

example 1:

Mb=R, Moraine blanket area roughly equals the exposed bedrock area.

/ the component in front of the symbol is more abundant (55 to 70%) than the one that follows.

example 2:

Mb/R, Moraine blanket area is more than the area of exposed bedrock

// the component in front of the symbol is considerably more abundant (70 to 90%) than the component that follows.

example 3:

Mb//R, Moraine blanket area is considerably more than the area of exposed bedrock.

Modified by Thurber Consultants Ltd. from "Terrain Classification System", British Columbia E.L.U.C. Secretariat, 1978 (3rd.printing). Refer to this publication, available from the Resource Analysis Br., B.C. Ministry of Environment, for important descriptive details of the terrain mapping legend.

THURBER CONSULTANTS LTD.
VICTORIA VANCOUVER EDMONTON

Figure 2.31-4
TERRAIN MAPPING LEGEND

Figure 2.31 - 5

Sheet 1

	Elco Mining Ltd.	DRAWN: R.G.
		TRACED:
	TERRAIN MAPPING	DATE: Sept. 1980
		APPROVED:
	Elco Mine Railway Elk River Valley, B.C.	SCALE: 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers		DRAWING NO: 17-848-0-2

Figure 2.31 - 5

Sheet 2

	Elco Mining Ltd.	DRAWN: R.G.
	TERRAIN MAPPING	TRACED:
	Elco Mine Railway — Elk River Valley, B.C.	DATE: Sept. 1980
		APPROVED:
		SCALE: 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers		DRAWING NO: 17-848-0-2

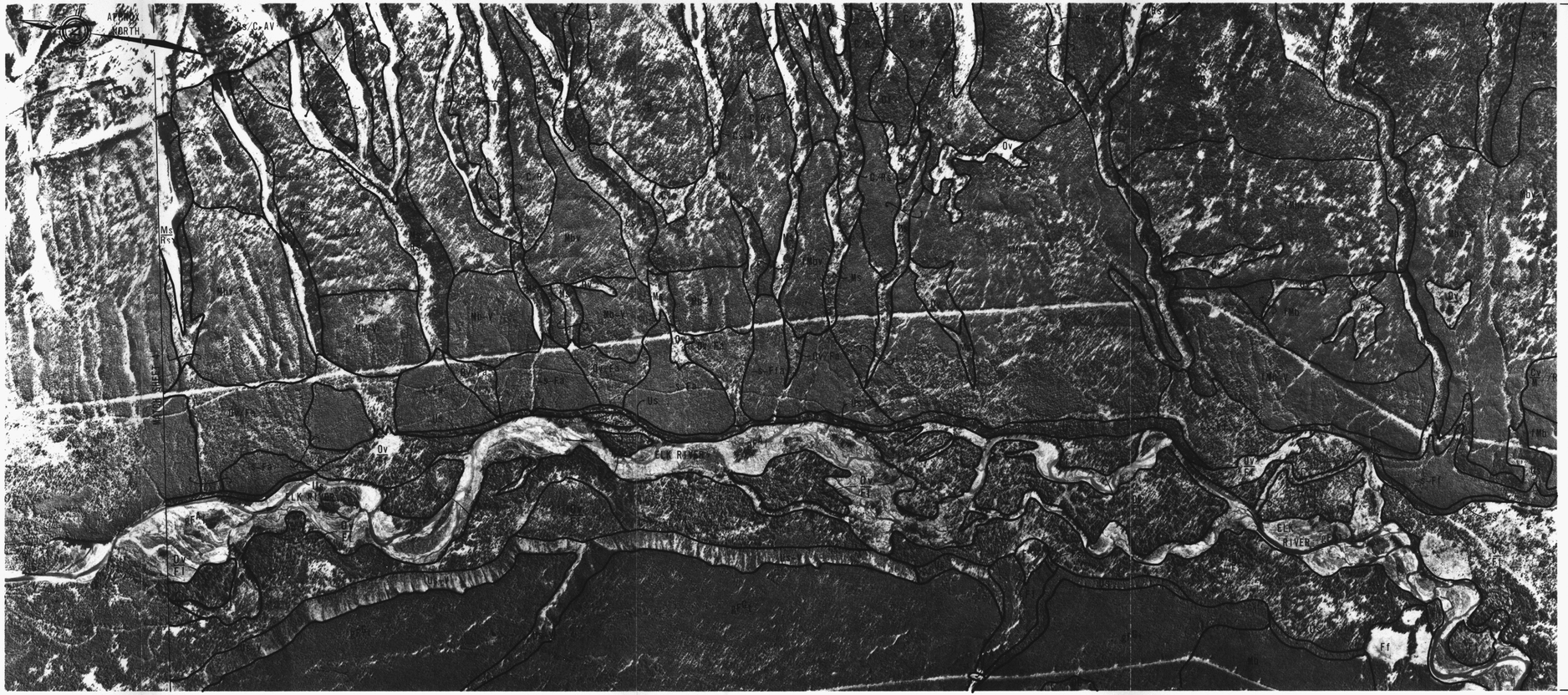


Figure 2.31 - 5

Sheet 3

	Elco Mining Ltd.	DRAWN: R.G.
		TRACED:
	TERRAIN MAPPING	DATE: Sept. 1980
		APPROVED:
	Elco Mine Railway Elk River Valley, B.C.	SCALE: 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers		DRAWING No: 17-848-0-2

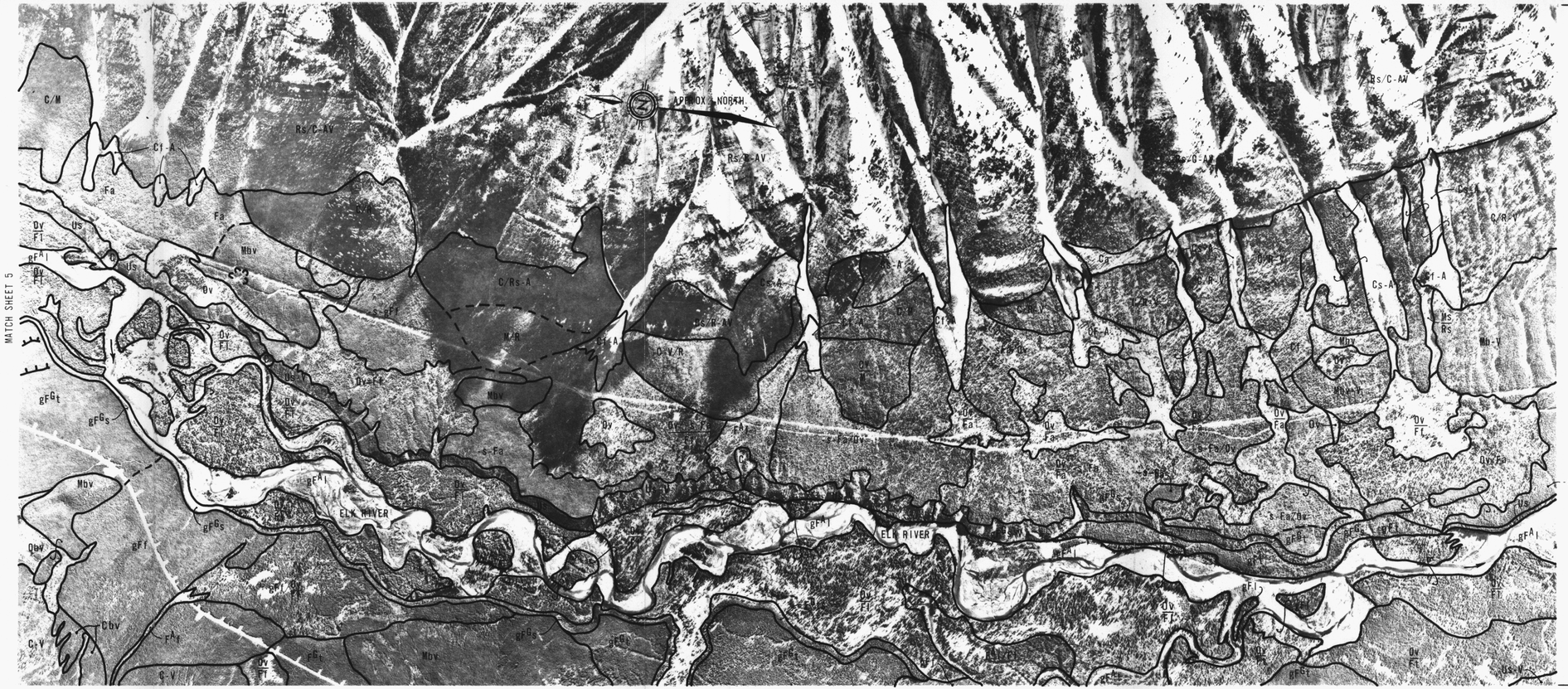


Figure 2.31 - 5

Sheet 4

Elco Mining Ltd.	DRAWN	R.G.
	TRACED	
TERRAIN MAPPING	DATE	Sept. 1980
	APPROVED	
Elco Mine Railway Elk River Valley, B.C.	SCALE	1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers	DRAWING NO.	17.848-0-2

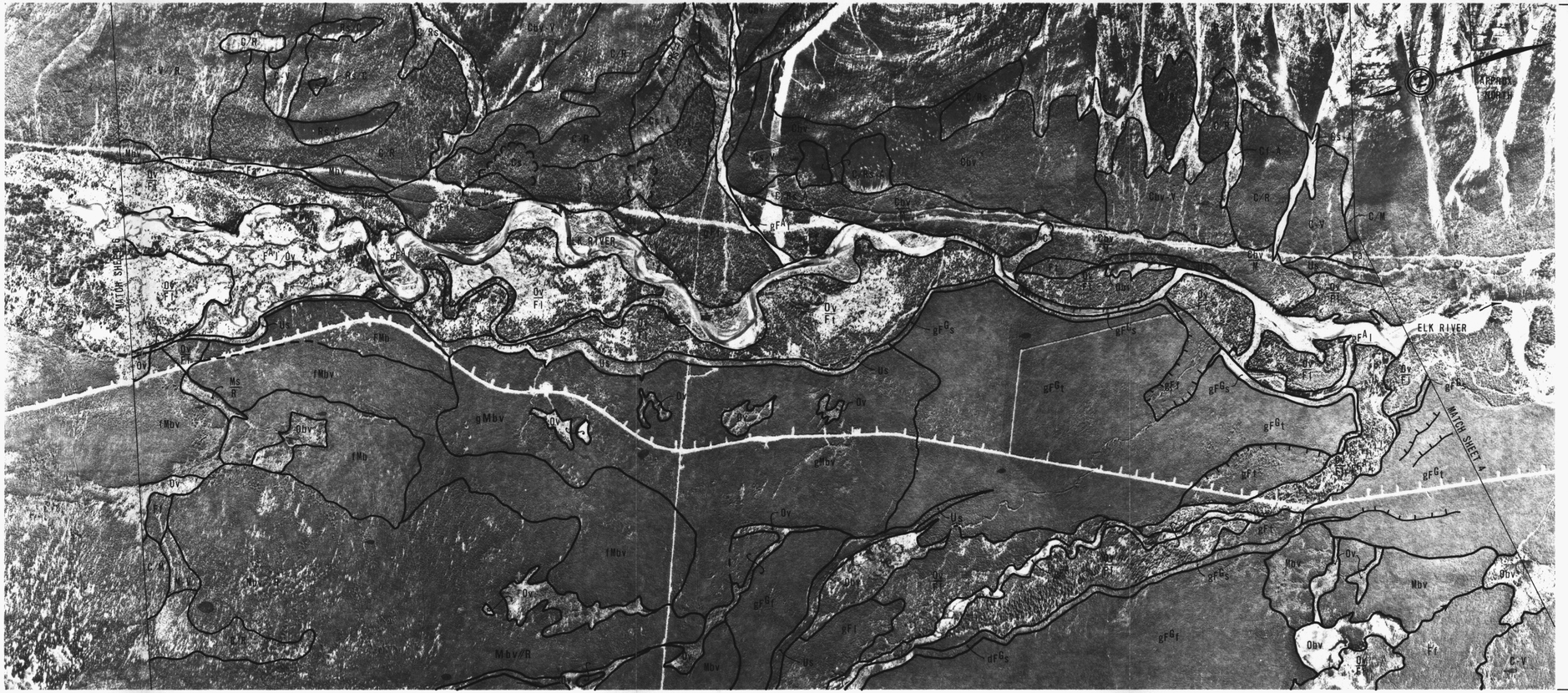


Figure 2.31 - 5

Sheet 5

Elco Mining Ltd.	DRAWN R.G.
	TRACED
TERRAIN MAPPING	DATE Sept. 1980
	APPROVED
Elco Mine Railway. Elk River Valley, B.C.	SCALE 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers	DRAWING NO. 17-848-0-2

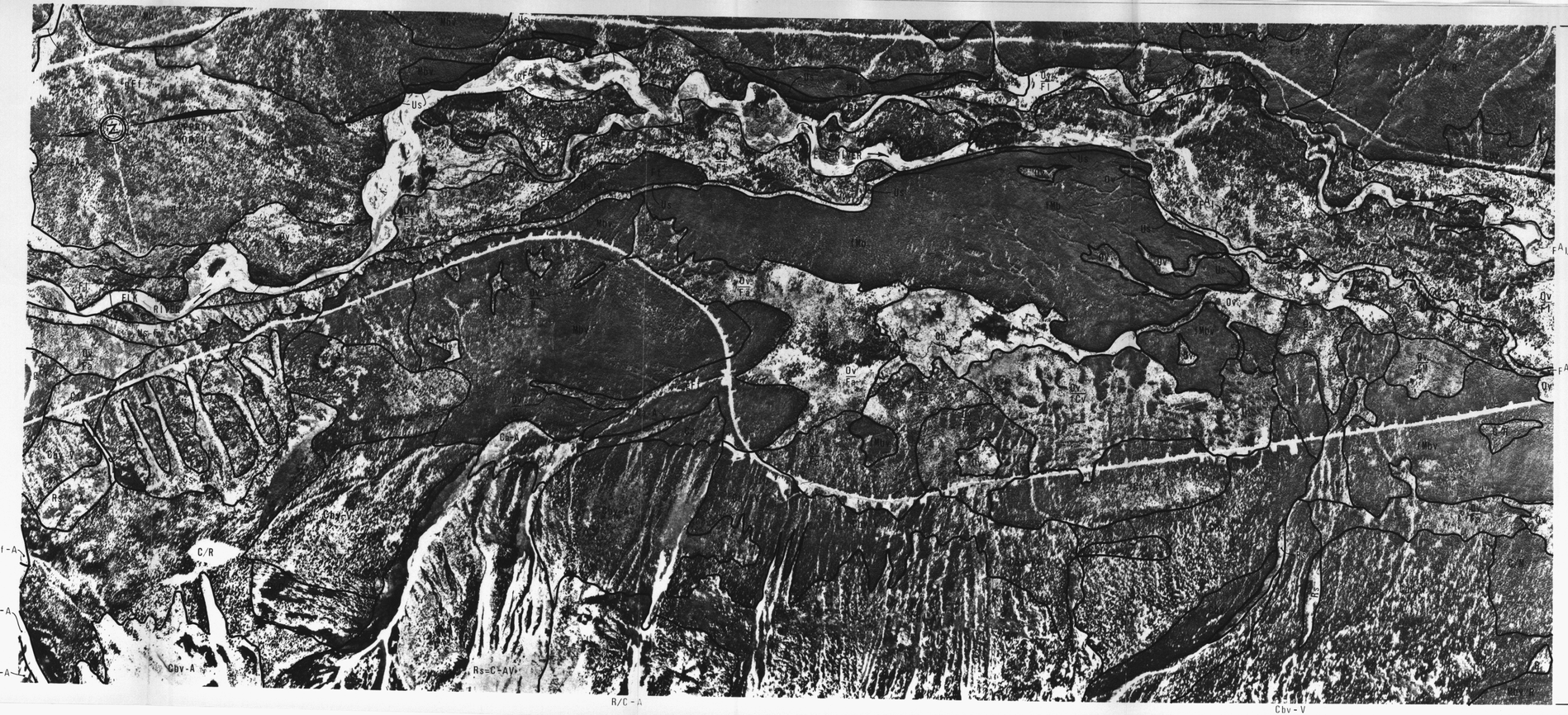


Figure 2.31 - 5
Sheet 6

	Elco Mining Ltd.	DRAWN: R.G.
	TERRAIN MAPPING	TRACED:
		DATE: Sept. 1980
		APPROVED:
	Elco Mine Railway Elk River Valley, B.C.	SCALE: 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers		DRAWING NO.: 17-A48-0-7

Figure 2.31 - 5

Sheet 7

	Elco Mining Ltd.	DRAWN: R.G.
		TRACED:
	TERRAIN MAPPING	DATE: Sept. 1980
	Elco Mine Railway Elk River Valley, B.C.	APPROVED:
		SCALE: 1:12,000
THURBER CONSULTANTS LTD., Geotechnical Engineers		DRAWING NO: 17-848-0-2

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

International Engineering Company Inc. (IECO) was under contract to carry out overburden geotechnical and overburden hydrological studies on the various proposed open pit mine facilities. These facilities included the Elk River diversion and integrated mine haul road, Weary Creek diversion and waste dump, northeast interceptor ditch, mine water settling pond, tailings pond, west waste dump, forest service bypass road, and other minor facility areas, (see Appendix 6.0, "Site Exploration Plan---," Sheets 1-2).

During Elco's feasibility studies it was recognized that more detailed information was required on the overburden geology, hydrology and geotechnical parameters before final cut and fill and foundation designs could be made on the diversion channels and dams, retention ponds and waste dumps. Earlier studies had indicated that preglacial and/or interglacial channels filled with water bearing gravels could exist within the glacial till and on the bedrock surface. These could pose serious problems in particular to the river diversion. To carry out this field program IECO had two geological engineers and one soils engineer in the field

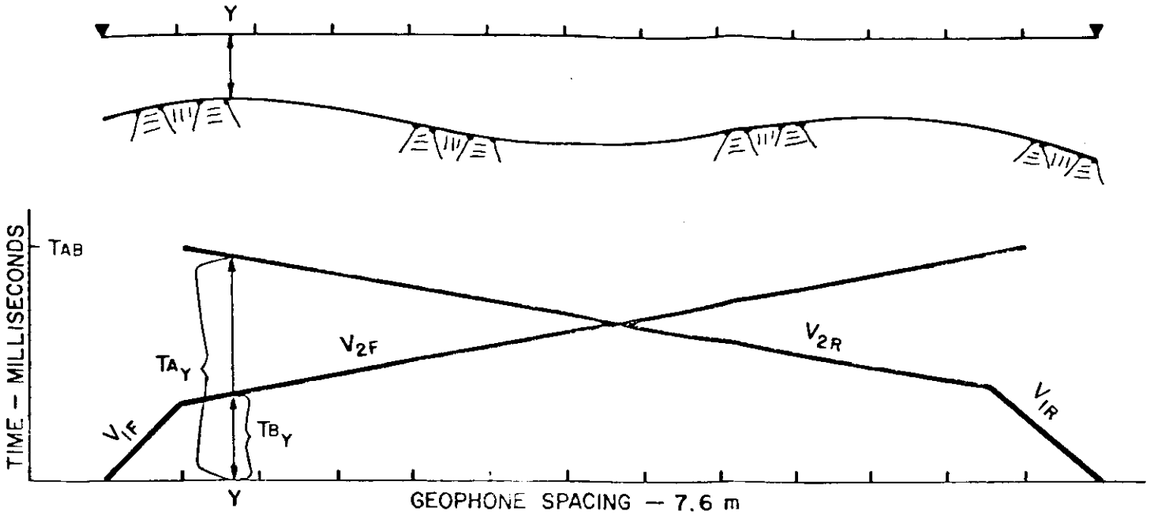
2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

on a full time basis and one geological engineer, one hydrologist and two geophysicists on a part time basis. The overburden geotechnical field program extended from July 15 to September 13.

Even though the drilling, pump testing, test pit digging and laboratory analysis were under Elco contract, IECO directly supervised this work. Seismic refraction surveys and interpretations were carried out by IECO geophysicists. See Figure 2.32-1, page 47 for methods of seismic analysis, and Table 2.32-1, page 48 and Figure 2.32-2, sheets 1-2, pages 49 and 50 for results of seismic investigations.

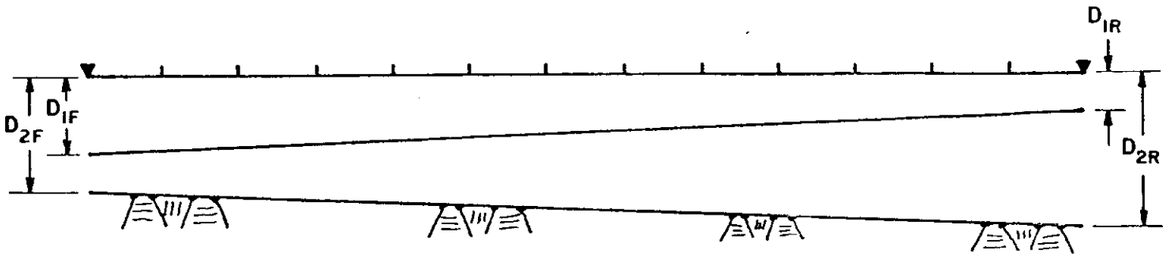
Drilling, test pit and lab analysis results are reported separately under Appendices 7.0, 8.0 and 9.0 respectively.

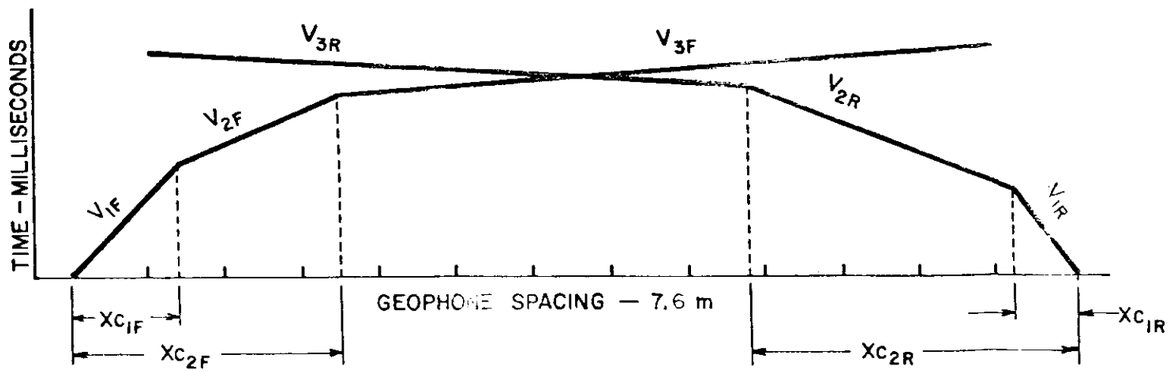
COMPUTATION FOR TWO LAYERS



$$\text{Depth at any 'Y'} = .5(TA_Y + TB_Y - TAB)\frac{V_1}{\sqrt{1-\left(\frac{V_1}{V_2}\right)^2}}$$

COMPUTATION FOR THREE OR MORE LAYERS





$$D_1 = \frac{Xc_1}{2}\sqrt{\frac{V_2 - V_1}{V_2 + V_1}} \quad ; \quad D_2 = \frac{Xc_2}{2}\sqrt{\frac{V_3 - V_2}{V_3 + V_2}} + .85(D_1)$$

D_1 and D_2 are projected below shot point ▼

Figure: 2.32-1

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

METHODS OF SEISMIC ANALYSIS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED SK INSPECTED
DRAWN BS RECOMMENDED
CHECKED APPROVED
DATE DEC. 1980

Table: 2.32-1

TABLE D-1

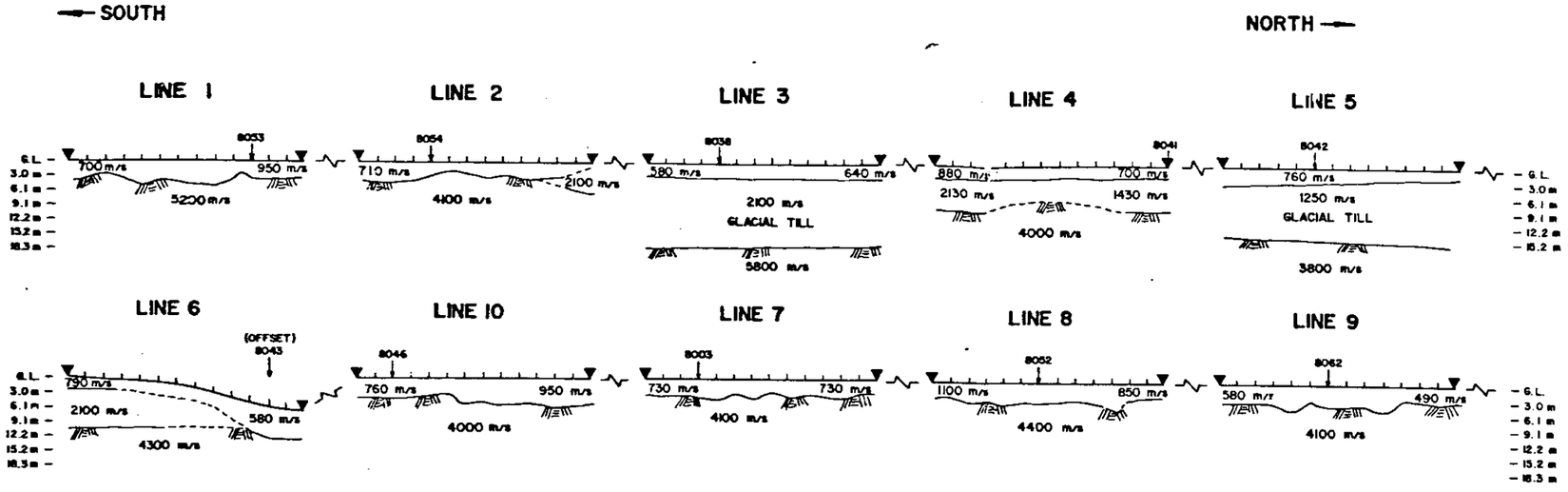
SEISMIC REFRACTION DATA
ELK RIVER COAL PROJECT - 1980

Location/Line #	Seismic Velocity (meters/second)				Depth (meters)			
	$V1_F$	$V1_R$	V2	V3	$D1_F$	$D1_R$	$D2_F$	$D2_R$
Haul Road -- 1	700	950		5200			3.7	4.0
2	710	2100		4100			3.4	6.7
3	580	640	2100	5800	2.7	3.0	17.7	17.4
4	880	700	1700	4000	3.0	2.1	9.1	10.1
5	760	760	1250	3800	4.0	1.8	14.6	15.9
6	790	580	2100	4300	4.3		10.7	6.7
7	730	730		4100			3.0	3.0
8	1100	850		4400			4.9	3.0
9	580	490		4100			4.0	4.0
10	760	950		4000			3.7	4.9
11	1100	850		4300			3.7	3.7
12	880	520	1600	6100	5.5	5.8	19.8	22.3
13	760	640		4100			3.4	3.4
14	490	460		4000			4.3	4.0
15	370	550		4300			3.4	4.0
17	940	850	2100	4000		2.1	3.7	11.6
18	790	530		4600			4.0	3.4
19	550	640		3400			3.4	4.3
20	700	850		4000			3.0	3.7
21	490	760		4300			3.4	3.0
Diversion Channel - 16	580	640	2400	6100	3.0	3.0	16.5	24.1
22	640	550	1200	3700	1.8		9.8	3.4
23	450	700	2400	4300	4.0	7.0	29.0	16.5
24	550	580	1700	3700	3.4	2.7	23.5	16.5
25	1300	750	2000	4000	3.7	2.7	16.8	16.8
26	750	750	2300	4300	4.6	2.4	15.2	17.4
27	450	580	2400	5200	4.0	2.7	15.9	9.1
28	610	610	2300	5200	2.1	2.7	20.7	17.7
29	450	550		4300			4.6	3.4
31	580	640		4100			4.6	2.4
32	700	640		4100			4.0	3.4
Sewage Lagoon - 30	1100	850	2400	•	2.1	2.7	*	*
Elkford Road - 34	700	640	2500	*	3.4	3.7	*	*
Weary Creek - 35	490	640	2500	*	3.7	4.9	*	*

EXPLANATION

$V1_F$ - Velocity of surficial deposits from forward seismic shot
$V1_R$ - Velocity of surficial deposits from reverse seismic shot
V2 - Velocity of intermediate layer (glacial till or gravel)
V3 - Velocity of bedrock
$D1_F$ - Depth to intermediate velocity layer (V2) from forward shot
$D1_R$ - Depth to intermediate velocity layer (V2) from reverse shot
$D2_F$ - Depth to bedrock (V3) from forward shot
$D2_R$ - Depth to bedrock (V3) from reverse shot

• - The minimum depth to bedrock is 24 meters. Geophone spacing limits the determination of depth to bedrock to this level.



EXPLANATION:

- ▼ — SHOT POINT
- — GEOPHONE LOCATIONS (7.6 m SPACING)
- 700 m/s — SEISMIC VELOCITY
- ——— — VELOCITY INTERFACE
- ////// — TOP OF ROCK
- 8053 ↓ — SURVEYED POSITION NUMBER
- ----- — APPROXIMATELY LOCATED VELOCITY INTERFACE

NOTE:

- SEE APPENDIX D FOR METHODS OF DEPTH CALCULATION.
- SEE EXHIBITS 1 AND 2 FOR SEISMIC LINE LOCATION.
- GROUND SURFACE PROFILES ARE APPROXIMATE. DEPTHS ARE RELATIVE TO THE GROUND SURFACE.

HORIZONTAL SCALE

0 50 100

METERS

Figure: 2.32-2 Sheet 1 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

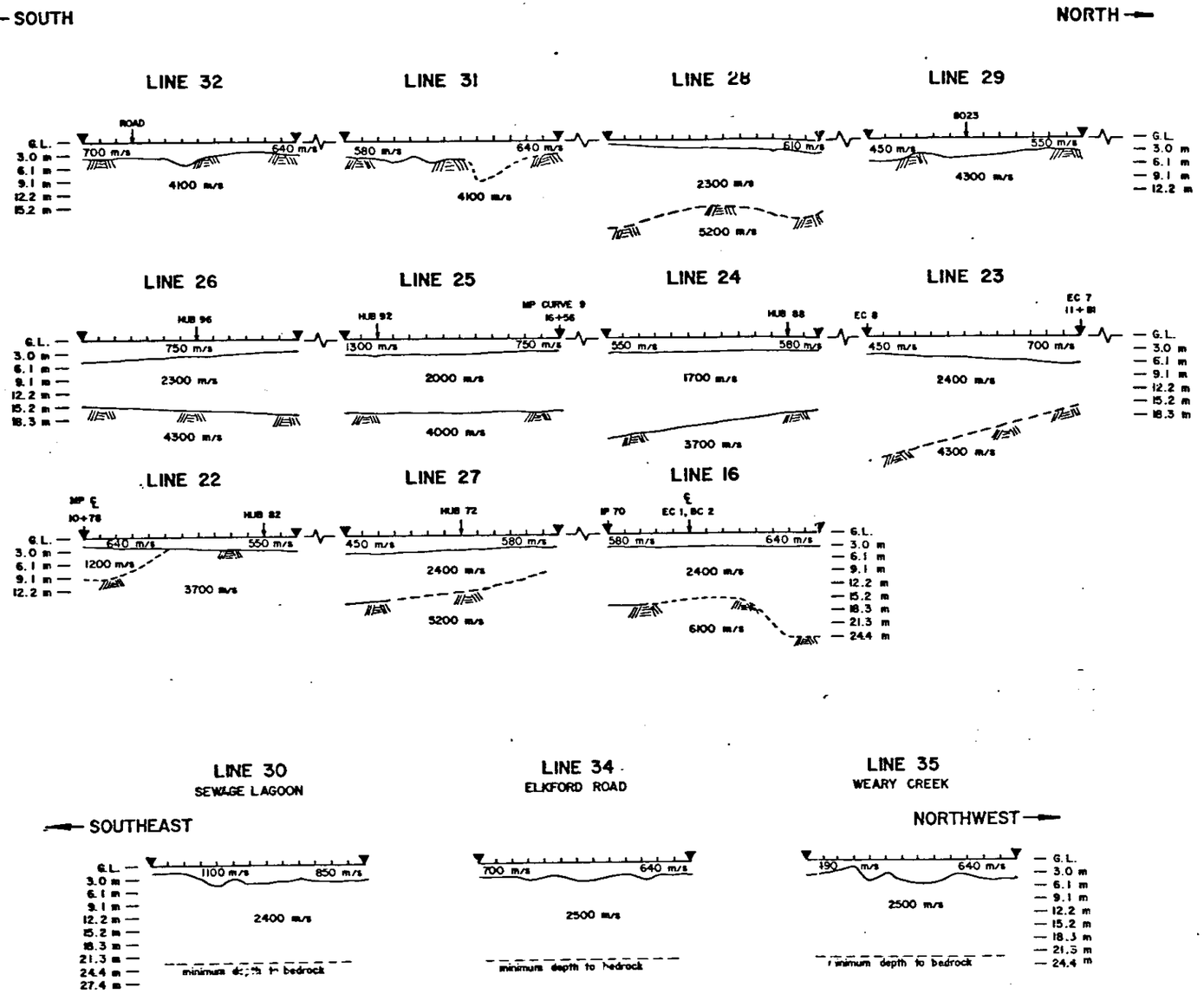
RESULTS OF SEISMIC REFRACTION INVESTIGATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED ____ INSPECTED ____
DRAWN ____ RECOMMENDED ____
CHECKED ____ APPROVED ____

APR. DECEMBER 1980

EXHIBIT 18
SHEET 1 OF 2



EXPLANATION:

- ▼ — SHOT POINT
- — GEOPHONE LOCATIONS (7.6 m SPACING)
- 700 m/s — SEISMIC VELOCITY
- ——— — VELOCITY INTERFACE
- — TOP OF ROCK
- 8053 ↓ — SURVEYED POSITION NUMBER
- ------ — APPROXIMATELY LOCATED VELOCITY INTERFACE

NOTES:

- MINIMUM DEPTH TO BEDROCK SEE TABLE D-1 FOR EXPLANATION
- SEE APPENDIX D FOR METHODS OF DEPTH CALCULATION
- SEE EXHIBITS 1 AND 2 FOR SEISMIC LINE LOCATIONS
- GROUND SURFACE PROFILES ARE APPROXIMATE. DEPTHS ARE RELATIVE TO THE GROUND SURFACE.

HORIZONTAL SCALE

0 50 100
METERS

Figure: 2.32-2 Sheet 2 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

RESULTS OF SEISMIC REFRACTION INVESTIGATIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A SUBSIDIARY OF MORRISON KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED DAS INSPECTED	DATE DECEMBER 1980
DRAWN VK RECOMMENDED	EXHIBIT 18
CHECKED APPROVED	SHEET 2 OF 2

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion

The river diversion consists of three sections which include a diversion dam at the Elk River - Cadorna Creek confluence, five small cutoff dams to be incorporated into the haul road embankment, and 5500 meters of excavated diversion channel west of the existing Elk River. The proposed method for river diversion around the planned mine is shown in Appendix 6.0, Sheet 1. The site of the diversion dam was selected after a review of environmental, mine planning, geology engineering, economic, surface hydrology and geotechnical factors. Evaluation of geotechnical data has shown that the depth to bedrock increases both upstream and downstream and that longer dam embankment would be required. It has been concluded that the site selected is the most suitable site for the diversion dam.

2.3211 Diversion Dam

1. Exploration and Testing

Seventeen drill holes totalling 302.4 linear meters

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion Cont'd.

2.3211 Diversion Dam Cont'd.

were completed at the proposed site of the diversion dam (see Appendix 6.0). Grain size analyses were performed on representative samples from borings (see Appendix 9.0).

2. Foundation Conditions

The proposed diversion dam will be founded on alluvium which varies in thickness from 16 meters on the east bank to one meter on the west bank (see Figures 2.3211-1 and 2.3211-2, pages 53 and 54). The alluvium varies from sandy gravel and gravelly sand to silty sand and silty gravel. The depth to ground water is uniformly less than two meters.

Glacial till, which occurs below the alluvium, consists of a heterogeneous mixture of silt, sand and gravel. It varies in thickness from 13 meters on the east bank to one meter on the west bank.

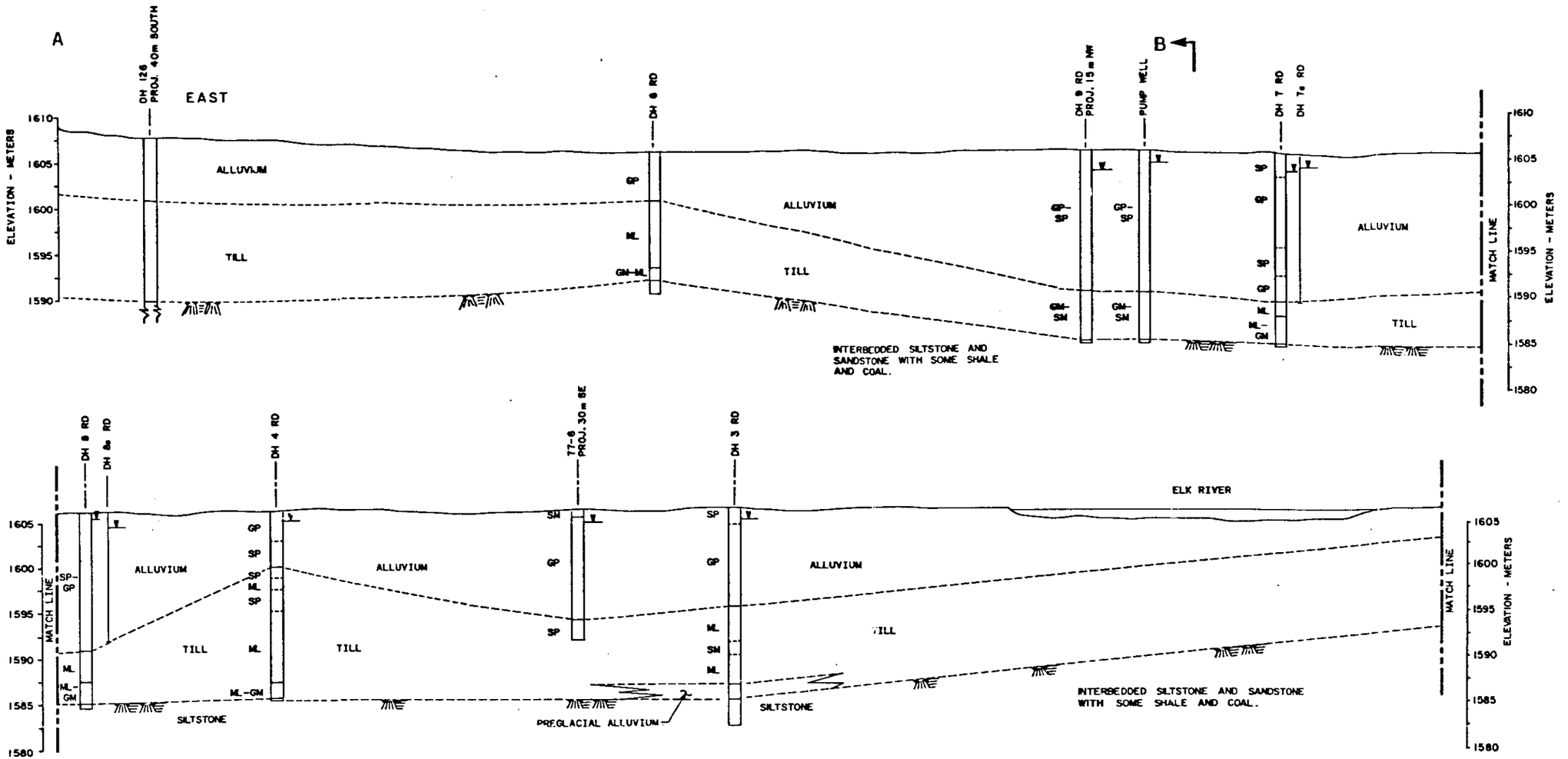


Figure: 2.3211-1

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION DAM
SECTION A-A

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

NO.	DATE	MADE	CHKD.	APPD.	REVISIONS
4					
3					
2					
1	ISSUED FOR PREP. OF PROPOSALS				

DESIGNED _____ INSPECTED _____
DRAWN CFA18C RECOMMENDED _____
CHECKED _____ APPROVED _____

DATE DECEMBER 1980

EXHIBIT 3

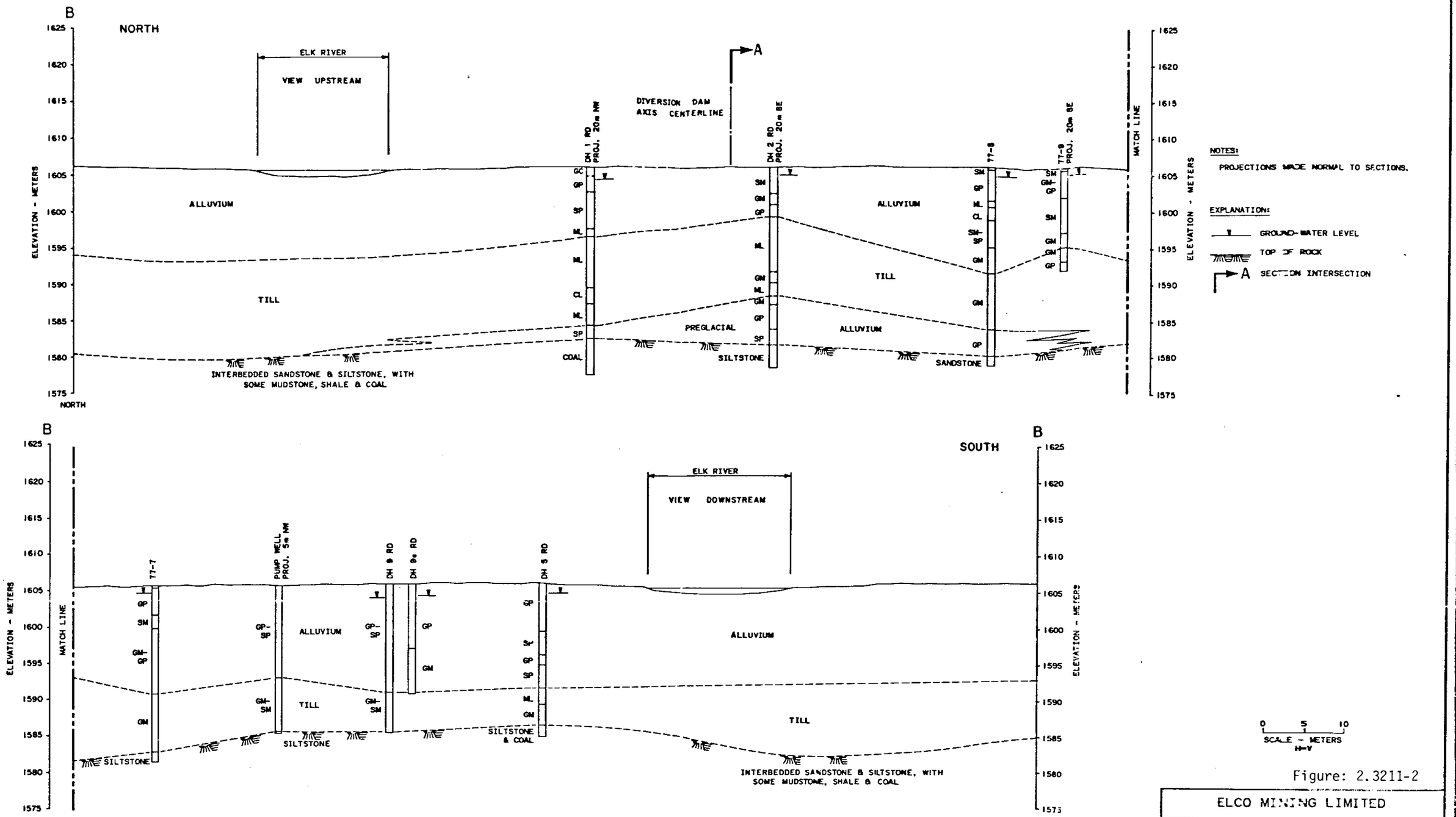


Figure: 2.3211-2

4					
3					
2					
1	ISSUED FOR PREP. OF PROPOSALS				
NO.	DATE	MADE	CHKD.	APPD.	

REVISIONS

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION DAM
SECTION B-B

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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DATE DECEMBER 1980
DRAWING NO. EXHIBIT 4

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

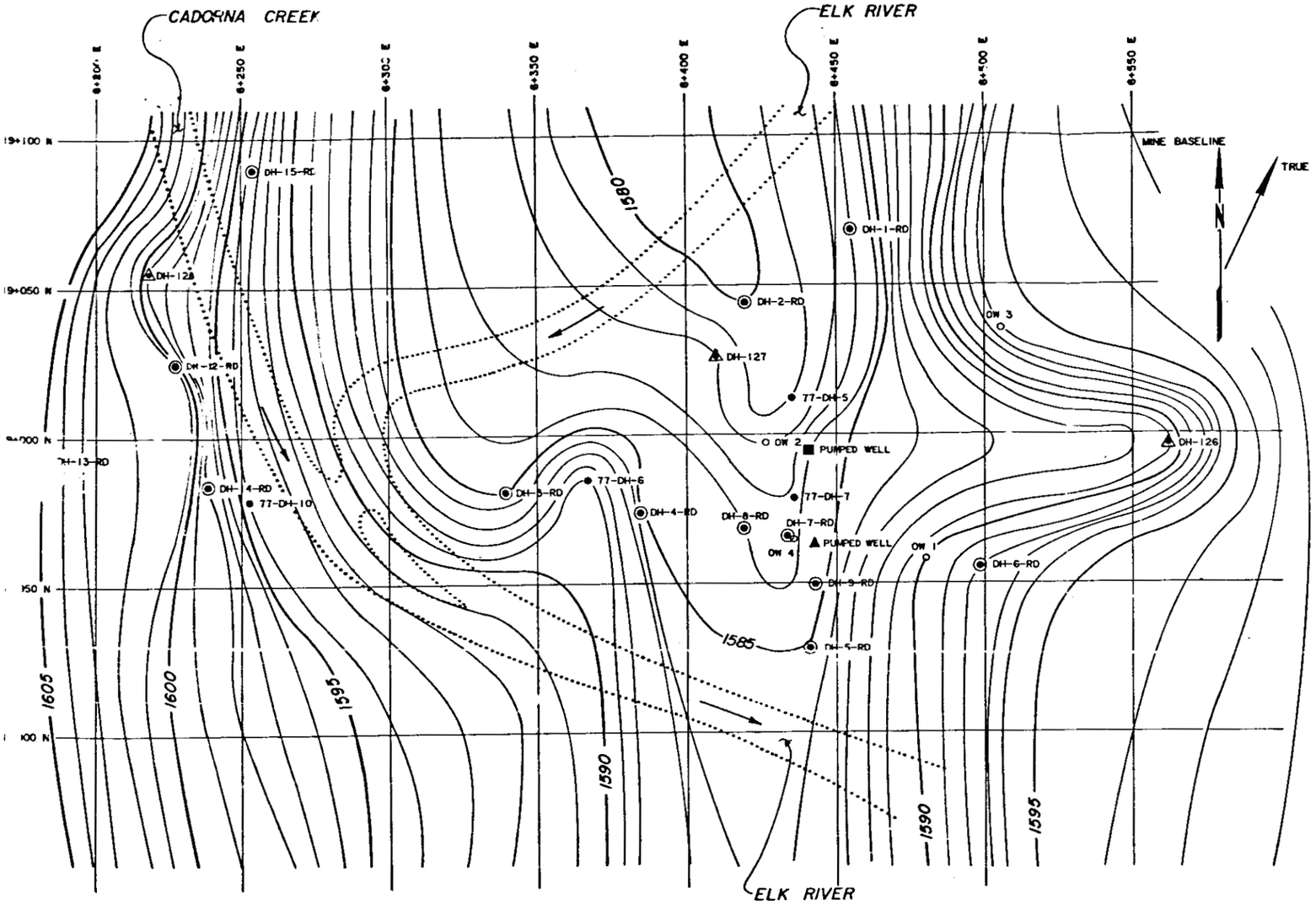
2.321 River Diversion Cont'd.

2. Foundation Conditions Cont'd.

Preglacial alluvium was found below the till in drill holes DH1RD, DH2RD and DH3RD. This alluvium, composed of sandstone gravels, is locally up to 7 meters thick and may be part of a buried channel found in other parts of the project area (see Appendix 6.0).

A bedrock contour map of the diversion dam area is shown on Figure 2.3211-3, page 56. The map is based on information from holes drilled in the diversion dam area. The preglacial buried channel appears as a north-south trending depression under the site of the diversion dam.

The permeability of the upper alluvial materials is expected to be high in sand and gravel where the percentage of material passing the #200 sieve is less than 17%. Dense glacial till, which is characterized by high percentages, up to 47%, of materials passing the #200 sieve, is expected to be relatively



EXPLANATION :

- 1605 — BEDROCK CONTOURS (Elevation in meters)
- — EXISTING STREAMS
- PUMPED WELL — GOLDER (1980)
- PUMPED WELL — IECO (1980)
- DRILL HOLES
  - DH-14-RD — (1980)
  - 77-DH-10 — (1976 – 1977)
  - DH-12B — (1976 – 1977)
- OW-1 — GOLDER OBSERVATION WELL (1980)

SCALE
0 50 100
METERS

Figure: 2.3211-3

NO.	DATE	MADE	CHKD.	APD.	REVISIONS
1	ISSUED FOR PREP. OF PROPOSALS				
2					
3					
4					

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
BEDROCK CONTOUR MAP -
DIVERSION DAM AREA

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED ____ INSPECTED ____ DATE DECEMBER 1980
DRAWN CADS/DKB110 RECOMMENDED ____
CHECKED ____ APPROVED ____

EXHIBIT 19

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion Cont'd.

2. Foundation Conditions Cont'd.

impervious. Permeability of the preglacial gravel in the buried channel is expected to be lower than the upper alluvium.

3. Seepage Control

The results of the pump test conducted between the diversion dam and the mine indicated that water infiltration may be expected through alluvium overlying the glacial till and possibly through narrow preglacial channels underlying the glacial till.

2.3212 Diversion Channel

1. Exploration and Testing

Nine drill holes totalling 97.7 lineal meters, 12 test pits and 15 seismic lines were completed along the proposed diversion channel (see Appendices 6.0, 7.0 and 8.0 respectively). Grain

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion Cont'd.

2.3212 Diversion Channel Cont'd.

1. Exploration and Testing Cont'd.

size analyses, Atterberg limits, and specific gravity tests were performed on representative samples from borings and test pits (see Appendix 9.0).

2. Foundation Conditions

The proposed diversion channel is divided into north, middle and south sections to facilitate description (see Appendix 6.0). Geologic profiles along the diversion channel center line are shown on Figures 2.3212-1 through 2.3212-3 pages 59 to 63. Profiles normal to the diversion channel are presented on Figures 2.3212-4 through 2.3212-6 , pages 64 to 66.

C1 NORTH

SOUTH

ELEVATION - METERS

1645 1640 1635 1630 1625 1620 1615 1610 1605 1600 1595 1590 1585 1580

ELK RIVER

CADORNA CREEK

ALLUVIUM

TILL

SLOPE WASH AND TILL

EXISTING GROUND PROFILE

SL 19 SL 20 SL 21

TP 3 RD TP 2 RD TP 4 RD

PROJ. 30m W PROJ. 10m W

MATCH LINE SHEET 2 OF 2 EXHIBIT 6

INTERBEDDED SANDSTONE AND SILTSTONE WITH SOME THIN BEDS OF MUDSTONE, SHALE AND COAL.

TILL

COAL

PROPOSED INVERT OF DIVERSION CHANNEL

2.77.87 @ 0.60%

K9 K11 K13 K14 K16 K17 K18

0+00 0+16.78 B.C.#2 0+20 B.C.#1 0+81.35 E.C.#1

1+01.35 B.C.#2 E.C.#3

4+13.38 B.C.#5

5+33.38 B.C.#4

6+79.38 E.C.#4

8+01.78 B.C.#3 E.C.#5

9+41.46 B.C.#6 E.C.#6

10+39.60 B.C.#7 E.C.#7

11+60.58 B.C.#8 E.C.#8

12+52.63 B.C.#9 E.C.#9

NORTH SECTION

C1

ELEVATION - METERS

1620 1615 1610 1605 1600 1595 1590 1585

CADORNA CREEK

IN 261m @ 20%

ALLUVIUM

SLOPE WASH AND TILL

0+00 0+16.78 B.C. #2

EXPLANATION

SL 19 — SEISMIC LINE

— TOP OF ROCK

— GROUND-WATER LEVEL

TP3RD ML CL — TEST PIT

NOTE:
ALL PROJECTIONS NORMAL TO SECTION

ELEVATION - METERS

1610 1605 1600 1595

HORIZONTAL SCALE
0 50 100 200
METERS

VERTICAL SCALE EXAGGERATED 10X HORIZONTAL SCALE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION CHANNEL
SECTION C–C1

Figure: 2.3212-1 Sheet 1 of 2

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INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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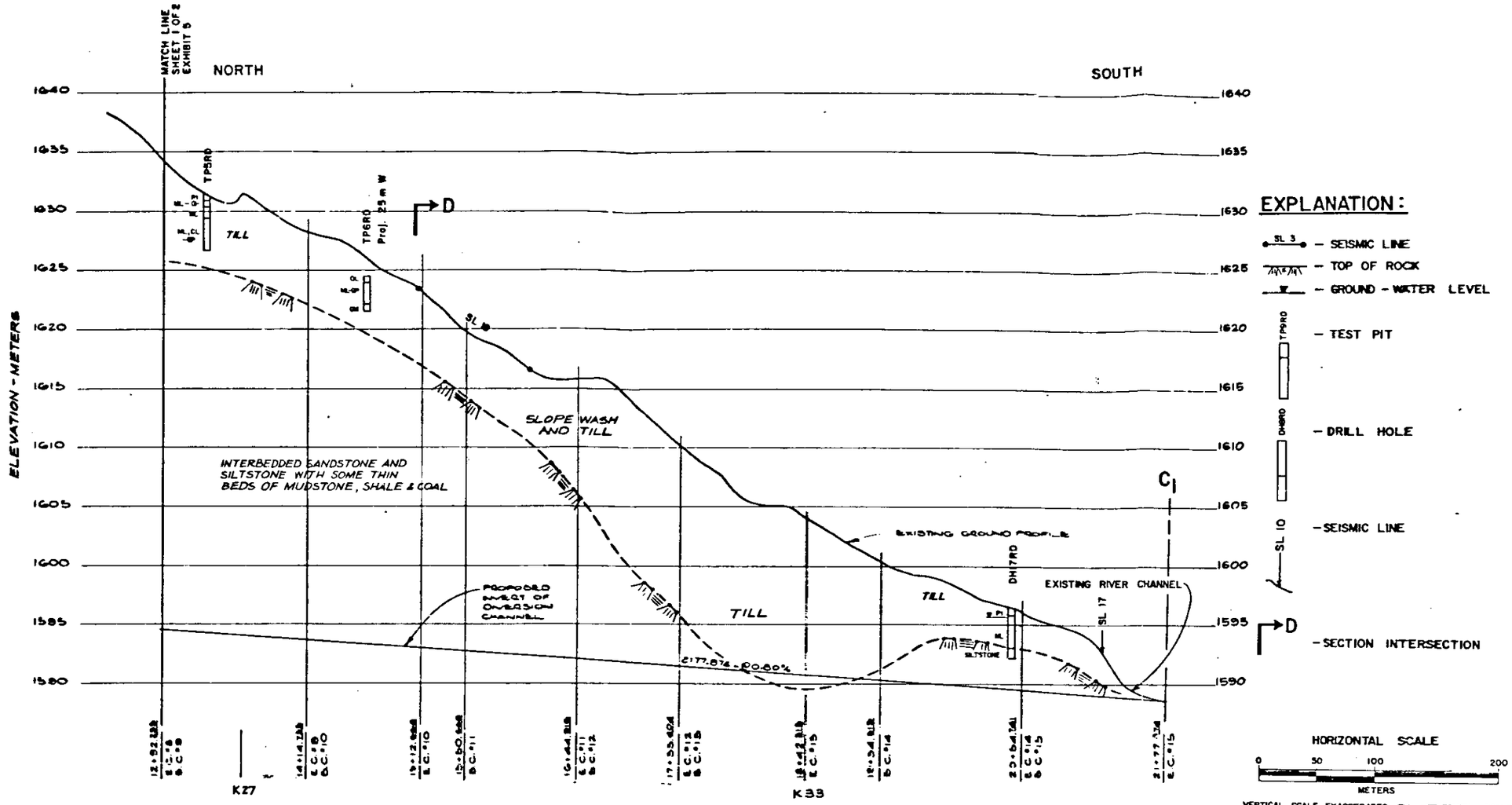
DATE DECEMBER 1980
EXHIBIT 5
SHEET 1 of 2

REV	DESCRIPTION	CHK'D	DATE

ISSUED DATE
A REVISED MANUSCRIPT MAY 1981

ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ELK RIVER DIVERSION
NORTH DIVERSION PROFILE

DRAWN BY
CHECKED BY
MAP SHEET NO 100.80.2
SCALE 1:2500 HORIZ. 1:250 VERT.
DATE OCT/80
DRAWING NO R-EE80-N100-038 1 of 5



NORTH SECTION

Figure: 2.3212-1 Sheet 2 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION CHANNEL
SECTION C-C

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
180 HOWARD STREET SAN FRANCISCO CALIFORNIA 94105

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DRAWN GJS RECOMMENDED ___ EXHIBIT 5
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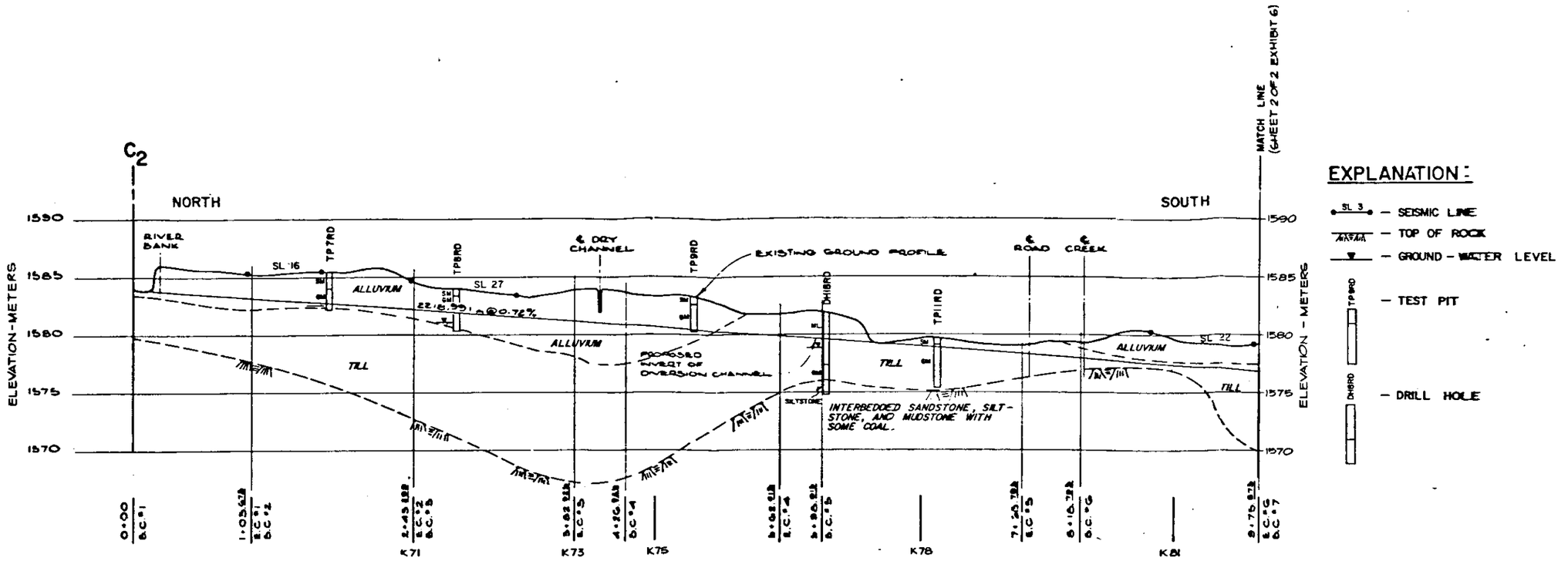
REV	DESCRIPTION	CHK'D	DATE
	SS.E.		DATE
	A PENCIL MANUSCRIPT		

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ELK RIVER DIVERSION
NORTH DIVERSION PROFILE

DRAWN BY	SCALE 1000 FEET/IN. 1:200 METRIC
CHECKED BY	DATE 9/80
MAP SHEET NO. 100 B0.2	DWG NO. EC E250-1100-014 R-5



EXPLANATION:

- SL 3 — SEISMIC LINE
- — TOP OF ROCK
- — GROUND-WATER LEVEL
- TP8RD — TEST PIT
- DH8RD — DRILL HOLE

MIDDLE SECTION

HORIZONTAL SCALE

0 50 100 200

METERS

VERTICAL SCALE EXAGGERATED 10X HORIZONTAL SCALE

Figure: 2.3212-2 Sheet 1 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION CHANNEL
SECTION C2-C2

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET SAN FRANCISCO CALIFORNIA 94105

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CHECKED ___ APPROVED ___

EXHIBIT 6
SHEET 1 of 2

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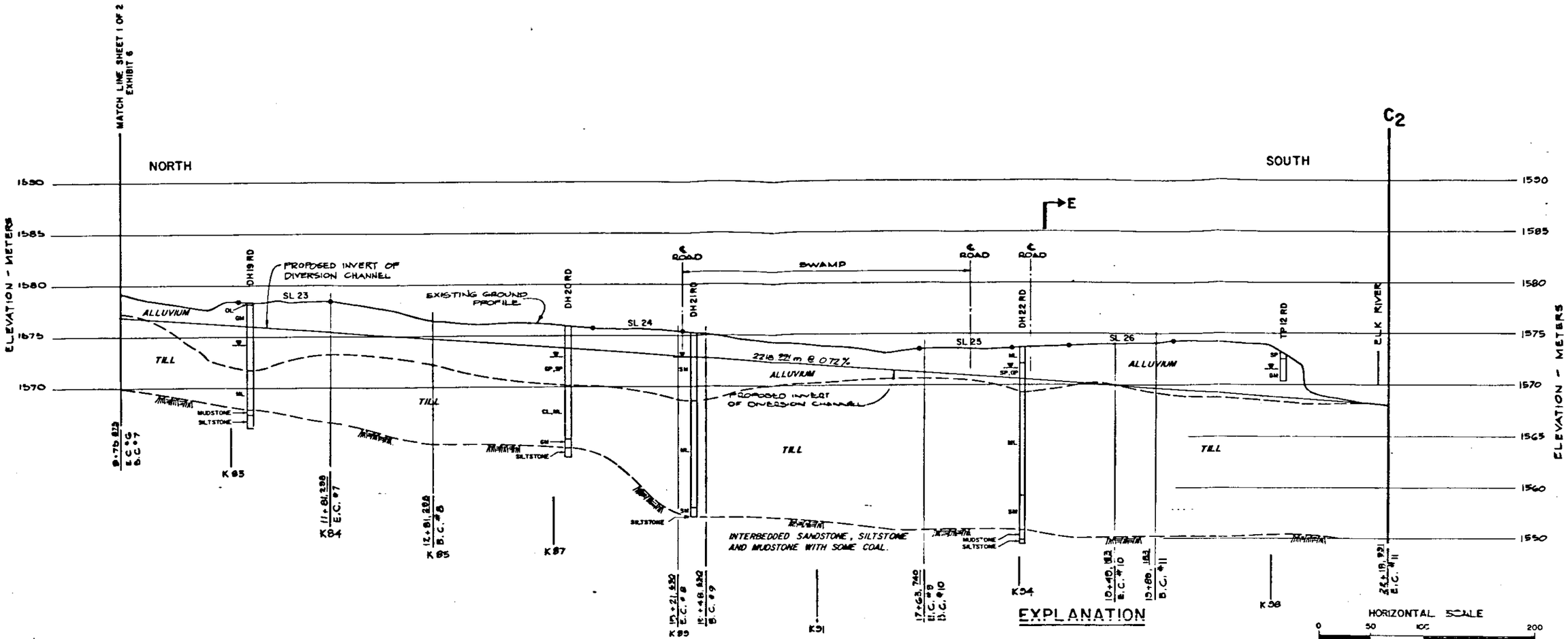
ISSUED — DATE
A PENCIL MANUSCRIPT — NOT ISSUED

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ELK RIVER DIVERSION
MIDDLE DIVERSION PROFILE

DRAWN BY
CHECKED BY
MAP SHEET NO. 100.E3.2
SCALE 1:200 HOR. 1:200 VERT.
DATE OCT/80
DWG NO. EC-MM-1680-034 3/6



MIDDLE SECTION

EXPLANATION

- SL 26 — SEISMIC LINE
- TOP OF ROCK
- GROUND-WATER LEVEL
- TP12 RD / DH22 RD — TEST PIT/DRILL HOLE
- E — SECTION INTERSECTION

HORIZONTAL SCALE
0 50 100 200
METERS
VERTICAL SCALE EXAGGERATED 5X HORIZONTAL SCALE

Figure: 2.3212-2 Sheet 2 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
DIVERSION CHANNEL
SECTION D-D2-C2

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET SAN FRANCISCO CALIFORNIA 94105

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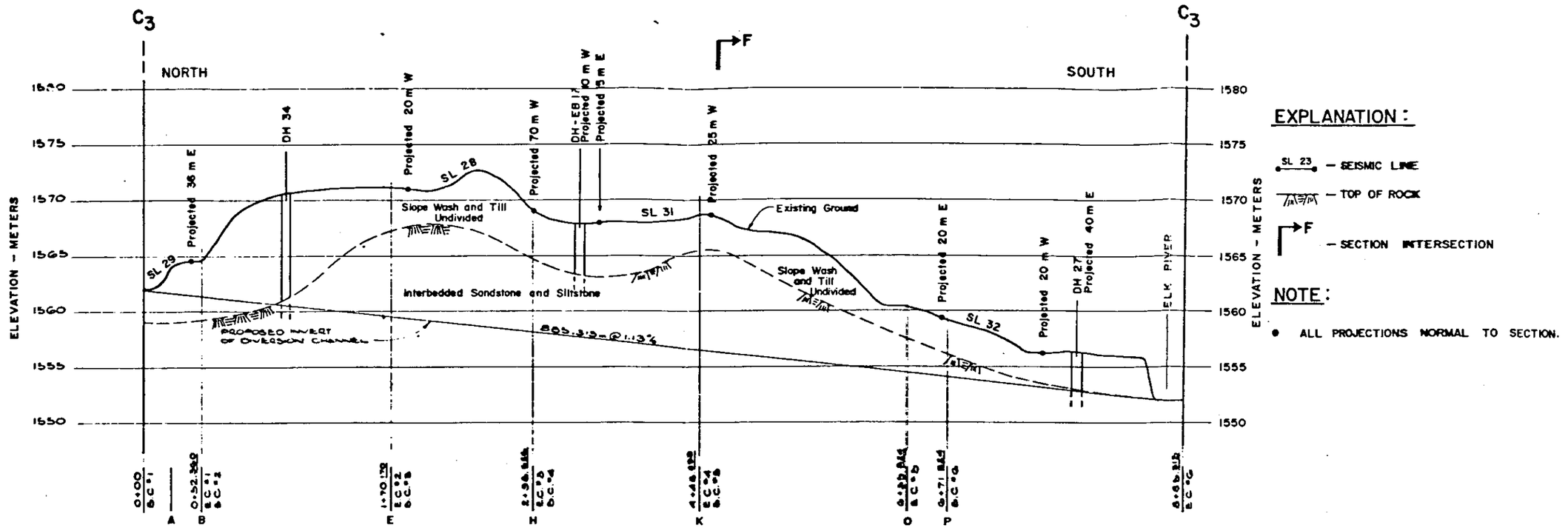
REV.	DESCRIPTION	CHKD	DATE

A PENCIL MANUSCRIPT

ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ELK - TECK DIVERSION
MIDDLE DIVERSION PROFILE

DRAWN BY ___ SCALE AS NOTED 1" = 100'-0" H 1" = 20'-0" V
CHECKED BY ___ DATE OCT. 1980
MAP SHEET NO. 104 H 2 DWG. NO. E1-TEK-M140-016 4 OF 5



SOUTH SECTION

EXPLANATION :

SL 23 — SEISMIC LINE

— TOP OF ROCK

F — SECTION INTERSECTION

NOTE :

- ALL PROJECTIONS NORMAL TO SECTION.

HORIZONTAL SCALE

0 50 100 200

METERS

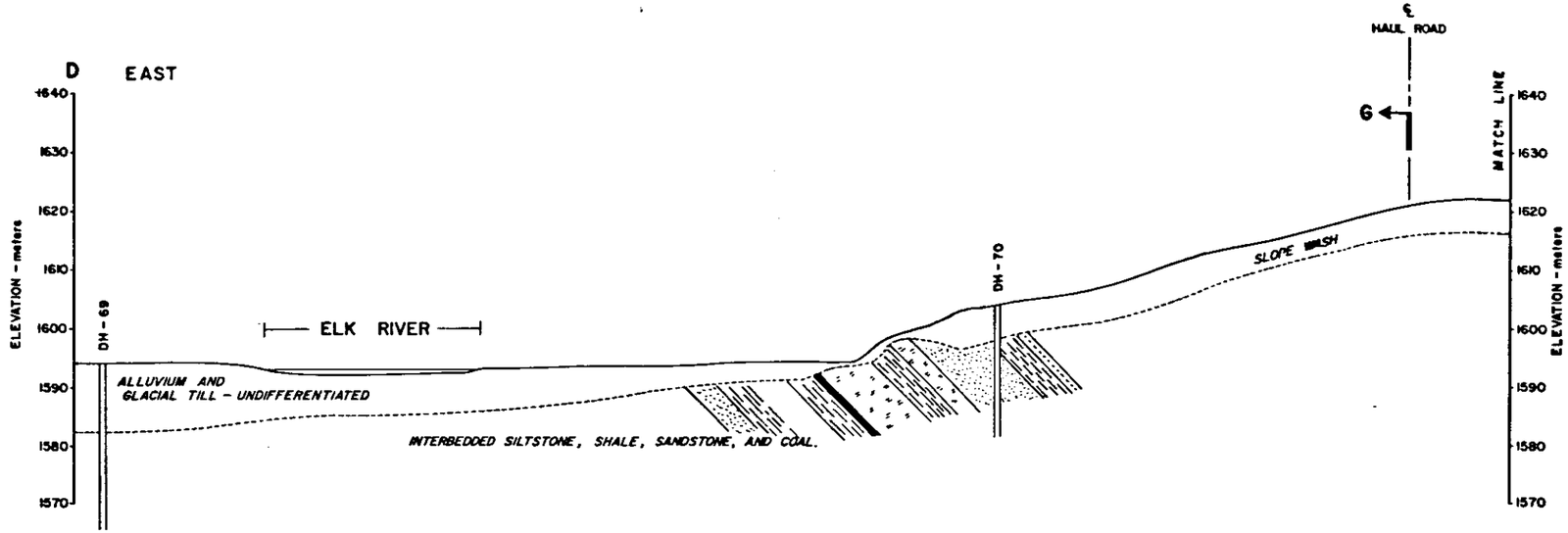
VERTICAL SCALE EXAGGERATED 10X HORIZONTAL SCALE

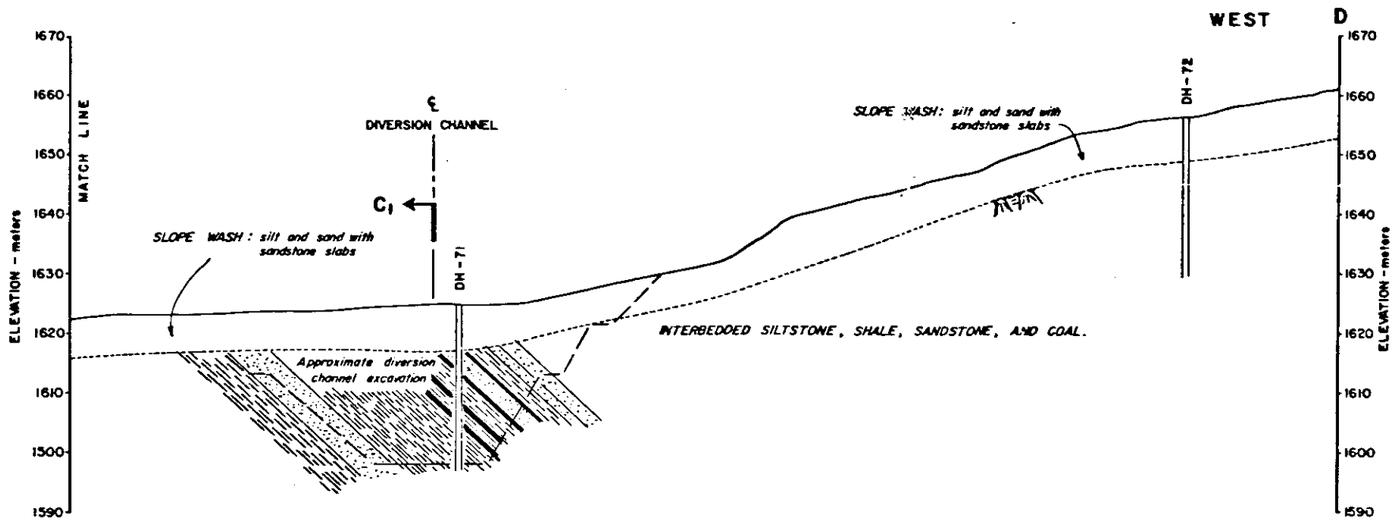
Figure: 2.3212-3

ELCO MINING LIMITED	
ELK RIVER COAL PROJECT BRITISH COLUMBIA	
DIVERSION CHANNEL SECTION C3–C3	
CONSULTING ENGINEERS INTERNATIONAL ENGINEERING COMPANY, INC. A MORRISON-KNUDSEN COMPANY 180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105	
DESIGNED ___ INSPECTED ___ DRAWN ___ RECOMMENDED ___ CHECKED ___ APPROVED ___	DATE DECEMBER 1980 EXHIBIT 7

REV	DESCRIPTION	CHK'D	DATE
			DATE
A	PENCIL MANUSCRIPT		OCT 1980

ELCO MINING LIMITED	
ELK RIVER COAL PROJECT BRITISH COLUMBIA	
ELK RIVER DIVERSION SOUTH DIVERSION PROFILE	
DRAWN BY	SCALE 1:2000 HORIZ. 1:200 VERT.
CHECKED BY	DATE OCT/80
MAP SHEET NO. 100 80 8	DWG NO. 1210-4100-014 SHT 5





EXPLANATION:

- TOP OF ROCK
- G — SECTION INTERSECTION
- DH-69 — DRILL HOLE

SCALE

0 10 20 40

METERS
H = V

Figure: 2.3212-4

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION CHANNEL
SECTION D - D

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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EXHIBIT 8

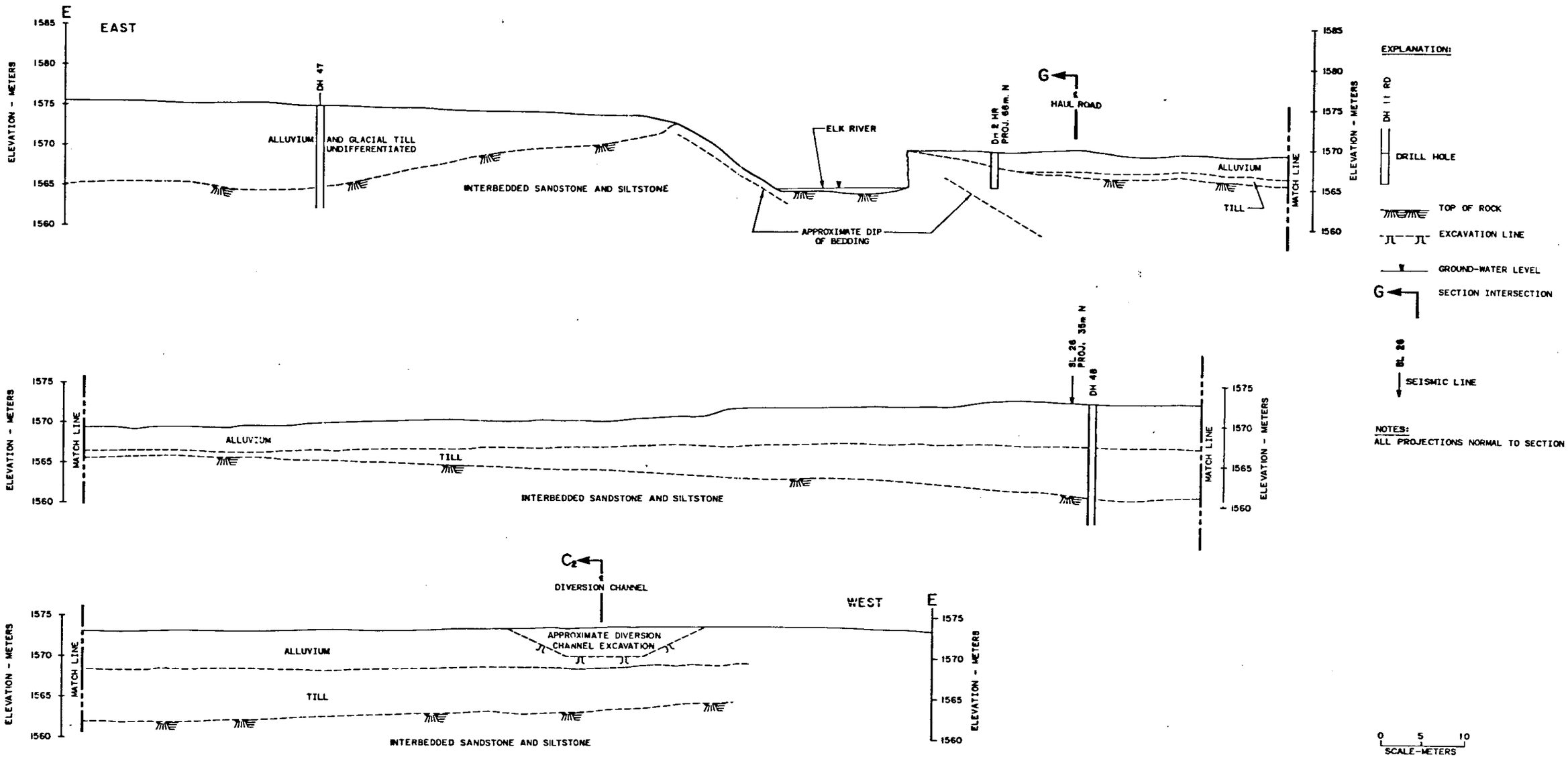

Figure: 2.3212-5

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
DIVERSION CHANNEL
SECTION E-E

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A NORTHERN KRUGER COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

NO.	DATE	MADE	CHKD.	APPD.	REVISIONS
4					
3					
2					
1	ISSUES FOR PREP. OF PROPOSALS				

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DRAWN CF/DOT RECOMMENDED ____
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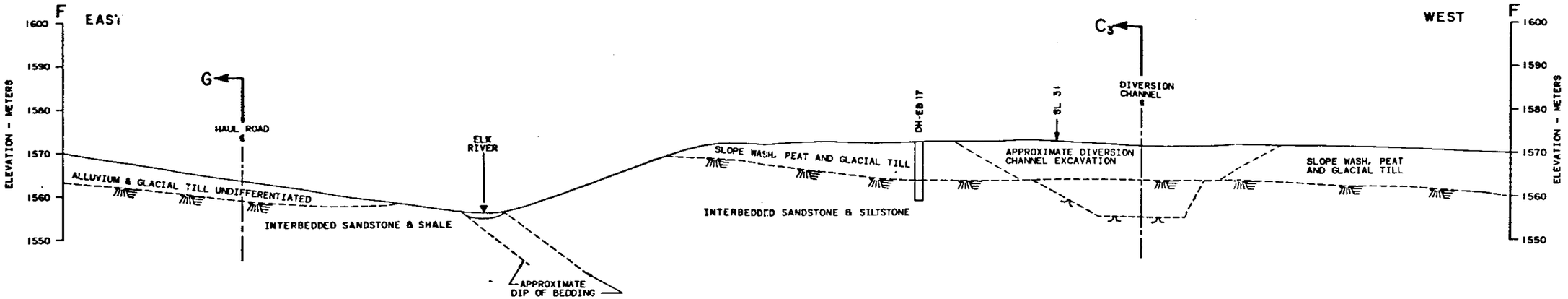
DATE DECEMBER 1980

EXHIBIT 9



EXPLANATION:

DH 24 — DRILL HOLE

SL 31 — SEISMIC LINE

EXCAVATION LINE

GROUND-WATER LEVEL

TOP OF ROCK

G — SECTION INTERSECTION

0 10 20

SCALE—METERS
H=V

Figure: 2.3212-6

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DIVERSION CHANNEL
SECTION F-F

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A HORN-SCHMIDSEN COMPANY
180 HARRD STREET, SAN FRANCISCO, CALIFORNIA 94105

NO.	DATE	MADE	CHKD.	APPD.	REVISIONS
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3					
2					
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DESIGNED ____ INSPECTED ____
DRAWN CFA2 RECOMMENDED ____
CHECKED ____ APPROVED ____

DATE DECEMBER 1980

EXHIBIT 10

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion Cont'd.

2.3212 Diversion Channel Cont'd.

3. Seepage Control

Seepage from the rock section of the proposed diversion channel is expected to be minimal. Those portions of the middle and south sections which will be founded on alluvium will require a cutfoff to prevent flow into the mine. This cutoff will be incorporated into the haul road design.

4. Cut Slope Criteria

Recommended cut slopes in soil will be 2 horizontal: 1 vertical. Rock slopes on the east bank of the new river channel should be cut parallel to the rock bedding planes, as shown in Figure 2.3212-4, page 64. Rock slopes on the west bank should be cut parallel to a strong joint set which is particularly noticeable in the thicker sandstone beds. Golder Associates analyzed rock structural data and indicated that this joint set dips 60^{o} to 80^{o} NE.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.321 River Diversion Cont'd.

2.3212 Diversion Channel Cont'd.

5. Erosion Protection

The northern and southern sections of the proposed river diversion channel are primarily in a rock cut. Erosion in the rock sections is not expected to be a problem. However, in the alluvium and till sections, which are primarily in the middle section of the river channel, will need erosion protection (see Figure 2.3212-2), pages 61 & 62. The alluvium will be highly erodible both in the channel bottom and on the banks. Erosion protection will be designed for the alluvial areas. The dense will will also be erodible but not to the extent that it would result in unstable channel conditions.

2.322 Haul Road and Cutoff Dams

The proposed haul road extends south from the diversion dam to the site of the settling pond, a distance of 6590 meters (see Appendix 6.0, Sheets 1-2). The haul road will act as a dyke

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.322 Haul Road and Cutoff Dams Cont'd.

between the diversion channel and the mine. Five cutoff dams are planned to prevent flow from the new diversion channel back into the existing Elk River channel. These cutoff dams will be incorporated into the haul road embankment where practical.

Exploration and Testing

1. Haul Road

Four drill holes, DH1HR to DH4HR, totalling 22.6 lineal meters, and seismic lines 1 through 15 were completed during the 1980 program of geotechnical investigations (see Appendix 6.0, Sheets 1 - 2 and Figure 2.32-2, pages 49 and 50 respectively).

2. Cutoff Dams

Two drill holes, DH10RD and DH11RD, and test pit TP12RD were completed at the proposed sites of the cutoff dams during the 1980 program of geotechnical investigations (see Appendix 6.0, Sheets 1 - 2 for location, and Appendices 7.0 and 8.0 respectively for logs).

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits Cont'd.

2.322 Haul Road and Cutoff Dams Cont'd.

Foundation Conditions

1. Haul Road

The proposed haul road will be founded on alluvium, glacial till and bedrock (see Figure 2.322-1, page 71). The thickness of surficial deposits varies from 2 to 21 meters with an average thickness of approximately five meters. The average depth to ground water in the middle section of the haul road is about one meter. Alluvium and glacial till are of high density, with blow counts from standard penetration tests approximately 65 blows per 0.3 meteres in non-gravelly materials.

Siltstone and sandstone outcrops are common along the haul road alignment. Strike of bedding is approximately N20^{O} W with dips of 30^{O} or greater to the southwest. The depth to top of bedrock ranged from 3.0 to 4.4 meters in the holes drilled.

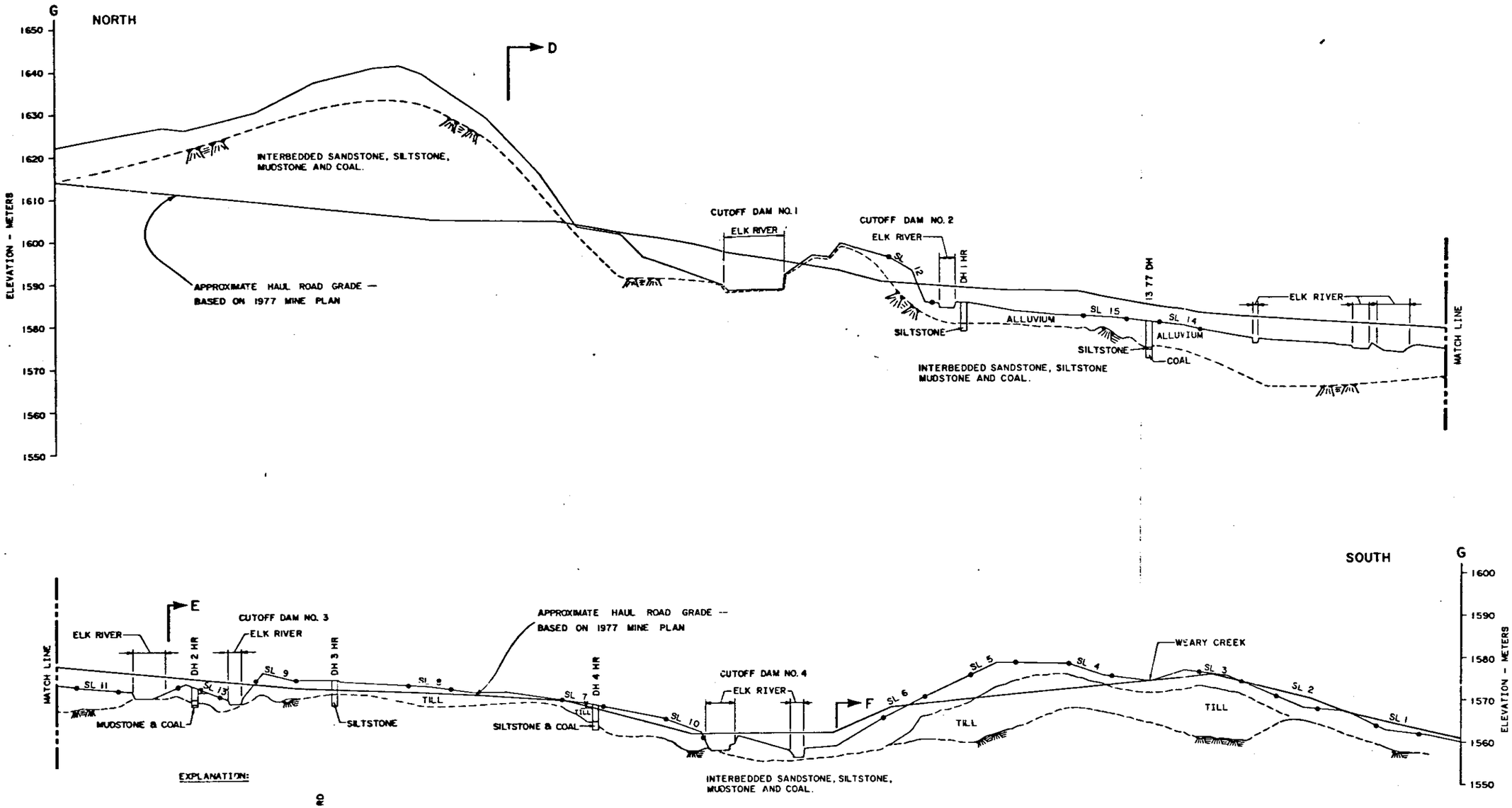

Figure: 2.322-1

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

HAUL ROAD PROFILE
SECTION G-G

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A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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EXHIBIT 11

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.322 Haul Road and Cutoff Dams Cont'd.

2. Cutoff Dams

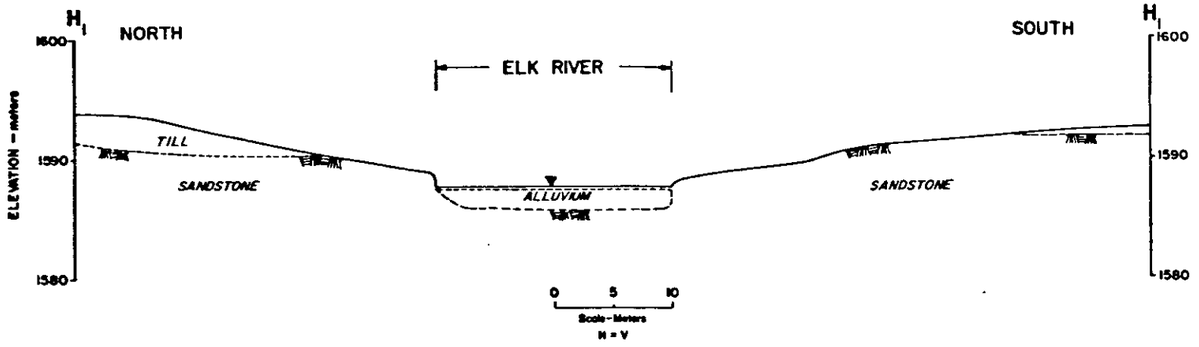
Cutoff Dam No. 1, at the southern end of the river channel north section, has moderately hard to hard sandstone exposed on both abutments. Seismic line 17, located near the north abutment, indicates that bedrock is present at a depth of four to seven meters; however, the haul road grade will be in bedrock (Figure 2.322-1, page 71.

Cutoff Dam No. 2 is underlain by alluvium to a depth of 2.6 to 4.6 meters (see Figure 2.322-2, Sheets 1 - 2, pages 73 and 74). Standard penetration tests indicate that the alluvium is of high density with blow counts ranging from 50 to 96 per 0.3 meters. Glacial till of high density is present below the alluvium to a depth of up to eight meters. Siltstone was encountered below the glacial till. Ground water is found at an average depth of 2.0 meters.

Cutoff Dam No. 3 site is underlain by sand to a depth of 0.3

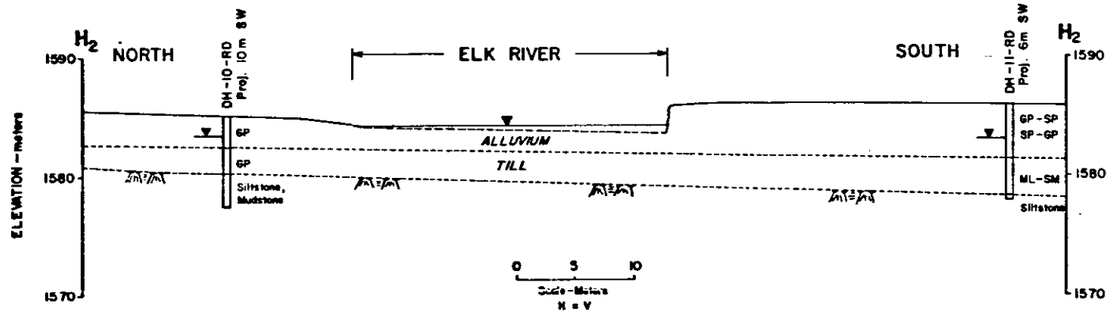
Cutoff Dam – no. 1

View East – (upstream)



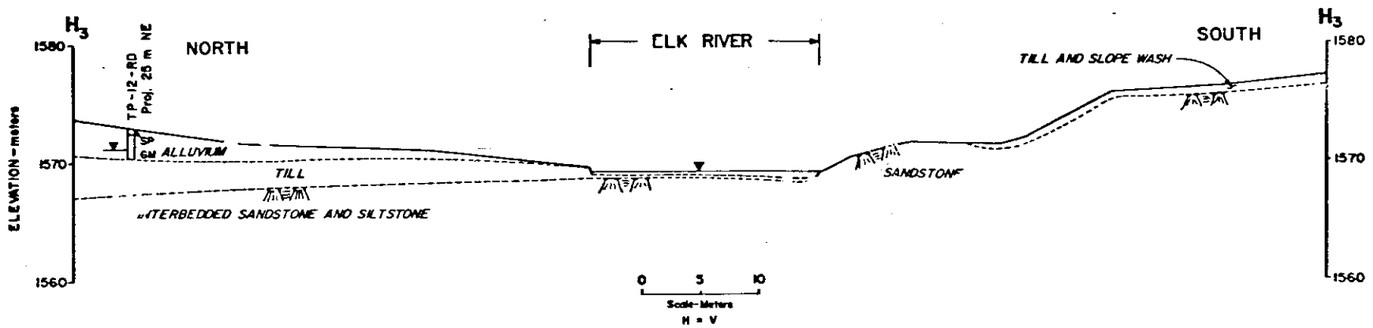
Cutoff Dam – no. 2

View East – (downstream)



Cutoff Dam – no. 3

View East – (upstream)



EXPLANATION:

- GROUND-WATER LEVEL
- TOP OF ROCK
- DH-11-RD — DRILL HOLE

NOTE:

- PROJECTIONS MADE NORMAL TO SECTION.
- ADAPTED FROM DRAWING BY McELHANNEY SURVEYING & ENGINEERING LTD.

Figure: 2.322-2 Sheet 1 of 2

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA

CUTOFF DAMS
SECTIONS H-H

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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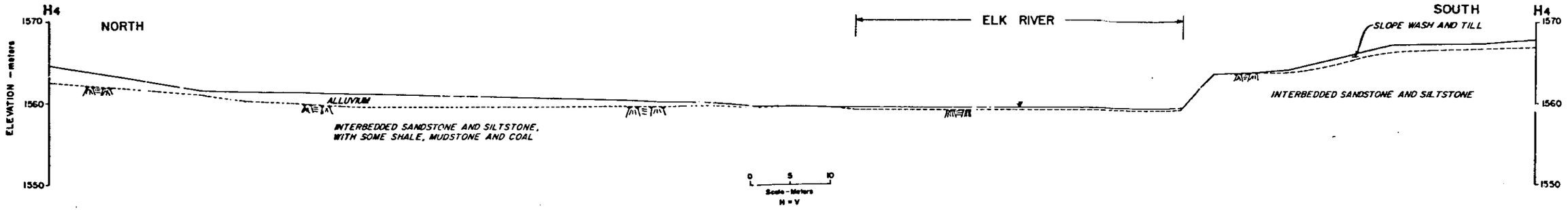
Cutoff Dam – no. 4

View East – (downstream)

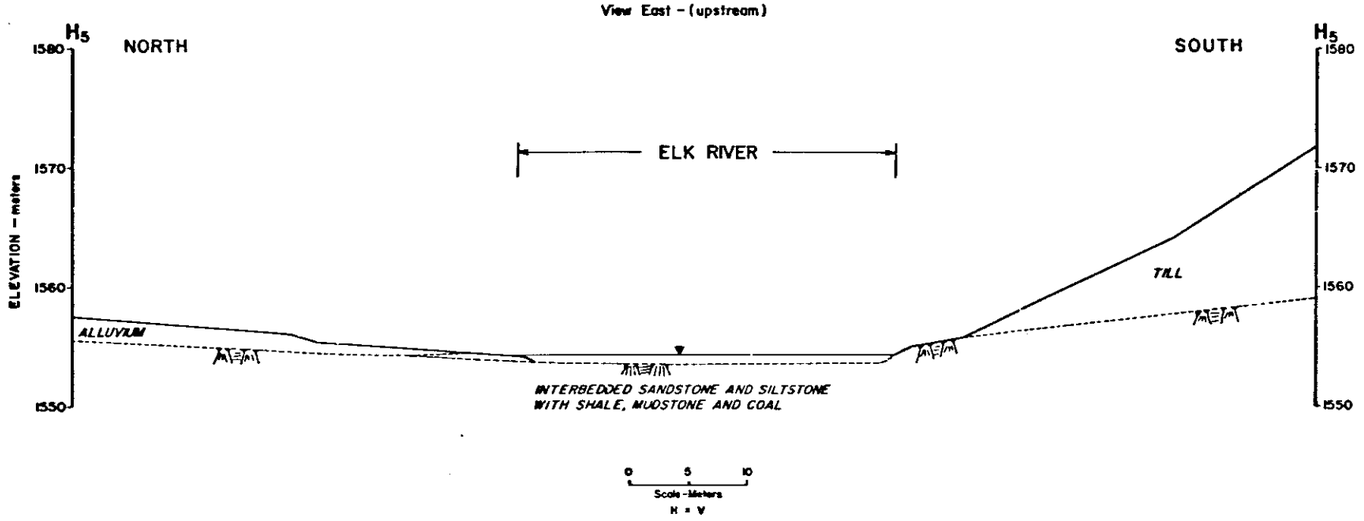


EXPLANATION:

- GROUND-WATER LEVEL
- TOP OF ROCK

Cutoff Dam – no. 5

View East – (upstream)



NOTE:

- PROJECTIONS MADE NORMAL TO SECTION.
- ADAPTED FROM DRAWING BY McELHANNEY SURVEYING & ENGINEERING LTD.

Figure: 2.322-2 Sheet 2 of 2

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA

CUTOFF DAMS
SECTIONS H-H

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 – EMBARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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EXHIBIT 12
SHEET 2 of 2

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.322 Haul Road and Cutoff Dams Cont'd.

2. Cutoff Dams Cont'd.

meters and silty gravel to a depth of at least 2.4 meters. Depth to ground water was 1.7 meters in TP12RD. Sandstone outcrops are present on the south bank of Elk River and bedrock is expected at a shallow depth on the north bank (see Figure 2.322-2, sheets 1-2, pages 73 and 74).

Between Cutoff Dams No. 2 and No. 4 most of the haul road foundation will be in alluvium and till (see Figure 2.322-1, page 71). The greatest thickness of alluvium below the proposed haul road embankment is located along the Elk River upstream of Cutoff Dam No. 3. The preglacial Elk River also flowed through this same area.

Cutoff Dam No. 4 is underlain by bedrock and the river is flowing over bedrock. Alluvium is very shallow on the north bank of the Elk River and the bedrock on the south bank is covered by thin deposits of slope wash and till.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.322 Haul Road and Cutoff Dams Cont'd.

2. Cutoff Dams Cont'd.

Cutoff Dam No. 5 is the southern-most cutoff dam and may be the only one constructed separate from the haul road embankment. The right abutment (north) is mostly bedrock covered with a thin deposit of alluvium. On the left abutment bedrock is noted at the river's edge (see Figure 2.322-2, sheets 1 - 2, pages 73 and 74. No subsurface exploration was conducted at the sites of Cutoff Dams No. 4 and No. 5.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.323 West Waste Dump

The proposed west waste dump will be located west of the Elk River (see Appendix 6.0); its approximate area is 2.9×10^6 square meters. Maximum dump height is expected to be approximately 140 meters.

To intercept runoff from the slope above the west waste dump, a drainage ditch will be excavated on the west side of the bypass road. This ditch will divert runoff into drainages to the north or south of the proposed waste dump.

Exploration and Testing

Fifteen test pits, TP1WW through TP15WW, were excavated during the 1980 field season. Four representative samples from test pits were subjected to grain size analyses and Atterberg limits determinations. The results of the laboratory testing are presented in Appendix 9.0.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.323 West Waste Dump Cont'd.

Foundation Conditions

A typical cross-section through the west waste dump is shown on Figure 2.323-1, page 79. The waste dump will be underlain by glacial till, slope wash, locally deep lenses of alluvium and peat. Slope wash, overlying the till, is characterized by sandy, silty gravel and poorly graded gravel. The till is composed of silt, sandy silt, silty gravel and local concentrations of boulders. Sandy and gravelly alluvial lenses are present locally as are moderate thicknesses of peat. The depth to ground water averages 2.5 meters. Local saturated areas with standing water are common in the eastern part of the waste dump area. Two small streams flow across the waste dump area from the west to the southeast. During September 1980 the flow in each of these streams was estimated to be between 0.10 and 0.14 m^3/s.

Representative samples from test pits were classified as CL, CL-ML, SM and SM-SC with 20% to 94% of the materials passing

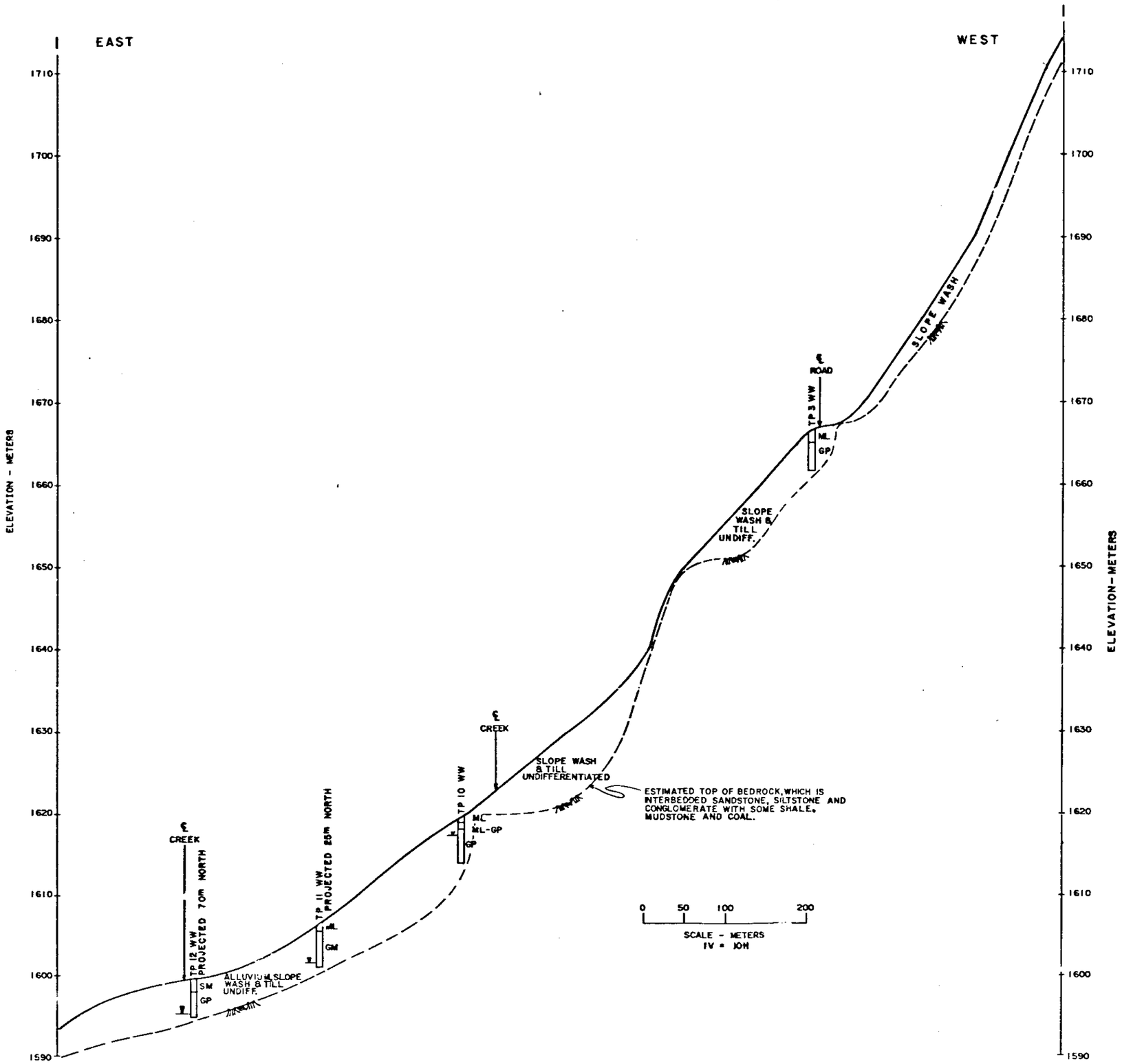

Figure: 2.323-1

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA
WEST WASTE DUMP
SECTION 1-1

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EXHIBIT 13

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.323 West Waste Dump Cont'd.

Foundation Conditions Cont'd.

the #200 sieve. These fine portions of the samples are low plasticity. The low natural moisture content (9% to 28%) for these materials should be compared to optimum water content derived from compaction tests.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.324 Plant Site

Geotechnical investigations of the proposed plant site during the 1980 field season were confined to limit exploration at the sites of the sewage lagoon and the hostel.

The proposed plant site is on the west bank of the Elk River and west of the south section of the diversion channel (see Appendix 6.0, Sheet 1 - 2). The sewage lagoon will be located on the north edge of the plant site in an east-sloping, low, swampy area. The hostel will be on the east-facing slope west of the plant site.

Exploration and Testing

Field investigations in 1980 at the sites of the above described plant site appurtenances were limited by time and budget considerations. Seismic line 30 and drill hole DH1SL were located at the proposed site of the sewage lagoon, and test pits TP1H and TP2H were located at the proposed site of the hostel (see Appendix 6.0, Sheet 1). Grain size analyses and Atterberg

2.32 Geotechnical Investigations of the Mine Site Overburden Deposits

2.324 Plant Site Cont'd.

Exploration and Testing Cont'd.

limits determinations were made on 1980 test pit samples. Numerous test pit samples from the 1977 geotechnical investigations were tested for physical properties, see test results Appendix 9.0).

Foundation Conditions

The proposed sewage lagoon will be underlain by highly organic material which covers dense glacial till (see Figure 2.32-2, Sheet 2, page 50). The glacial till below the peat appears to be impervious and has a high dry strength. The materials were classified as clayey, silty sand, silty gravel, and organic clay and silt, and were taken from test pits to a depth of five meters during plant site investigations in 1977. These materials are layered and form lenses. Drill hole DH1SL indicated that moisture content in the dense glacial till decreases below nine meters. Water was on the surface of the lagoon area and

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.324 Plant Site Cont'd.

Foundation Conditions Cont'd.

the till was saturated to a depth of approximately three meters. Depth to bedrock in this area is greater than 23 meters, and part of the preglacial Elk River channel may underlie this area.

The proposed hostel will be founded on layers and lenses of silt, silty gravel and organic silt which were sampled to a depth of 5.5 meters but which continue to a undetermined depth. Ground water is very shallow with an average depth less than one meter. Bedrock was not encountered at either site.

Laboratory tests performed on glacial till indictaed from 19% to 74% of material passing the #200 sieve. Most samples are CL, ML or ML-CL mixtures with low plasticity indices (PI = 7.5 to 20.7). Compaction and permeability tests performed on a till sample from TP1H indicated a material of low permeability and high bearing capacity. A comparison of optimum water content from compaction tests and natural water content indicates that the till may be too wet to be placed in its natural state.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.325 Railroad

IECO's geotechnical investigations during the 1980 field season were limited to the vicinity of the proposed railroad loop and the crossing at Bleasdell Creek.

Exploration and Testing

Exploration along the railroad alignment consisted of test pits TP1RR and TP16TD along the proposed railroad loop, and one seismic line at the Bleasdell Creek crossing (see Appendix 6.0, Sheet 2). No laboratory testing was performed in 1980.

Foundation Conditions

The proposed railroad loop will be founded on glacial till composed of silt (ML), sand (SP) and silty gravel (GM) with boulders up to 0.3 meters in diameter. The till is very dense below three meters and backhoe refusal occurred in test pits between 3.4 meters and 5.5 meters. Ground water was encountered at three meters in test pit TP16TD. Surface water ponding is widespread.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.325 Railroad Cont'd.

Foundation Conditions Cont'd.

Seismic investigations at the crossing of Bleasdell Creek were made. Because of high background noise from flowing water, resolution of the seismic refraction log was poor; however, bedrock is expected to be at a depth of 15 to 20 meters in the center of the creek bed.

2.326 Tailings Pond

The proposed tailings pond will be located west of the Elk River, approximately 6 km south of the Elk River-Cadorna Creek confluence (see Appendix 6.0, Sheet 2). The crest length of the tailings dam will be 2760 meters with a maximum height of 20 meters. The tailings confinement area or tailings pond will have an area of approximately 710,000 square meters.

Exploration and Testing

Sixteen test pits, TP1TD through TP16TD, were excavated along

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

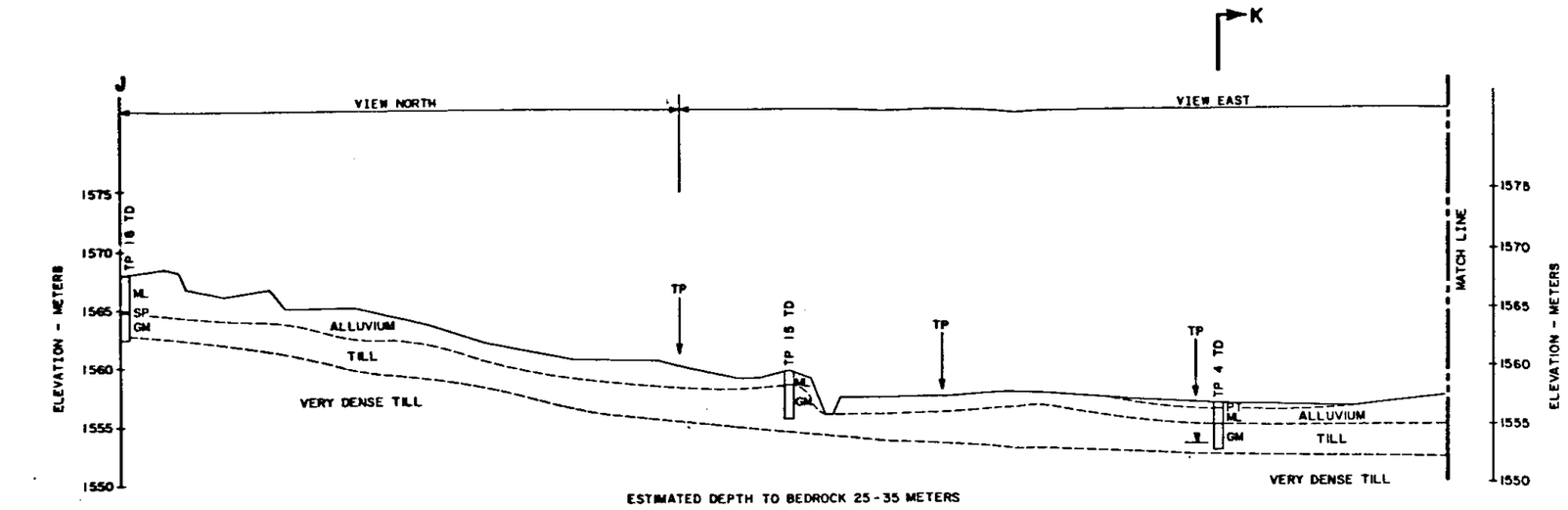
2.326 Tailings Pond Cont'd.

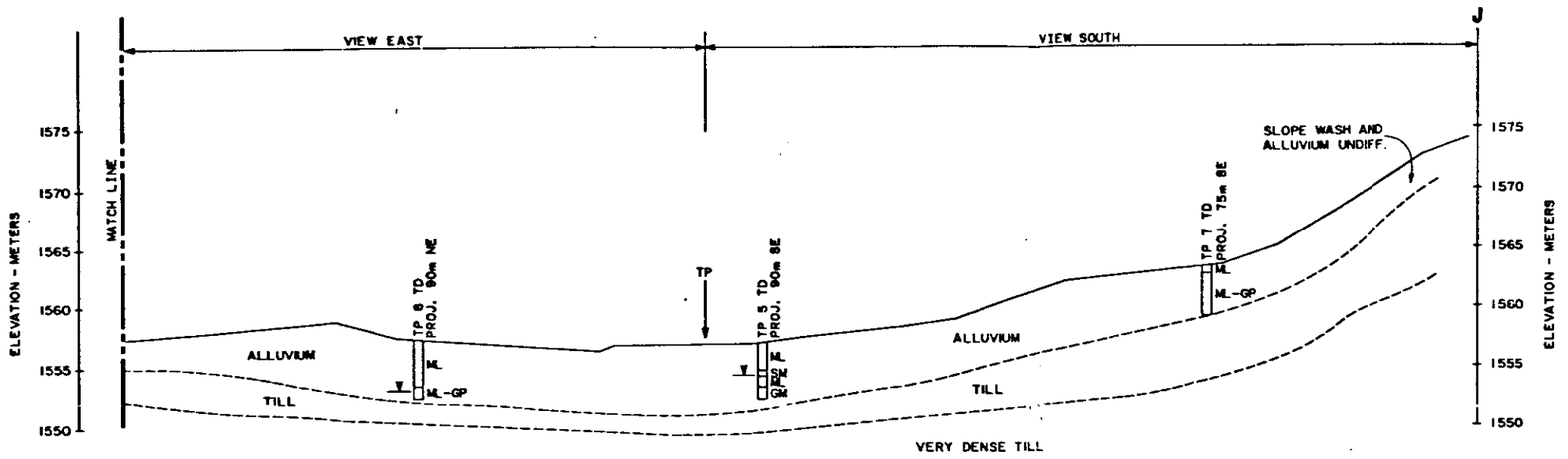
Exploration and Testing

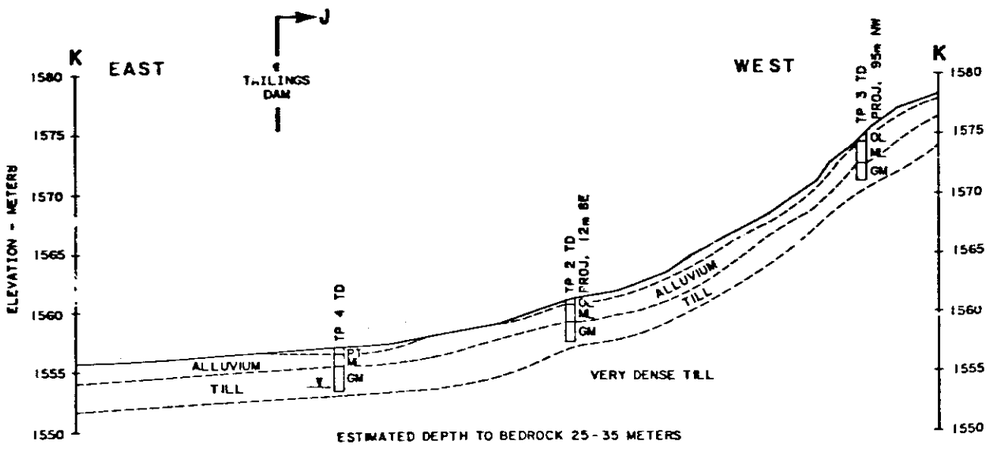
the center line of the proposed tailings dam and within the confinement area. Pit depth varied from 2.7 meters to 5.5 meters. Physical property tests performed on representative test pit samples were mechanical analyses, Atterberg limits, specific gravity, natural moisture content, compaction, permeability and consolidation. The results of these tests are presented in Appendix 9.0.

Foundation Conditions

The proposed tailings dam will be founded on moderately dense to dense glacial till composed of clay, silt, and gravelly, sandy silt (see Figure 2.326-1, page 87). The till is commonly covered by up to 0.5 meters of saturated peat. Gravelly lenses are common in the till and are frequently water-bearing. Till stratigraphy in the mine area indicates that these lenses are not continuous. Gravel content in the till generally increased







EXPLANATION:

TP 7 TD — TEST PIT

G — SECTION INTERSECTION

GROUND-WATER LEVEL

TP — TURNING POINT

NOTE:

PROJECTION MADE NORMAL TO SECTION

0 25 50 100

SCALE - METERS
IV=10H

Figure: 2.326-1

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA
TAILINGS POND
SECTION J-J
SECTION K-K

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A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.326 Tailings Pond Cont'd.

Foundation Conditions Cont'd.

with depth. Seismic refraction surveys show the till to range from 10 to 48 meters thick in the area of the tailings dam.

Laboratory tests performed on glacial till indicate that 60% to 87% of materials pass the #200 sieve. A sample, representative of typical till material, is characterized by low plasticity and a dry density of 1815 kg/m^3 at an optimum moisture content of 13.8%; this value is close to the natural moisture content of the material. Permeability tests performed on compacted samples resulted in K values typical of impermeable materials (6.1×10^{-9} to 1×10^{-10} cm/sec). Consolidation tests performed on a disturbed composite sample indicate that settlement will be minimal and within acceptable limits for the tailings dam.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.327 Settling Pond

The proposed settling pond will be located east of the Elk River, approximately 6 km south of the Elk River-Cadorna Creek confluence, and across the river from the proposed tailings dam (Appendix 6.0, Sheet 2). The crest length of the embankment is approximately 1200 meters. The embankment will have a crest elevation of 1548 meters and a maximum height of 10.7 meters. The pond will cover an area of approximately 150,000 square meters and have a reservoir capacity of approximately one million cubic meters.

Exploration and Testing

Eight drill holes, DH1SP through DH8SP, were completed along the proposed embankment and in the pond area (Appendix 6.0, sheet 2). The depth of the drill holes varied from 5.2 to 17.1 meters and drilling totalled 84.6 lineal meters. Standpipes (2.5 cm I.D. PVC), to measure water levels were installed in all of the drill holes except DH7SP, (see Appendix 7.0, Drill Hole Logs). Eleven test pits, TP1SP through TP11SP, were excavated along the proposed embankment and in the pond

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.327 Settling Pond

Exploration and Testing Cont'd.

area. The depth of the test pits varied from 2.1 to 5.5 meters (see Appendix 8.0).

Physical property tests were made on representative samples from the drill holes and test pits. These tests included sieve and hydrometer analysis, Atterberg limits, specific gravity, compaction, permeability and consolidation. Results of these tests are presented in Appendix 9.0.

Foundation Conditions

Typical geologic cross-sections along the center line of the proposed settling pond embankment and across the settling pond are seen in Figures 2.327-1 and 2.327-2, pages 91 and 92. The settling pond will be founded on alluvium, which varies in thickness from 4.0 to 15.3 meters. The alluvium is composed of silt, gravel, silty gravel and silty sand. The gravels which cover much of the settling pond embankment area will have

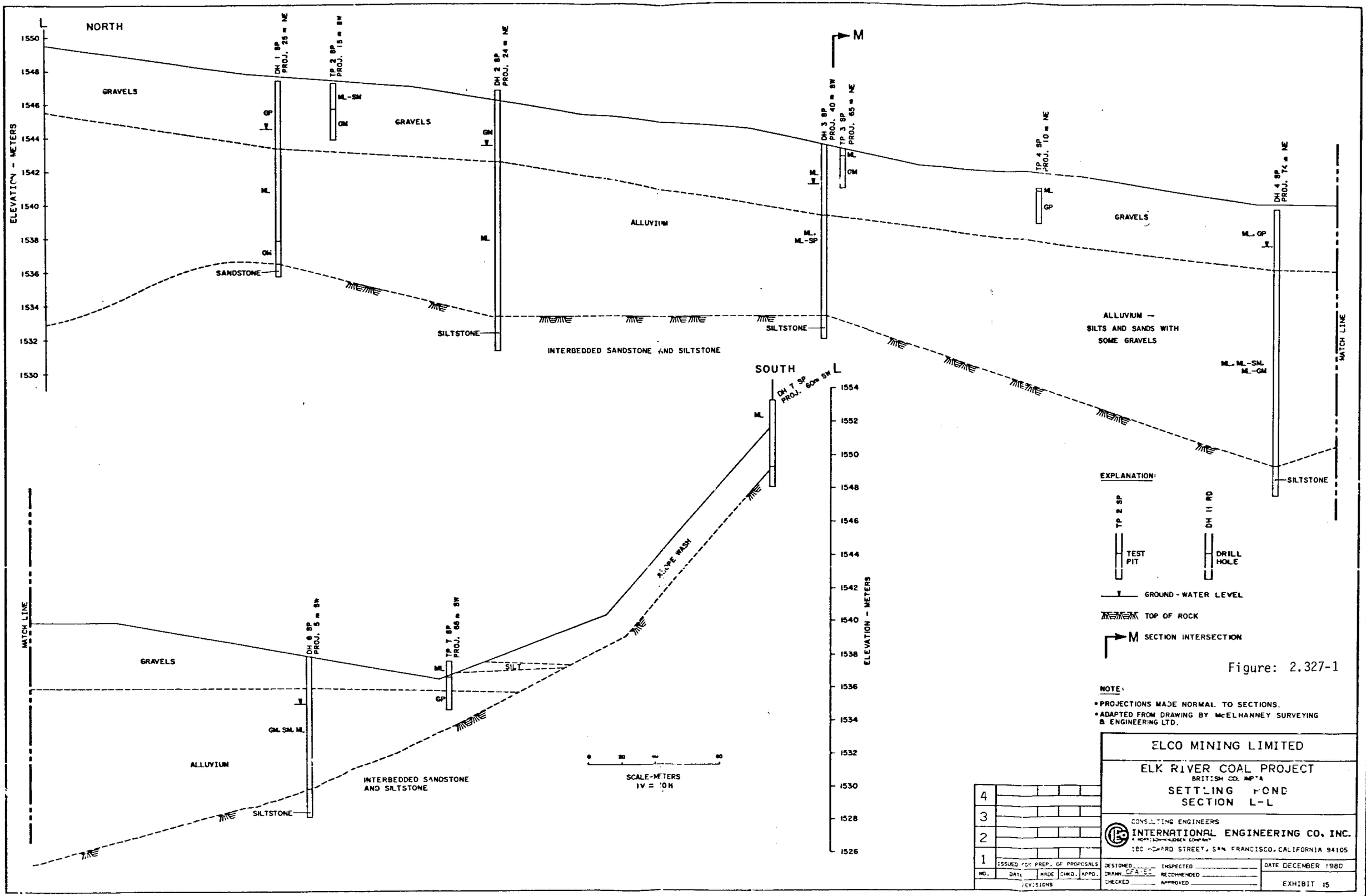

Figure: 2.327-1

NOTE:

- PROJECTIONS MADE NORMAL TO SECTIONS.
- ADAPTED FROM DRAWING BY McELHANNEY SURVEYING & ENGINEERING LTD.

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA

SETTLING POND
SECTION L-L

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING CO. INC.
A HOPEMAN-HUDSON COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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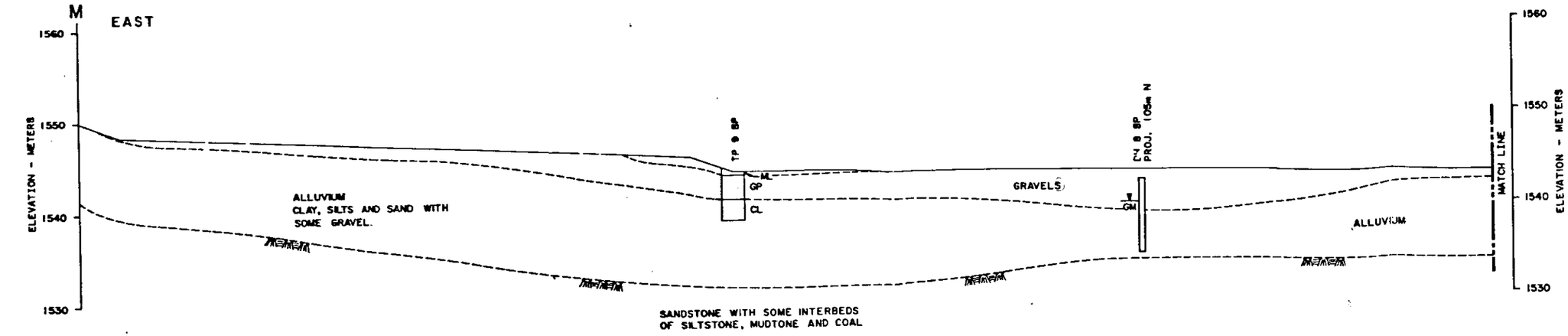

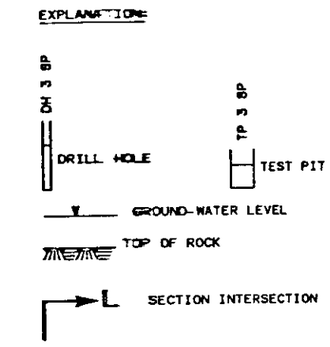

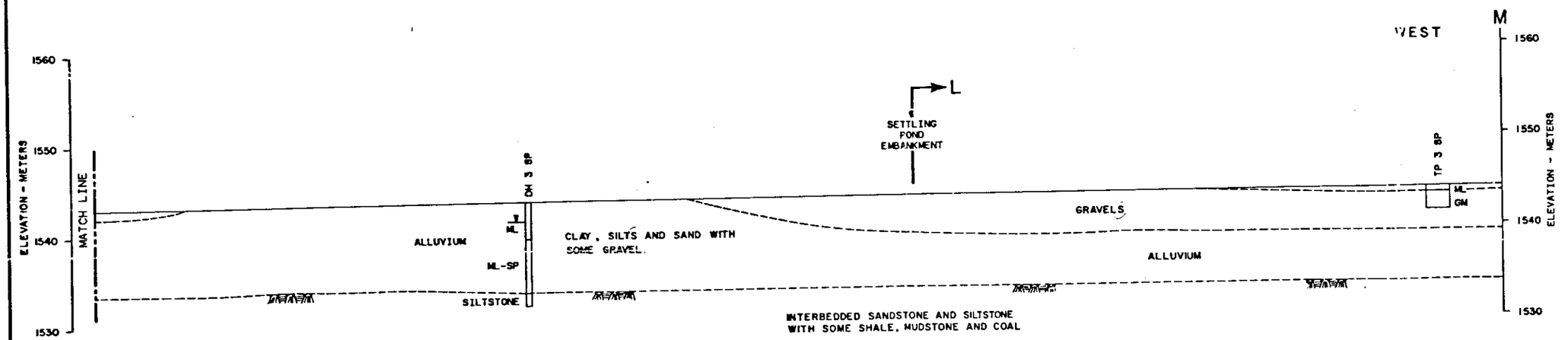

NOTE:

- PROJECTIONS MADE NORMAL TO SECTION.

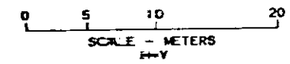

Figure: 2.327-2

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ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

SETTLING POND
SECTION M-M

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A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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a high permeability. The silts will have a lower permeability; however, no permeability tests were made during the 1980 exploration. The depth to ground water in drill holes ranged from 1.9 to 3.3 meters. Ground water levels in the drill holes appeared to be influenced by the water level in the Elk River. Siltstone and sandstone were encountered in drill holes below the alluvium.

Consolidation, permeability, and compaction tests were performed on disturbed samples from test pits. Laboratory test results and standard penetration tests indicate that the alluvium will provide a foundation of adequate strength to support the proposed embankment, and reservoir seepage is expected to be minimal.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.328 Weary Valley Waste Dump and Diversion Channel

The proposed Weary Valley waste dump will be located on the east side of the Elk River in a narrow valley eroded by Weary Creek into the Fernie shale (see Appendix 6.0, sheets 1 - 2). The surface area of the proposed waste dump will be 1.45×10^6 square meters. The valley surface is hummocky and uneven, and surface runoff is channelled into Weary Creek.

An interceptor ditch or diversion channel will prevent runoff from the slopes above the waste dump from flowing through the dump and will carry the flow of Weary Creek. The diversion channel will be located approximately along the 1800 meter contour at the east boundary of the waste dump. An alternative would be the design of a cut and cover channel at the bottom of Weary Creek Valley. The channel cover would be designed to carry the load of the dump and Weary Creek would flow through the channel for the life of the dump, approximately six years. When the dump is no longer active, a new Weary Creek channel would be designed and constructed across the top of the dump.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.328 Weary Valley Waste Dump and Diversion Channel Cont'd.

Exploration and Testing

Six test pits, TP1WC through TP6WC, and seismic line 35 were completed in the area of the proposed waste dump. Test pits TP7WC through TP11WC were located along the Weary Creek diversion channel (see Appendix 6.0, Sheets 1 - 2). Physical properties tests performed on representative test pit samples included mechanical analyses, Atterberg limits and natural moisture content. The results of these tests are presented in Appendix B.

Foundation Conditions

1. Waste Dump

The proposed waste dump will be founded on slope wash, alluvium and loose glacial till; these materials are composed of silty sand, silt and gravel. Ground water is present at 5.5 meters depth in test pit TP2WC. Water-bearing alluvial

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.328 Weary Valley Waste Dump and Diversion Channel Cont'd.

1. Waste Dump Cont'd.

lenses are, however, common throughout the glacial till. Seismic refraction surveys indicate that the bedrock depth is at least 23 meters (see Figure 2.32-2, Sheet 2, page 50).

Sieve analyses of representative test pit samples indicate that 3% to 8% of materials pass the #200 sieve. The low content of fines indicates that the foundation materials may be highly pervious.

2. Diversion Channel

The proposed Weary Creek diversion channel will be founded primarily on slope wash composed of clay and silty gravel. Bedrock was present at a depth of 5.5 meters in test pit TP11WC. Ground water was not encountered. Sieve analyses of test pit samples indicate that 5% to 12% of materials pass the #200 sieve. The low content of fines indicates that the foundation

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.328 Weary Valley Waste Dump and Diversion Channel Cont'd.

2. Diversion Channel Cont'd.

material may be highly pervious. The loose, pervious nature of the foundation suggests that the channel must be lined.

2.329 Northeast Interceptor Ditch

The proposed northeast interceptor ditch is located on the west sloping hillside east of the mine area at about 1700 meters elevation. The ditch alignment follows the natural contours of the hillside, except at the northern end, where the flow will be carried in an existing gully west to the Elk River a short distance upstream from the diversion dam. The slope of the ditch varies from 0.00034 to 0.00056 m/m. Where side-hill slopes are too steep to construct a channel, flumes will be used to carry the flow.

Exploration and Testing

To date, geotechnical exploration of the northeast interceptor

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.329 Northeast Interceptor Ditch Cont'd.

Exploration and Testing Cont'd.

ditch has been limited to air photo interpretation and a reconnaissance traverse of the survey cut-line which closely follows the proposed ditch alignment (see Appendix 6.0, Sheet 1), and one test pit, TPINEI (see Appendix 8.0). Grain size analysis performed on a representative sample from the test pit indicated the material to be silty gravel (GM).

Foundation Conditions

Surface traverses indicate that most materials to be excavated will consist of talus, slope wash, weathered till and alluvium deposited in fans, terraces and the Elk River flood plain. Because the maximum ditch depth is less than 2.5 meters, little, if any bedrock is expected to be encountered in channel excavation. The talus and slope wash consist of sand, silt and gravel, with angular to subrounded rock fragments. In general, these materials are loose and permeable.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.329 Northeast Interceptor Ditch Cont'd.

Foundation Conditions Cont'd.

The alluvium is mostly sandy gravel with subrounded to rounded particles, including boulders. Rocks in the alluvium are primarily limestone, sandstone and quartzite, with lesser amounts of shale. The till consists of clayey, silty gravel with subangular to subrounded particles. A sieve analysis performed on a till sample from five meters depth test in test pit TPINEI indicated 7% passing the #200 sieve. Large boulders of sandstone, limestone and quartzite are common. Till stripped from the mine area can be used as a source of impervious lining for the ditch. The excavated pervious materials can be utilized as fill to construct the down slope embankment. Riprap materials to be used for channel protection can be obtained from alluvial and colluvial material excavated during ditch construction.

Rock slides are present along the ditch alignment and extend to the east up the various gullies. Vegetation present in these areas indicates these slides have been stable for many years.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.32 Geotechnical Investigation of the Mine Site Overburden Deposits

2.329 Northeast Interceptor Ditch Cont'd.

Foundation Conditions Cont'd.

Their presence does, however, show that a potential for future rock slides exists, particularly in the event of an excessive accumulation of snow on slopes above the interceptor ditch. Surface water was noted in the deeper gullies. At higher elevations it is flowing on bedrock but at the elevation of the interceptor ditch it is flowing a few feet below the surface through the coarsealluvium that has accumulated in the bottom of the gullies.

2.33 Other Geotechnical Overburden Investigations

2.331 Forestry Bypass - Access Road

The access road alignment extends along the west side of the valley from the town of Elkford to the mine site a distance of 48.3 km. The alignment of the existing road is followed wherever possible. The forestry bypass road will continue from the mine site north for a distance of 8 km. It will be built on the west slope of the valley north of the plant site, turning

2.331 Forestry Bypass - Access Road Cont'd.

east to cross the Elk River on the crest of the diversion dam, and joining the existing road east of the river, (see Index Map, page 2.

The access road will have a gravel surface during the construction phase of the mine, to be upgraded to a bituminous surface when mining operations begin. A drainage ditch on the west side of the bypass road will divert runoff from the west slope away from the west waste dump and the plant site.

Exploration and Testing

Five test pits, TP1FB through TP5FB, were excavated to a maximum depth of 5.5 meters along the north section of the forestry bypass road west of the Elk River-Cadorna Creek confluence (see Appendix 6.0, Sheet 1). Representative samples were analyzed for grain size and Atterberg limits. The material encountered in the test pits was medium to very dense glacial till composed of silty, clayey gravel (GM) to sandy gravel (GP), generally overlain by 0.3 to 0.6 meters of organic material.

Exploration and Testing Cont'd.

The fines are classified as slightly to moderately plastic clay or silt. Gravel content in the till commonly increased with depth and contained cobbles and boulders to 1.2 meters in diameter. Water inflow occurred at a depth of three meters in test pit TP3FB, but water was not encountered in the other test pits. Bedrock was not reached in any of the test pits (see Figure 2.330-1, page 103). Details of test results are presented in Appendix 9.0.

Foundation Conditions

Most of the road will be constructed on glacial till, but, locally, the road will be on outwash gravel, alluvial fan material, and alluvial gravels in the flood plains of the Elk River and tributary streams. In general, the materials at the surface will present no problems if satisfactory drainage is provided. Compressible organic overburden will require removal. Some local depressions

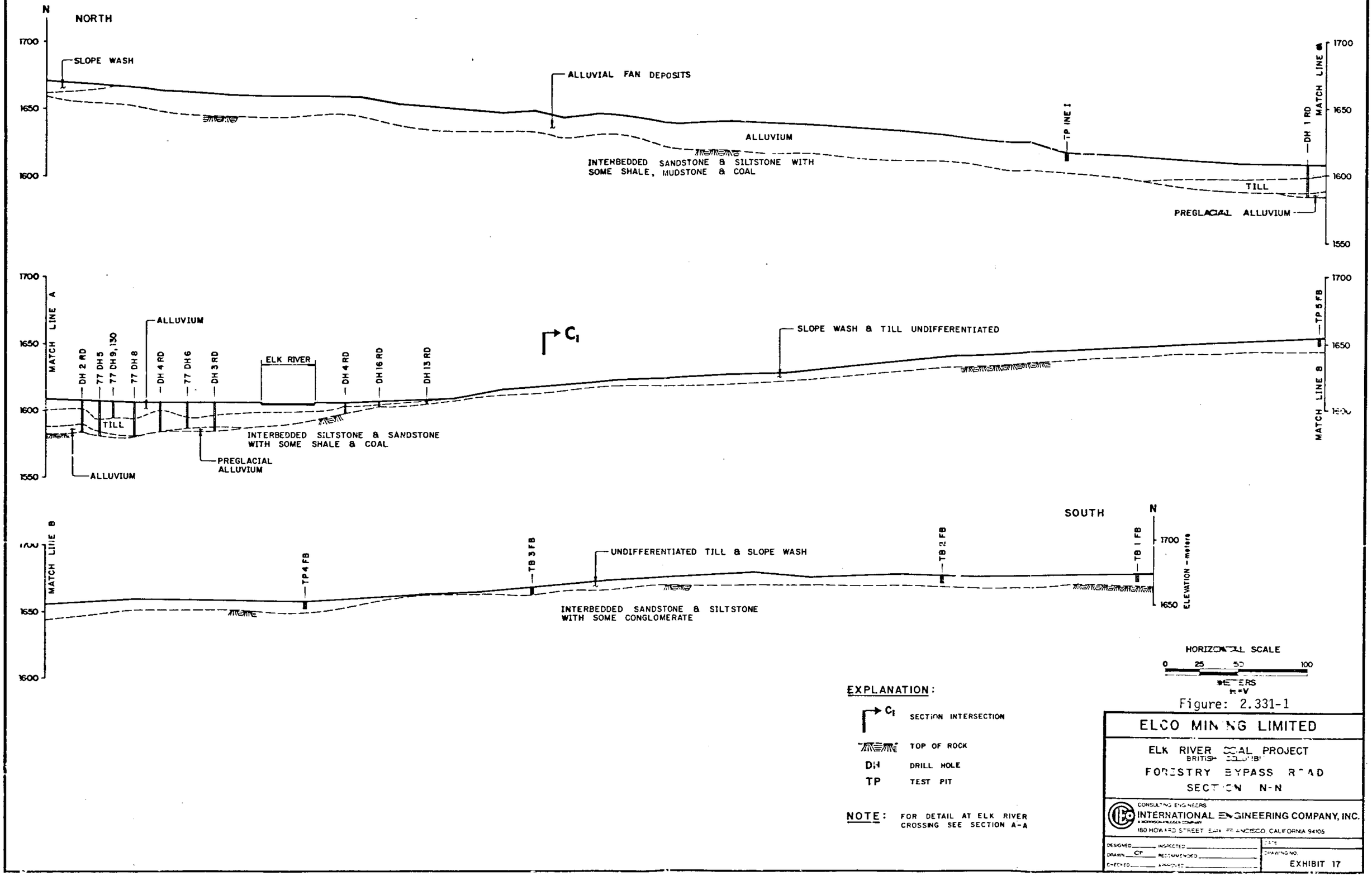

Figure: 2.331-1

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

FORESTRY BYPASS ROAD
SECTION N-N

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET SAN FRANCISCO, CALIFORNIA 94105

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EXHIBIT 17

in till which are filled with saturated silts, sands and organic material will also require attention. The depressions will require complete excavation and back-filling with well-compacted material to provide a stable foundation for the access road. Roadside ditches will be necessary to collect flow from runoff and poorly drained areas and direct it away from the road.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.34 Overburden Ground Water Investigations on the Mine Site

The purpose of the overburden ground water investigations was to determine the alluvial aquifer conditions at the Elk River diversion dam site at the north end of the proposed open pit mine. Seepage beneath the diversion dam and into the mine could then be studied once the alluvial aquifer parameters had been determined by the evaluation of pumping test data.

The scope of work included the drilling of a pump-test well and observation wells. Geotechnical exploration drill holes drilled in 1977 were also included as observation wells. Golder Associates investigated the bedrock aquifer in the river diversion dam area during 1980. However, a review of their test data was not included in the IECO scope of work. The relationship between the alluvial aquifer and bedrock aquifers was not fully determined.

Evaluation of test data and determination of ground water parameters aided in the conceptual design of several alternatives for seepage control under the diversion dam. Hydrological testing was limited to the diversion dam site. No regional hydrologic water level or water quality studies were performed.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

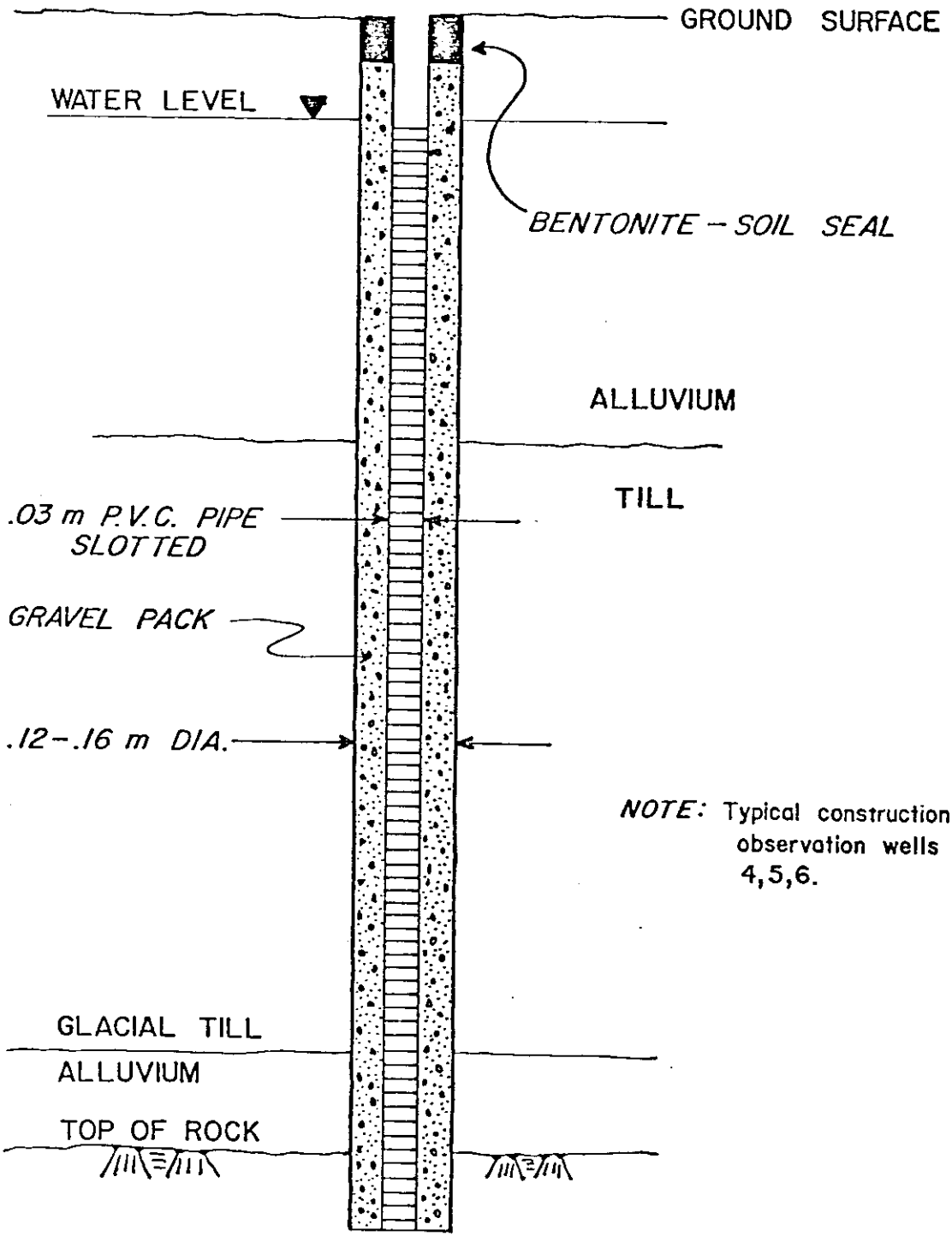
2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

A pumping test well and a series of observation wells were constructed and developed in order to evaluate the hydrogeologic parameters of the unconsolidated surficial deposits in the diversion dam area. The observation wells were drilled by Allkind Drilling Company, using a Failing 1500 rotary drilling rig. Drillwell Enterprises drilled the pumping test well using a Bucyrus-Erie 12-R rotary drilling rig.

Drilling of the observation wells began in July 1980. Organic drilling fluid (Revert) was used to prohibit well plugging by drilling fluids and to provide better hydraulic connection between the well and the aquifer. The drilling was observed and the holes were logged by an IECO geologist. Periodic standard penetration drive samples were also taken (see drill hole logs in Appendix 7.0).

Perforated PVC casing was installed in the drill holes and the annular space and backfilled with washed river gravel. A bentonite seal was used to prevent surface water infiltration. Typical construction details are shown in Figures 2.34-1 and 2.34-2, pages 107-108). Piezometers installed in 1977 were also incorporated into the water level monitoring network.

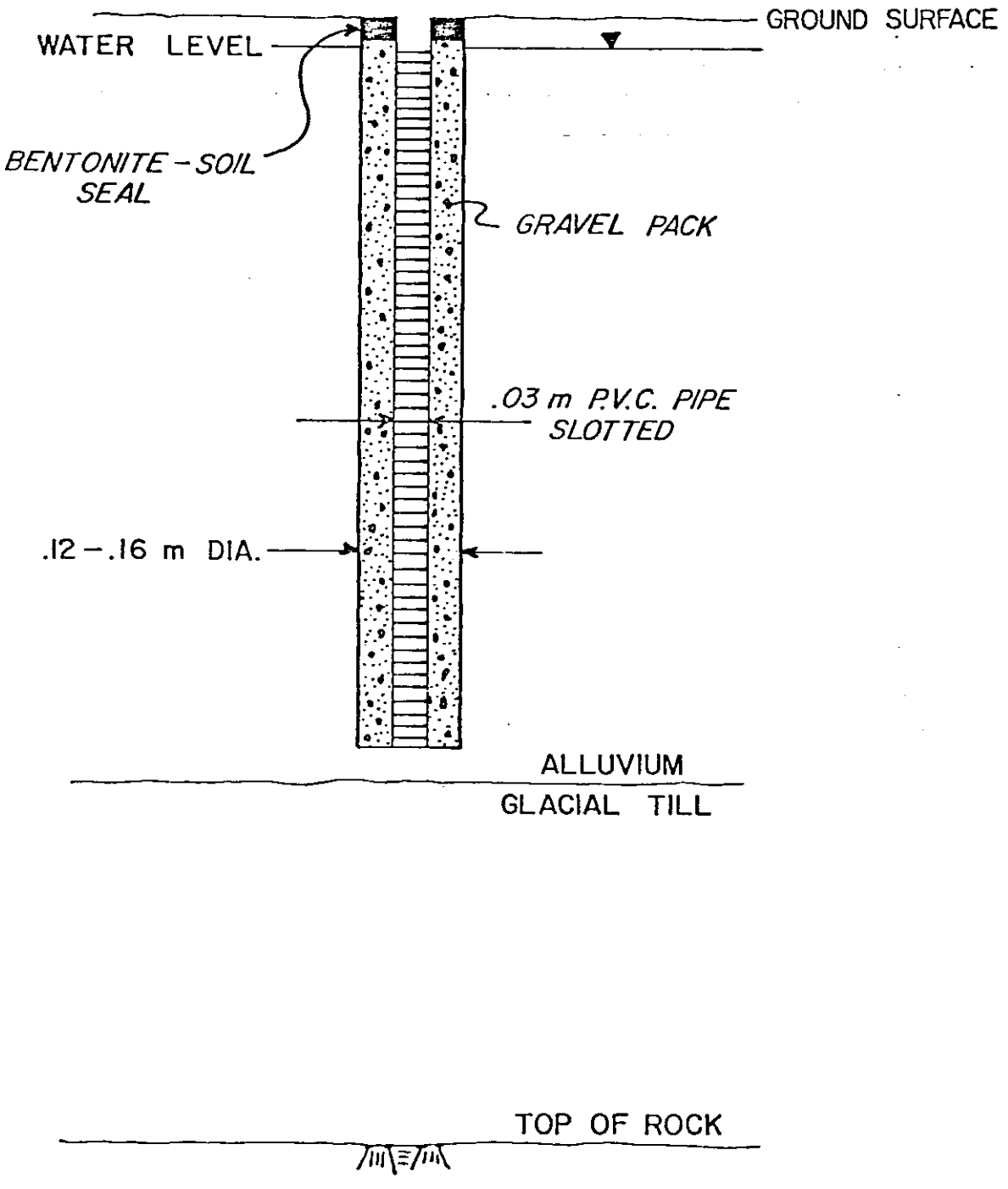
OBSERVATION WELL



NOTE: Typical construction detail for observation wells DH – 1,2,3, 4,5,6.

Figure: 2.34-1

OBSERVATION WELL



NOTE: Typical construction detail for observation wells DH - 7a, 8a, 9a.

Figure: 2.34-2

2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

The test well was drilled on August 17, 1980, by the air rotary method. Steel casing and UOP Johnson wire-wound V notch stainless steel screen were installed on August 24, 1980. See Figure 2.34-3, page 110 for well log and well construction details. The test well was developed naturally by air pumping. Preliminary quantitative flow estimates obtained during the development period indicated that the capacity of the well could be about 750-1150 litres per minute (lpm).

On September 5, 1980, a 10 hp test pump was installed. Drawdown achieved by this pump was minimal. A higher capacity pump was substituted in order to achieve a greater drawdown in the pumped well and observation wells. The pumping test started on September 7, 1980, using a four stage 20 hp Pioneer submersible pump. Pumping of the test well continued for a period of 72 hours. The flow rate was monitored by a McCrometer Flowmeter. The test well produced an average of 2170 lpm for 4320 minutes with a drawdown of approximately 0.56 meters. Specific capacity of the well is approximately 3875 lpm per meter of drawdown. Near equilibrium was attained at approximately 1300 minutes.

PUMP WELL

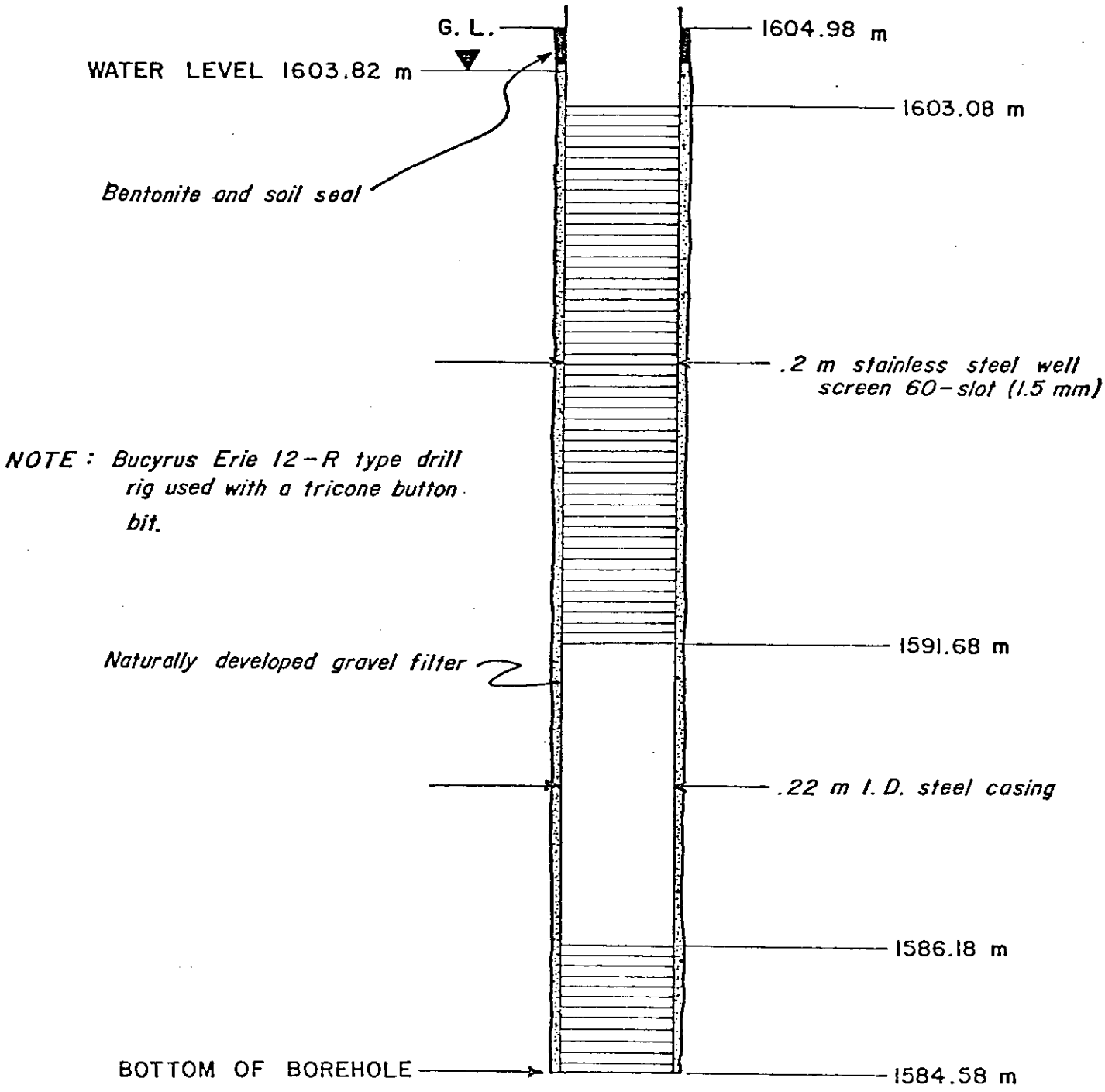


Figure: 2.34-3

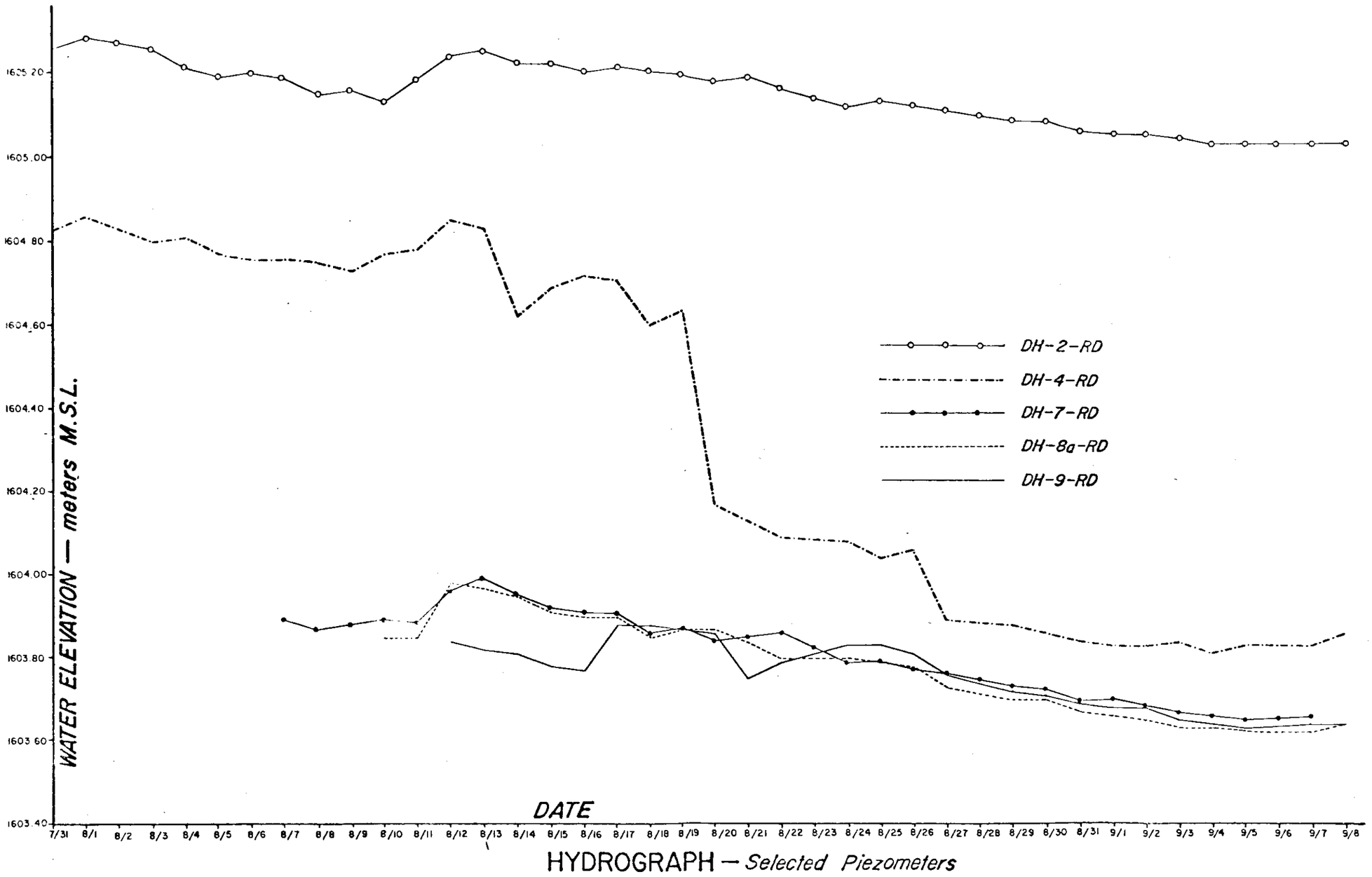
2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

Fifteen observation wells and one pump well were monitored during the pumping test and during the recovery phase of the test. Water levels were also recorded on a daily basis during a period of time from the end of July to the beginning of the pump test in early September (Figures 2.34-4, page 112). Locations of the observation wells and the pump well are shown on Figure 2.34-5 page .

After pumping started, the observation wells were monitored in a standard pumping test sequence. After 4320 minutes of pumping, the sequence was repeated for the recovery of water levels in the pump well and observation wells. Recovery was monitored for 420 minutes.

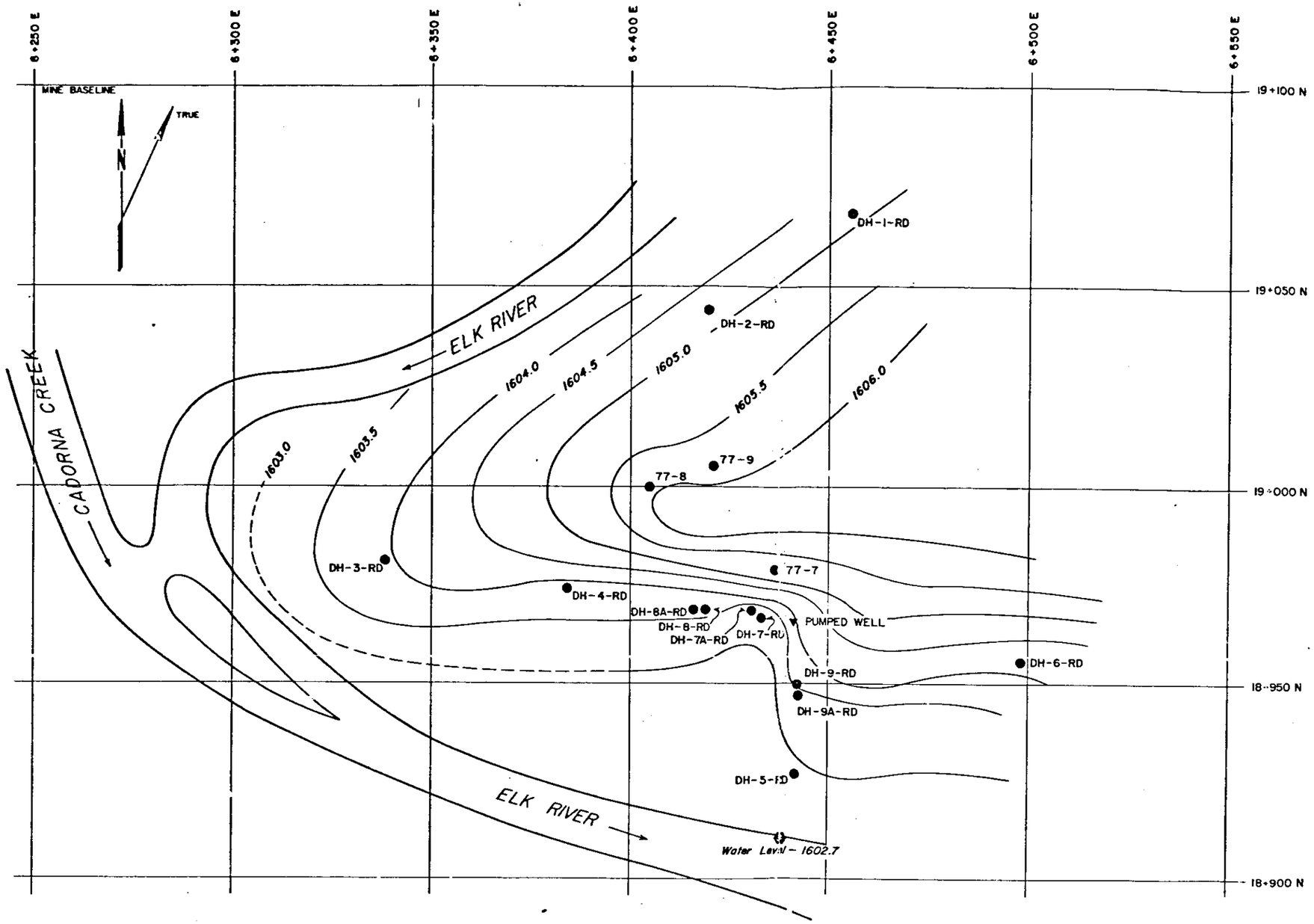
Aquifer parameters were analyzed graphically using the Theis (1935) non-equalibrium equation and Cooper and Jacob's (1946) modification of the Theis method. These graphical analyses are based on formulas that mathematically describe the cone of depression that expands with time, resulting from constant pumping of a well. The Theis equation is:

$$T = \frac{Q}{4\pi s} W(u) \qquad S = \frac{4 T t u}{r^2}$$



HYDROGRAPH — *Selected Piezometers*

Figure: 2.34-4



EXPLANATION:

- DH-7-RD ● OBSERVATION WELL
- ▼ PUMPED WELL
- ⬢ RIVER WATER LEVEL
- —1606.0— ALLUVIAL GROUND-WATER CONTOUR (ELEVATION IN METERS)

NOTE:

ALL WATER LEVEL MEASUREMENTS DERIVED FROM DATA OBTAINED ON SEPTEMBER 7, 1980.

SCALE

0 5 10 20 30 40 50

METERS

Figure: 2.34-5

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ALLUVIAL AQUIFER
GROUND-WATER CONTOURS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

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DATE DECEMBER 1980

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2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

Where:

Q = uniform discharge from well, (L^3T^{-1})

S = drawdown in the observation well, (L)

T = transmissivity of the aquifer, (L^2T^{-1})

S = storativity (non-dimensional)

r = distance from center of pumped well to the observation well, (L)

t = time since start of pumping, (T)

W(u) = the well function or exponential integral of u (non-dimensional)

$u = \frac{r^2 s}{4Tt}$ (non-dimensional)

Jacob and Cooper (1946) modified the Theis non-equilibrium formula to make use of a graphical solution that is linearly related to the logarithm of time. This approach is considered valid if u is equal to or less than 0.01. Equations used for evaluation of the semi-log plot of drawdown and time are:

$$T = \frac{2.300}{4\pi s} \qquad S = \frac{2.25\ Tto}{r^2}$$

2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

Where:

Q = uniform discharge from well, (L^3T^{-1})

s = drawdown over one log cycle, (L)

T = transmissivity of aquifer, (L^2T^{-1})

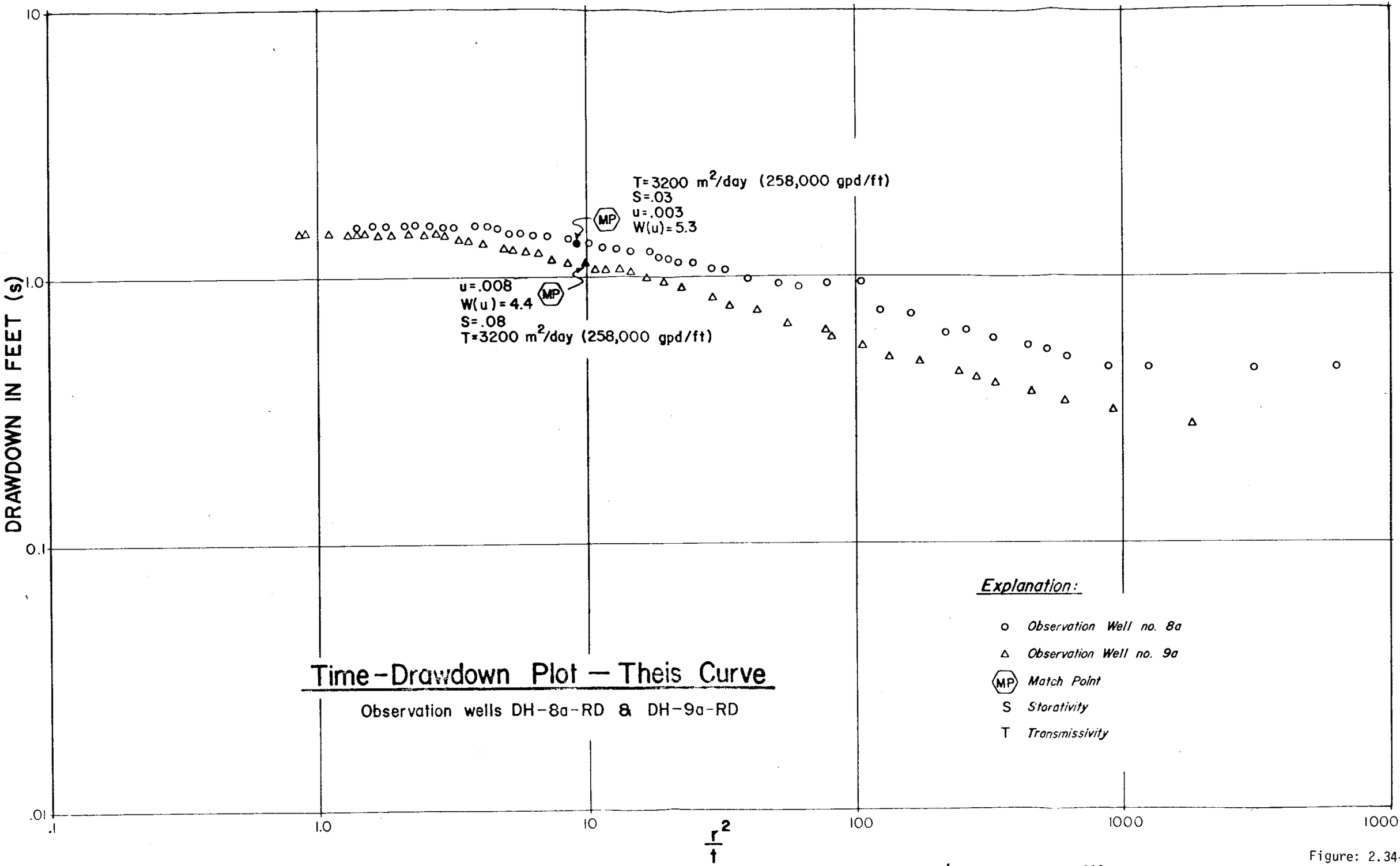
S = storativity (non-dimensional)

t_o = time at zero drawdown intercept, (T)

r = distance from test well to observation well, (L)

Figures 2.34-6 through 2.34-11 pages 116 through 121 show selected Theis and Jacob drawdown time plots.

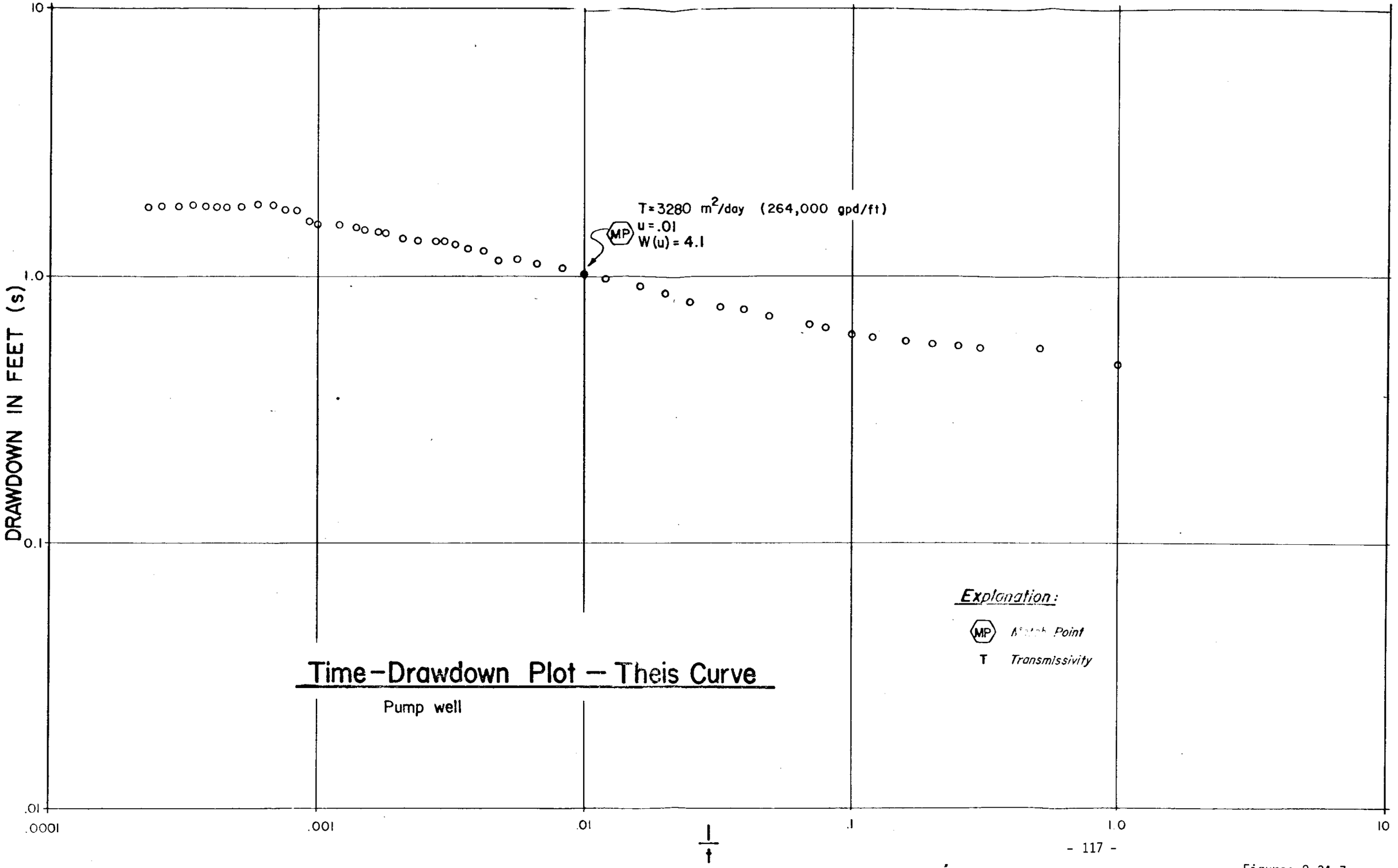
Transmissivities computed from the pump well and observation wells ranged between 2500 and 5100 square meters per day. A representative transmissivity for use in the diversion dam area is 3400 square meters per day. Table 2.34-1, page 122 presents calculated aquifer coefficients using both drawdown and recovery data for representative observation wells. Assuming an aquifer thickness of 12 meters, average hydraulic conductivity would be 0.33 cm/s. The storage coefficient ranges from 0.003 to 0.11 indicating that unconfined and semi-confined conditions exist at the various observation well locations. Upper portions



Time-Drawdown Plot — Theis Curve

Observation wells DH-8a-RD & DH-9a-RD

Figure: 2.34-6



Time-Drawdown Plot — Theis Curve

Pump well

Figure: 2.34-7

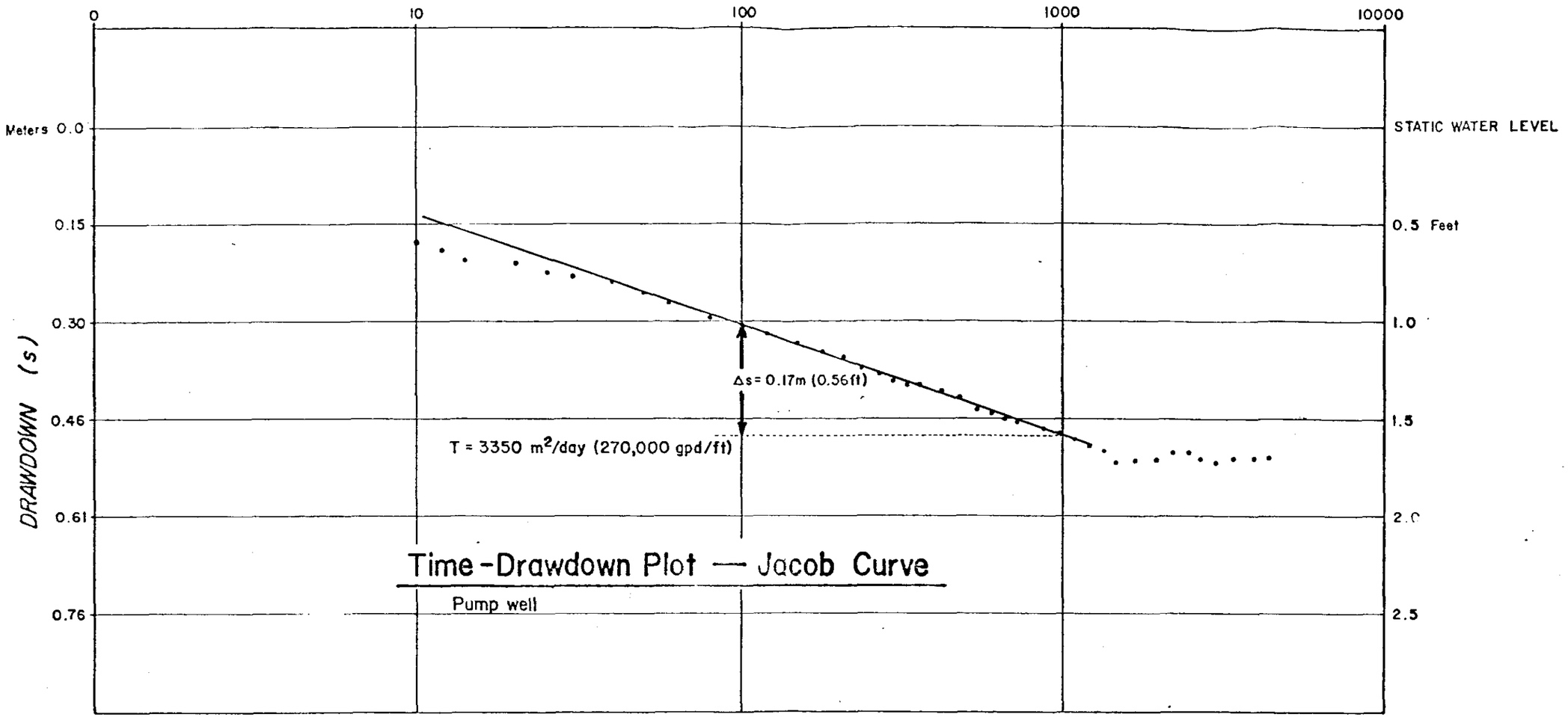

ELAPSED TIME – Minutes
0
10
100
1000
10000
Meters 0.0
0.15
0.30
0.46
0.61
0.76
STATIC WATER LEVEL
0.5 Feet
1.0
1.5
2.0
2.5
DRAWDOWN (s)
Δs = 0.17m (0.56ft)
T = 3350 m²/day (270,000 gpd/ft)
Time-Drawdown Plot — Jacob Curve
Pump well

Figure: 2.34-8

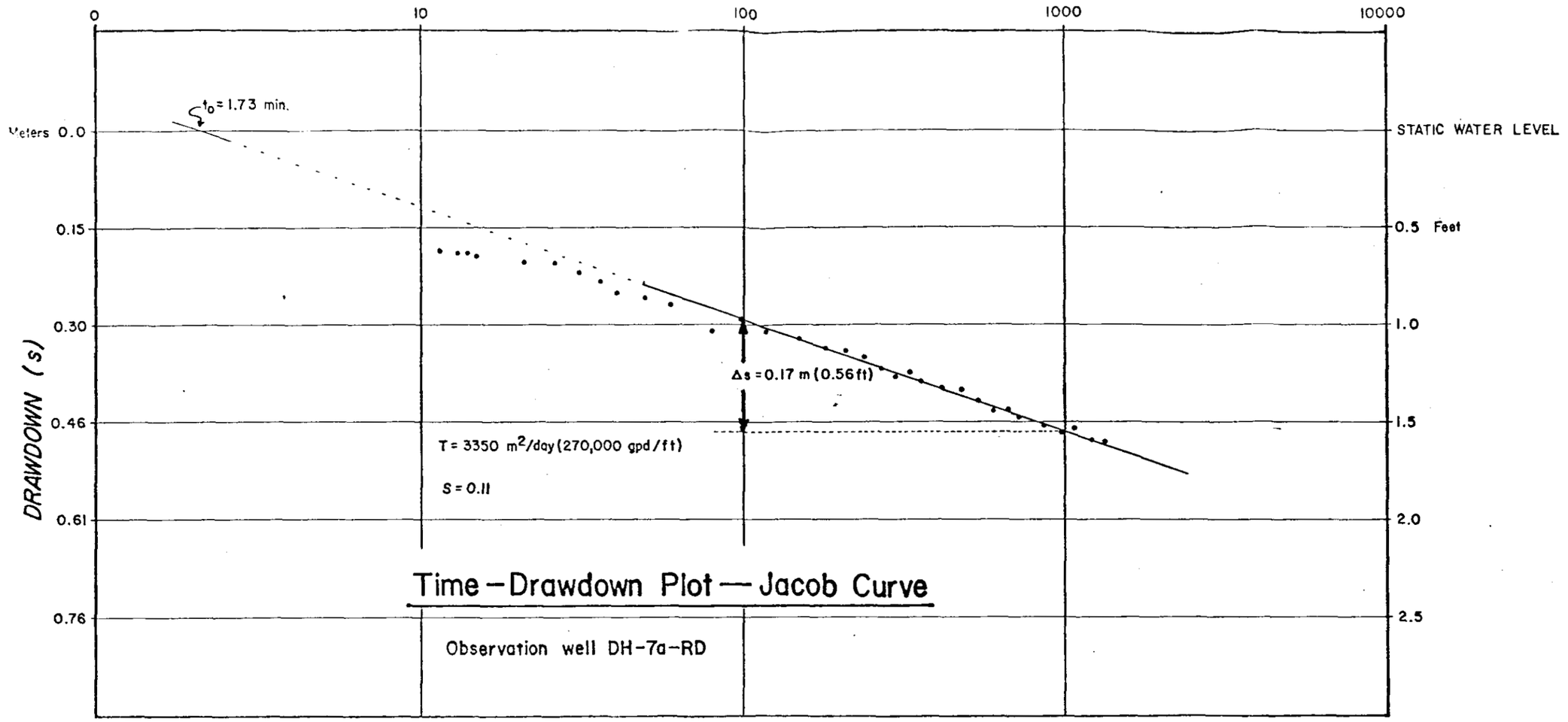

ELAPSED TIME — Minutes
0
10
100
1000
10000
t_o = 1.73 min.
Meters 0.0
0.15
0.30
0.46
0.61
0.76
DRAWDOWN (s)
STATIC WATER LEVEL
0.5 Feet
1.0
1.5
2.0
2.5
Δs = 0.17 m (0.56 ft)
T = 3350 m²/day (270,000 gpd/ft)
S = 0.11
Time – Drawdown Plot — Jacob Curve
Observation well DH-7a-RD

Figure: 2.34-9

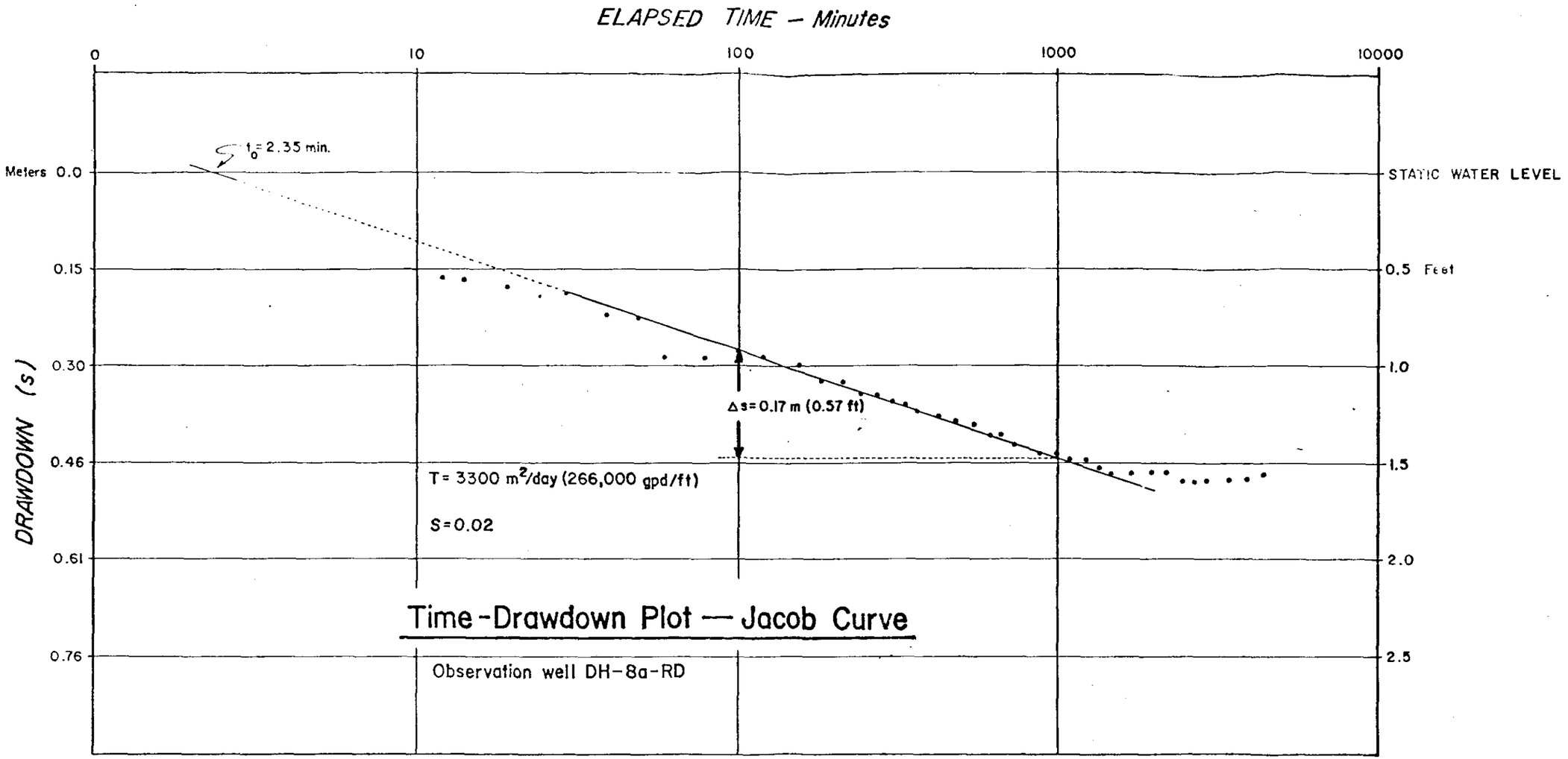


Figure: 2.34-10

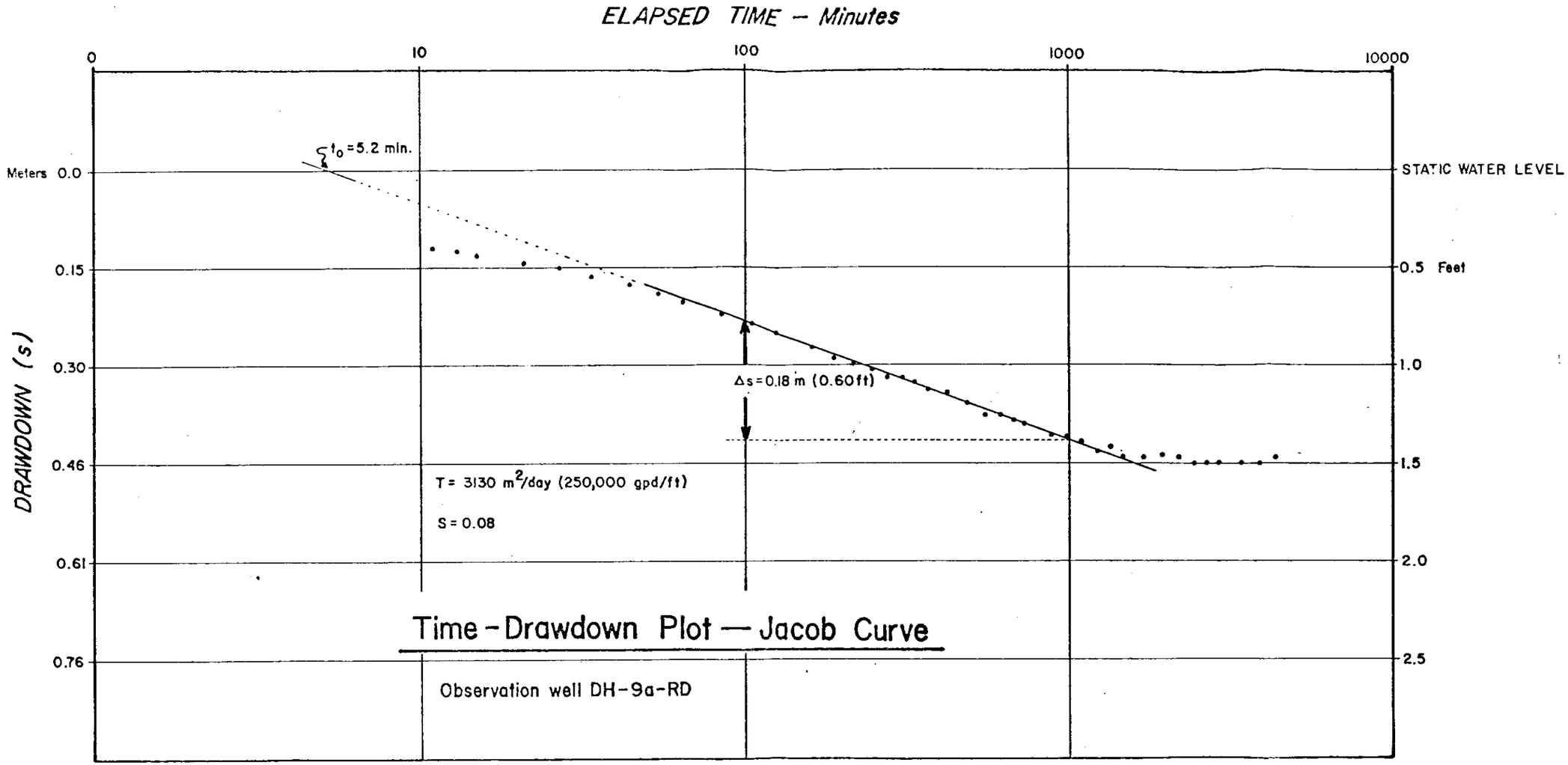


Figure: 2.34-11

Table: 2.34-1

CALCULATED AQUIFER COEFFICIENTS FROM
SELECTED OBSERVATION WELLS

Observation Well Number	Distance From Pump Well (m)	Method of Analysis	Transmissivity $T(m^2/day)$	Storativity S (Dimensionless)
Pump Well	-	Theis	3280	-
		Jacob	3350	-
		Jacob (recovery)	3960	-
DH-3-RD	106	Jacob	5080	0.004
		Jacob (recovery)	3760	0.003
DH-4-RD	56	Jacob	4820	0.01
		Jacob (recovery)	3240	0.004
DH-5-RD	44	Jacob	3910	0.02
		Jacob (recovery)	2840	0.01
DH-7A-RD	9	Jacob	3350	0.11
		Jacob (recovery)	2530	0.39
DH-8A-RD	24	Theis	3200	0.03
		Jacob	3300	0.02
		Jacob (recovery)	2940	0.03
DH-9A-RD	18	Theis	3200	0.08
		Jacob	3130	0.08
		Jacob (recovery)	2570	0.09

of the alluvial sediments are often silty and their low permeability may cause some confinement.

A combination of several water control methods can be used on this project. These methods include:

- Impervious walls to provide a cutoff trench beneath diversion or cutoff dams. These may be constructed through use of a bentonite slurry trench or a compacted earth-filled trench completed with glacial till or other low permeability material.

- Horizontal drains - drilled horizontally from the mine slope.

- Sump systems to remove water issuing from horizontal drains and mine slopes.

- French drains at the toe of the slope and other interception drains.

2.34 Overburden Ground Water Investigations on the Mine Site Cont'd.

- Wellpoint system - a dewatering system placed on a berm on the mine slope at the contact of the glacial till with the lower alluvium. Wellpoint jet eductor systems can be used for dewatering zones beyond the vacuum lift limit of conventional wellpoint systems.

- Deep wells - partial pre-drainage or depressurization of the recent and/or pre-glacial alluvium at the river diversion site.

Most of these methods can be used to some extent for water control in the alluvium or bedrock at the Elk River mine site. However, in order to preclude excessive infiltration into the spoil materials, to minimize high pumping costs, and to diminish the impact of long-term pumpage of ground water, an impervious wall or cutoff trench is recommended. The cutoff would reduce flow in the unconsolidated permeable zones beneath diversion dams, and along diversion channels. Minor seepage through cutoff walls and fractured bedrock may be intercepted by wells, or a well point-eductor system, if required.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.35 Mine Rock Slope Geological/Geotechnical Investigations

Golder Associates Ltd. was under contract to carry out bedrock slope stability and hydrogeological investigations on the proposed open pit mine. In addition, they would also study the foundation areas of the two external rock waste dumps and make recommendations for dump design.

To carry out the field work Golder had two hydrogeologists, one structural geologist, one technician and one waste dump specialist in the field for varying periods of time. In all, the hydrogeological investigations were the most extensive.

To assist Golder with their investigations, two contractors, Drillwest Enterprises Ltd. and CPI Equipment Ltd. were under Elco contract to carry out well drilling and pump testing respectively. These contractors, however, were under Golder supervision.

The Golder 1980 geotechnical field program consisted of three main topics:

- Ground Water Investigations
- Pit Slope Stability Investigations
- Evaluation of Waste Dump Stability.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.35 Mine Rock Slope Geological/Geotechnical Investigations Cont'd.

2.351 Ground Water Investigations

As part of the 1977 investigation, Golder Associates were to assess the ground water conditions in bedrock in the area of the proposed open pit. Results of work carried out indicated that high hydrostatic pressures existed in the basal sandstone of the footwall, and also that the nature of the overlying sedimentary sequence presented a series of contrasting permeabilities, which could have serious implications with regard to effective dewatering.

Based on the findings of the preliminary study, Golder Associates were again retained in 1980 to thoroughly investigate the dewatering requirements for the proposed open pit development. The investigation was to be restricted to bedrock hydrogeology only and was directed to investigate endwall, highwall and footwall requirements. The purpose of the 1980 investigation was to verify the results of the earlier study over a greater area, to provide an interpretation of the hydrogeology and to define dewatering requirements for both slope stability and the handling of ground water inflows.

2.3 GEOLOGICAL AND GEOTECHICAL FIELD WORK Cont'd.

2.35 Mine Rock Slope Geological/Geotechnical Investigations Cont'd.

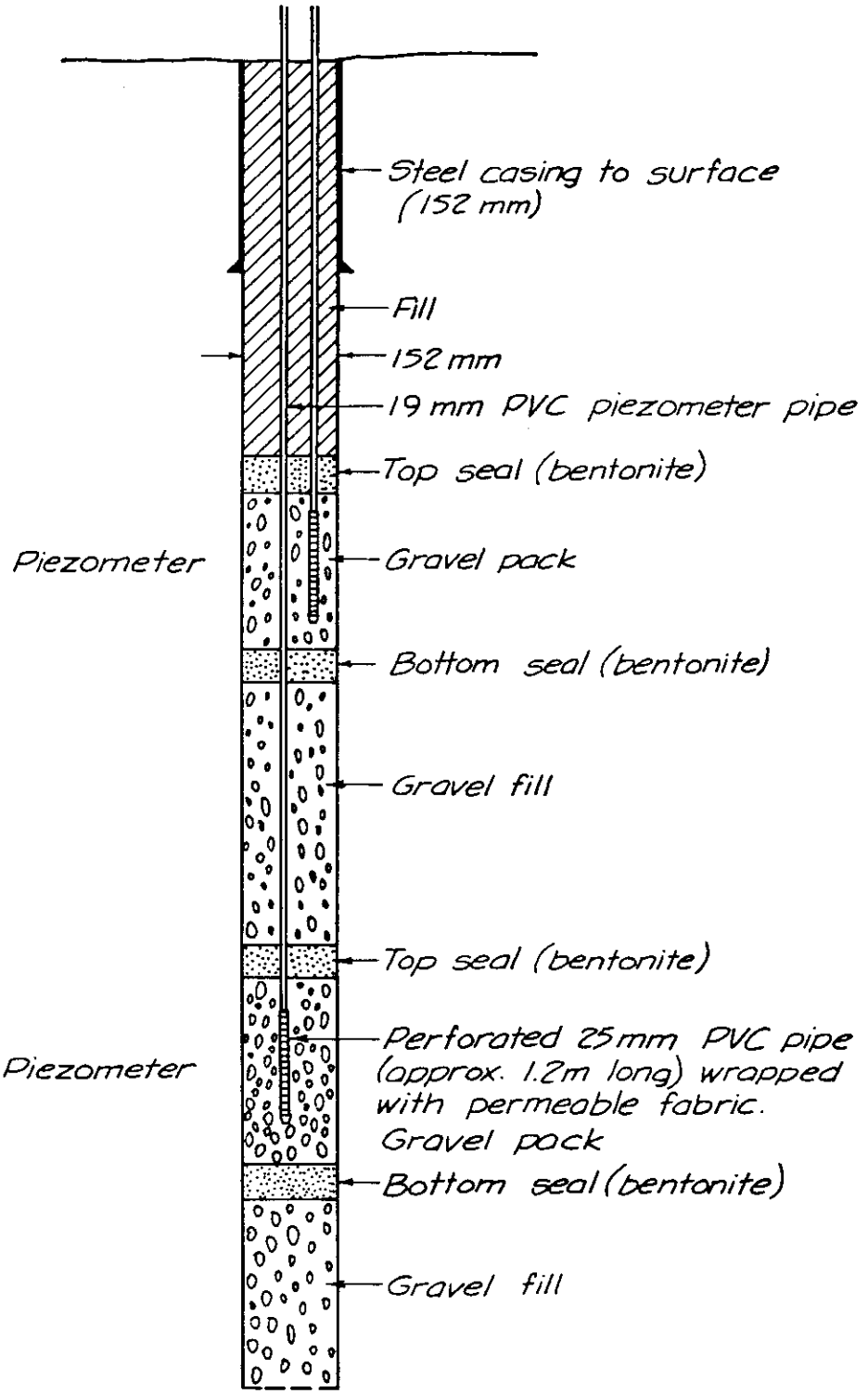
2.351 Ground Water Investigations Cont'd.

The bedrock geology of both the highwall and endwalls consist of an interbedded sequence of steeply dipping coal seams, sandstones, siltstones, shales and mudstones. This sequence is bounded on the east by the underlying basal sandstone member of the Kootenay Formation. The basal sandstone member forms the footwall of the proposed open pit development.

The field test program was designed to test each bedrock member of the Kootenay Formation by means of pumping tests. One pump test was located at the north endwall to test the coal-bearing member, and a second test was located midway along the footwall to test the basal sandstone member. Results from the north endwall test would also be applied to the highwall as it will expose the same sequence.

Each pump test site consisted of one 200 mm diameter pump well and four 150 mm diameter observation wells each completed with 3 PVC standpipe type piezometers. Figure 2.351-1, page 128 illustrates completion details of a typical observation well.

TYPICAL PIEZOMETER INSTALLATION



Schematic Only - Not to Scale

Project No. 802-1538 Drawn A.D. Reviewed Date Feb. '81

Figure: 2.351-1

Both pump test sites were located to take advantage of existing pneumatic piezometers which were installed during the 1977 investigation. All drilling was carried out by Drillwell Enterprises using a Bucyrus-Erie 12R top drive air rotary drill rig. The overburden was drilled with tricone and cased using a casing hammer. The bedrock was drilled open hole using an air-operated down hole-hammer drill.

The drilling was constantly supervised and directed by Golder Associates. During drilling, samples of drill cuttings were collected every 1.5 m to establish a lithologic log. Where encountered, water flows were measured and recorded on the logs. Well completions were carried out by Golder Associates with the aid of the drill crew. The drilling and completion logs of all holes are contained in Appendix 10.0.

Once installation of the pump well and all observation wells was completed at each site, a period of piezometer monitoring was undertaken to ensure equilibration of piezometric heads prior to commencement of pumping. Drawdown due to pumping

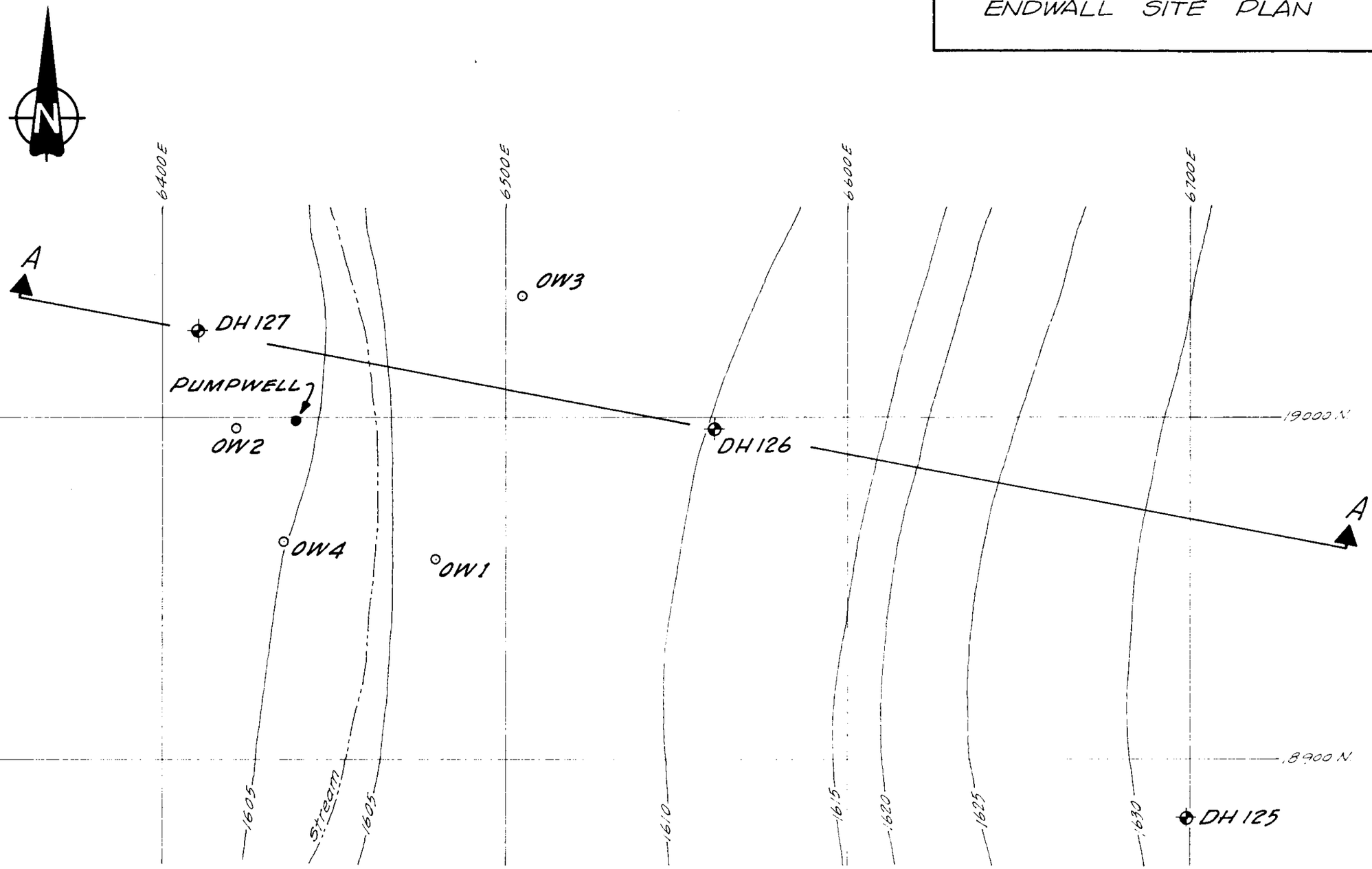
and recovery (once the pumping had ceased) were monitored in all piezometers and the well.

2.3511 North Endwall/Highwall Pump Test Cont'd.

The location and layout of the north endwall pump test is illustrated in plan and section in Figures 2.3511-1 and 2.3522-2, pages 131 and 132. At the highwall and endwalls, it was considered necessary to assess the quantities of ground water flows which would be encountered. For this reason, the north endwall/highwall well was constructed by screening the entire length of bedrock drilled. The well was drilled to the anticipated pit depth of 180 m below ground. By screening the entire bedrock section, pumping would extract ground water from all units intersected and thus would simulate the performance of an actual dewatering well.

During drilling, the variable nature of the rock units with regard to hydrogeologic characteristics became very obvious as water flows ranged from 6 l/sec. in O.W. 1 to less than 0.1 l/sec. in O.W. 3. In general, greater flows were

ENDWALL SITE PLAN



Scale 1:1200

Contour Interval - 5m.

Figure: 2.3511-1

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Date Nov. '80

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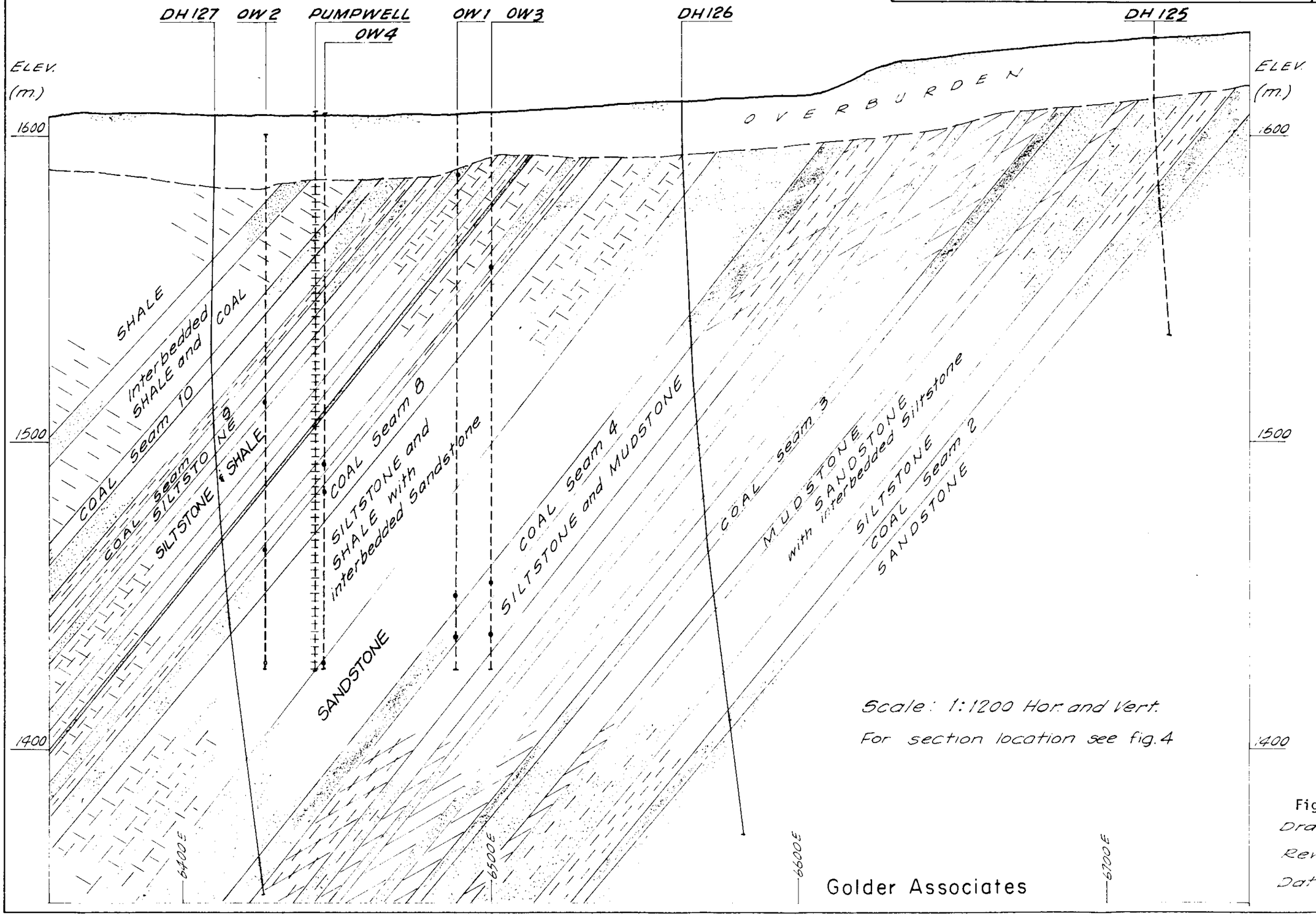
SECTION A-A'



Scale: 1:1200 Hor. and Vert.

For section location see fig. 4

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Figure: 2.3511-2

Drawn ing.

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Date Nov '80

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experienced in the sandstone units however, this was not always the case and there is, therefore, a strong indication of secondary permeability due to structure (i.e. jointing, etc.).

The pump well was completed with a slotted liner casing to provide protection for the pump and to maintain hole stability. Development using an air jetting tool was carried out. Generally, all drilling and hole completion procedures were carried out with a minimum of difficulty.

Once the site was prepared and completed and after sufficient time had passed to allow equilibration of the piezometric heads the pump test was carried out.

A five (5) horsepower, 42 stage submersible pump was installed in the well at a depth of 180 m on a 50 mm diameter pipe. A 50 mm diameter PVC pipe was laid out from the pump well to discharge water approximately 100 m south of the well. A flow meter was attached to the discharge pipe approximately 8 m from the pump well.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.35 Mine Rock Slope Geological/Geotechnical Investigation Cont'd.

2.351 Ground Water Investigations Cont'd.

2.3511 North Endwall/Highwall Pump Test Cont'd.

Several short duration pumping tests were performed initially to determine the most effective pumping rate for the life of the test. After each test, the wells were allowed to recover fully before the next test was initiated.

After starting the pump test, the pumping rate ranged generally from 0.57 to 0.88 l/sec. with an average of 0.69 l/sec. As the drawdown in the well increased, the pumping rate was found to lower, since the water had to be pumped against an increasing hydraulic head.

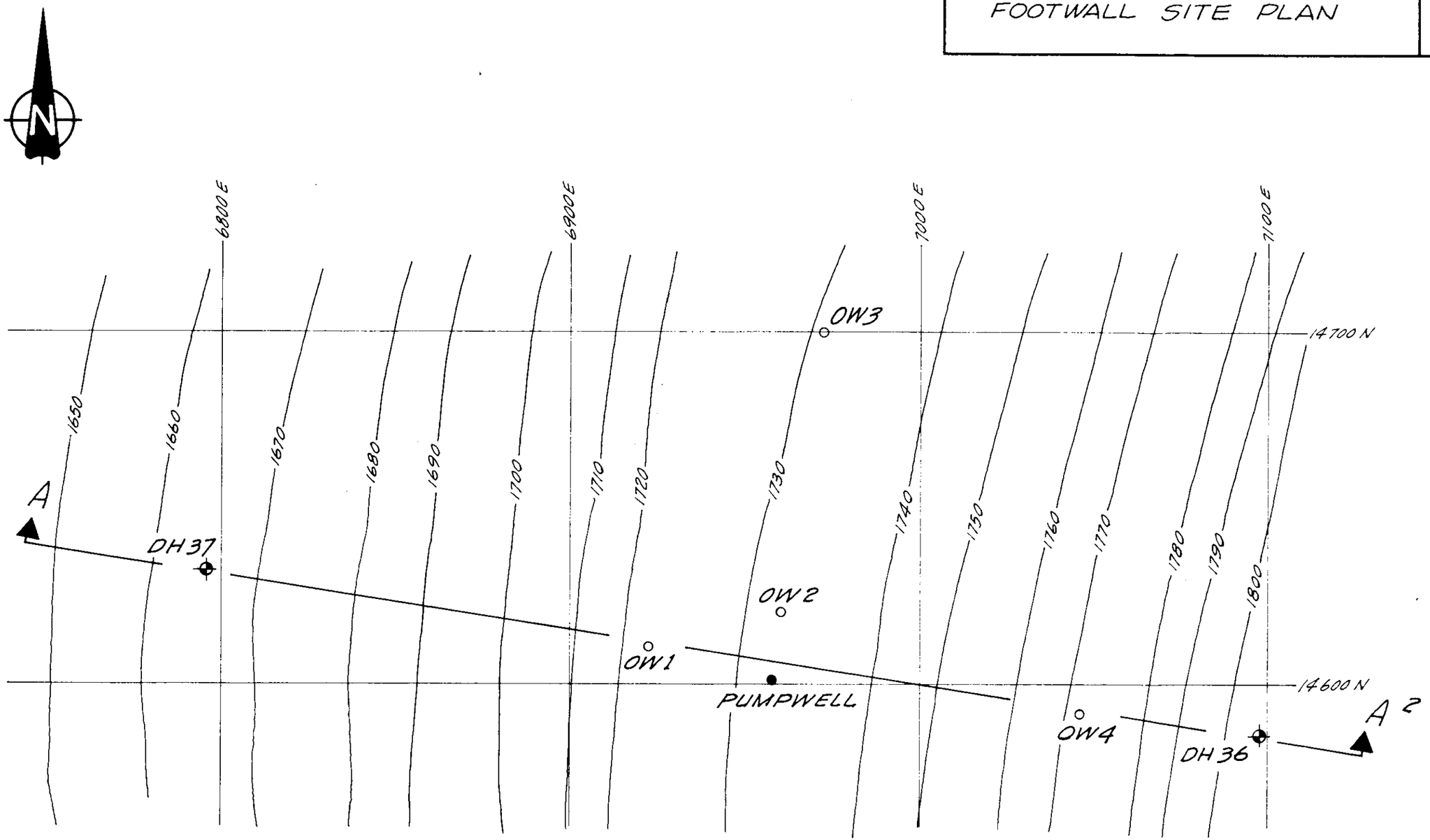
It was intended to produce as much drawdown in the well as was available, and thereby create as large an impact as possible. In doing this, it became increasingly difficult to maintain a constant discharge rate as mentioned above. Not only was the pump quite sensitive to changes in hydraulic head, but the aquifer itself was very sensitive to only minor fluctuations in discharge rate. Slight variations in discharge rate (less than 0.1 l/sec.) were found to have dramatic effects on the

water level in the well. It was necessary to have personnel constantly monitoring the discharge rate and pumping level, and also to constantly adjust the gate valve to maintain the desired discharge rate. The initial discharge rate of 0.88 l/sec. was roughly maintained for the first 7 to 8 days of pumping after which significant fluctuations occurred. Fortunately, the flow meter was a type which also recorded total volume during the test and, therefore, an average discharge rate for the entire 23 day test could be calculated. Once pumping had ceased, recovery readings were taken until sufficient stabilization had been achieved.

2.3512 Footwall Pump Test

The location and layout of the footwall test is shown in Figures 2.3512-1 and 2.3512-2, pages 136 & 137. Earlier studies had indicated high hydrostatic pressures, in the basal

FOOTWALL SITE PLAN



Scale 1:1200

Contour Interval - 10m.

Figure: 2.3512-1

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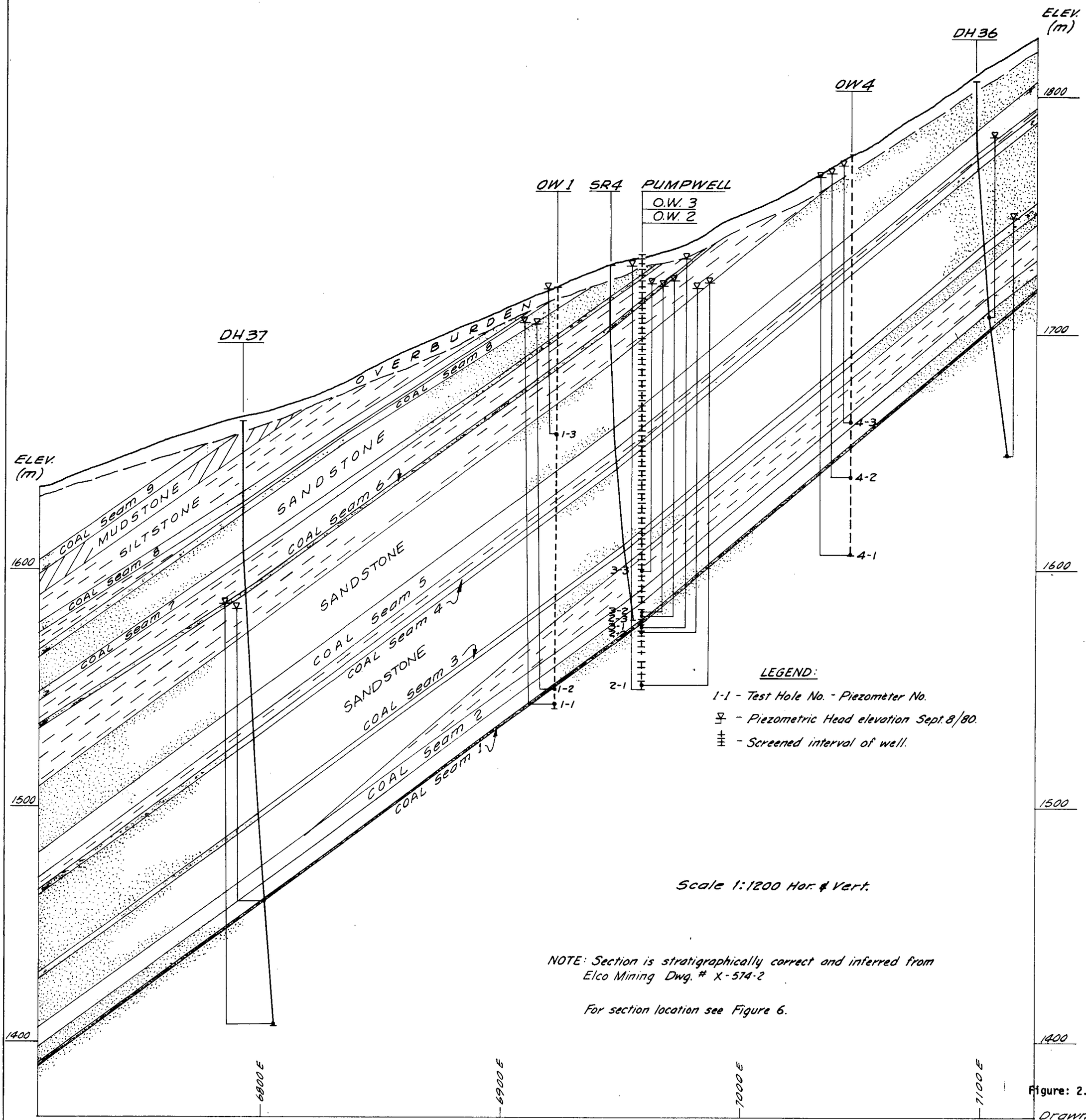
FOOTWALL PUMPTEST SITE
SECTION A-A²



LEGEND:

1-1 - Test Hole No. - Piezometer No.

⏚ - Piezometric Head elevation Sept. 8/80.

‡ - Screened interval of well.

Scale 1:1200 Hor. & Vert.

NOTE: Section is stratigraphically correct and inferred from Elco Mining Dwg. # X-514-2

For section location see Figure 6.

Figure: 2.3512-2

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2.3512 Footwall Pump Test

sandstone, which would be undesirable in terms of slope stability. The footwall test was aimed at determining if reduction of these high pressures could be achieved by induced methods (i.e. wells or drains).

As it was required to test only the basal sandstone member, the pump well was constructed in such a way that flows from materials above the basal sandstone were sealed off and prevented from interferring with basal sandstone flows. The pump well was drilled to a depth of 113 m at 203 mm diameter. A 152 mm diameter unit casing was lowered to the bottom of the hole and cemented in place. The hole was then advanced at 152 mm diameter to 182.9 m. The well was then developed by the air surge method using a jetting tool.

In drilling the pump well and observation wells, water flows ranging between 0.5 and 1.5 l/sec. were encountered. These flows were almost exclusively from the coal-bearing Kootenay

formation (coals, sandstones and siltstones, etc.) which overlies the basal sandstone. Only in hole O.W. 4 did the basal sandstone contribute any measurable flow (0.3 l/sec.). In all other holes, no detectable ground water flows were experienced in the basal sandstone unit. Apparently, the flow in O.W. 4 was fracture related.

Drilling of all holes was done quickly and without difficulty through the coal-bearing member. When the basal sandstone was encountered (at the base of no. 2 coal seam), drilling was significantly slower and penetration of this very hard and apparently massive sandstone unit was quite difficult.

All hole completions were carried out successfully and without any difficulty. Piezometers were installed and monitored for approximately one month, after which the piezometric levels were considered to have reached stabilization and pump testing could proceed.

2.3 GEOLOGICAL AND GEOTECHNICAL FIELD WORK Cont'd.

2.35 Mine Rock Slope Geological/Geotechnical Investigation Cont'd.

2.351 Ground Water Investigations Cont'd.

2.3512 Footwall Pump Test Cont'd.

A pump, identical to that used at the north endwall test, was lowered to a depth of 183.5 m in the footwall well. A 50 mm diameter PVC pipe was laid out from the well to discharge water at a point below observation well no. 1. A flow meter identical to that used at the endwall test was attached near the end of the discharge line in the only flat-lying area available.

Since inflows were obviously not sufficient to keep up with even very low pump rates, it was decided to pump the water level down to near the top of the pump (approximately 180 m) and roughly maintain this drawdown in the well for the duration of the test. In this way, a sink is created which will have the greatest impact possible on the surrounding piezometers.

2.3512 Footwall Pump Test Cont'd

The procedure for maintaining a depressed water level was to turn the pump on periodically and discharge whatever water had accumulated. The guidelines for this were to let the water level recover no more than 10 m (approximately 10 m depth) and then pump the level down again to the 180 m depth level. Initially, this meant turning the pump on three times a day (every 8 hours) as the inflow rate was approximately 5.8×10^{-3} l/sec. As time progressed, the inflow rate reduced to an average of approximately 3.5×10^{-3} l/sec. which meant the pump needed turning on only twice a day.

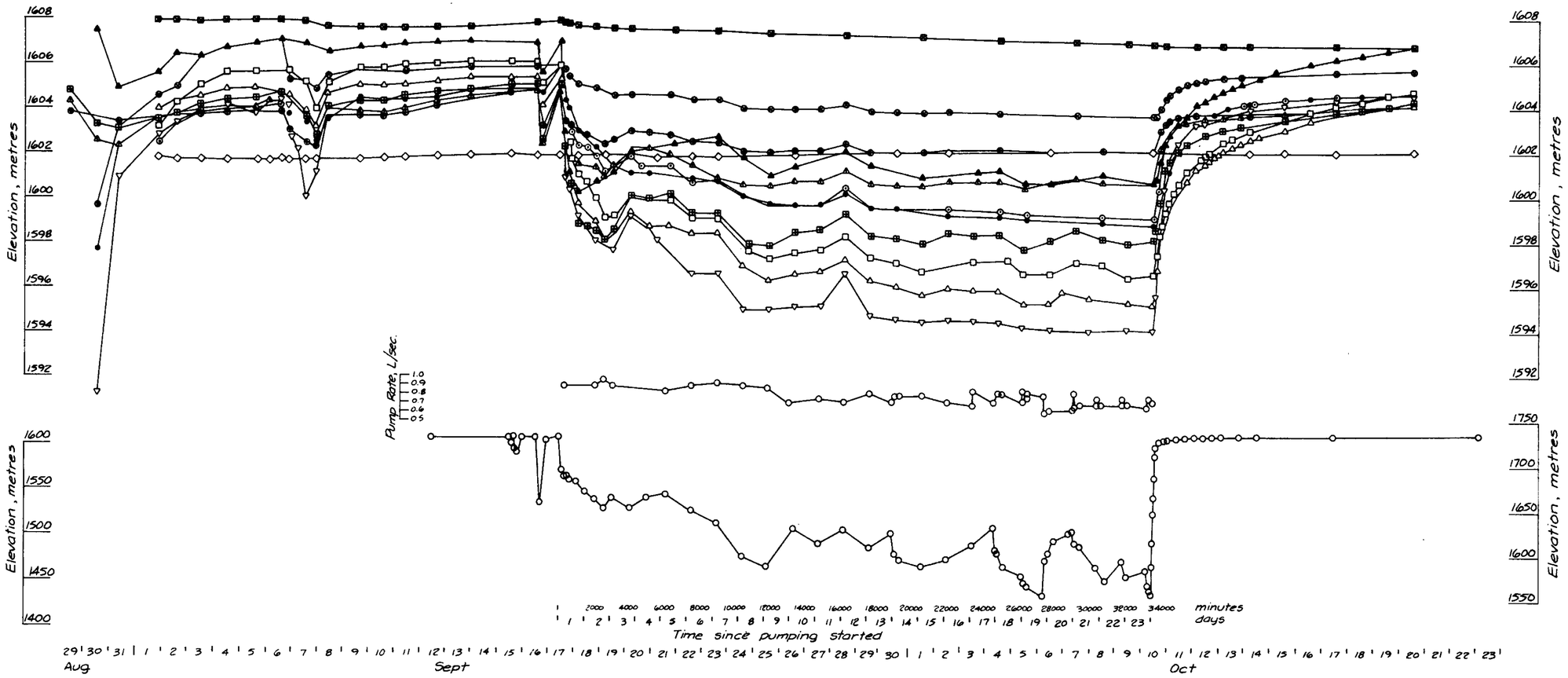
The water level was kept depressed in the well for approximately 33 days while monitoring of the piezometers was carried out. After 33 days, the well was permitted to recover towards a static level.

The pump test data was reduced using Golder Associates pump test program. The reduced data was then used to plot hydrographs for each pump test and to permit analysis by conventional methods.

2.3513 North Endwall/Highwall Pump Test Analysis

The hydrograph of this pump test is illustrated in Figure 2.3513-1, page 142.

PIEZOMETRIC HYDROGRAPHS
ENDWALL/HIGHWALL SITE



LEGEND

- O.W. 1-1
- -2
- -3
- O.W. 2-1
- -2
- -3
- O.W. 3-1
- -2
- -3
- O.W. 4-1
- -2
- -3

Figure: 2.3513-1
Drawn R.D.
Reviewed ____
Date: Dec. '80

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2.3513 North Endwall/Highwall Pump Test Analysis Cont'd

It can be seen that drawdown results were significantly affected by the fluctuation of the discharge rate. However, recovery results are uniform and consistent and permit a good check on the results of the analysis.

Three conventional methods of analysis were used for this test. The Theis curve and Jacob methods were used to analyze drawdown data, and the Theis recovery method was used to analyze the recovery data. Although many of the assumptions inherent in all these methods were violated, due mainly to the geological nature of the material being tested, it is felt that the results of analysis are adequate for the purposes of this study. In the absence of analytic techniques for complex situations, it is acceptable to utilize conventional techniques as long as the limitations and inaccuracies are kept in mind when applying the results to required designs.

In using the Theis and Jacob methods for analysis of drawdown, only early time was analyzed due to fluctuation of pumping rate and obvious effects of leakage from overburden during the latter part of the test. The leakage is ignored at this stage since it is assumed that a drained condition in the overburden would exist for the mining operation. Because early times were used, the discharge rate was chosen at 0.88 l/sec. which is most correct for

2.3513 North Endwall/Highwall Pump Test Analysis Cont'd

this period.

The recovery analysis should be considered more reliable since the curves are smooth and uniform and are not influenced by a fluctuating pump rate. The overall average pump rate of 0.68 l/sec. was used for the recovery analysis as this is the theoretical rate of recharge which would be balancing the average pumping rate.

The results of analyses are summarized in Table 2.3513-1, Page 145.

For design purposes, the inflow from the endwall is expected to be in the order of 0.076 l/sec. (1 Imp. gmp) per meter length of wall. These flows could be handled in the ditches and directed towards pit sumps or pumped directly out of the pit.

The highwall is expected to behave similar to the endwall with regard to drainage in that flows will be small and the material should be self-draining. However, the orientation of the bedding along the highwall may interfere with drainage should less permeable beds create barriers and hence cause pressure build-up. This situation would occur if fracture flow were interrupted by more massive beds, or the fracture pattern was not conductive to free drainage.

TABLE 2.3513-1

RESULTS OF HIGHWALL PUMP TEST

OBSERVATION WELL NOS.	THEIS CURVE		JACOB	STRAIGHT LINE	THEIS RECOVERY	ROCK TYPE
	T m^2/sec.	S	T m^2/sec.	S	T m^2/sec.	
	3.3×10^{-5}	1.9×10^{-4}	3.66×10^{-5}	1.5×10^{-4}	2.77×10^{-5}	Coal Seam #4
O.W. 1	3.42×10^{-5}	1.28×10^{-4}	3.93×10^{-5}	1.02×10^{-4}	2.62×10^{-5}	SST
	7.5×10^{-5}	2.5×10^{-4}	8.48×10^{-5}	1.83×10^{-4}	2.73×10^{-5}	SST
O.W. 2	4.38×10^{-5}	5.4×10^{-4}	4.88×10^{-5}	4.7×10^{-4}	1.41×10^{-5}	SLST
	3.89×10^{-5}	9.94×10^{-3}	5.75×10^{-5}	6.56×10^{-3}	2.3×10^{-5}	SST
O.W. 3	1.34×10^{-5}	5.02×10^{-5}	1.99×10^{-5}	3.7×10^{-5}	4.19×10^{-5}	Coal Seam #4
	1.17×10^{-4}	8.97×10^{-4}	1.61×10^{-4}	6.44×10^{-4}	7.0×10^{-5}	SLST
	3.33×10^{-5}	3.65×10^{-4}	2.83×10^{-5}	3.71×10^{-4}	3.19×10^{-5}	SST
O.W. 4	5.69×10^{-5}	2.88×10^{-4}	6.85×10^{-5}	2.22×10^{-4}	4.44×10^{-5}	Coal Seam #8
	1.25×10^{-4}	5.48×10^{-4}	1.3×10^{-4}	4.2×10^{-4}	7.11×10^{-5}	SST

2.3513 North Endwall/Highwall Pump Test Analysis Cont'd

In order to avoid the possible pressure build-up affecting bench stability, inclined drain holes should be drilled into the bench faces, see Figure 2.3513-2, Page 147.

For design purposes, the hole should be located at 25 m intervals on every bench (15 m vertical separation) on the ultimate wall. Holes on successive benches should be offset laterally by 12.5 m.

The holes can be drilled with a standard airtrack-type drill and should be inclined upwards at 30 degrees from the horizontal to a minimum depth of 30 m long. A perforated pipe should be installed in the hole and where high ground water flows are encountered, additional holes drilled at 12.5 m spacing on either side.

Water draining from the drain holes and from the slope should be collected in ditches on the inside of haul roads on the face and then conducted to the in-pit sumps.

2.3514 Footwall Pump Test Analysis

The pump test hydrograph for the footwall test is shown in Figure 2.3514-1, Page 148. As illustrated, the piezometers showed no response to the depressed water level in the well. Some

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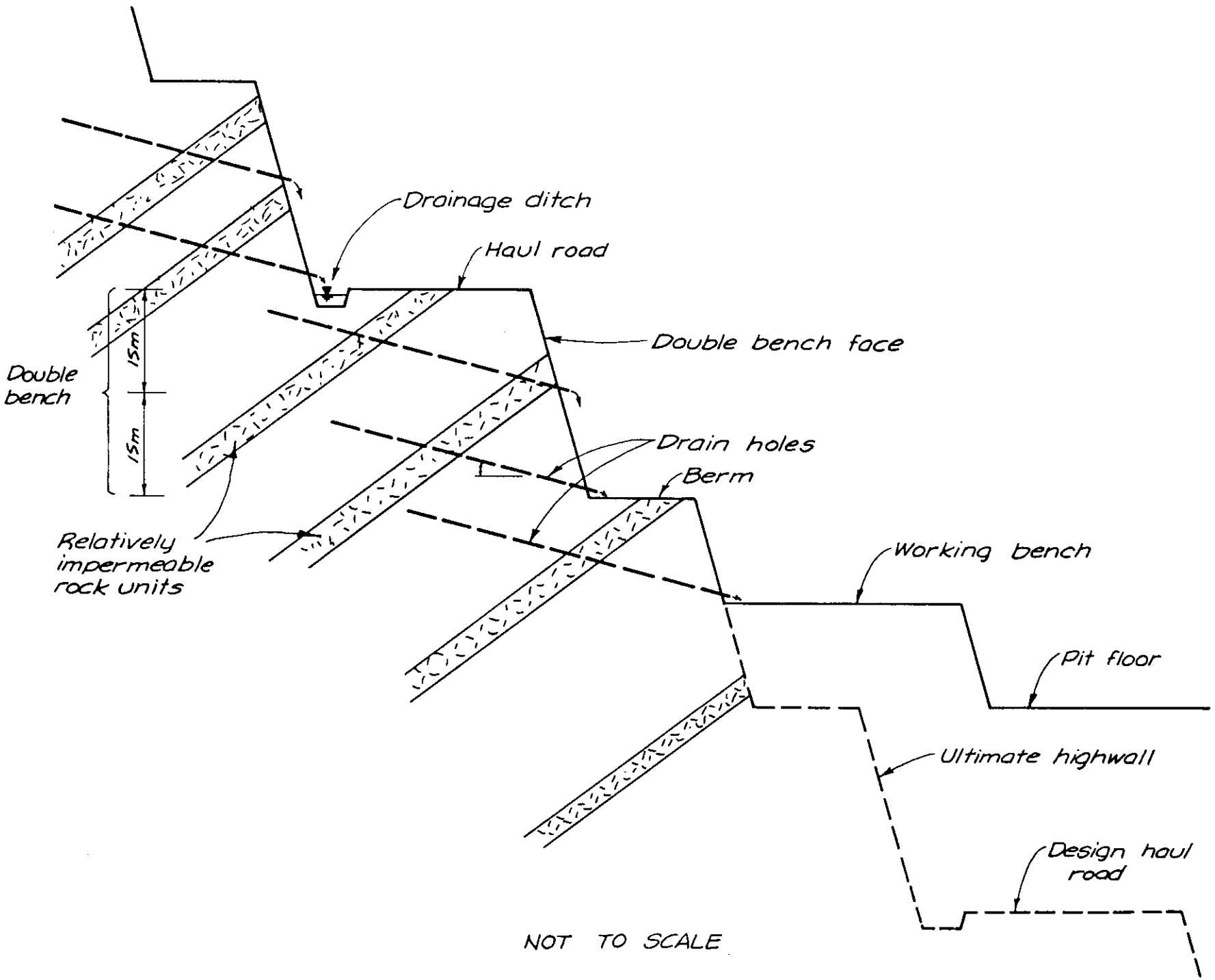


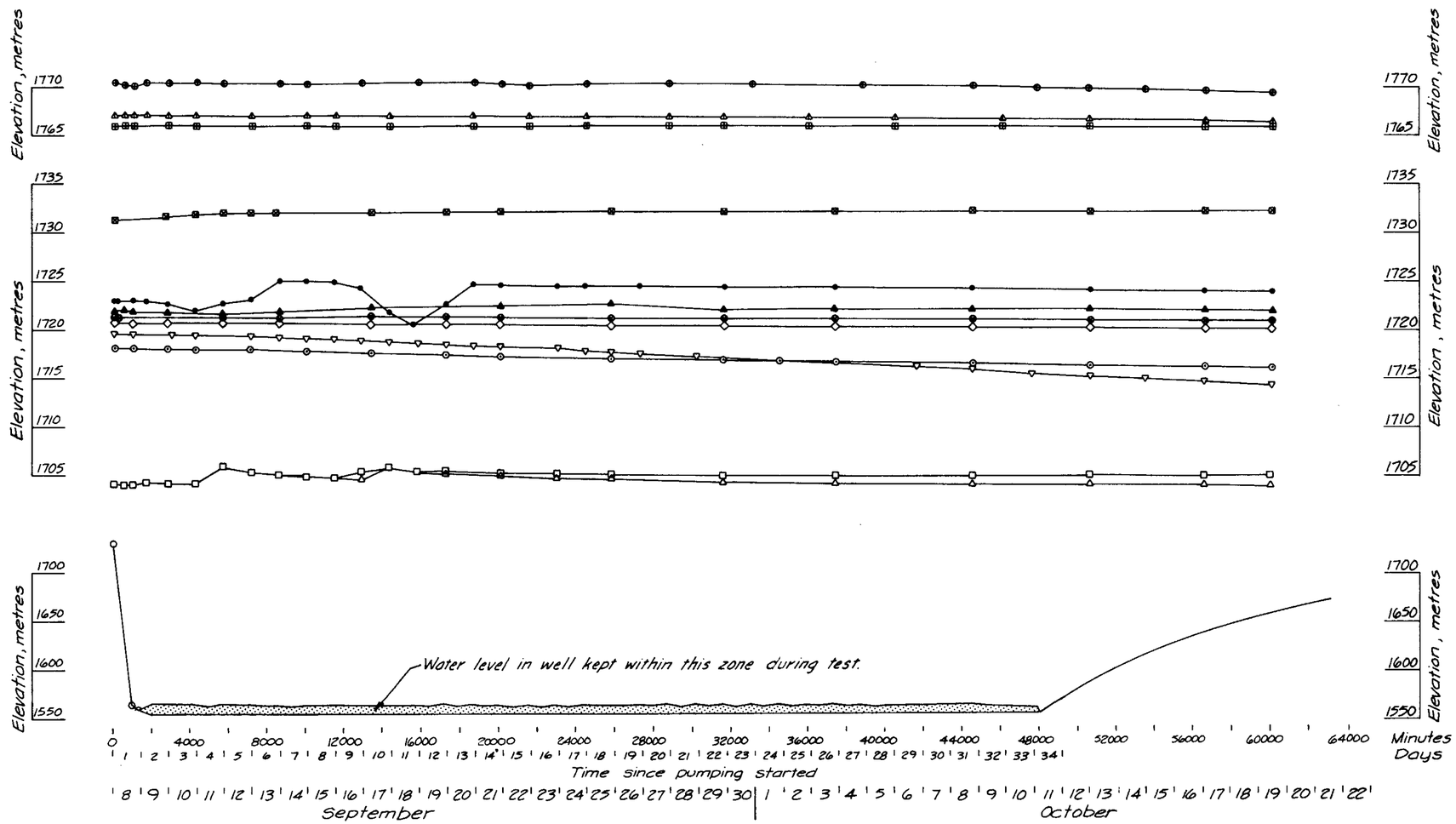
BASIC ELEMENTS OF HIGHWALL SLOPE DEWATERING

Golder Associates

Figure: 2.3513-2

PIEZOMETRIC HYDROGRAPHS FOOTWALL SITE

Figure 9



LEGEND

- O.W. 1-1
- -2
- -3
- O.W. 2-1
- -2
- -3
- O.W. 3-1
- -2
- -3
- O.W 4-1
- -2
- -3

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Reviewed
Date: Dec. '80

Golder Associates Figure: 2.3514-1

802-1538

2.3514 Footwall Pump Test Analysis Cont'd

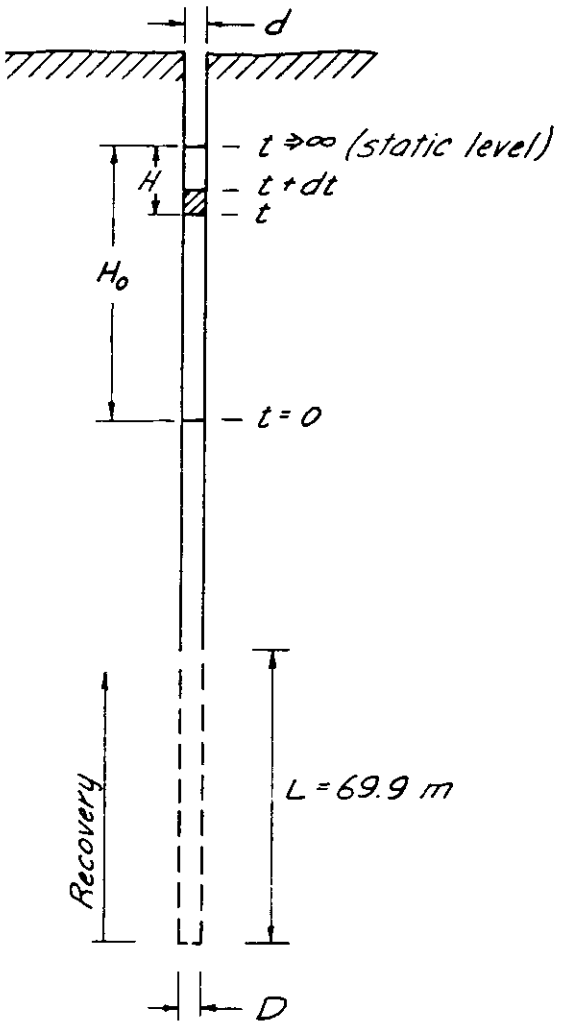
fluctuations were monitored but these are not attributed to the test.

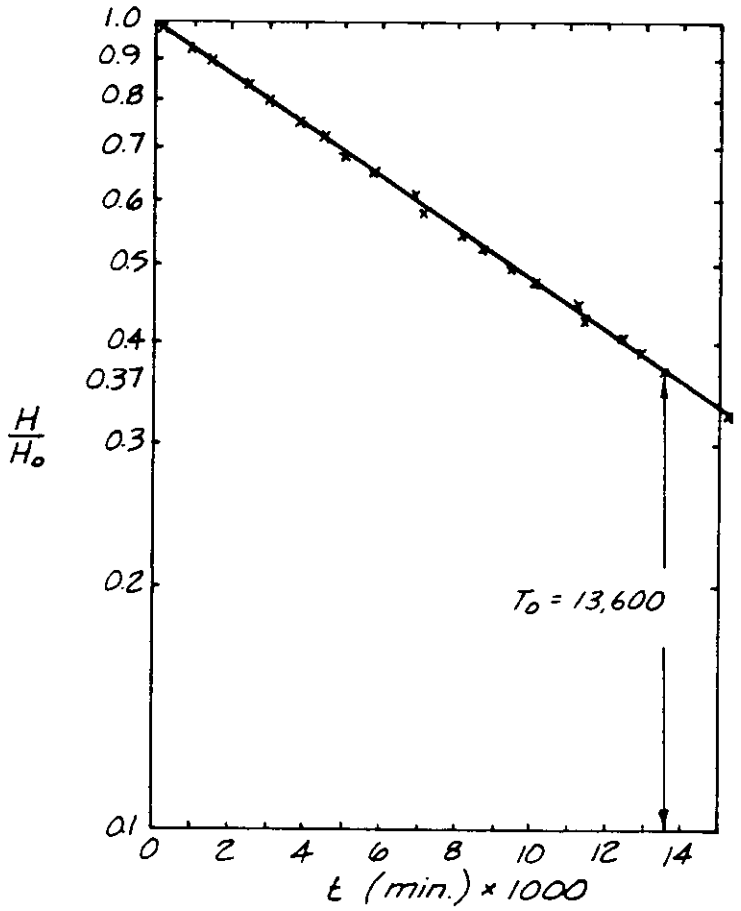
Since response was virtually non-existant, analysis is limited to the recovery of the water level in the pump well. Two analysis techniques are available for this situation. The Hvorslov technique solves for hydraulic conductivity in a test where response from a situation of non-equilibrium towards equilibrium is monitored. Such is the case in the well where the depressed water level represents a non-equilibrium condition and the recovery or the rising head is towards equilibration. The details and calculations of this analysis are illustrated in Figure 2.3514-2, Page 150. The results of this analysis indicate a hydraulic conductivity for the basal sandstone member of 4.1×10^{-10} m/s.

A second analysis technique is one that was used for the endwall test, namely the Theis recovery analysis. The plotting and calculations for this analysis of the footwall well are included in Appendix B with the endwall test calculations. The stabilized inflow rate of 3.5×10^{-3} l/sec. was used as the pump rate for this analysis. The results of the analysis indicate a transmissivity value of 4.2×10^{-9} m^2/sec. for the basal sandstone.

As mining progresses along the footwall, quantities of ground

HVORSLEV RISING HEAD TEST ANALYSIS
FOOTWALL PUMPWELL





$$K = \frac{d^2 \ln\left(\frac{2mL}{D}\right)}{8LT} = \frac{(.1524)^2 \ln\left(\frac{2\sqrt{10}\ 69.9}{.1524}\right)}{(8)(69.9)(13{,}600 \times 60)}$$

$$= 4.1 \times 10^{-10}\ m/sec.$$

K = Hydraulic Conductivity (m/sec.)

$m = \sqrt{Kn/Kv} = \sqrt{10}$ (assumption)

T = Basic Time Log = elapsed time corresponding to a normalized recovery of 0.37.

D = d = hole & casing diameter = .1524 m

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Figure: 2.3514-2

2.3514 Footwall Pump Test Analysis Cont'd

water will be encountered in the coal-bearing member which is being stripped off the basal sandstone. Since these quantities will be similar to those encountered at the endwalls and the highwall, prior dewatering of this member does not appear necessary and flows could be handled with in-pit systems.

The basal sandstone member is seen to possess high hydrostatic pressures which are not likely to dissipate rapidly as mining progresses. To control the high pressures and maintain a stable pit wall the following measures should be taken:

- Improve natural surface drainage at the crest and behind the footwall to reduce recharge to this unit.
- Locate gravity drain holes along the face as mining progresses in an attempt to intercept as much fracture flow as is possible.
- Install and monitor pneumatic type piezometers to check the progress of pore pressure dissipation

2.352 Pit Slope Stability Studies

The geotechnical rock slope stability studies carried out in 1980 involved the following:

- Detailed structural logging of selected rock core for the highwall area.

2.353 Pit Slope Stability Studies Cont'd

- Structural mapping of exposures in highwall area.
- Structural mapping of exposures in footwall area.

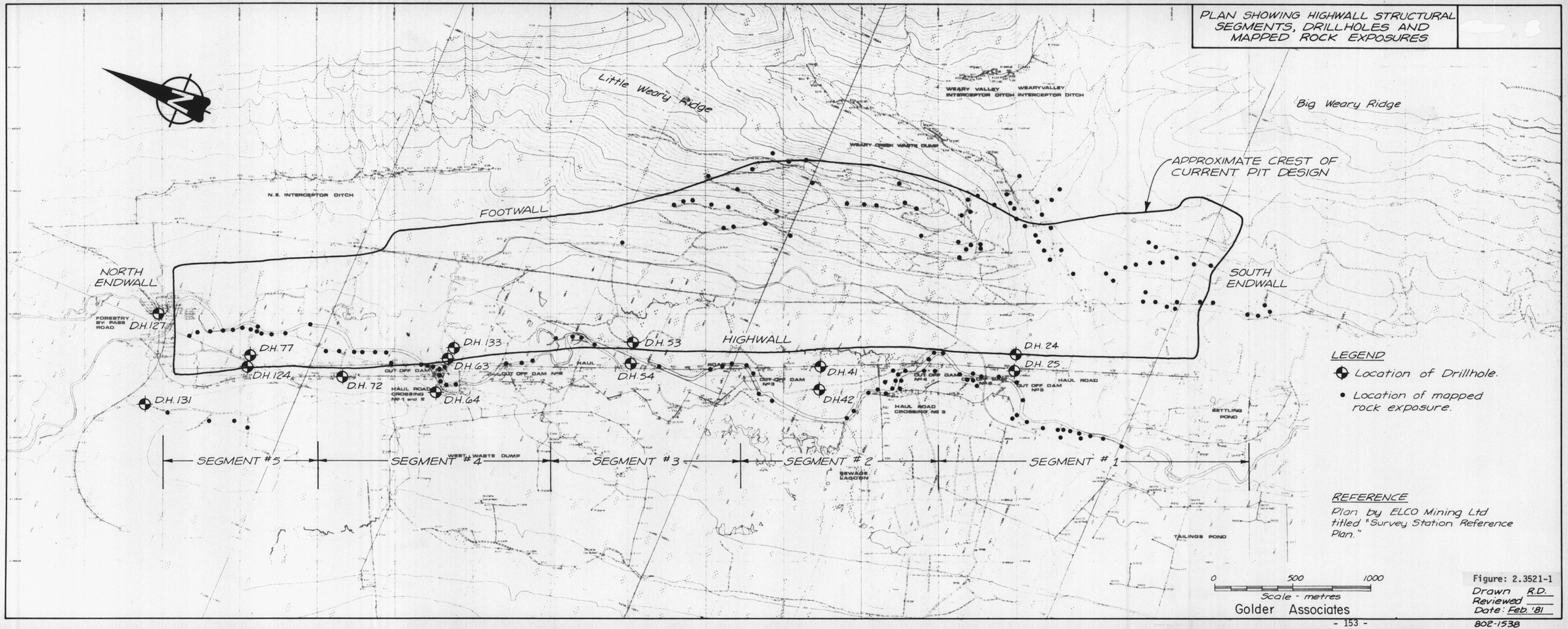
2.3521 Highwall Study

The structural interpretation of the highwall area made in 1977 indicated the possibility of increased joint dips toward the south with the resulting potential for steeper bench faces and overall slope angles. Confirmation of the highwall structure was made by reviewing exploration cores and by detailed structural field mapping. Oriented core logging was performed in order to relate joints to bedding such that true joint orientation could subsequently be determined.

A geotechnical mapping program was also undertaken to examine all surface exposures in detail for joint and bedding continuity.

Structural Mapping

Rock cuts and exposures in the highwall area were mapped, recording the orientation of the bedding and jointing fractures. Figure 2.3521-1, Page 153 shows the locations of the exposures mapped.


PLAN SHOWING HIGHWALL STRUCTURAL SEGMENTS, DRILLHOLES AND MAPPED ROCK EXPOSURES
Little Weary Ridge
Big Weary Ridge
WEARY VALLEY INTERCEPTOR DITCH
WEARY CREEK WASTE DUMP
N.E. INTERCEPTOR DITCH
APPROXIMATE CREST OF CURRENT PIT DESIGN
FOOTWALL
HIGHWALL
NORTH ENDWALL
SOUTH ENDWALL
FORESTRY BY-PASS ROAD
D.H.127
D.H.131
D.H.124
D.H.77
D.H.72
D.H.133
D.H.63
D.H.64
D.H.53
D.H.54
D.H.41
D.H.42
D.H.24
D.H.25
CUT OFF DAM
CUT OFF DAM No2
CUT OFF DAM No3
CUT OFF DAM No4
CUT OFF DAM No5
HAUL ROAD
HAUL ROAD CROSSING No1 and 2
HAUL ROAD CROSSING No 3
WEST WASTE DUMP
SEWAGE LAGOON
SETTLING POND
TAILINGS POND
SEGMENT #5
SEGMENT #4
SEGMENT #3
SEGMENT #2
SEGMENT #1
LEGEND
Location of Drillhole.
Location of mapped rock exposure.
REFERENCE
Plan by ELCO Mining Ltd titled "Survey Station Reference Plan."
0
500
1000
Scale - metres
Golder Associates
Figure: 2.3521-1
Drawn R.D.
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Date: Feb '81
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2.3521 Highwall Study Cont'd

Structural Core Logging

All core was logged in detail for geotechnical parameters.

Features recorded in the logging included:

- downhole depth
- rock quality designation
- recovery

Additional structural data recorded included:

- fracture type
- dip
- dip direction (referenced to bedding)
- form or shape
- roughness
- infillings.

Included in the drill holes logged by Golder Associates were two holes requested by IECO. As these holes were located in the highwall area, they were included in the interpretation of the highwall structure.

The drill holes logged were as follows:

DH	25	63
DH	26	64
DH	41	72*
DH	42	77
DH	53	124
DH	54	131*

* Denotes drill holes logged at request of IECO.

2.3521 Highwall Study Cont'd

Referenced orientations were used to derive structural fabric orientations based upon the overall geological interpretation.

To determine structural trends, the proposed highwall has been divided into five segments for the purpose of deriving slope design parameters. The segments, together with approximate co-ordinate boundaries and related data groups, are as follows (see Figure 2.3521-1, Page 153):

Segment	Coordinate Boundaries	Drill Hole Data
1	12+000N - 14+000N	DH 25/26
2	14+000N - 15+250N	DH 41/42
3	15+250N - 16+500N	DH 53/54
4	16+500N - 18+000N	DH 63/64/72/133
5	18+000N - 19+500N	DH 77/124/131/127

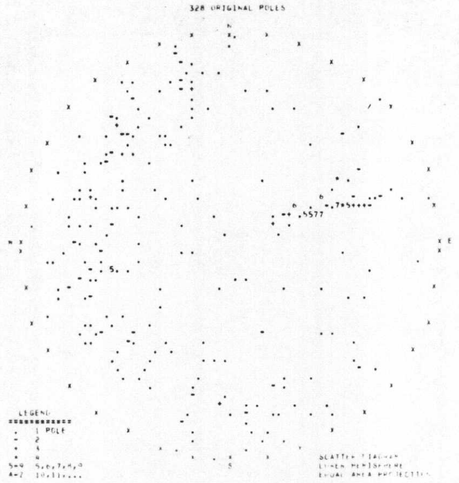
This data is presented stereographically in Figures 2.3521-2 to 2.3521-8, pages 156 to 162 respectively.

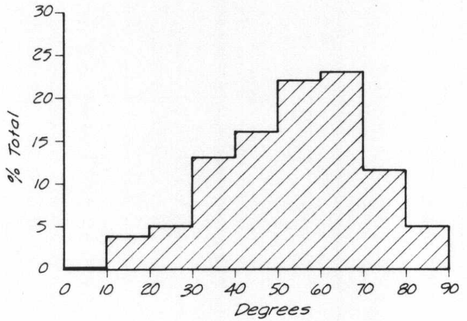
Initial interpretation of these data groups indicates that the most significant structural feature is the joint set dipping perpendicular to bedding and dipping in the same direction as the proposed pit wall (see Figure 2.3521-2, Page 156).

The stereographic projections of the discontinuity data indicates the presence of three major joint sets throughout the area. The mean orientation of these sets are as follows:

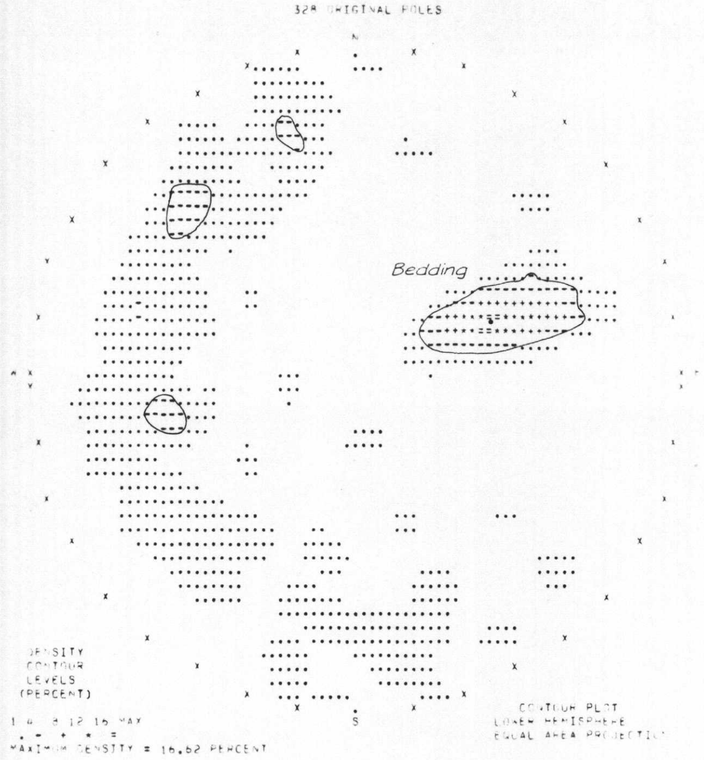
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLES 25 & 26

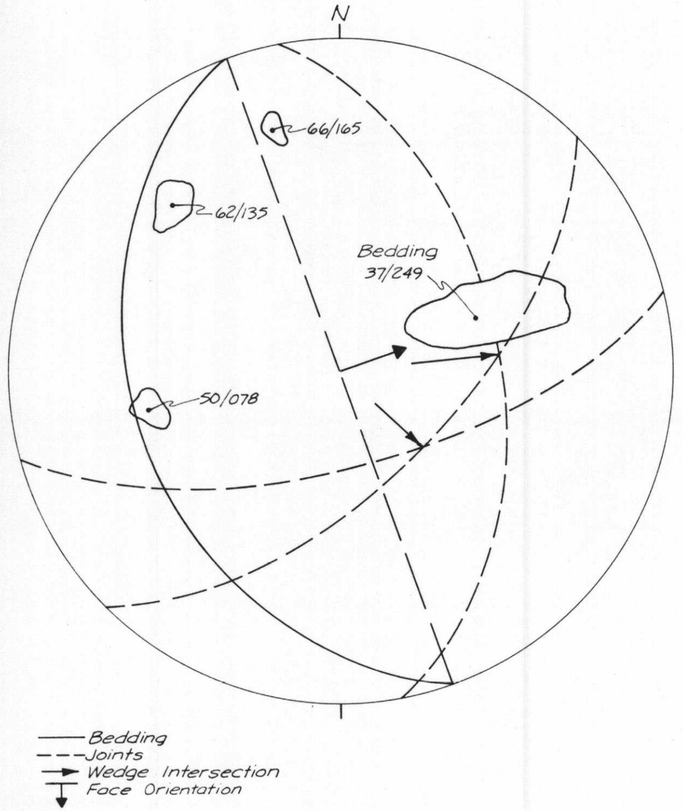
Figure 14





HISTOGRAM OF POLE ANGLES





Golder Associates Figure: 2.3521-2

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Reviewed
Date: Feb '81
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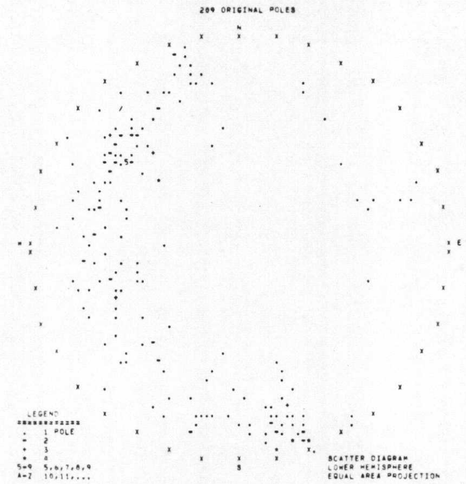
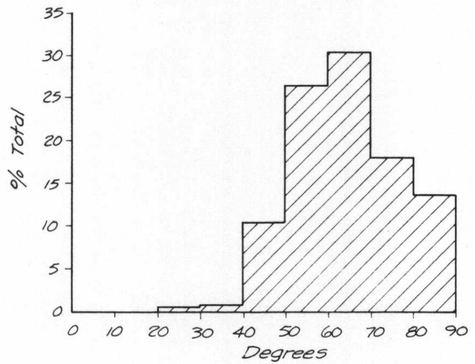
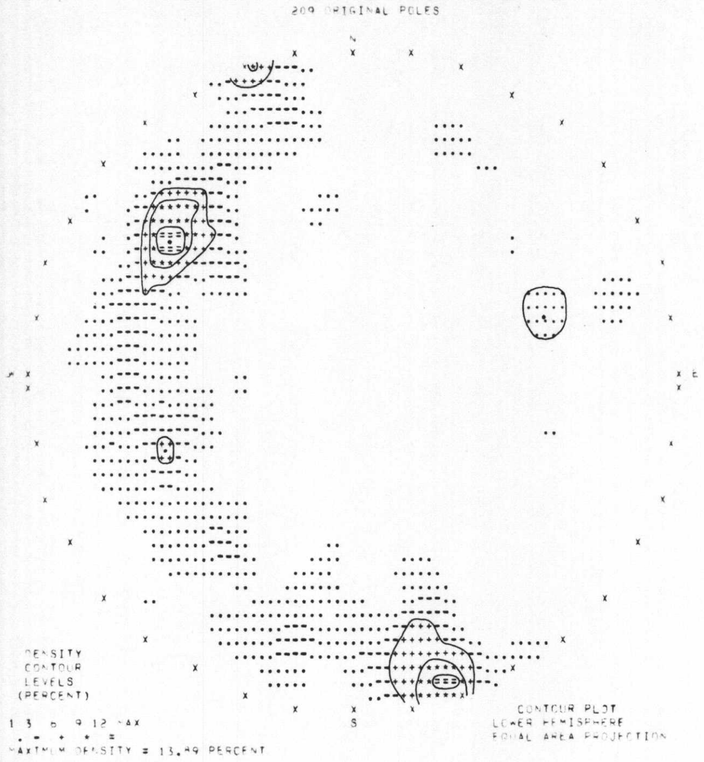
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLES 41 & 54

Figure 15





HISTOGRAM OF POLE ANGLES



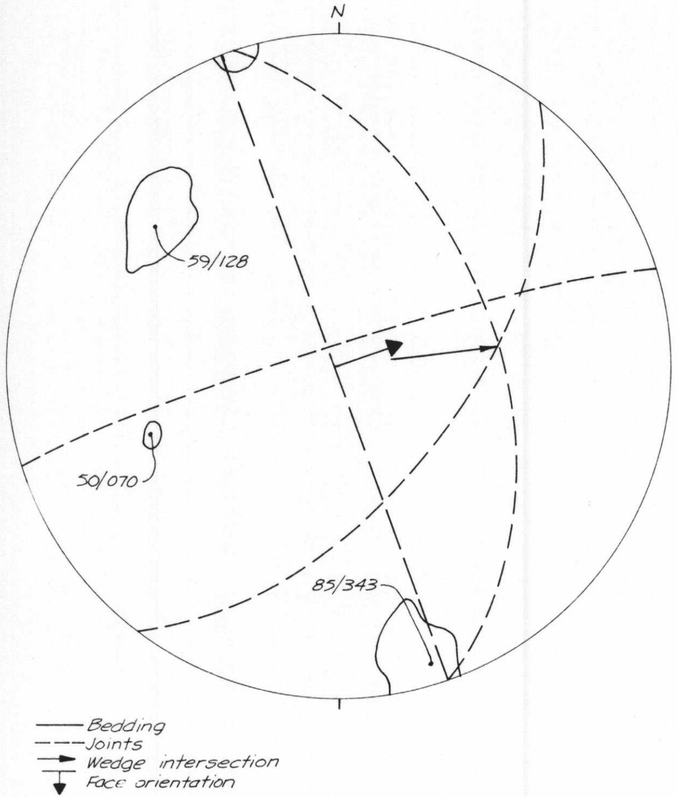


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Figure: 2.3521-3

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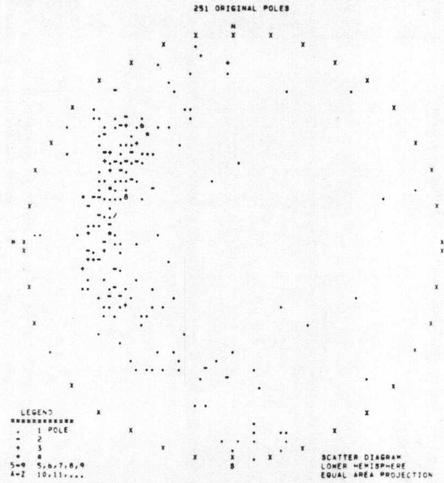
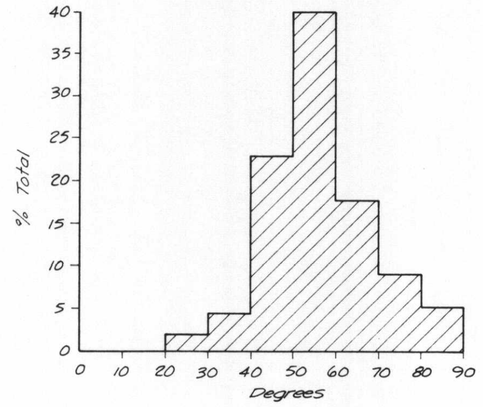
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLES 53 & 54





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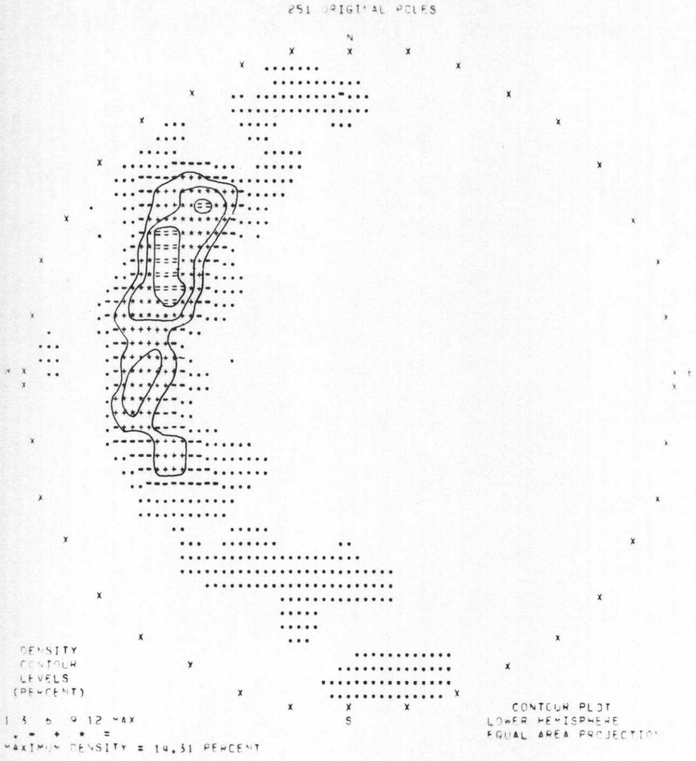

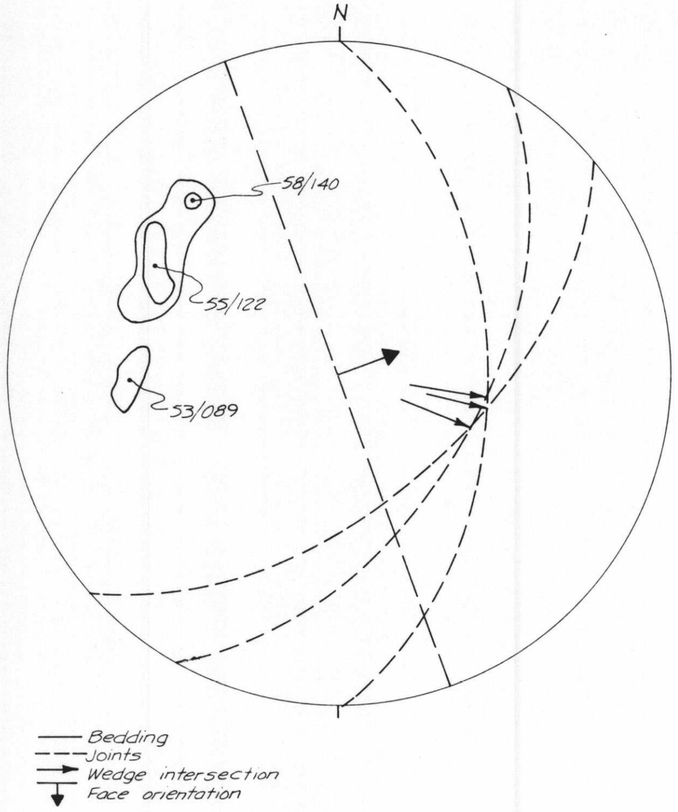

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Figure: 2.3521-4

Drown R.D.
Reviewed
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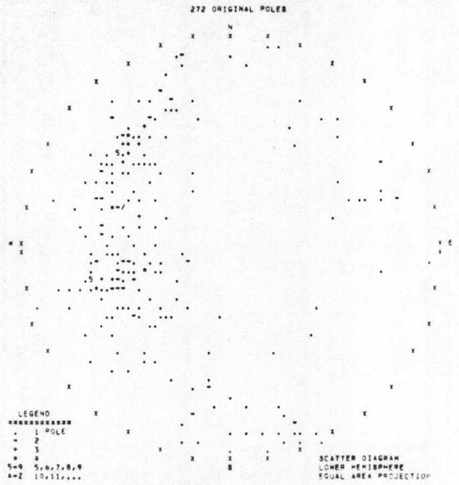
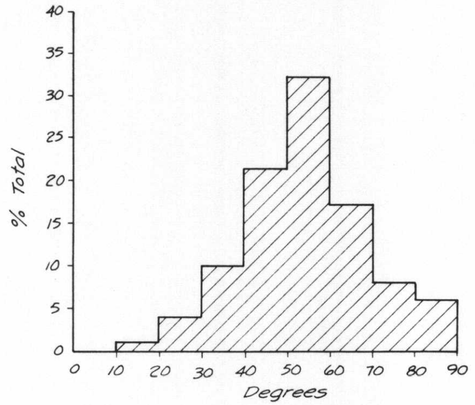
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLES 63 & 64





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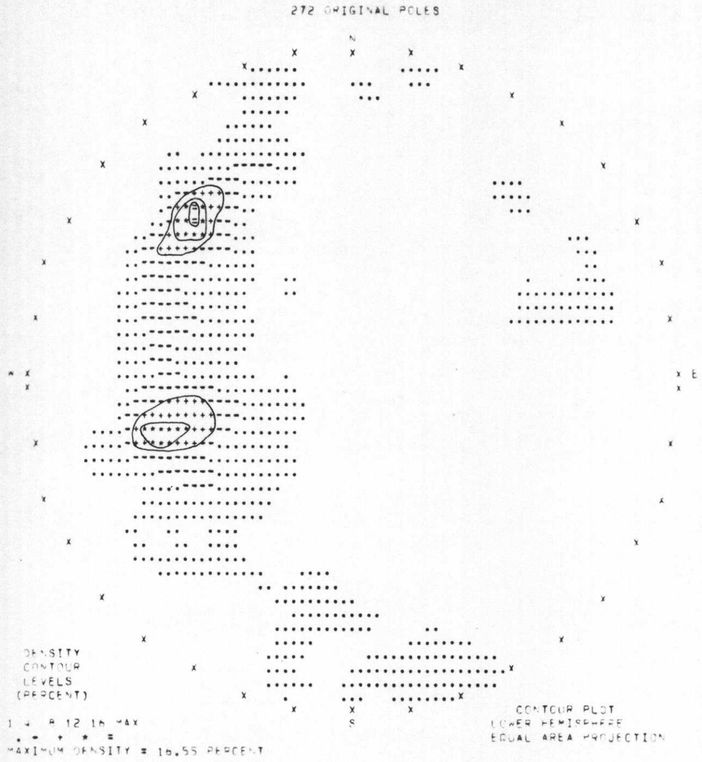

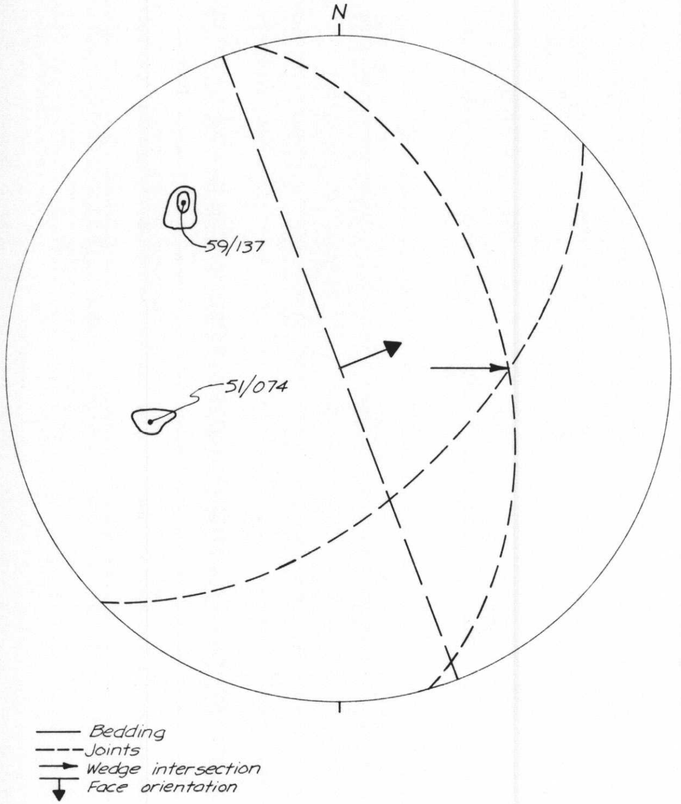

Figure: 2.3521-5

Drawn R.D.
Reviewed
Date: Feb '81

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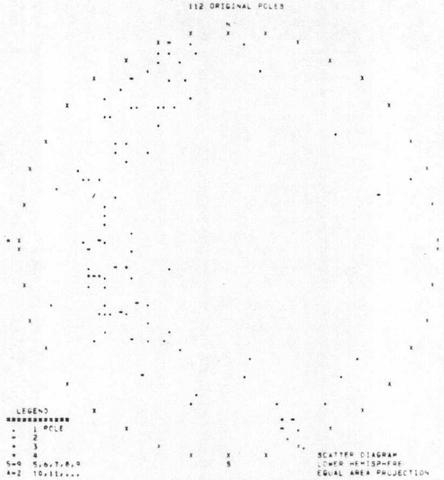
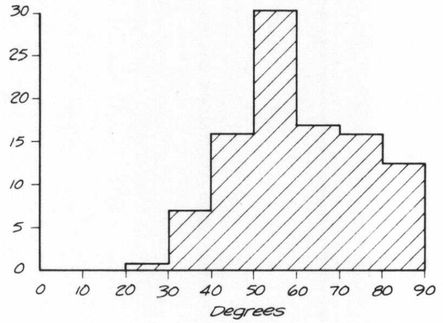
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLE 72





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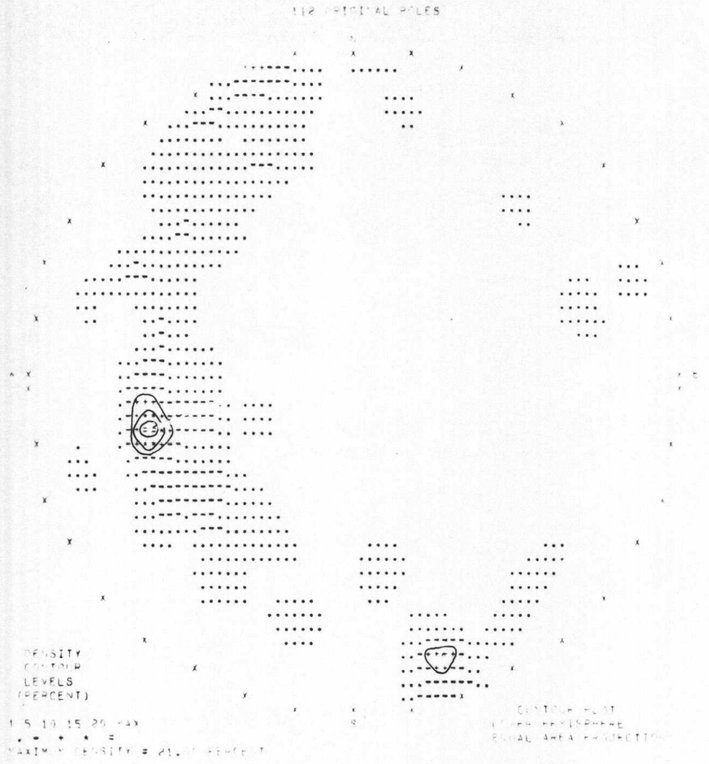

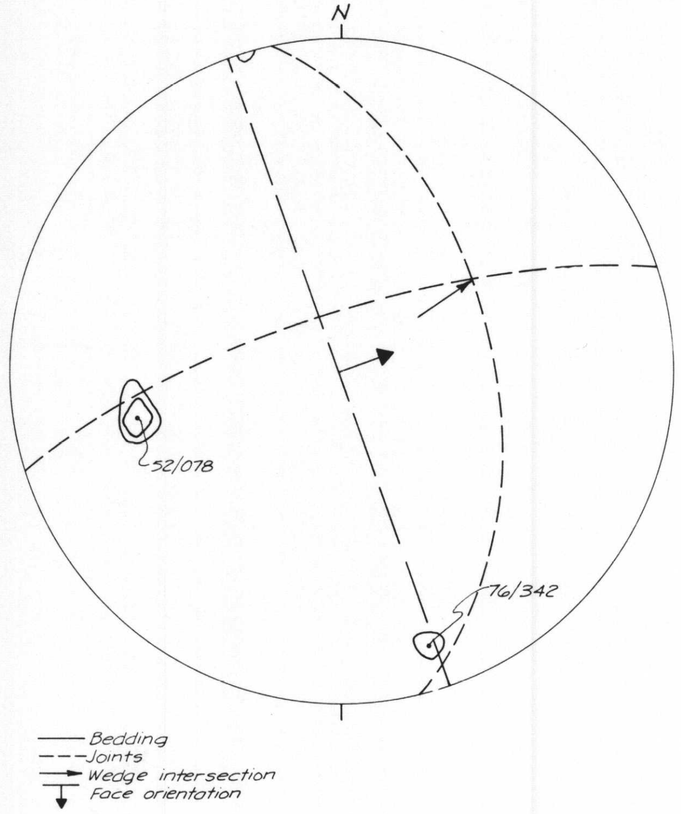

Figure: 2.3521-6
Drawn R.D.
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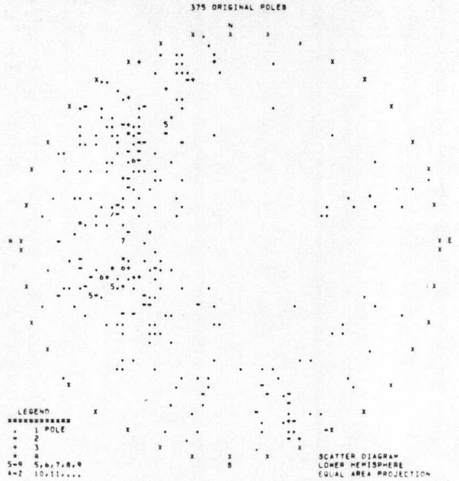
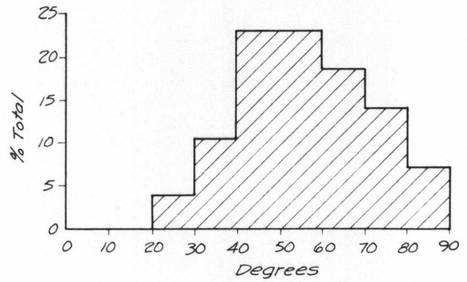
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLE 77 & 124





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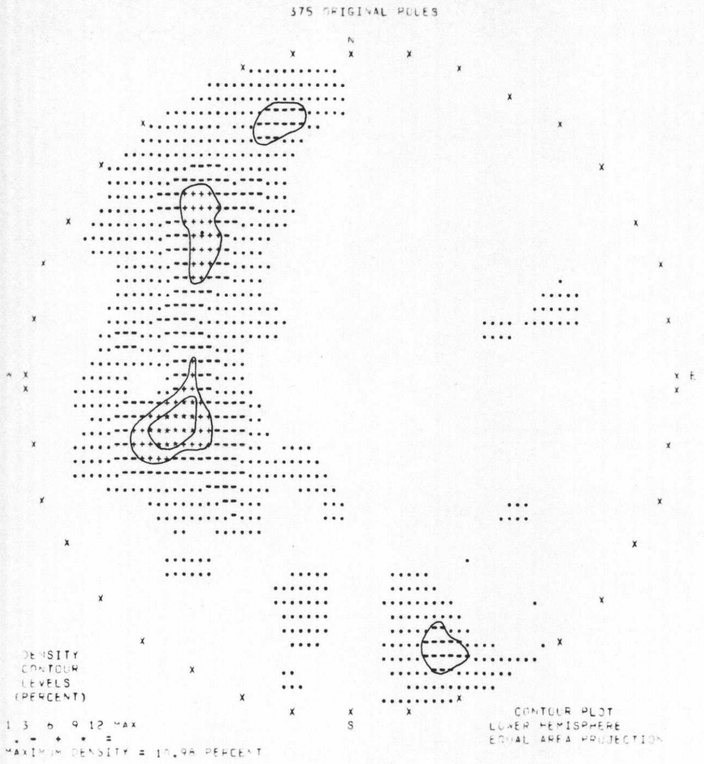

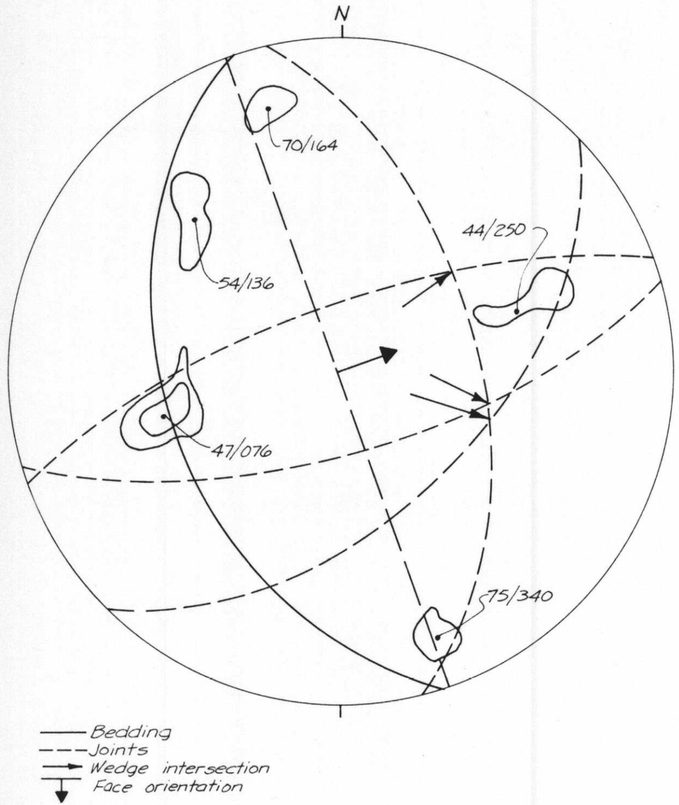

Figure: 2.3521-7
Drawn R.D.
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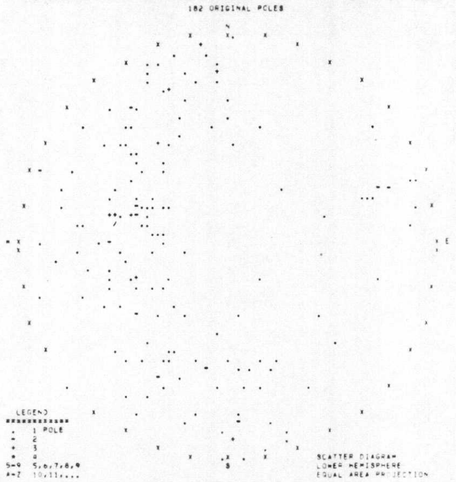
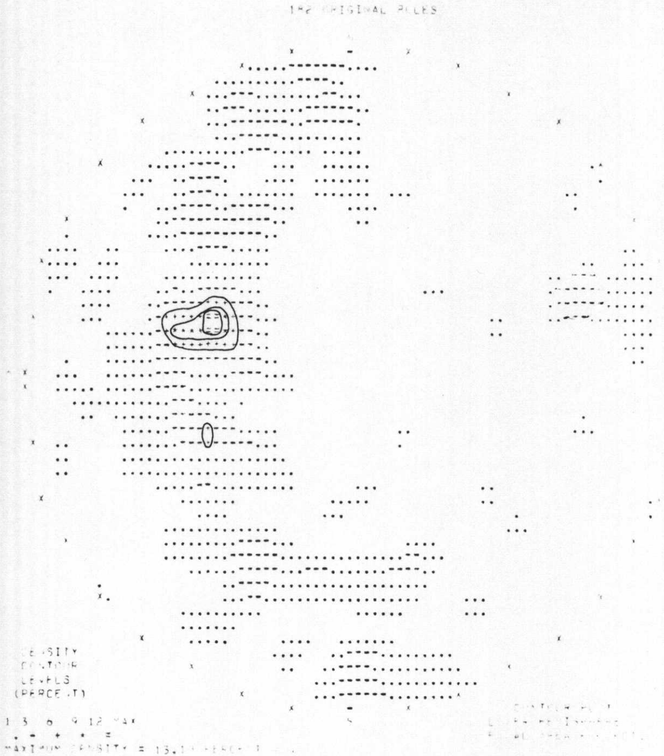
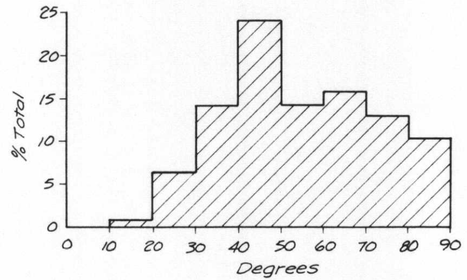
STRUCTURAL ANALYSIS
ORIENTED CORE DRILLHOLE 131







HISTOGRAM OF POLE ANGLES

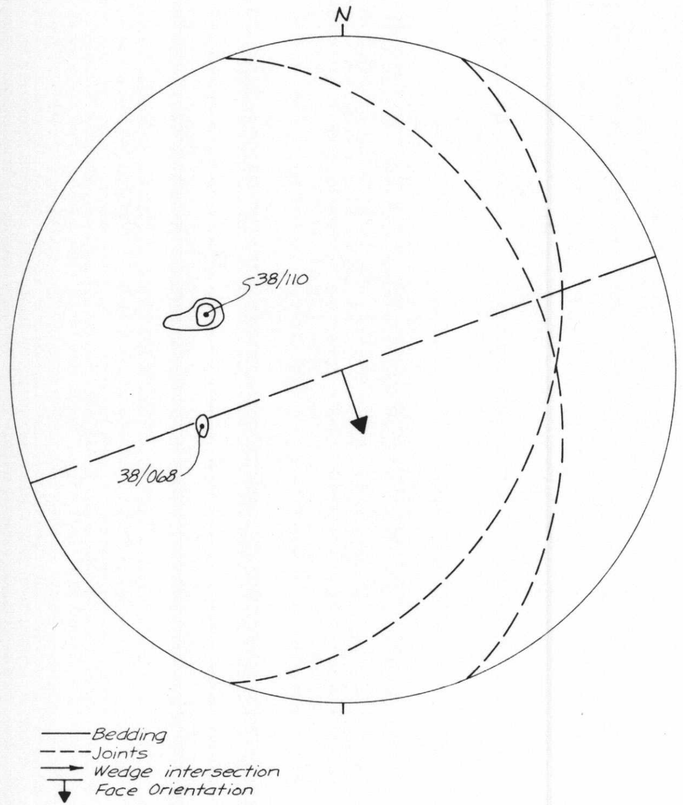


Figure: 2.3521-8
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2.3521 Highwall Study Cont'd

Dip	Dip Direction
55 degrees	126 degrees
52 degrees	071 degrees
80 degrees	343 degrees

To evaluate the trend of joint dips along the highwall, the data from each structural segment was analyzed separately and dip histograms derived. A mean dip value was then determined for all the joint sets recorded in each segment, together with a shallow end of range value. Approximately 80 per cent of the cumulative population are steeper than this value. The mean joint dips for the relevant structural segments are tabulated below:

	Mean Joint Dip		Shallow End of Range Value	
Segment	Core Logging	Surface Mapping	Core Logging	Surface Mapping
1	65	65	40	50
2	60	65	50	50
3	60	65	50	50
4	55	60	40	50
5	50	60	40	55

The above data infers that the joints are steeper near surface than at depth in the highwall area. The discrepancy between the surface mapping and the drill hole data does not indicate that the sequence has a shallower bedding dip at depth. However, it should be noted that fewer data points were recorded in the surface mapping than in the core logging, and the small variation in mean dips does not affect the overall slope design.

2.3521 Highwall Study Cont'd

Since the values for joint dip obtained from core logging indicate generally shallower joint dips than those obtained from surface mapping, the designs for the highwall have been based on the shallower values.

2.3522 Footwall Study

Since only limited geotechnical mapping had been performed in both the 1971 and 1977 geotechnical programs, a mapping program was undertaken to examine all surface exposures in detail for structural trends, joint and bedding continuity.

This mapping data was used to confirm the initial footwall data and to revise the initial footwall slope design.

The sandstone below No. 1 seam frequently shows cross-bedding features with some natural separation along the forset beds. This is reflected in the structural core logging carried out in 1977 which shows a dispersion of data for bedding dip angles.

A stereoplot of detailed mapping of exposures in the footwall sequence recognized the following joint sets:

Dip	Dip Direction
65 degrees	132 degrees
87 degrees	165 degrees
74 degrees	013 degrees
50 degrees	098 degrees
50 degrees	076 degrees

2.3522 Footwall Study Cont'd

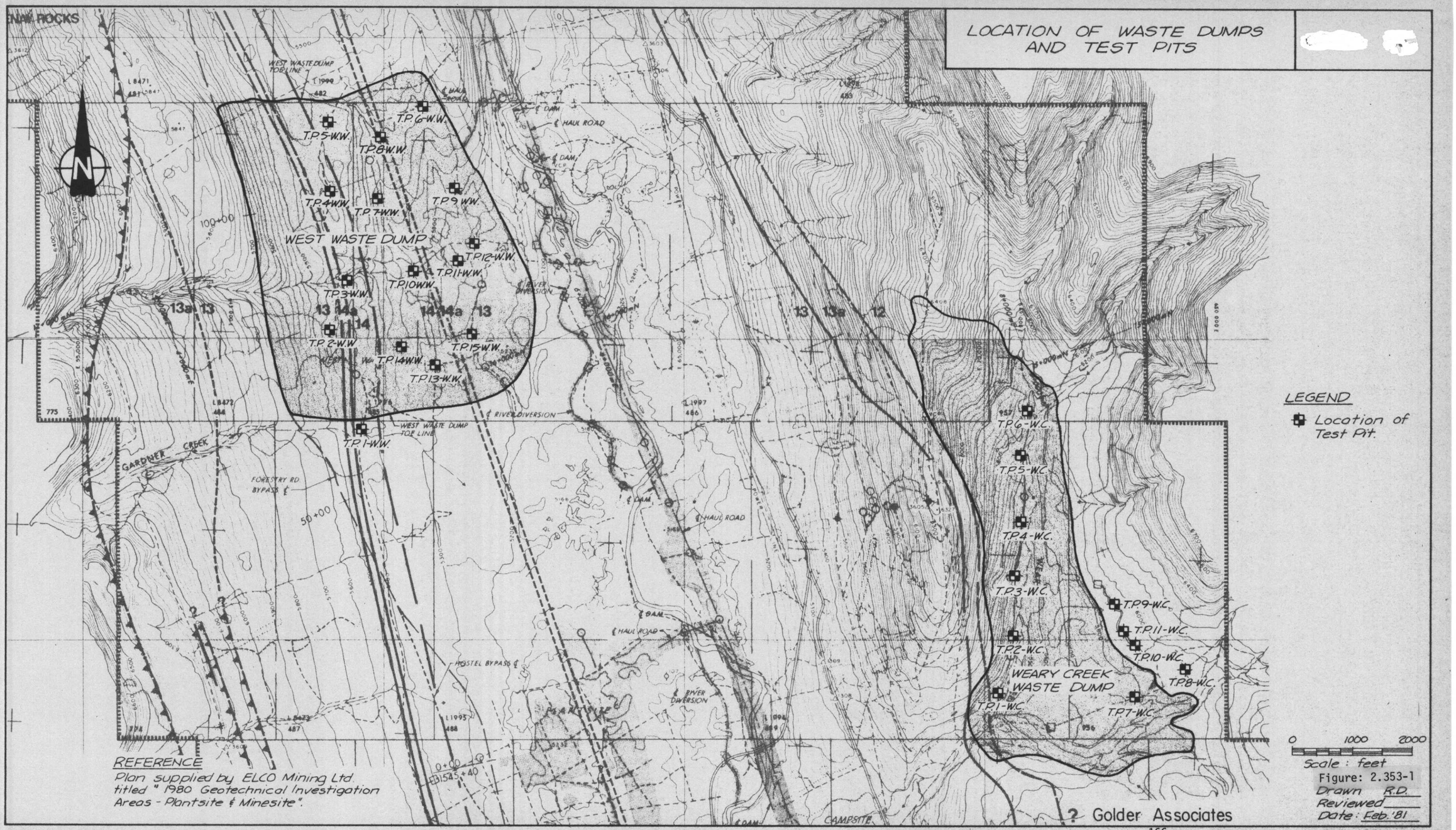
Using the proposed design, the resulting ultimate footwall below Little Weary Ridge would be up to 400 m high without benches. The angle of this slope would be totally dependent on bedding dip. The footwall mapping recorded a mean dip of approximately 40 degrees in the south end of the proposed pit. Towards the north end of the property, the bedding dips are known to steepen slightly, reaching a mean of approximately 45 degrees. The resulting ultimate footwall north of 14+500N would be approximately 150 m high with no benches.

2.353 Evaluation of Waste Dump Stability

Elco has proposed to develop three waste dumps for the disposal of waste rock overburden that will be generated in the course of their proposed open pit mining operation. As part of the 1980 geotechnical study, Golder Associates were requested to evaluate the stability of the proposed waste dumps.

The waste dumps will be developed within three areas; the East dump will be located within the Weary Creek Valley, the West dump will be located in the Elk River Valley northwest of the western limit of the proposed mine (Figure 2.353-1, Page 166 and the third dump will be located in the open pit itself.

The objective of the study was to make stability recommendations


LOCATION OF WASTE DUMPS AND TEST PITS
WEST WASTE DUMP
WEARY CREEK WASTE DUMP
T.P.1-W.W.
T.P.2-W.W.
T.P.3-W.W.
T.P.4-W.W.
T.P.5-W.W.
T.P.6-W.W.
T.P.7-W.W.
T.P.8-W.W.
T.P.9-W.W.
T.P.10-W.W.
T.P.11-W.W.
T.P.12-W.W.
T.P.13-W.W.
T.P.14-W.W.
T.P.15-W.W.
T.P.1-W.C.
T.P.2-W.C.
T.P.3-W.C.
T.P.4-W.C.
T.P.5-W.C.
T.P.6-W.C.
T.P.7-W.C.
T.P.8-W.C.
T.P.9-W.C.
T.P.10-W.C.
T.P.11-W.C.
WEST WASTE DUMP TOE LINE
RIVER DIVERSION
HAUL ROAD
DAM
GARDNER CREEK
FORESTRY RD BYPASS
HOSTEL BYPASS
CAMPSITE
LEGEND
Location of Test Pit.
REFERENCE
Plan supplied by ELCO Mining Ltd. titled " 1980 Geotechnical Investigation Areas - Plantsite & Minesite".
0 1000 2000
Scale : feet
Figure: 2.353-1
Drawn R.D.
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2.353 Evaluation of Waste Dump Stability Cont'd

concerning the waste dump foundations and face angles for the operating dumps prior to regrading the slope to the angle of repose in accordance with government regulations.

The foundation conditions within the area that will be occupied by the proposed surface waste dumps were investigated by means of airphoto interpretation, ground reconnaissance, mapping of soil and rock exposures, and excavation of shallow test pits.

2.3531 Weary Creek Waste Dump

Investigating the foundation conditions, several exposures, particularly along the south fork of Weary Creek, were found to consist of coarse sand and gravel containing a large proportion of silt, with scattered cobbles and boulders. These sediments appear to be glacial-fluvial in origin, and the plateau-like feature between the north and south fork appears to be a glacial-fluvial outwash deposit.

The glacial-fluvial sediments are underlain by glacial till, which is in turn underlain by rocks of the Fernie group. Both the north and south forks of Weary Creek appear to have eroded and downcut into both the glacial-fluvial sediments and the underlying glacial till, and to have exposed the Fernie shale bedrock along the creek.

2.3531 Weary Creek Waste Dump Cont'd

Stream erosion has resulted in oversteepening of the banks on either side of both the north and south forks of Weary Creek, and the slopes above the creek show evidence of old failure scars, although none of these exhibit signs of recent activity.

Several test pits were excavated in the proposed north fork waste dump area as part of the field investigation program carried out by IECO. Access to the test pit locations was gained using a bulldozer. The resulting cut started at the toe of the slope and angled upward in a northerly direction along the western side of the north fork. The backslope of this cut constitutes an excellent soil exposure along the slope and at several locations revealed exposures of colluvium, and in some cases, old slide debris which is underlain by a layer of peaty topsoil. This is supporting evidence of past shallow-seated instability along the natural oversteepened sides of the drainage courses.

Generally, the surficial soils witnin the foundation area of the waste dump consist of a variable thickness of silt, sand, sandy gravel and glacial till.

The main soil types encountered in the test pits were as follows:

- Loose brown SAND with organic debris.

2.3531 Weary Creek Waste Dump Cont'd

- Loose brown sandy GRAVEL with cobbles and subangular to subrounded boulders.
- Stiff, grey/brown, silty TILL with some sand and gravel layers.

Experience indicates that the stability of waste dumps comprised of Kootenay formation rocks is governed primarily by the slope of the topography on which the dump is constructed.

The gradient of the drainage course, in the downstream direction is relatively flat, and there is virtually no possibility that the dump could fail as a result of "en masse" base sliding in the direction parallel to the axis of the stream. Furthermore, along the sections transverse to the axis of the Weary Creek drainage course, the lateral limits of the proposed waste dump will be supported by the sloping topography along both the east and west sides of the valley. This will preclude instability along the lateral boundaries of the dump.

A segment of the completed dump will extend a short distance downstream from the junction between the north and south forks. This segment will, in effect, be the only "face" presented by the dump in its final configuration, and will again be confined on either side by slopes of Weary Creek. Provided that stream flows are satisfactorily diverted, preventing the "build-up" of pore water

2.3531 Weary Creek Waste Dump Cont'd

pressures, there is little possibility that this segment of the waste dump might become unstable.

2.3532 West Waste Dump

The natural slopes within this area are generally less than 15 degrees, and generally dip toward the east. The topography is undulating, the surface containing a number of swampy depressions that are filled with peat and organic material.

Test pits indicate that the proposed area of the West dump is underlain by sandy silt, gravel and silty tills, similar to the native foundation soils at the Weary Creek waste dump. Up to 1 meter of peat was excavated in T.P. 14, and several poorly drained depressions within the foundation area of the dump are filled with peat and highly organic silts.

Any peaty soils that occupy isolated depressions within the foundation area of the waste dump should be removed prior to construction of the dump.

Considering the proposed perimeter channel to the north, west and south of the dump, and the river diversion to the east, there will be minimal surface run-off entering the foundation area of the dump.

2.3532 West Waste Dump Cont'd

As the operating crest is advanced progressively, coarse rock will segregate out of the advancing face to form a pervious zone over the base of the layer. The coarse segregated rock at the base of the waste pile will be sufficiently pervious to act as a drain for percolation that will occur through the dump itself. This will prevent the development of any hydrostatic pressures beneath the base of the dump that could adversely affect stability.

2.3533 Open Pit Waste Dump

The proposed open pit waste dump is planned to be developed by backfilling after mining operations have been completed at the north end of the pit.

When construction commences, the dump will be developed by free dumping or by end dumping, the actual construction being largely dependent upon the actual mining sequence.

If the in-pit waste dump is developed progressively from the pit floor, at one end of the pit, the waste rock, with the exception of the developing crests and slope face, will be confined by the pit walls.

The stability of the backfilled dump during its development will

2.3533 Open Pit Waste Dump Cont'd

be dependent on the angle of the slope face. As even small "sliver" failures could interrupt mining operations along the pit, the slope face should be maintained at an angle equal or shallower to the angle of repose. Alternatively, the dump could be developed in lateral stages by the progressive construction of berms, across the pit floor that would prevent "run-out" of debris from occasional sliver failures in the slope face.

3.1 EXPLANATION OF OTHER DEVELOPMENT WORK

During the 1979/80 term of licence Elco carried out other work which, with exception for the reclamation activities, was not directly associated with the work programs described in SECTION 2 of this report. This included certain "off property" work which pertained to the development of the Elk River Coal Project. This work is described below.

3.2 CORE STORAGE RENOVATIONS

Renovations were made on the core storage area from April to June of 1980 in preparation for the oriented core analysis carried out by Golder Associates.

During the various drilling programs over the years, the core had been stored in several buildings which had been vandalized. It was estimated after renovations that over 7000 feet of core were lost due to vandalism.

The core was moved by flat deck truck to the main storage area where it was sorted and piled according to drillhole number. The number of boxes shifted was 7200 (approx. 115,000 feet of core).

After the sorting and clean up was completed the building itself was made secure by placing wire mesh over the windows and blocking all doors except the main entrance. The main door was made from heavy planks and was fastened by a heavy metal lock.

3.2 CORE STORATE RENOVATIONS CONT'D

Inside the building all rows of core boxes were secured by heavy timber racks.

Each row of core was then indexed and cataloged.

3.3 RECLAMATION OF TERRAIN DISTURBANCES AND ASSOCIATED ACTIVITIES

During the fall of 1980 field reclamation activities comprised the recontouring, seeding and fertilizing of 7.1 km of newly cut tote roads, 28.7 km of reused existing access roads, and 114 test pit and drill sites comprising 1.97 Ha of terrain. In addition about 5.1 Ha of orphan exploration areas were seeded and fertilized.

Finally, to ensure adequate environmental protection as per the 1980 program approved pursuant to permit C-49, an environmental protection coordinator was retained for field and office activities and the water quality in the Elk River was periodically sampled and analysed.

Moreover the full costs of preparation and reproduction of the 1979 Annual Reclamation Report[5] were incurred during this reporting period as well as part of the preparation costs of the 1980 Annual Report.

3.4 ENVIRONMENTAL DEVELOPMENT WORK

3.41 Streamgauging

The streamgauging program was continued throughout the reporting period. Apart from the routine stage/discharge measurement trips, three of the stations were improved by the construction of log shelters for the purpose of reducing data and instrument losses due to vandalism and for the purpose of increasing reliable and continuing operations during the winter months.

The hydrological design parameters for the Elk River Project were reviewed and revised this year.

The 1979/80 Hydrological Summary which is forwarded biannually to several regulatory agencies was prepared during this report period.

3.42 Climate Monitoring

The climatological monitoring program commenced during June of 1979, at the request of several regulatory agencies, and was continued during the reporting period. Both stations were severely damaged by vandals during September of 1979 and most repair costs were incurred during the reporting period. Moreover, due to data losses caused by cold weather effects on electrically powered and/or excited instrumentation, it was deemed prudent to place the recording instruments and batteries in log shelters, which were constructed during the summer of 1980. While thus also reducing the vulnerability to

3.42 Climate Monitoring Cont'd

vandalism there is a continuing concern as the sensors are placed in the open and remain exposed to destruction by vandals.

3.43 Air Quality

The background dustfall monitoring program, commenced during June, 1979, at the request of the Pollution Control Branch (MOE), was continued during this period. On site servicing is done as part of the climate program and all transport and staff costs are charged there.

3.44 Water Quality

The baseline water quality investigation for six sites on the Elk River, Cadorna Creek, Forsyth Creek and Weary Creek was completed during this period. The program was implemented at the request of the Water Investigations Branch and the Pollution Control Branch (MOE).

3.45 River Diversion Survey and Design Activities

During the report period a conceptual plan of the Elk River Diversion Channels was completed in final form, most preparatory work having been executed during the preceding work period.

Field work has been reported earlier in Section 2 of this report.

3.46 Fish Inventories

At the request of the Fish and Wildlife Branch (MOE) additional investigations were made into the fish content of the Elk River. Although partly implemented during the previous reporting period, costs were also incurred during the present reporting year.

During the preceding reporting period a literature survey was made of the habitat preferences of Yellowstone Cut-throat Trout, Dolly Varden Char, and Mountain Whitefish at the request of the Fish and Wildlife Branch (MOE).

3.47 Archaeological Inventories

Prior to the on-site disturbances necessary for the implementation of the 1980 Geotechnical and Survey Program, an archeological assessment of site potential was made.

3.5 COMMUNITY DEVELOPMENT WORK

3.51 Hostel Concept Planning

A concept plan for a mine-site hostel was evolved early during 1980 to respond to a request for evaluation of this alternative to new town construction made by the Environment and Land Use Committee.

3.52 Transportation System Planning

Additional work was undertaken to evaluate helicopter transportation of the work force to existing communities and to respond to helicopter noise inquiries by Sparwood, Fernie and Cranbrook.

3.6 PROJECT APPROVAL AND PERMIT ACQUISITION ACTIVITIES

3.61 Stage II Approval Activities

Substantial costs were incurred to conduct investigations into alternatives to the new town construction proposal which did not gain approval-in-principle at the cabinet level. These investigations comprised a qualitative and a quantitative opinion survey relative to interest in future employment at the Elk River Mine in an area extending from Creston in the West Kootenay District to Ft. McLeod in southwest Alberta. In addition a submission was prepared on the Hostel/commute concept for evaluation by the Coal Guidelines Steering Committee. The quantitative opinion survey involved the completion of 1039 questionnaires by area residents and the processing of up to 61 answers per questionnaire.

3.62 Stage III Approval Activities

While preparatory work for various permit applications was pursued during the reporting period, the costs were accumulated against general administrative programs as it involved work by Elco's staff rather than consultants.

3.62 Stage III Approval Activities Cont'd

In one case however, the costs were accumulated as a discrete entity, ie. the preparatory work for the acquisition of approval of the proposed system of work pursuant to Section 6, C.M.R.A.

3.63 Exploration Permit and Reporting Activities

During the 1980 term of licence Elco Mining Limited renewed its Free Miners Certificate, extended the term of the Elk River coal licences, applied and obtained a Licence To Cut Timber, and prepared and submitted to the B.C. Government the following reports:

- Report on the 1979/80 Development Work Carried out on the Elk River Coal Project [2]
- Annual Summary of Exploration Work [6]
- Notice of Work on a Coal Licence [7]
- Application for Reclamation on a Coal Licence [8]

The above last two reports were filed in conjunction with Elco's 1980 summer field program.

3.7 ENGINEERING DEVELOPMENT WORK

3.71 Mine

The majority of work carried out in this area involved the elaboration of the task description of the 1980 geotechnical field work in relation to mine and other facilities planning.

There was, however, other work performed in this area. This included:

- Simplification of the loading concept in the open pit mine where it was found economically and technically feasible to replace the former loading concept based upon the use of conventional shovels, frontend loaders and small hydraulic shovels by the use of one main loading device - a $14m^3$ hydraulic shovel.

- A conceptual mine plan was established to determine an equipment list and subsequent investment and operation cost for a hypothetical west flank operation in order to assess preliminary economical parameters.

- Coal quality parameters for a multiproduct east flank operation- a medium and a high volatile product - have been established in order to assess the economics and marketing potential for such an operation.

3.72 Coal Preparation

An analysis of results of last year's flotation test and investigations for coal recovery from middlings by crushing has shown a potential increase of the overall plant yield from 63% to 65.5%.

3.73 Railway

Mapping of the surficial geology have resulted in alterations of the initial location of the railway centerline in order to avoid potential problem areas. These alterations don't change the location of the already approved access corridors.

3.74 Port

Investigations were carried out on alternative terminal options open to Elco for its future coal shipments.

3.75 Power Supply

Preliminary investigations have been undertaken to assess the feasibility of power generation using tailings and solid refusal on fuel.

3.8 PROJECT PLANNING AND DEVELOPMENT

The main objectives of Elco Mining Limited during the past year were:

- Pursue Stage III permit applications,
- Carry out geotechnical investigations to support the work system approval (Section 7 of CMRA),

- Follow-up unresolved items remaining from the Stage II approval-in-principle,
- Negotiate and secure contract arrangements with the railway company,
- Check alternatives for harbour development,
- Prepare an exploration program and work plan for a steam coal feasibility assessment,
- Plan and budget the next engineering work phase,
- Carry out project promotion with potential new customers and partners.

The negotiations with CP Rail for the west bound traffic were brought to an interim conclusion by signing a memorandum of agreement on behalf of Elco as 50% shareholder in the Joint Venture for the west bound traffic attributable to the Elco shareholders. In this memorandum the major part of the conditions under which CP Rail will transport Elco's coal to tide water has been defined and agreed upon. As soon as Elco's owners and partners will decide to implement the project the transportation agreement will be finalized on the basis of the principles laid down in the memorandum of agreement.

Elco proposed to its shareholders to carry out a phased feasibility investigation on the western part of Elco's licence area in which large reserves of steam coal are indicated.

SECTION 4

SCHEDULE OF 1979/80

DEVELOPMENT WORK

EXPENDITURES FOR THE

ELK RIVER COAL LICENCES

Table 4.0-1
Sheet 1

ELCO MINING LIMITED

SCHEDULE OF 1979/80 DEVELOPMENT WORK EXPENDITURES ON THE ELK RIVER COAL LICENCES

REPORTED PURSUANT TO SECTION 18, COAL ACT AND SECTION 15, COAL ACT REGULATIONS

FOR THE PERIOD NOVEMBER 1979 TO OCTOBER 1980

Category of Work	Total Phase 1b	Licence Group 118	Licence Group 119	Licence Group 120	Licence Group 121	Licence Group 122
Exploration and Development Work						
Exploration Work						
Aerial Mapping	38,011.38	6,968.74	8,869.31	7,602.20	4,434.70	10,136.43
Field Surveying						
- McElhanney	138,783.68	25,443.62	32,382.82	27,756.45	16,191.59	37,009.20
- Kerr Wood Leidal	32,771.39	-	13,901.62	11,925.51	6,944.26	-
Surficial Geology Mapping of Railway Corridor - Thurber	24,048.19	-	1,844.26	-	-	22,203.93
Geotechnical Investigations of Mine Overburden						
- IECO	26,127.81	998.04	10,799.78	5,617.82	8,468.11	244.06
- Allkind Drilling	53,484.51	1,978.93	19,548.59	8,450.59	23,506.44	-
- Drillwell	9,045.00	-	-	-	9,045.00	-
- CPI	7,080.00	-	-	-	7,080.00	-
- UMA	9,095.25	252.14	2,592.29	1,183.26	5,067.56	-
Geotechnical Investigations of Mine Rock Stages						
- Golder	60,790.72	5,045.63	26,869.50	10,152.05	18,723.54	-
- Drillwell	87,496.00	-	41,320.61	-	46,175.39	-
- CPI	18,873.00	-	9,436.50	-	9,436.50	-
Elco Field Support Costs						
- Construction (McMeekin)	116,140.39	6,549.27	62,410.69	19,519.39	25,940.25	1,720.79
- Camp & Catering	106,068.37	106,068.37	-	-	-	-
- Transportation	6,835.37	1,253.15	1,594.92	1,367.06	797.47	1,822.77
- Core Storeage Renovations	9,020.92	1,653.83	2,104.88	1,804.17	1,052.45	2,405.59

Table 4.0-1
Sheet 2

ELCO MINING LIMITED

SCHEDULE OF 1979/80 DEVELOPMENT WORK EXPENDITURES ON THE ELK RIVER COAL LICENCES
REPORTED PURSUANT TO SECTION 18, COAL ACT AND SECTION 15, COAL ACT REGULATIONS
FOR THE PERIOD NOVEMBER 1979 TO OCTOBER 1980

Category of Work	Total Phase 1b	Licence Group 118	Licence Group 119	Licence Group 120	Licence Group 121	Licence Group 122
Elco Field Support Costs						
- Archeologist	4,258.00	780.63	993.53	851.59	496.77	1,135.48
- First Air	5,498.84	1,008.12	1,283.06	1,099.75	641.54	1,466.37
- Drafting & Reproduction	4,780.00	876.33	1,115.33	955.99	557.67	1,274.68
- Other	7,957.24	1,458.83	1,856.69	1,591.43	928.35	2,121.94
Engineering Development Work						
Mine Engineering						
- Bench Maps	6,986.78	1,280.91	1,630.25	1,397.34	815.13	1,863.15
- Consultants (E&B)	154,173.42	28,265.06	35,973.76	30,834.37	17,987.08	41,113.15
- Drafting & Reproduction	8,974.82	1,645.38	2,094.12	1,794.95	1,047.07	2,393.30
Coal Preparation						
- Consultants (E&B)	38,543.36	7,066.27	8,993.44	7,708.59	4,496.77	10,278.29
Engineering & Transportation Contract Work						
- MK Engineering	9,830.96	1,802.34	2,293.89	1,966.17	1,146.96	2,621.60
- Railway & Port	8,539.59	1,565.59	1,992.57	1,707.90	996.29	2,277.24
Environmental Development Work						
Stream Gauging	37,915.23	6,951.11	8,846.88	7,582.97	4,423.49	10,110.78
Climate Monitoring	25,915.84	4,751.23	6,047.23	5,183.12	3,023.55	6,910.31
Air Quality Monitoring	12,839.44	2,353.89	2,995.87	2,567.86	1,497.95	3,423.87
Water Quality Monitoring	51,524.13	9,446.07	12,022.28	10,304.72	6,011.21	13,739.85
River Diversion & Design	15,923.71	-	6,754.84	5,794.64	3,374.23	-
Fish Inventories	5,960.78	1,092.81	1,390.85	1,192.14	695.43	1,589.55
Reclamation	29,661.98	1,507.94	14,068.15	5,783.38	7,178.33	1,124.18
Drafting & Reproduction	8,974.82	1,645.38	2,094.12	1,794.95	1,047.07	2,393.30

Table 4.0-1
Sheet 3

ELCO MINING LIMITED

SCHEDULE OF 1979/80 DEVELOPMENT WORK EXPENDITURES ON THE ELK RIVER COAL LICENCES
REPORTED PURSUANT TO SECTION 18, COAL ACT AND SECTION 15, COAL ACT REGULATIONS
FOR THE PERIOD NOVEMBER 1979 TO OCTOBER 1980

Category of Work	Total Phase 1b	Licence Group 118	Licence Group 119	Licence Group 120	Licence Group 121	Licence Group 122
Community Development Work						
Hostel Concept & Transportation System Planning	96,796.55	17,746.00	22,585.84	19,359.11	11,293.04	25,812.56
Project Approval & Permit Acquisition Work						
Stage III Approval	9,055.74	1,660.22	2,113.00	1,811.13	1,056.51	2,414.88
Section 7 - CMRA Permit	3,465.89	635.41	808.71	693.17	404.36	924.24
Project Planning, Promotion & Presentation						
Scheduling & Progress Control	44,271.56	8,116.43	10,330.02	8,854.22	5,165.07	11,805.82
Project Presentations & Marketing	10,047.77	1,842.09	2,344.48	2,009.53	1,172.25	2,679.42
Subtotal: Exploration & Development Work	1,384,478.43	266,843.25	393,338.67	225,999.40	262,859.32	235,392.79
Administration						
Salaries	341,034.02	62,522.77	79,574.52	68,206.10	39,787.70	90,942.93
Temporary Staff	47,078.79	8,631.09	10,985.04	9,415.66	5,492.58	12,554.42
Office Supplies	5,522.29	1,012.42	1,288.53	1,104.45	644.27	1,472.62
Vehicles - Lease/Rental	14,141.01	2,592.51	3,299.57	2,828.17	1,644.80	3,770.96
Vehicles - Operating/Maint.	9,193.63	1,685.49	2,145.18	1,838.71	1,072.60	2,451.65
Legal Fees	3,820.27	700.38	891.40	764.05	445.70	1,018.74
Audit Fees	5,742.94	1,052.87	1,340.02	1,148.57	670.02	1,531.46

Table 4.0-1
Sheet 4

ELCO MINING LIMITED

SCHEDULE OF 1979/80 DEVELOPMENT WORK EXPENDITURES ON THE ELK RIVER COAL LICENCES
REPORTED PURSUANT TO SECTION 18, COAL ACT AND SECTION 15, COAL ACT REGULATIONS
FOR THE PERIOD NOVEMBER 1979 TO OCTOBER 1980

Category of Work	Total Phase 1b	Licence Group 118	Licence Group 119	Licence Group 120	Licence Group 121	Licence Group 122
Administration						
Data Processing	10,071.74	1,846.48	2,350.07	2,014.33	1,175.05	2,685.81
Travel Expenses & Meetings	39,020.68	7,153.78	9,104.81	7,804.06	4,552.46	10,405.57
Taxes	25,381.93	4,653.34	5,922.45	5,076.33	2,961.26	6,768.55
Permits & Fees	7,016.23	1,286.30	1,637.12	1,403.23	818.57	1,871.01
Office Rent, Utilities & Maint.	69,453.11	12,733.04	16,205.71	13,890.48	8,102.94	18,520.94
Equipment Rentals	3,258.84	597.45	760.40	651.76	380.20	869.03
Reproduction Costs	9,707.88	1,779.77	2,265.17	1,941.56	1,132.60	2,588.78
Postage & Freight	6,670.34	1,222.89	1,556.41	1,334.06	778.21	1,778.77
Telephone, Telegraph, Telex	22,600.90	4,143.49	5,273.54	4,520.13	2,636.80	6,026.94
Other Office Expenses	8,912.83	1,634.01	2,079.66	1,782.55	1,039.84	2,376.77
Insurance	2,161.00	396.18	504.23	432.20	252.12	576.27
SUB-TOTAL: ADMINISTRATION	630,788.43	115,644.30	147,183.81	126,156.39	73,592.71	168,211.22
GRAND TOTAL	2,015,266.86	382,487.55	540,567.48	352,155.79	336,452.03	403,604.01

1) Elco Mining Limited
August 28, 1978: Stage II Report

2) Elco Mining Limited
1978-79: Follow-up Work (reviews, meetings, additional submissions) in Response to ELUC Review of Stage II Report

3) Elco Mining Limited
January 17, 1979: Section 7, Coal Mines Regulation Act, Work System, Presentation to Ministry of Mines and Petroleum Resources

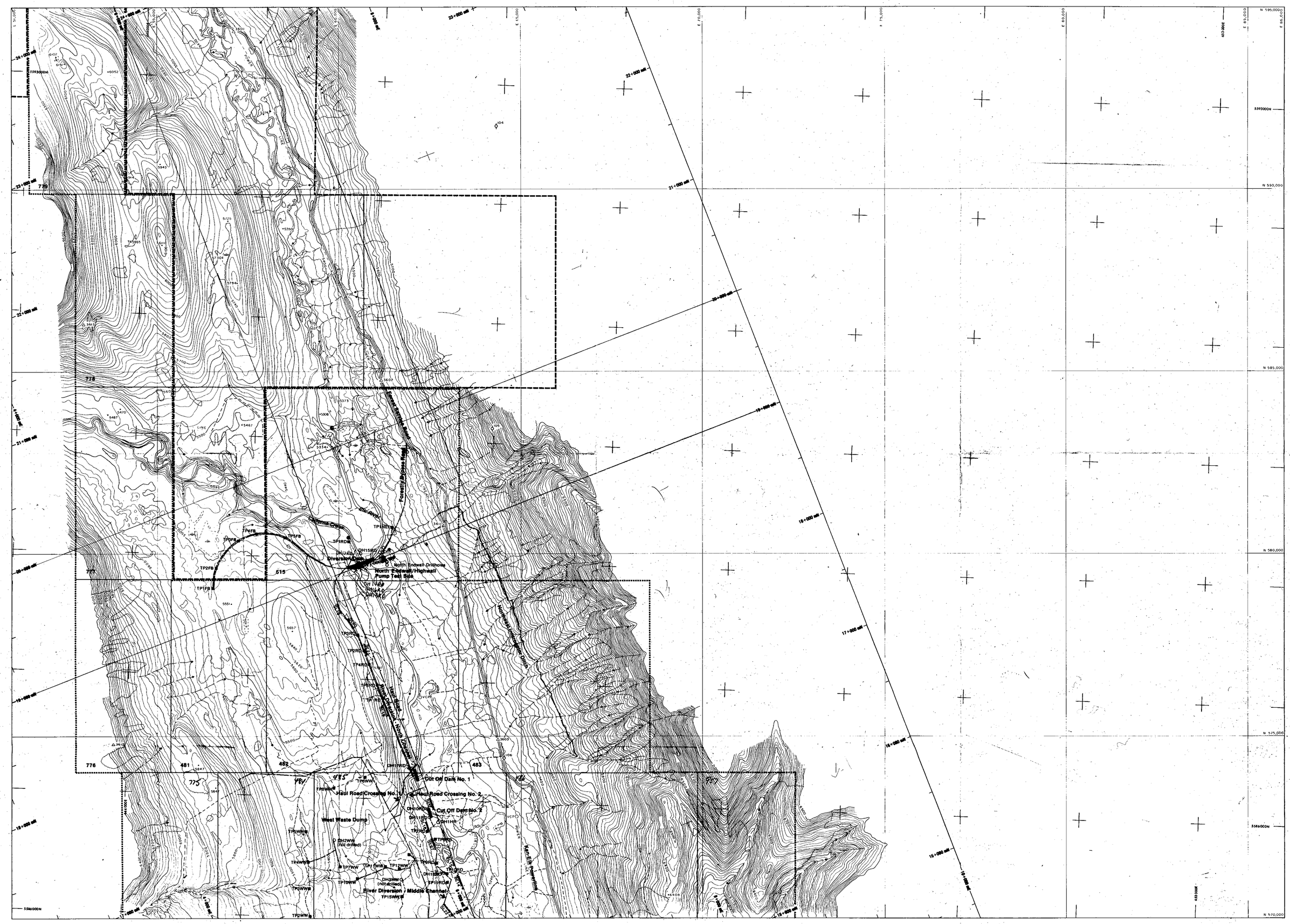
4) Elco Mining Limited
December 5, 1979: Report on the 1978/79 Development Work Carried Out On The Elk River Coal Project

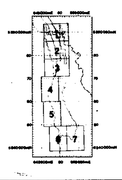
5) Elco Mining Limited
February, 1980: Annual Reclamation Report For 1979

6) Elco Mining Limited
December 4, 1980: Summary of Exploration and Development Work Performed in 1980 on Nonproducing Properties

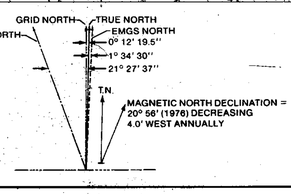
7) Elco Mining Limited
June 2, 1980: Notice of Work on a Coal Licence

8) Elco Mining Limited
June 2, 1980: Application For A Reclamation Permit on A Coal Licence





COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.



LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- 4802ft Spot Elevation
- Elco Mining Limited Coal Licences
- B. C. Coal Reserve Coal Licences

1979/80 FIELDWORK

- DRILL HOLES
- PUMP TEST WELLS
- TEST PITS
- NEW ROADS
- SURVEY CUT LINES
- SEISMIC SURVEY LINES
- CLIMATIC MONITORING STATION
- STREAM GAUGING STATION

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
279	

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

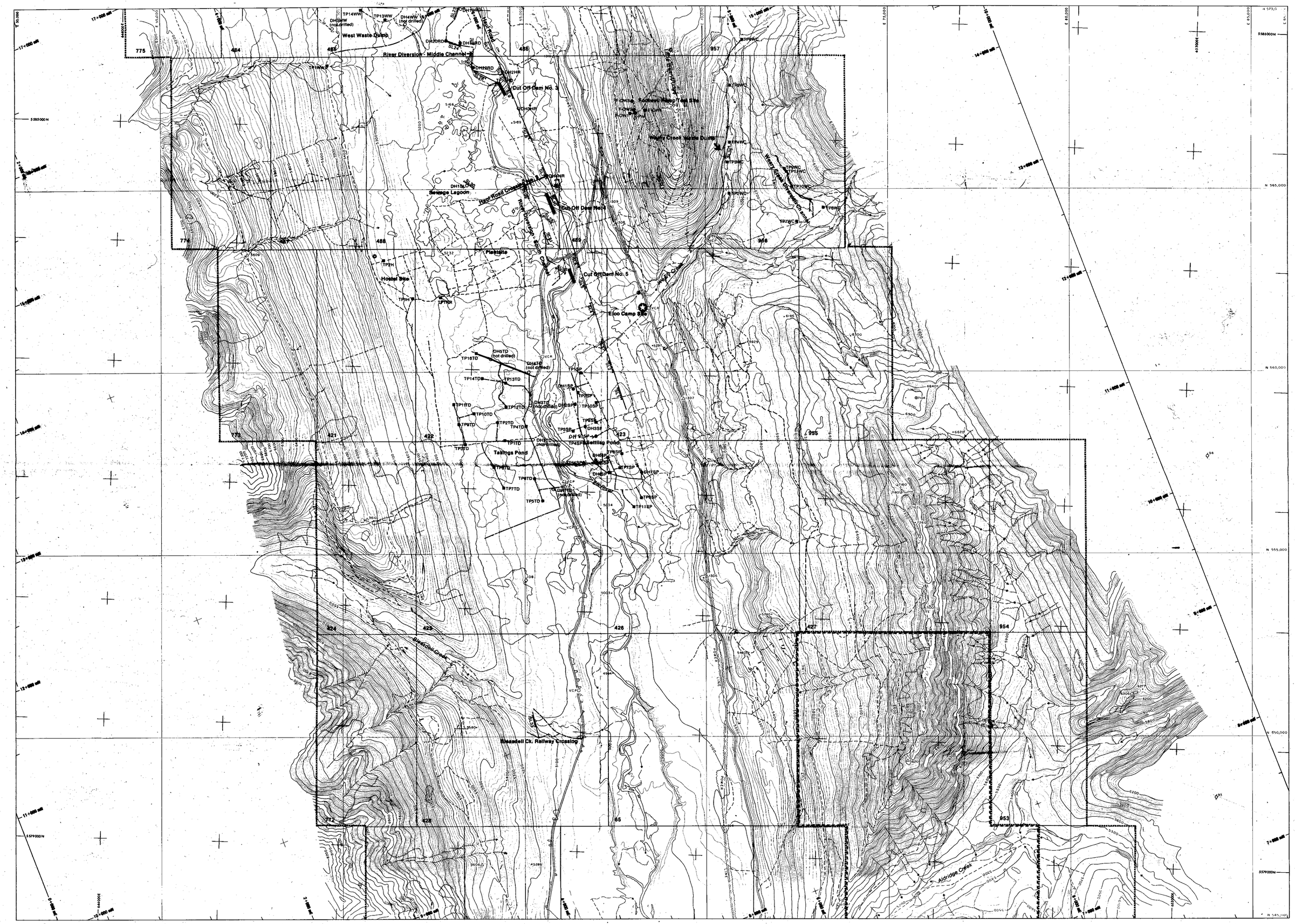
BRITISH COLUMBIA

PLAN OF 1979/80 FIELD WORK - MINE SITE

DRAWN BY	SCALE 1:12000
CHECKED BY G.F.A.	DATE January, 1981
MAP SHEET NO. 1 of 7	DWG. NO.

Appendix 1.0-A

K-ELK River 80(2)A



COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.

GRID NORTH — TRUE NORTH
MINE GRID NORTH — EMGS NORTH
0° 12' 19.5"
1° 34' 30"
21° 27' 37"
T.N.
MAGNETIC NORTH DECLINATION = 20° 56' (1976) DECREASING 4.0' WEST ANNUALLY

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- Elco Mining Limited Coal Licences
- Fording Coal Ltd. Coal Licences

1979/80 FIELDWORK

- DRILL HOLES
- PUMP TEST WELLS
- TEST PITS
- NEW ROADS
- SURVEY CUT LINES
- SEISMIC SURVEY LINES
- CLIMATIC MONITORING STATION
- STREAM GAUGING STATION

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

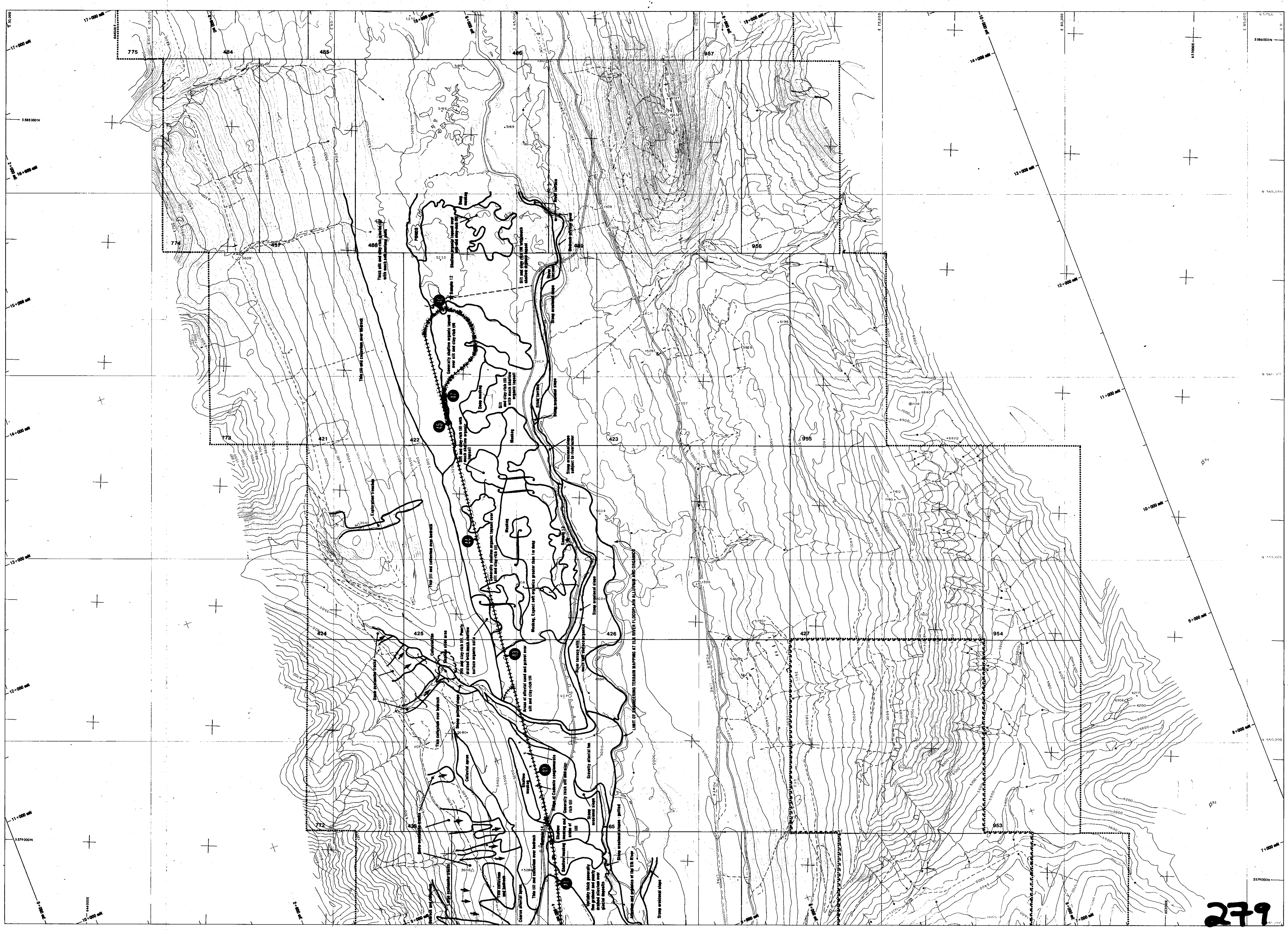
ISSUED DATE

279

ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
PLAN OF 1979/80 FIELD WORK - MINE SITE

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 2A of 7	DWG. NO.

Appendix 1.0-A K Elk River 80(21)A



GRID NORTH TRUE NORTH
EMGS NORTH
MINE GRID NORTH
0° 12' 19.5''
1° 34' 30''
21° 27' 37''
T.N.
MAGNETIC NORTH DECLINATION = 20° 56' (1976) DECREASING 4.0' WEST ANNUALLY

COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- Elco Mining Limited Coal Licences
- Fording Coal Ltd. Coal Licences
- 50 Kilometre Posts

SCALE IN FEET: 0 500 1000 2000 3000 4000 5000 6000
SCALE IN METRES: 0 500 1000 1500 2000

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

PLAN OF 1979/80 FIELD WORK - RAILWAY

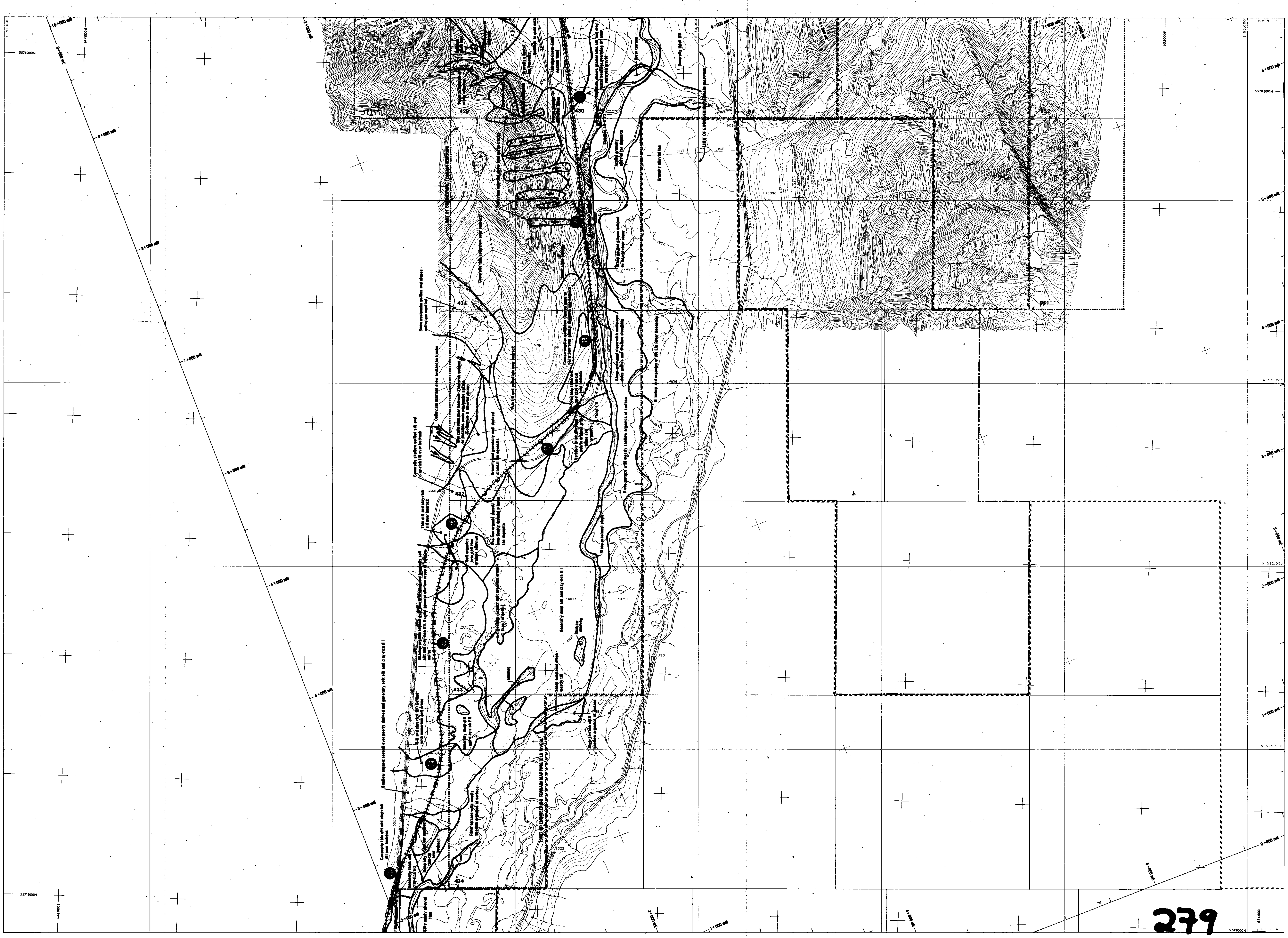
THURBER CONSULTANTS LTD.

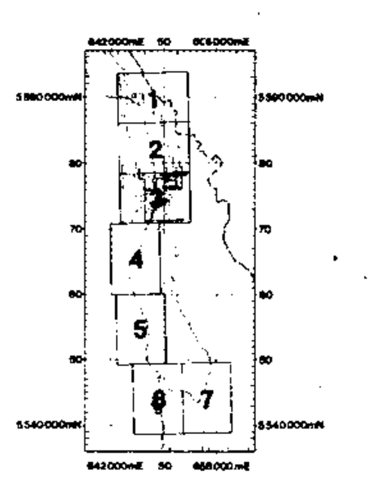
DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 2 of 7	DWG. NO.

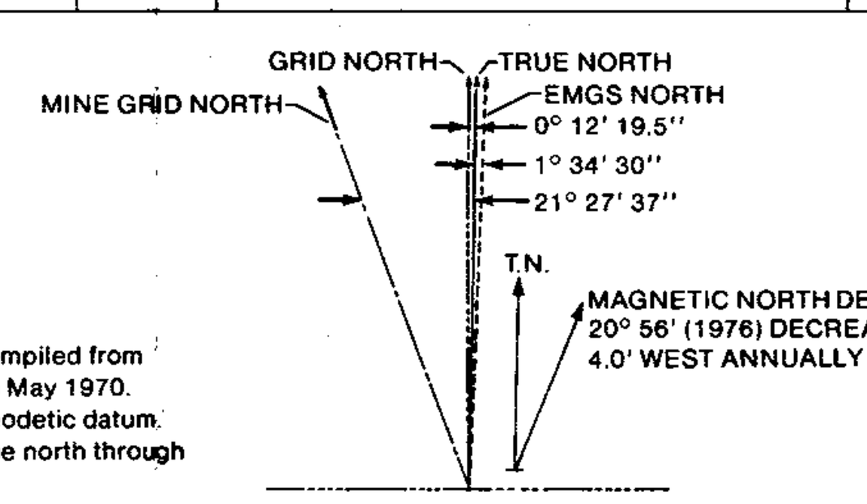
Appendix 1.0-B

K- Elk River 80(2)A

279







COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970.
Elevations referred to geodetic datum.
Grid north referred to true north through meridian 114° 42'.

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- Elco Mining Limited Coal Licences
- Fording Coal Ltd. Coal Licences
- Cominco Freehold
- Cominco Coal Licences
- Kilometre Posts

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

PLAN OF 1979/80 FIELD WORK - RAILWAY

THURBER CONSULTANTS LTD.

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 3 of 7	DWG. NO.

279

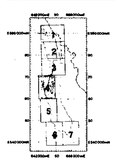
Appendix 1.0-B. K-Elk River 80(2)A

ARROWS SHOW COLLUVIUM MANTLED SNOW AVALANCHE TRACKS - LIMITS SHOWN BY LINE BOUNDARY

ARROWS SHOW COLLUVIUM MANTLED SNOW AVALANCHE TRACKS - LIMITS SHOWN BY LINE BOUNDARY

Transmission Line to Fording Coal Mine

279



COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.

0° 12' 19.5" GRID NORTH
TRUE NORTH
T.N.
1° 34' 30" EMGS NORTH
MAGNETIC NORTH DECLINATION = 20° 56' (1976) DECREASING 4.0' WEST ANNUALLY

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- Cominco Freehold
- Cominco Coal Licences
- Fording Coal Ltd. Coal Licences
- Kilometre Posts

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE
	ISSUED		DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

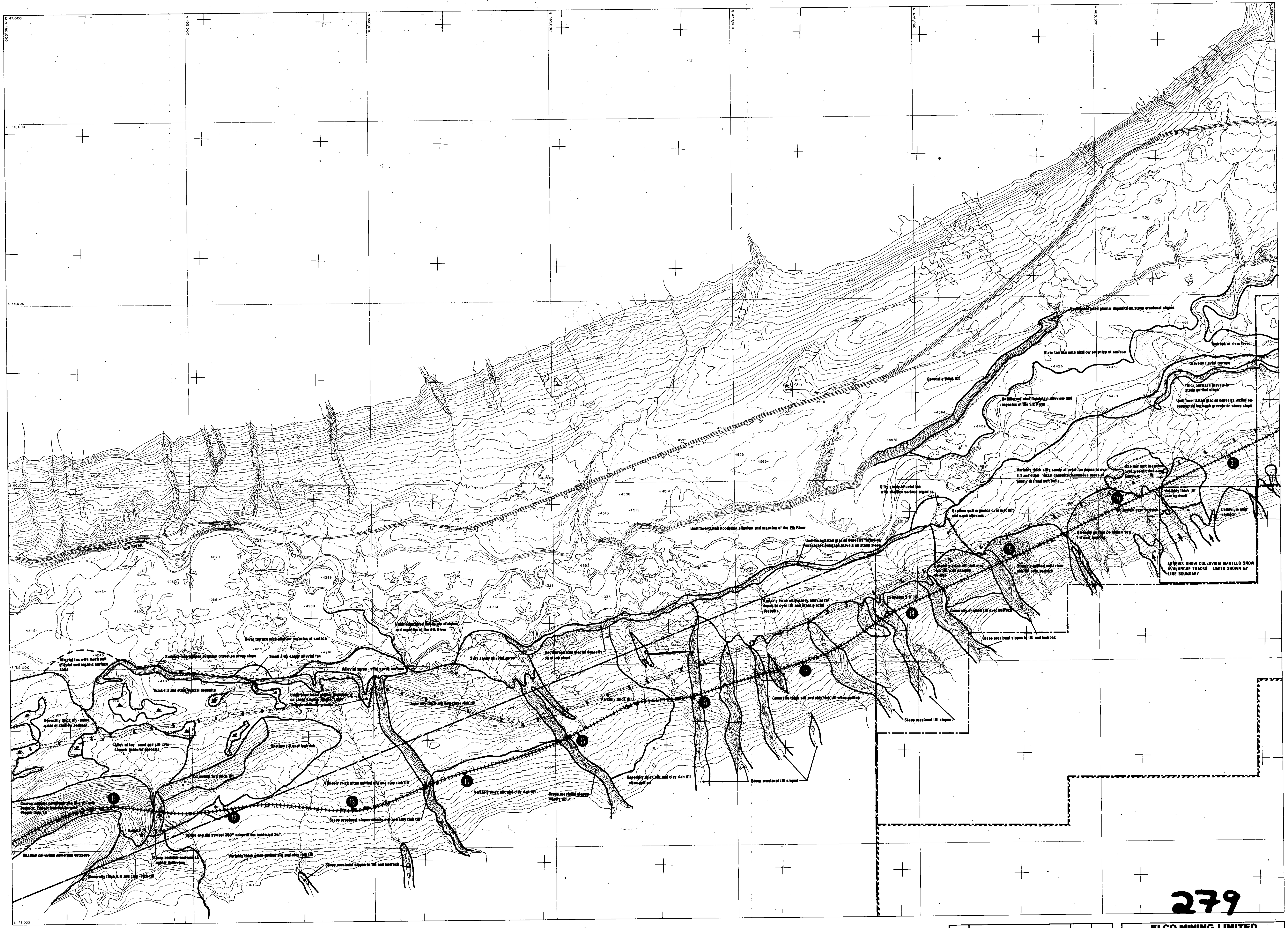
BRITISH COLUMBIA

PLAN OF 1979/80 FIELD WORK - RAILWAY

THURBER CONSULTANTS LTD.

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 4 of 7	DWG. NO.

Appendix 1.0-B K Elk River 80 (2) A



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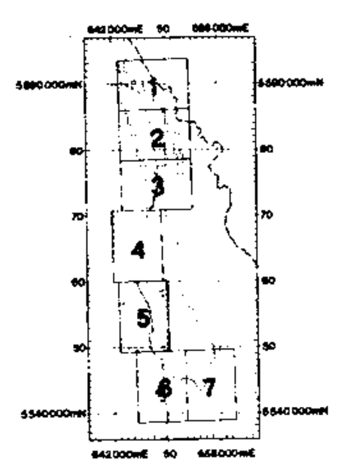


COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970.
Elevations referred to geodetic datum.
Grid north referred to true north through meridian 114° 42'.

0° 12' 19.5" — GRID NORTH
TRUE NORTH
T.N.
1° 34' 30" — EMGS NORTH
MAGNETIC NORTH DECLINATION = 20° 56' (1976) DECREASING 4.0' WEST ANNUALLY

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- Cominco Freehold
- Cominco Coal Licences
- Fording Coal Ltd. Coal Licences
- B. C. Coal Ltd. Freehold
- 50 Kilometre Posts

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
PLAN OF 1979/80 FIELD WORK - RAILWAY
THURBER CONSULTANTS LTD.

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 5 of 7	DWG. NO.

Appendix 1.0-B

K-Elk River 80(2)A

Bridge crossing to Forestry Road and Elk Rd.

River terrace

Floodplain alluvium

River terrace silty sand over sand and gravel

River terrace

River terrace

Steep erosional slope

ELK RIVER

Soft organics

Generally thick till some areas of shallow bedrock

Muskegs

Colluvium and thin till over bedrock. Expect bedrock in cuts deeper than 1m

Variably thick silt-clay till over bedrock. Expect bedrock in cuts deeper than 2m

Colluvium and till over bedrock. Expect bedrock in cuts deeper than 1m.

Colluvium and till over shallow bedrock

Soft organics

Variably thick silt clay till over bedrock

Steep erosional slope - bedrock controlled

Till

Soft organics

River terrace - sand and gravel

Thick till

Steep erosional slope - bedrock controlled

Variably thick, silt-clay till over bedrock. Expect bedrock in cuts deeper than 2m

Soft organics

CUT LINE

ELCO MINING GRID SYSTEM

EMGS COORDINATES METRIC GRID

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF 2TM ZONE 11, 115° 00' W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE MONUMENT BLEASDELL, WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAYBE SUBJECT TO READJUSTMENT AT A LATER DATE. DISTANCES ARE REDUCED TO 1500 M DATUM AND THE CO-ORDINATES ARE IN METERS

279

COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.

0° 12' 19.5" GRID NORTH
TRUE NORTH
T.N.
1° 34' 30" EMGS NORTH
MAGNETIC NORTH DECLINATION = 20° 58' (1976) DECREASING 4.0' WEST ANNUALLY

LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- Contours
- Spot Elevation
- B. C. Coal Ltd. Freehold
- 50 Kilometre Posts

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

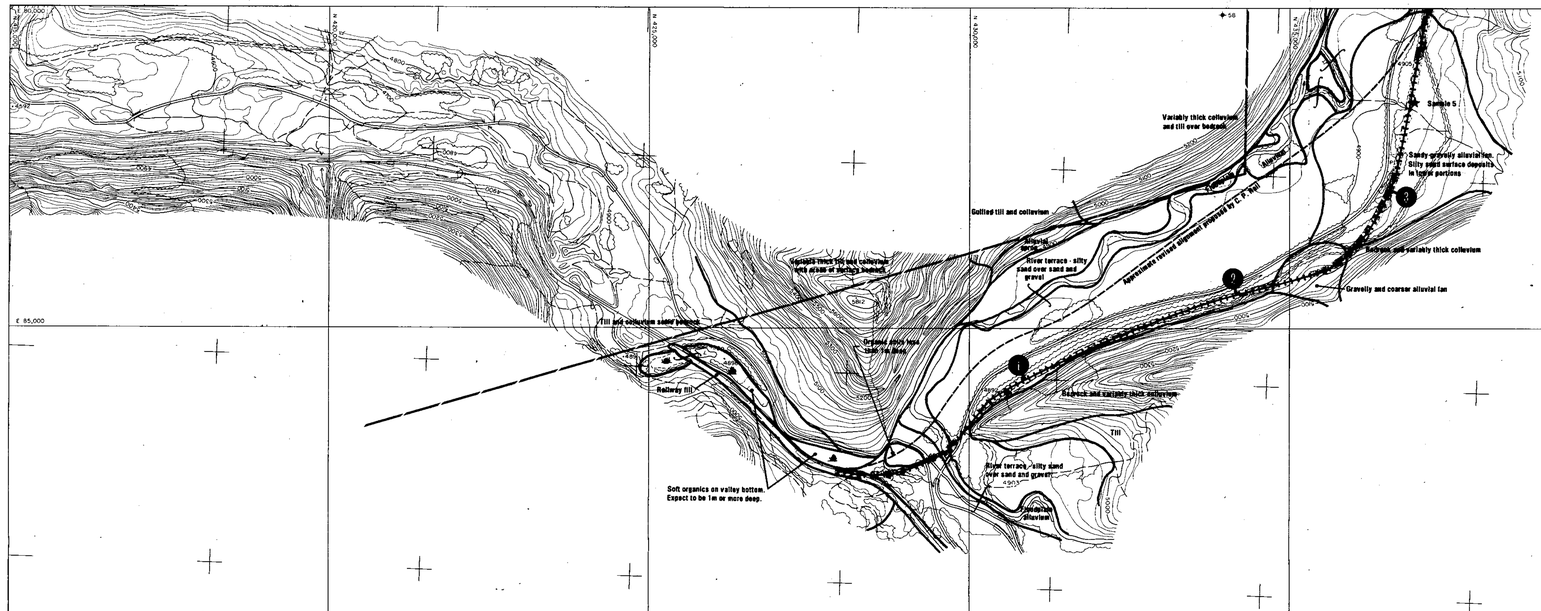
PLAN OF 1979/80 FIELD WORK - RAILWAY

THURBER CONSULTANTS LTD.

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 6 of 7	DWG. NO.

Appendix 1.0-B

K-Elk River 80(2)A

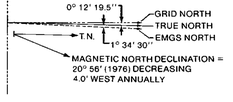


ELCO MINING GRID SYSTEM

EMGS CO-ORDINATES (METRIC GRID)
BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W
THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500 M. DATUM AND THE CO-ORDINATES ARE IN METERS

279

COMPILATION NOTE:
Topographic Mapping compiled from aerial photography flown May 1970. Elevations referred to geodetic datum. Grid north referred to true north through meridian 114° 42'.



LEGEND:

- Horizontal Control
- Vertical Control
- Targets
- Photo Centre
- Drill Hole
- Trench
- Cut Line
- Power Line
- Roads
- Tree Lines
- Rivers
- Creeks
- Swamps
- 4800 Contours
- 4802* Spot Elevation
- B. C. Coal Ltd. Freehold
- B. C. Coal Ltd. Coal Licences
- Crowsnest Resources Ltd. Coal Licences
- 50 Kilometre Posts

0 500 1000 2000 3000 4000 5000 6000 SCALE IN FEET
0 500 1000 1500 2000 SCALE IN METRES

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

PLAN OF 1979/80 FIELD WORK - RAILWAY

THURBER CONSULTANTS LTD.

DRAWN BY	SCALE 1:12000
CHECKED BY	DATE January, 1981
MAP SHEET NO. 7 of 7	DWG. NO.

K-Elk River 80(21)

N.E. INTERCEPTOR DITCH

FORESTRY BY PASS ROAD

CUT OFF DAM No1

HAUL ROAD

CUT OFF DAM No2

HAUL ROAD CROSSING No 1 and 2

CUT OFF DAM No3

CUT OFF DAM No4

CUT OFF DAM No5

HAUL ROAD CROSSING No 3

WEARY VALLEY INTERCEPTOR DITCH

WEARY CREEK WASTE DUMP

WEST WASTE DUMP

SEWAGE LAGOON

279

Appendix 2.0

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

SURVEY STATION REFERENCE PLAN

SCALE 1: 5000

McElhanney Surveying & Engineering Ltd.

400, 999 8th Street S.W., Calgary, Alberta T2R 1J5 (403) 245-4711, Telex 038-25537

SHEET 1 OF 2

WEARYVALLEY
INTERCEPTOR DITCH

HAUL ROAD

CUT OFF DAM
No 5

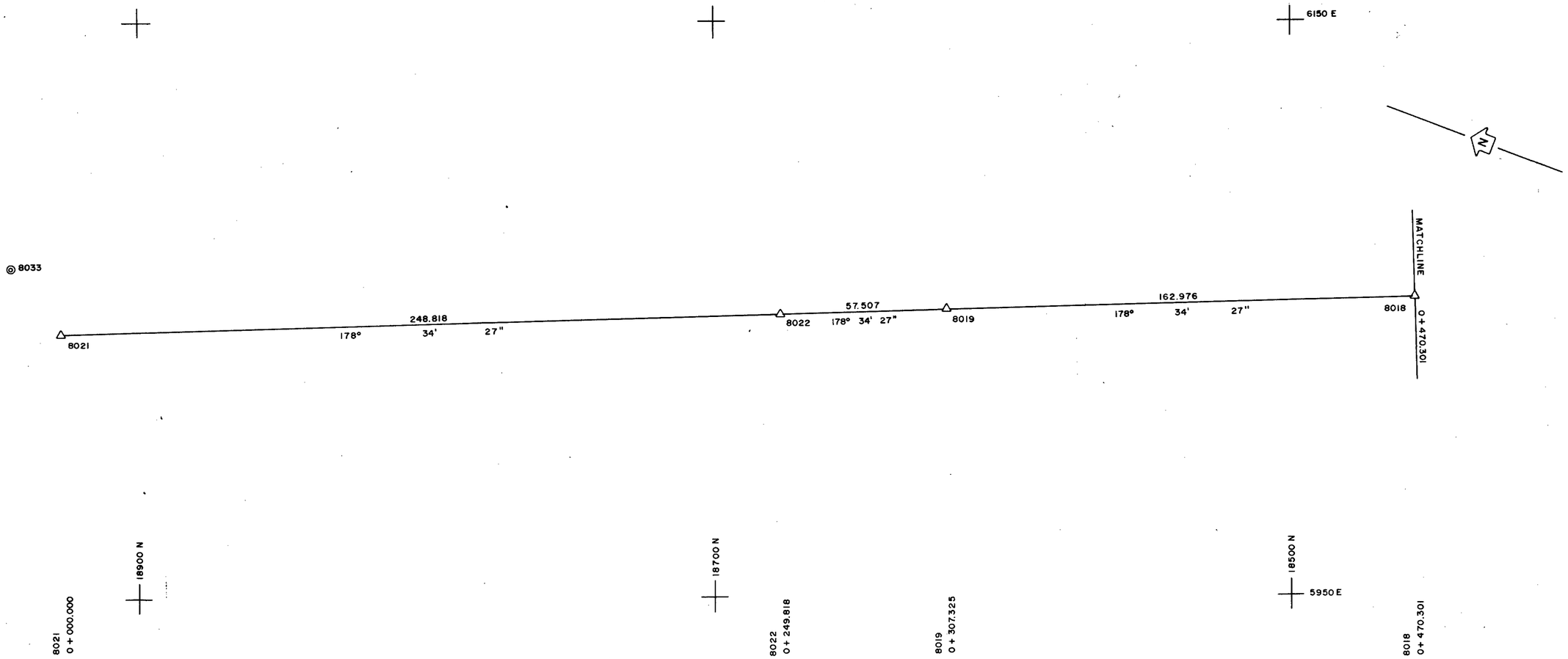
SETTLING
POND

TAILINGS POND

BLEASDELL
CREEK CROSSING

SHEET 2 OF 2

279



NOTE:
△ DENOTES IRON SPIKE
◎ DENOTES RE-BAR SET IN CONCRETE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date Sept. 1980
Scale: HOR. 1:1000 VERT. 1:200	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th. M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 19

371

K- Elk River 80(2)A

6150 E

18500 N

18300 N

18100 N

17900 N

N

MATCHLINE

8018 0+470.301

140.864 178° 34' 27"

8011

139.229 178° 34' 27"

8010

71.077 178° 34' 27"

8009

54.844 178° 34' 27"

8001

70.264 178° 34' 27"

8002 0+946.679

MATCHLINE

5950 E

8018 0+470.301

8011 0+611.165

8010 0+750.384

8009 0+821.471

8001 0+876.415

8002 0+946.679

1646

1642

1638

1634

1630

1626

MATCH LINE 0+470.301

MATCH LINE 0+946.679

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale:	HOR. 1:1000 VERT. 1:200
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

2 of 14

279

K-Elk River 30(2)A

17900 N

17700 N

17500 N

6150 E

MATCHLINE 0+946.681

8002

74.530
178° 34' 27"

8070

124.113
178° 34' 27"

8071

96.914
178° 34' 27"

8072

106.585
178° 34' 27"

8073

46.491
178° 34' 27"

8074

MATCHLINE 1+395.314

N

8002 0+946.681

8070 1+021.211

8071 1+145.324

8072 1+242.238

8073 1+348.823

8074 1+395.314

5950 E

1634
1630
1626
1622
1618
1614
1610
1606
1602
1598
1594

MATCHLINE 0+946.681

MATCHLINE 1+395.314

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:200	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th. M

279

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450 - 999 - 8th STREET S.W. CALGARY.

3 of 14

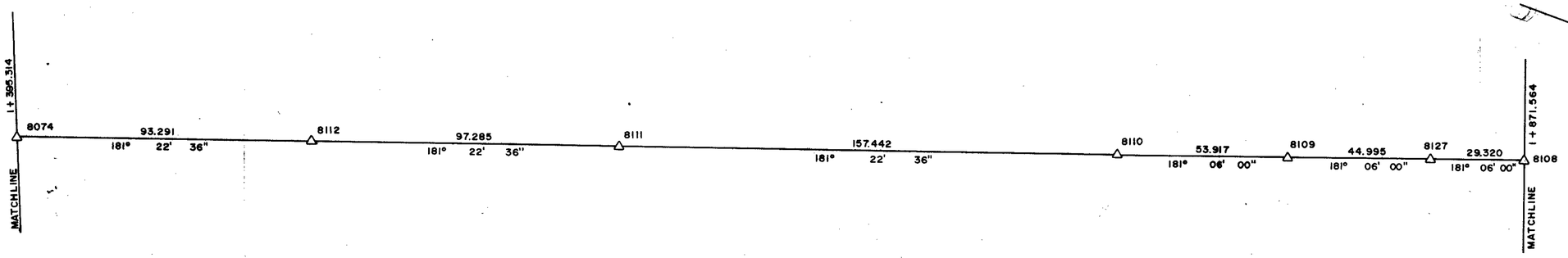
K-Elk River 80(2)A

17500N

17300N.

17100N.

6150 E.



5950E

8074 1+395.314

8112 1+488.605

8111 1+585.890

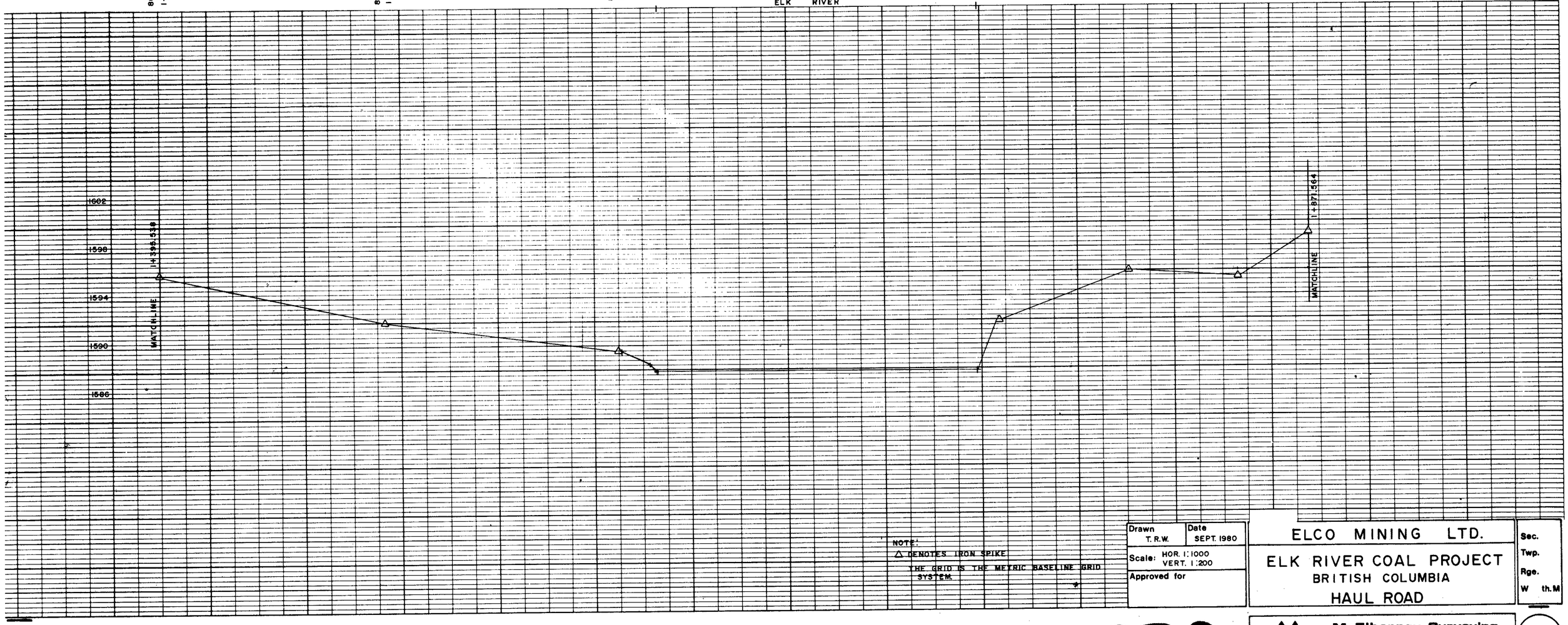
ELK RIVER

8110 1+743.332

8109 1+797.249

8127 1+842.244

8108 1+871.564



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:200	
Approved for	

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ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

279

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

4 of 14

K-Elk River 50(21A

5-14

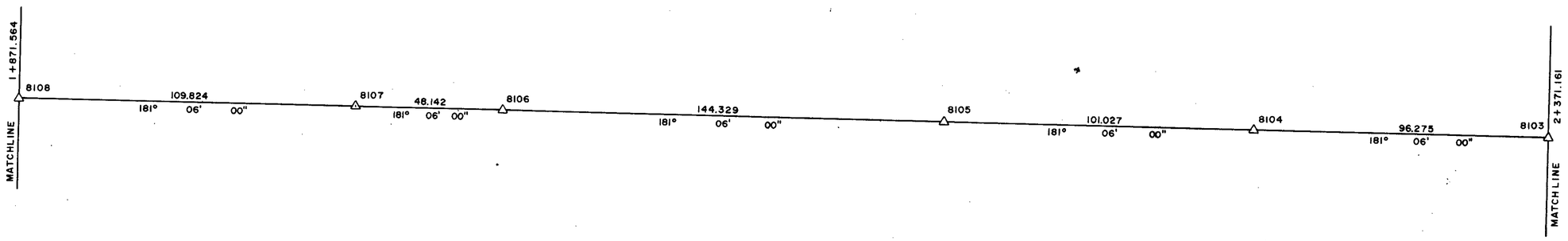
17100 N.

16900 N

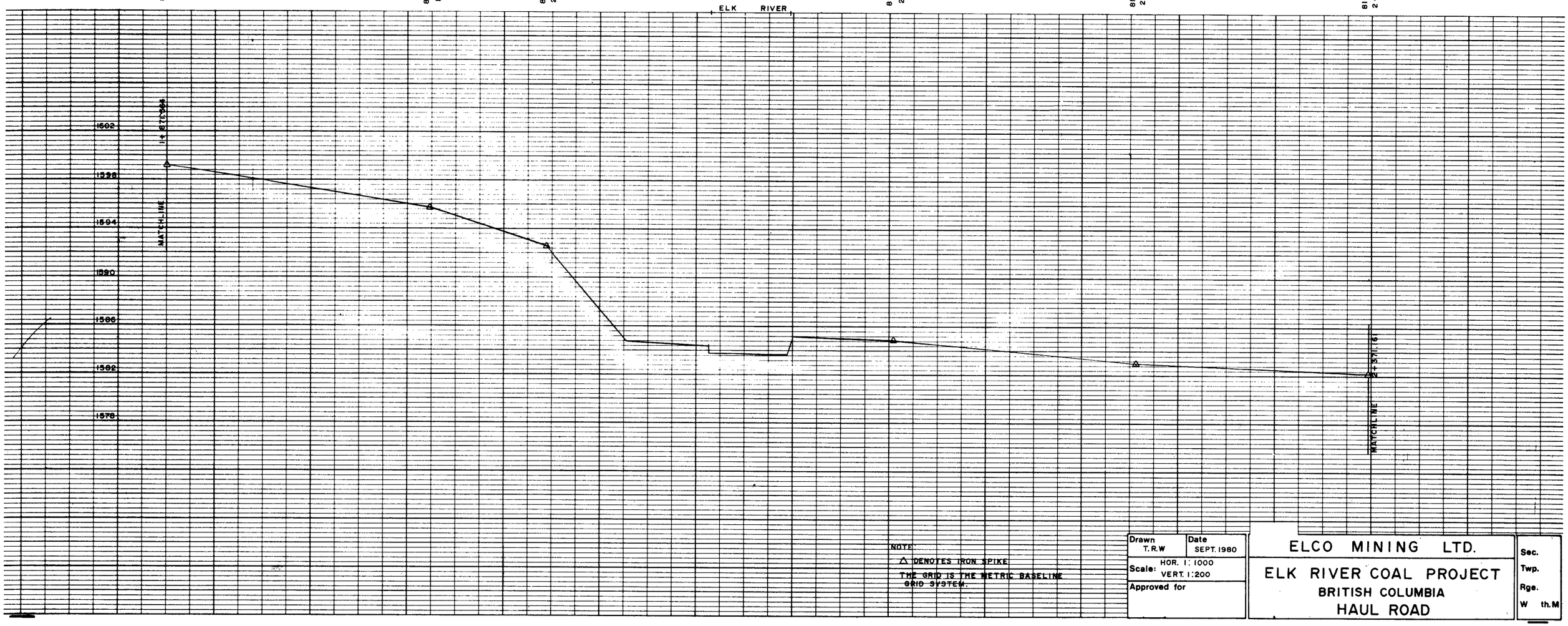
16700 N

16500 N

6150 E



5950 E.



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T. R. W	Date SEPT. 1980
Scale:	HOR. 1:1000 VERT. 1:200
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec. Twp. Rge. W th. M

279

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

5 of 14

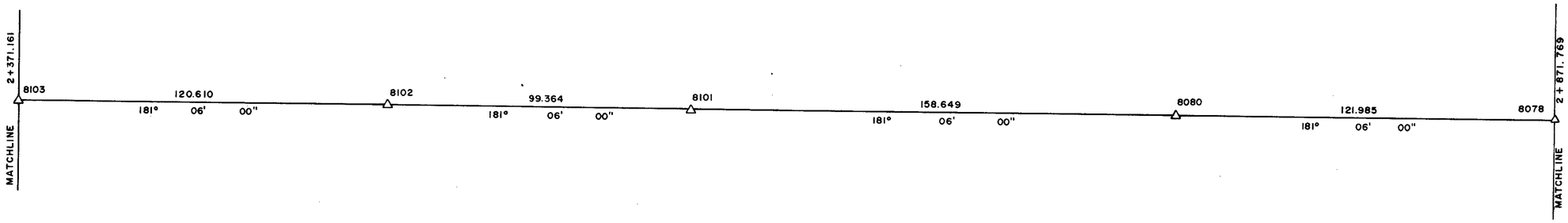
K-ELK River 80(2)A

16500 N

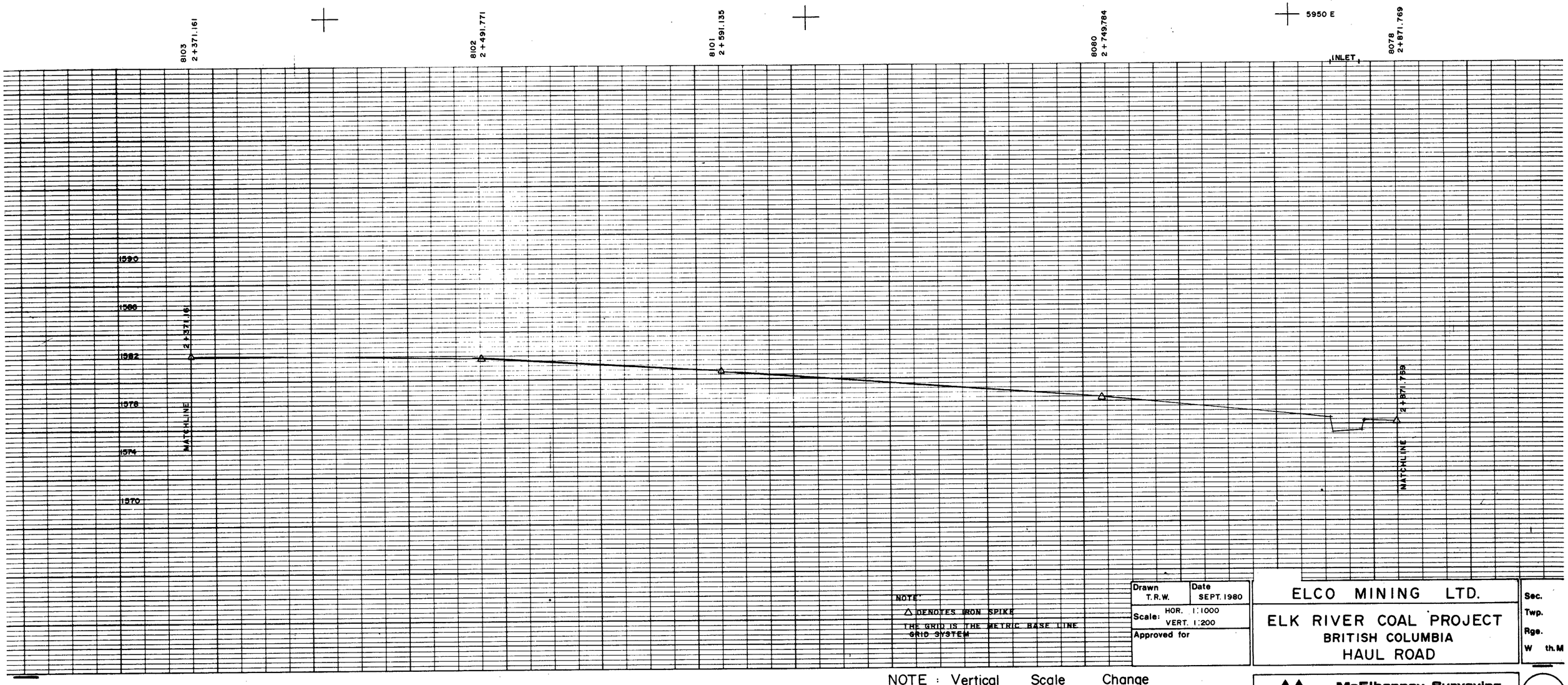
16300 N

16100 N

6150 E



5950 E



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASE LINE GRID SYSTEM

Drawn T.R.W.	Date SEPT. 1980
Scale:	HOR. 1:1000 VERT. 1:200
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

NOTE : Vertical Scale Change Between Sheet 6 And 7

279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

6 of 19

K-ELK River 80 (2)A

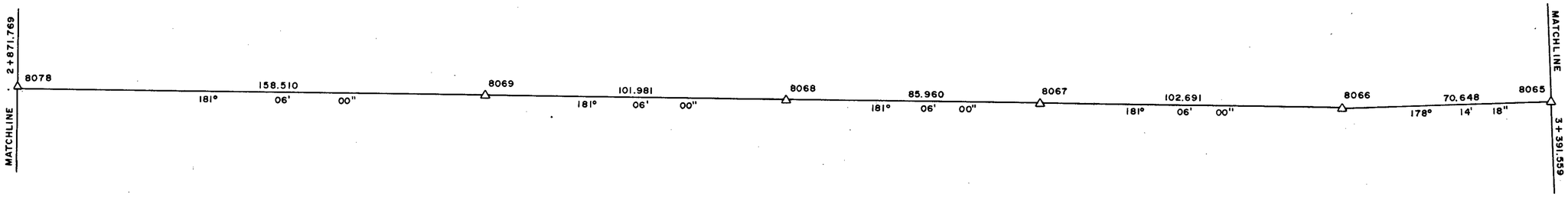
16100 N

15900 N

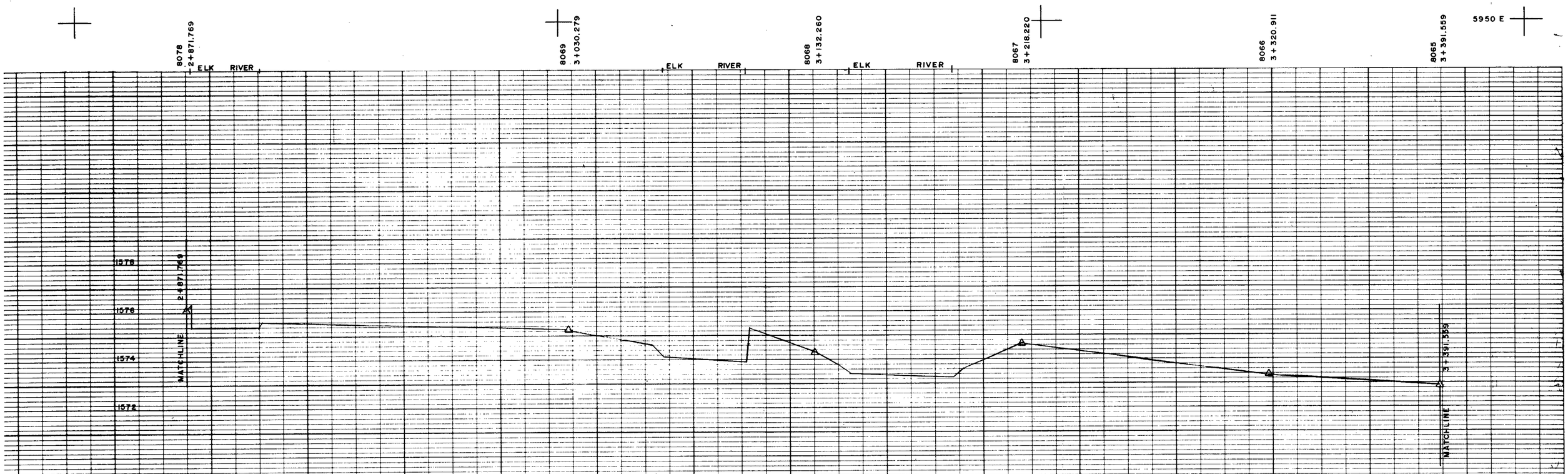
15700 N

6150 E

15500 N



5950 E



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale:	HOR. 1:1000 VERT. 1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

NOTE Vertical Scale Change Between Sheet 6 And 7

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

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K-Elk River 80(21A

279

15500 N

15300 N

15100 N

6150 E

N

3+391.559
MATCHLINE
8065
194.236
178° 14' 18"
8064
91.050
178° 14' 18"
8063
80.040
178° 14' 18"
8062
69.169
178° 14' 18"
8060
110.761
178° 14' 18"
8059
3+936.815
MATCHLINE

5950 E

8065 3+391.559 ELK RIVER 8064 3+585.795 8063 3+676.845 ELK RIVER 8062 3+756.885 8060 3+826.054 8059 3+936.815

1578
1576
1574
1572
1570
1568

3+391.559 MATCHLINE

3+936.815 MATCHLINE

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

8 of 14

279

K-Elk River 80(2)A

9-14

15100N

14900 N

14700 N

14500 N

6150 E

N

3+936.815
8059
MATCHLINE

118.807
178° 14' 18"

8058

97.720
178° 14' 18"

8052

99.564
178° 14" 18"

8051

81.066
178° 14' 18"

8050

111.770
178° 14' 18"

8049
4+445.742
MATCHLINE

5950 E

8059 3+936.815
8058 4+055.622
8052 4+153.342
8051 4+252.906
8050 4+333.972
8049 4+445.742

1578
1576
1574
1572
1570

MATCHLINE 3+936.815

MATCHLINE 4+445.742

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

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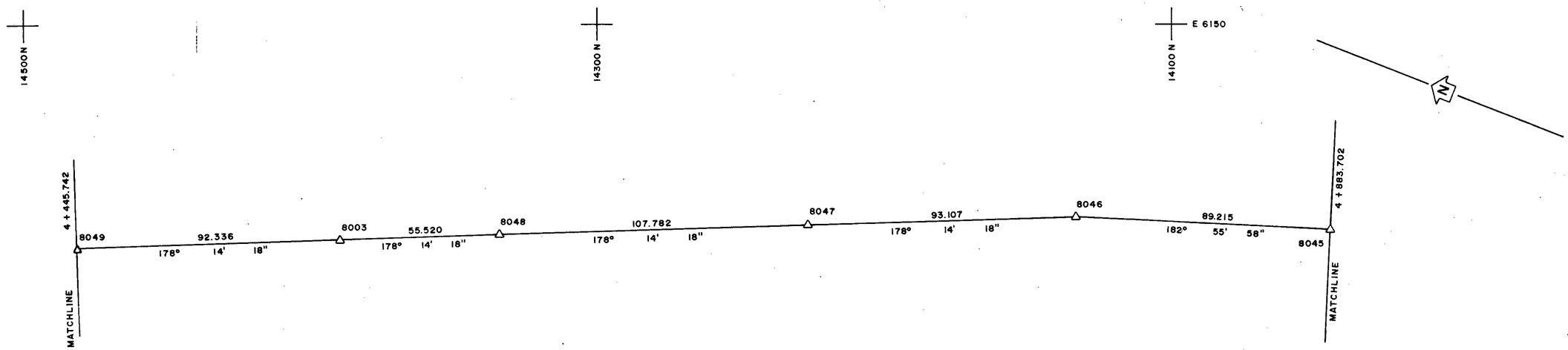
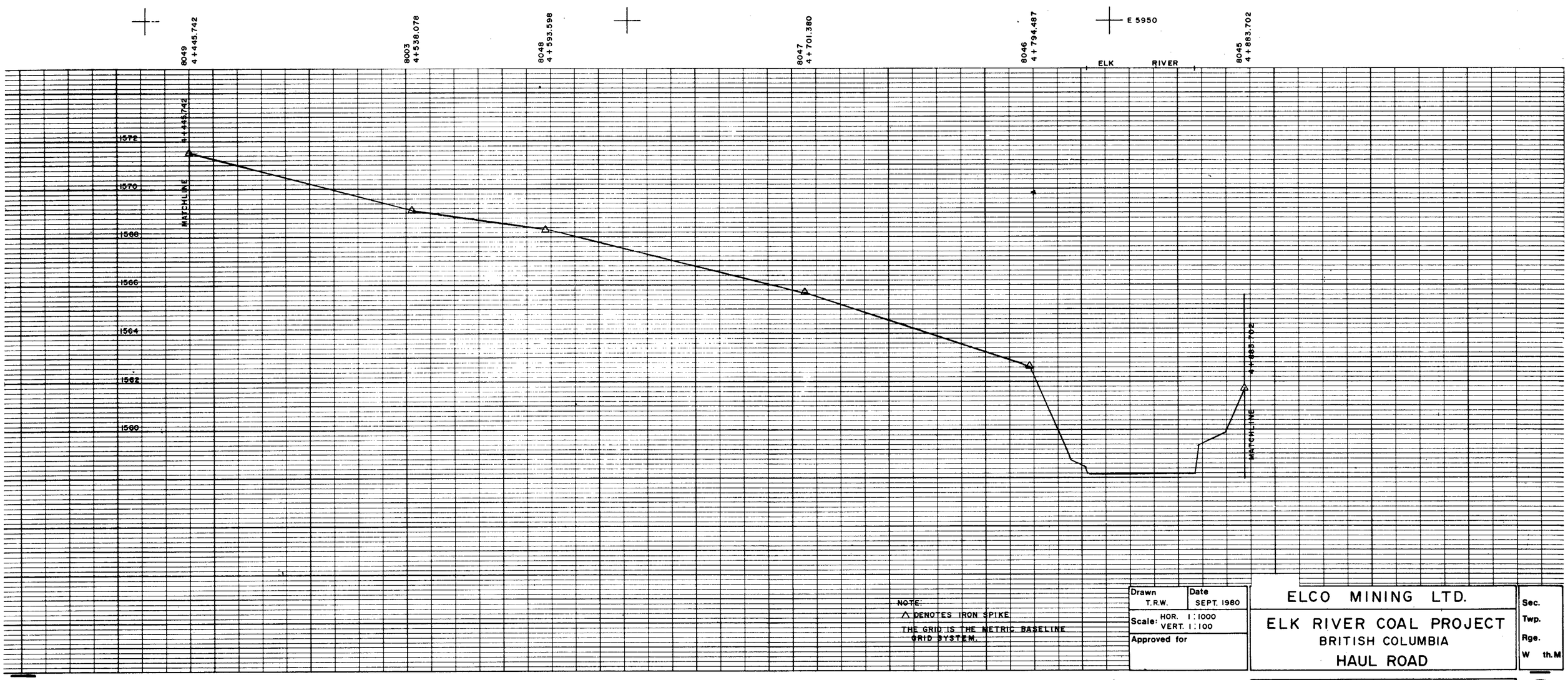
279

K-Elk River 80(2)A





NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale:	HOR. 1 : 1000 VERT. 1 : 100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

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279

K-Elk River 80(2)A

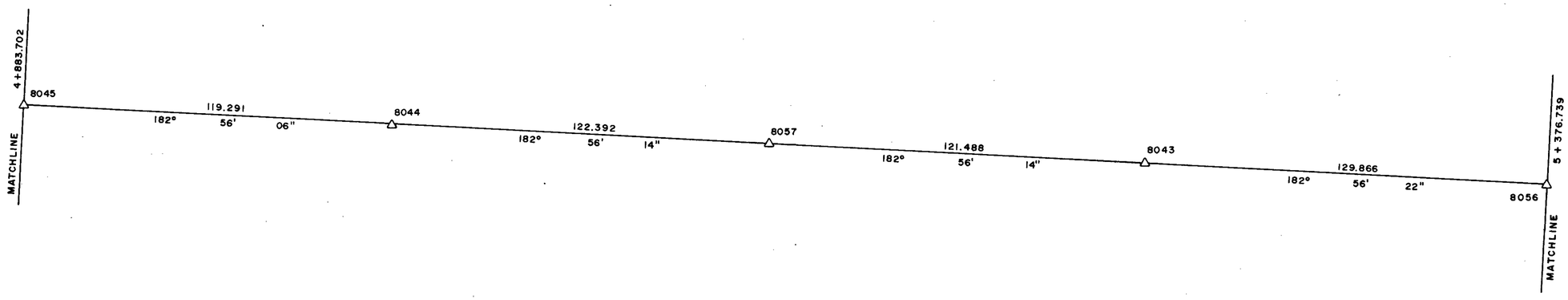
14100 N

13900 N

13700 N

6150 E

13500 N



5950 E

8045 4+883.702

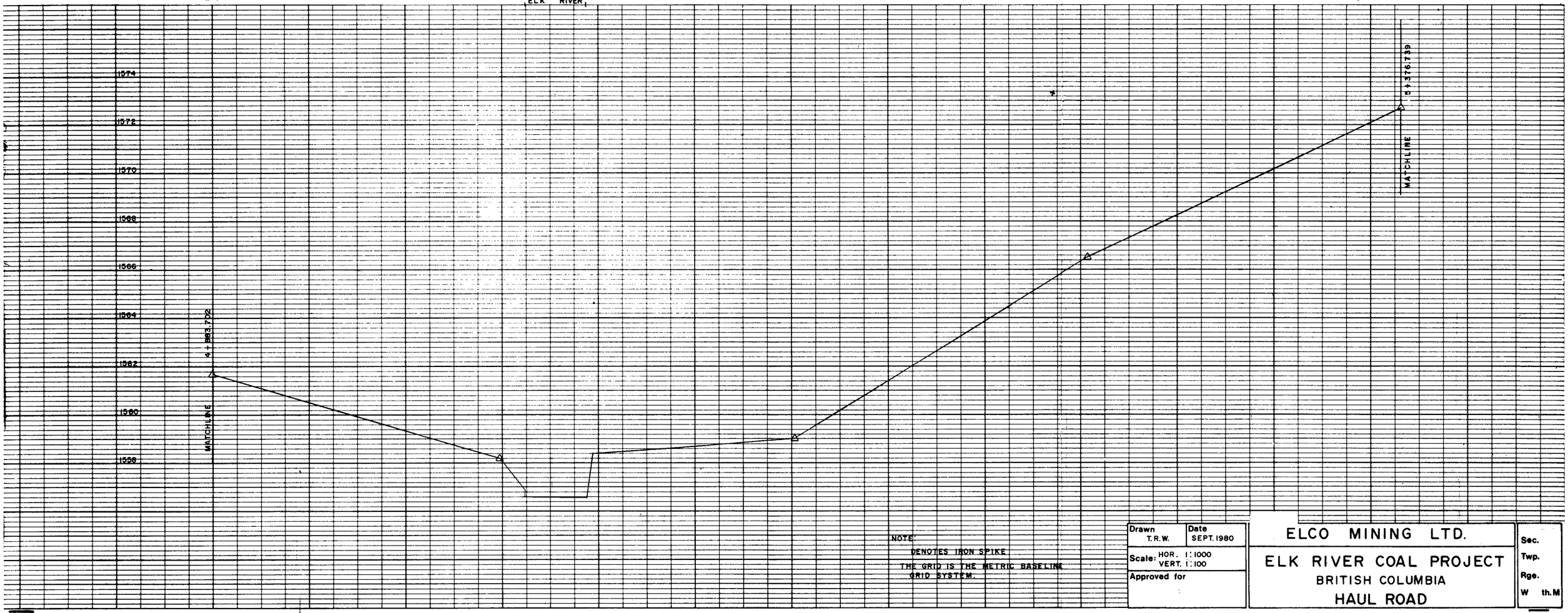
8044 5+002.993

ELK RIVER

8057 5+125.385

8043 5+246.873

8056 5+376.739



NOTE:

DENOTES IRON SPIKE

THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD

Sec.
Twp.
Rge.
W th.M

279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

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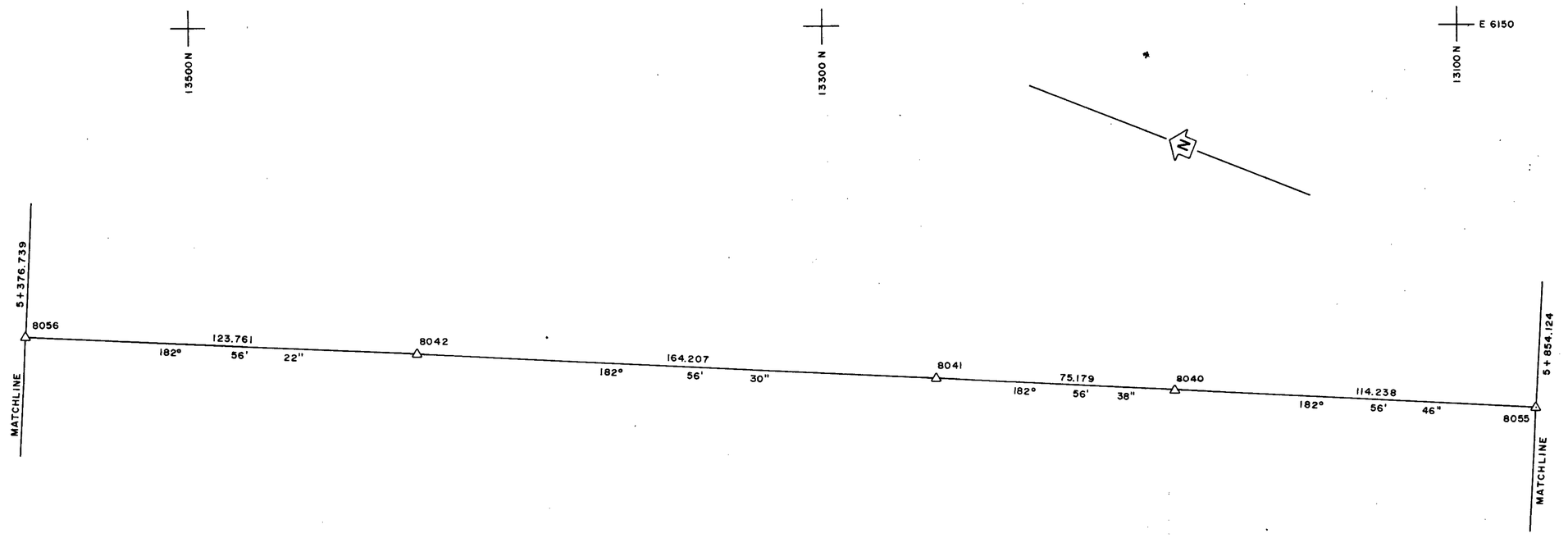
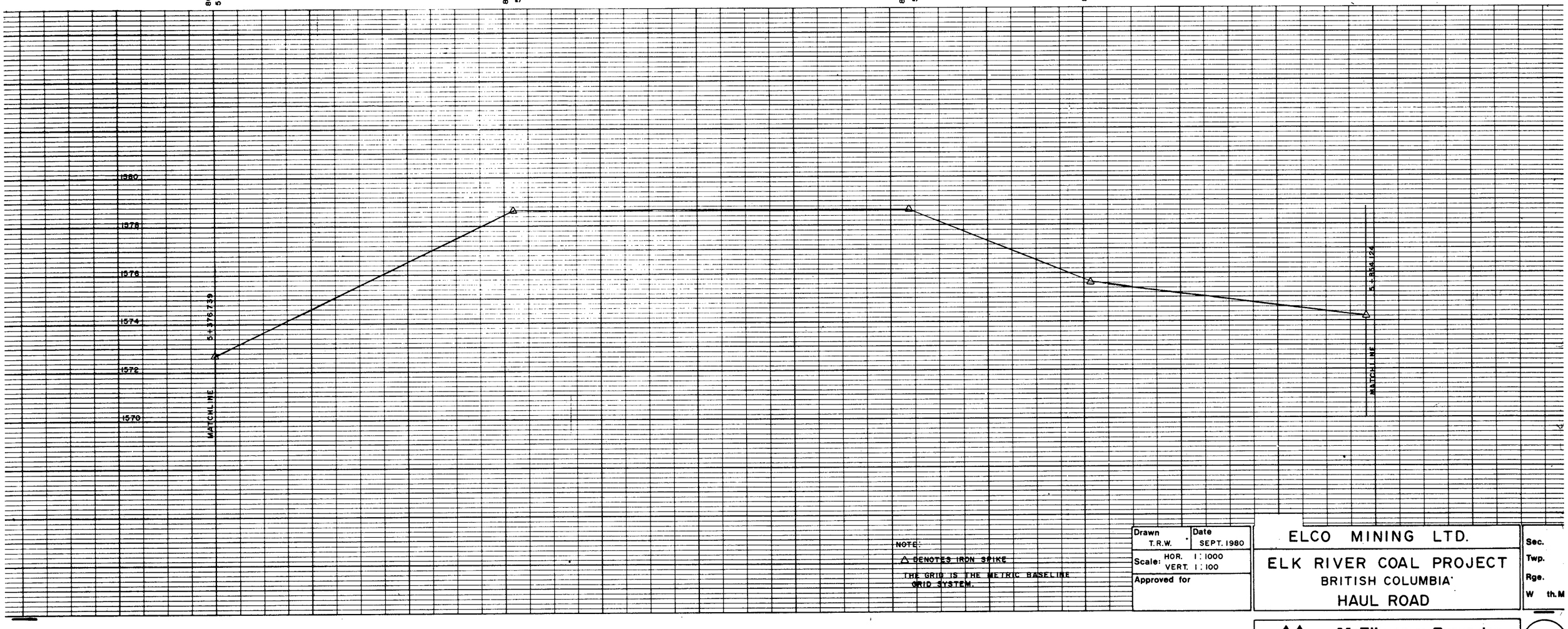
K-Elk River 80(2)A





NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale:	HOR. 1:1000 VERT. 1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

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279

K-Elk River 80(2)19

13100 N

12900 N

12700 N

E 6150

E 5950

N

MATCHLINE 5+854.124

8055

88.444
182° 56' 46"

8039

102.184
182° 57' 14"

8038

86.727
182° 57' 22"

8037

102.111
182° 57' 30"

8054

99.754
182° 57' 30"

8036

6+333.344

MATCHLINE

8055 5+854.124

8039 5+942.568

8038 6+044.752

8037 6+131.479

8054 6+233.590

8036 6+333.344

1578
1576
1574
1572
1570
1568
1566

MATCHLINE 5+854.124

MATCHLINE 6+333.344

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T. R.W.	Date SEPT. 1980
Scale: HOR. 1 : 1000 VERT. 1 : 100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

13 of 19

279

K-ELK River 80(2)A

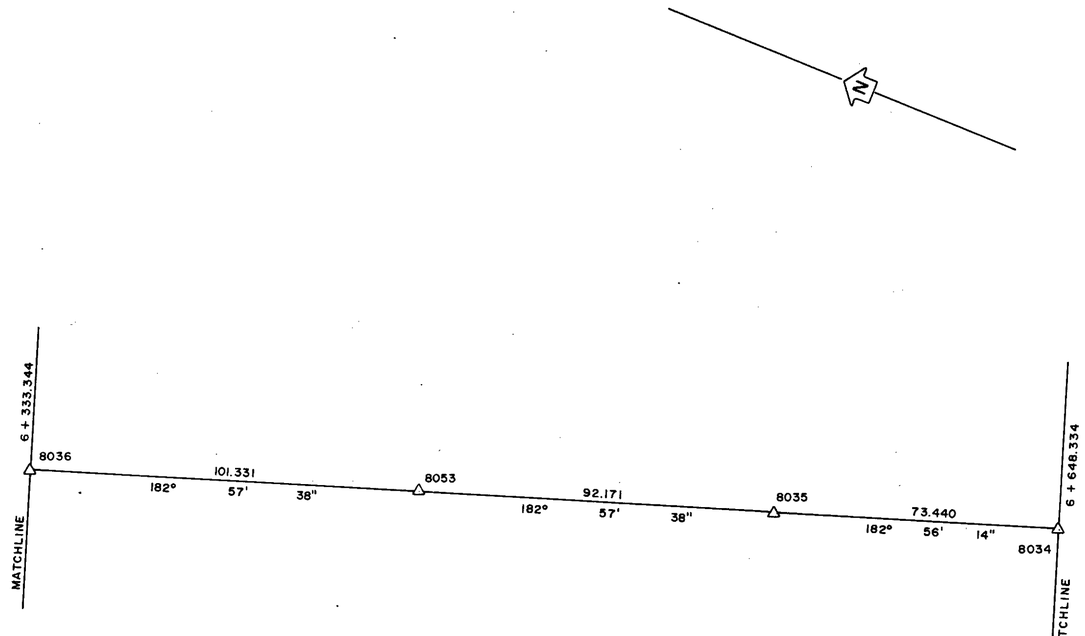
12700 N

12500 N

12300 N

E 6150

E 5950

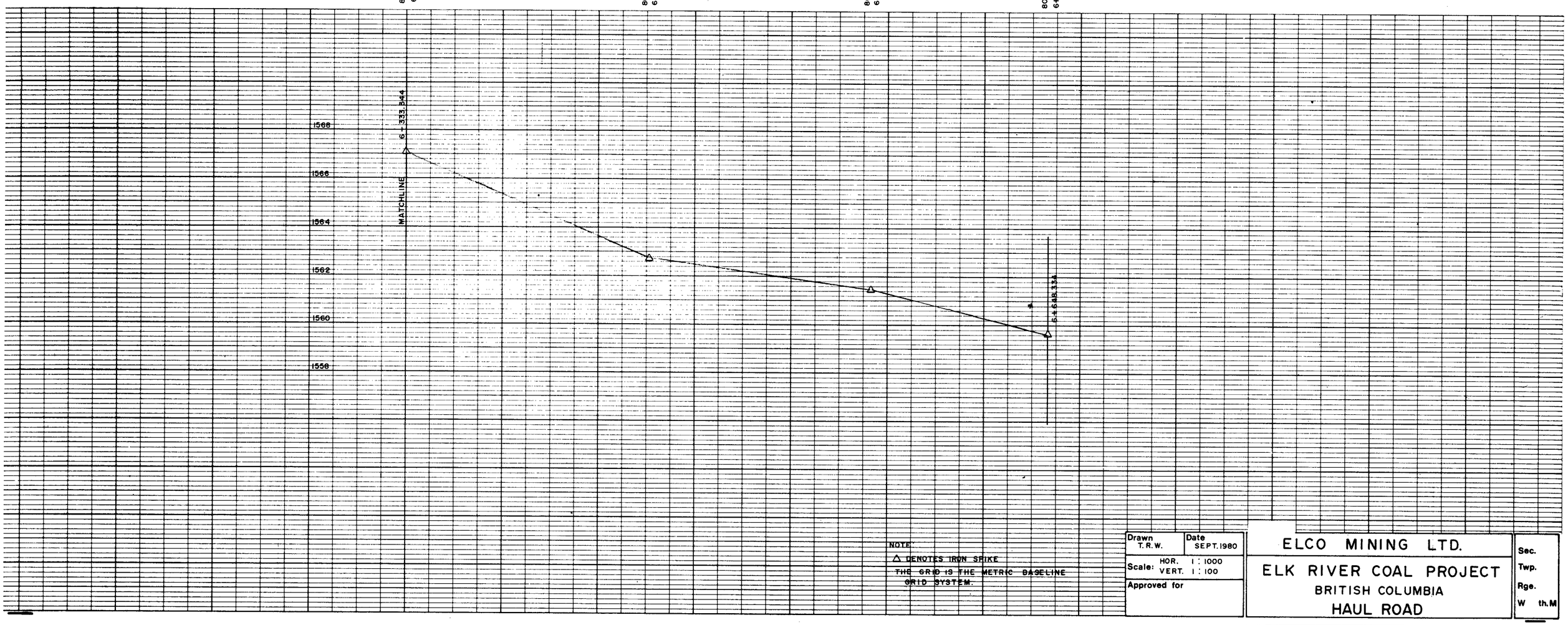


8036 6+333.344

8053 6+434.675

8035 6+526.846

8034 6+648.334



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date SEPT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD

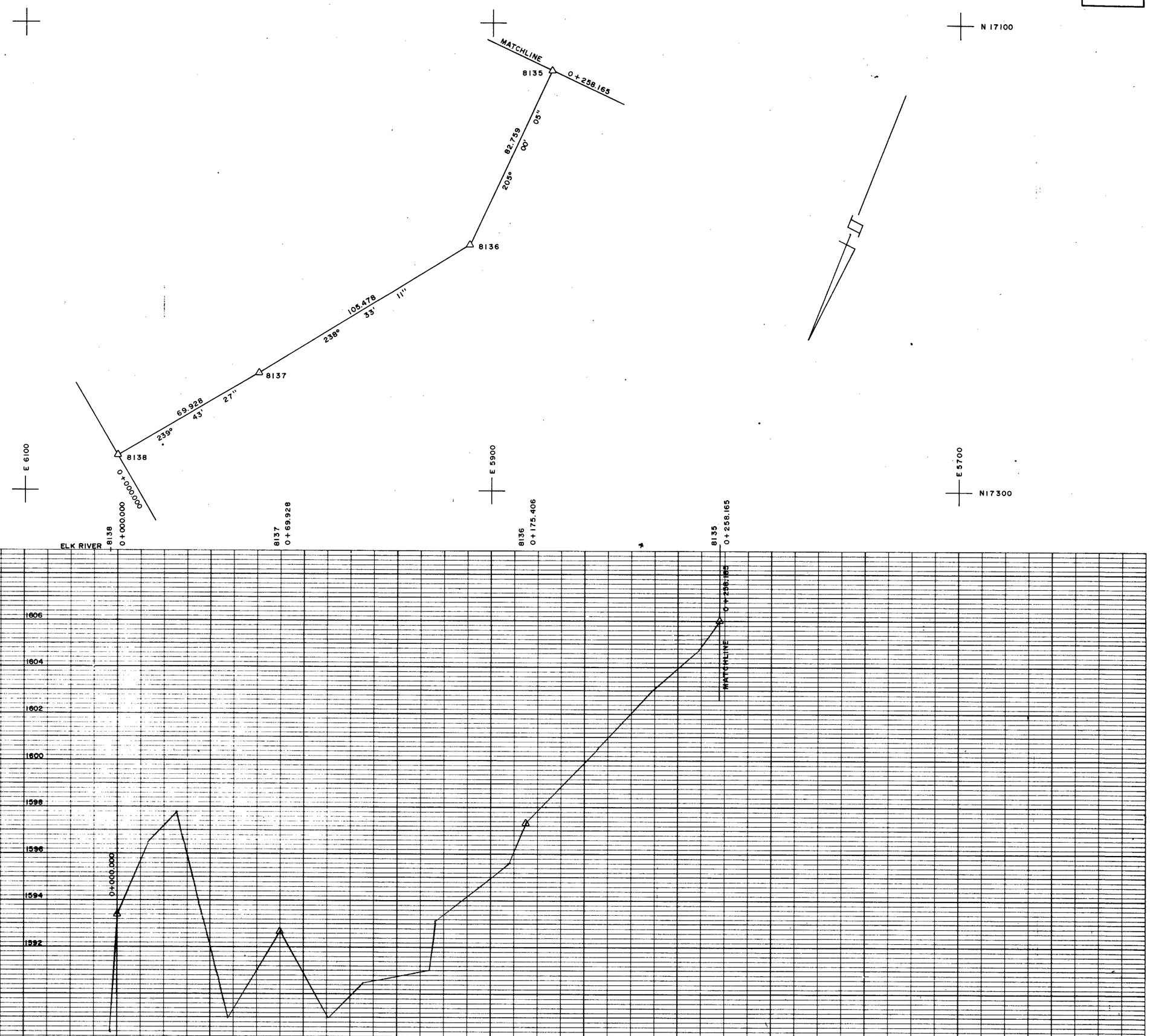
Sec.
Twp.
Rge.
W th.M

279

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

19 of 19

K-Elk River 80(2)A



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W	Date OCT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD CROSSING No. 1

Sec. Twp. Rge. W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

1 of 2

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K-Elk River 80(2)A

Appendix: 3.0-B Sheet 1 of 2

N 16900

E 5900

E 5700

N 17100

8134
0+468.084

79.060
251° 33' 15"

8075

79.677
223° 26' 19"

8134

51.182
223° 26' 19"

8135
0+258.165

MATCHLINE

MATCHLINE

8135
0+258.165

8113
0+309.347

8075
0+389.024

8134
0+468.084

1618
1616
1614
1612
1610
1608
1606
1604

NOTE:
DENOTES IRON SPIKE.

THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR.	1 : 1000
VERT.	1 : 100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD CROSSING No. 1

Sec.
Twp.
Rge.
W th.M

279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

2 of 2

K-Elk River 80(2)A

1 — 1

6100 E

5900 E

5700 E

N 16900

N 17100

8127 0+000.000

8128 38.724 269° 59' 52"

8129 58.565 269° 59' 52"

8130 63.875 269° 59' 52"

8131 83.457 37' 46" 221°

8132 97.167 37' 46" 221°

8133 55.227 47' 57" 264°

8127 0+000.000

8128 0+038.724

8129 0+097.289

ELK RIVER

8130 0+161.164

8131 0+244.621

8132 0+341.788

8133 0+397.015

1616
1614
1612
1610
1608
1606
1604
1602
1600
1598
1596
1594
1592
1590
1588
1586

0+000.000

0+397.015

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn	Date
T.R.W.	OCT. 1980
Scale: HOR: 1:1000 VERT: 1:200	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD CROSSING No. 2

Sec. Twp. Rge. W th. M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

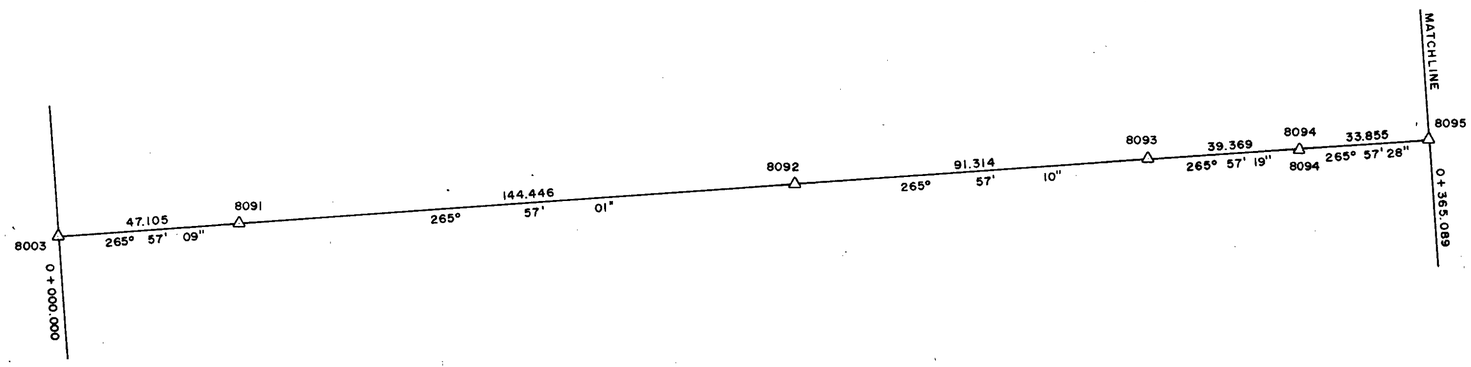
1 of 1

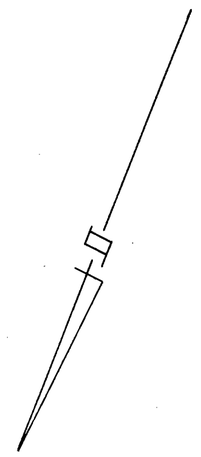
279

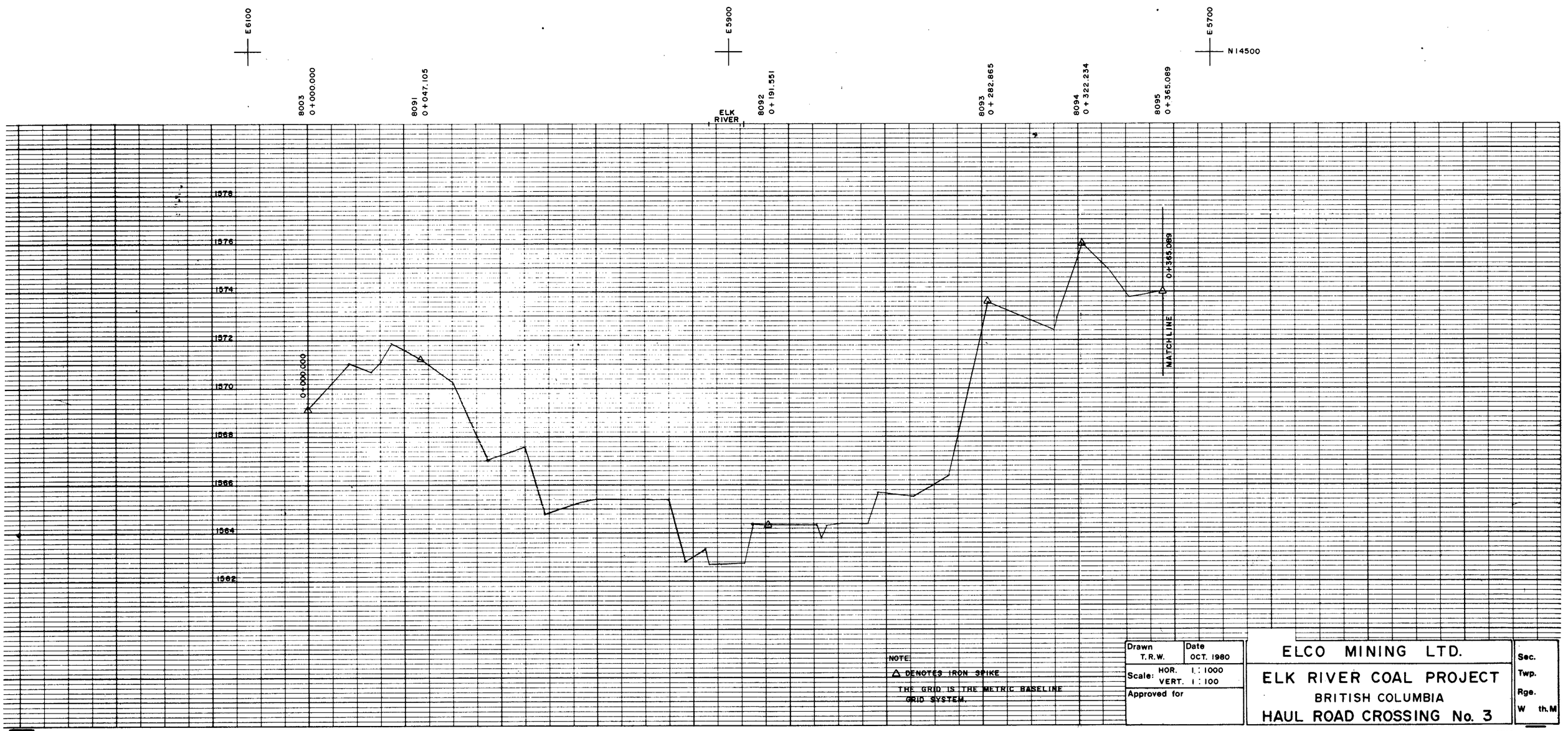
K-Elk River 80(2)A

Appendix: 3.0-C Sheet 1 of 1

1-2







NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR.	1 : 1000
VERT.	1 : 100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

HAUL ROAD CROSSING No. 3

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 2

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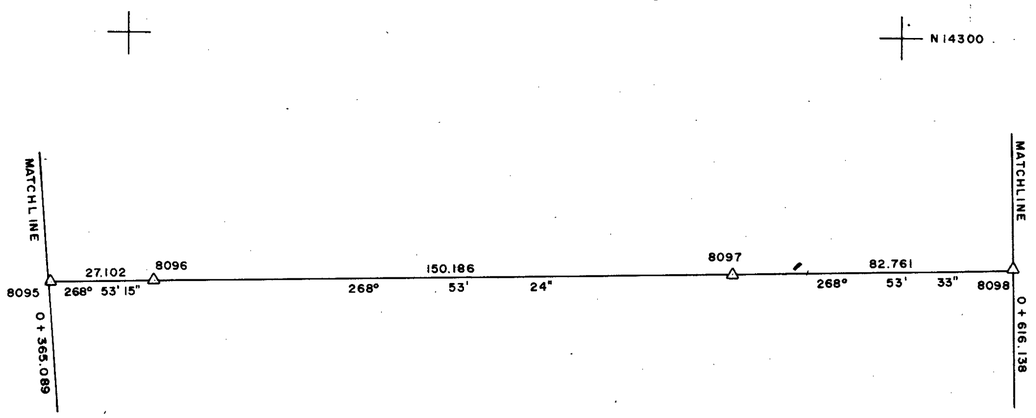
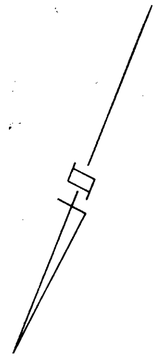
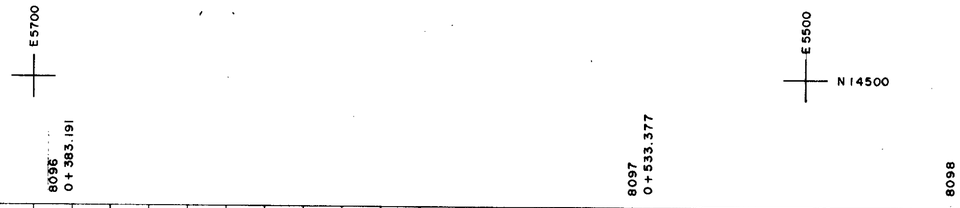
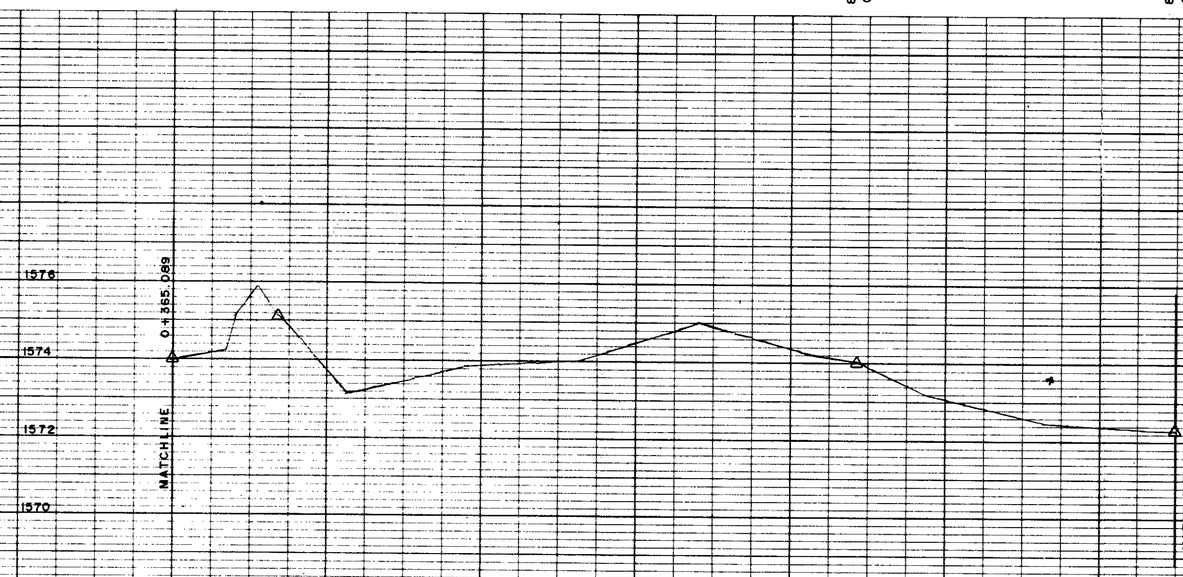
K-Elk River 80(21)A

Appendix; 3.0-D Sheet 1 of 2









NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
HAUL ROAD CROSSING No. 3

Sec.
Twp.
Rge.
W th.M

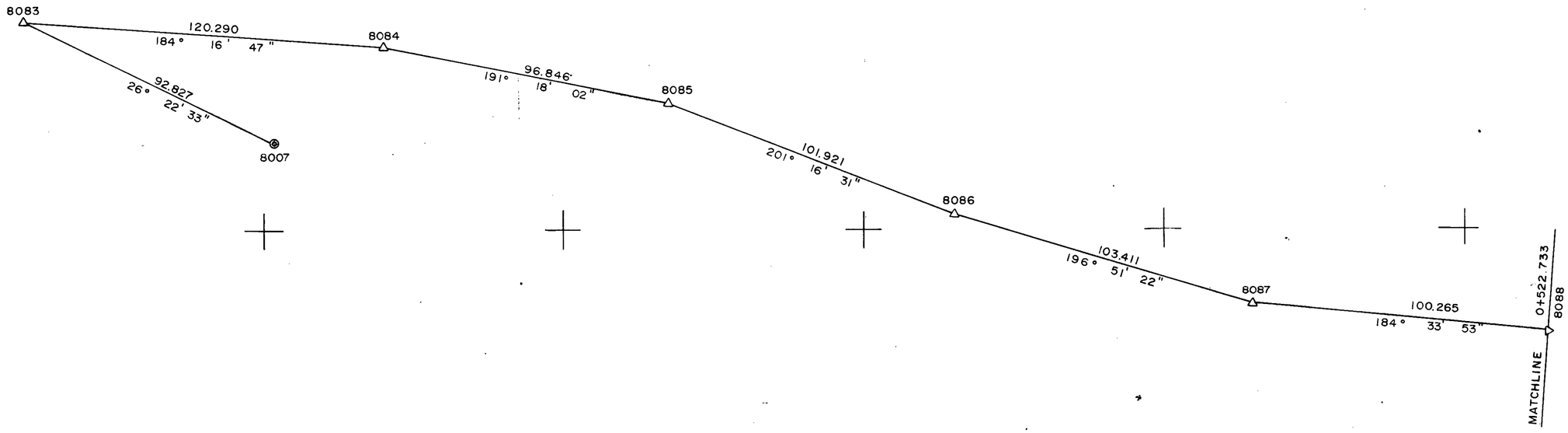
279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

2 of 2

K-Elk River 80(2)A

Appendix: 3.0-D Sheet 2 of 2



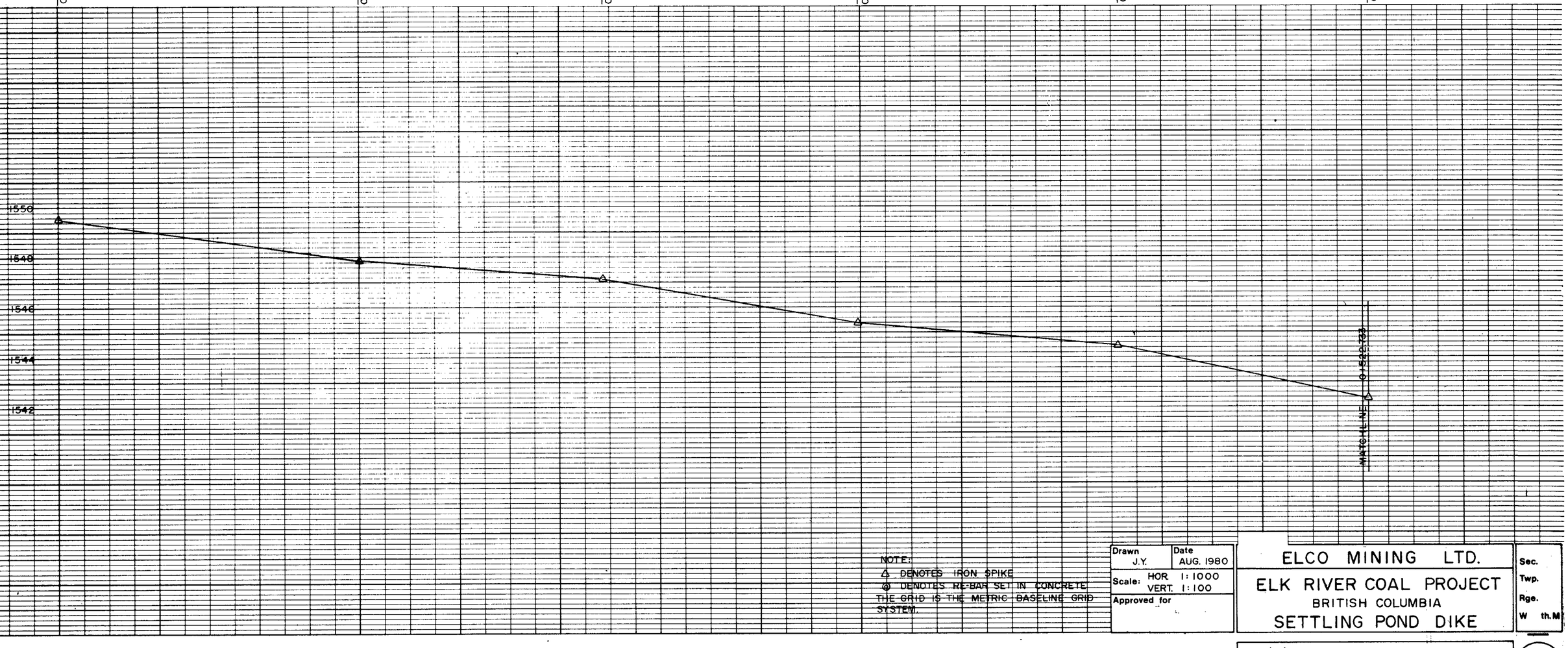
5700 E

5600 E

5500 E

12800 N | 12700 N | 12600 N | 12500 N | 12400 N | 12300 N | 12200 N

8083 0+000.000 | 8084 0+120.290 | 8085 0+217.136 | 8086 0+319.057 | 8087 0+422.468 | 8088 0+522.733



NOTE:
△ DENOTES IRON SPIKE
◎ DENOTES RE-BAR SET IN CONCRETE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn J.Y.	Date AUG. 1980
Scale: HOR 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

SETTLING POND DIKE

Sec. Twp. Rge. W th. M

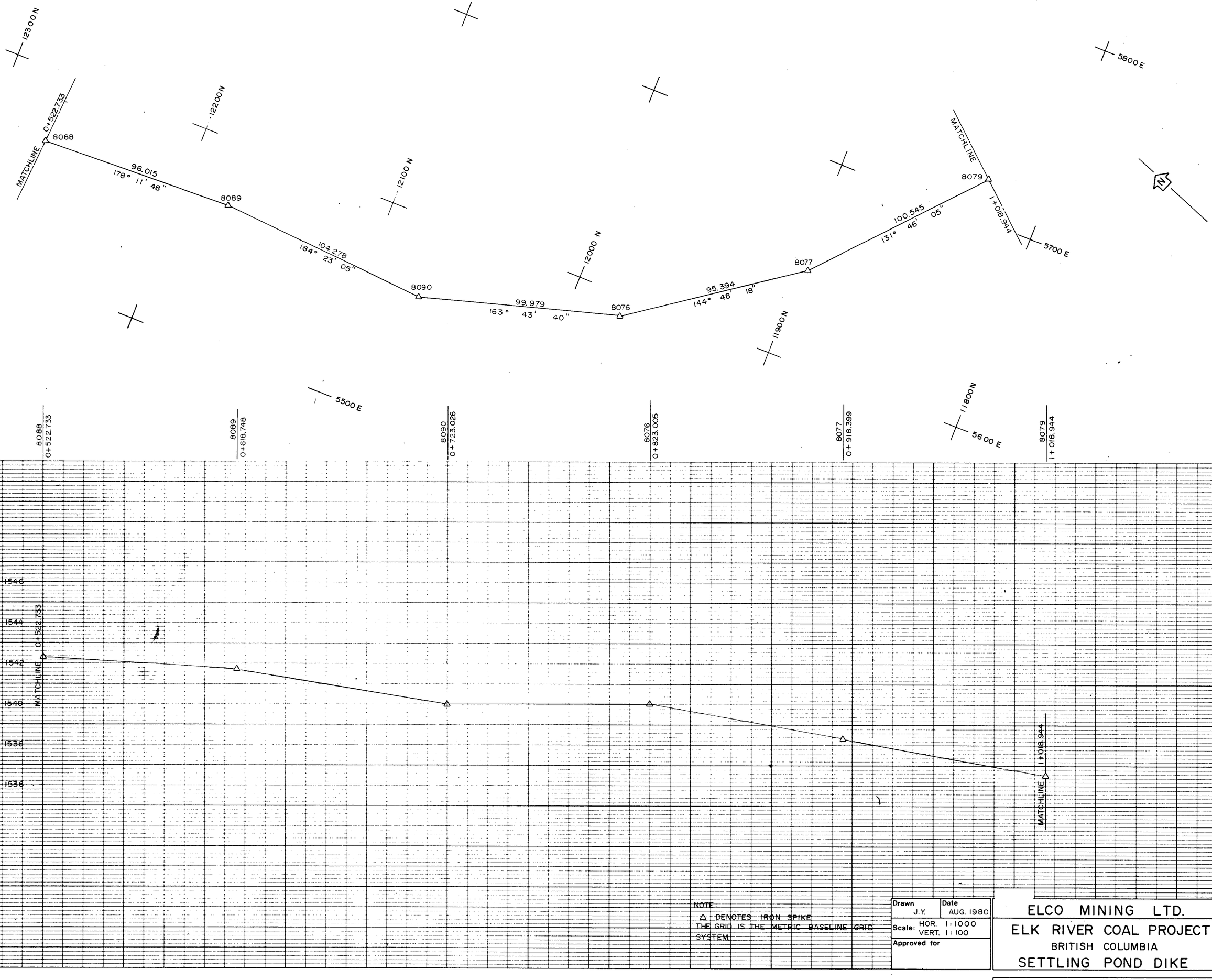
McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 3

279

K-Elk River 80(2)A

Appendix: 3.0-E Sheet 1 of 3



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn J.Y.	Date AUG. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
SETTLING POND DIKE

Sec. Twp. Rge. W th.M

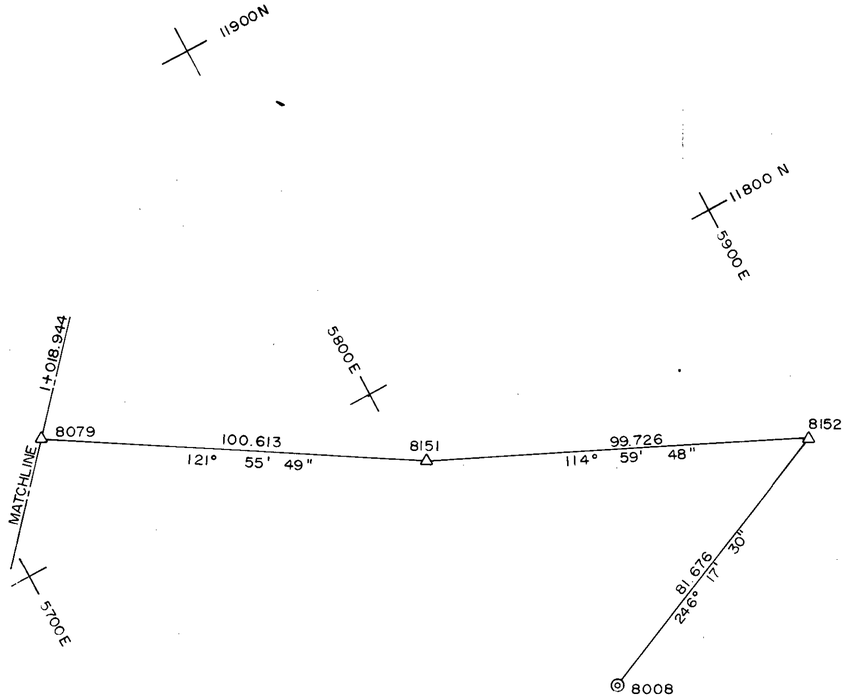
McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

2 of 3

279

M-Elk River 80(21)A

3-3

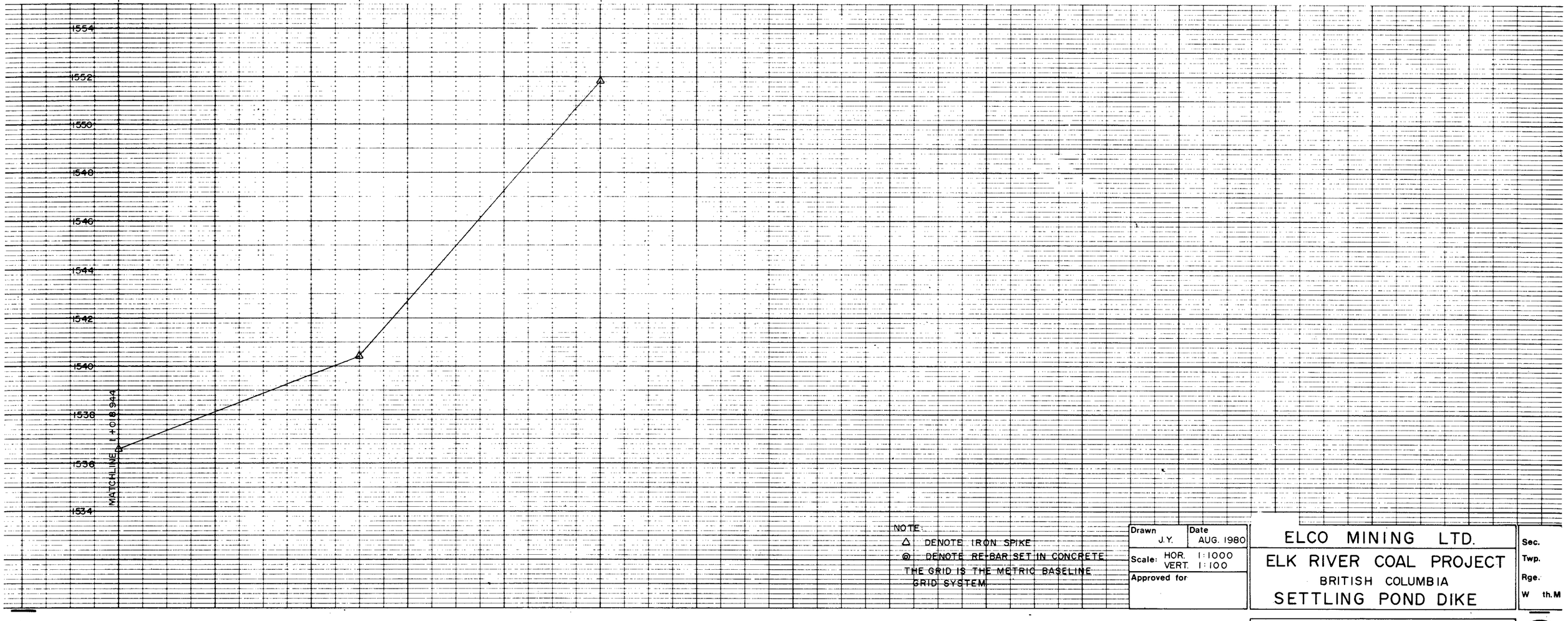


11600N

8079
1+018.944

8151
1+119.607

8152
1+219.333



NOTE:
△ DENOTE IRON SPIKE
◎ DENOTE RE-BAR SET IN CONCRETE.
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn J.Y.	Date AUG. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
SETTLING POND DIKE

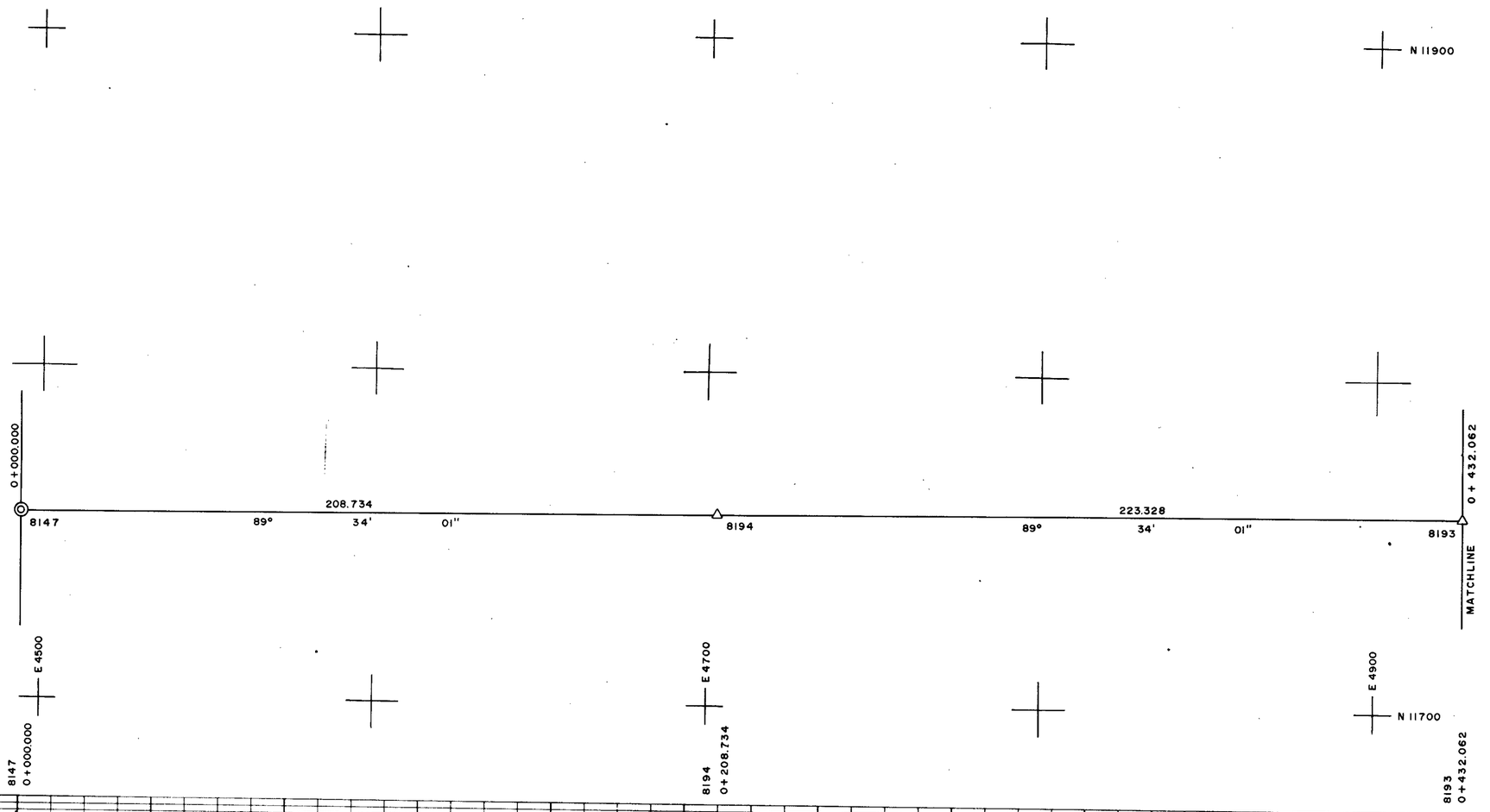
Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

3 of 3

279

K-ELK River 8(2)A



⊙ DENOTES RE-BAR SET IN CONCRETE
△ DENOTES IRON SPIKE

THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR.	1 : 1000
VERT.	1 : 100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 7

279

K-Elk River 80(9)A

2-7

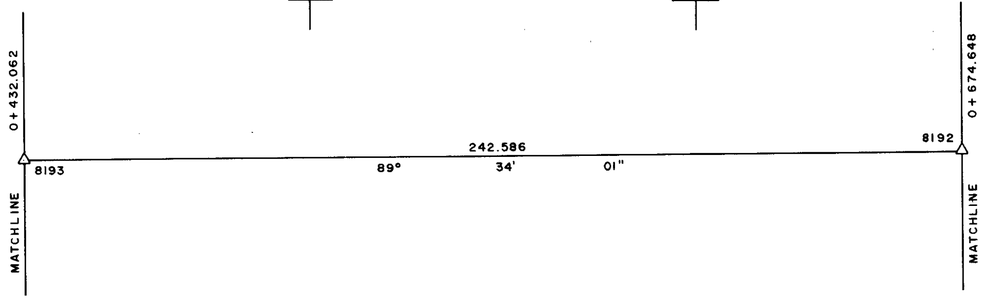
N 11900

E 4900

E 5100

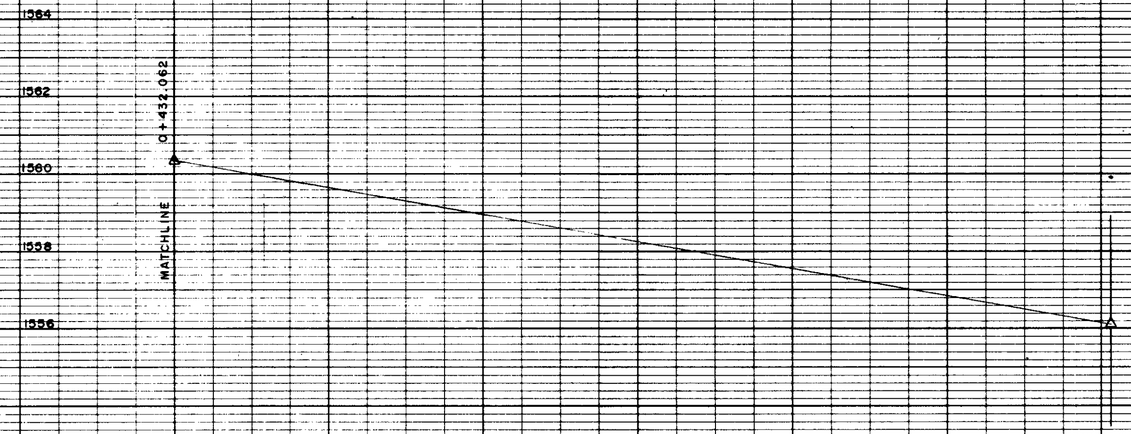
E 5300

N 11700



8193
0+432.062

8192
0+674.648



NOTE:
△ DENOTES IRON SPIKE.
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T. R. W.	Date OCT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

Sec. -
Twp.
Rge.
W th.M

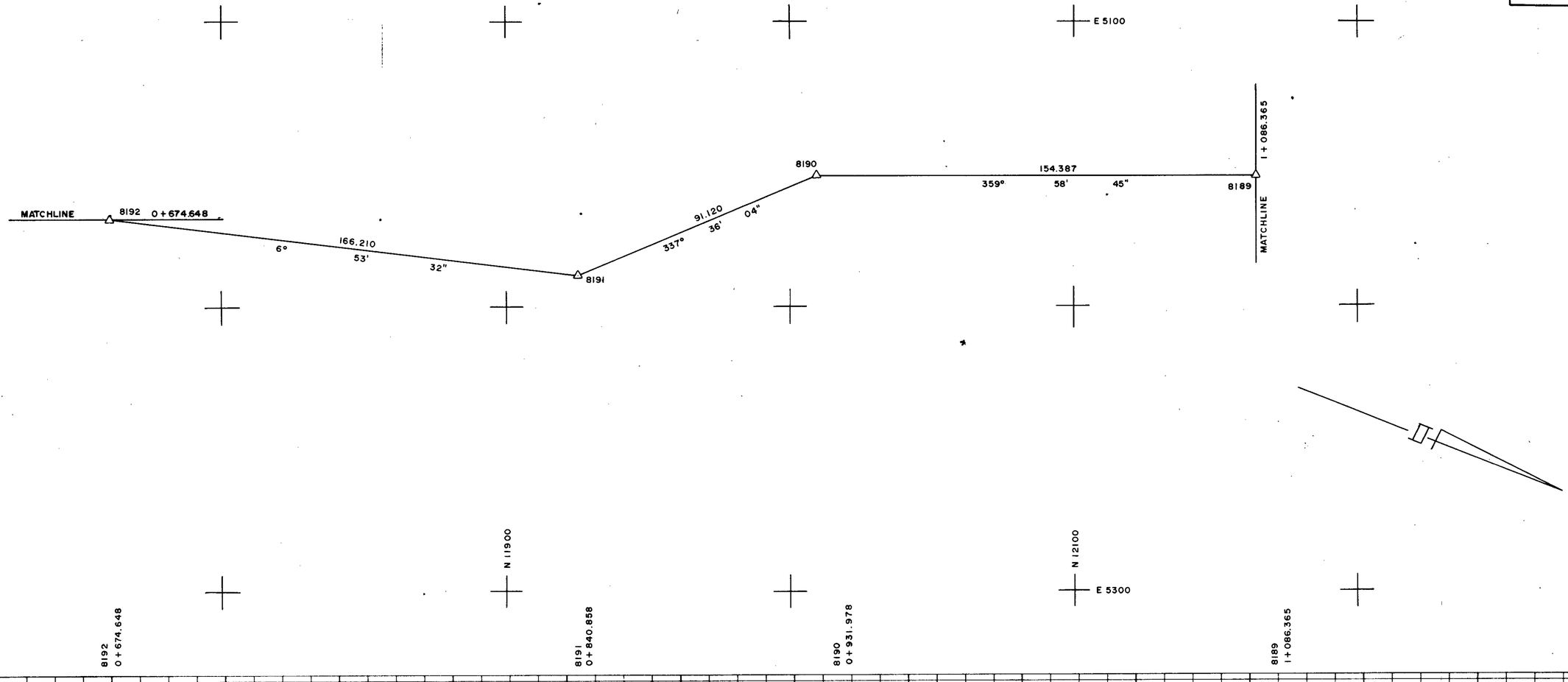
McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

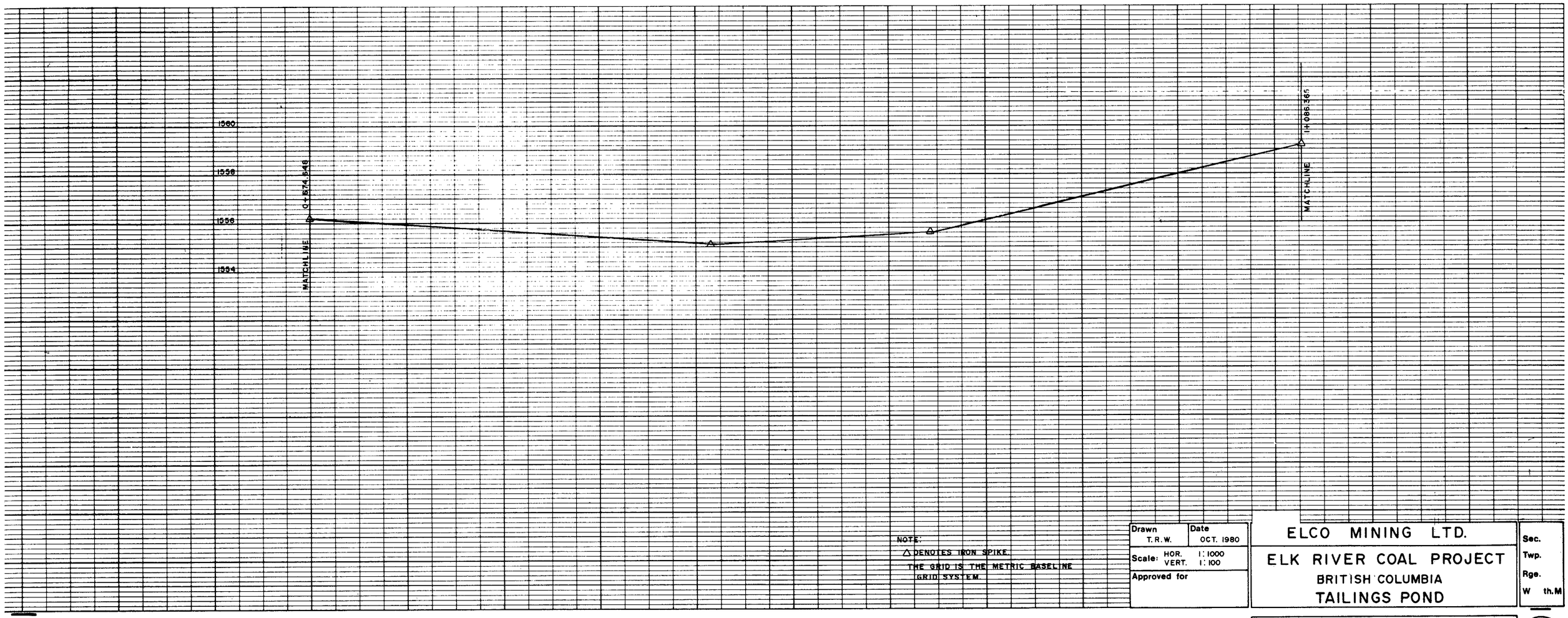
2 of 7

279

K-Elk River 8(21A

Appendix: 3.0-F Sheet 2 of 7





NOTE:
△ DENOTES IRON SPIKE.
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
TAILINGS POND

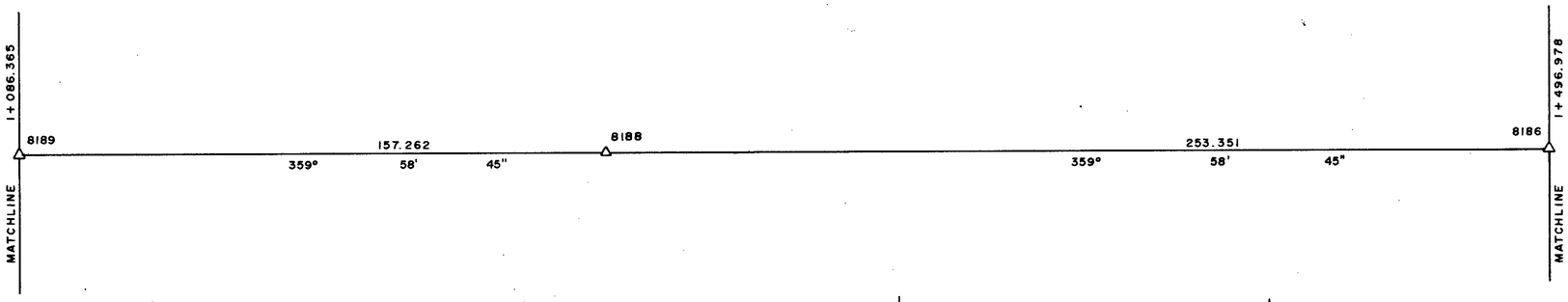
Sec.
Twp.
Rge.
W th.M

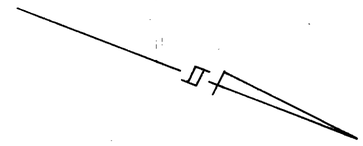
McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

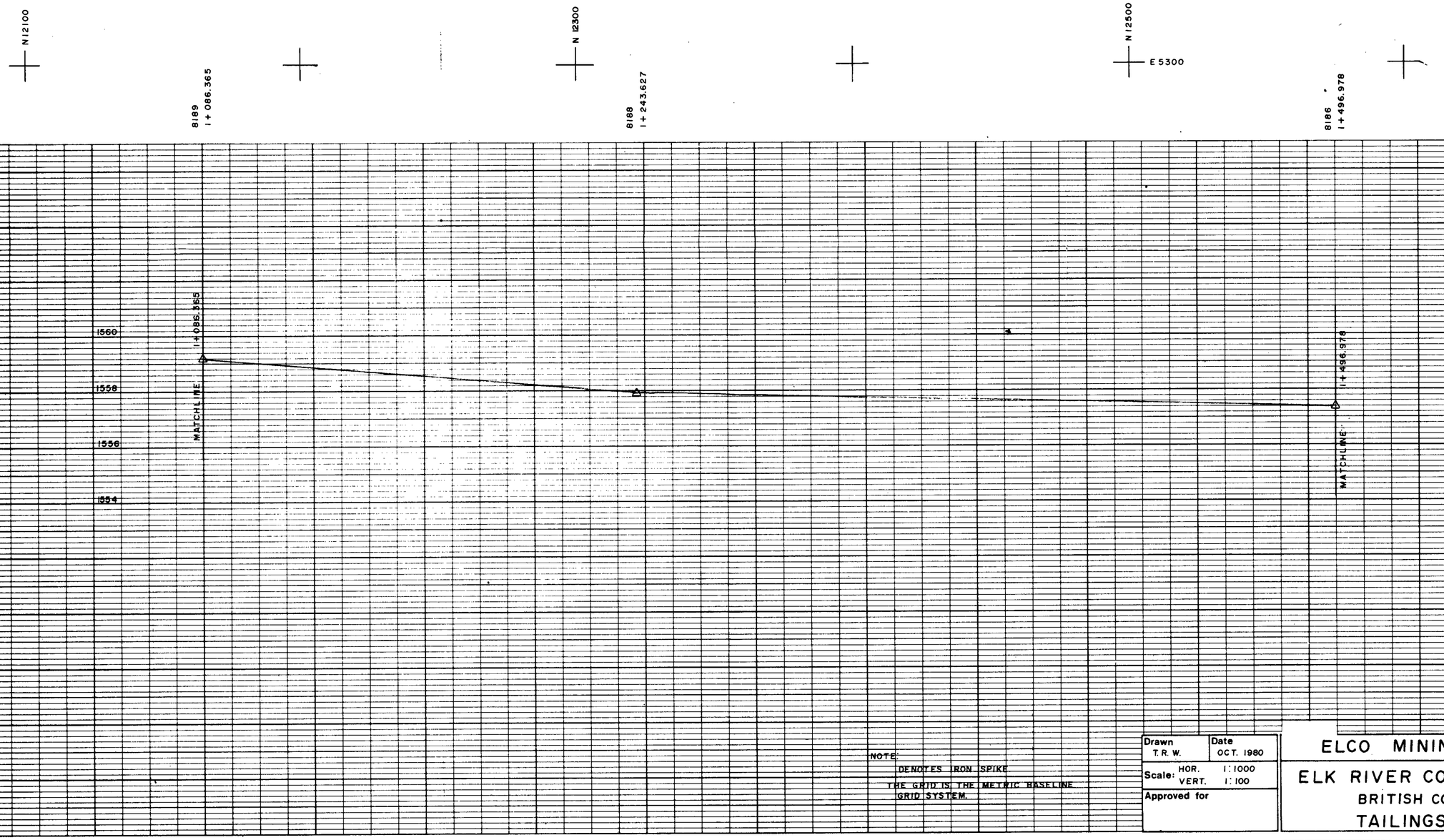
3 of 7

279

K-Elk River 80(2)A







NOTE:
DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T. R. W.	Date OCT. 1980
Scale: HOR.	1:1000
VERT.	1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

4 of 7

279

K-Elk River 80(2)A

E 5100

E 5200

E 5300

N 12500

N 12700

MATCHLINE 1+496.978

8186

46° 37' 00" 123.790

8187

20° 32' 03" 98.868

8139

20° 32' 03" 47.115

8140

MATCHLINE 1+766.751

8186 1+496.978

8187 1+620.768

8139 1+719.636

8140 1+766.751

1562

1560

1558

1556

MATCHLINE 1+496.978

MATCHLINE 1+766.751

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T. R. W.	Date OCT. 1980
Scale: HOR.	1:1000
VERT.	1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

Sec. Twp. Rge. W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

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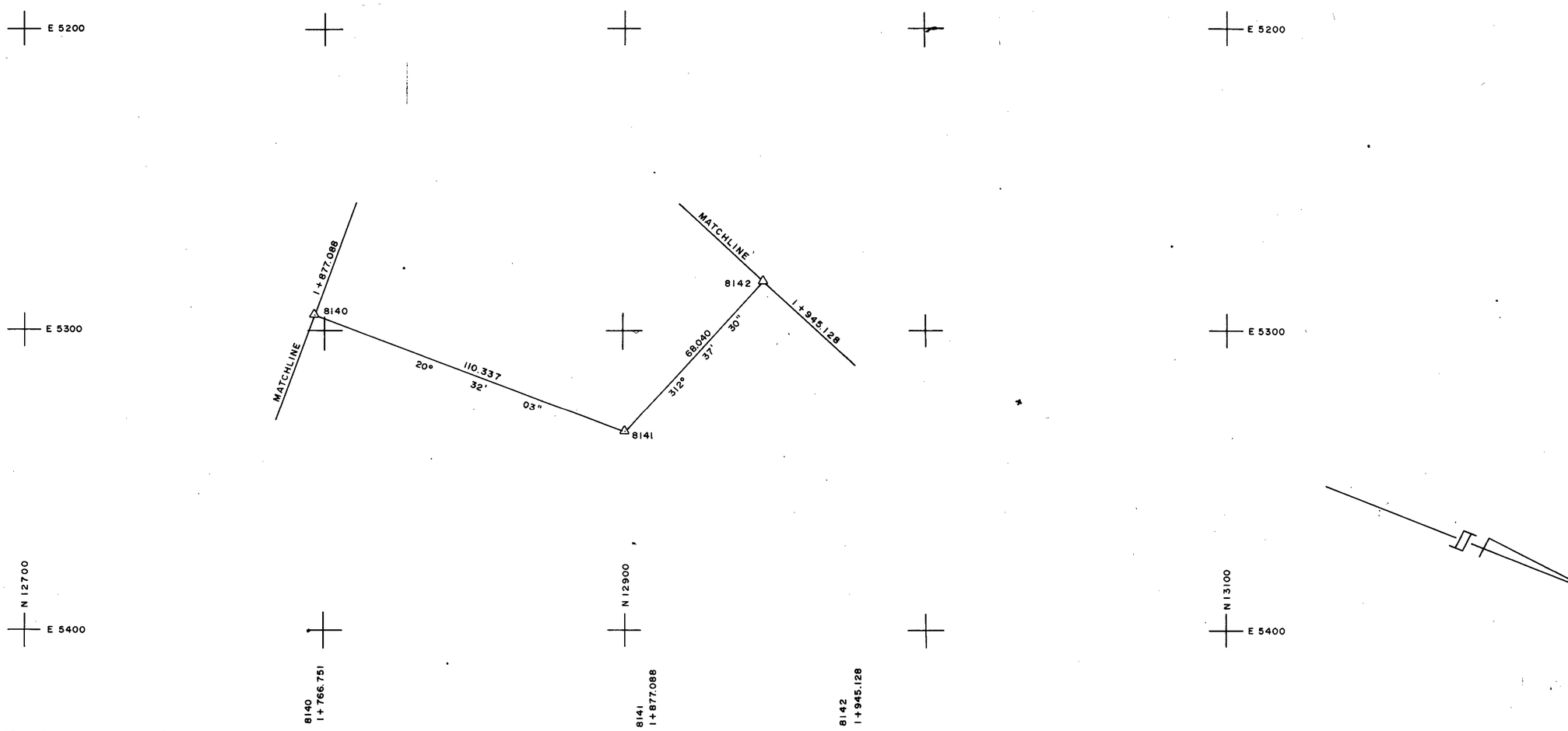
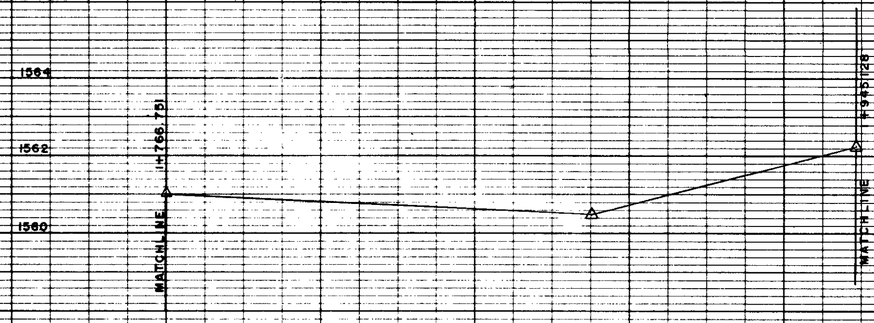
279

K-Elk River 60(2)A





NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T.R.W.	Date OCT. 1980
Scale:	HOR. 1 : 1000 VERT. 1 : 100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

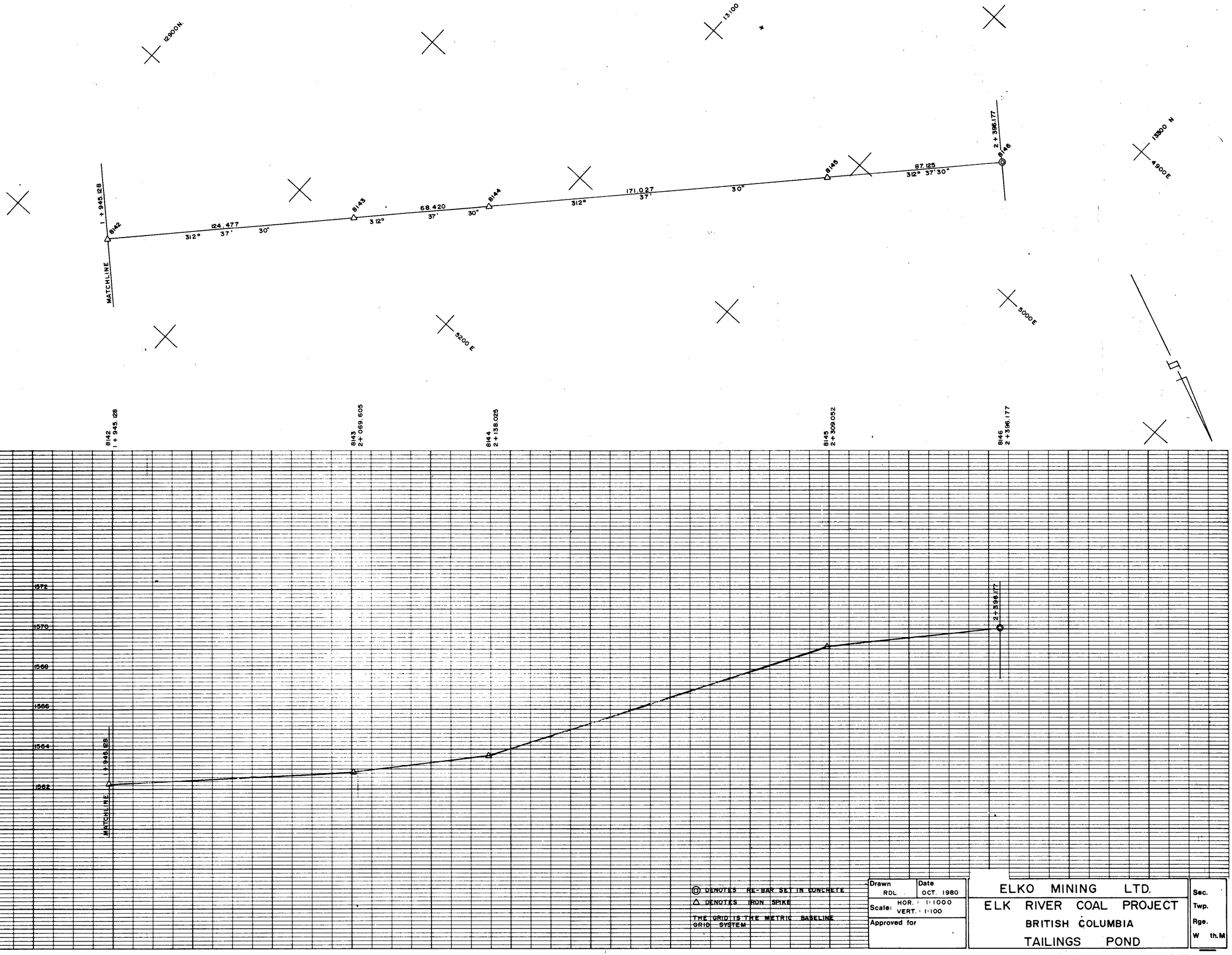
Sec. Twp. Rge. W th. M

279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

6 of 7

K-Elk River 8062A



⊚ DENOTES RE-BAR SET IN CONCRETE

△ DENOTES IRON SPIKE

THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn RDL	Date OCT. 1980
Scale:	HOR. : 1:1000 VERT. : 1:100
Approved for	

ELKO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

TAILINGS POND

Sec. Twp. Rge. W th. M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

7 of 7

279

K-Elk River 80(a)A

1-1

17300 N.

17200 N.

17100N.

6000 E.

2° 32' 41"
90.089

6100 E.

ELK RIVER

1598

1596

1594

1592

1590

1588

1586

Drawn RDL	Date OCT., 1980
Scale: HOR.: 1 : 1000 VERT.: 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

RIVER DIVERSION DAM # 1

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 1

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K-Elk River 8(2)A

Appendix: 3.0-G Sheet 1 of 1

1-1

17000 N.

16900N.

16800N.

6100 E

6000 E

3° 55' 06"
73.171

ELK RIVER

1588

1586

1584

1582

Drawn RDL.	Date OCT. 1980
Scale:	HOR.: 1:1000 VERT.: 1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

RIVER DIVERSION DAM #2

Sec.
Twp.
Rge.
W th. M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

1 of 1

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K-Elk River 80(2)A

Appendix: 3.0-H Sheet 1 of 1

I—I

6100 E

6000 E.

111.381
355° 15' 43"

5900 E

1530 N.

1520 N.

1510 N.

ELK RIVER

1578
1576
1574
1572
1570
1568

Drawn RDL.	Date OCT., 1980
Scale:	HOR.: 1:1000 VERT.: 1:100
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
RIVER DIVERSION DAM #3

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 1

279

B-Elk River 82G/1A

14300 N

14200 N

14100 N

14000 N

6100E

359° 21' 09"
177.011

6000E

ELK RIVER

1568

1566

1564

1562

1560

1558

Drawn RDL	Date OCT., 1980
Scale:	HOR.: 1:1000 VERT.: 1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

RIVER DIVERSION DAM #4

Sec.
Twp.
Rge.
W th. M

279

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

1 of 1

K-Elk River 8(2)A

1-1

13600N

13500N.

13400 N.

6000 E

0° 37' 07"
103.756

5900E.

ELK RIVER

1572
1570
1568
1566
1564
1562
1560
1558
1556
1554

Drawn RDL.	Date OCT., 1980
Scale:	HOR. 1:1000 VERT. 1:100
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
RIVER DIVERSION DAM #5

Sec.
Twp.
Rge.
W th.M

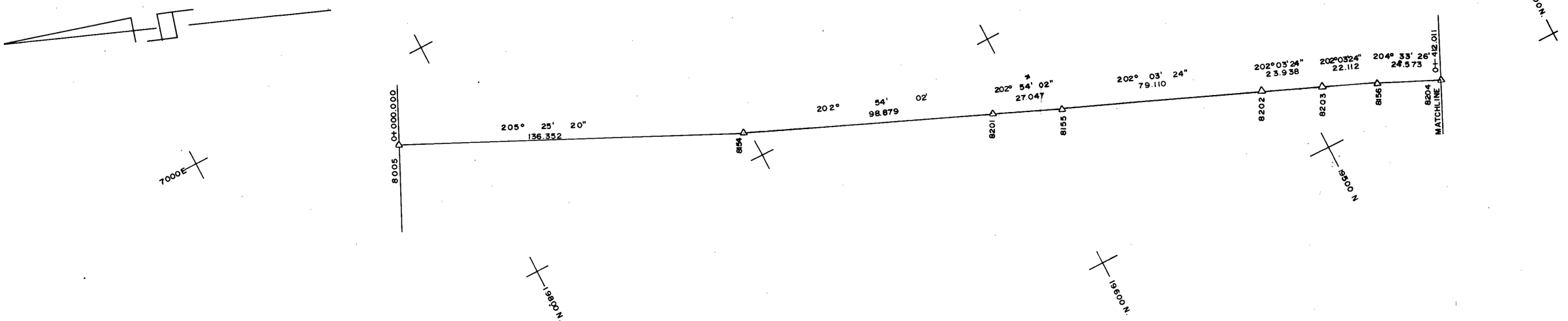
McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

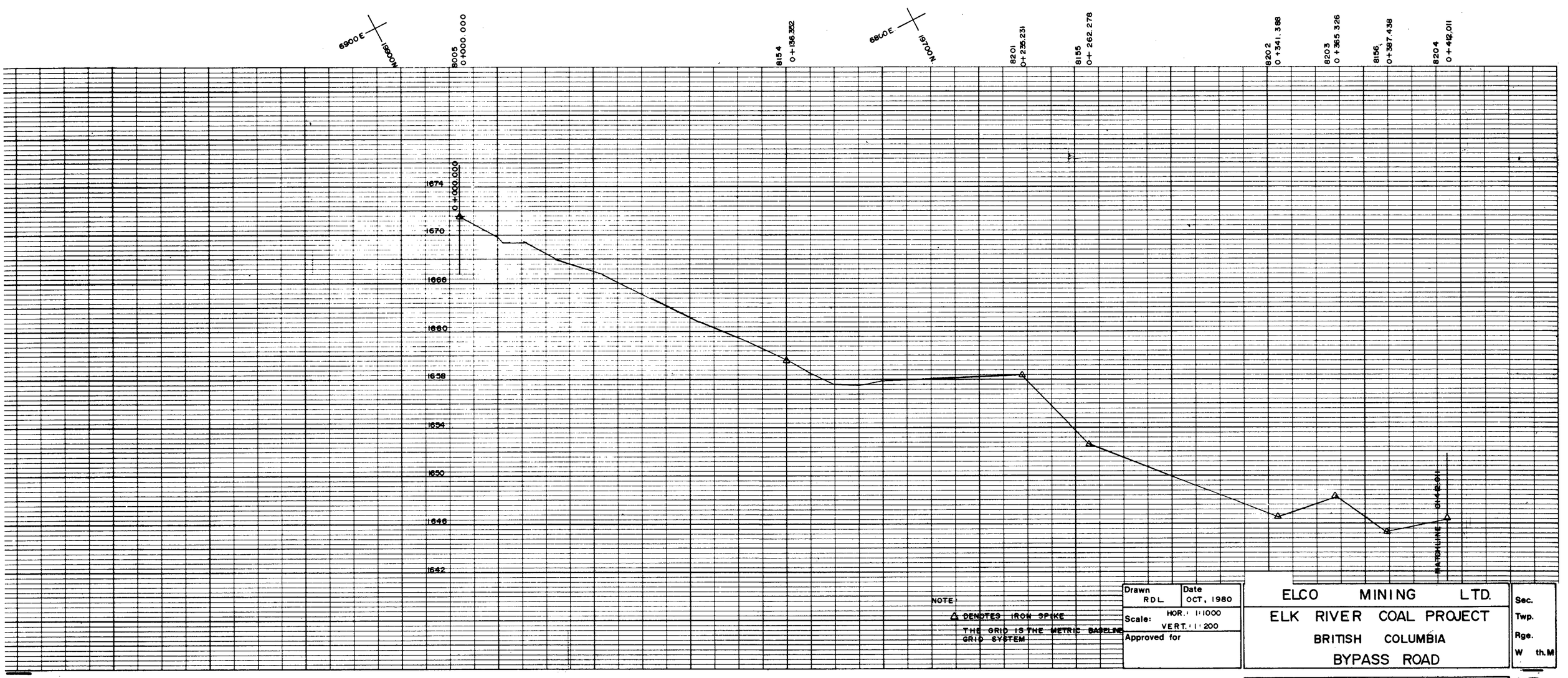
1 of 1

279

K-Elk River 80(2)A

Appendix: 3.0-K Sheet 1 of 1





NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn RDL	Date OCT, 1980
Scale:	HOR.: 1:1000 VERT.: 1:200
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
BYPASS ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

1 of 5

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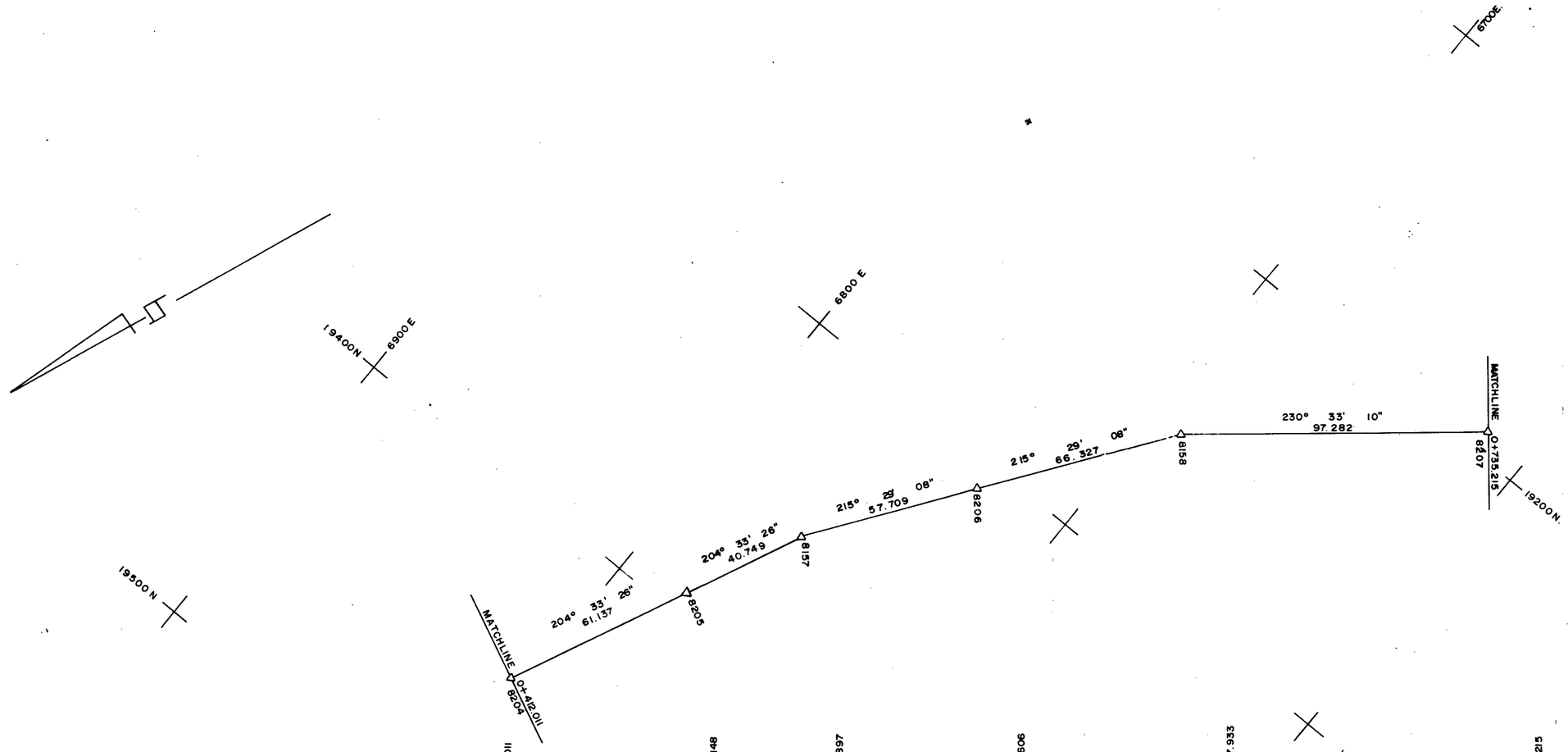
K-Elk River 60(21A



NOTE

△ DENOTES IRON SPIKE

THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn RDL	Date OCT., 1980
Scale: HOR. 1:1000 VERT. 1:200	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

BYPASS ROAD

Sec.
Twp.
Rge.
W th.M

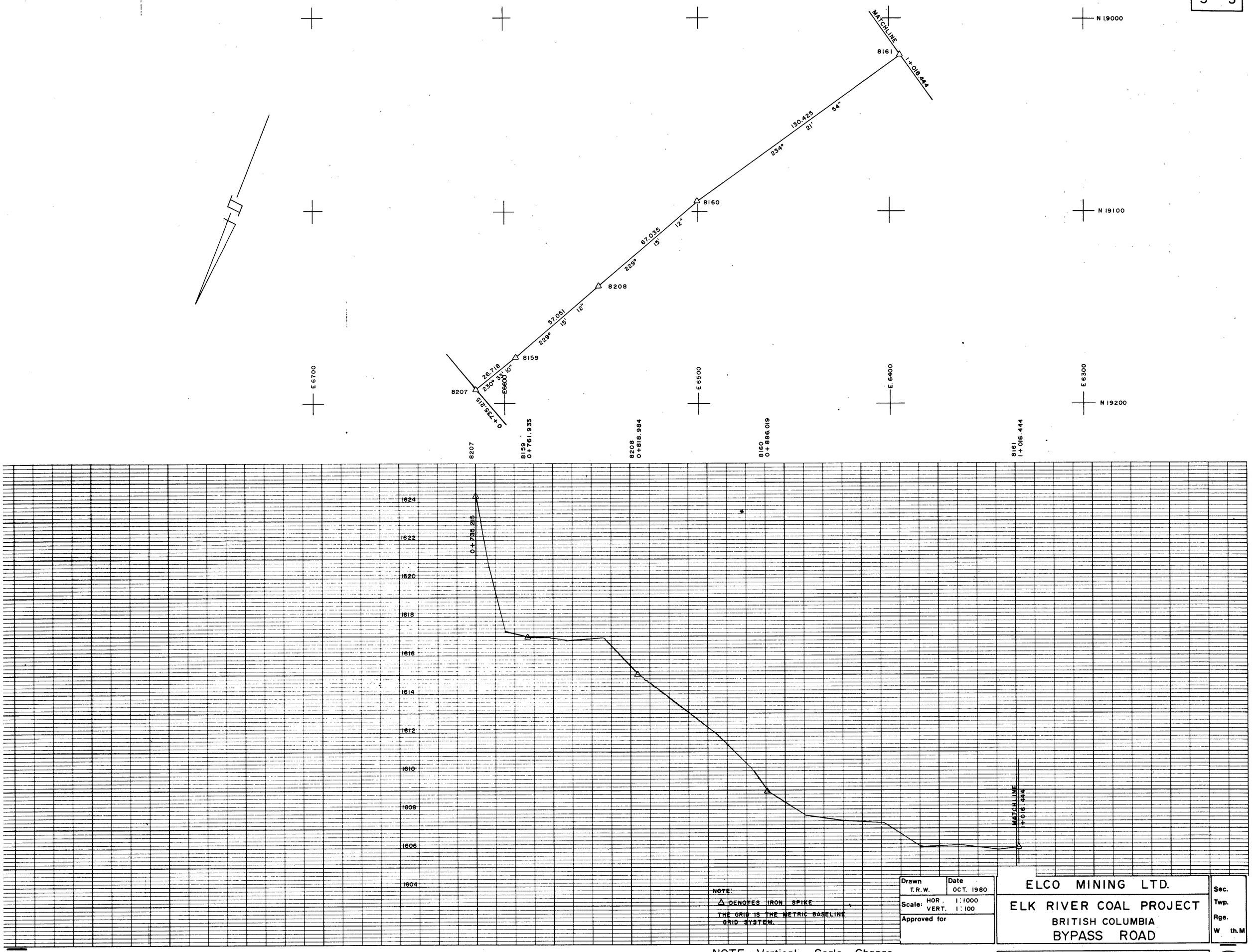
NOTE: Vertical Scale Change Between Sheet 2 And 3

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

2of5

279

K-Elk River 80(a)1A



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR.	1:1000
VERT.	1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT
BRITISH COLUMBIA
BYPASS ROAD

Sec.
Twp.
Rge.
W th.M

NOTE : Vertical Scale Change Between Sheet 2 And 3

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

3 of 5

279

K-Elk River 80(2)A

4 – 5

N 18900

18900 N

N 19000

19000 N

N 19100

19100 N

E 6500

E 6400

E 6300

E 6200

E 6100

E 6000

E 5900

8161
1+016.444

8162
1+111.022

8163
1+174.091

8164
1+253.111

8209
1+292.702

8165
1+380.500

MATCHLINE 1+016.444

8161

94.578
250° 13' 46"

8162

63.069
267° 16' 48"

8163

79.020
281° 26' 48"

8164

39.591
292° 08' 28"

8209

67.798
292° 08' 28"

8165

MATCHLINE 1+380.500

1624
1622
1620
1618
1616
1614
1612
1610
1608
1606
1604

MATCHLINE 1+016.444

MATCHLINE 1+380.500

NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM

Drawn T.R.W.	Date OCT. 1980
Scale: HOR.	1:1000
VERT.	1:100
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

BYPASS ROAD

Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450 – 999 – 8th STREET S.W. CALGARY.

4 of 5

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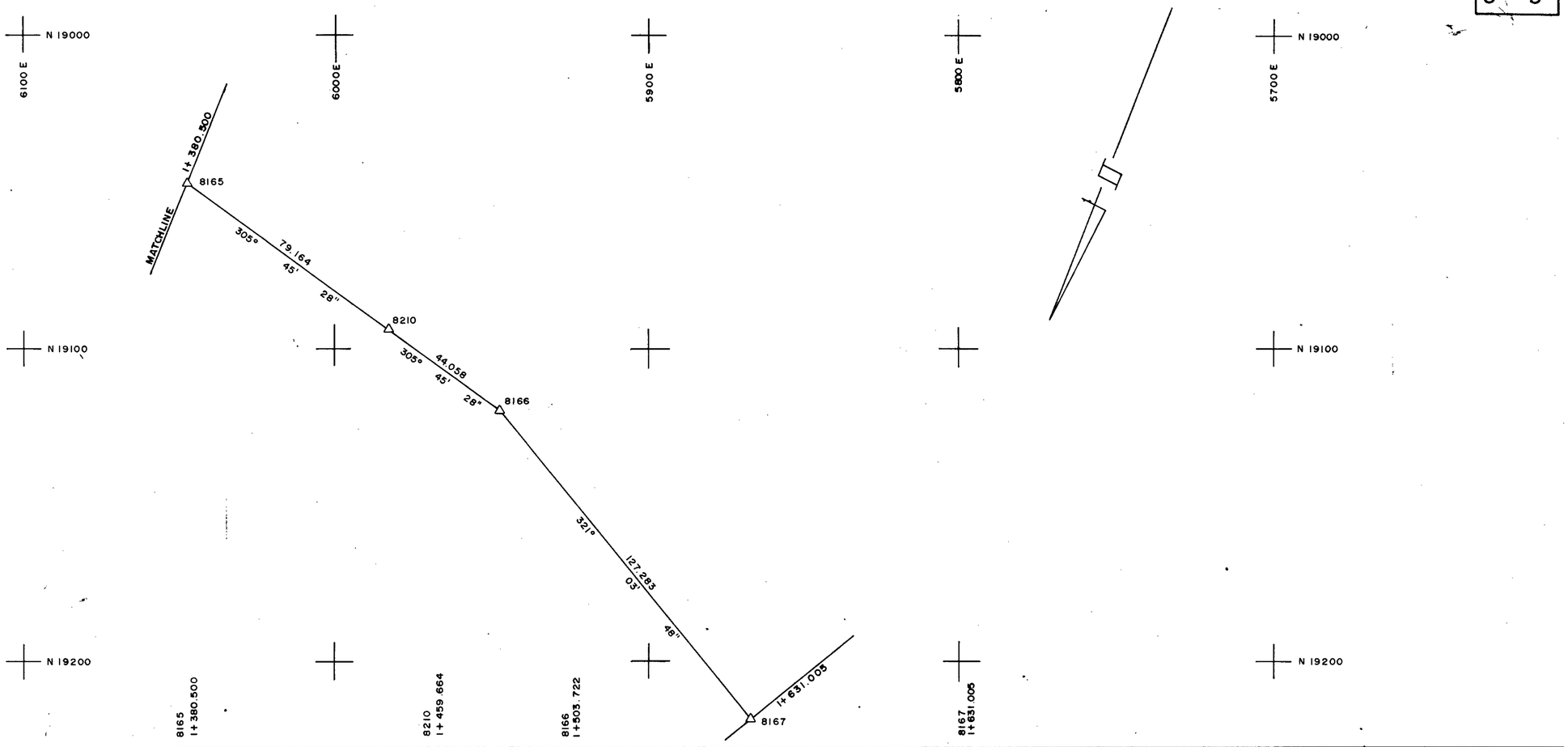
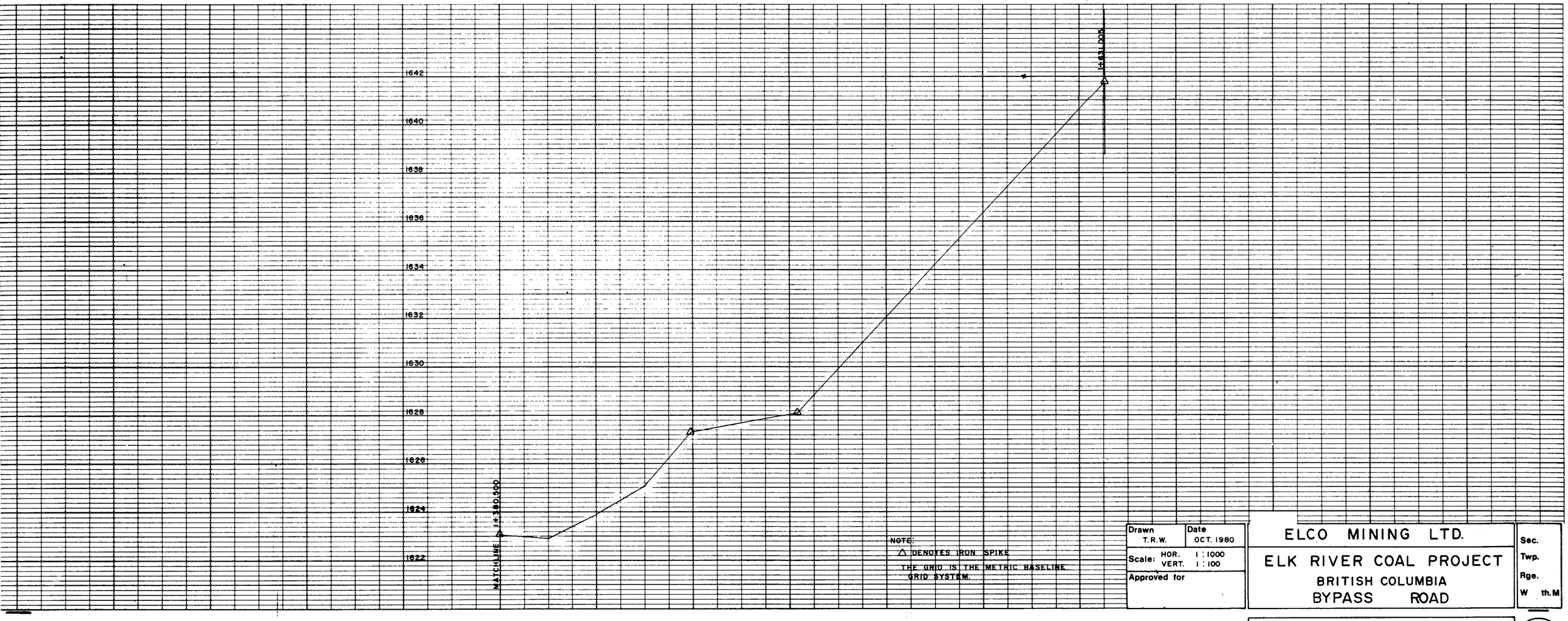
K-Elk River 6(2)A

Appendix: 3.0-L Sheet 4 of 5





NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASELINE GRID SYSTEM.

Drawn T.R.W.	Date OCT. 1980
Scale: HOR. 1:1000 VERT. 1:100	
Approved for	

ELCO MINING LTD.

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

BYPASS ROAD

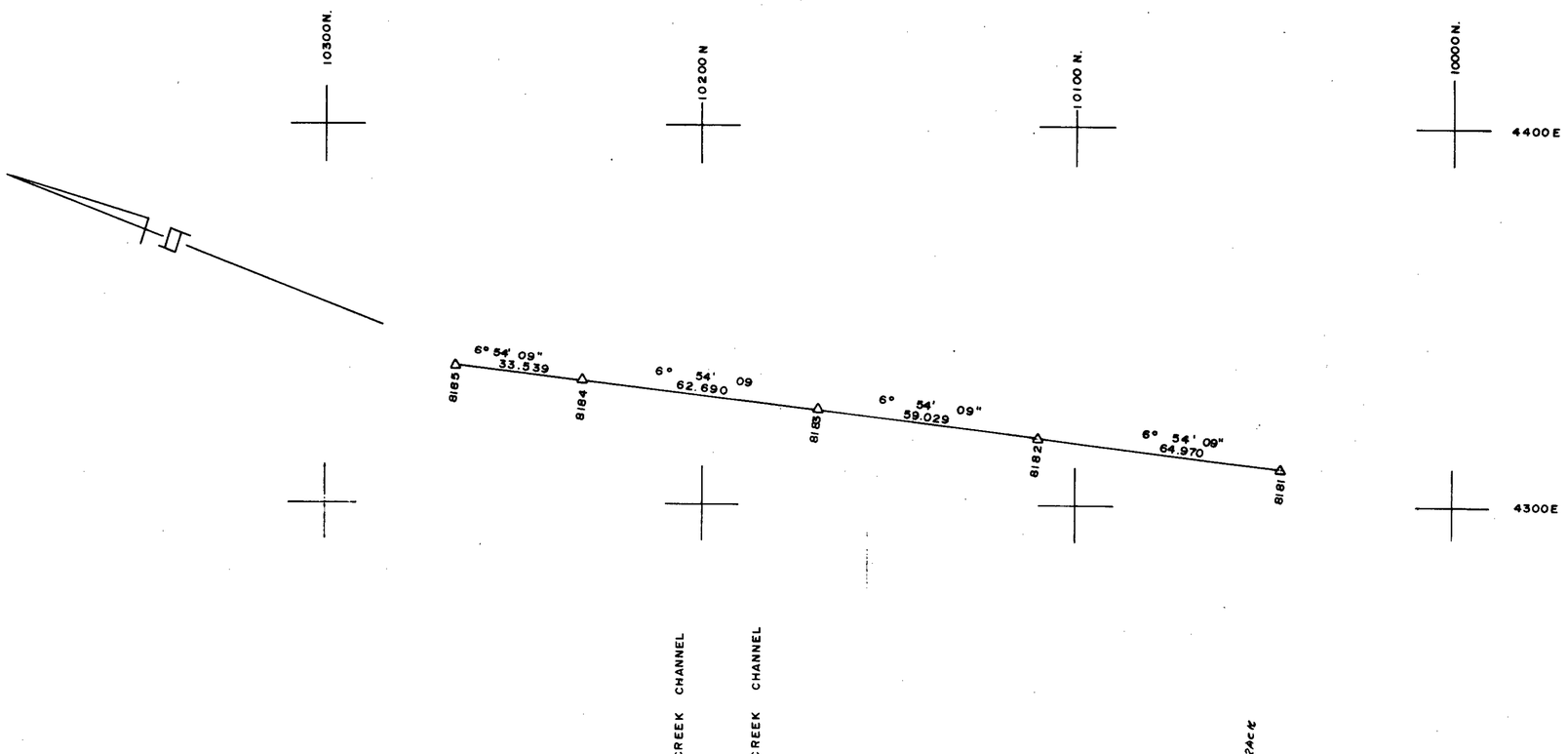
Sec. Twp. Rge. W th. M

McElhanney Surveying & Engineering Ltd.
450 - 999 - 8th STREET S.W. CALGARY.

5 of 5

279

K-Elk River 60(2)A



NOTE:
△ DENOTES IRON SPIKE
THE GRID IS THE METRIC BASE LINE GRID SYSTEM

Drawn RDL	Date OCT., 1980
Scale: HOR. = 1:1000 VERT. = 1:200	
Approved for	

ELCO MINING LTD.
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
BLEASDELL CREEK CROSSING

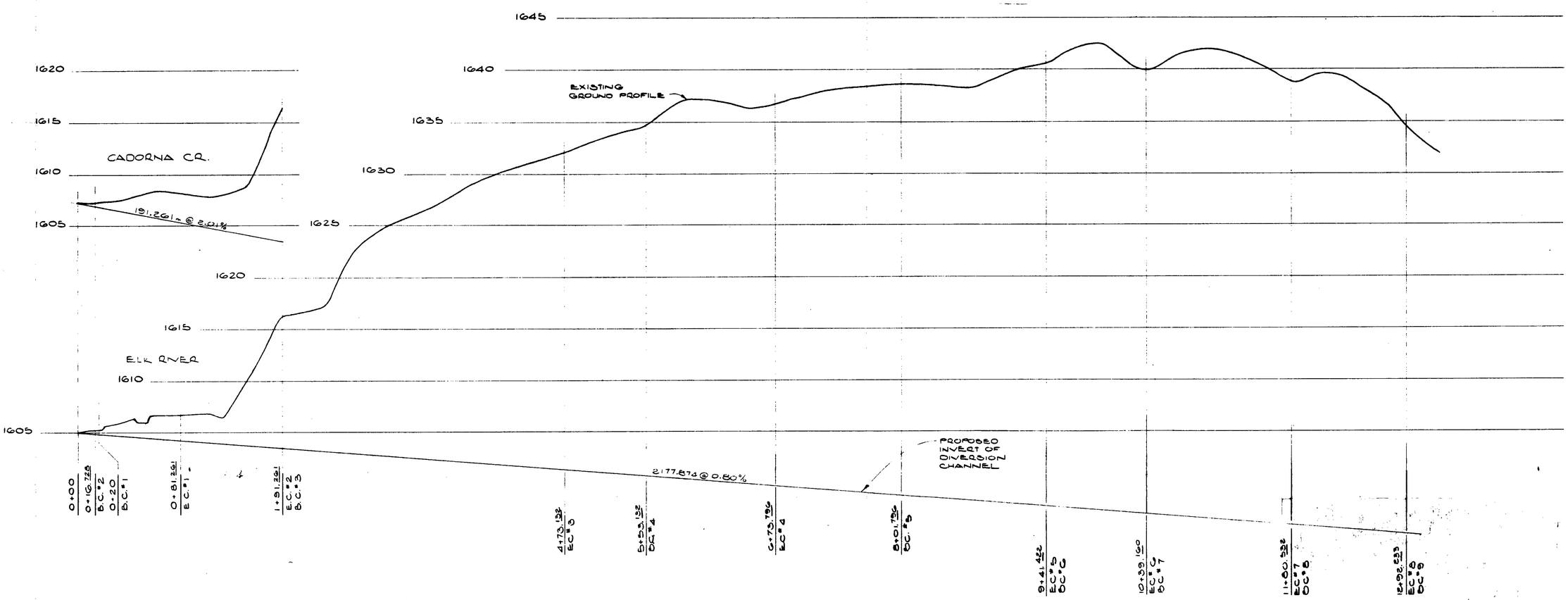
Sec.
Twp.
Rge.
W th.M

McElhanney Surveying & Engineering Ltd.
450-999-8th STREET S.W. CALGARY.

1 of 1

279

K-Elk River 8(2)A



279

15-Elk River-5013.R

Appendix 4.0 - A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A PENCIL MANUSCRIPT	Nov.19/80

ELCO MINING LIMITED

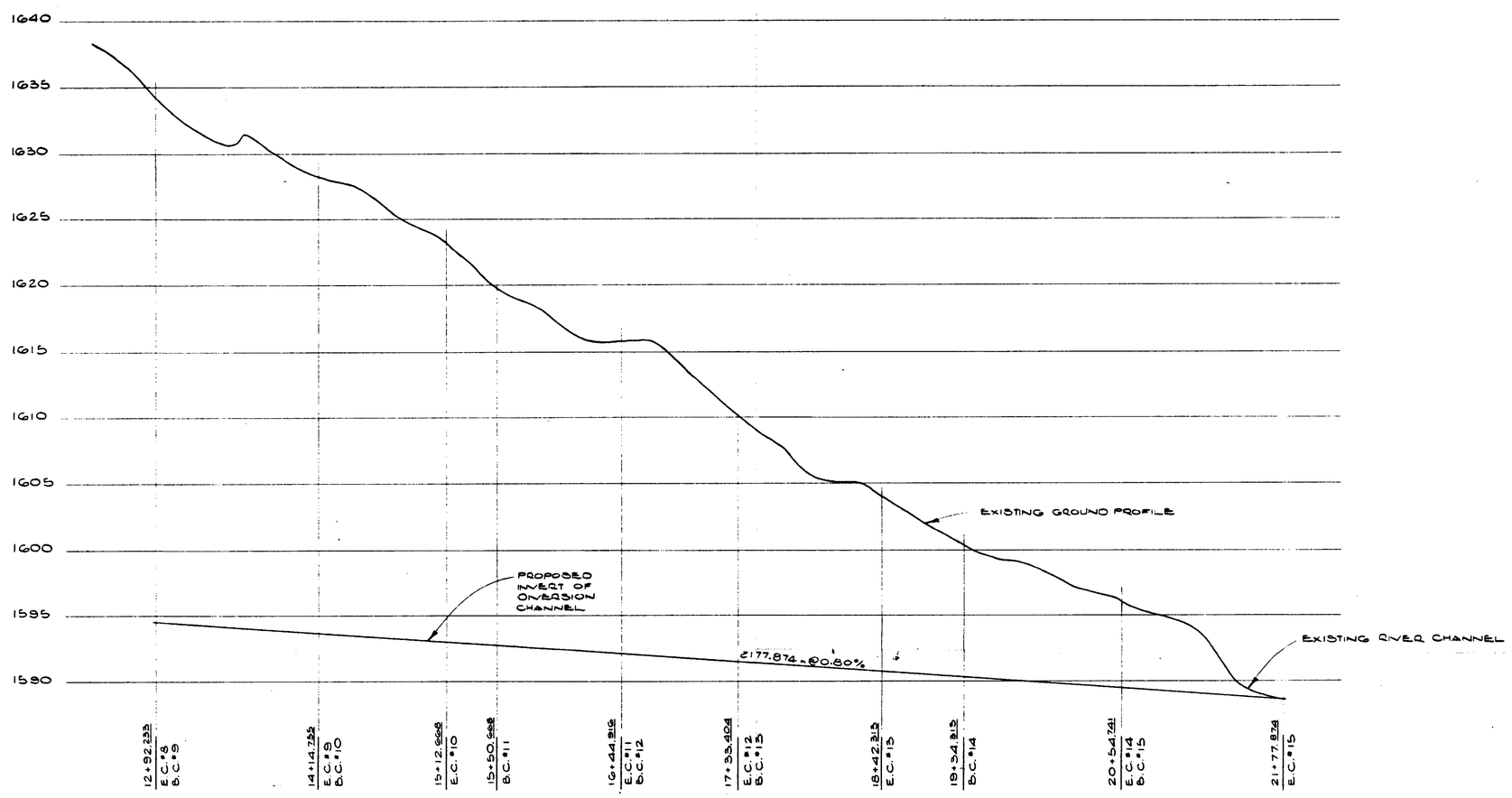
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

ELK RIVER DIVERSION

NORTH DIVERSION PROFILE.

DRAWN BY: KERR WOOD LEIDAL ASSOCIATES	SCALE: 1:2000 HORIZ. 1:200 VERT.
CHECKED BY:	DATE: OCT/80
MAP SHEET NO.: 100.80.2	DWG. NO.: EC-ELKD-1-1100-034 1 of 5



279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A. PENCIL MANUSCRIPT	NOV 14/80

K-Elk River Fo(a)A

Appendix 4.0 - A

ELCO MINING LIMITED

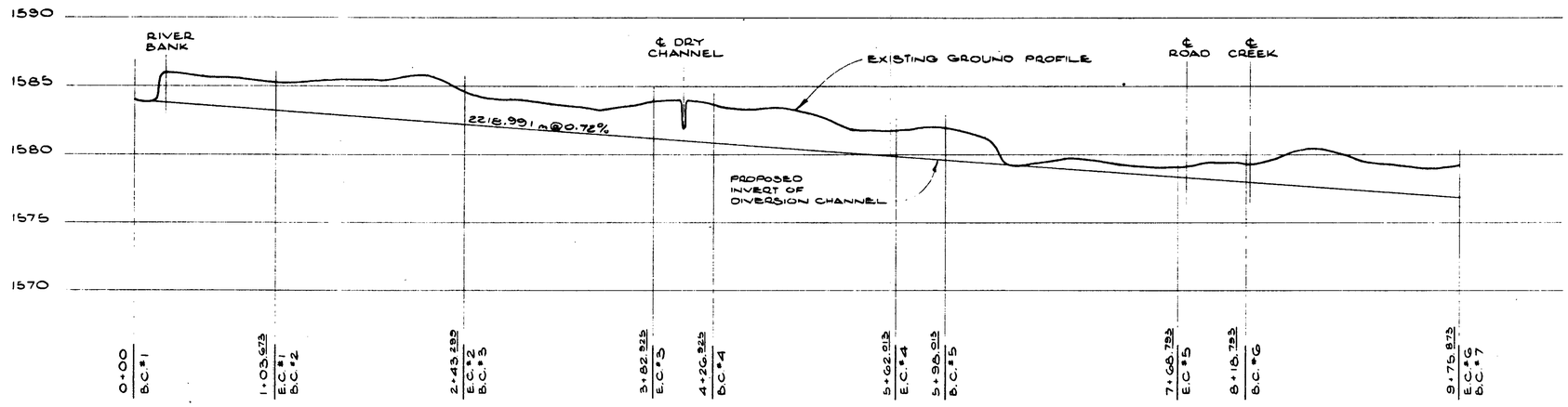
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

ELK RIVER DIVERSION

NORTH DIVERSION PROFILE

DRAWN BY: KERR WOOD LEIDAL ASSOCIATES	SCALE: 1:5000 HOR. 1:2. 1:200 VERT.
CHECKED BY:	DATE: OCT/80
MAP SHEET NO.: 100.80.2	DWG. NO.: EC-ERW0-1C100-034 2"5



279

K. ELK River FD(2)A

Appendix 4.0 - A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A PENCIL MANUSCRIPT	NOV. 14/80

ELCO MINING LIMITED

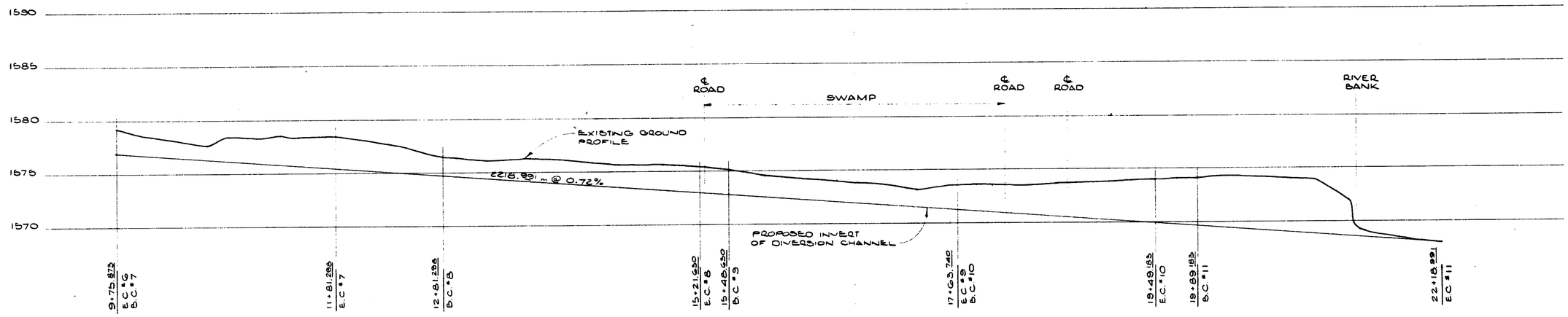
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

ELK RIVER DIVERSION

MIDDLE DIVERSION PROFILE

DRAWN BY KERR WOOD LEIDAL ASSOCIATES	SCALE 1:2000 HORIZ. 1:200 VERT.
CHECKED BY	DATE OCT/80
MAP SHEET NO. 100.80.2	DWG. NO. EC-ERM0-16100-034 3/5



279

K-Elk River 80(a)A

Appendix 4.0 - A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A PENCIL MANUSCRIPT	Nov 14/80

ELCO MINING LIMITED

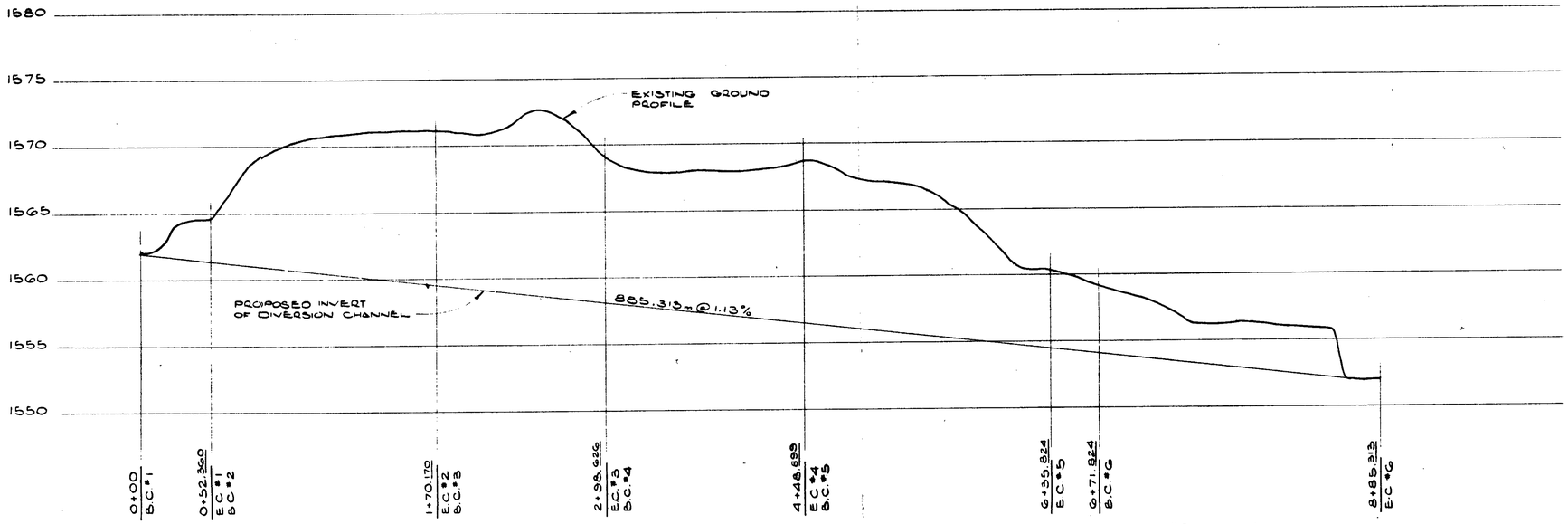
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

ELK RIVER DIVERSION

MIDDLE DIVERSION PROFILE

DRAWN BY KERR WOOD LEIDAL ASSOCIATES	SCALE 1:2000 HORIZ 1:200 VERT.
CHECKED BY	DATE OCT. 1980
MAP SHEET NO. 100 80 2	DWG. NO. EC-EEBO-16140-034 4 of 5



279

K Elk River 80131A

Appendix 4.0 - A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A. PENCIL MANUSCRIPT	NOV. 14/80

ELCO MINING LIMITED

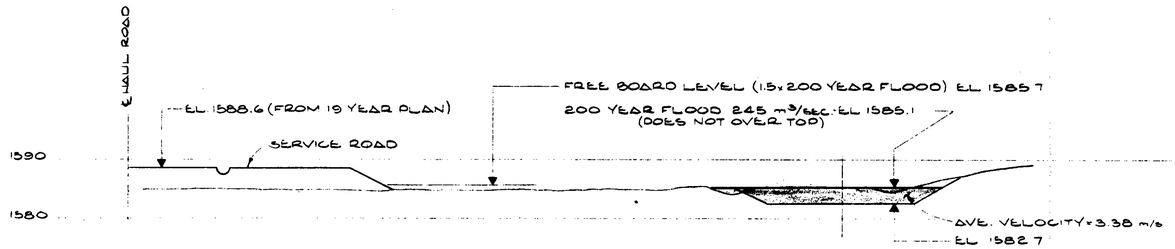
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

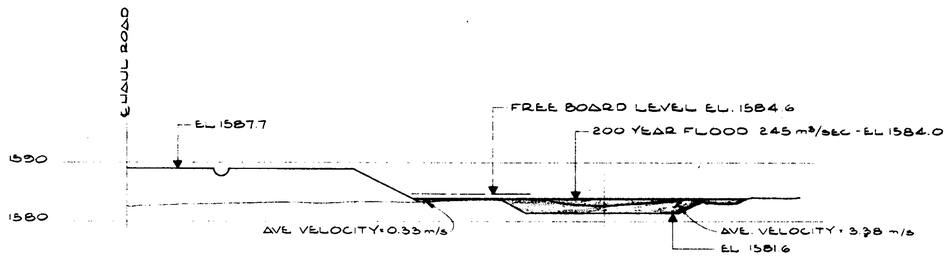
ELK RIVER DIVERSION

SOUTH DIVERSION PROFILE

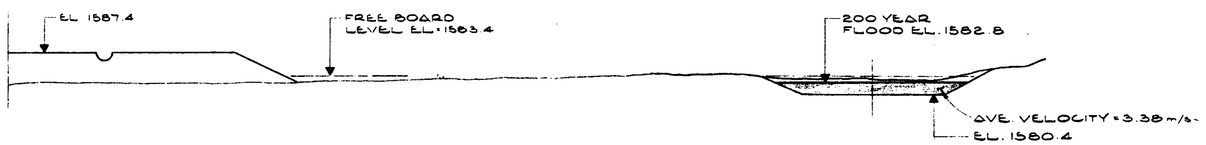
DRAWN BY: KERR WOOD LEIDAL ASSOCIATES	SCALE: 1:2000 HORIZ 1:200 VERT.
CHECKED BY:	DATE: OCT/80
MAP SHEET NO.: 100.80.2	DWG. NO.: EC-ER80-16100-024 5 of 5



SECTION AT 16,739 N
(NEAR MIDPOINT OF CURVE #2, CHAINAGE 1+84.00)



SECTION AT 16,610 N
(NEAR MIDPOINT OF CURVE #3, CHAINAGE 3+38.00)



SECTION AT 16,450 N
(NEAR MIDPOINT OF CURVE #4, CHAINAGE 4+95.00)

NOTES - 200 YEAR FLOOD (85% CONFIDENCE LEVEL) IS 245 m³/sec. SOURCE: ELCO MINING LTD, JUNE 1980.
- MINIMUM FREEBOARD LEVEL DEFINED BY 1.5 x 200 YEAR FLOOD = 376.5 m³/sec.
- ELEVATIONS OF HAUL ROAD DETERMINED FROM ELCO MINING LTD. 19 YEAR MINE PLAN, DRAWING Nº XC-EQ-77-10000-108

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K-Elk River 80/81A

Appendix 4.0 - B

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A. PENCIL MANUSCRIPT	14/11/80

ELCO MINING LIMITED

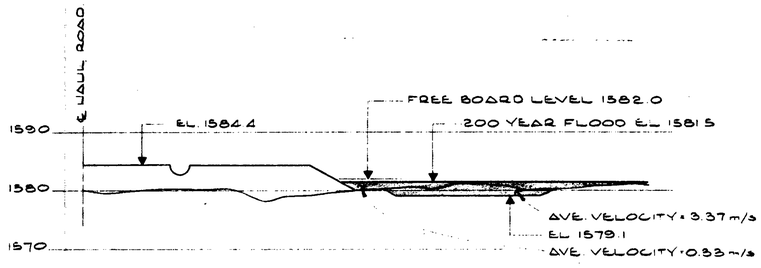
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

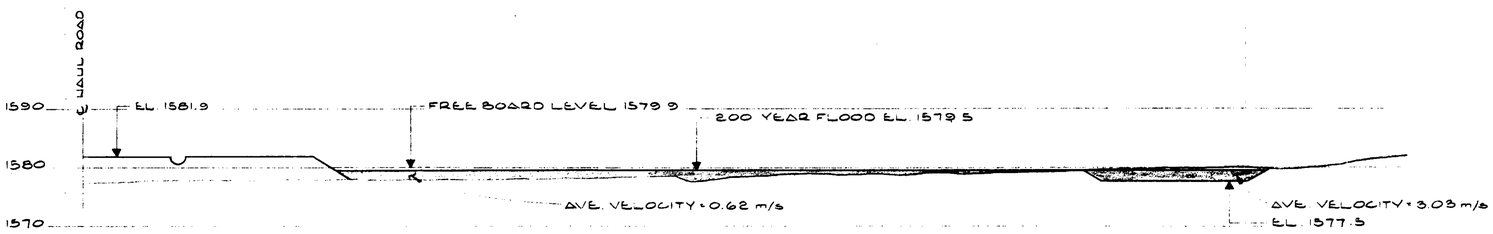
ELK RIVER DIVERSION

FLOOD LEVELS AND HAUL ROAD ELEVATIONS

DRAWN BY: KRAR WOOD LOIDAL ASSOCIATES	SCALE: 1"=500 HORIZ. 1"=50 VERT.
CHECKED BY	DATE: OCT/80
MAP SHEET NO.	DWG. NO.: EC-EQ80-16100-085/3

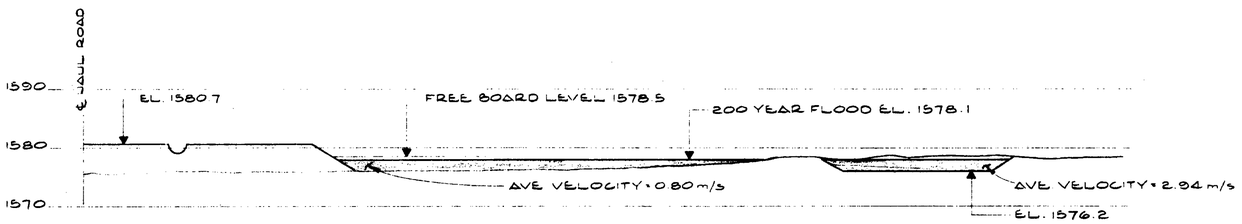


SECTION AT 16,299 N
(NEAR MIDDOINT OF CURVE #5, CHAINAGE 6+83.00)

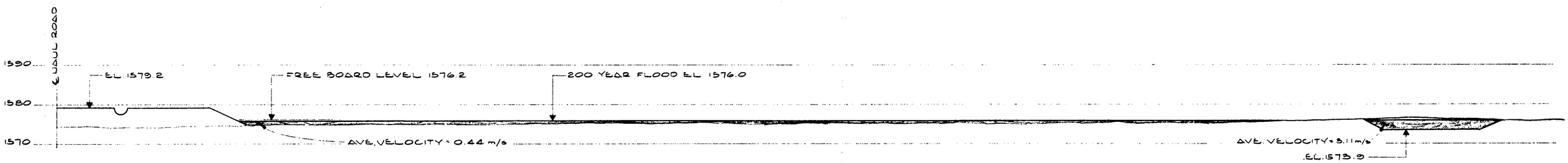


SECTION AT 16,126 N
(NEAR MIDDOINT OF CURVE #6, CHAINAGE 8+97.00)

NOTES:
- 200 YEAR FLOOD (95% CONFIDENCE LEVEL) = 9.845 m³/sec. SOURCE: ELCO MINING LTD. JUNE 1980.
- MINIMUM FREEBOARD LEVEL DEFINED BY 1.5 x 200 YEAR FLOOD = 376.5 m³/sec.
- ELEVATIONS OF HAUL ROAD DETERMINED FROM ELCO MINING LTD 19 YEAR MINE PLAN, DRAWING № XC-ER-77-10000-108



SECTION AT 15,975 N
(NEAR MIDDOINT OF CURVE #7, CHAINAGE 10+79.00)



SECTION AT 15,751 N
(NEAR MIDDOINT OF CURVE #8, CHAINAGE 14+01.00)

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K-Elk River 50(3)(A)

Appendix 4.0 - B

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A. PENCIL MANUSCRIPT	14/11/80

ELCO MINING LIMITED

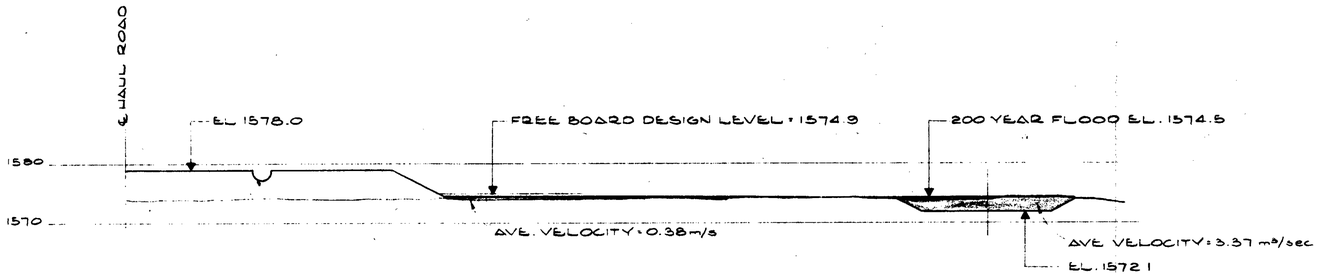
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

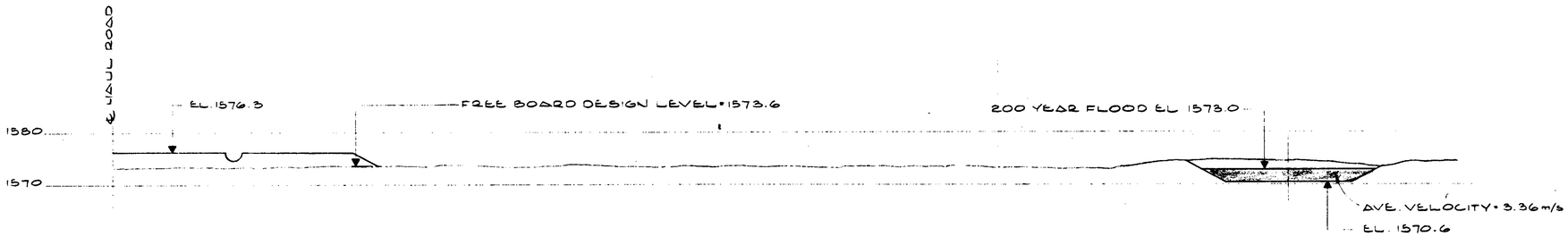
ELK RIVER DIVERSION

FLOOD LEVELS AND HAUL ROAD ELEVATIONS

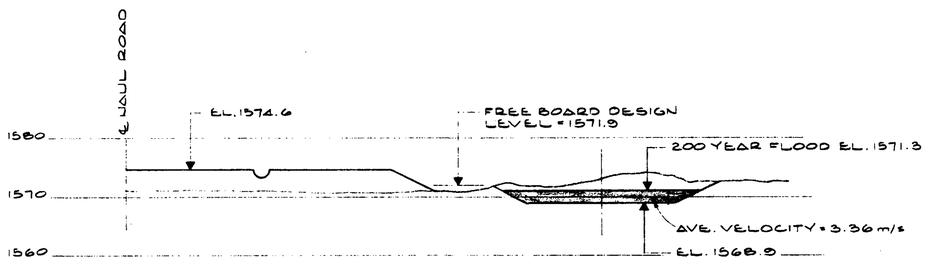
DRAWN BY: KERR WOOD LEIDAL ASSOCIATES	SCALE: 1:500 HORIZ 1:500 VERT.
CHECKED BY:	DATE: OCT/80
MAP SHEET NO.: 100.80.2	DWG. NO.: EC-ERBO-16100-035 23



SECTION AT 15,603 N
(NEAR MIDPOINT OF CURVE #9, CHAINAGE 16+56.00)



SECTION AT 15,430 N
(NEAR MIDPOINT OF CURVE #10, CHAINAGE 18+56.00)



SECTION AT 15,255 N
(NEAR MIDPOINT OF CURVE #11, CHAINAGE 21+04.00)

NOTES - 200 YEAR FLOOD (95% CONFIDENCE LEVEL) IS 245 m³/sec. SOURCE: ELCO MINING LTD, JUNE 1980.
- MINIMUM FREEBOARD LEVEL DEFINED BY 1.5 × 200 YEAR FLOOD = 576.5 m³/sec
- ELEVATIONS OF HAUL ROAD DETERMINED FROM ELCO MINING LTD. 15 YEAR MINE PLAN, DRAWING Nº XC-EQ-77-10000-108

279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE
A. DENCIL MANUSCRIPT	

K-Elk River 80(2)A

Appendix 4.0 - B

ELCO MINING LIMITED

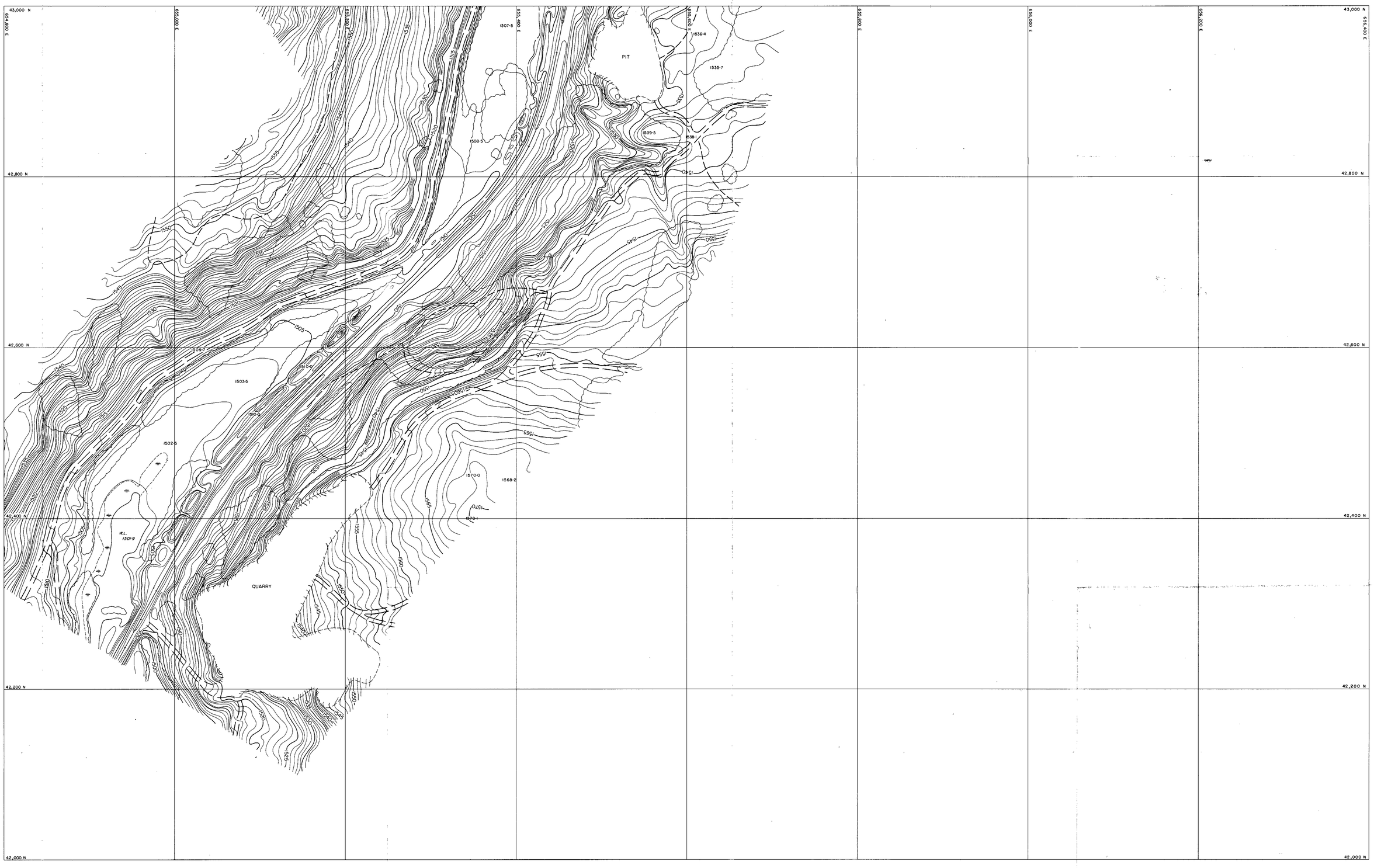
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

ELK RIVER DIVERSION

FLOOD LEVELS AND HAUL ROAD ELEVATIONS

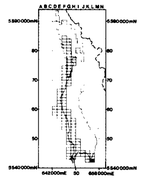
DRAWN BY: KERR WOOD LEIDAL ASSOCIATES	SCALE: 1:500 HORIZ. 1:500 VERT.
CHECKED BY:	DATE: OCT/80
MAP SHEET NO.: 100.80.2	DWG. NO.: EC-EQ80-16100-035 3/4



SHEET INDEX:

42 L

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11,117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 © 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K-Elk River PD(2)A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 42L	DWG. NO.

APPENDIX: 5.0

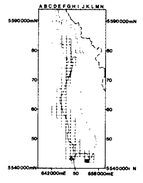
43,000 N
653,200 E
653,400 E
653,600 E
653,800 E
654,000 E
654,200 E
654,400 E
654,600 E
654,800 E
42,800 N
42,600 N
42,400 N
42,200 N
42,000 N

1538-2
1539-8
42,400 N
1500
1532-3

SHEET INDEX:

42K

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11,117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... R.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

271

H Elk River 10 (2)0

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

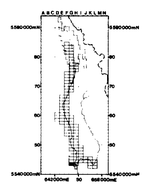
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 42K	DWG. NO.

APPENDIX: 5.0

SHEET INDEX:

43 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE. DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	BD
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

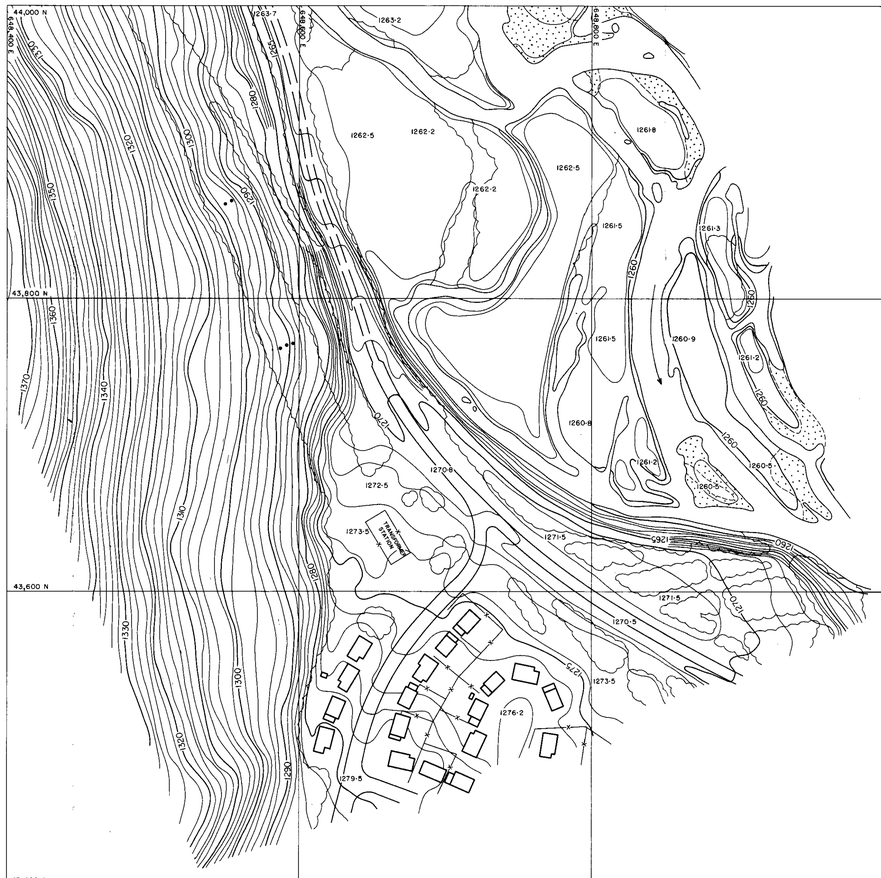
279 K-Elk River 30(2)A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 43G	DWG. NO.

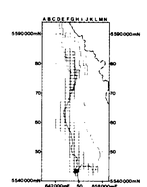
APPENDIX: 5.0



SHEET INDEX:

43H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11,117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279 K-Elk River 20/2/19

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 43H	DWG. NO.

APPENDIX: 5.0

44,000N
653,500E
653,600E
653,700E
653,800E
653,900E
654,000E
654,100E
654,200E
654,300E
654,400E
654,500E
654,600E
44,000N
43,800N
43,600N
43,400N
43,200N
43,000N
1498·2
1498
1497·2
1498·5
1499
1498
1498
1499·7
1499
1499·4
1499·8
1500
1500
43,800N
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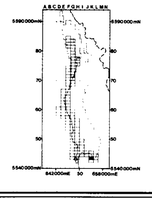
43,000N

SHEET INDEX:

43 K

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

SPOT ELEVATION ..... 2077·8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE ..... +222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962·3

279 K-Elk River 20(2)A

REV.	DESCRIPTION	CHK'D.	DATE

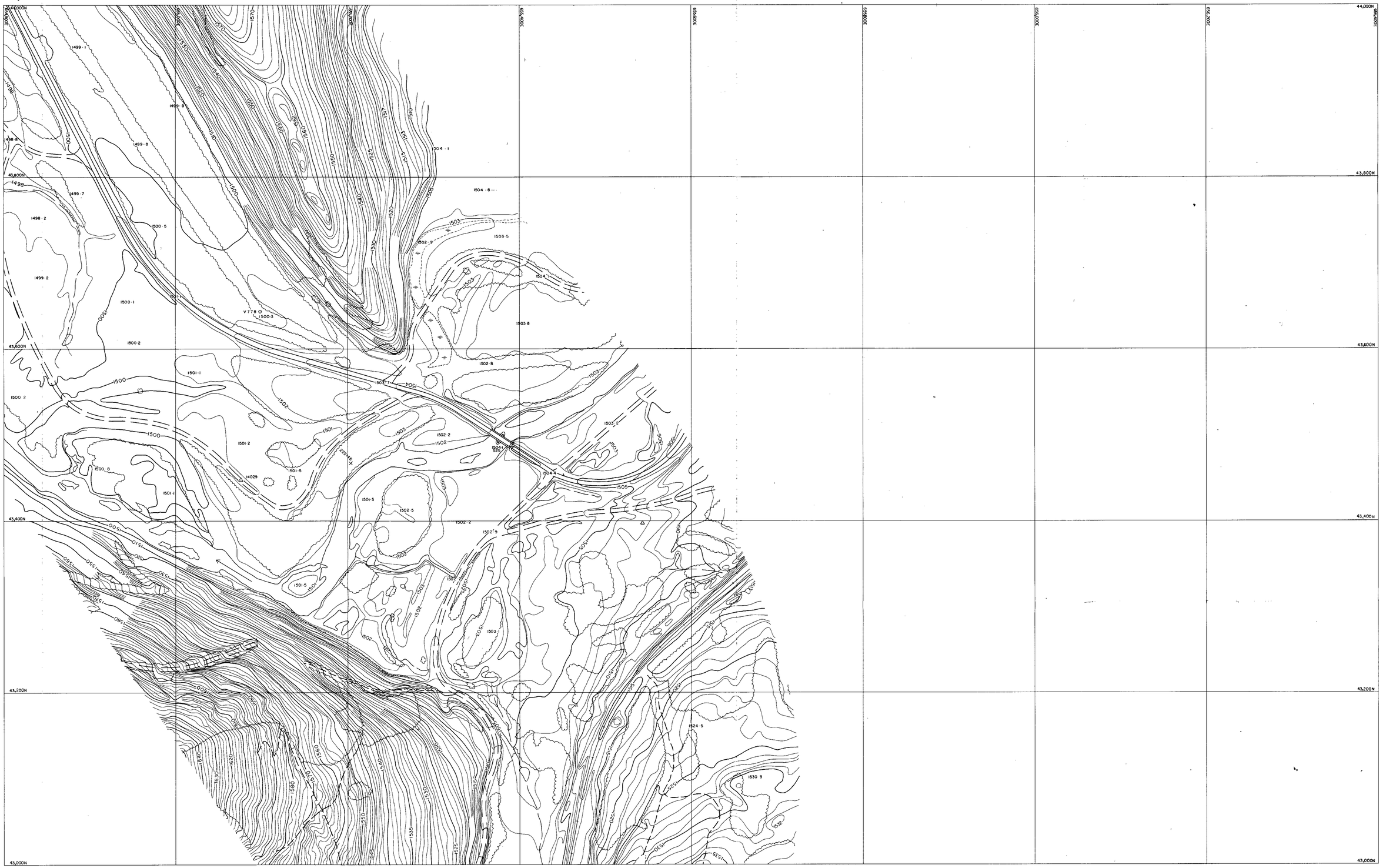
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 43K	DWG. NO.

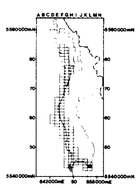
APPENDIX : 5.0



SHEET INDEX:

43 L

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962·3

279

K-Elk River 82G/A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

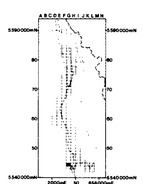
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 43L	DWG. NO.

APPENDIX: 5.0

SHEET INDEX:

44 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K Elk River 80(G)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

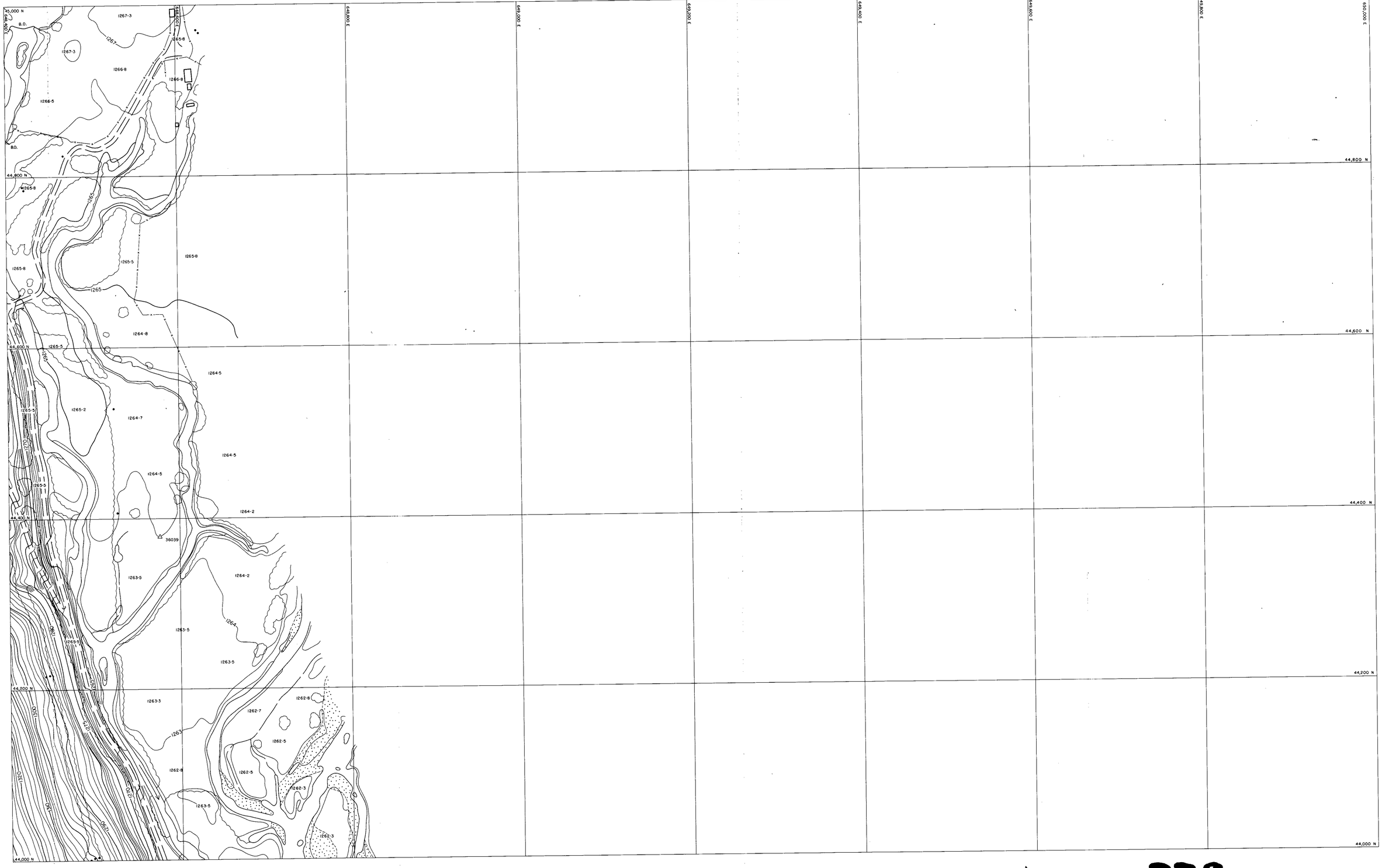
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 44G	DWG. NO.

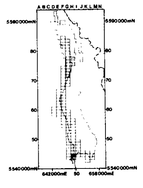
APPENDIX: 5.0



SHEET INDEX:

44 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(Q)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

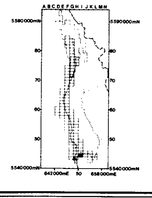
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 44 H	DWG. NO.

APPENDIX 3.0

SHEET INDEX:

441

UTM
Zone 11
Center Meridian
=117°W.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 30(2)A

REV.	DESCRIPTION	CHK'D.	DATE

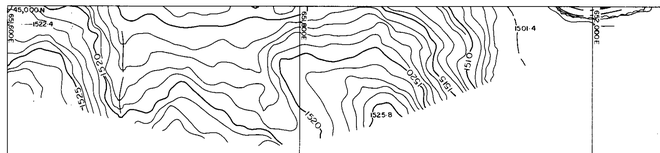
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 44 I	DWG. NO.

APPENDIX: 5.0



652,200E | 652,400E | 652,600E | 652,800E | 653,000E | 653,200E

45,000N

44,800N

44,800N

44,600N

44,600N

44,400N

44,400N

44,200N

44,200N

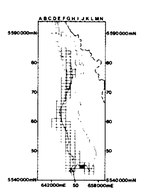
44,000N

44,000N

SHEET INDEX:

44 J

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	22132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River Pg(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

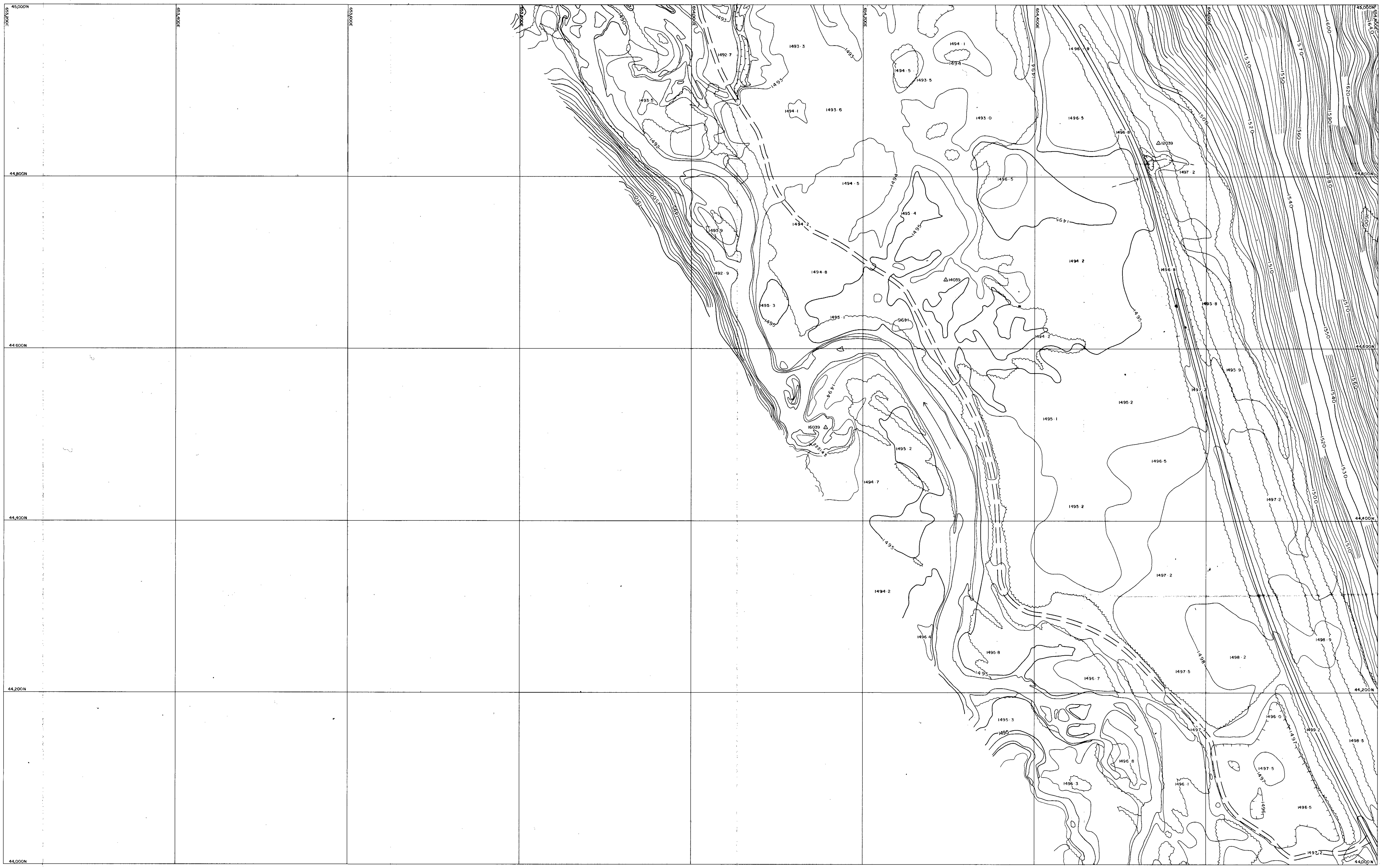
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 44J	DWG. NO.

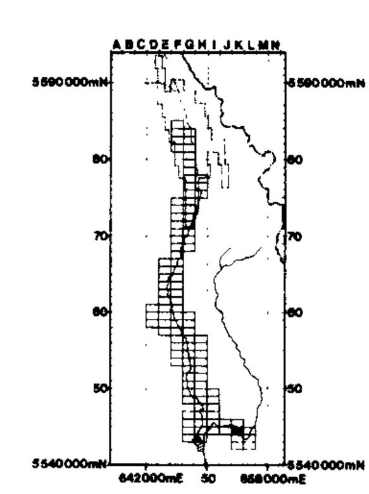
APPENDIX: 5.0



SHEET INDEX:

44K

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE	• • •	TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

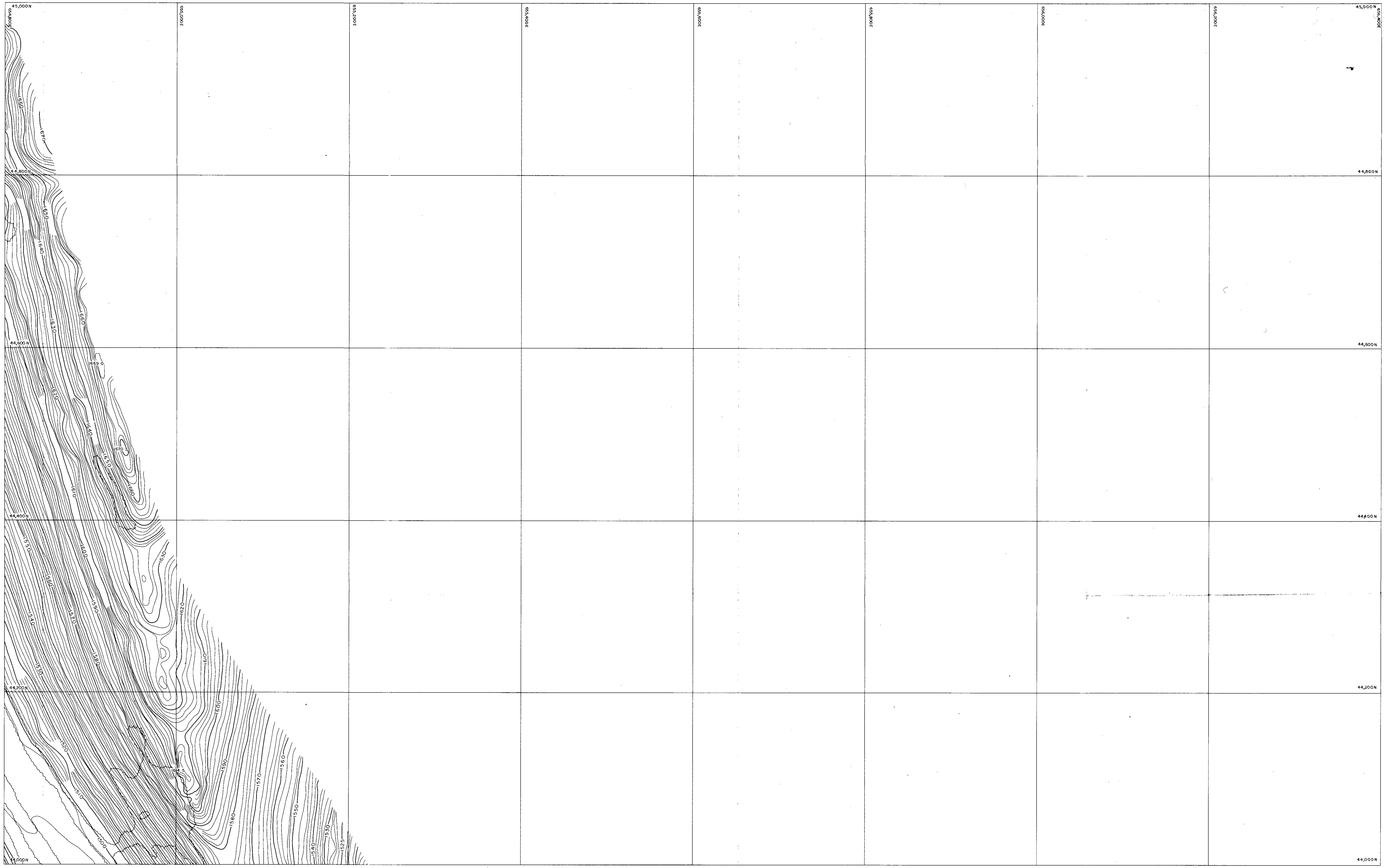
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY		SCALE	1:2000
CHECKED BY		DATE	
MAP SHEET NO.	44K	DWG. NO.	

APPENDIX: 5.0



SHEET INDEX:

44 L

UTM
Zone 11
Center Meridian
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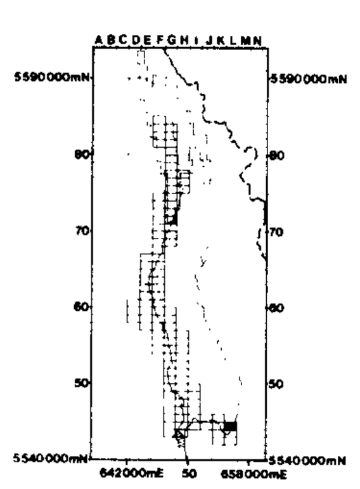

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LEGEND:

SPOT ELEVATION	2077·8
ROAD	
TRACK OR TRAIL	
POLE	• • •
BUILDING	
CREEKS	
LAKE	
SWAMP	
BEAVER DAM	B.D.
FALLS/RAPIDS	
CONTOURS	1500
TREES	
AIR PHOTO CENTRE	+222132
HORIZONTAL CONTROL POINT	△ 24049
VERTICAL CONTROL POINT	V 62 ⊙ 1962·3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 80(2)A

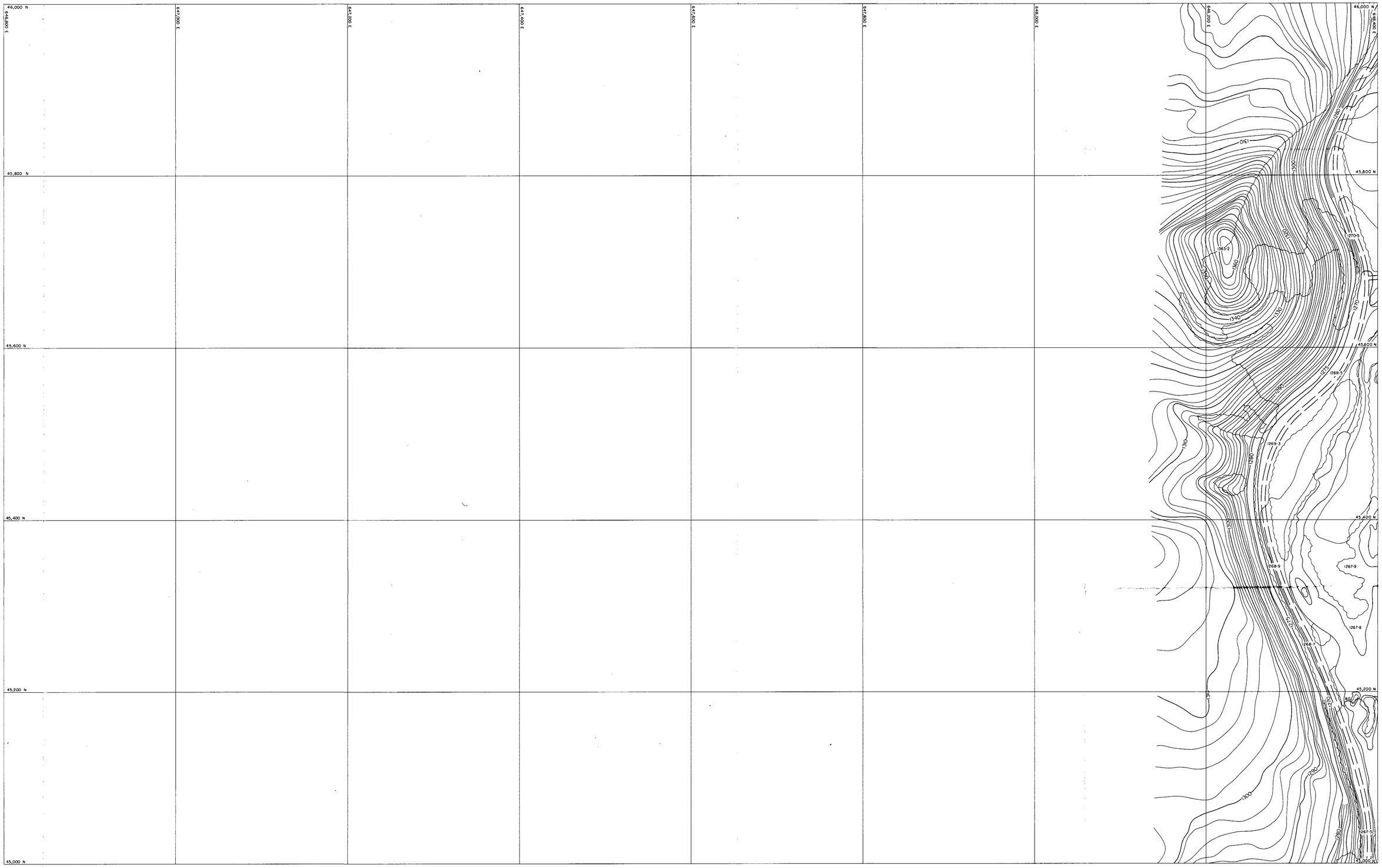
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 44L	DWG. NO.

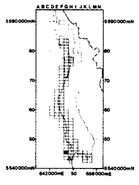
APPENDIX : 5.0



SHEET INDEX:

45G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

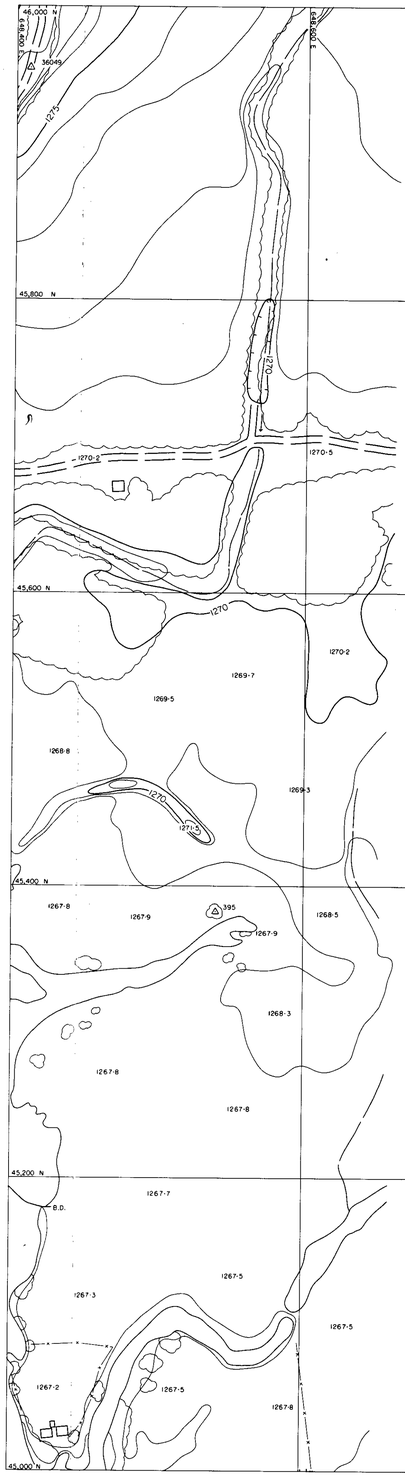
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 45G	DWG. NO.

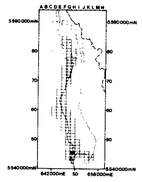
APPENDIX : 5.0



SHEET INDEX:

45H

UTM
Zone 11
Center Meridian
=117°w.Gr.



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SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERT[redacted] ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

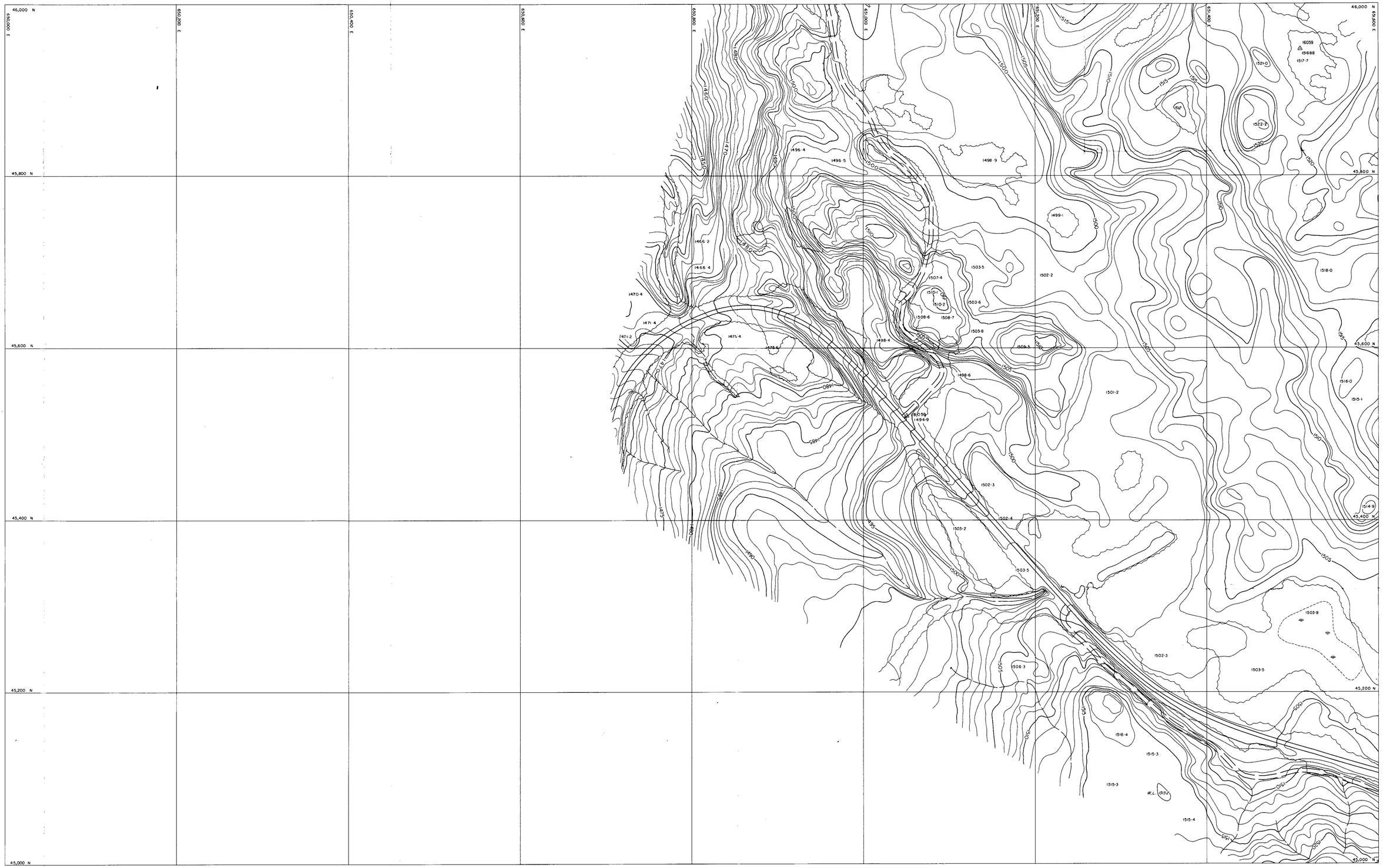
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 45H	DWG. NO.

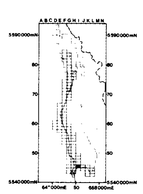
APPENDIX : 5.0



SHEET INDEX:

451

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80/21A

REV.	DESCRIPTION	CHK'D.	DATE

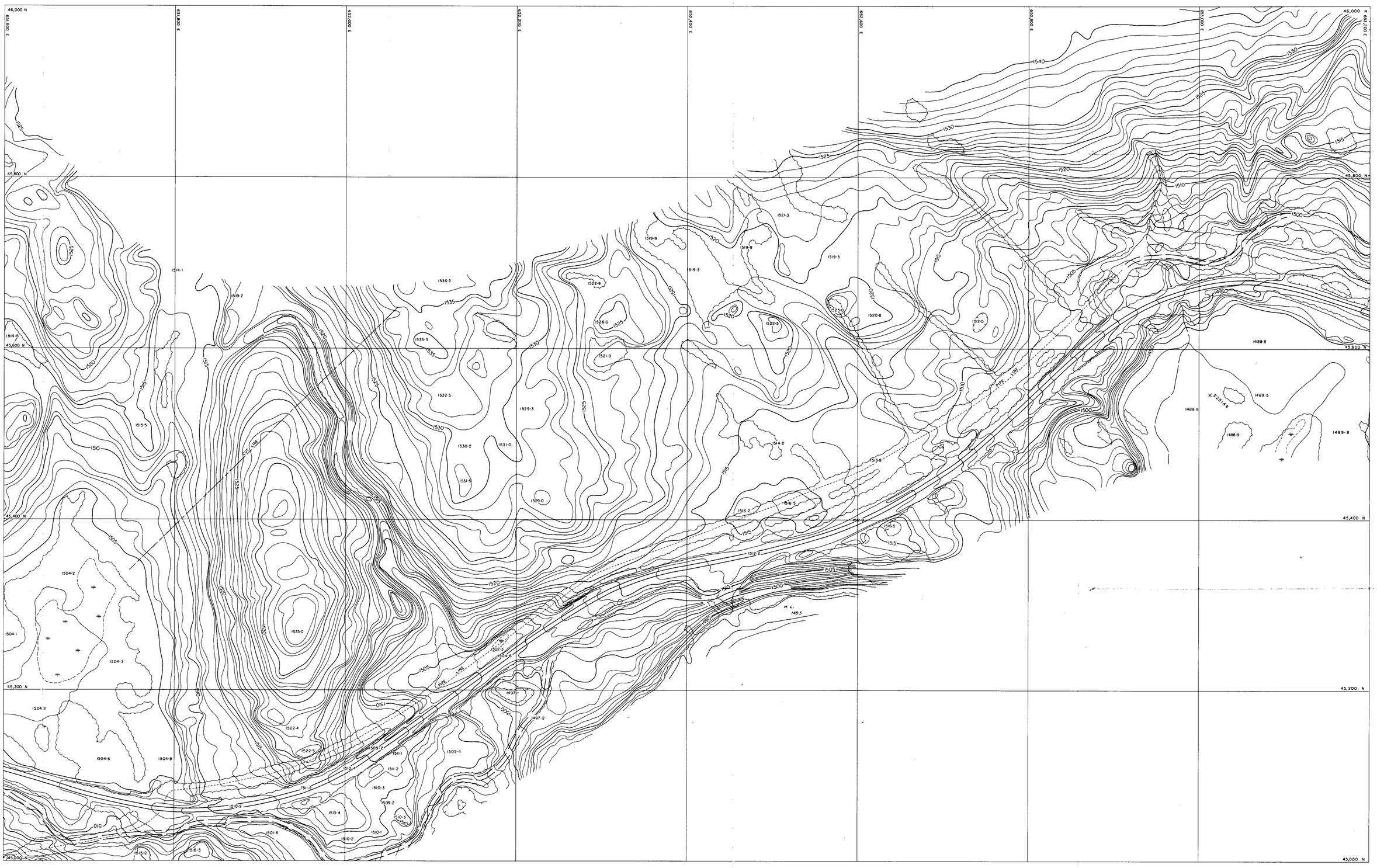
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 451	DWG. NO.

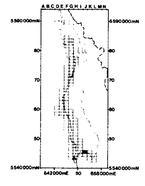
APPENDIX 5.0



SHEET INDEX:

45J

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... + 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K. Elk River 10/2/19

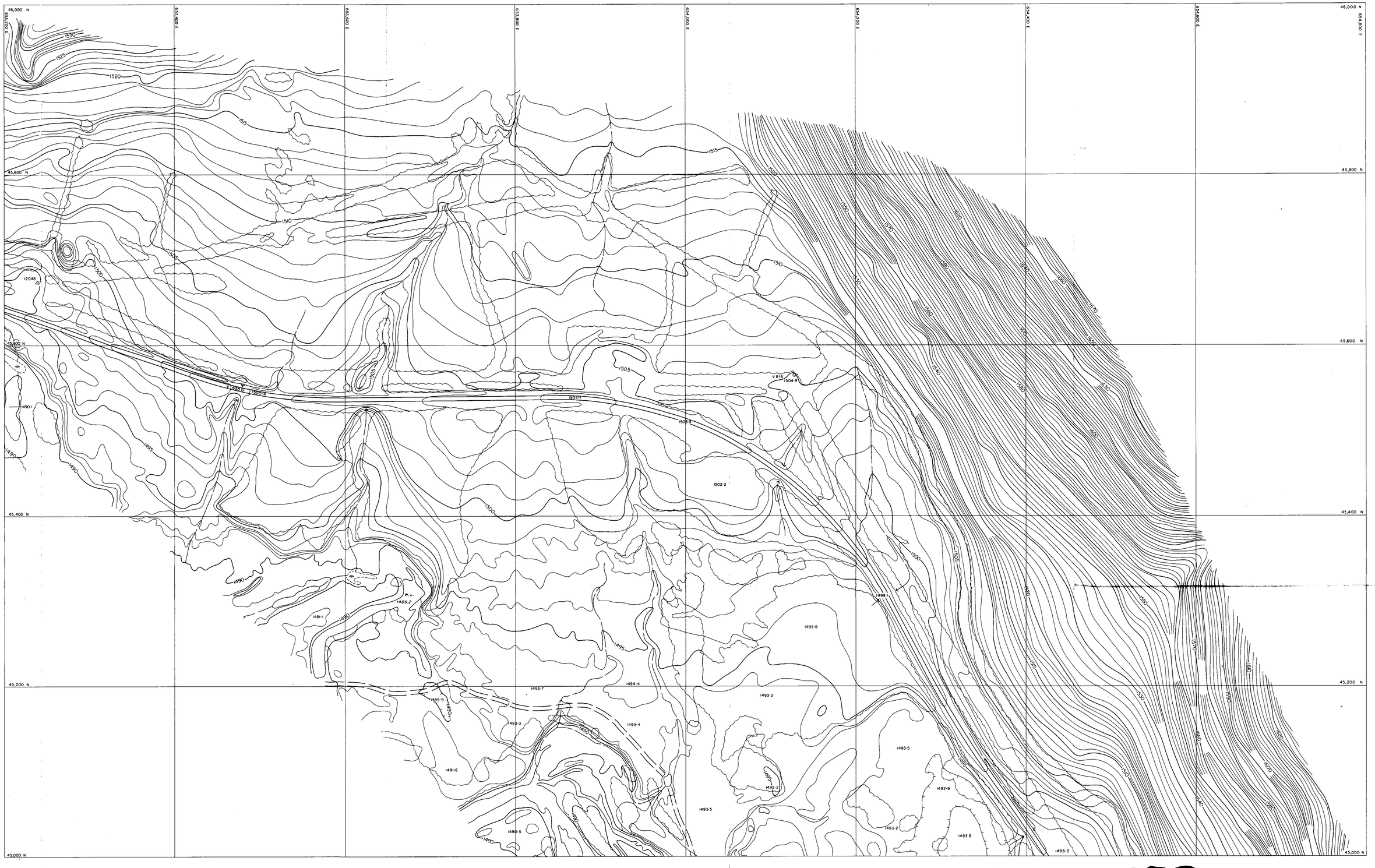
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 45J	DWG. NO.

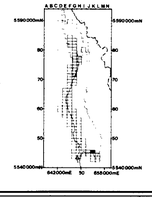
APPENDIX: 5.0



SHEET INDEX:

45K

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT ... △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 80/219

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 45K	DWG. NO.

APPENDIX 1 5.0

547,000N

546,800N

546,600N

546,400N

546,200N

546,000N

649,600E

649,800E

650,000E

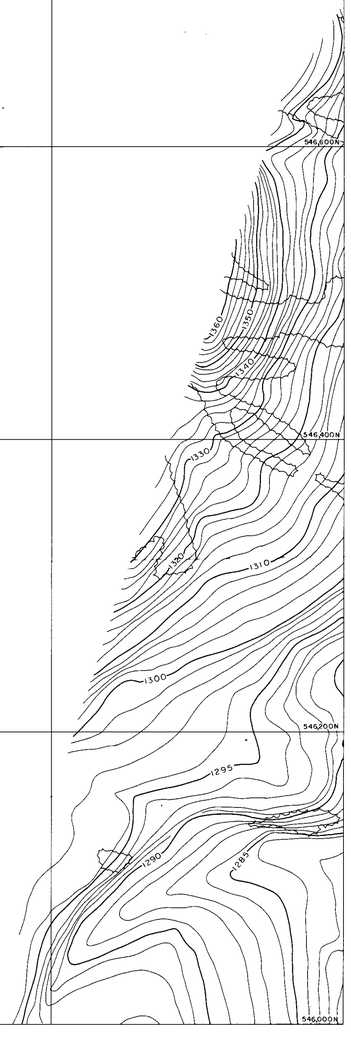
650,200E

650,400E

650,600E

650,800E

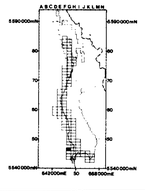
651,000E



SHEET INDEX:

46 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

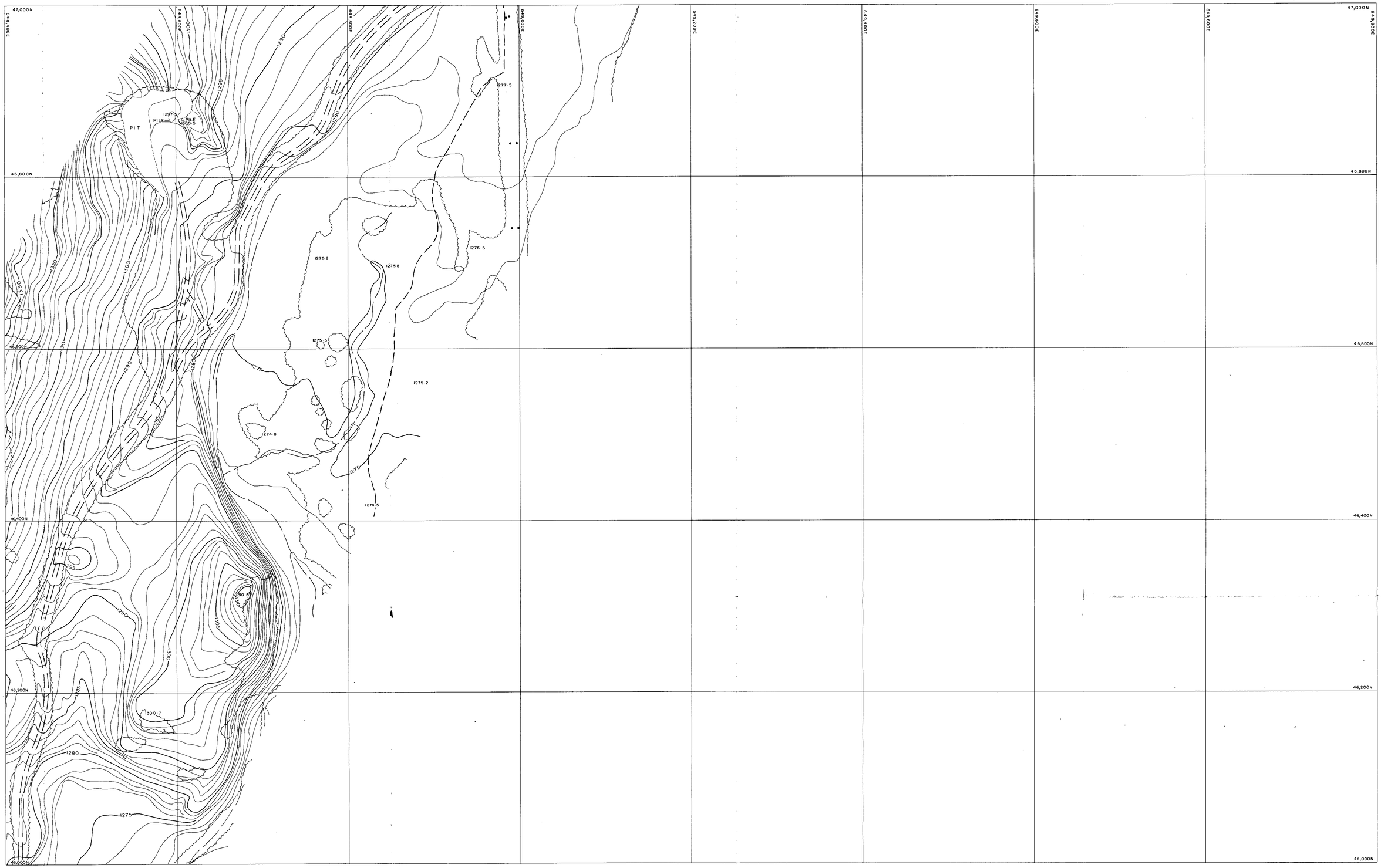
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 46 G	DWG. NO.

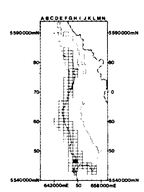
APPENDIX: 5.0



SHEET INDEX:

46 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

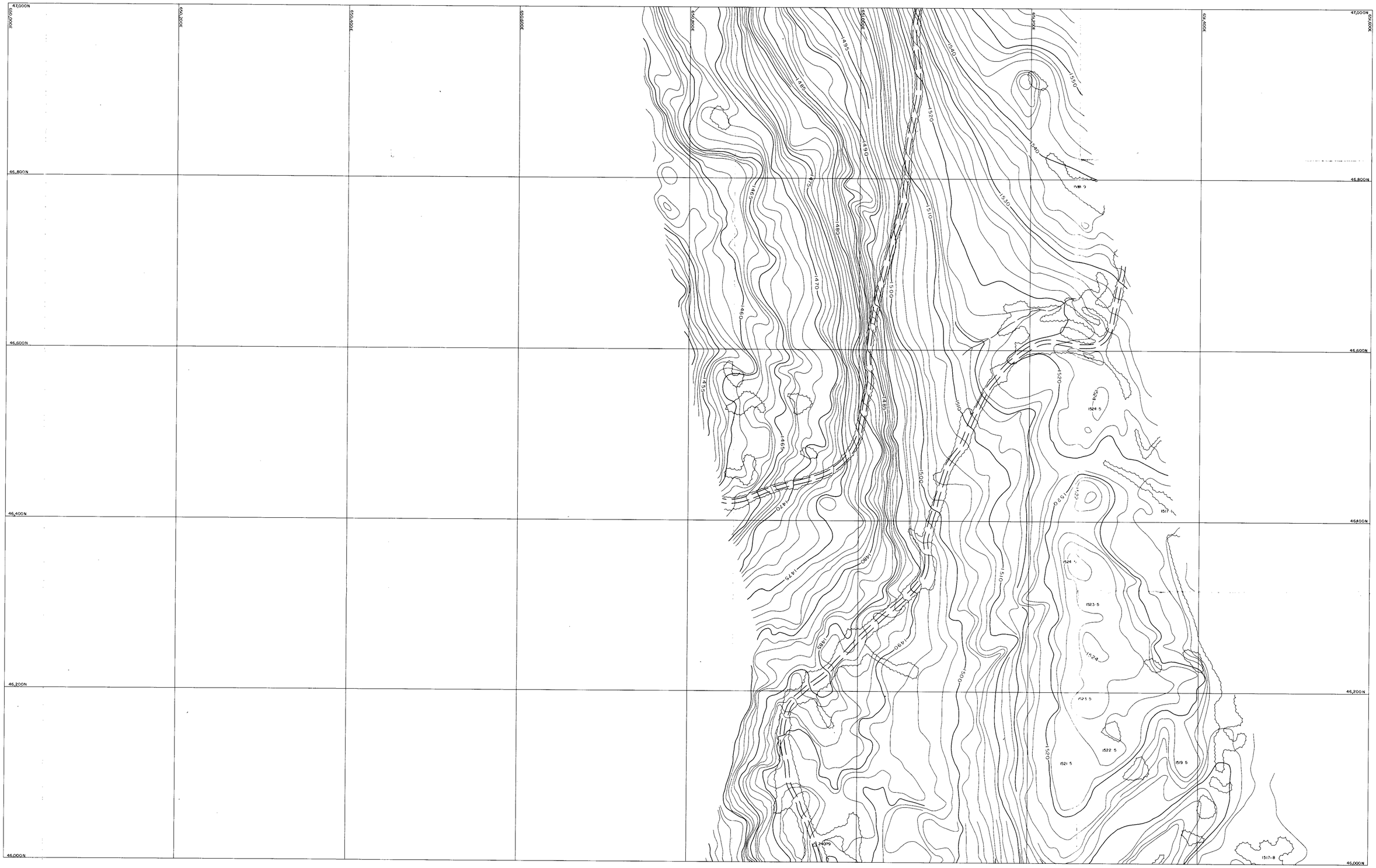
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 46H	DWG. NO.

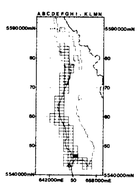
APPENDIX: 5.0



SHEET INDEX:

461

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

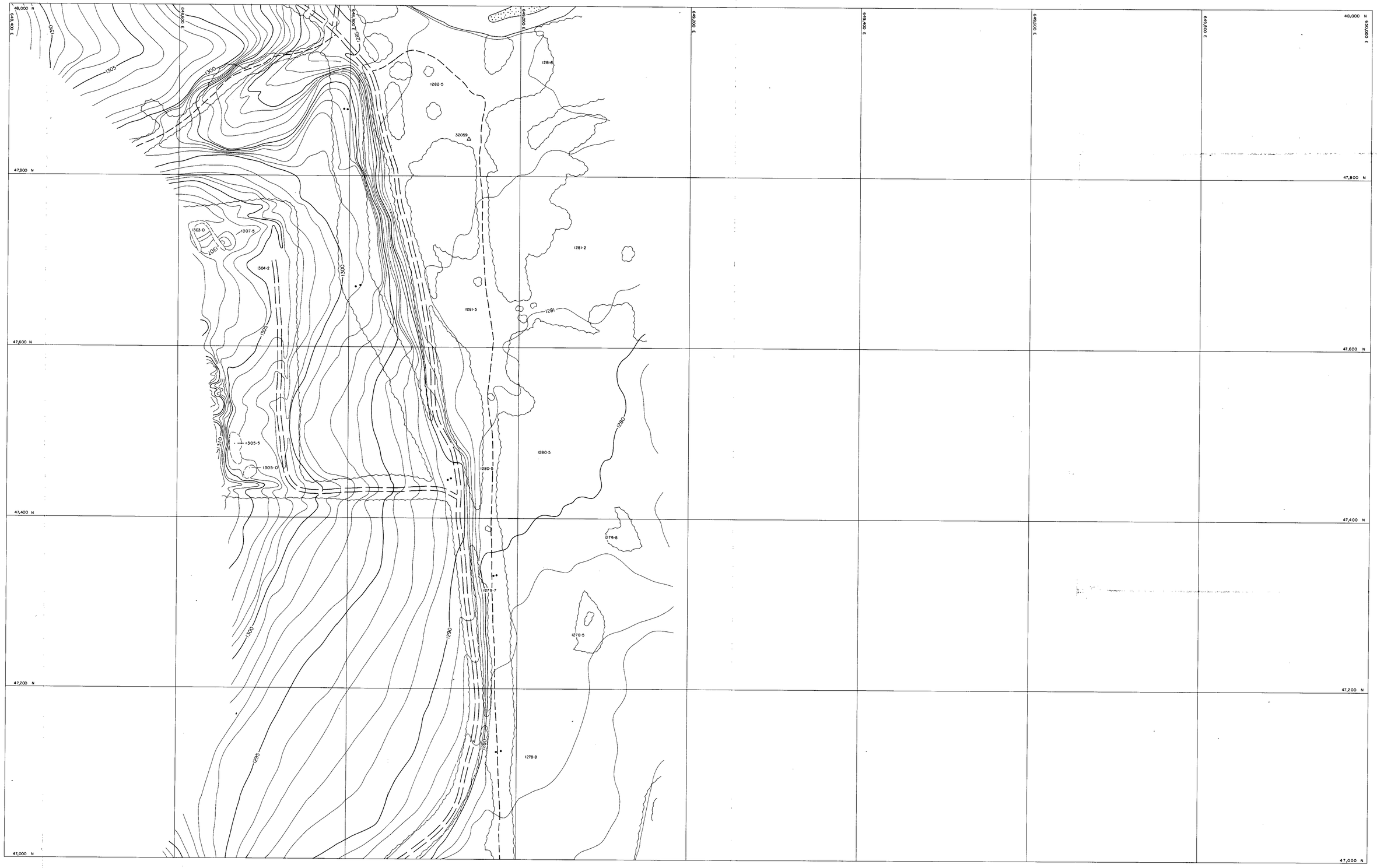
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 461	DWG. NO.

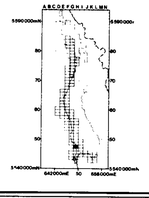
APPENDIX : 5.0



SHEET INDEX:

47H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

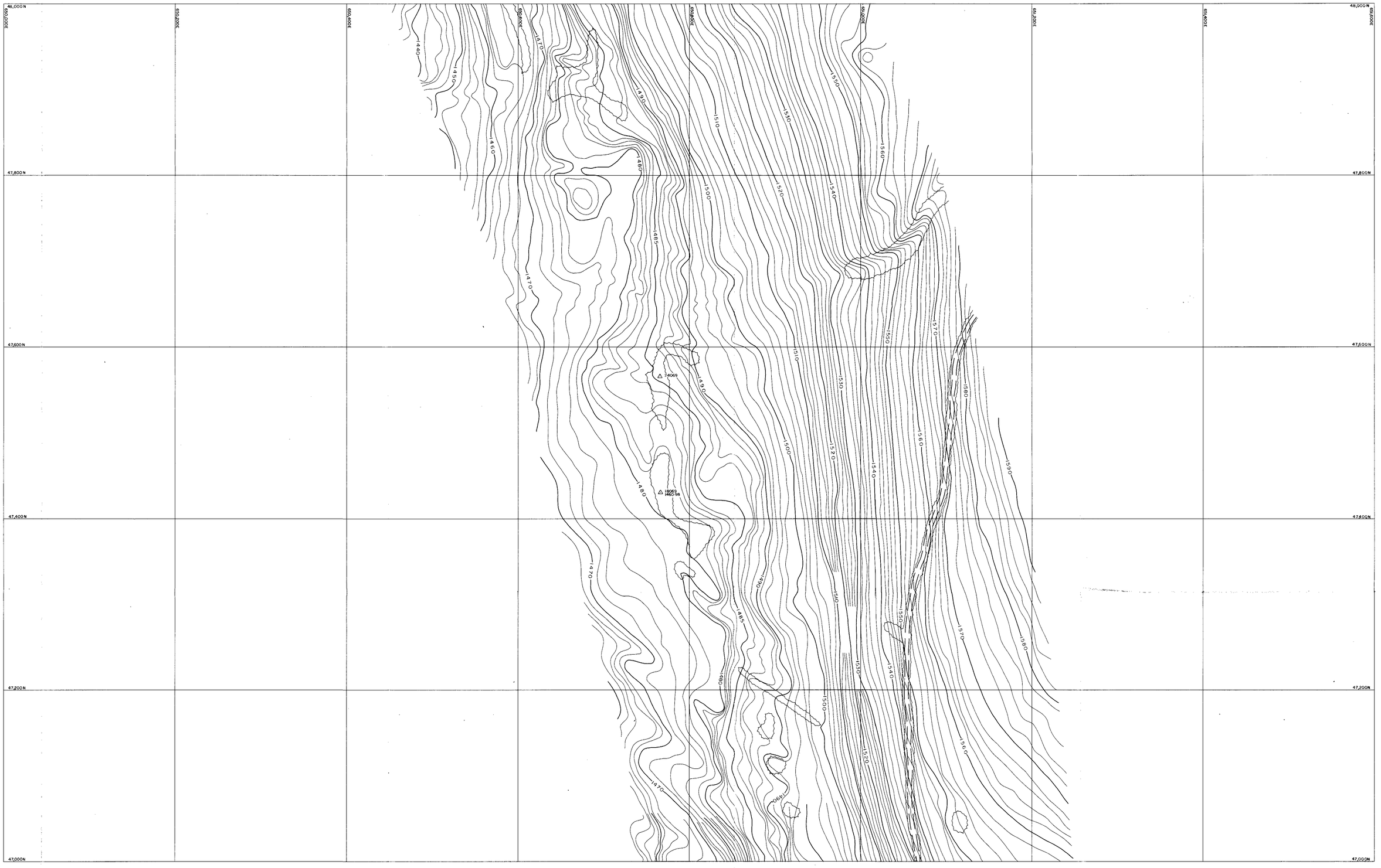
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 47H	DWG. NO.

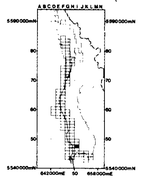
APPENDIX : 50



SHEET INDEX:

47 I

UTM
Zone 11
Center Meridian
=117°w.Gr.



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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 50(2)A

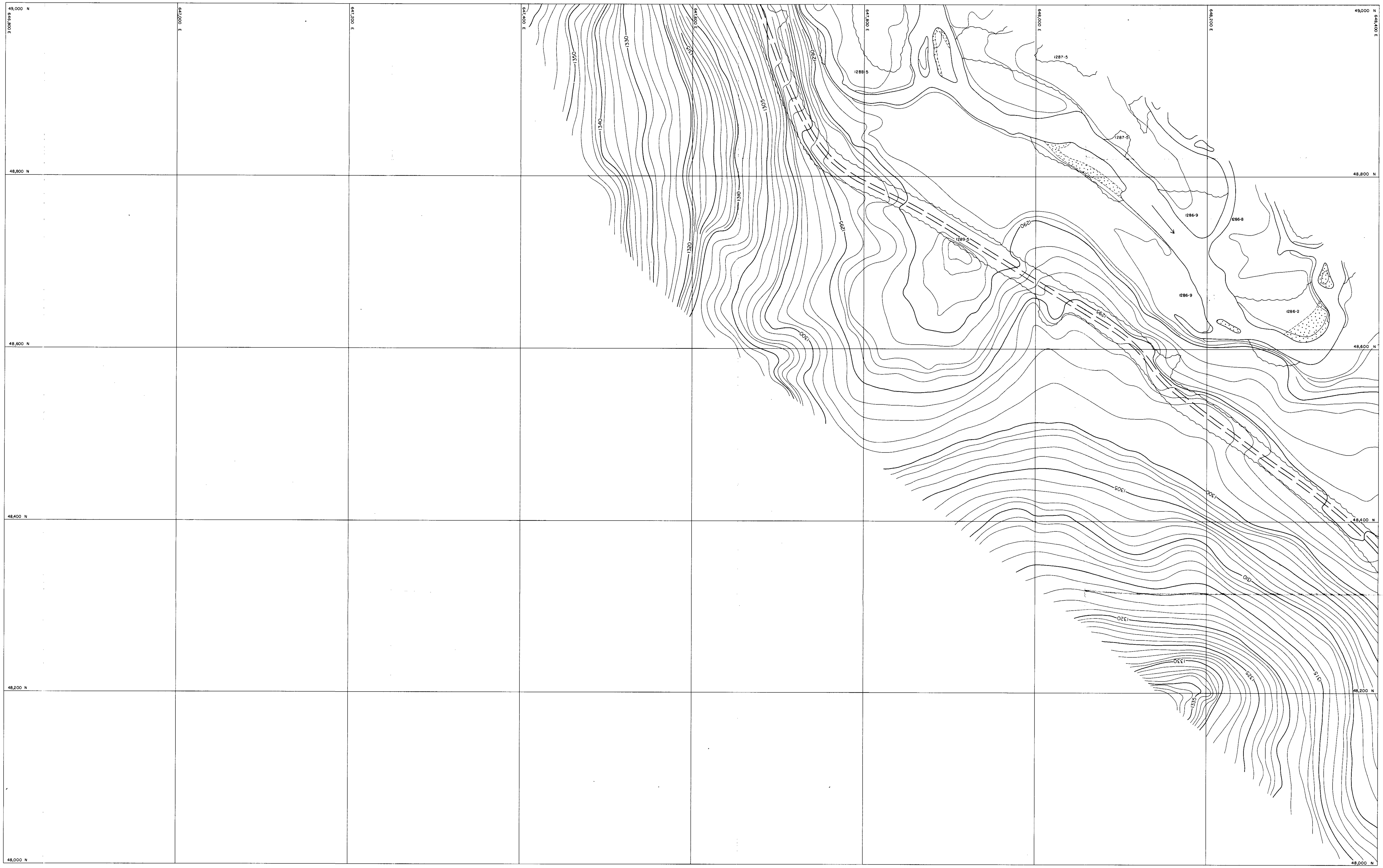
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 47 I	DWG. NO.

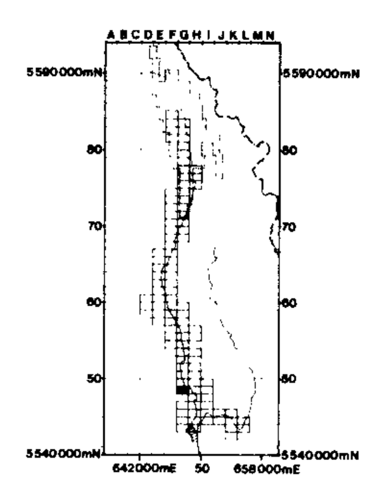
APPENDIX : 50



SHEET INDEX:

48G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279 K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

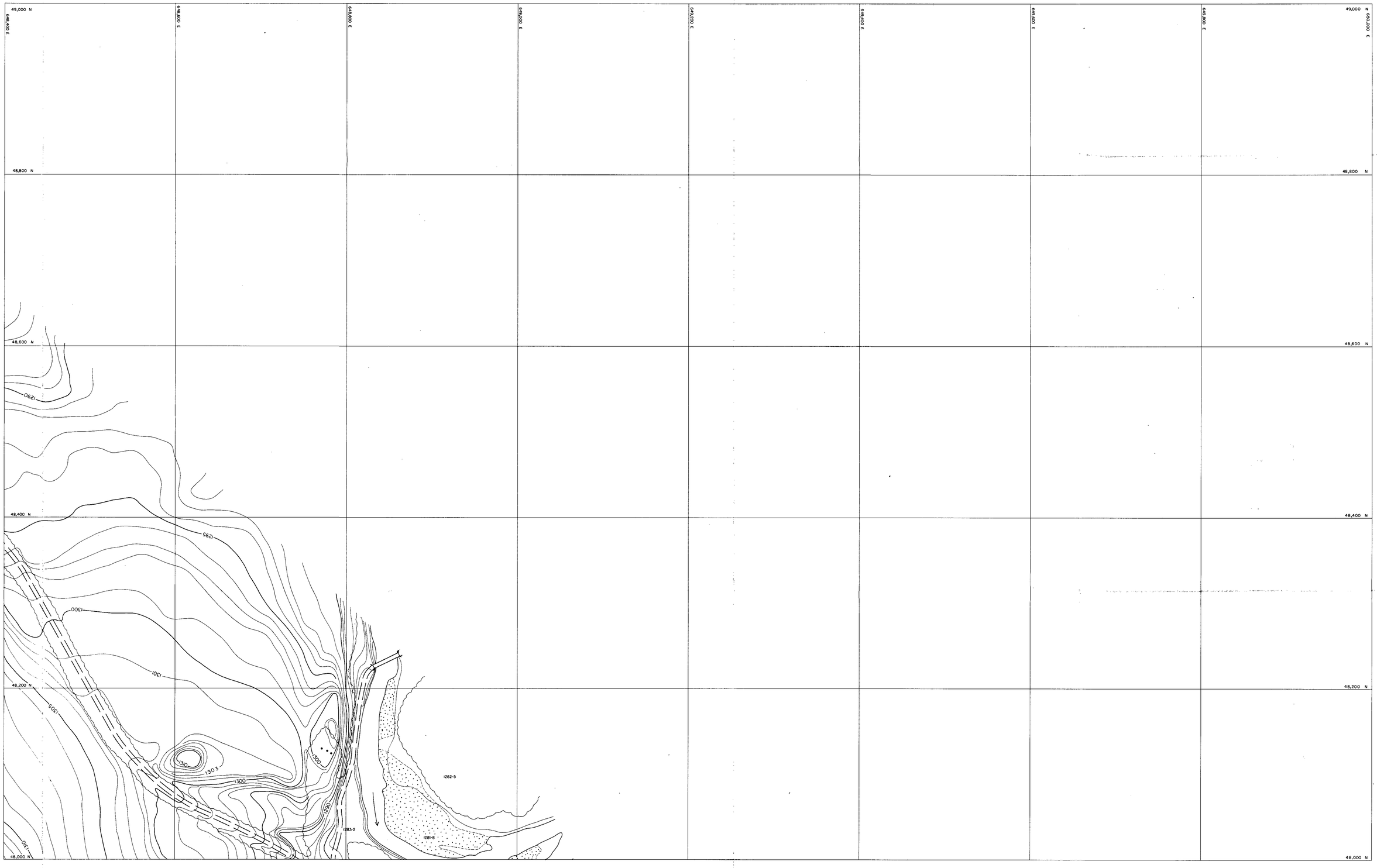
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 48G	DWG. NO.

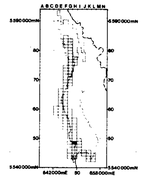
APPENDIX : 5.0



SHEET INDEX:

48 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 O 1962-3
SWAMP			

279
R-Elk River 80/2/A

REV.	DESCRIPTION	CHK'D.	DATE

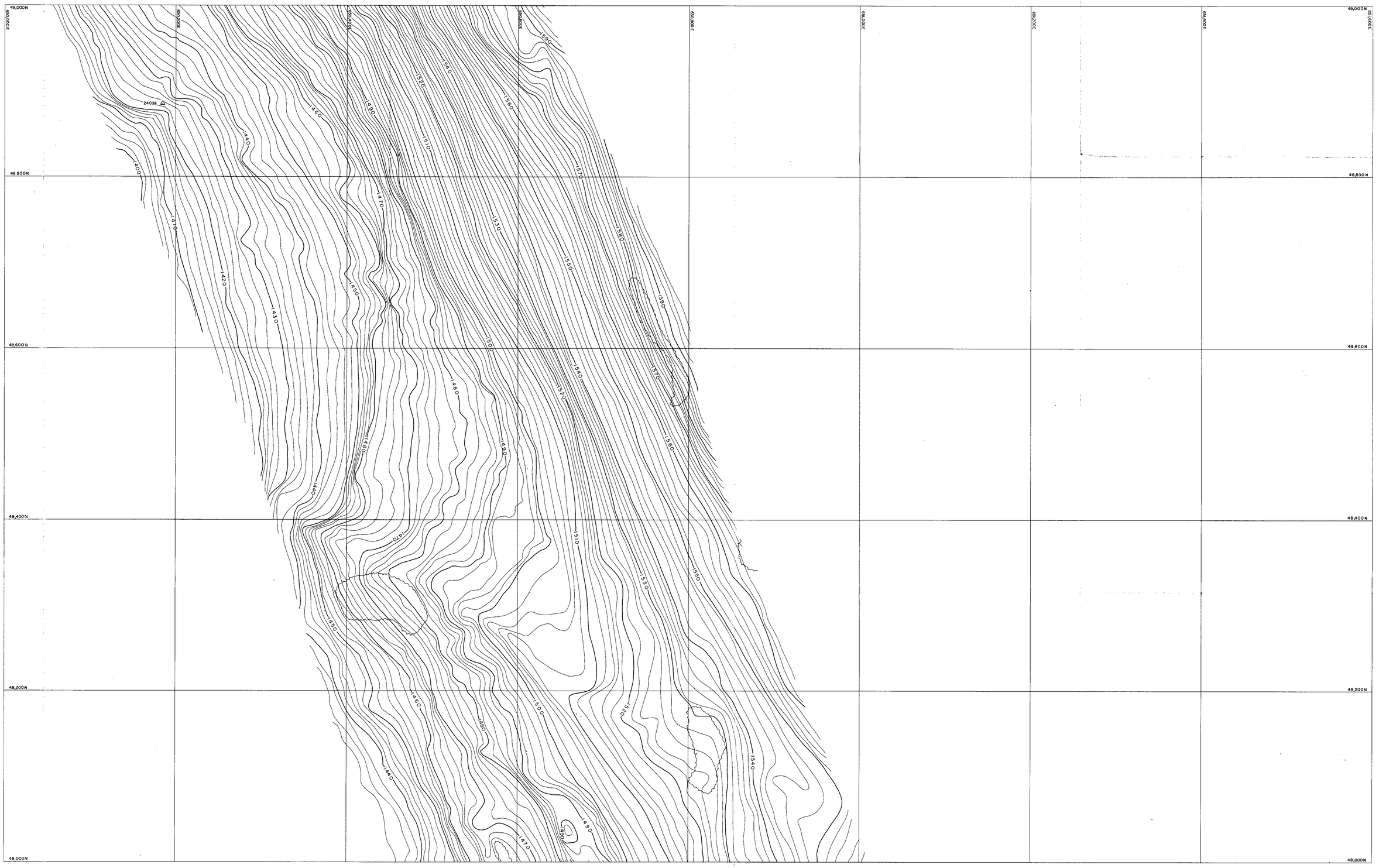
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 48 H	DWG. NO.

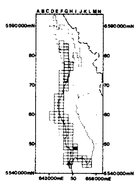
APPENDIX: 5.0



SHEET INDEX:

481

UTM
Zone 11
Center Meridian
=117°w.Gr.



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SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION ..... 2077·8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....
BEAVER DAM .....
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

X-Elk River 80(2)A

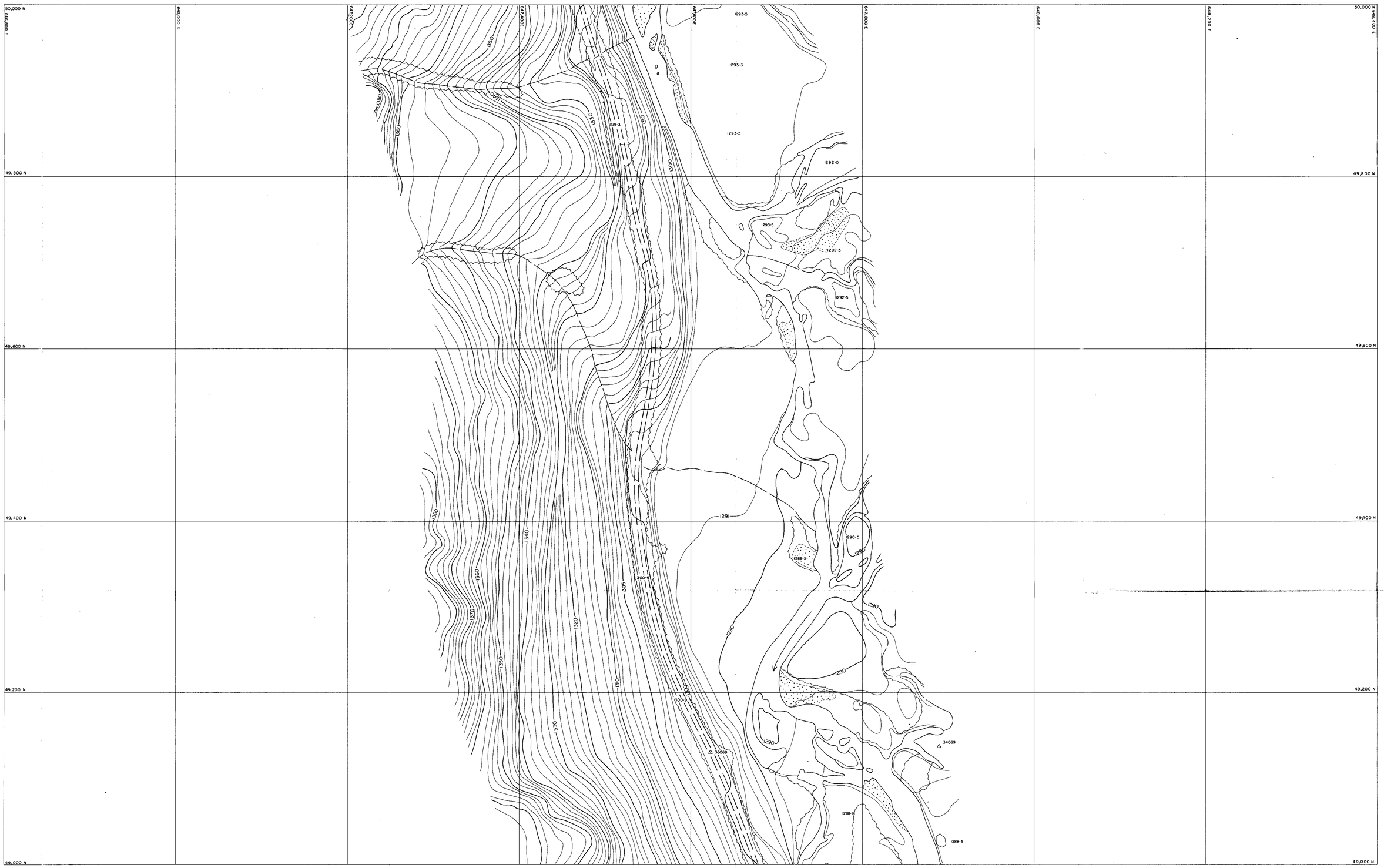
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 48 I	DWG. NO.

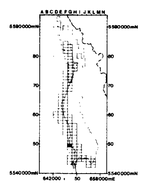
APPENDIX : 5.0



SHEET INDEX:

49G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

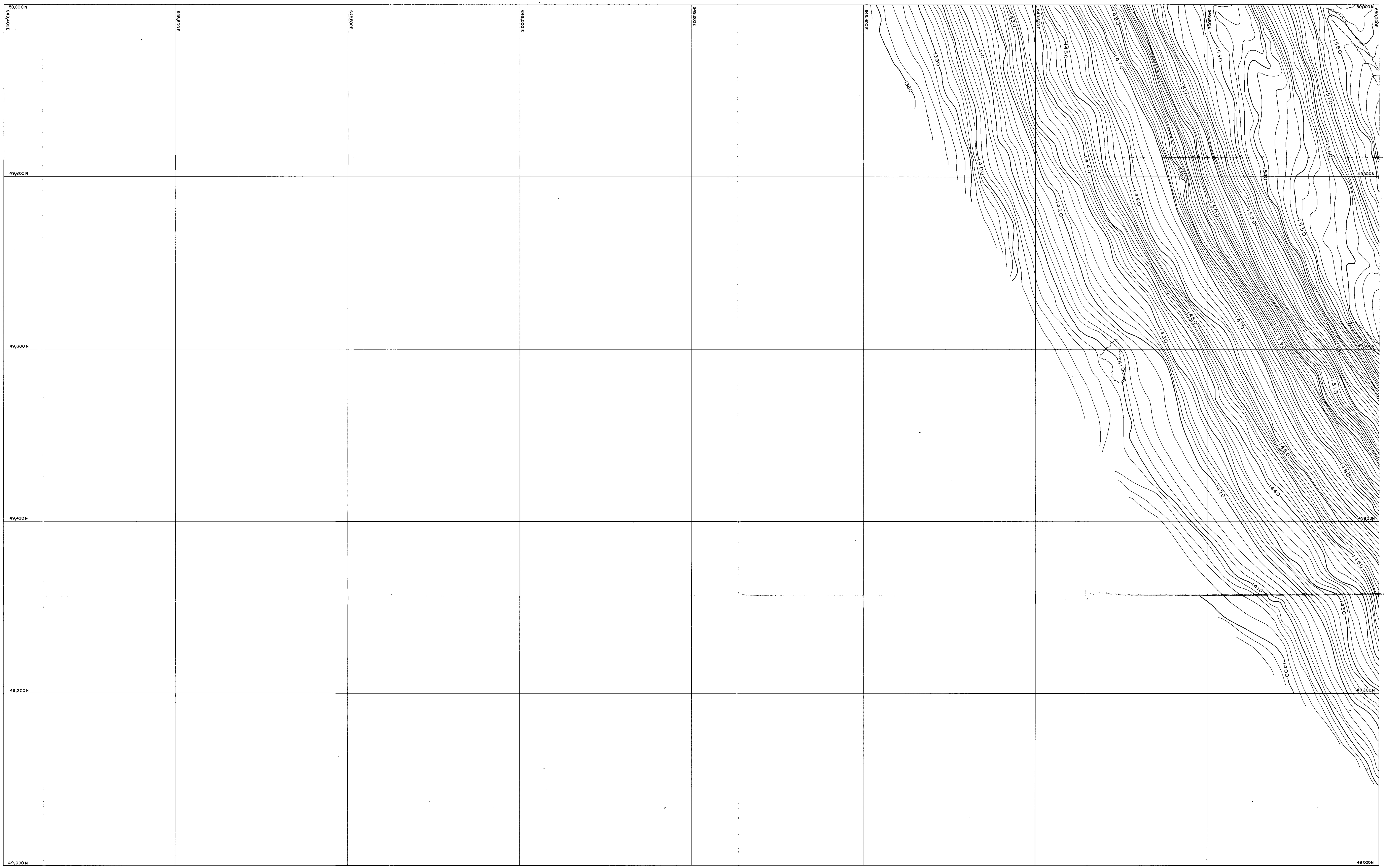
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 49G	DWG. NO.

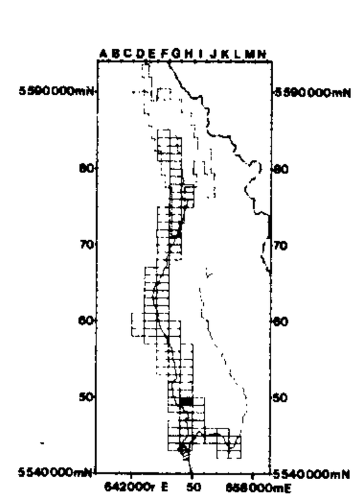
APPENDIX : 5.0



SHEET INDEX:

49H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8
ROAD	
TRACK OR TRAIL	
POLE	• • •
BUILDING	
CREEKS	
LAKE	
SWAMP	
BEAVER DAM	B.D.
FALLS/RAPIDS	
CONTOURS	1500
TREES	
AIR PHOTO CENTRE	+ 222132
HORIZONTAL CONTROL POINT	△ 24049
VERTICAL CONTROL POINT	V 62 ⊙ 1962·3

279

K·Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

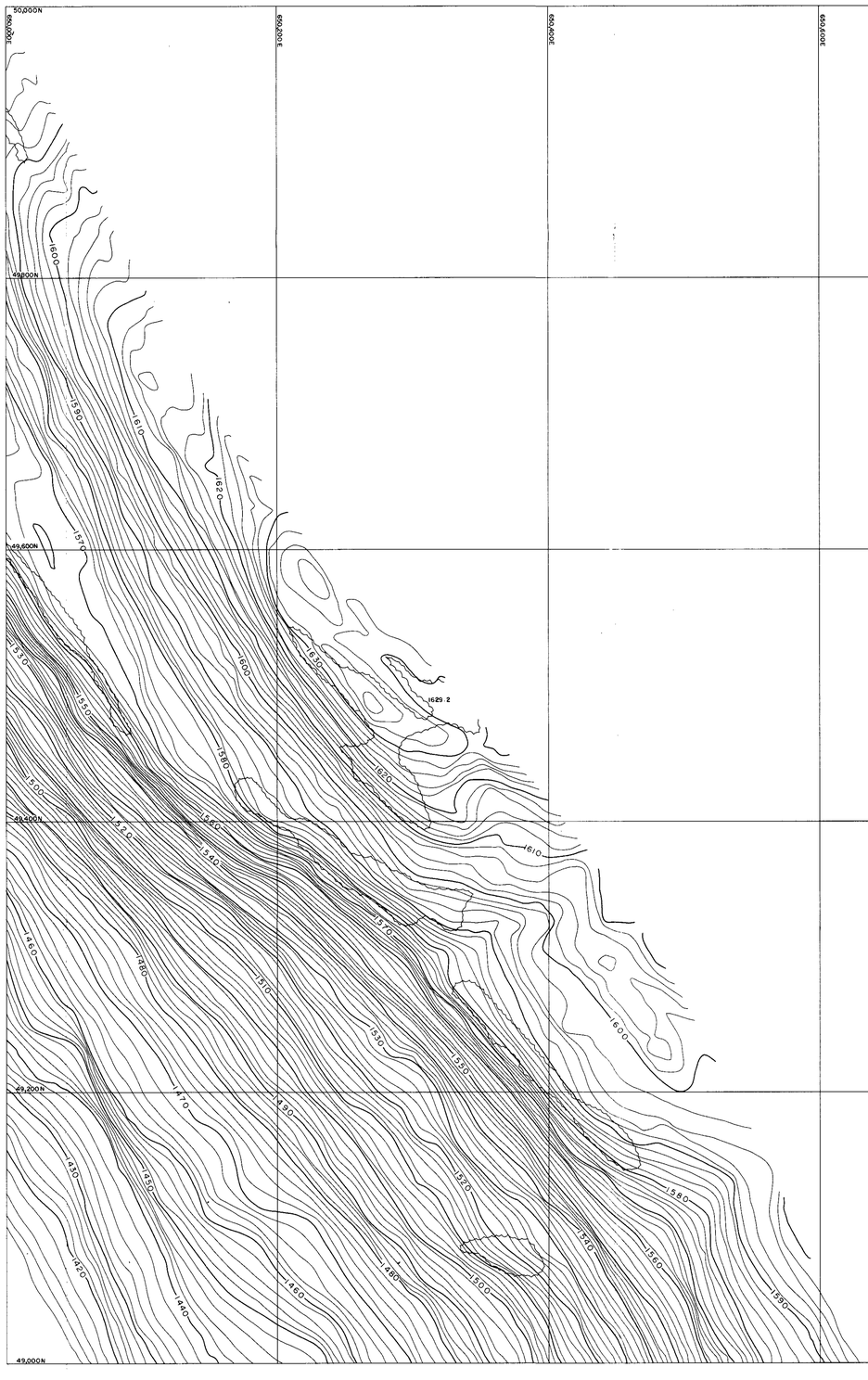
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 49 H	DWG. NO.

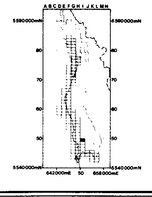
APPENDIX: 5.0



SHEET INDEX:

491

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279 K-Elk River 82G/4

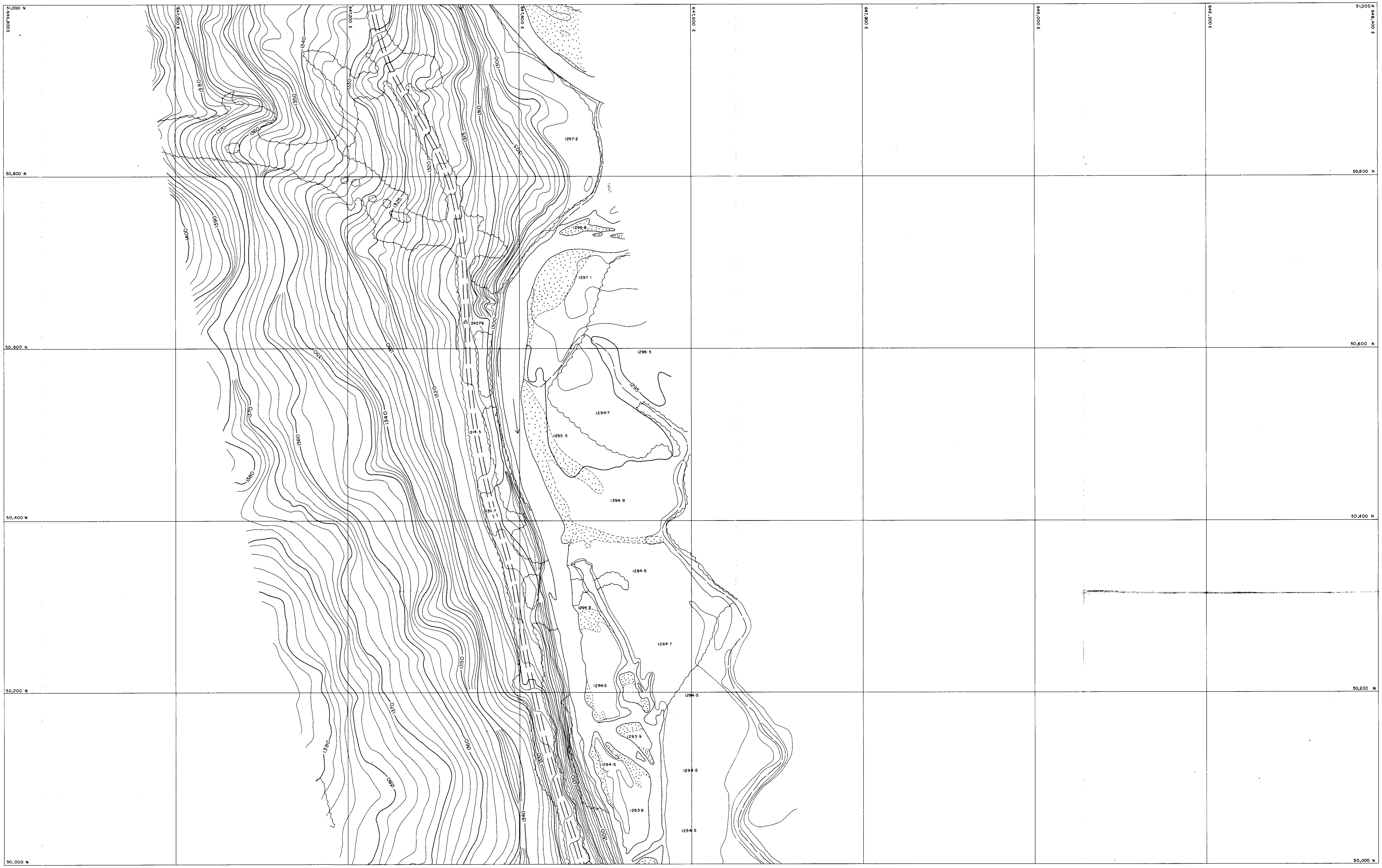
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 49 I	DWG. NO.

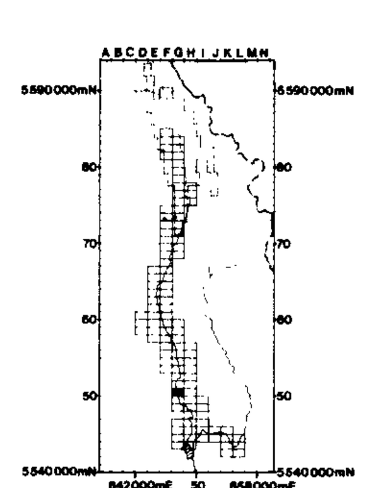
APPENDIX 15.0



SHEET INDEX:

50 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2 M WITH 1 M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE	• • •	TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279 K-Elk River 80/21A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

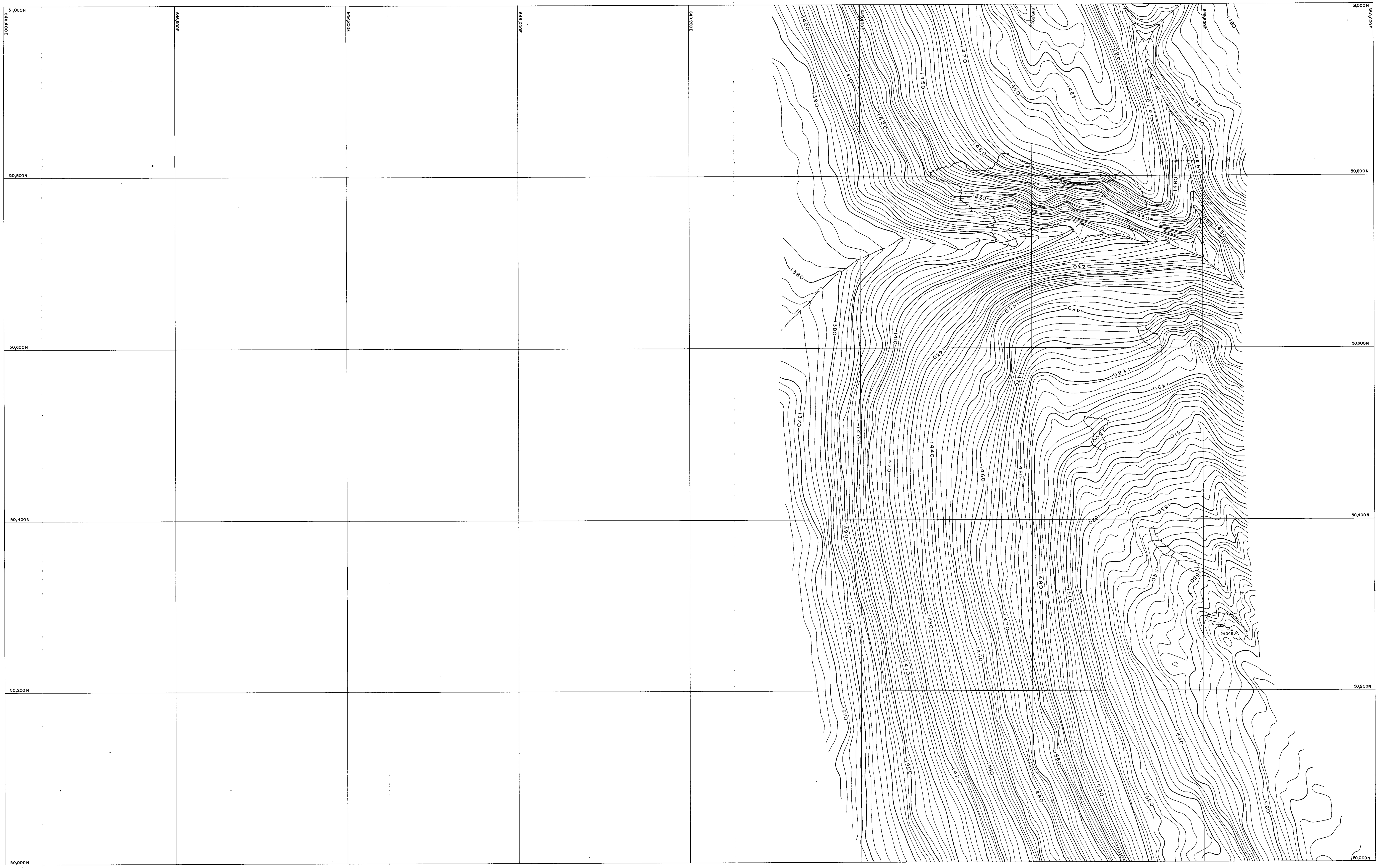
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 50G	DWG. NO.

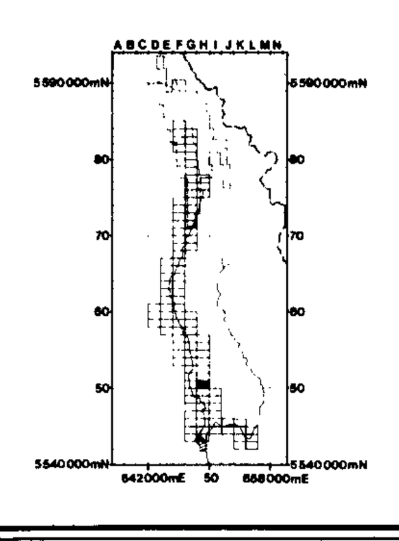
APPENDIX : 5.0



SHEET INDEX:

50 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION .... 2077·8
ROAD ....
TRACK OR TRAIL ....
POLE ....
BUILDING ....
CREEKS ....
LAKE ....
SWAMP ....
BEAVER DAM .... B.D.
FALLS/RAPIDS ....
CONTOURS 1500
TREES ....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT ...... △ 24049
VERTICAL CONTROL POINT .... V 62 ⊙ 1962·3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

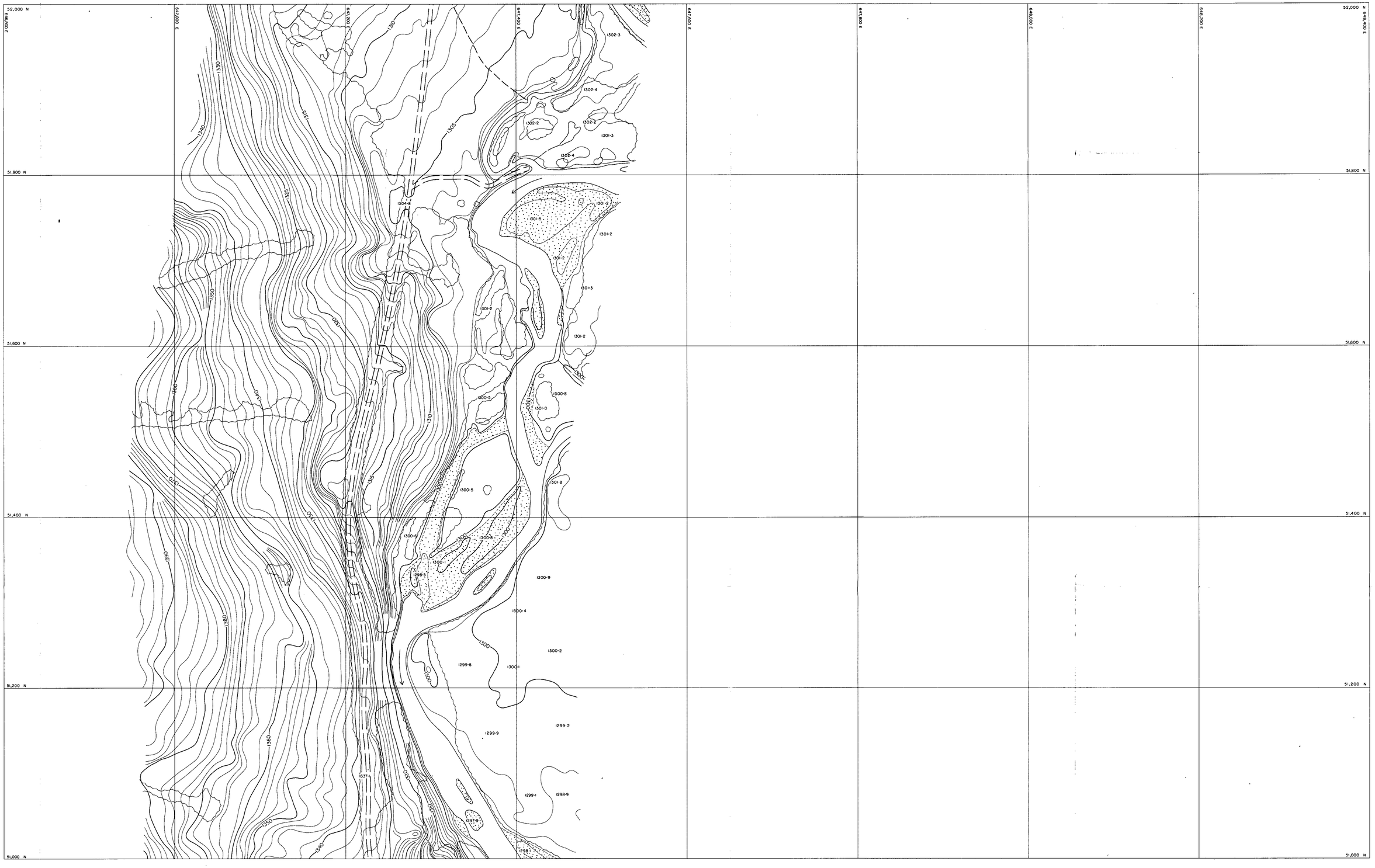
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 50 H	DWG. NO.

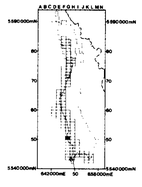
APPENDIX : 5.0



SHEET INDEX:

51 G

UTM
Zone 11
Center Meridian
=117°W.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30".

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +22132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279

A-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

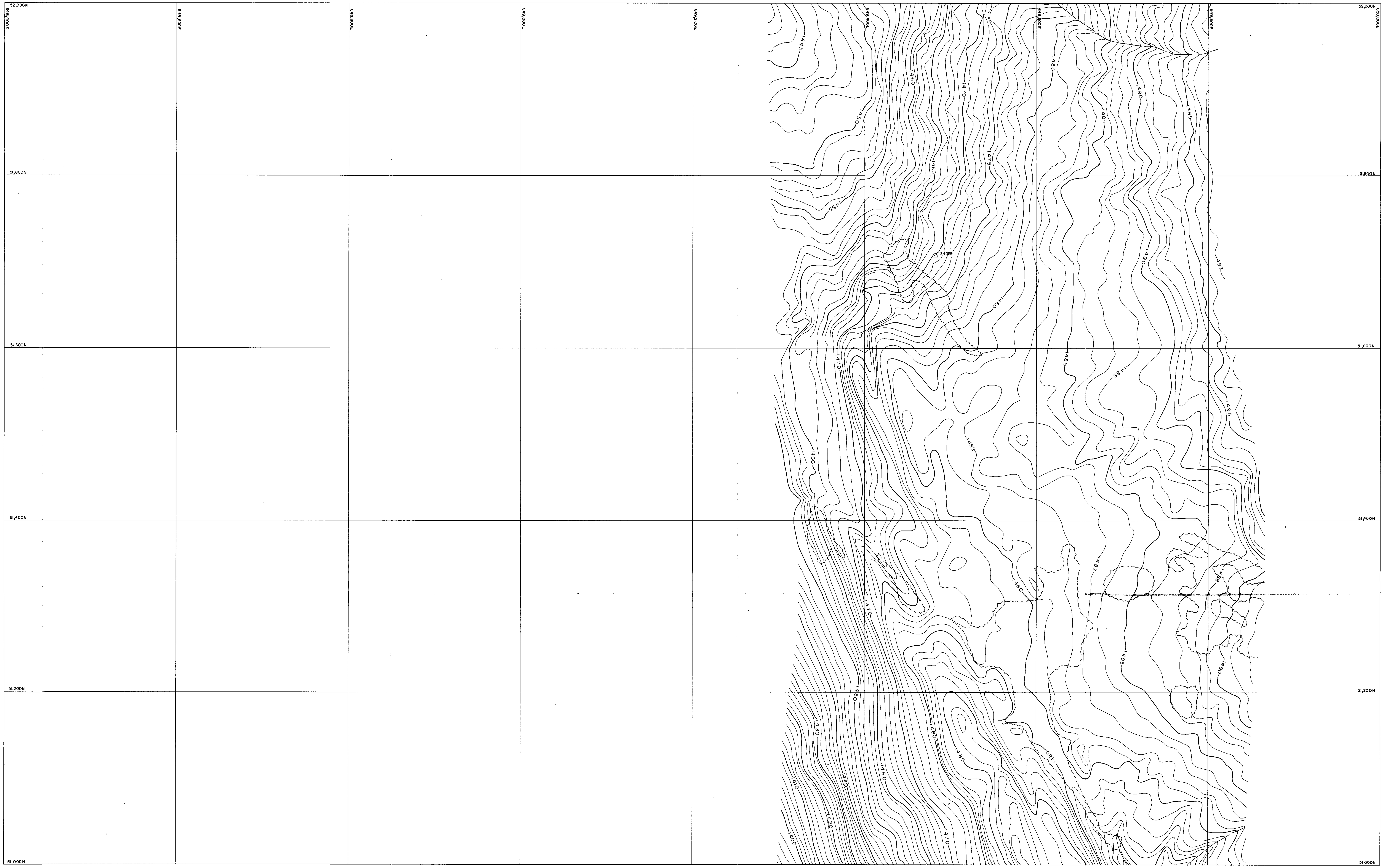
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 51G	DWG. NO.

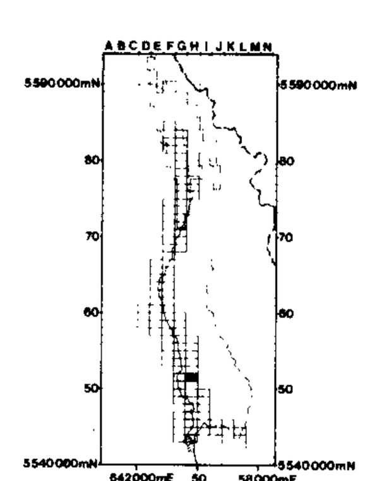
APPENDIX : 5.0



SHEET INDEX:

51H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279 K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

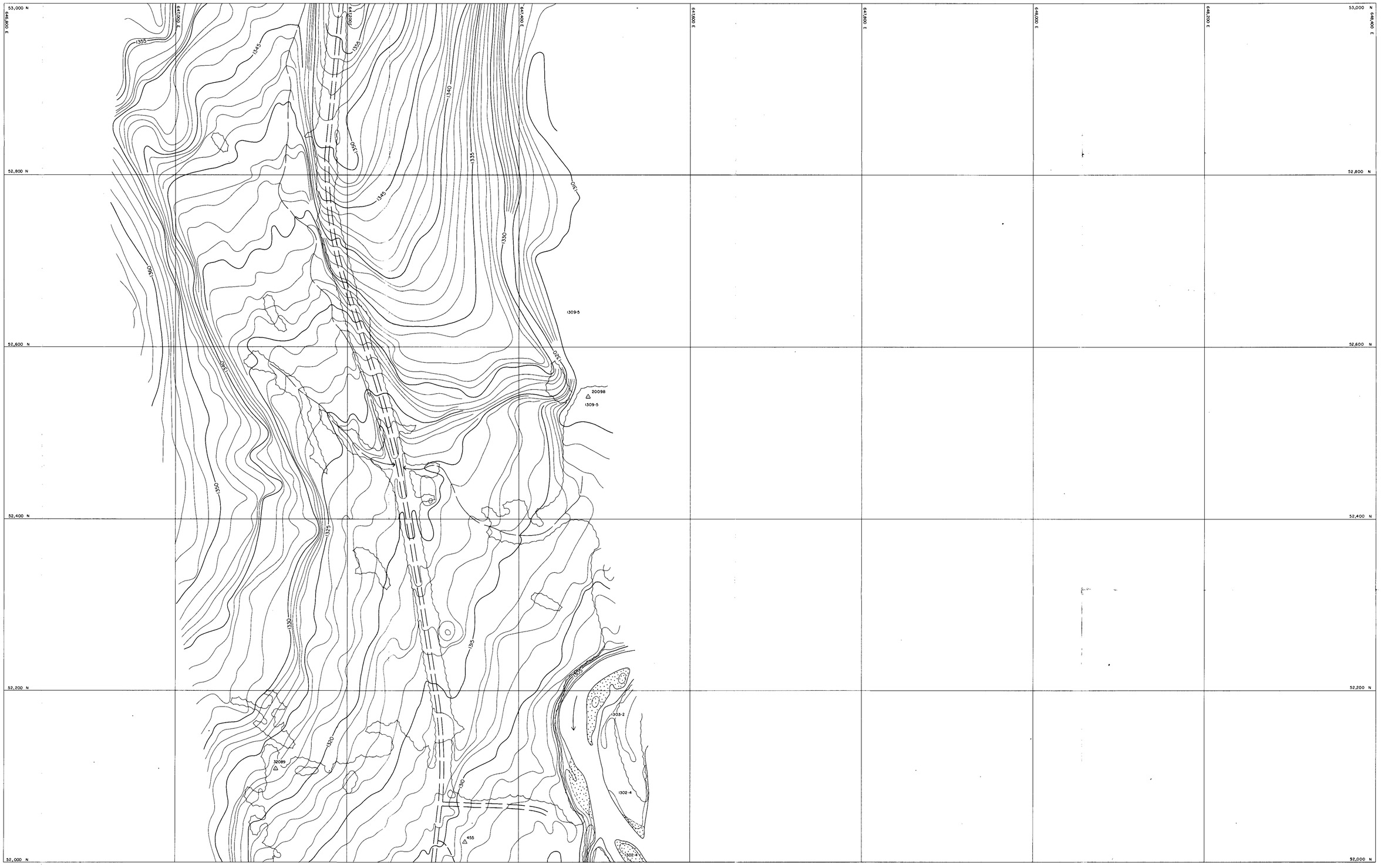
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 51 H	DWG. NO.

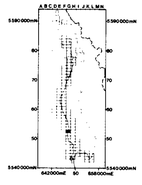
APPENDIX : 5.0



SHEET INDEX:

52G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX. 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	8.0
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279 K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

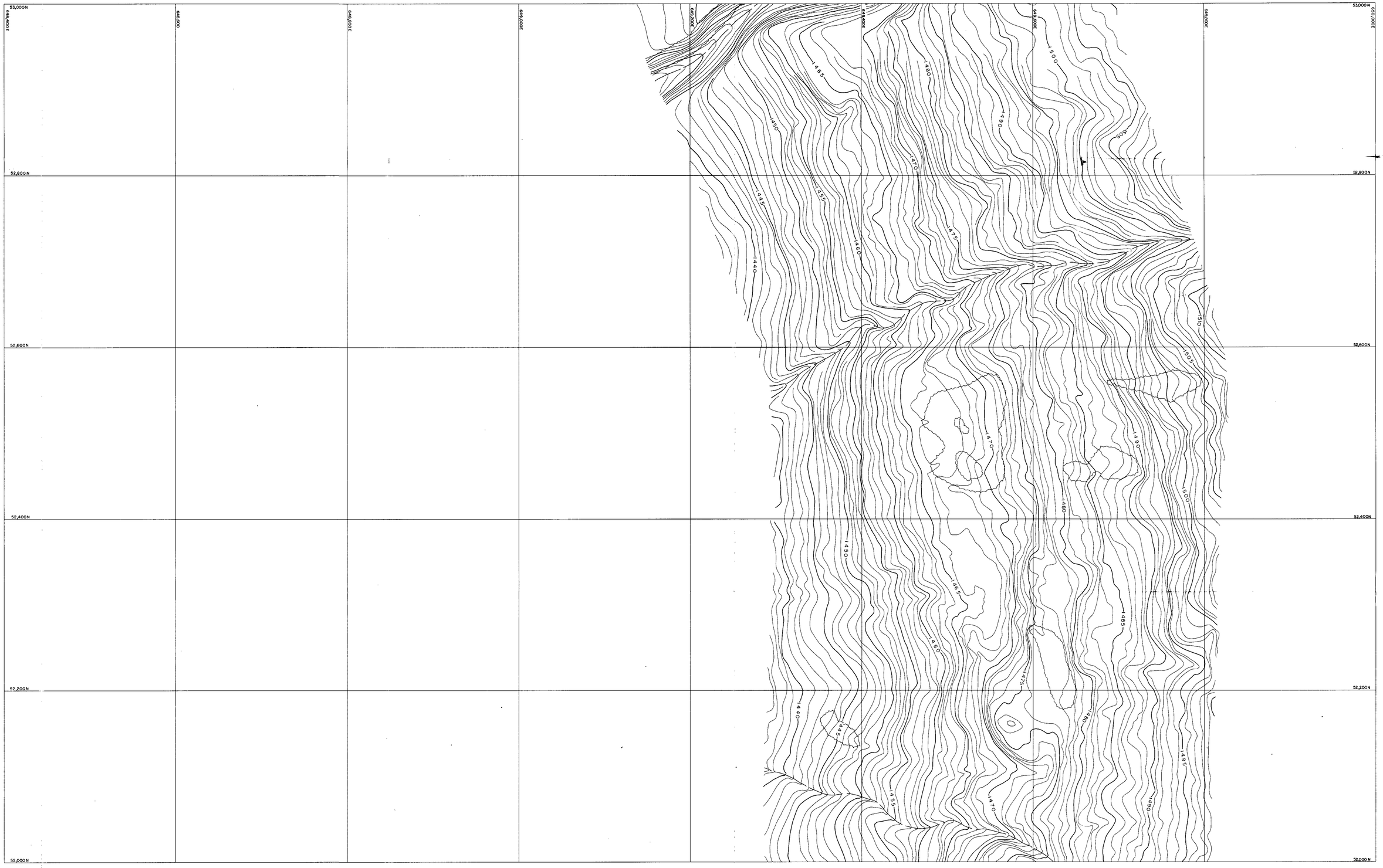
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 52G	DWG. NO.

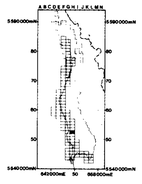
APPENDIX : 5.0



SHEET INDEX:

52 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



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DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80/21A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 52 H	DWG. NO.

APPENDIX 5.0

54,000 N
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E
53,800 N
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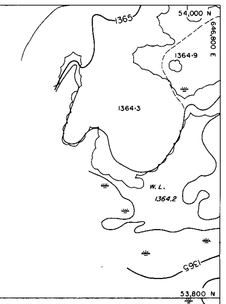
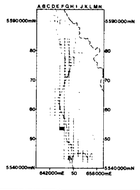
53,400 N
53,200 N
53,000 N



SHEET INDEX:

53 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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LEGEND:

SPOT ELEVATION ..... 2077·8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

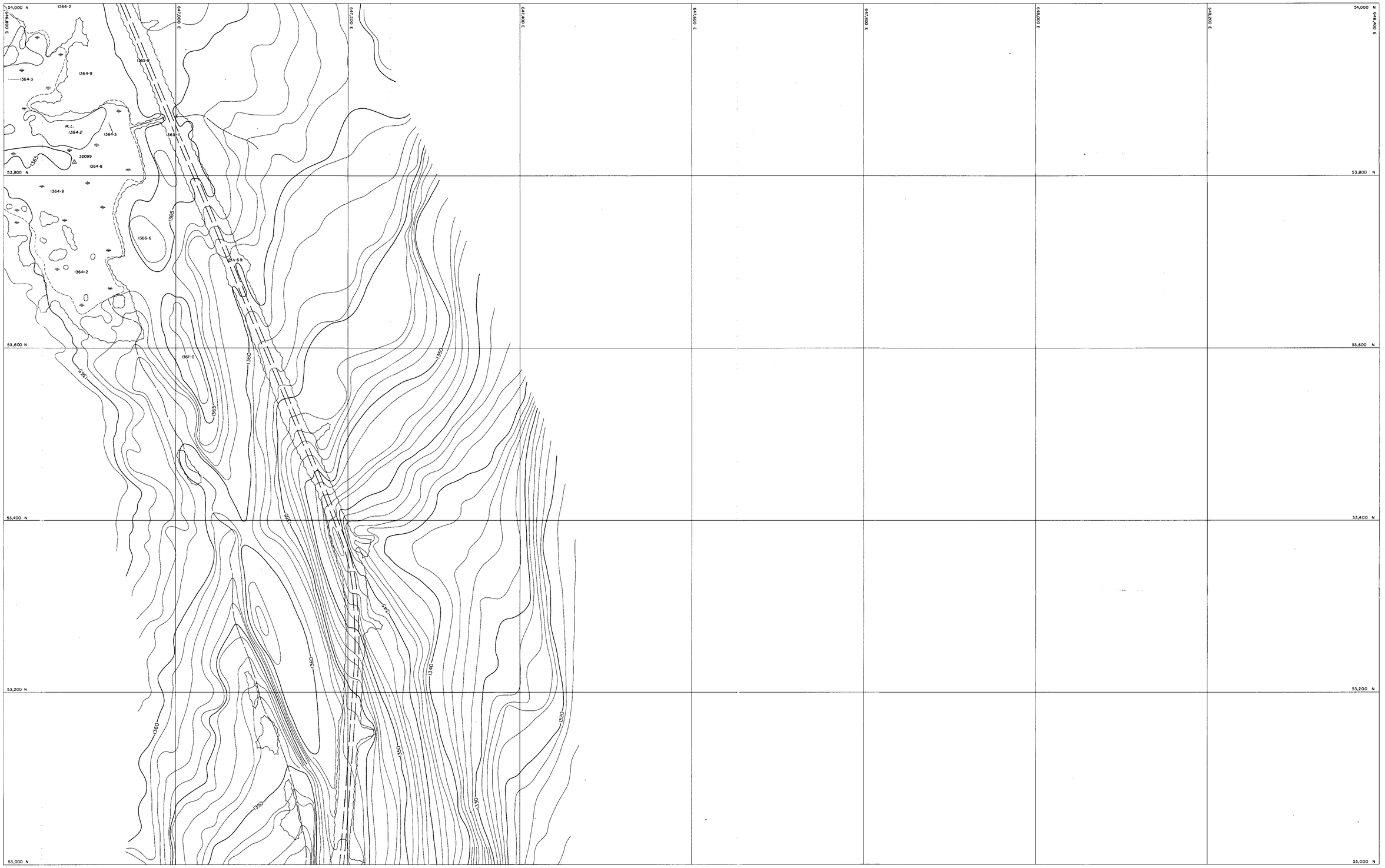
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 53F	DWG. NO.

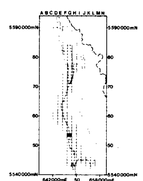
APPENDIX: 5.0



SHEET INDEX:

53 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11,117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80/210

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 53G	DWG. NO.

APPENDIX: 50

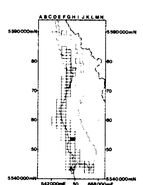
54,000 N
648,400 E
648,600 E
648,800 E
649,000 E
649,200 E
649,400 E
649,600 E
649,800 E
650,000 E
53,800 N
53,600 N
53,400 N
53,200 N
53,000 N

1442-8

SHEET INDEX:

53H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX. 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE ..... +222:132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 © 1962-3

279

X-Elk River 80/2/A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

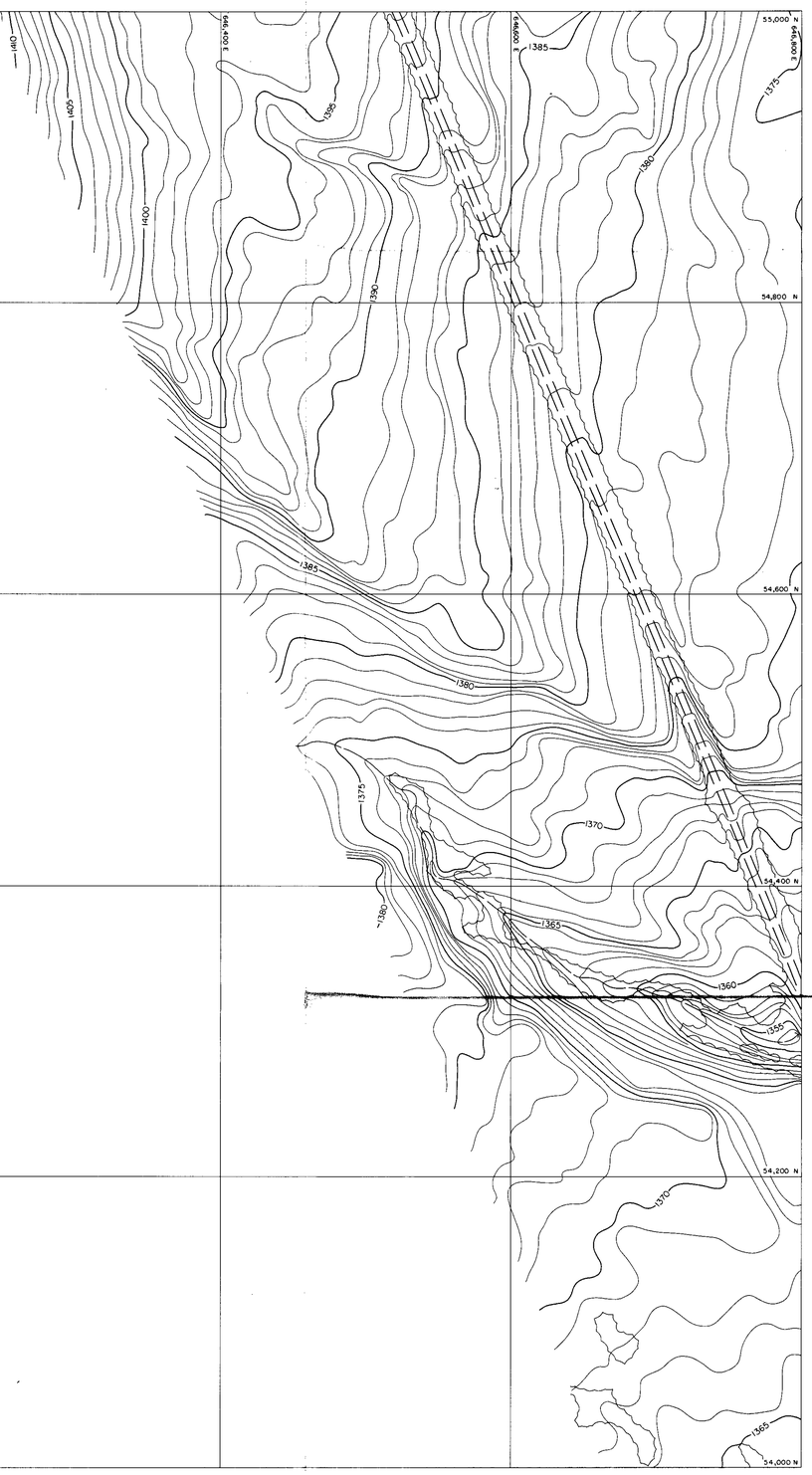
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 53H	DWG. NO.

APPENDIX: 5.0

279

K-Elk River 82(2)A

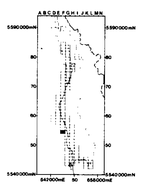
55,000 N
54,800 N
54,600 N
54,400 N
54,200 N
54,000 N
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E



SHEET INDEX:

54 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

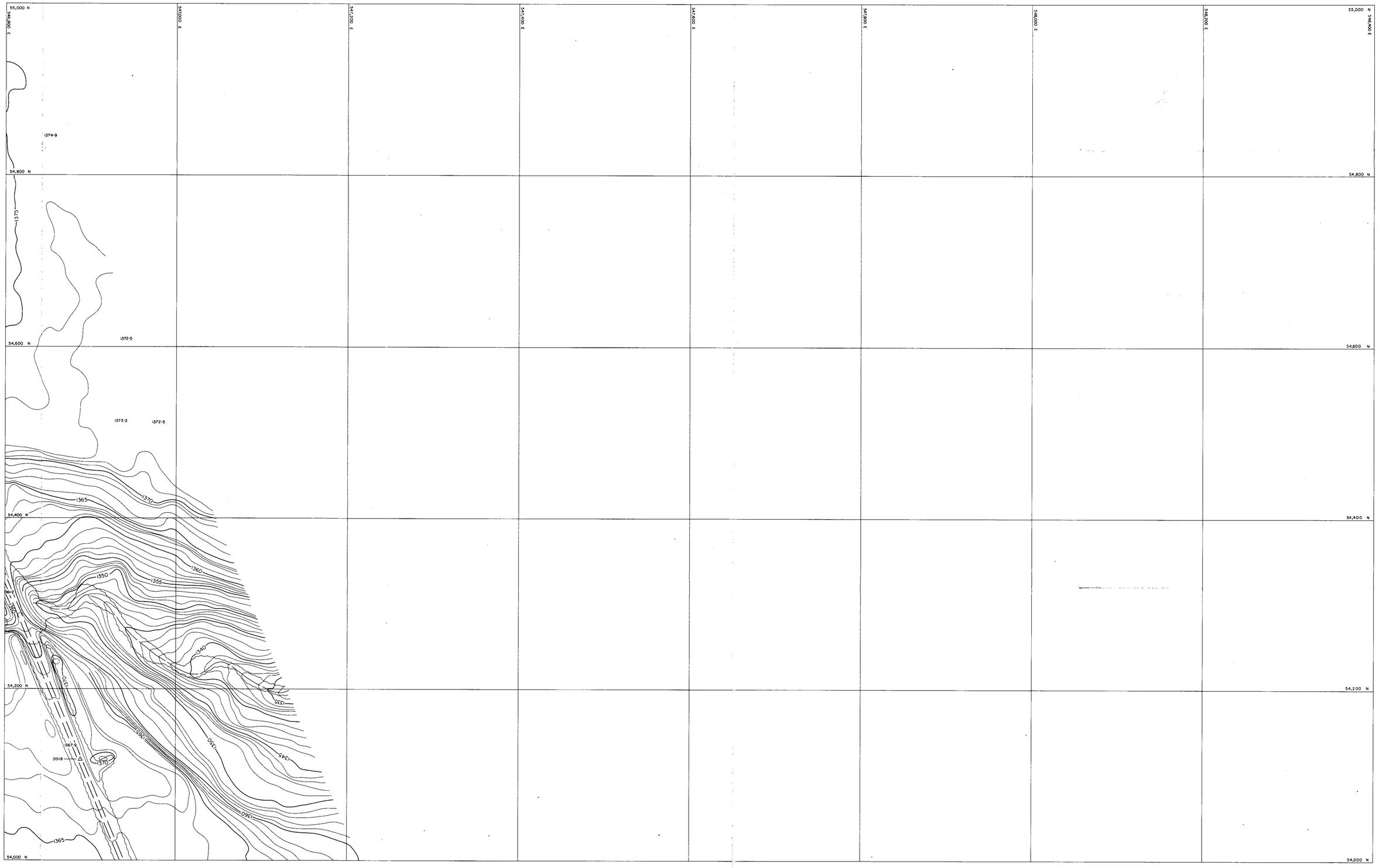
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

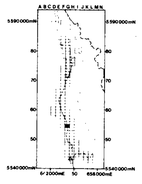
DRAWN BY		SCALE	1:2000
CHECKED BY		DATE	
MAP SHEET NO.	54F	DWG. NO.	



SHEET INDEX:

54 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

279 K-Elk River 80(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

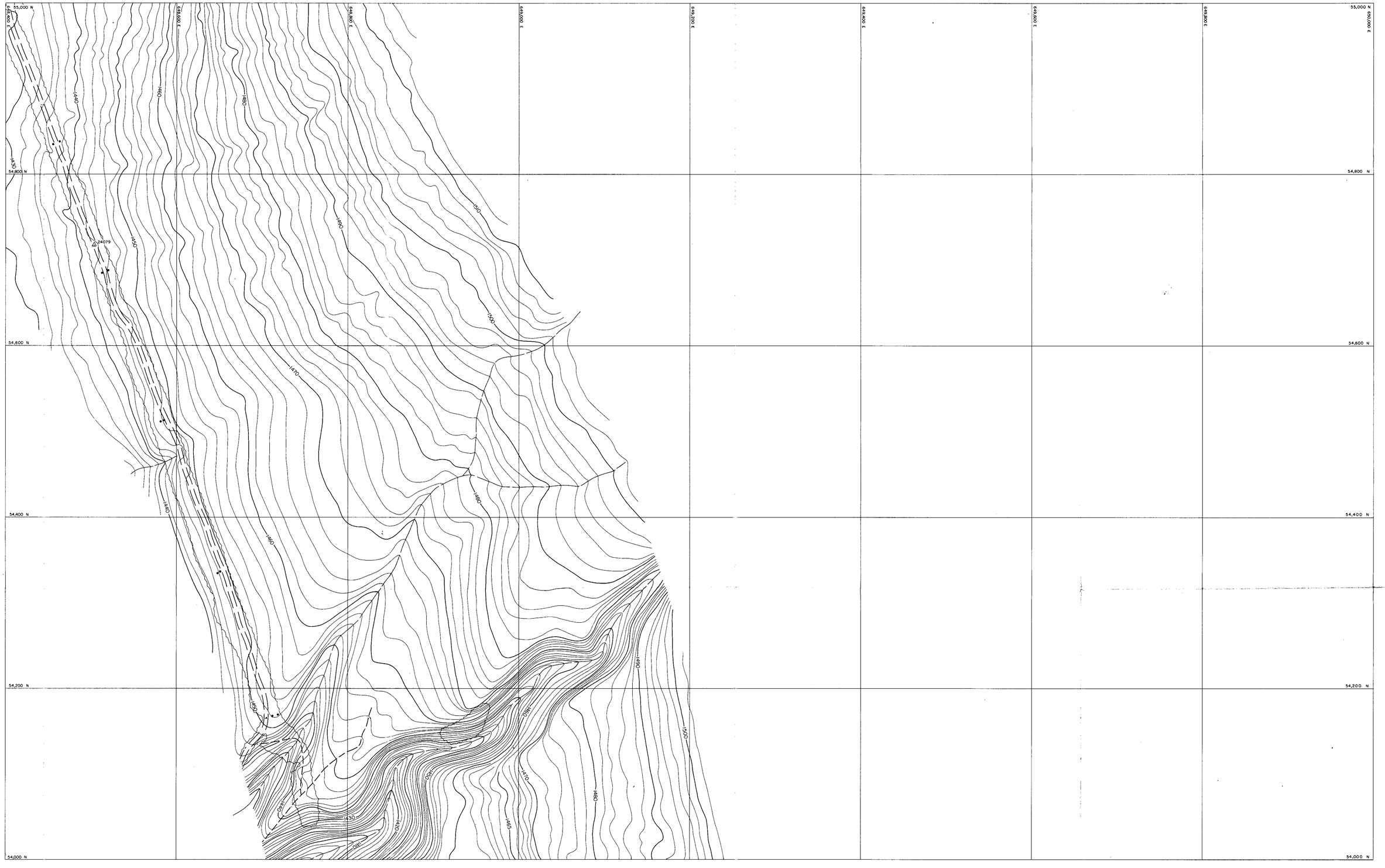
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 54 G	DWG. NO.

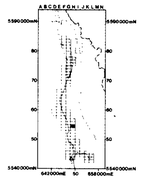
APPENDIX 5.0



SHEET INDEX:

54 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 @ 1962-3

279

K-Elk River 80(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

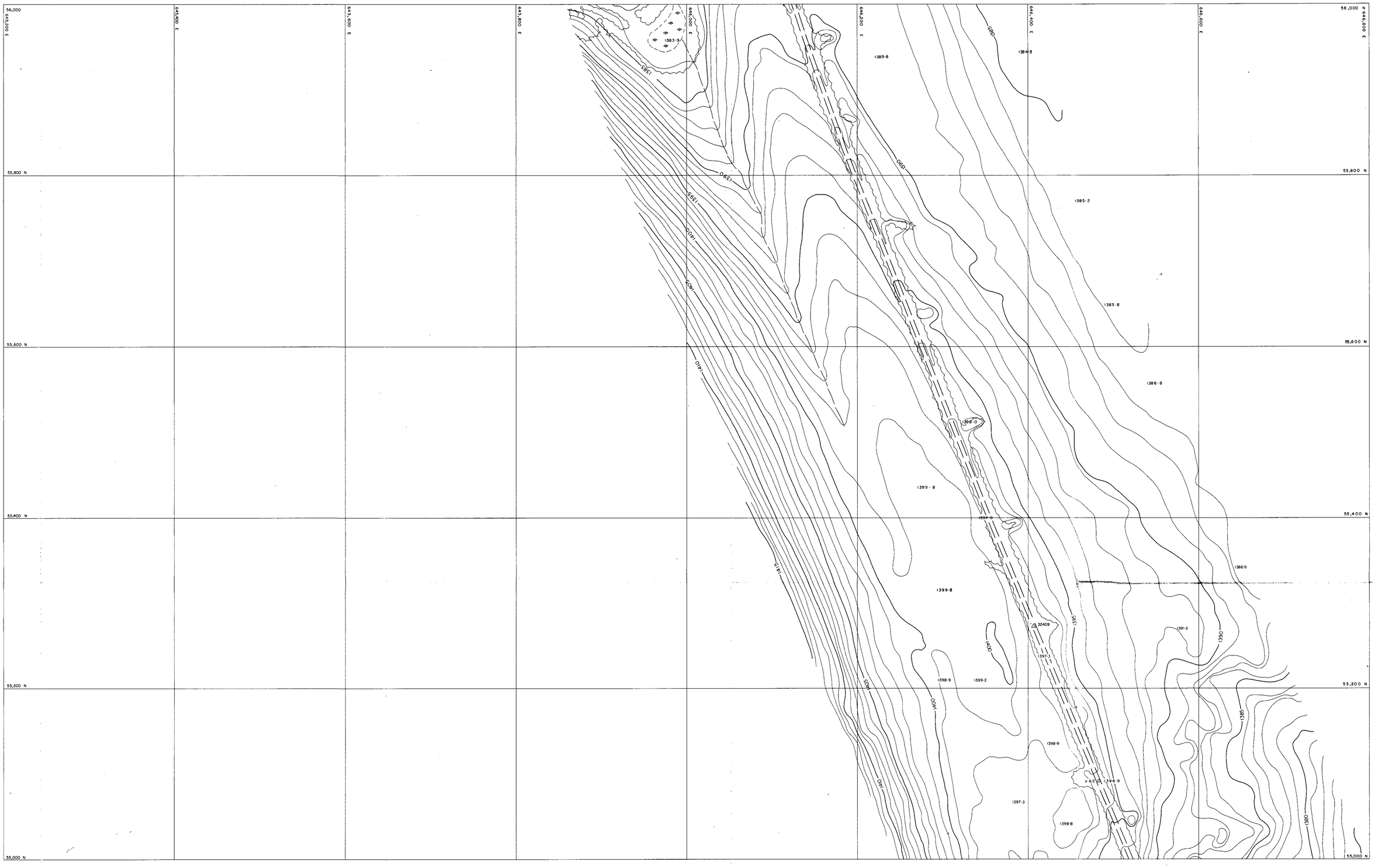
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 54 H	DWG. NO.

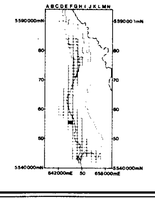
APPENDIX : 3.0



SHEET INDEX:

55F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

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SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50/21A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

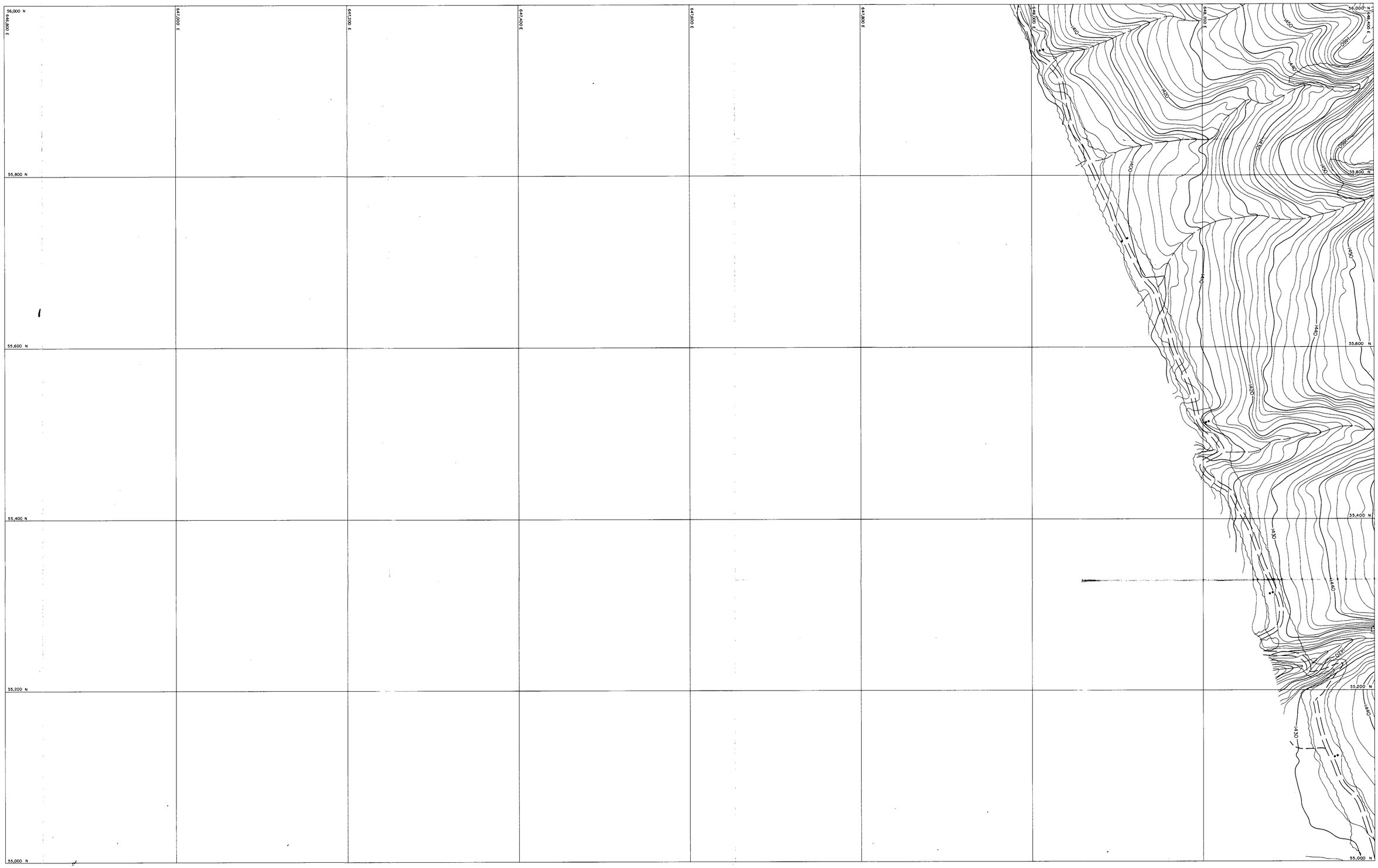
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 55F	DWG. NO.

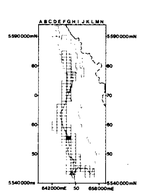
APPENDIX 5.0



SHEET INDEX:

55G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222/32
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 206(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

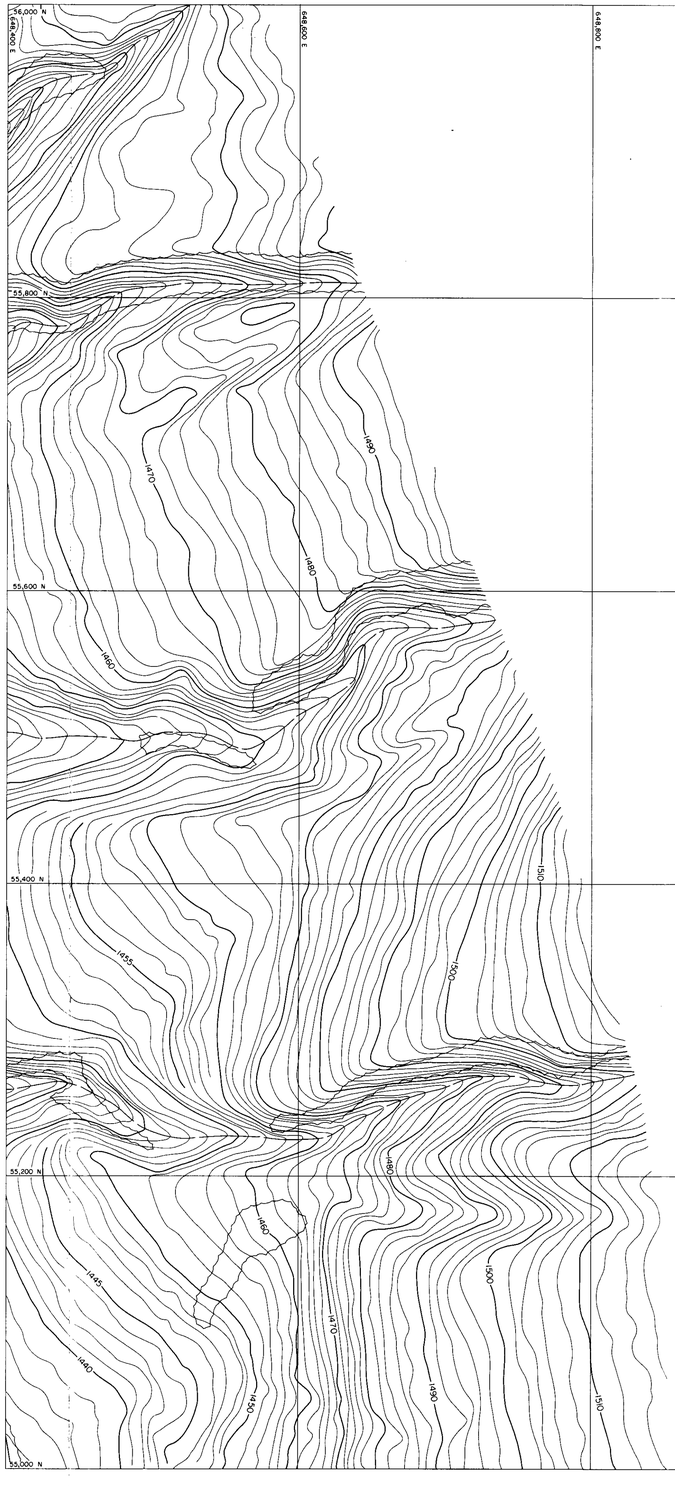
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 55G	DWG. NO.

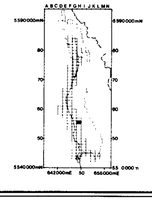
APPENDIX : 5.0



SHEET INDEX:

55 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

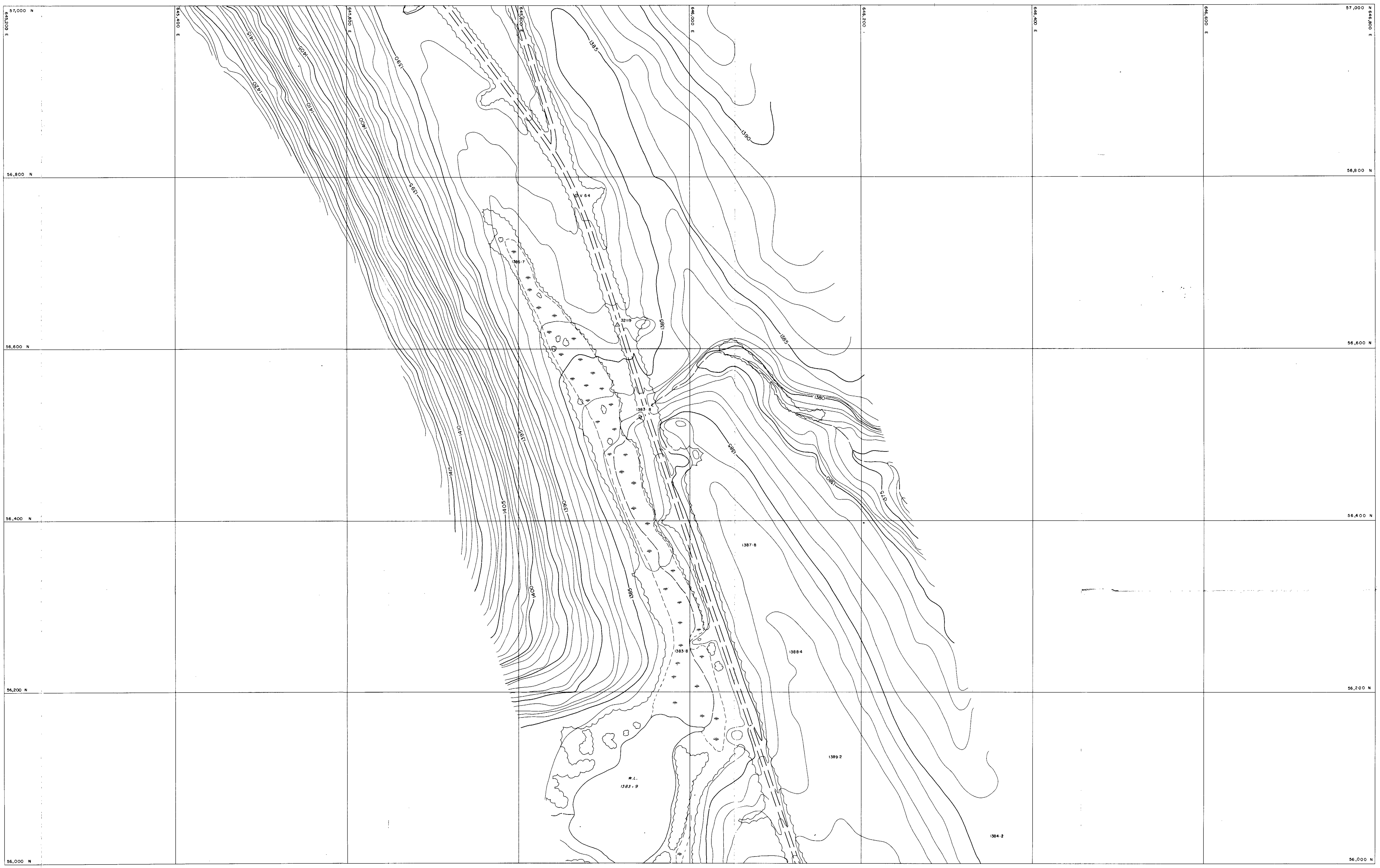
ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 55H	DWG. NO.

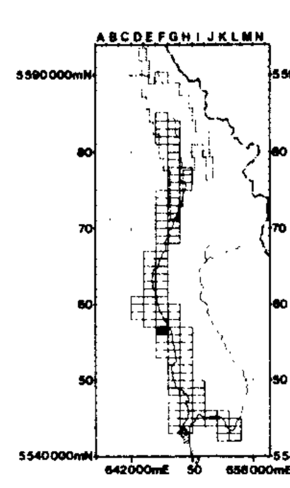
APPENDIX : 5.0



SHEET INDEX:

56 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2 M WITH 1 M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE	• • •	TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

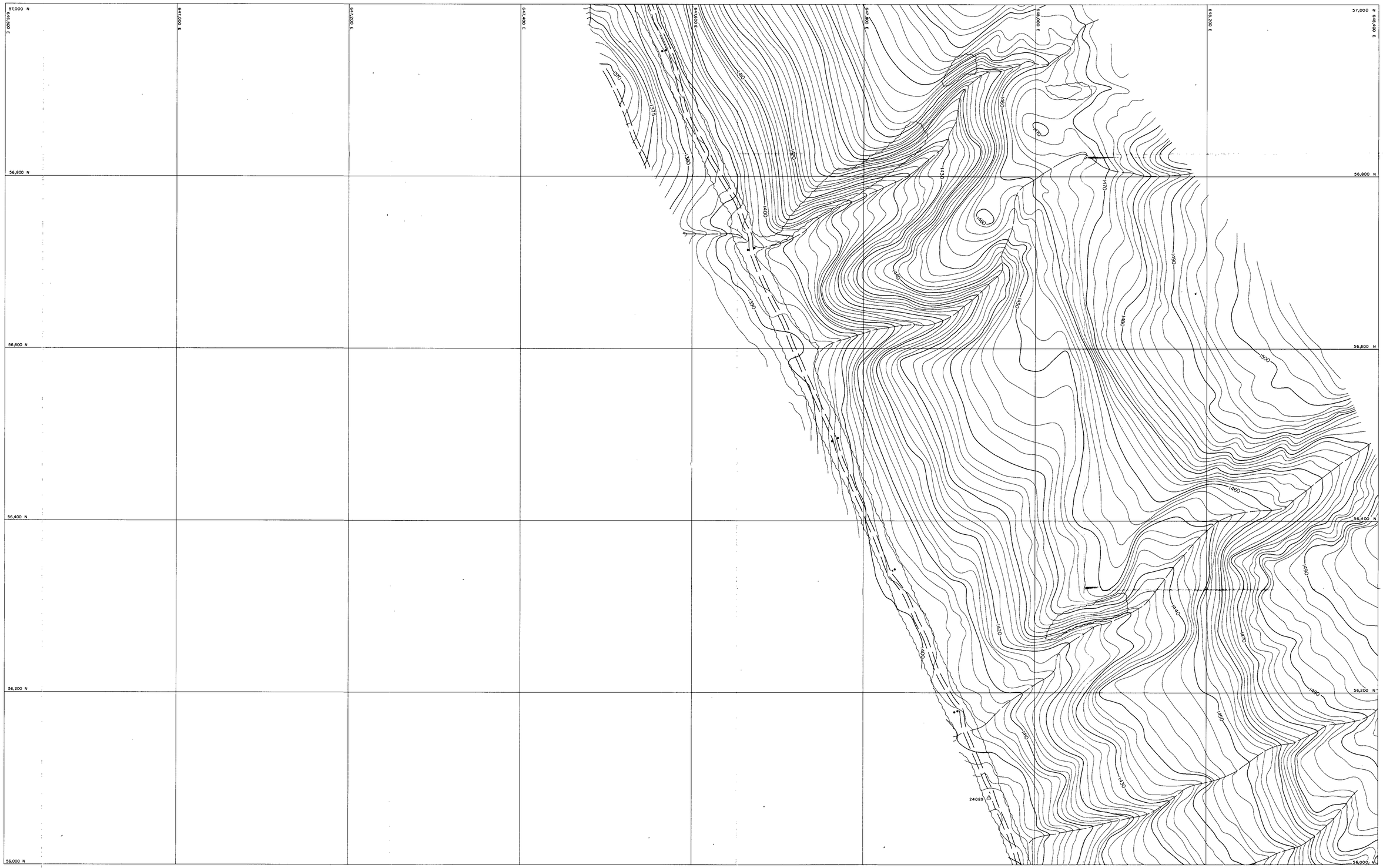
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 56 F	DWG. NO.

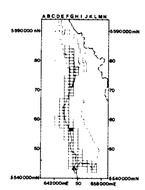
APPENDIX: 6.0



SHEET INDEX:

56 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

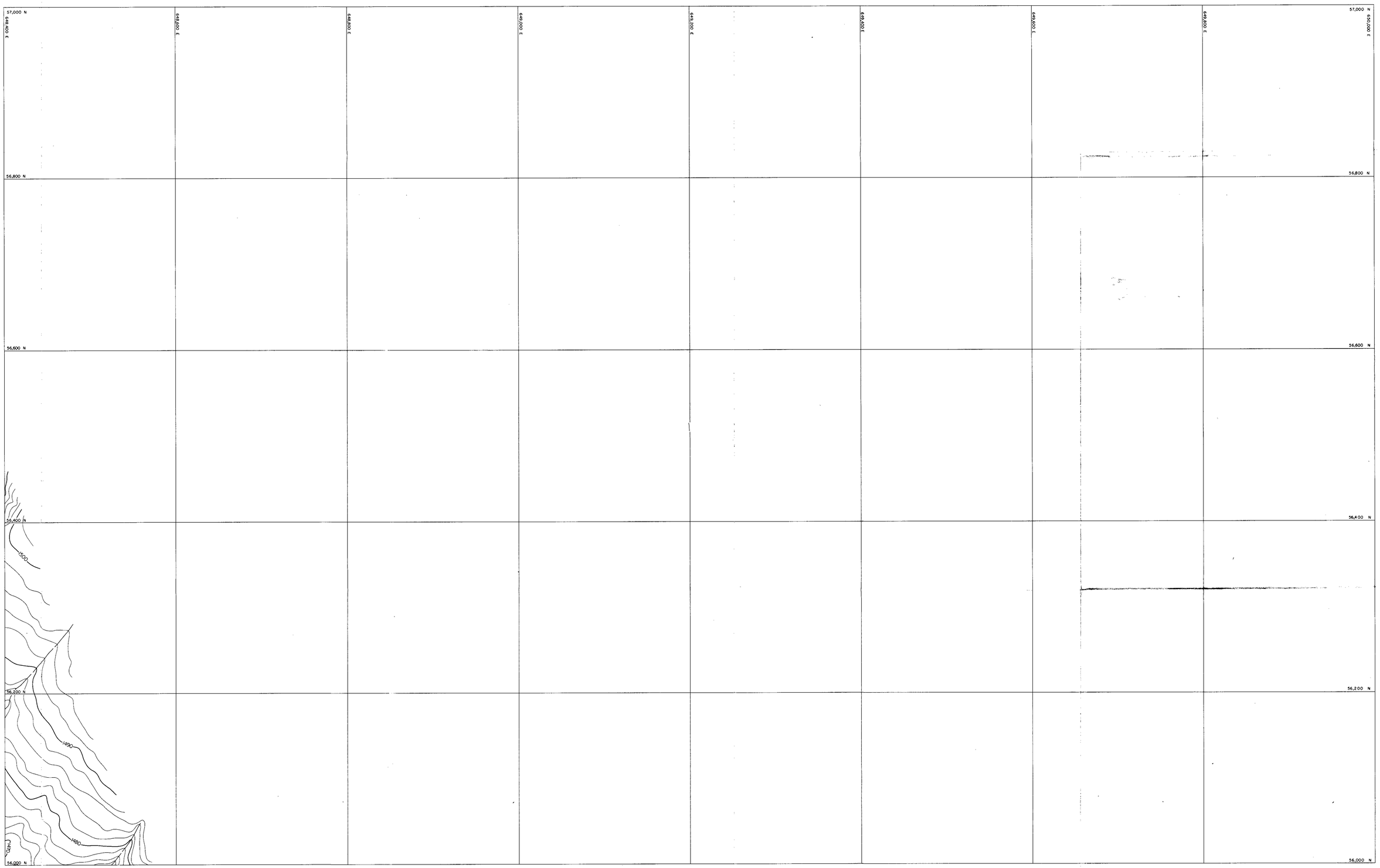
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 56G	DWG. NO.

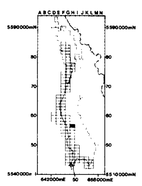
APPENDIX : 5.0



SHEET INDEX:

56 H

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	BD
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 80/210

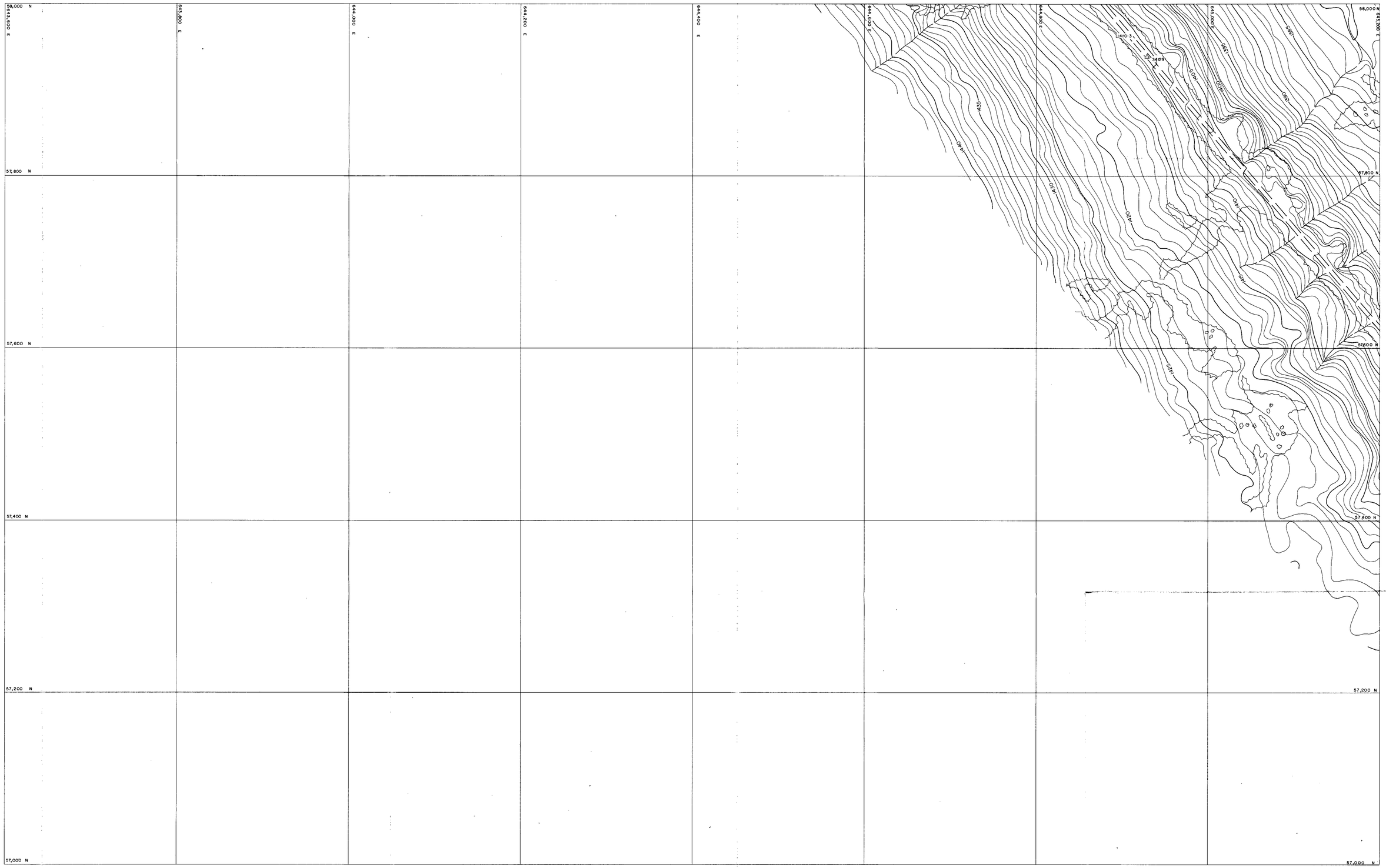
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 56 H	DWG. NO.

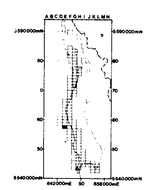
APPENDIX 5.0



SHEET INDEX:

57 E

UTM
Zone 11
Center Meridian
=117°W.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30".

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K. Elk Riv. 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

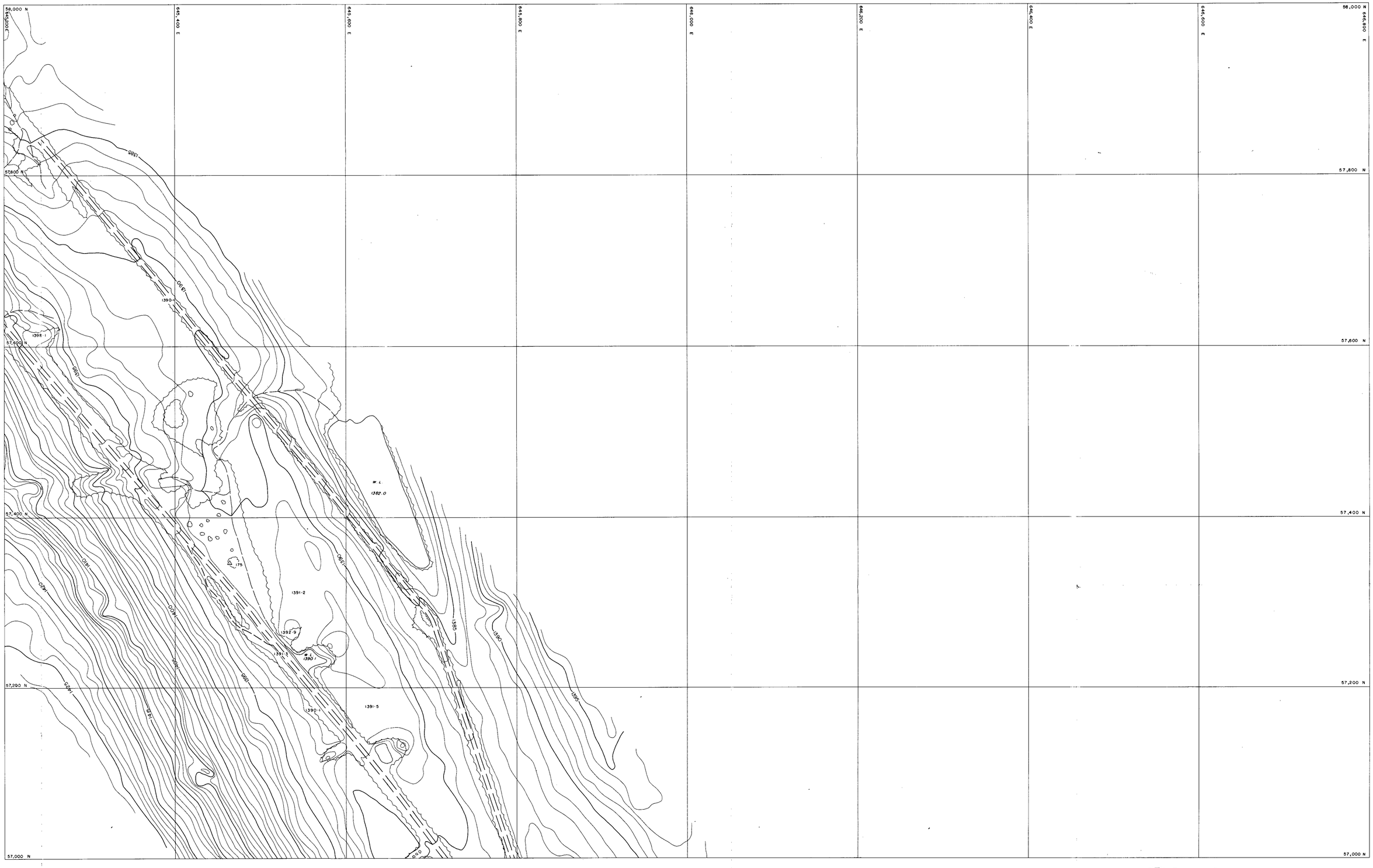
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 57E	DWG. NO.

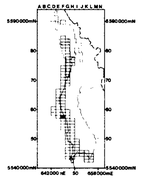
APPENDIX: 5.0



SHEET INDEX:

57 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

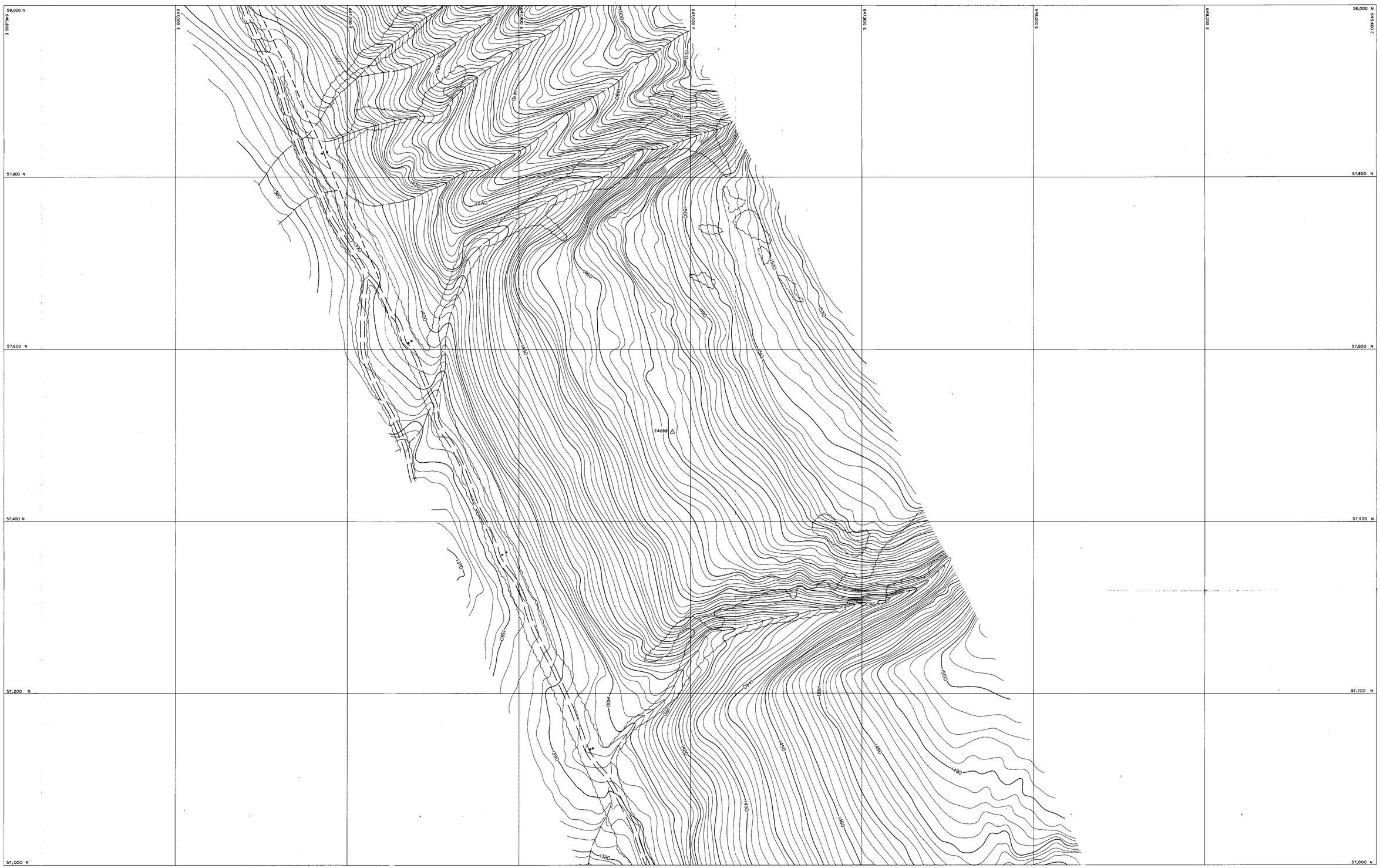
279 K-Elk River 30 6 1A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 57 F	DWG. NO.

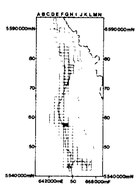
APPENDIX : 5.0



SHEET INDEX:

57 G

UTM
Zone 11
Center Meridian
=117°W.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 57G	DWG. NO.

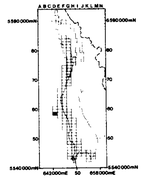
APPENDIX : 5.0

59,000 N
642,200 E
642,200 E
642,400 E
642,600 E
642,800 E
643,000 E
643,200 E
643,400 E
59,000 N 643,400 E
58,800 N
58,800 N
58,600 N
58,600 N
58,400 N
58,400 N
58,200 N
58,200 N
58,000 N
58,000 N

SHEET INDEX:

58 D

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34'30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	BD
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80(g)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 58D	DWG. NO.

APPENDIX : 5.0

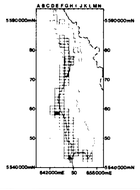
279

K-Elk River 80(2)A

SHEET INDEX:

58 E

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE: -2

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11.117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222-132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 58 E	DWG. NO.

APPENDIX: 5.0

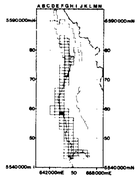
279

H-Elk River 80(2)A

SHEET INDEX:

58 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

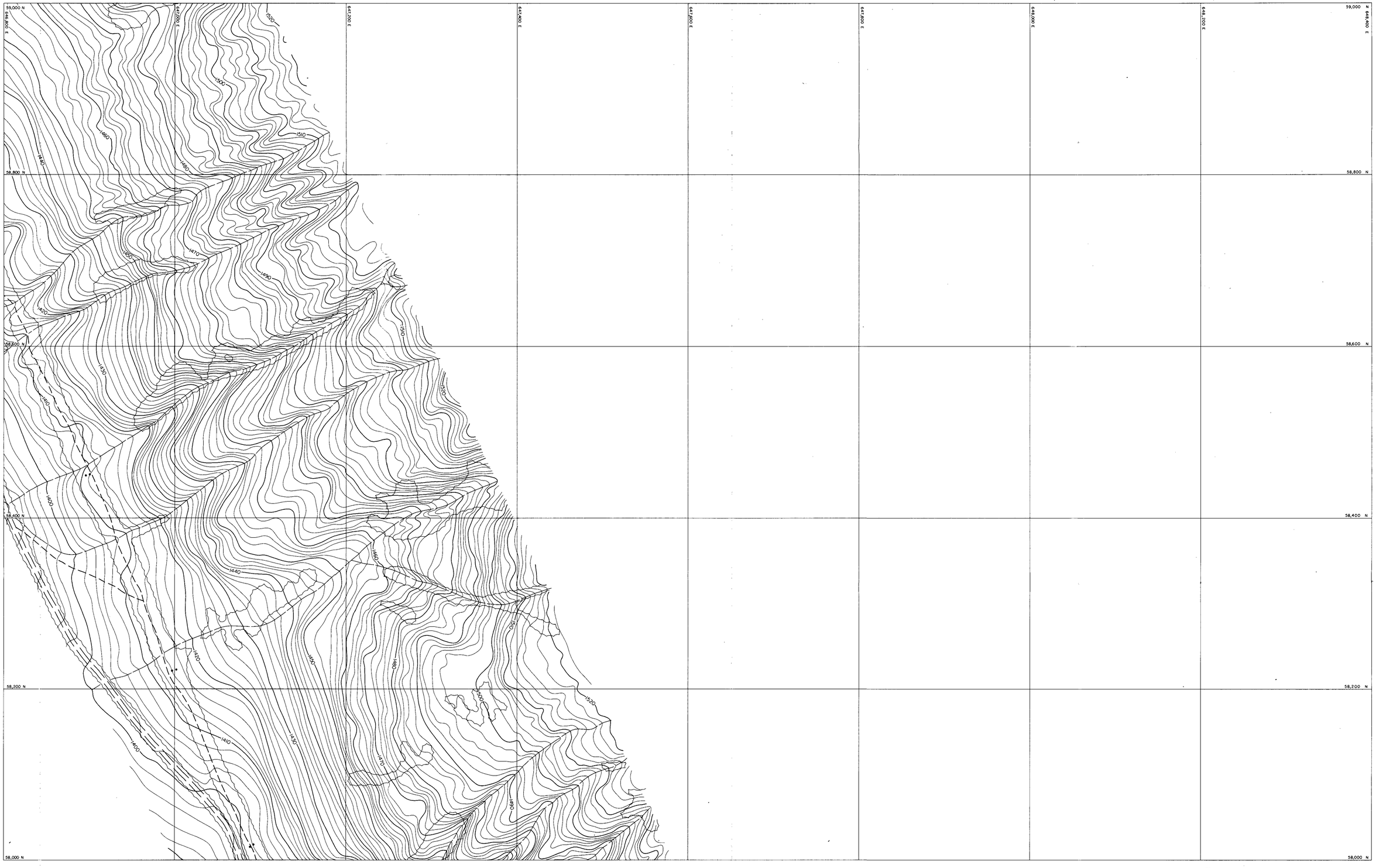
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 58 F	DWG. NO.

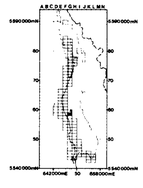
APPENDIX : 5.0



SHEET INDEX:

58 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

k-Elk River 58(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 58G	DWG. NO.

APPENDIX : 5.0

60,000 E
642,000 E
642,200 E
642,400 E
642,600 E
642,800 E
643,000 E
643,200 E
643,400 E
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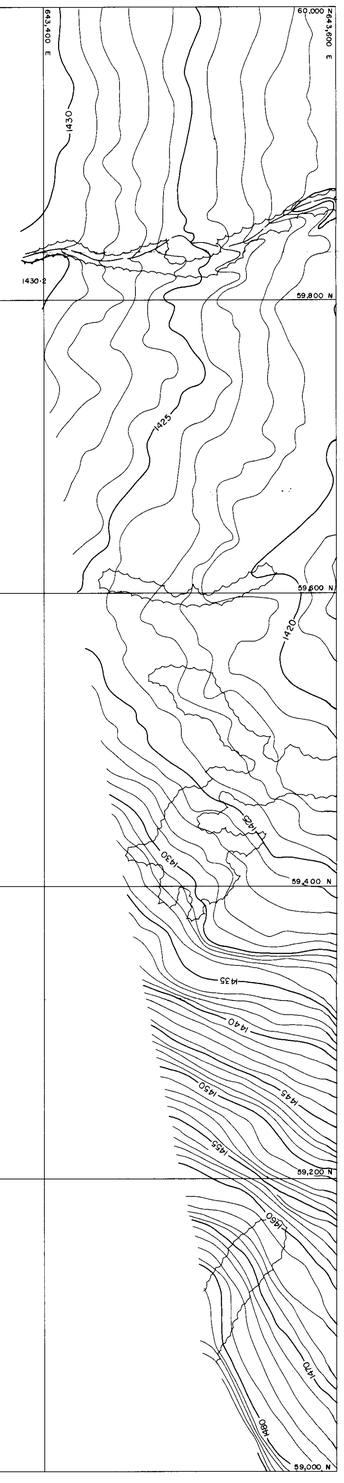
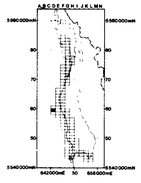
59,400 N
59,200 N
59,000 N



SHEET INDEX:

59 D

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 30/2/18

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 59 D	DWG. NO.

APPENDIX 5.0

279

K-Elk River 82G/1A

SHEET INDEX:

59E

UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 59E	DWG. NO.

APPENDIX: 5.0

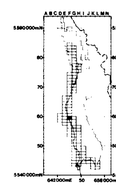
279

K-Elk River 80(2)A

SHEET INDEX:

59 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-6
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

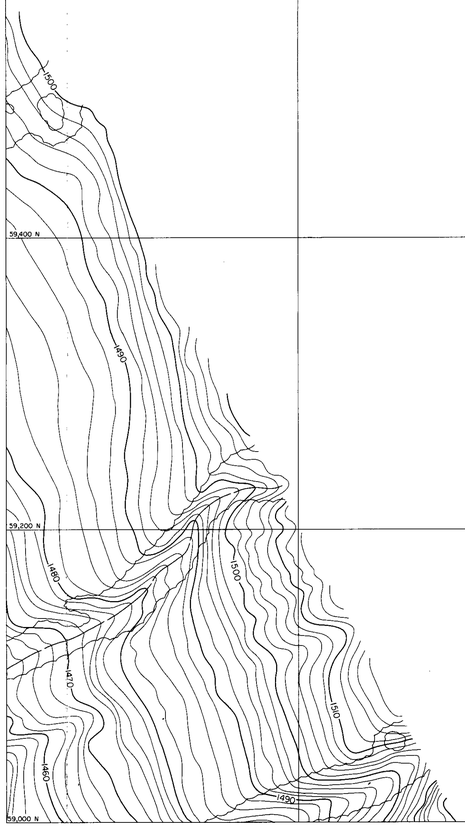
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 59 F	DWG. NO.

APPENDIX: 5.0

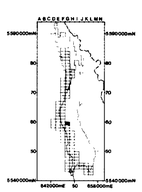
60,000 N
646,000 E
646,200 E
646,400 E
59,800 N
59,600 N
59,400 N
59,200 N
59,000 N



SHEET INDEX:

59 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

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SCALE OF PHOTOGRAPHY APPROX 1:15,000
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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 59 G	DWG. NO.

APPENDIX : 5.0

70,000 N
642,000E
642,200E
642,400E
642,600E
642,800E
643,000E
643,200E
643,400E
643,600E
70,000 N
60,800 N
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60,600 N
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60,400 N
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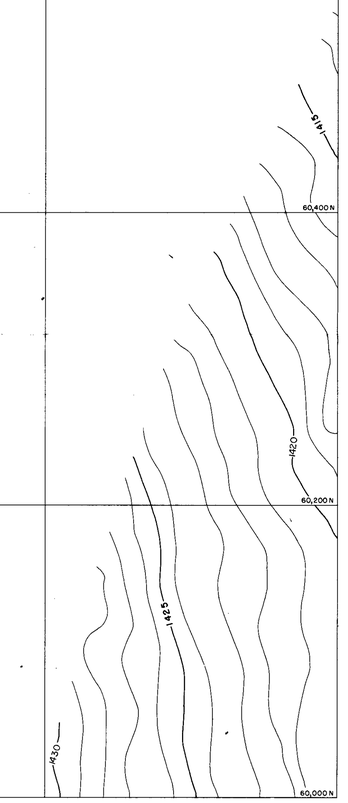
60,000 N



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60 D

UTM
Zone 11
Center Meridian
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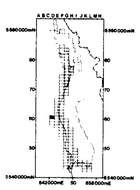


GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

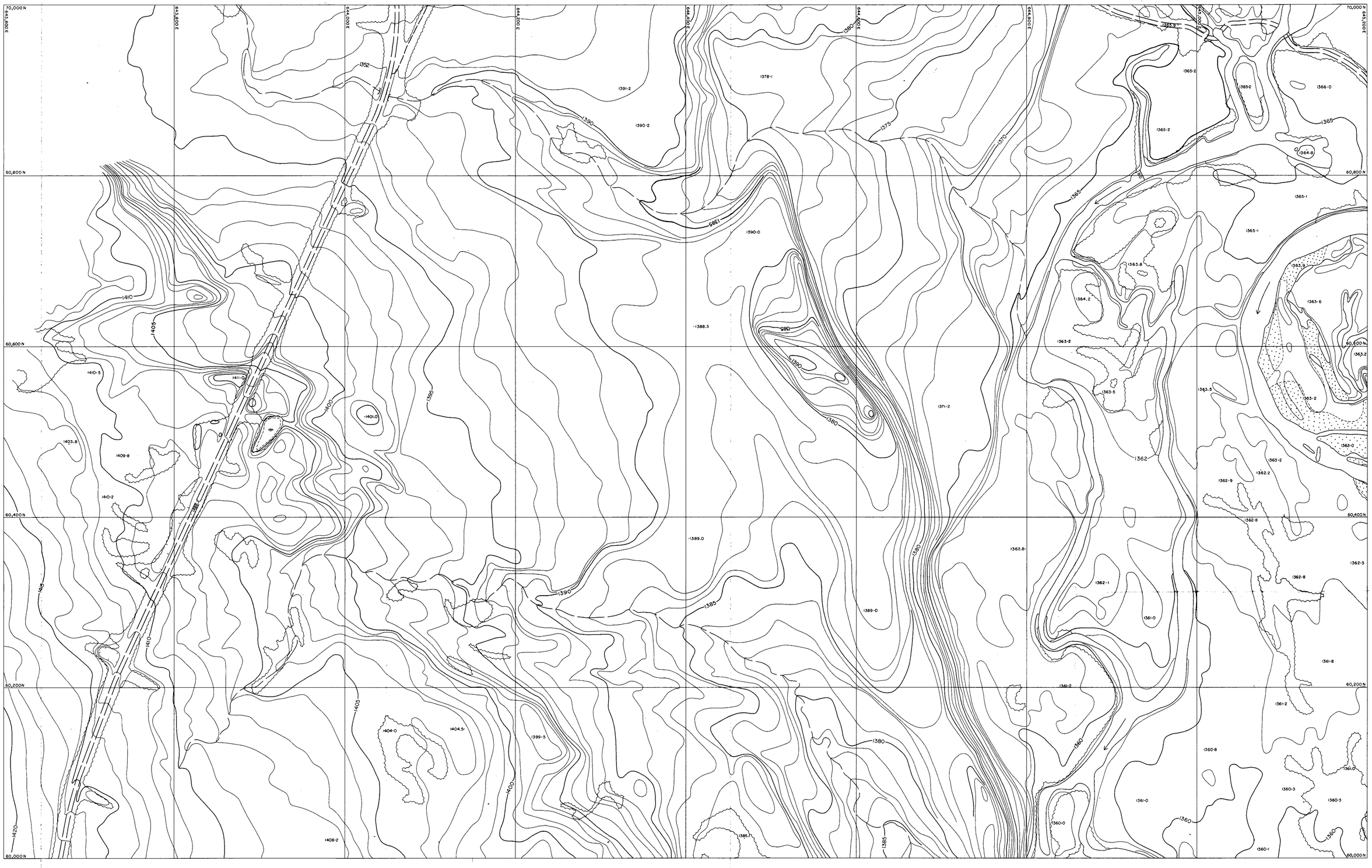
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 60 D	DWG. NO.

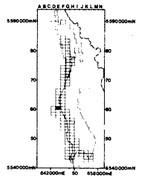
APPENDIX : 5.0



SHEET INDEX:

60 E

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

Kk Elk River Sofalia

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

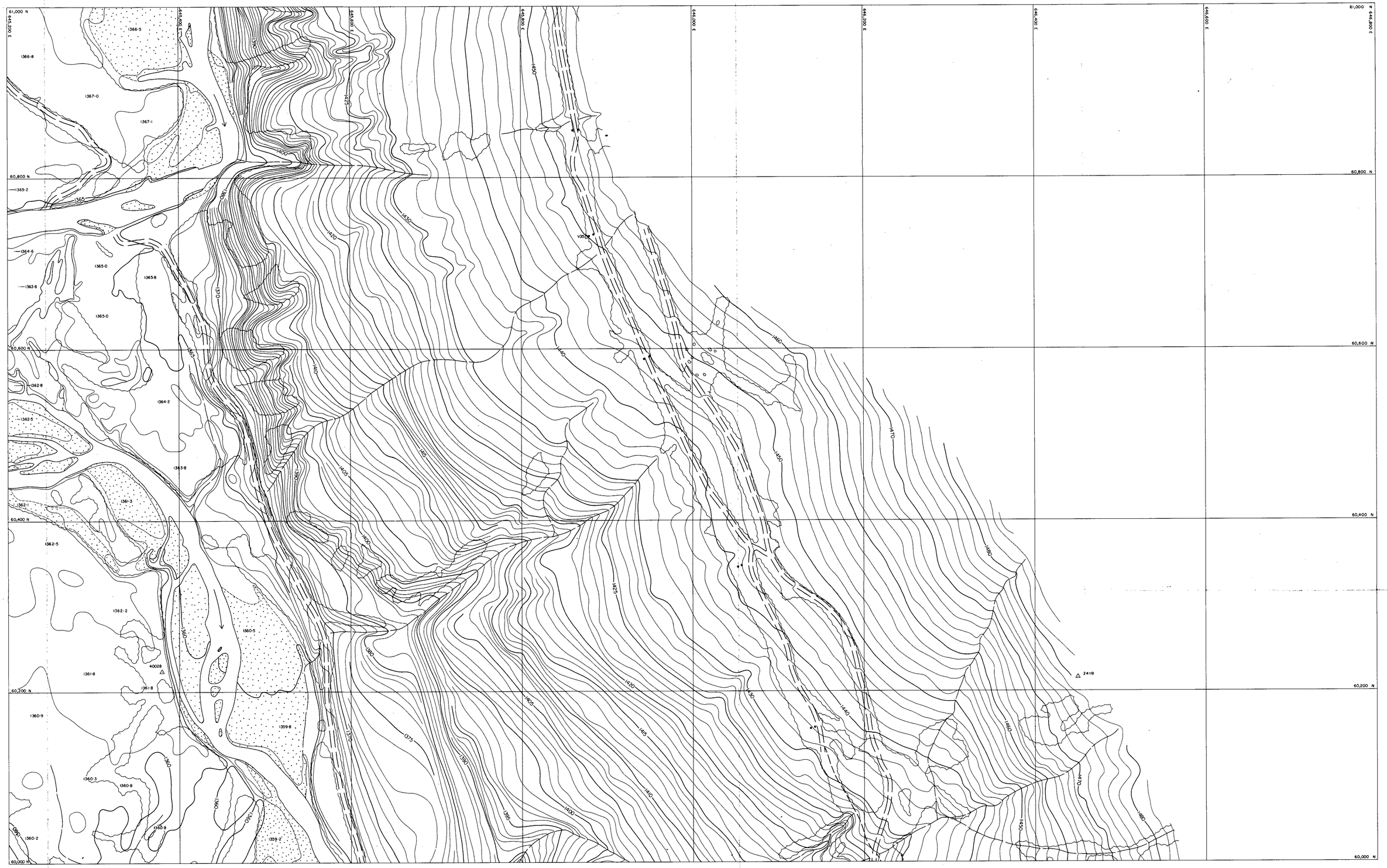
BRITISH COLUMBIA

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 60E	DWG. NO.

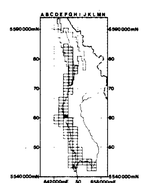
APPENDIX 5.0



SHEET INDEX

60 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 © 1962-3
SWAMP			

279 K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

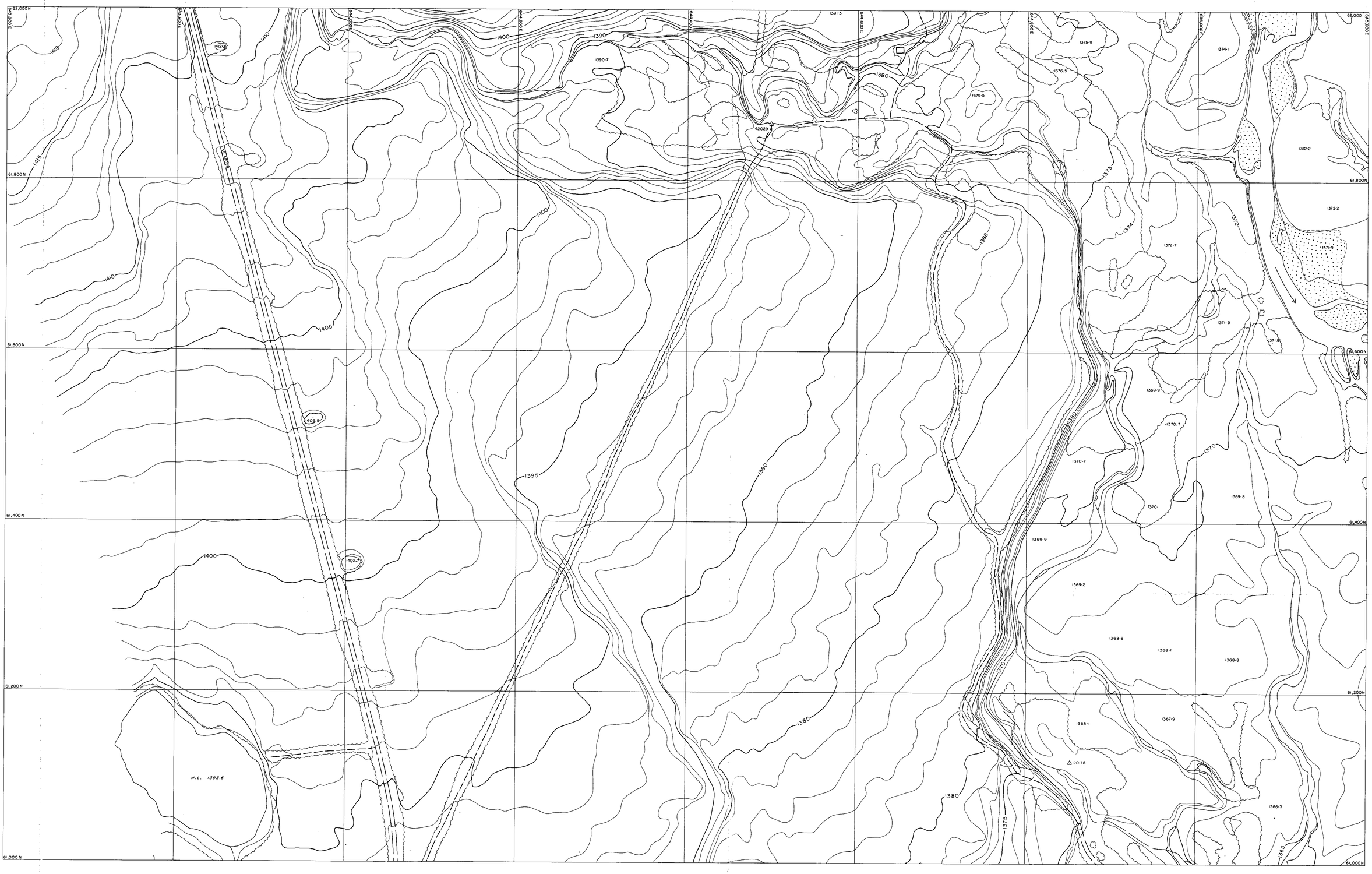
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 60 F	DWG. NO.

APPENDIX : 5.0



SHEET INDEX:

61 E

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Zone 11
Center Meridian
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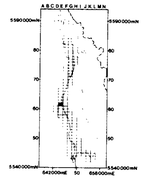

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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K. Elk River 80/2/A

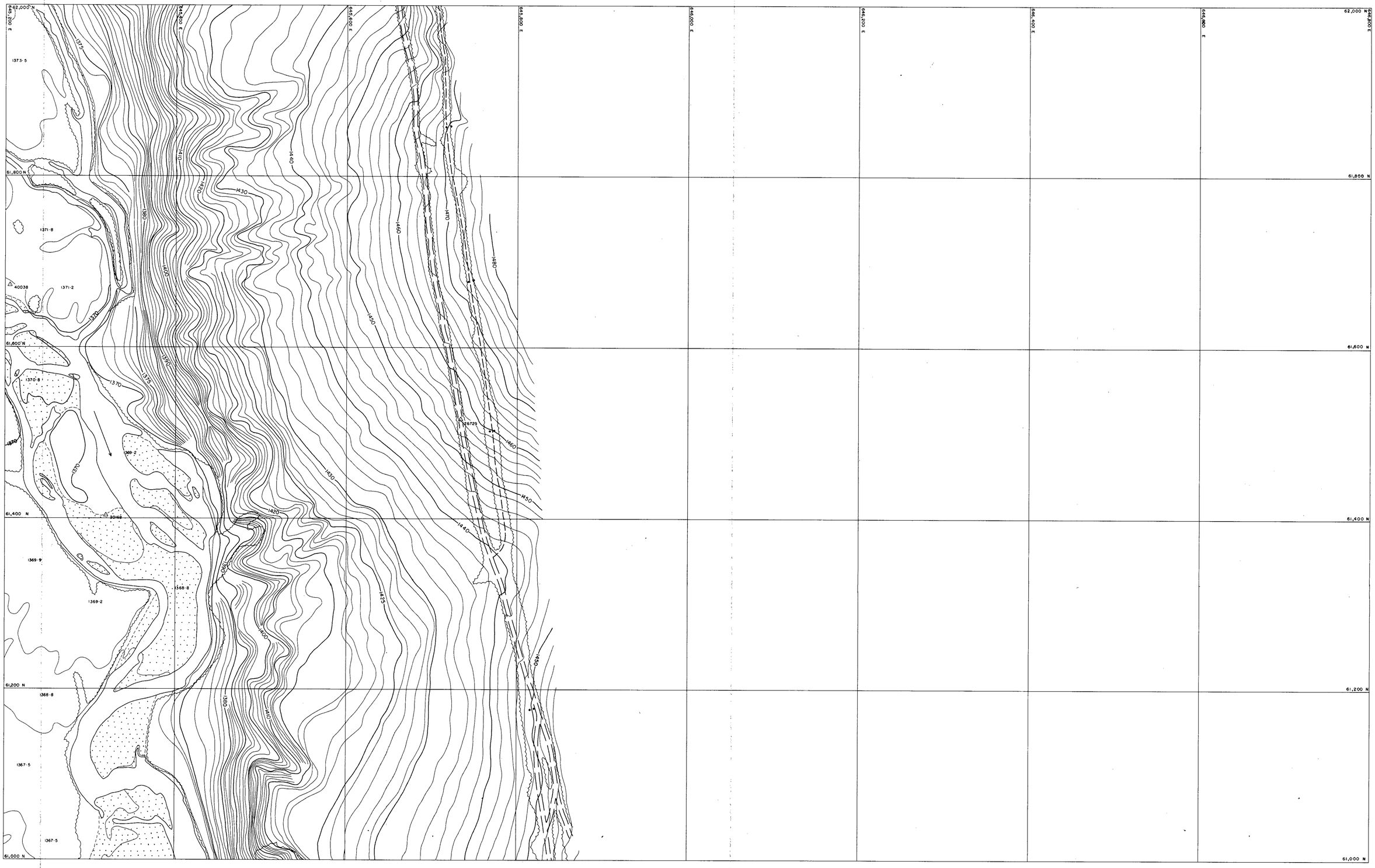
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 61E	DWG. NO.

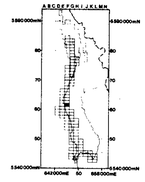
APPENDIX : 5.0



SHEET INDEX:

61 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 8D(2)A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 61 F	DWG. NO.

APPENDIX: 5.0

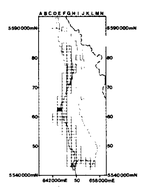
279

K-Elk River 20(2)A

SHEET INDEX:

62 E

UTM
Zone 11
Center Meridian
=117°W.Gr.



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SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 @ 1962-3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

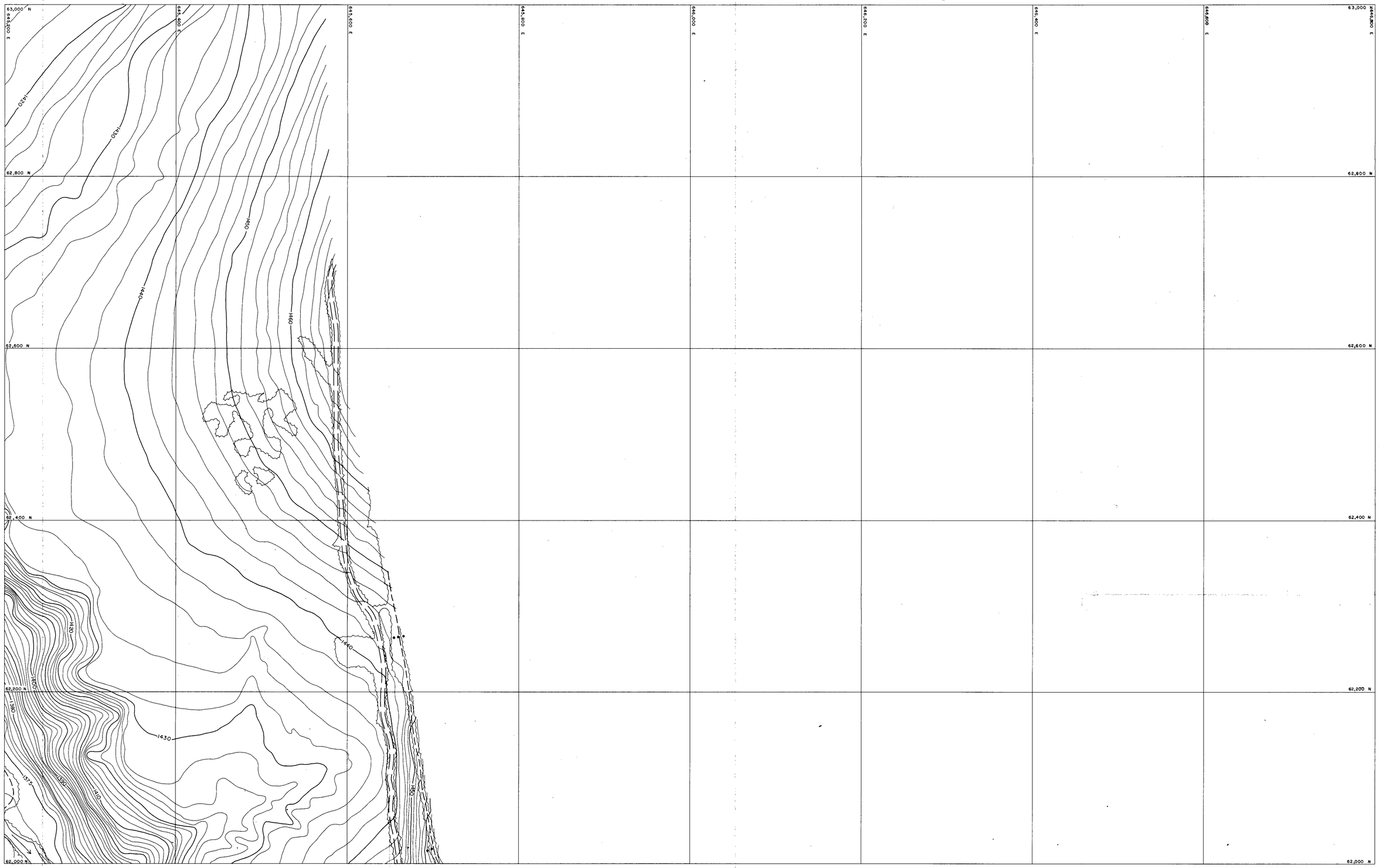
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 62 E	DWG. NO.

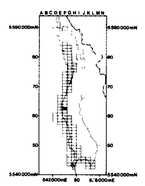
APPENDIX: 5.0



SHEET INDEX:

62 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 80(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

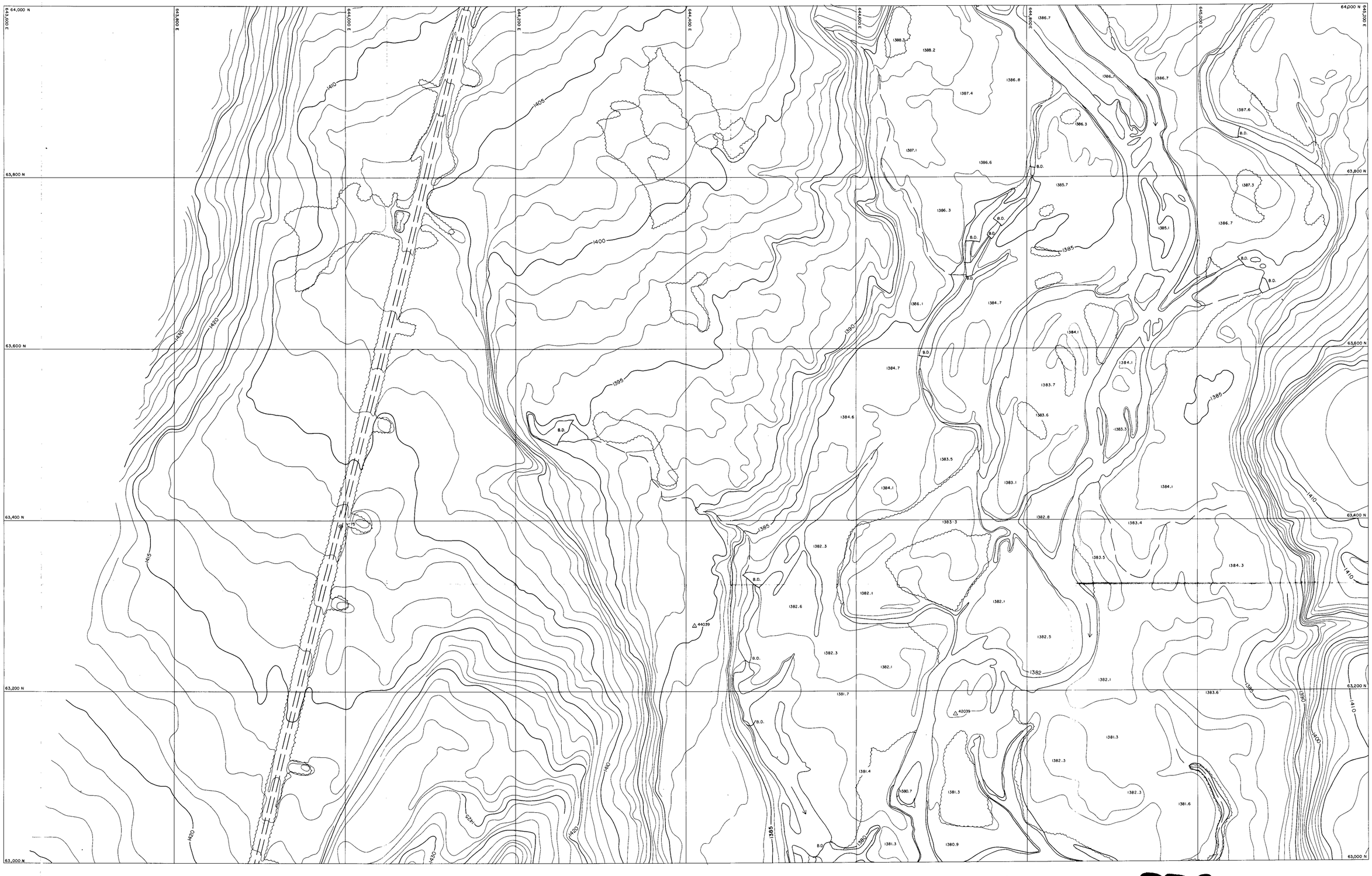
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 62 F	DWG. NO.

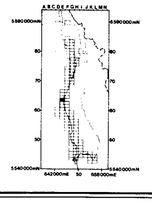
APPENDIX: 5.0



SHEET INDEX:

63 E

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-5

271

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

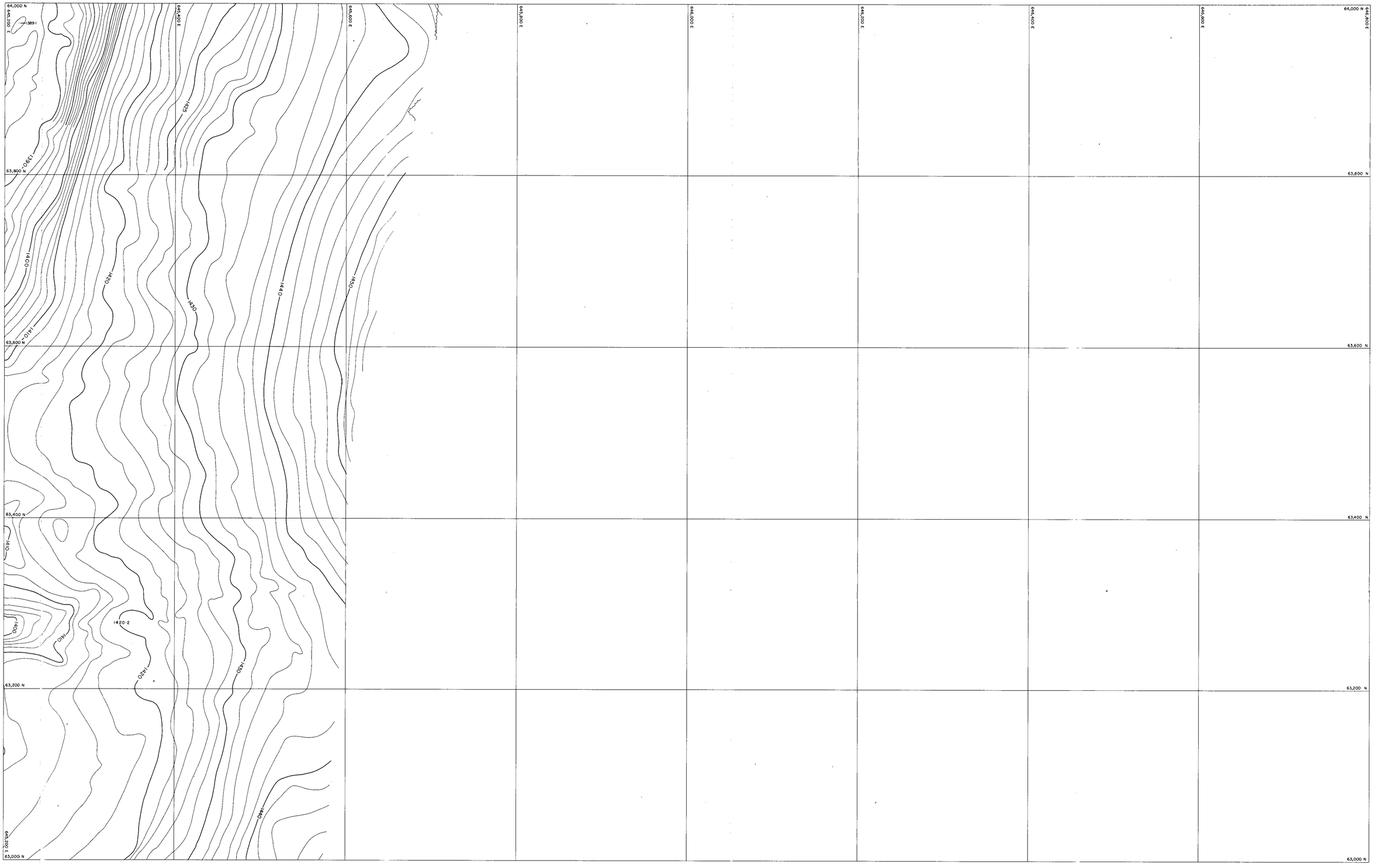
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 63E	DWG. NO.

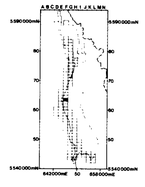
APPENDIX : 5.0



SHEET INDEX:

63 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 50(2)A

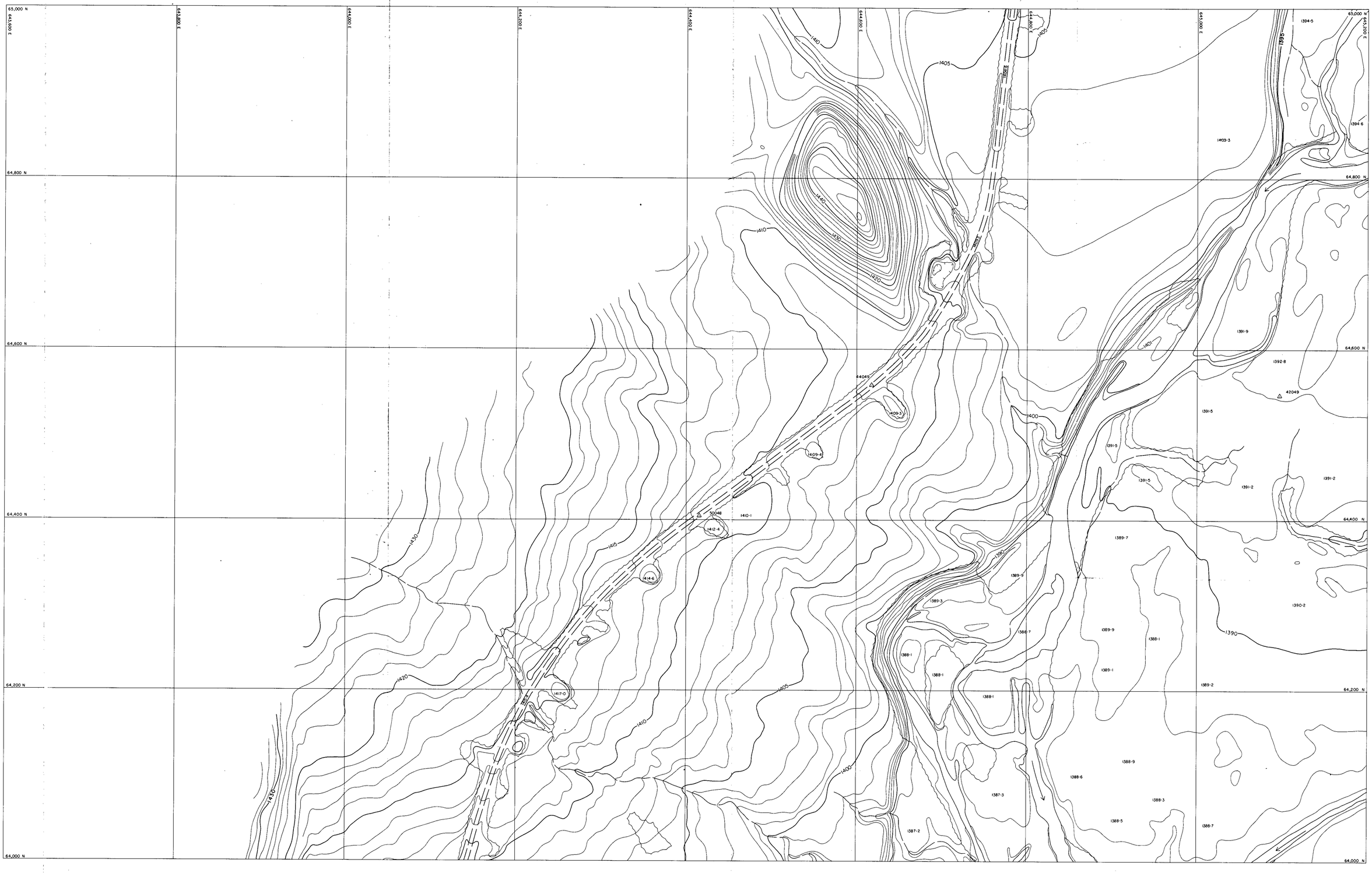
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 63F	DWG. NO.

APPENDIX : 5.0



SHEET INDEX:

64 E

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Zone 11
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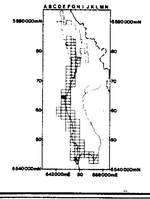

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LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 10(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

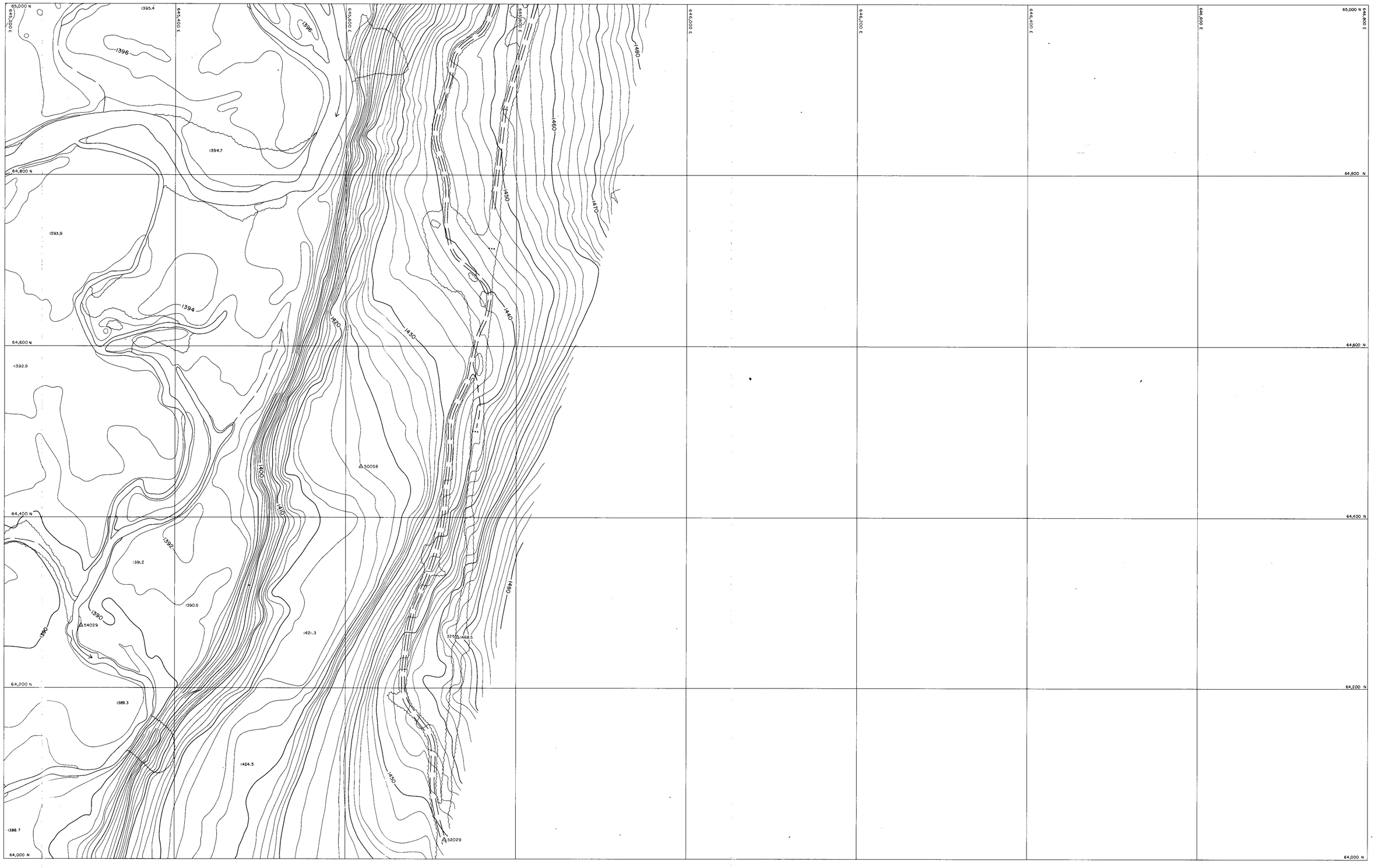
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 64E	DWG. NO.

APPENDIX 5.0



SHEET INDEX:

64 F

UTM
Zone 11
Center Meridian
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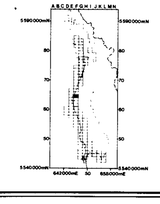

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CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962·3

279

K-Elk River 80(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 64F	DWG. NO.

APPENDIX: 5.0

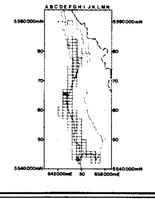
643,800 E
644,000 E
644,200 E
644,400 E
644,600 E
644,800 E
645,000 E

66,000 N
65,800 N
65,600 N
65,400 N
65,200 N
65,000 N

SHEET INDEX:

65 E

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE. DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 @ 1962-3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

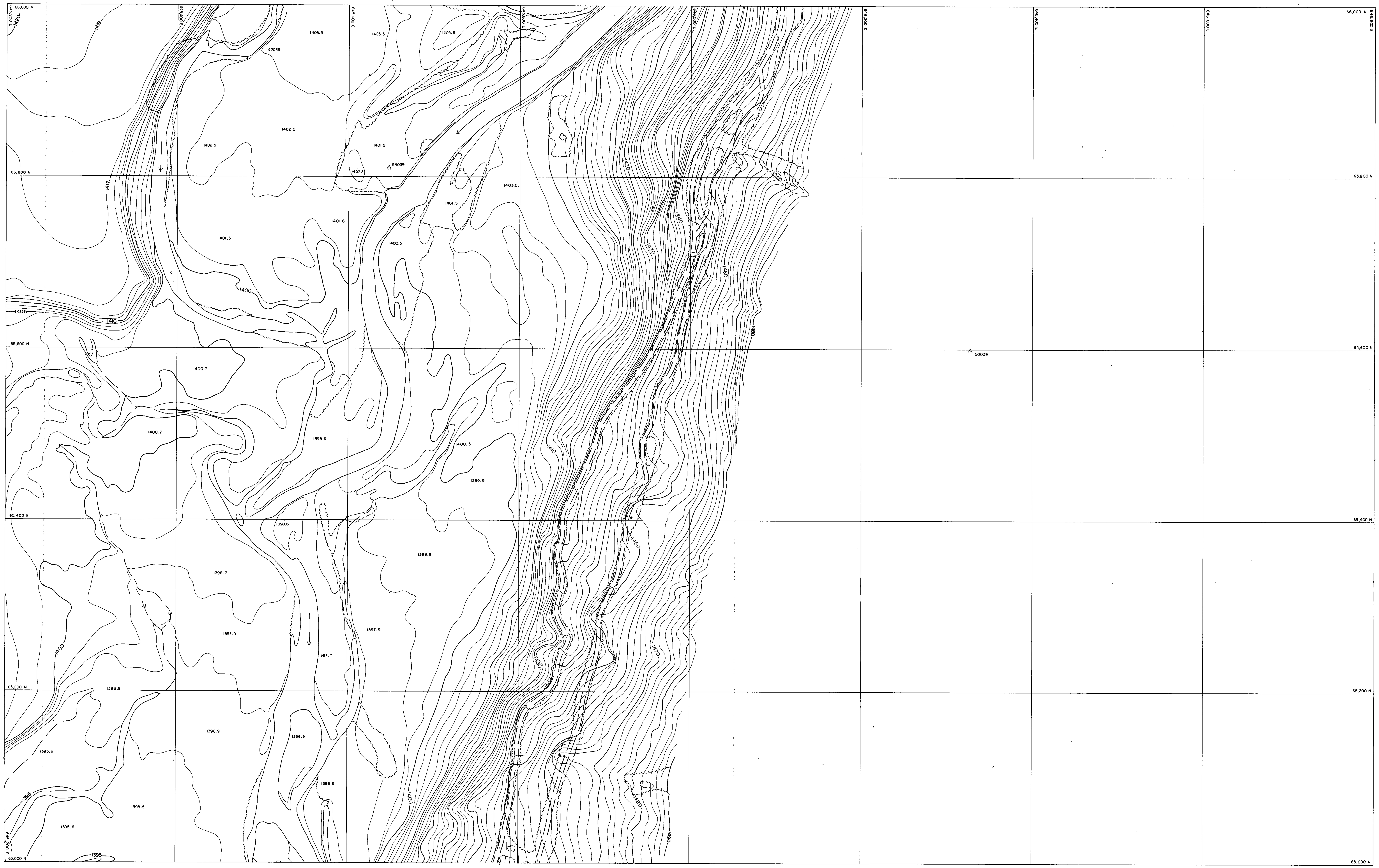
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 65E	DWG. NO.

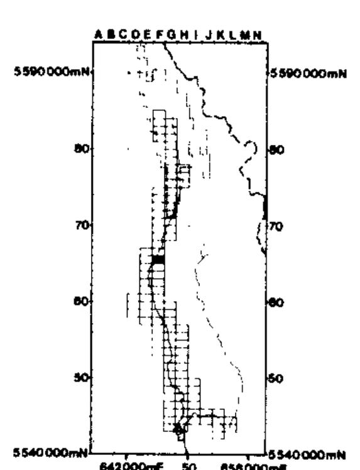
APPENDIX : 5.0



SHEET INDEX:

65 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE	• • •	TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 80(2)A

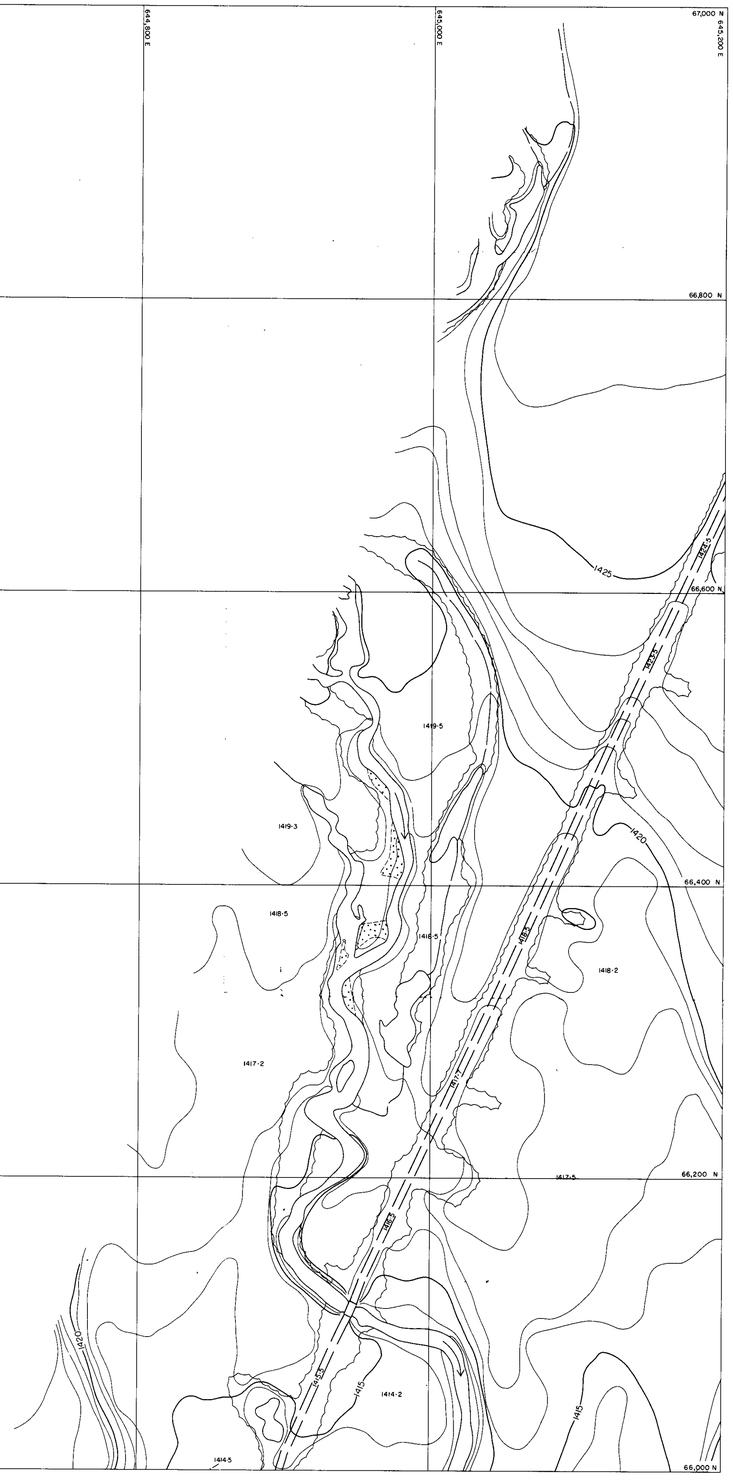
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 65F	DWG. NO.

APPENDIX : 5.0

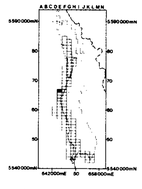


644,600 E | 644,400 E | 644,200 E | 644,000 E | 643,800 E | 643,600 E

SHEET INDEX:

66 E

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

V-Elk River 80/2/A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

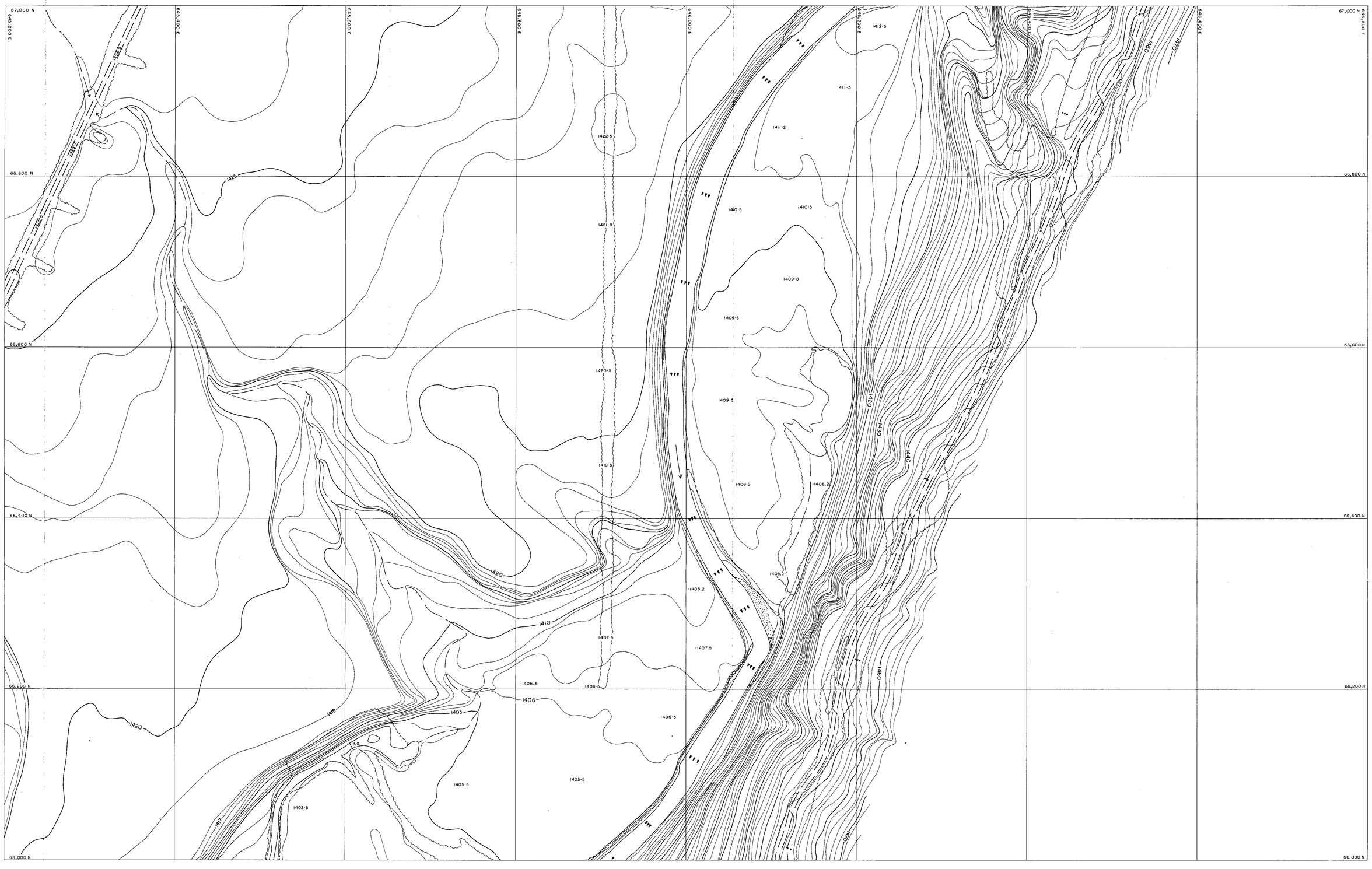
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 66 E.	DWG. NO.

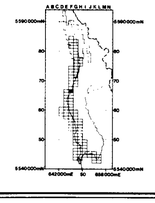
APPENDIX : 5.0



SHEET INDEX:

66 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... R.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

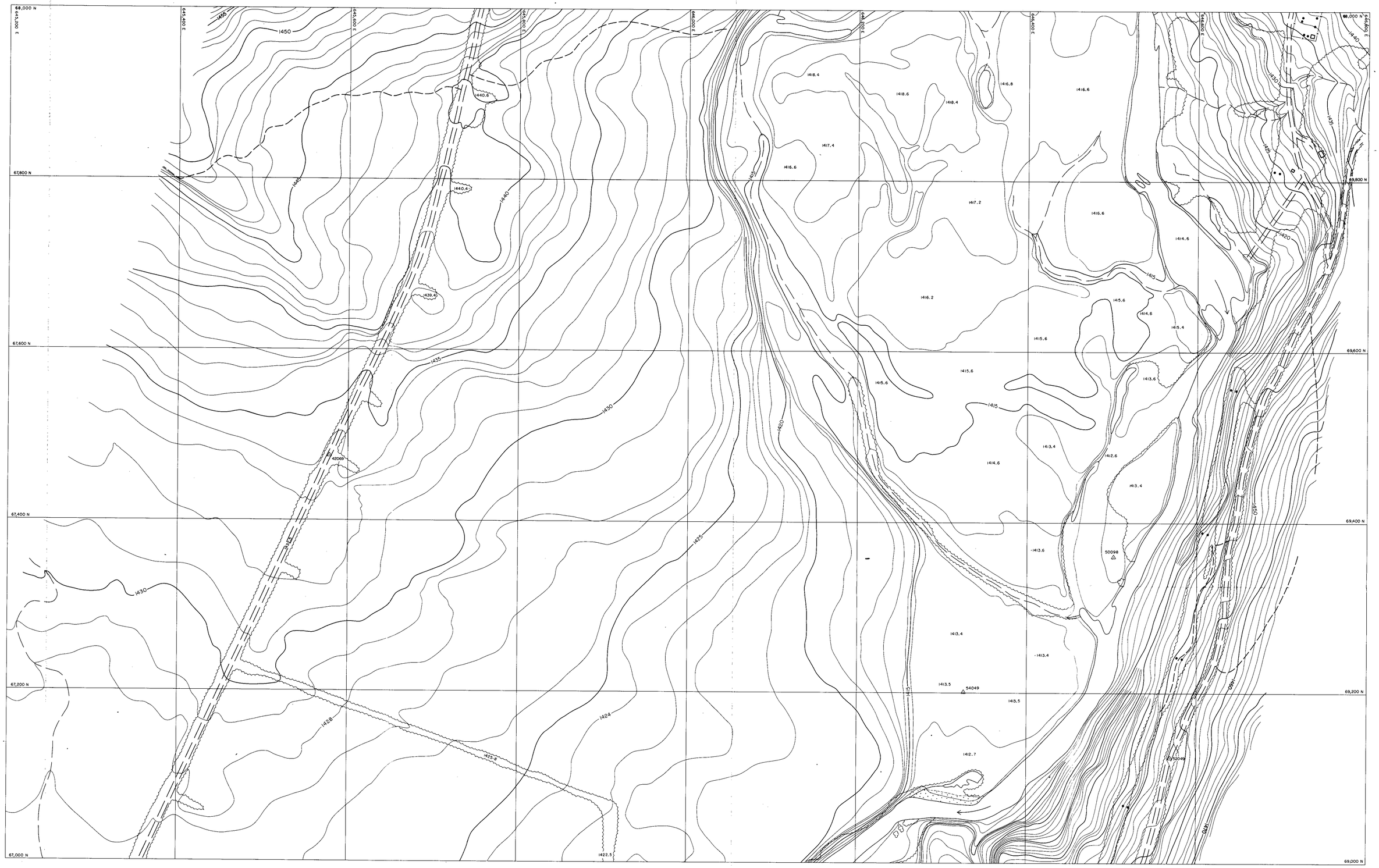
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

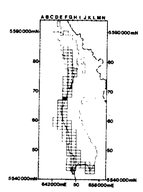
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 66 F	DWG. NO.

APPENDIX : 5.0



SHEET INDEX:

67F



UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(Q)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 67F	DWG. NO.

APPENDIX : 5.0

69,000 N
68,800 N
68,600 N
68,400 N
68,200 N
68,000 N
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E

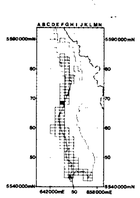
△735
△111
△50118
△54059
56059 Δ
V 72

1488
1480
1469.4
1479.4
1467.5
1468.6
1460
1450
1475
1470
1472.4
1470.6
1462.4
1465.2
1445
1440
1435
1420
1430
1425
1447.6
1448.6
1455
1422.6
1424.6
1424
1423.4
1422.8
1421.6
1422.6
1421.6
1421.4
1420.6
1420.8
1421.4
1420.6
1420.8
1421.4
1420.8
1419.6
1421.6
1420.4
PIT
1419.2
1419.4
1419.8
1418.6
1418.4
1418.8
1419.6
1419.4
1418.6
1418
1417.4
1417.5
1432.4

SHEET INDEX:

68 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-B
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM .....
FALLS/RAPIDS .....
CONTOURS .....
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

A-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

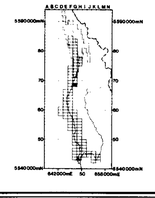
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 68 F	DWG. NO.

APPENDIX: 3.0

SHEET INDEX:

68 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 22132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962·3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K. Elk River 80(2)A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 68 G	DWG. NO.

APPENDIX: 5.0

70,000 N
69,800 N
69,600 N
69,400 N
69,200 N
69,000 N
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E

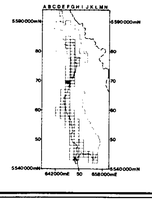
1490
1470
1450
1430
1410
1460
1440
1420
1480
1425
1459.9
1459.6
1461.2
1460.2
1454.4
1441.6
1427.4
1426.4
1424.8
1425.4
1425.6
1424.4
1423
1422.6
1423.4
PIT
PIT

△ 50108

SHEET INDEX:

69 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX. 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

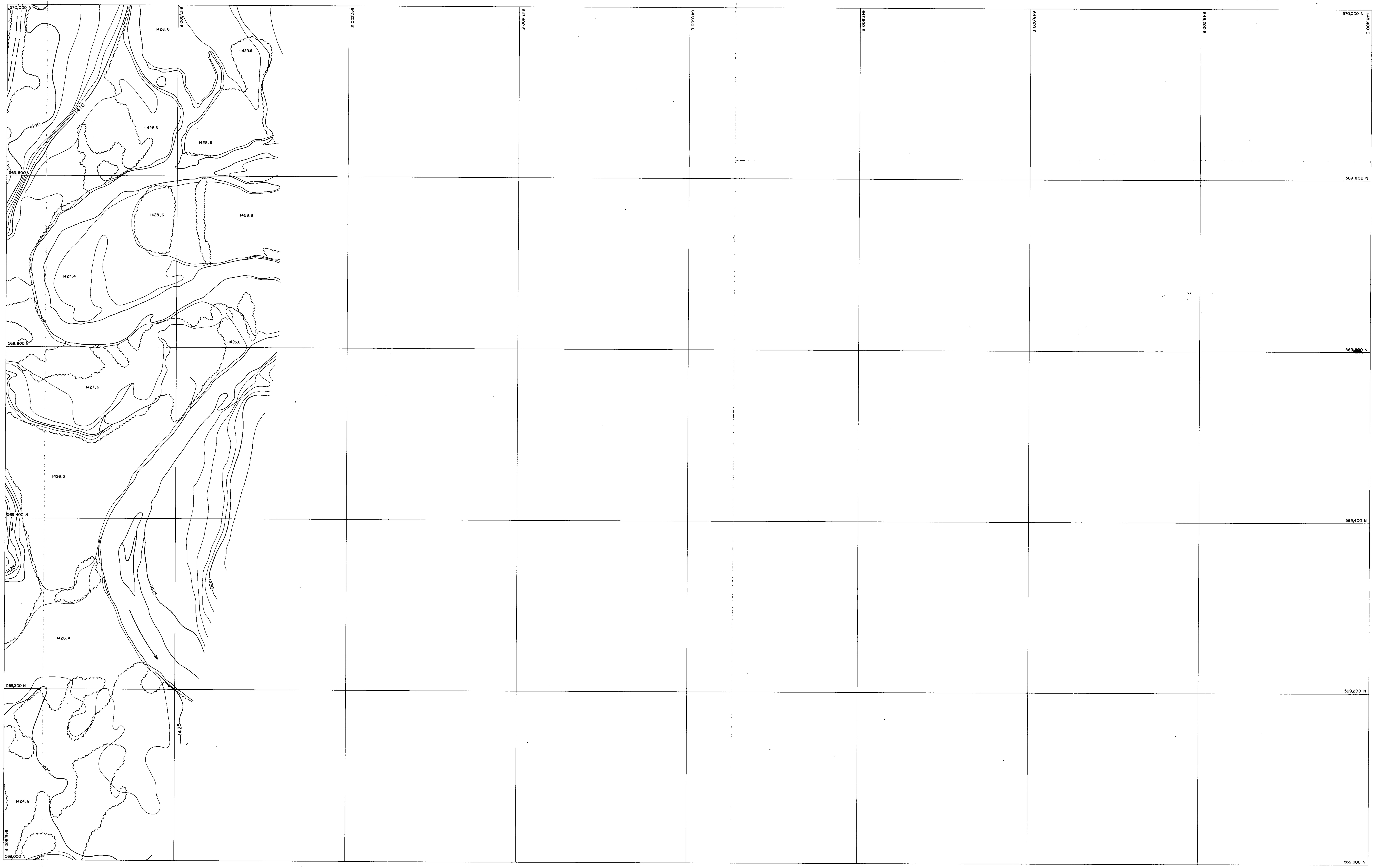
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 69 F	DWG. NO.

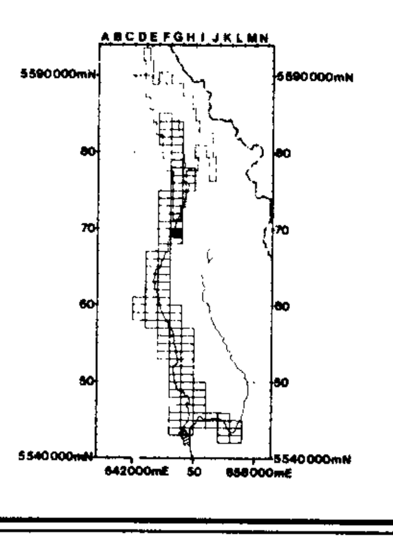
APPENDIX : 5.0



SHEET INDEX:

69 G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION .... 2077·8
ROAD
TRACK OR TRAIL
POLE
BUILDING
CREEKS
LAKE
SWAMP
BEAVER DAM .... B.D.
FALLS/RAPIDS
CONTOURS 1500
TREES
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .... △ 24049
VERTICAL CONTROL POINT .... V 62 ⊙ 1962·3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

279

K-Elk River 80(2)A

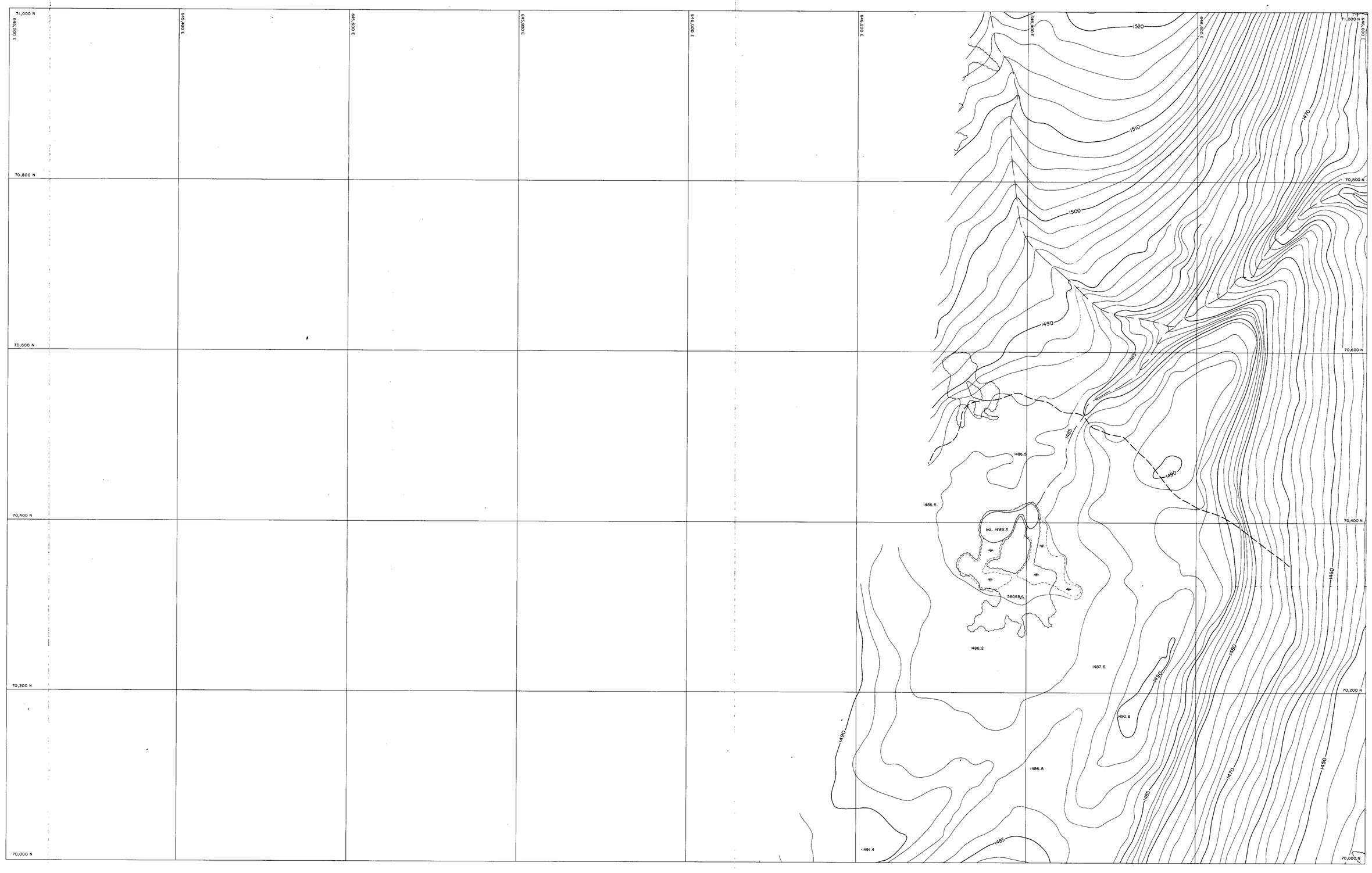
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 69G	DWG. NO.

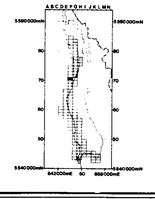
APPENDIX 15.0



SHEET INDEX:

70 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	v 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

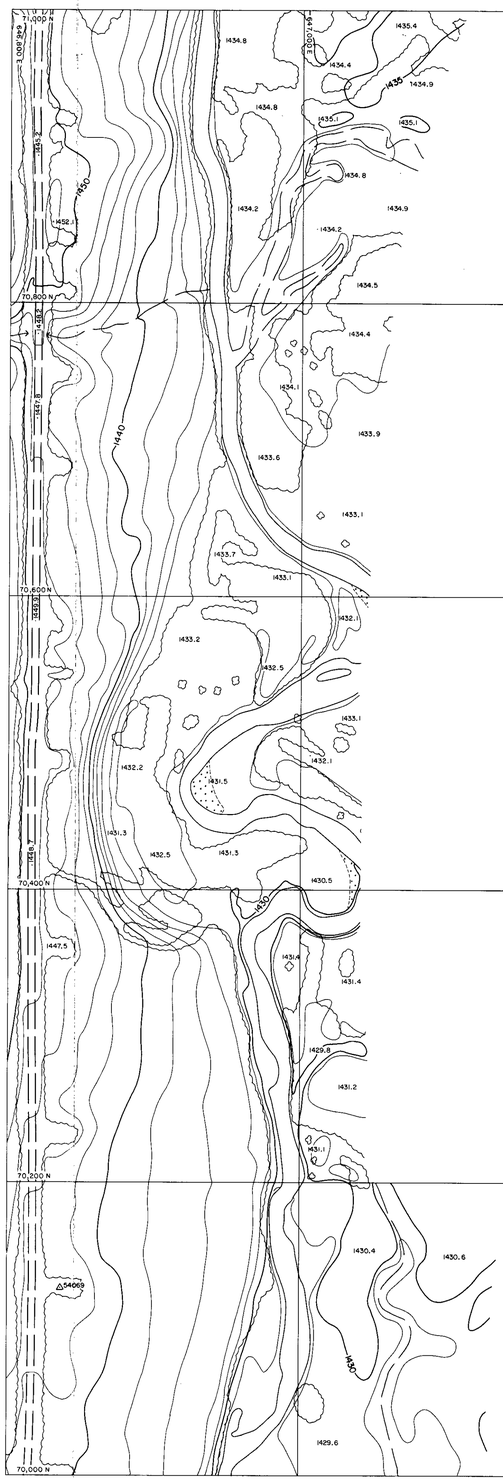
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 70 F	DWG. NO.

APPENDIX : 5.0

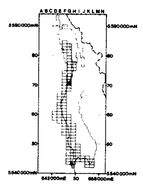


647,200 E | 647,400 E | 647,600 E | 647,800 E | 648,000 E | 648,200 E | 648,400 E

SHEET INDEX:

70 G

UTM
Zone 11
Center Meridian
=117°W.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1°34' 30".

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11,117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE. DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077.8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279 K-Elk River SD(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

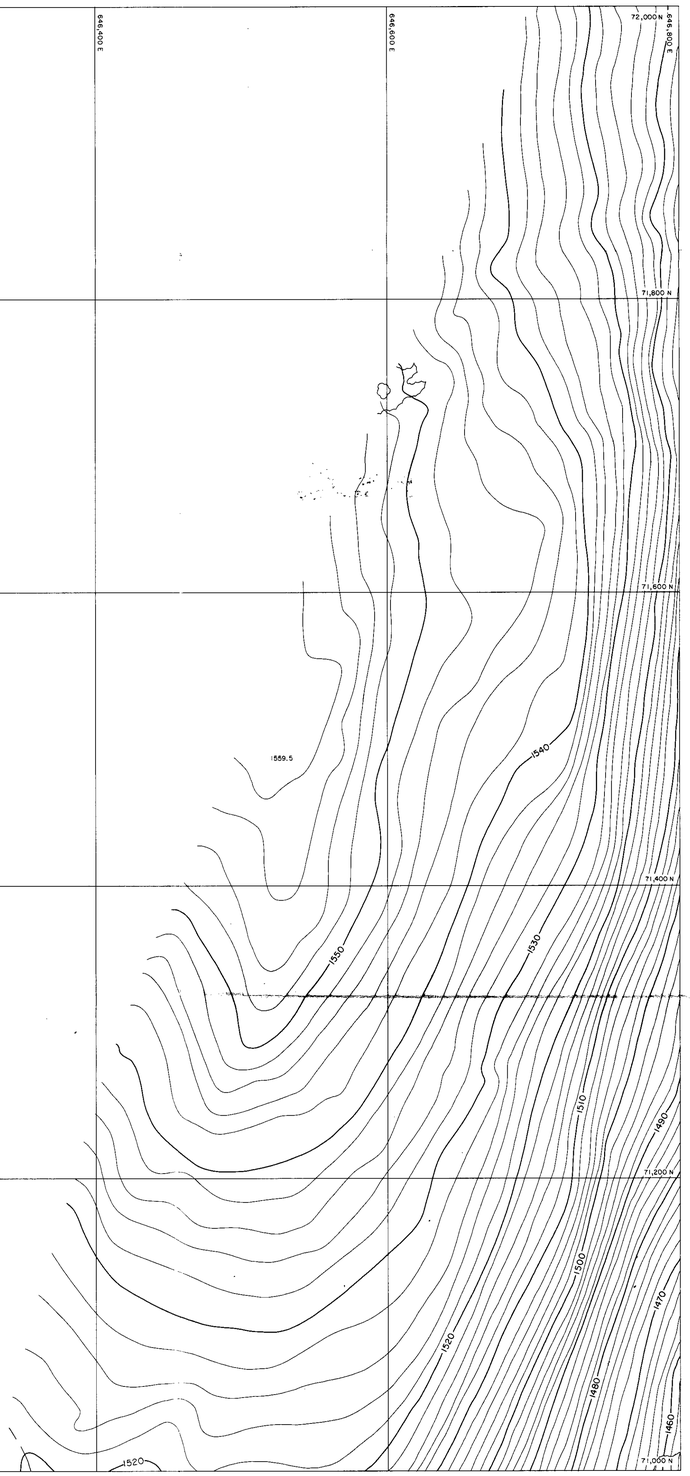
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 70G	DWG. NO.

APPENDIX : 3.0

645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E

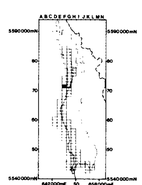
72,000 N
71,800 N
71,600 N
71,400 N
71,200 N
71,000 N



SHEET INDEX:

71F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 22132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

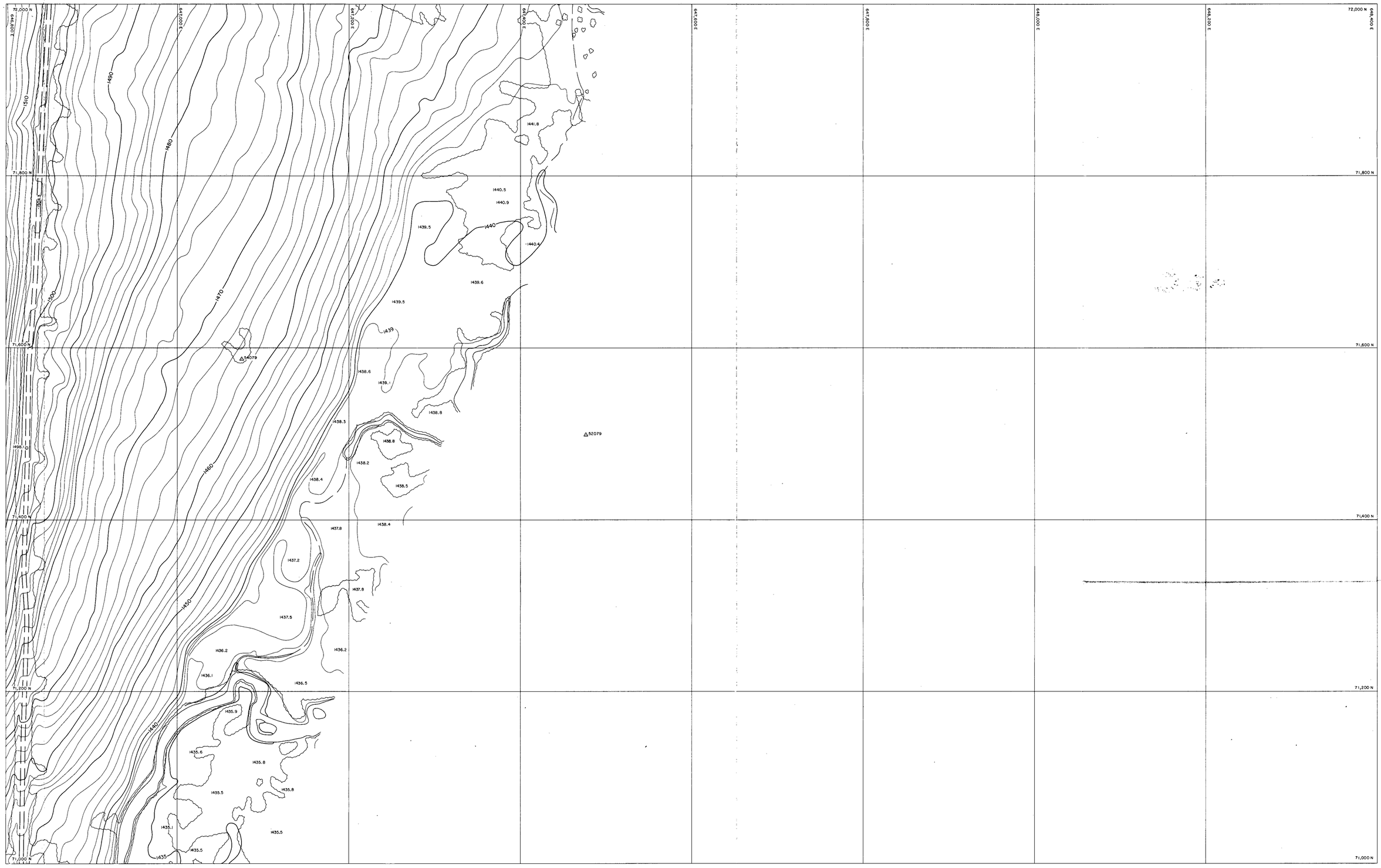
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

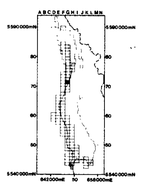
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 71F	DWG. NO.

APPENDIX : 5.0



SHEET INDEX:



71G

UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO [illegible] 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL [illegible] POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80/31A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 71G	DWG. NO.

APPENDIX: 5.0

73,000 N
72,800 N
72,600 N
72,400 N
72,200 N
72,000 N

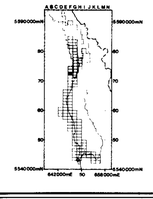
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E

1690
1600
1590
1580
1560
1540
1530
1520

SHEET INDEX:

72 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-B
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... R.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

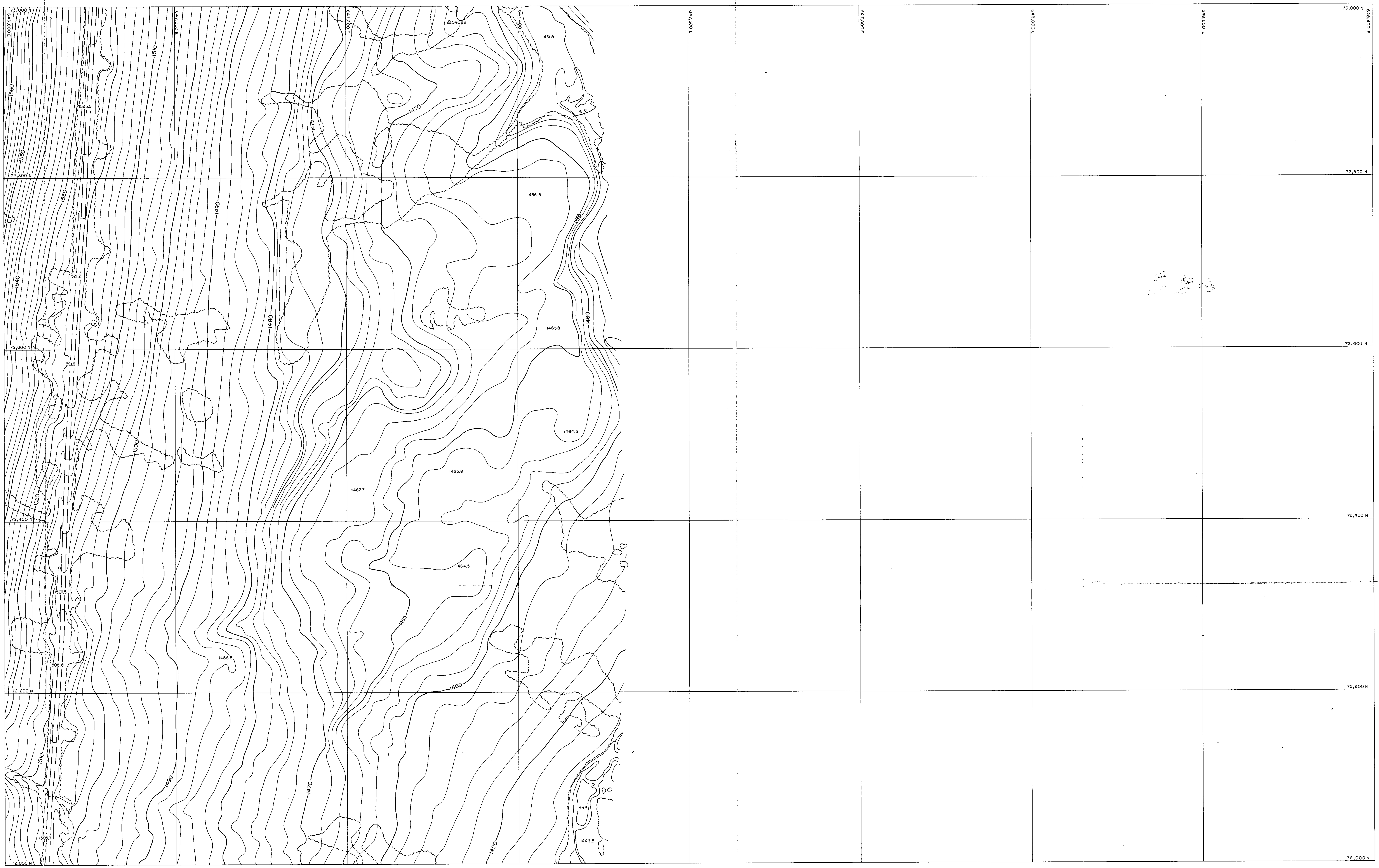
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 72 F	DWG. NO.

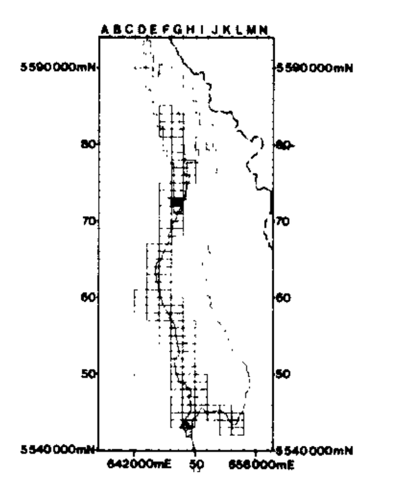
APPENDIX: 5.0



SHEET INDEX:

72G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE	• • •	TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279 K-Elk River 90(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 72G	DWG. NO.

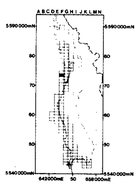
APPENDIX : 5.0

74,000 N
646,200 E
646,400 E
646,600 E
646,800 E
646,000 E
646,200 E
646,400 E
646,600 E
74,000 N
73,800 N
73,800 N
73,600 N
73,600 N
73,400 N
73,400 N
73,200 N
73,200 N
73,000 N
73,000 N
1570
1580
1603-2
1600
1590
1580

SHEET INDEX:

73F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077-8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

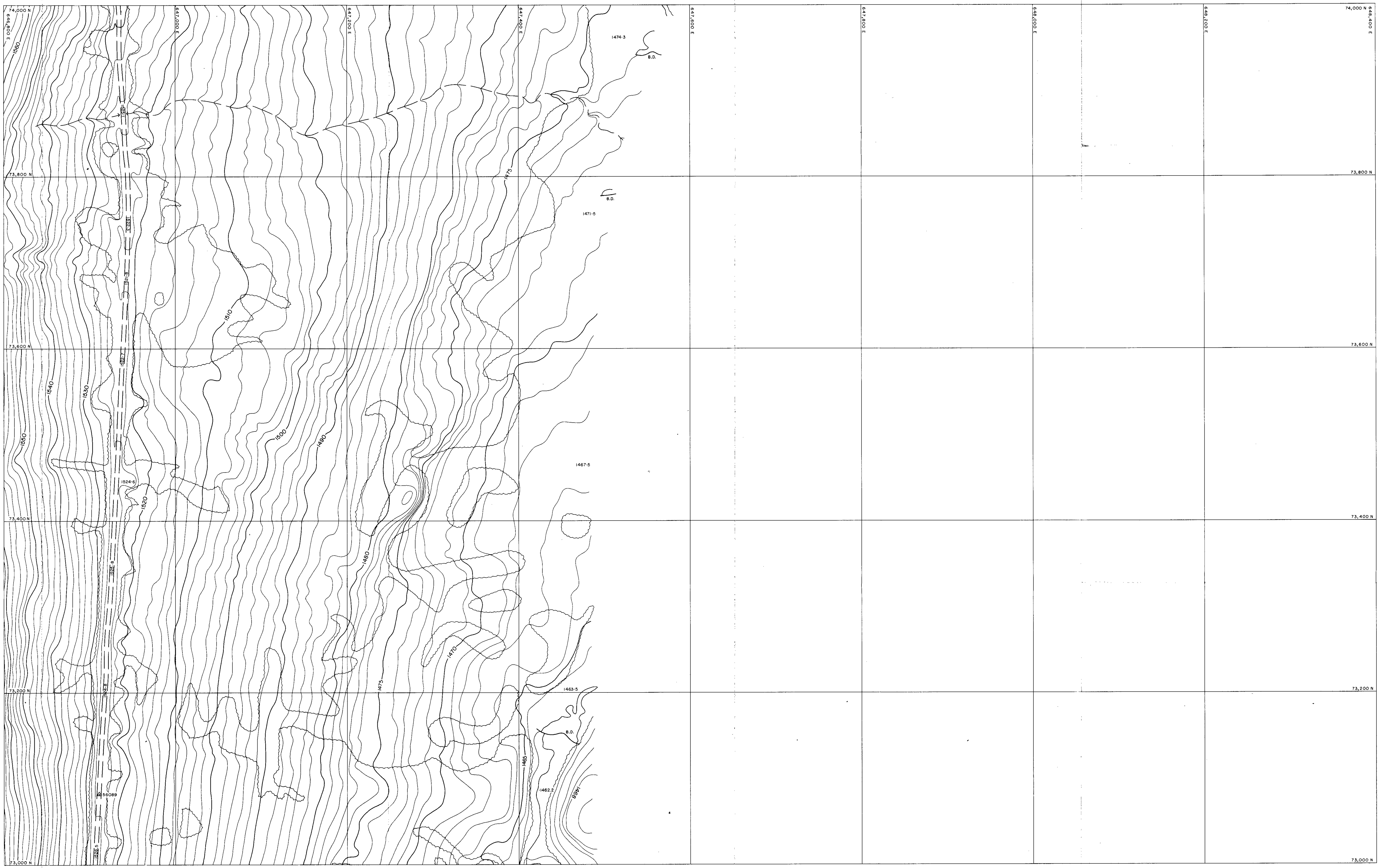
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 73F	DWG. NO.

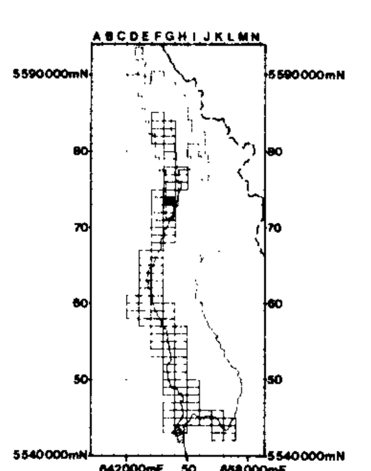
APPENDIX : 5.0



SHEET INDEX:

73G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	+ 222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K-Elk River 80(2)A

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 73G	DWG. NO.

APPENDIX : 5.0

75,000 N
645,200 E
645,400 E
645,600 E
645,800 E
646,000 E
646,200 E
646,400 E
646,600 E
646,800 E
75,000 N

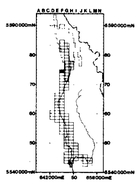
74,800 N
74,600 N
74,400 N
74,200 N
74,000 N

1500

SHEET INDEX:

74 F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 80(3)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

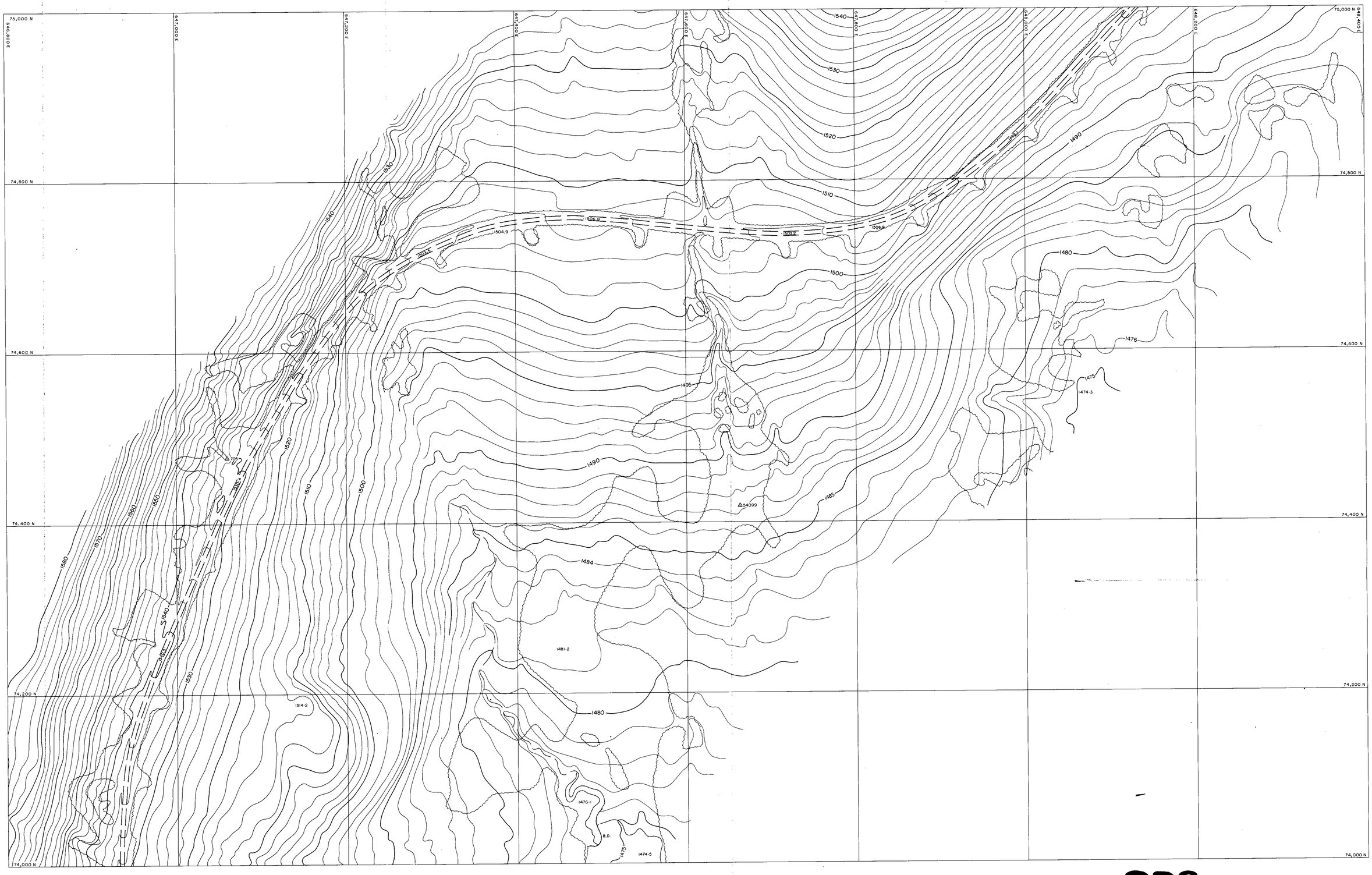
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 74 F	DWG. NO.

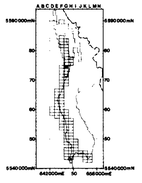
APPENDIX : 5.0



SHEET INDEX:

74G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962-3
SWAMP			

279

K-Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 74G	DWG. NO.

APPENDIX: 5.0

76,000 N
646,800 E
647,000 E
647,200 E
647,400 E
647,600 E
647,800 E
648,000 E
648,200 E
648,400 E
76,000 N
75,800 N
75,600 N
75,400 N
75,200 N
75,000 N

△54109

1620
1610
1600
1590
1580
1570
1560
1550
1540
1530
1520
1510
1500
1490
1530

SHEET INDEX:

75G

UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

K-Elk River 80(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

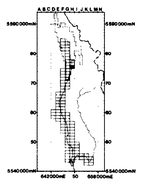
ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 75G	DWG. NO.

APPENDIX 7, 5.0

SHEET INDEX:



75H

UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT ..... △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River P0(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

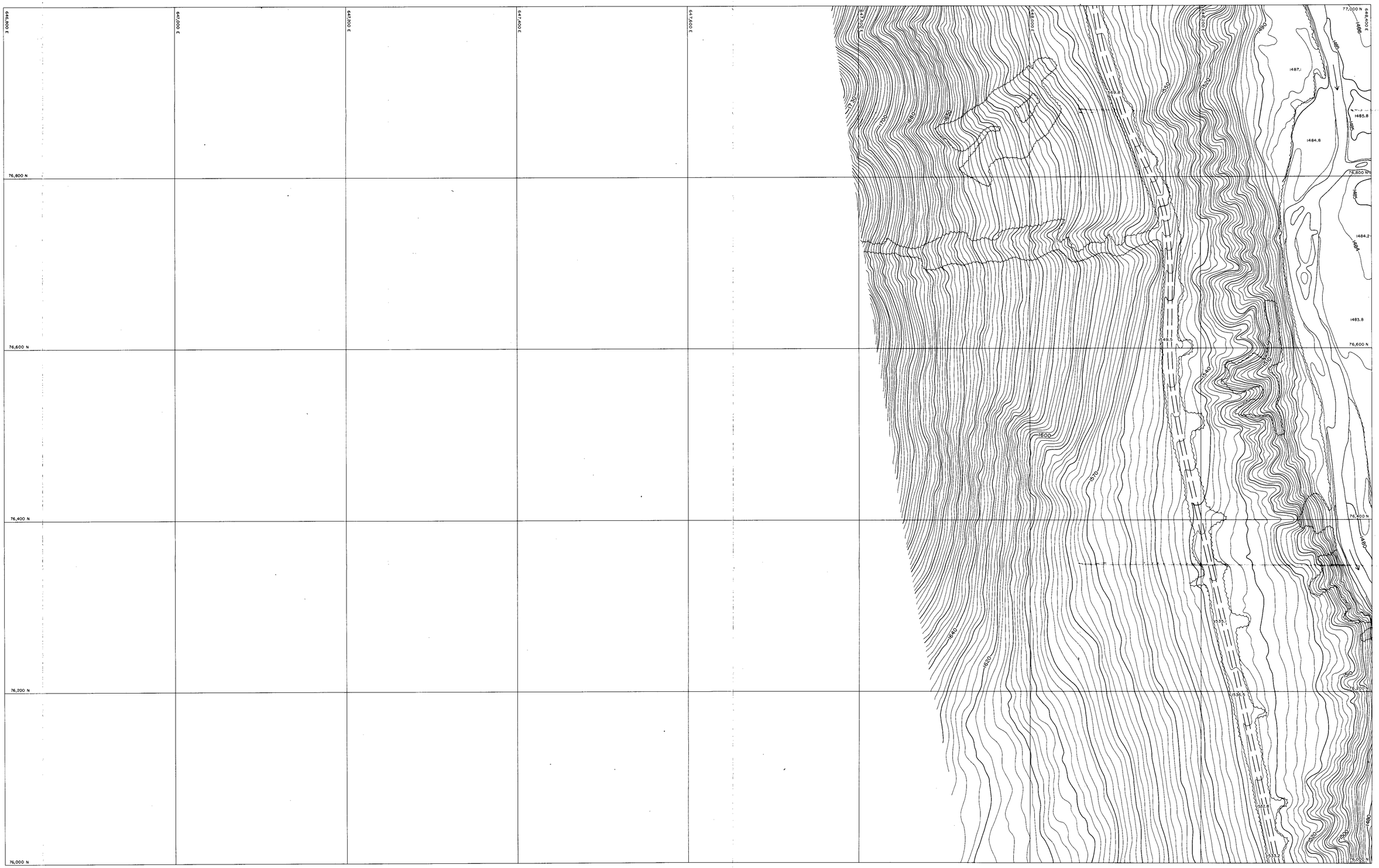
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 75H	DWG. NO.

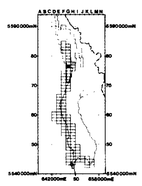
APPENDIX 15.0



SHEET INDEX:

76G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279

K-Elk River 82G/2A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

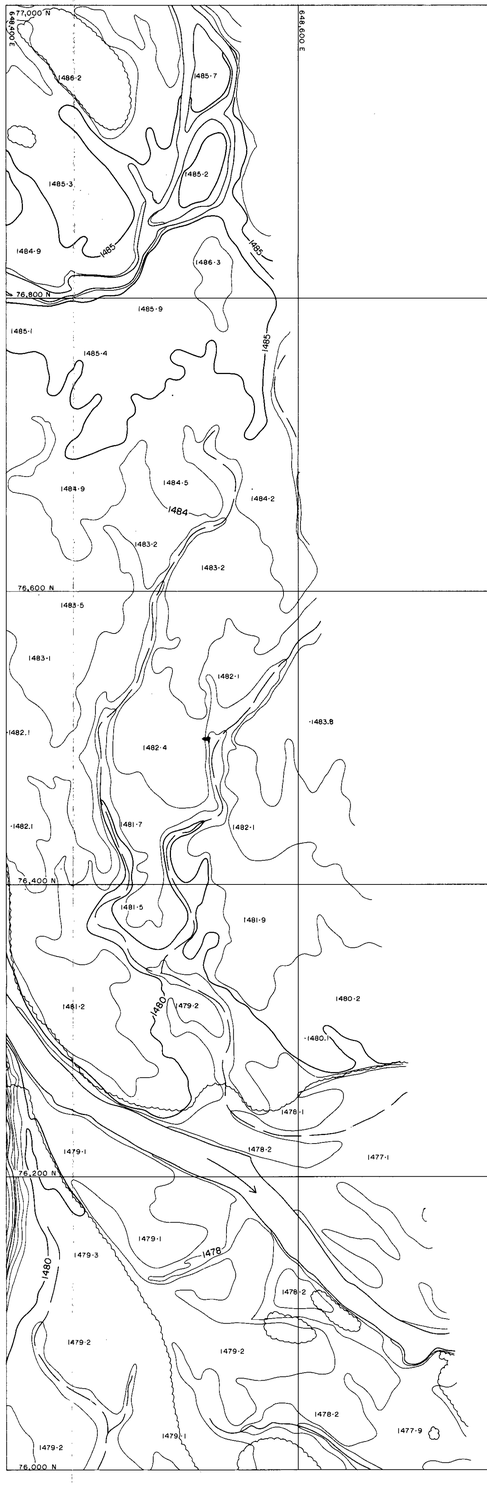
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 76G	DWG. NO.

APPENDIX: 6.0



SHEET INDEX:

76H

UTM
Zone 11
Center Meridian
=117°w.Gr.

GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 76H	DWG. NO.

APPENDIX : 8.0

78,000 N
646,800 E
647,000 E
647,200 E
647,400 E
647,600 E
647,800 E
648,000 E
648,200 E
648,400 E
78,000 N
77,800 N
77,600 N
77,400 N
77,200 N
77,000 N

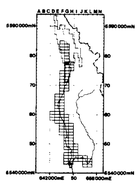
△68019
△56119
△60018
64019
△54119

1600 1590 1580 1570 1560 1550 1540 1530 1520 1510 1500 1494 1493.2 1492 1491.5 1491 1490 1490.4 1490.2 1489 1488.9 1488.5 1488.1 1486 1720 1700 1680 1660 1650 1590 1570 1550

SHEET INDEX:

77G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM .....
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT ... △ 24049
VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

X-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

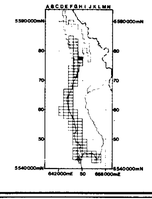
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 77G	DWG. NO.

APPENDIX : 30

SHEET INDEX:

77H

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222:132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

279

K. Elk River 50(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

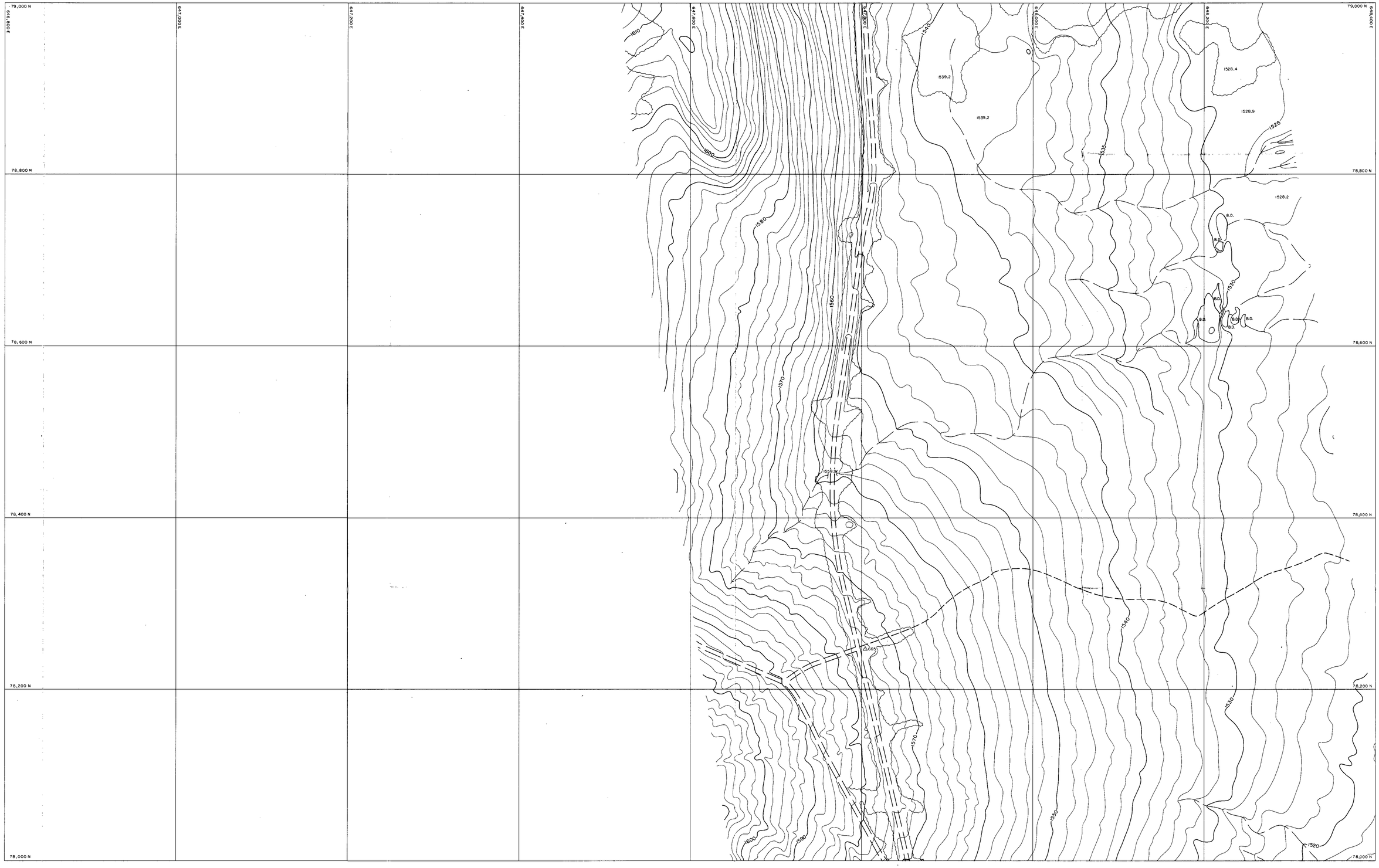
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 77H	DWG. NO.

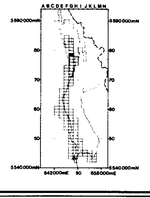
APPENDIX : 5.0



SHEET INDEX:

78G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
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LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-5

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K-Elk River 5a(2)A

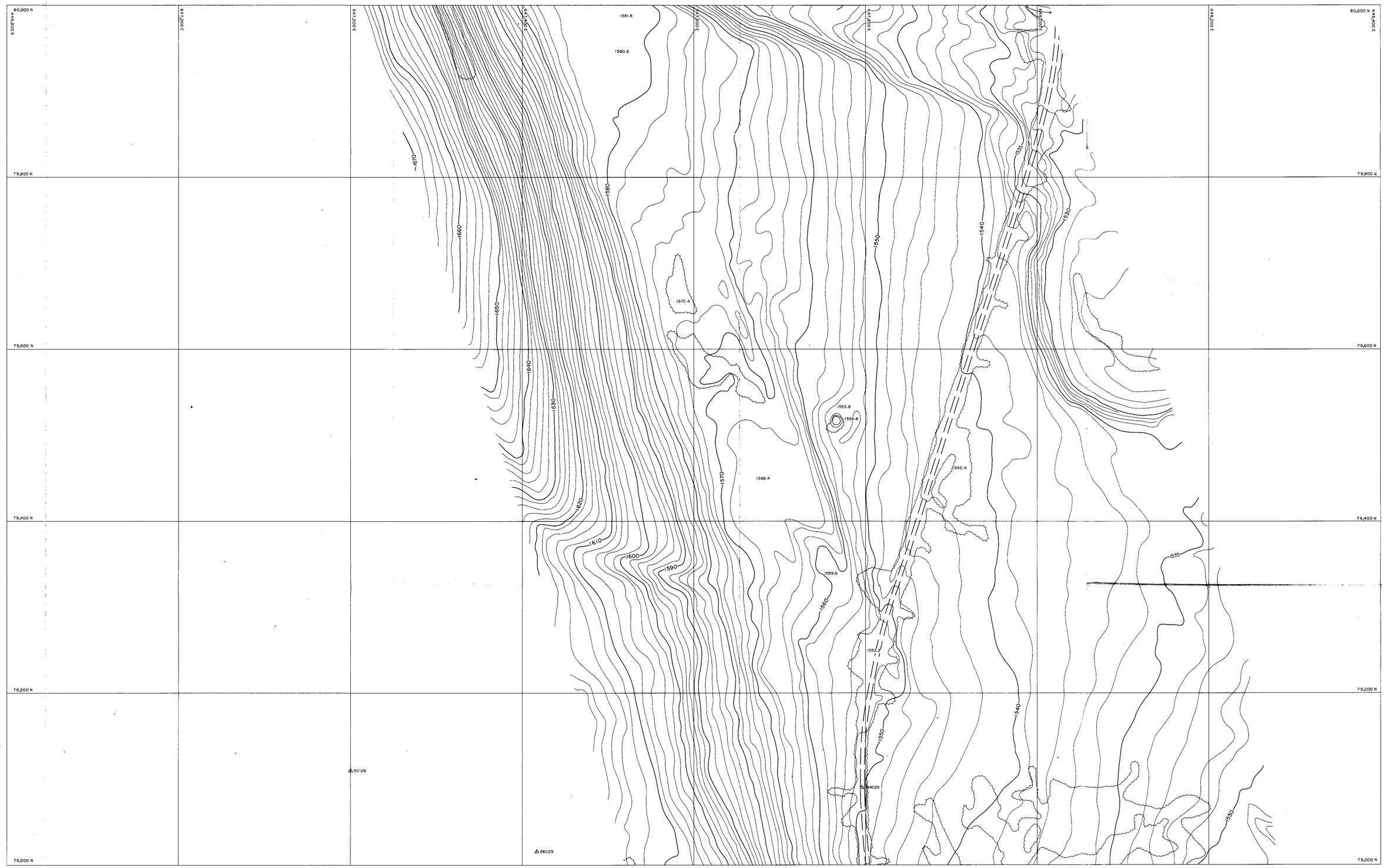
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 78 G	DWG. NO.

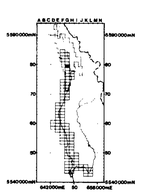
APPENDIX: 5.0



SHEET INDEX:

79G

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River Pd(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

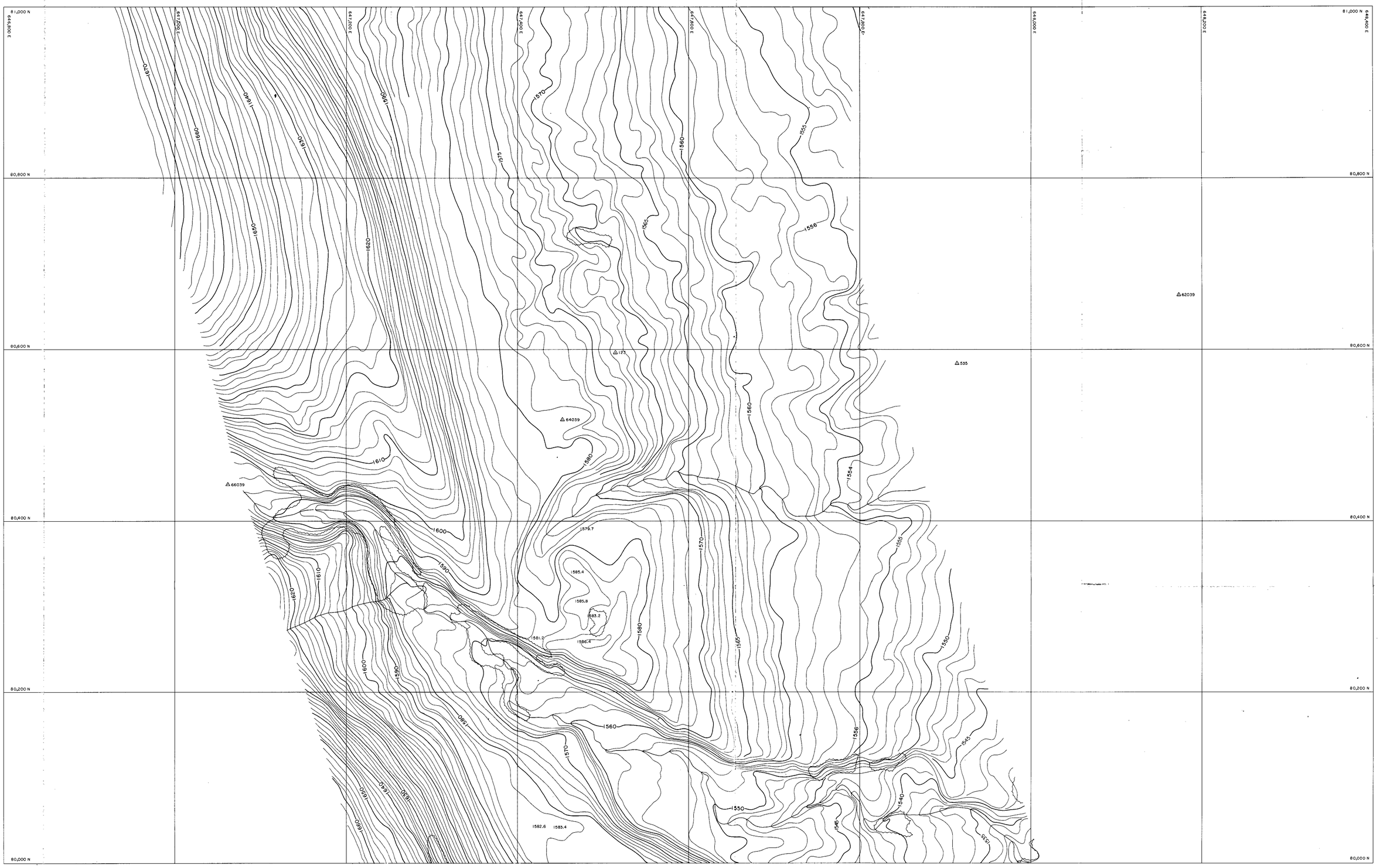
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 79G	DWG. NO.

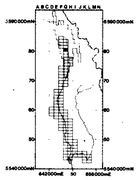
APPENDIX : 5.0



SHEET INDEX:

80G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

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LEGEND:

SPOT ELEVATION	2077·8	BEAVER DAM	B.D.
ROAD		FALLS/RAPIDS	
TRACK OR TRAIL		CONTOURS	1500
POLE		TREES	
BUILDING		AIR PHOTO CENTRE	222132
CREEKS		HORIZONTAL CONTROL POINT	△ 24049
LAKE		VERTICAL CONTROL POINT	V 62 ⊙ 1962·3
SWAMP			

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

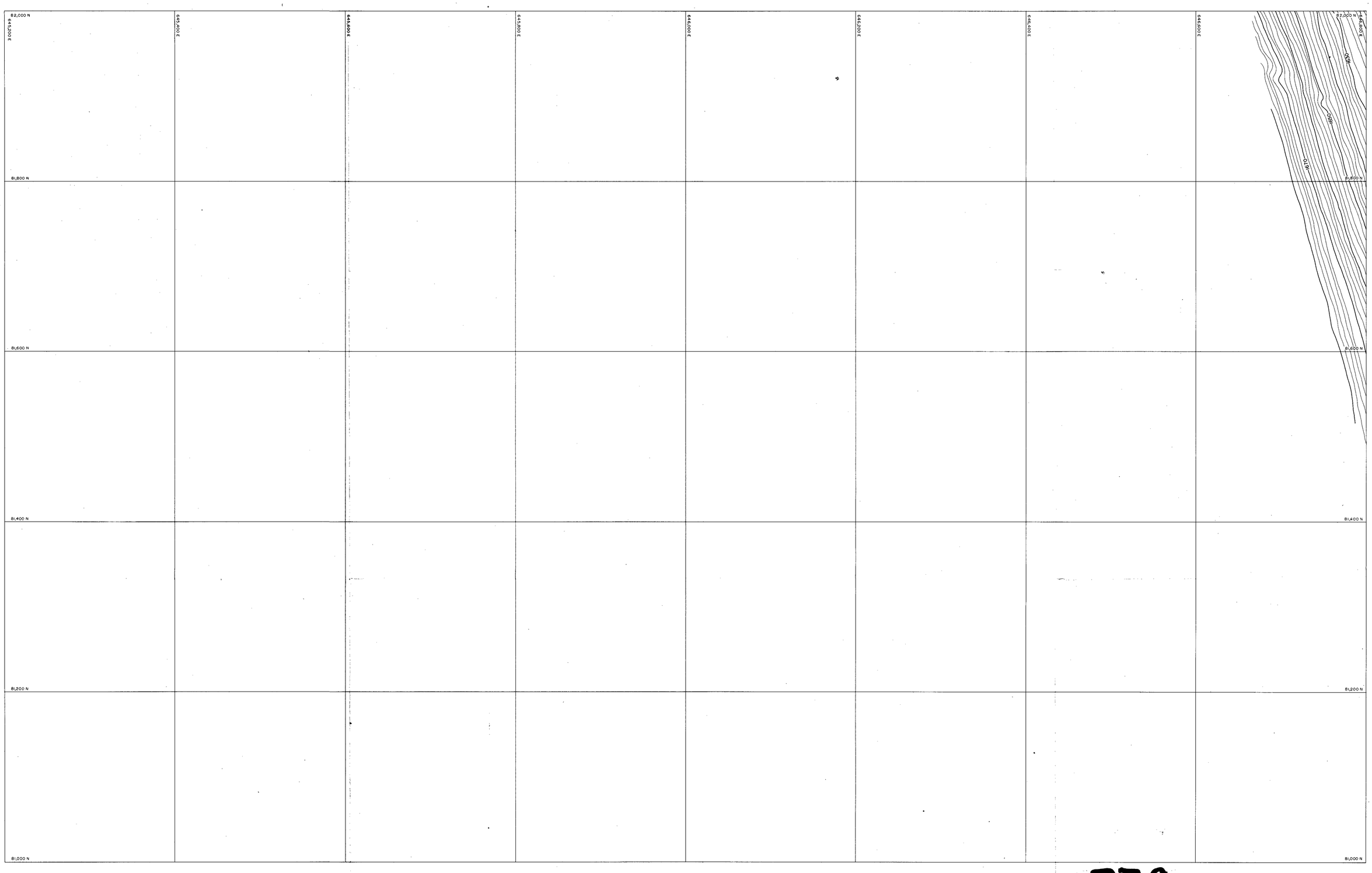
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 80G	DWG. NO.

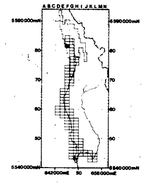
APPENDIX: 5.0



SHEET INDEX:

81F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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LEGEND:

SPOT ELEVATION ..... 2077·8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM ..... B.D.
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE 222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K-Elk River 80(3)A

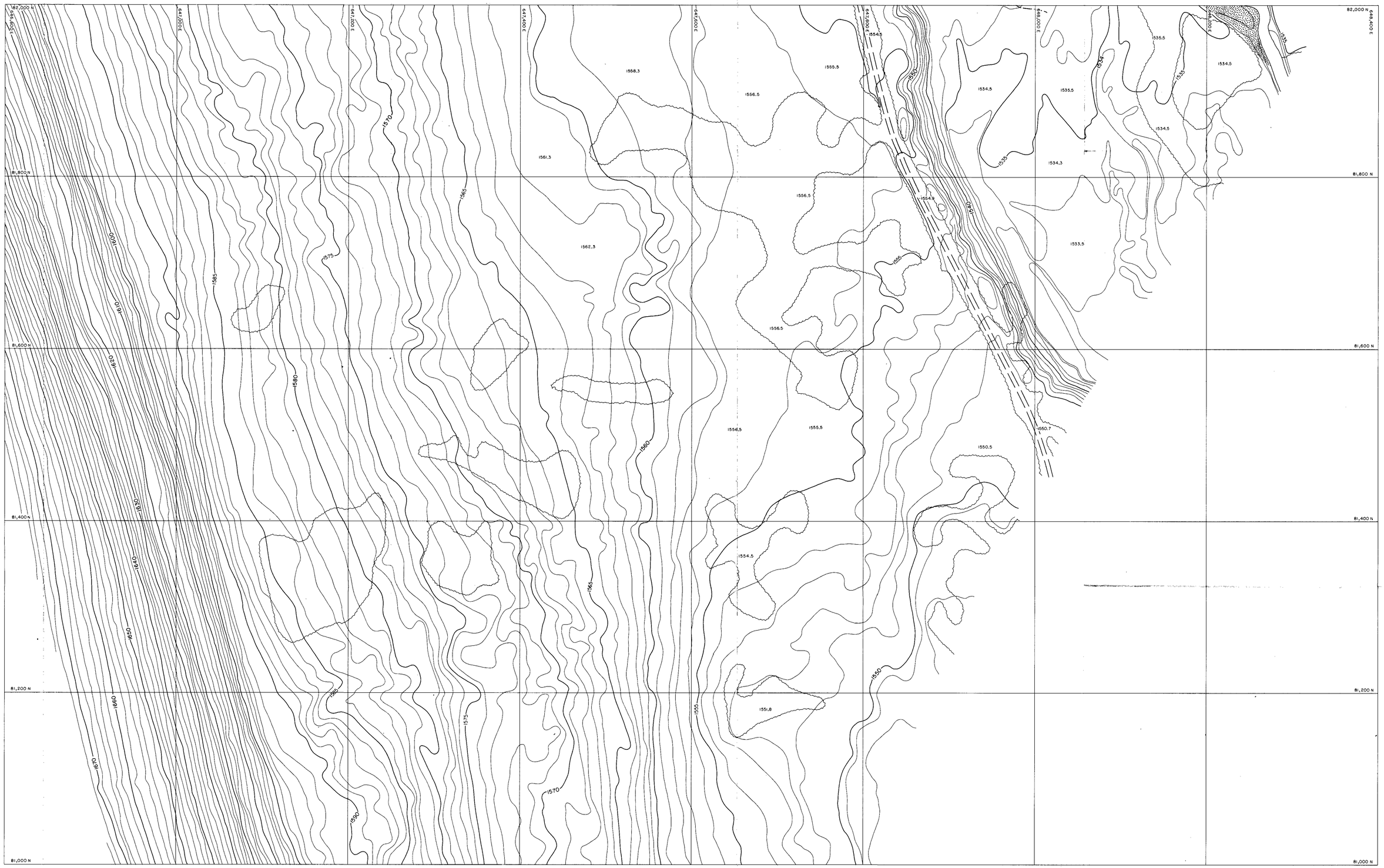
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 81F	DWG. NO.

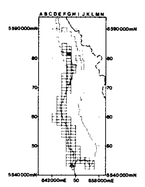
APPENDIX : 5.0



SHEET INDEX:

81G

UTM
Zone 11
Center Meridian
=117°W.Gr.



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LEGEND:

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- BUILDING .....
- CREEKS .....
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- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
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- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

K-Elk River 80(2)A

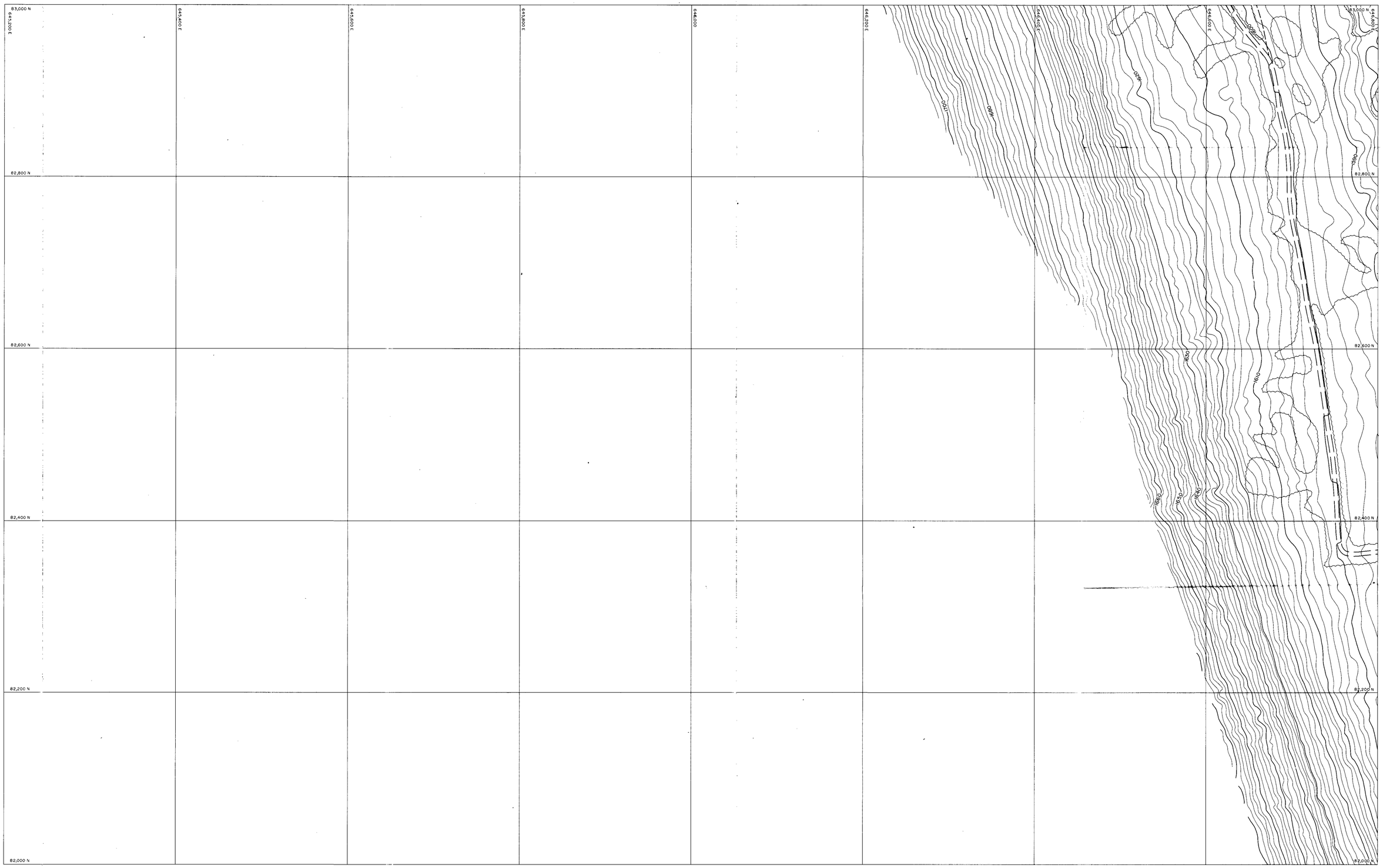
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 81G	DWG. NO.

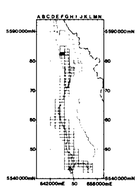
APPENDIX 5.0



SHEET INDEX:

82F

UTM
Zone 11
Center Meridian
=117°w.Gr.



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COMPILATION NOTE:

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LEGEND:

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- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 22132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 80(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 82F	DWG. NO.

APPENDIX 15.0

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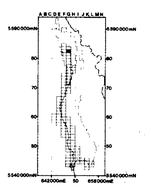
K-Elk River 50(2)A

SHEET INDEX:

82G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

BEARINGS ARE REFERRED TO THE CENTRAL MERIDIAN OF U.T.M. ZONE 11, 117°00'00" W. THE ORIGIN OF THE CO-ORDINATES IS THE FEDERAL GOVERNMENT CO-ORDINATE FOR MT. BLEASDELL WHICH IS CLASSIFIED BY THE GOVERNMENT AS FOURTH ORDER AND MAY BE SUBJECT TO READJUSTMENT AT A LATER DATE.
DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION 2077-8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM .....
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE 222132
- HORIZONTAL CONTROL POINT ... △ 24049
- VERTICAL CONTROL POINT ..... v 62 ⊙ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

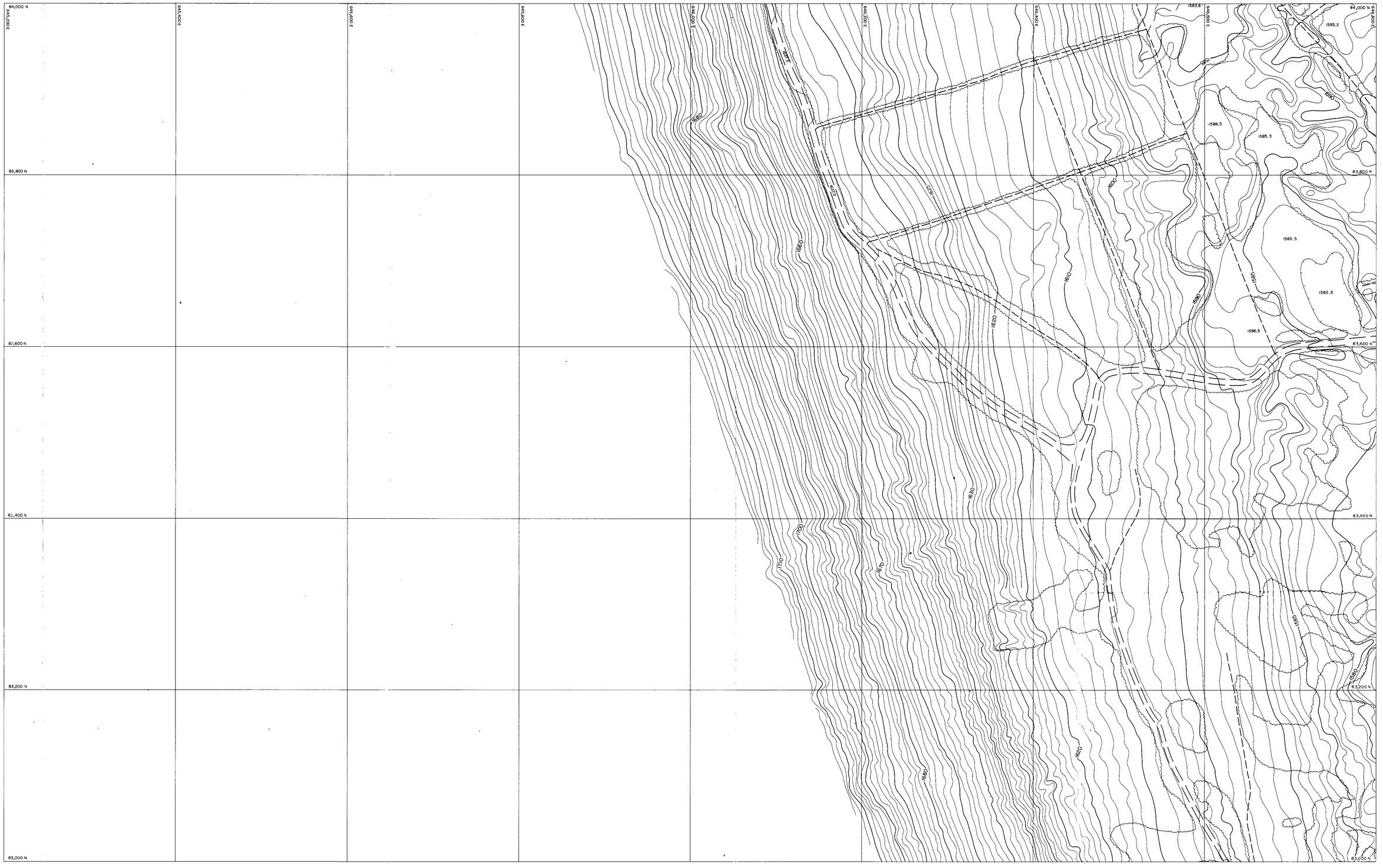
ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 82G	DWG. NO.

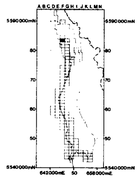
APPENDIX : 5.0



SHEET INDEX:

83F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS I° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 ⊙ 1962-3

279

K-Elk River 20(2)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

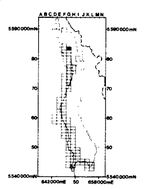
DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 83F	DWG. NO.

APPENDIX : 5.6

SHEET INDEX:

83G

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

EMGS CO-ORDINATES:

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

SPOT ELEVATION 2077-8
ROAD .....
TRACK OR TRAIL .....
POLE .....
BUILDING .....
CREEKS .....
LAKE .....
SWAMP .....

BEAVER DAM .....
FALLS/RAPIDS .....
CONTOURS 1500
TREES .....
AIR PHOTO CENTRE ..... +222132
HORIZONTAL CONTROL POINT .. △ 24049
VERTICAL CONTROL POINT ..... V 62 O 1962-3

279

K-Elk River 20(a)A

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

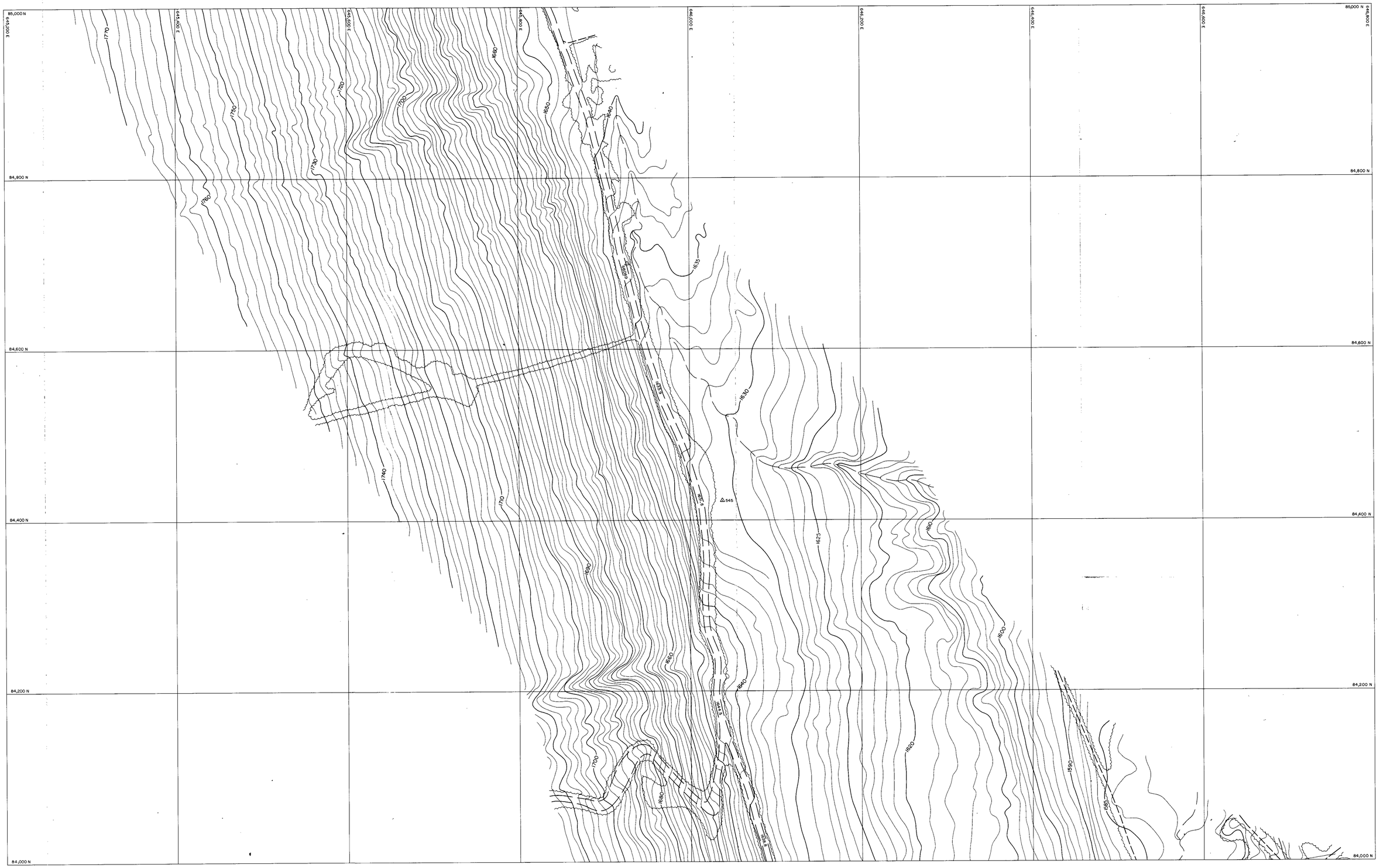
BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 83G	DWG. NO.

APPENDIX 15.0

279

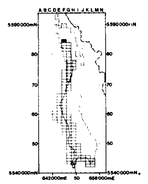
K-Elk River 5a(2)A



SHEET INDEX:

84F

UTM
Zone 11
Center Meridian
=117°w.Gr.



GRID CONVERGENCE:

EMGS GRID CONVERGENCE WITH TRUE NORTH AT Mt. BLEASDELL IS 1° 34' 30"

COMPILATION NOTE:

DATE OF PHOTOGRAPHY MAY 1979
SCALE OF PHOTOGRAPHY APPROX 1:15,000
CONTOUR INTERVAL 2M WITH 1M INTERPOLATED

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DISTANCES ARE REDUCED TO 1500m DATUM AND THE CO-ORDINATES ARE IN METERS.

LEGEND:

- SPOT ELEVATION ..... 2077·8
- ROAD .....
- TRACK OR TRAIL .....
- POLE .....
- BUILDING .....
- CREEKS .....
- LAKE .....
- SWAMP .....
- BEAVER DAM ..... B.D.
- FALLS/RAPIDS .....
- CONTOURS 1500
- TREES .....
- AIR PHOTO CENTRE ..... +222132
- HORIZONTAL CONTROL POINT .. △ 24049
- VERTICAL CONTROL POINT ..... V 62 @ 1962-3

REV.	DESCRIPTION	CHK'D.	DATE

ISSUED	DATE

ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

DRAWN BY	SCALE 1:2000
CHECKED BY	DATE
MAP SHEET NO. 84F	DWG. NO.

APPENDIX 5.8

K-E - River 80/314

Report on 1979/80 Development Work

Carried out on the Elk River Coal Project

VOLUME VII

APPENDICES 6.0, 7.0, 8.0, 9.0, 10.0

REPORT ON THE 1979/80 DEVELOPMENT WORK
CARRIED OUT ON THE ELK RIVER COAL PROJECT

VOLUME VII
LIST OF APPENDICES

Construction Material

Mine Pit

Grain Size Analysis

50 pages

Plasticity Index

9 pages

Permeability Test

Batch #1

Batch #2

Consolidation Test

Batch #1

Batch #2

Proctor Test

3 pages

10.0 Golder Drill Hole (wells) Logs

Footwall Pumpwell

Footwall O.W.1 to O.W.4 inclusive

Endwall Pumpwell

Endwall O.W.1 to O.W.4 inclusive

N.E. INTERCEPTOR DITCH

APPROXIMATE LIMIT – WEARY VALLEY WASTE DUMP

WEARY VALLEY INTERCEPTOR DITCH

APPROXIMATE LOCATION OF BURIED CHANNEL

FORESTRY BY PASS ROAD

DIVERSION DAM

ELK RIVER

CUT OFF DAM No 1

CUT OFF DAM No 2

HAUL ROAD CROSSING No 1 and 2

HAUL ROAD

CUT OFF DAM No 3

CUT OFF DAM No 4

CUT OFF DAM No 5

HAUL ROAD CROSSING No 3

℄ DIVERSION CHANNEL (NORTH)

℄ DIVERSION CHANNEL (MIDDLE)

℄ DIVERSION CHANNEL (SOUTH)

$H_1 - H_1$

$H_2 - H_2$

WEST WASTE DUMP

$H_3 - H_3$

$H_4 - H_4$

$H_5 - H_5$

SEWAGE LAGOON

APPROXIMATE LOCATION OF BURIED CHANNEL

℄ RAILROAD LOOP Approximate Location

EXPLANATION:

- DH2HR – DRILL HOLE
- TP8RD – TEST PIT
- LINE 2 – SEISMIC LINE
- 7781 – SURVEY STATION: McELHANNEY
- OK78 / A – SURVEY STATION: K W L
- B / B – SECTION LINE

279

SCALE

0 500 1000

METERS

Appendix: 6.0 Sheet 1 of 2

k-Elk River 20(3)A *(3)

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

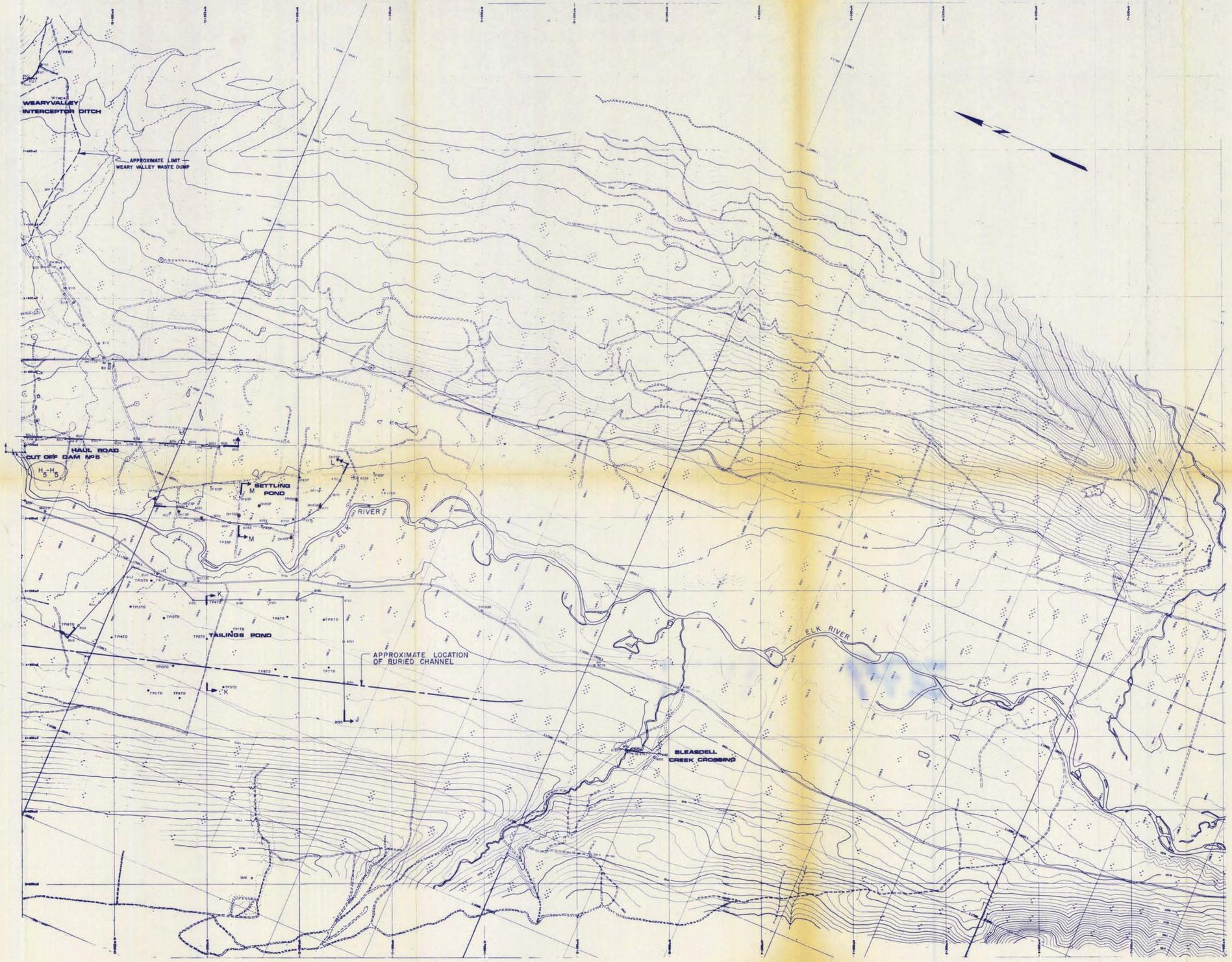
SITE EXPLORATION PLAN — NORTH AND MIDDLE SECTIONS

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED ____ INSPECTED ____
DRAWN GJS RECOMMENDED ____
CHECKED ____ APPROVED ____

DATE DECEMBER 1980

EXHIBIT I



EXPLANATION :

- DH2HR — DRILL HOLE
- TP8RD — TEST PIT
- LINE 2 — SEISMIC LINE
- 7781 — SURVEY STATION : McELHANNEY
- K78 / A — SURVEY STATION : K W L
- B / B — SECTION LINE

279

SCALE

0 500 1000

METERS

K-Elk River PD(2*)A *(3) Appendix: 6.0 Sheet 2 of 2

ELCO MINING LIMITED

ELK RIVER COAL PROJECT
BRITISH COLUMBIA

SITE EXPLORATION PLAN — SOUTH SECTION

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
180 HOWARD STREET, SAN FRANCISCO, CALIFORNIA 94105

DESIGNED ___ INSPECTED ___
DRAWN ___ RECOMMENDED ___
CHECKED ___ APPROVED ___

DATE DECEMBER 1980

EXHIBIT 2

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	Pump #1

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Diversion Dam	8-17-80	8-17-80	0.22m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18965.28 6440.77	1.16m. 1603.82	1604.98	20.1m. 1584.88

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Drillwell Enterprises	–	–	–	20.4m. 1584.58

DRILL MAKE AND MODEL	LOGGED BY:
Bucyrus Erie 12-R	C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING, DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.22m casing 0.20m tricone button bit				0.1 0 1.16m. ▼ 1.9 Johnson 0.2m. stainless steel well screen 60 slot (1.5mm.) 13.3 18.8 20.4		2 4 6 8 10 12 14 16 18 20 22			0.0-13.4m. ALLUVIUM 0.0-0.3m. Gravelly, sandy SILT, with org. roots 0.3-3.0m. Silty, sandy GRAVEL, loose, gray, fines, cohesive, plastic. 3.0m. decrease in fines. 3.0-13.4m. Sandy GRAVEL, est. ∠ 5% fines, 20-40% fine to coarse sand, 60-80% gravels and cobbles 13.4-20.1m. TILL Gravelly, sandy SILT, dk. gray, stiff to very stiff, plastic, low permeability. more gravel at 19.5m. 20.1-20.4m. SILTSTONE, dk. gray, mod. hard. Bottom of borehole

Screen and blank casing installed on 8-24-80. Well developed by air-pumping for 5 hrs. est. 570 lpm during development. Well will produce 760-1140 lpm.

HOLE NO. Pump #1

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-1-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	7-17-80	7-20-80	0.08m 0-16m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
19068.48 6455.58	2.25m 1604.88m	1607.13m	23.78m 1583.35m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	0.27m 6%	17	1	28.20m 1578.93m

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING, DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.16m tricone				set up 0800 7/17/80 * Drilling w/REVERT additive in circ. water					0.0-9.76m ALLUVIUM. SILTY GRAVELLY SAND Wet, 5%-60% non-plastic to sl. plastic fines, no dil. reac., 25%-75% med. to crse sand, 15%-65% hard, ang. gravel to 5cm. max., silt binder present locally, loose to sl. compact, black to brn; (GP-SP to SP-GP).
SPT 1	22	0.3		0900				1	SPT 1: Clayey gravel
0.16m tricone									SPT 2: Sandy gravel
SPT 2	105	0.3		0920				2	SPT 3: Gravelly sand
0.16m tricone									SPT 4: Gravelly sand
SPT 3	89	0.3		0950		5		3	SPT 5: Gravelly sand
0.16m tricone									SPT 6: Gravelly, sandy silt
SPT 4	46	0.3		1030				4	
0.14m tricone									
SPT 5	80	0.3		1105				5	
0.14m tricone									
SPT 6	40	0.3						6	
0.14m tricone				10m - drilling rate increased		10			9.76-21.95m GLACIAL TILL. SANDY-GRAVELLY SILT Moist to wet, 65%-95% non-plas. to sl. plas. fines, quick reac. to no dil. reac., <5% sand, 0-35% rounded to subang. pebbles, locally mottled, gray, brn, black, compact. (ML-GM).
SPT 7	33	0.3		1220				7	
0.14m tricone									SPT 7: Gravelly silt
SPT 8	40	0.3		1235				8	SPT 8: Sandy silt
0.14m tricone									SPT 9: Gravelly silt

INTERNATIONAL ENGINEERING CO., INC. SHEET 2 OF 2

DRILL LOG | PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-1-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
SPT 9	140	.28		1250 refusal, 0.13m 100 blows				9	Till continued
0.14m tricone						15			SPT 10: Gravelly silt
SPT 10	150	.25						10	SPT 11: Clayey, gravelly silt
0.14m tricone									SPT 12: Clayey, gravelly silt
SPT 11	134	.23		refusal, 0.07m 100 blows				11	SPT 13: Gravelly silt
0.12m tricone									SPT 14: Clayey gravelly silt
SPT 12	145	.3		1445				12	
0.12m tricone									
SPT 13	142			1510		20		13	
0.12m tricone				0.5 hour reaming boring 1600					
SPT 14	100			refusal, 0.12m 100 blows				14	
0.12m tricone				high water take at 22m					21.95 - 23.78 m ALLUVIUM. Gravelly sand; wet, <5% fines, 65% coarse, poorly graded sand, 30% angular pebbles to 2.5 cm max., loose black. (SP-GP).
SPT 15	145	0.3		1700				15	
0.12m tricone				0830					23.78 - 28.20 COAL
SPT 16	75	0		refusal, 75 blows 0 penetration		25		16	Physical Condition: Intensely frac., max. 5cm, min. small rock chips, fresh, friable, soft.
SPT 17	100/.07			1000				17	Lithology: Bituminous coal; black, pure, bedding & jointing not visible.
0.08m Core bit	CR 8	RQD 0		100 blows, 0.07m 1000 - 1715; reaming & driving casing					Bottom of borehole 28.20m
	20	0		casing set to 24.70 m.					Installed 0.08m ID perforated PVC standpipe to BOH; plugged at 21.95m 7/22/80; could not penetrate w/geophysc. probe.

HOLE NO. DH-1-RD

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO. 2037	HOLE NO. DH-2-RD
SITE: River Diversion	BEGUN 7/20/80	COMPLETED 7/22/80	HOLE SIZE 0.08-0.16m	ANGLE FROM HORIZ. & BEARING 90° —	
COORDINATES 19044.45 6420.54	DEPTH/EL. GROUND WATER 1.55m 1604.71m	GROUND EL. 1606.26	DEPTH/EL. TOP OF ROCK 25.92m 1580.34m		
DRILLING CONTRACTOR Allkind Drilling Ltd.	CORE RECOV. LENGTH/% 10% 0.29m	SAMPLES 16	CORE BOXES 1	DEPTH/EL. BOTTOM OF HOLE 27.29m 1578.97m	
DRILL MAKE AND MODEL Failing 1500	LOGGED BY: R. Raidl				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
0.12m tricone				Set up 0815 * Drilling w/REVERT additive in circ. water				
SPT 1	117	0.3		0900				1
0.12m tricone								
SPT 2	63	0.3		0925				2
0.12m tricone								
SPT 3	49	0.3		0945		5		3
0.12m tricone								
SPT 4	40	0.3		1040				4
0.14 tricone				reamed w/.16m tricone				
SPT 5	16	0.3		1145				5
0.14m tricone								
SPT 6	14	0.3		1210				6
0.12m tricone				1330 - 1530 reamed & cased to		10		
SPT 7	36	0.3		1535 9.53 m.				7
0.12m tricone								
SPT 8	75	0.3		1550				8
0.12m tricone								

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 7.01m. ALLUVIUM; SILTY SAND to SILTY GRAVEL. Wet, 5-15% sl. plastic fines, 15-70% hard, ang. gravel, max. 5cm., 25-75% med. to crse sand, no to slow dil. reac., silt binder, loose to sl. compact, sl. perv. to non pervious, black to brn. (SM-GM to GP-SP)

0 - 0.6 m. - residual soil.

SPT 1: Gravelly, silty sand
SPT 2: Gravelly silty sand
SPT 3: Silty, sandy gravel
SPT 4: Silty, sandy gravel

gradational contact

7.01 - 17.68 GLACIAL TILL. SANDY, GRAVELLY SILT. Moist to wet, 40% - 80% nonplastic fines, quick to slow dil. reac., low dry strength & toughness, 0-40% med-crse sand, poorly sorted, 5% - 50% ang., hard, gravel to 5cm. max., lms., ss., minor xlline rock frags., rounded pebbles near contact with lower alluvium, loose to compact, silt binder, not pervious, brn to black. (ML-SM to GM-SM)

SPT 5: Gravelly, sandy, silt
SPT 6: Gravelly silt
SPT 7: Sandy silt
SPT 8: Sandy gravelly silt
SPT 9: Sandy, silty gravel
SPT 10: Sandy gravelly silt

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-2-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone						15			Glacial Till continued SPT 11: Silty, sandy gravel SPT 12: Sandy gravel SPT 13 Sandy gravel SPT 14 Gravelly sand
SPT 9	135	0.3		1715				9	
0.12m tricone									
SPT 10	115	0.3		0700, 8/21/80				10	
0.12m tricone									17.68-24.39m ALLUVIUM SANDY GRAVEL. Wet, 5-15% non-plas. fines, 25-75% med to crse sand composed mostly of black lithic frags., none to very slow dil. reac., 15-60% hard ang. gravel to 5cm max., loose to mod. compact, gray to black. (GM-SM to GP-SP).
SPT 11	124	0.3		0730				11	
0.12m tricone									
SPT 12	100	.08		0825		20		12	
0.12m tricone									
SPT 13	100	.08		0850				13	
0.12m tricone									
SPT 14	100	.1		0935				14	
0.12m tricone				reamed w/0.14m tricone and cased to 22.6m					
SPT 15	100	.08						15	contact picked on change in drilling characteristics.
	CR	RQD							24.39-27.29 m. SILTSTONE Physical Charac. Closely-mod. frac. (most frac. mech.), max 10cm., min <1cm, mostly 2-5cm, frac. surf. w/staining shaly & wthrd at 24m, fresh below, hard & strong Lithology Sandy siltstone. Dk. gray w/ 5% med sand, bedding & jting unclear.
0.08m core bit	10	0				25			
SPT 16	100	.08							
0.08m core bit	10	0		finished 1400 8/22/80 Bottom of borehole	27.29m				
				borehole washed & bailed for ± 30 min.; water level at ± 18m; rec. to collar elev. w/i 30 minutes					2.5cm ID PVC to 15.2m due to caving in borehole; well slugged & found to be operating.

HOLE NO. DH-2-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	DH-3-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	7/23/80	7/28/80	0.08-0.16m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18981.85 6340.80	1.59m 1603.94	1605.53m	20.73m 1584.80m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	10% 0.3m	13	1	23.78m 1581.75m

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
0.14m tricone				Set up 0800 began drilling 0840 * Drilling w/REVERT additive in circ. water				
SPT 1	92	0.3		0855				1
0.14m tricone				sand line cable broke; drill rig down				
SPT 2	68	0.3		0825 8/25/80				2
0.12m tricone				0900, moved rig 1m to get off big boulder				
SPT 3	78	0.3		1205		5		3
0.12m tricone				reamed to 0.16m diam.				
SPT 4	98	0.3		1235				4
0.12m tricone								
SPT 5	63	0.3		1350				5
0.12m tricone								
SPT 6	19	0.3		1450				6
0.12m tricone						10		
SPT 7	21	0.3		1525				7
0.12m tricone								
SPT 8	43	0.3		1555				8
0.12m tricone								
SPT 9	142	0.2		1655				9

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 10.37m ALLUVIUM
SILTY SANDY GRAVEL, GRAVELLY SAND
Wet, 0-5% nonplastic fines, 40%-90% fine to coarse sand, poorly graded, 35-90% hard, angular to subangular gravel to 5cm max., loose, gray to black. (SP-GP) to (GP)

SPT 1: Silty, gravelly sand
SPT 2: Sandy gravel
SPT 3: Sandy gravel
SPT 4: Sandy gravel
SPT 5: Sandy gravel
SPT 6: silty sandy gravel

10.37 - 18.90m GLACIAL TILL
SANDY GRAVELLY SILT to SANDY SILT.
Wet to moist, 30-95% nonplastic fines, no to fast dil. reac., 5-50% med. to crse sand, 10-40% hard subang. to subrounded grav. to 2.5cm max., loose to well compacted, brn. (ML-GM, SM-GM, ML-SM)

HOLE NO. DH-3-RD

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-3-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING, DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
SPT 9	142	0.3						9	Glacial till continued SPT 7: Sandy, gravelly silt SPT 8: Sandy gravelly silt SPT 9: Sandy, gravelly silt SPT 10: Gravelly silty sand SPT 11: Gravelly silt SPT 12: Gravelly sandy silt
0.12m tricone				1715		15			
SPT 10	100	13		refusal: 100 blows 0.13m				10	
0.12m tricone				8/26/80 0850					
SPT 11	150	.13		refusal: 150 blows 0.13m				11	
0.12m tricone									
SPT 12	150	.10		0955 refusal, 150 blows .10m				12	
0.12m tricone									18.90 - 20.73m ALLUVIUM; GRAVELLY SAND Wet, < 5% fines, 80% med.-crse sand, poorly graded, 15% hard, ang. grav. to 2.5cm. max., mod. compact, gray to black. (SP-GP) (contact based on 100% rock cuttin
SPT 13	100	.02		1020 refusal, 100 blows 0.02m				13	
0.12m tricone						20			
	CR	RQD							
	20	0							20.73 - 23.78m SILTSTONE Physical Condition: Closely-intensely frac; max. 7.5cm, min < 2cm., mostly 2.5-5cm; some frag. surf. w/Fe-st., otherwise fresh. Most fracs. appear mech.. Lithology: Carbonaceous siltstone. Black, bedding & jting not readily discernible due to frac. nature of core. Sl. sandy w/coal specks.
0.12m core bit	10	0							
	25	0		Bottom of borehole	23.78m				
				Installed 2.5cm ID PVC to BOH after flushing; bottom 12.2m were slotted; backfilled w/grav. to approx. 2m, added 1 bag bentonite powder, filled to surf. Well slugged & found to be operating		25			

HOLE NO. DH-3-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-4-RD

SITE: River Diversion	BEGUN: 7/28/80	COMPLETED: 7/29/80	HOLE SIZE: 0.14m	ANGLE FROM HORIZ. & BEARING: 90° —
COORDINATES: 18974.75 6385.60	DEPTH/EL. GROUND WATER: 1.96m 1603.51m	GROUND EL.: 1605.47	DEPTH/EL. TOP OF ROCK: 20.4m 1585.07m	
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: 0 —	SAMPLES: 9	CORE BOXES: 1	DEPTH/EL. BOTTOM OF HOLE: 21.34m 1584.13m
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: R. Raidl			

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up 1030 started drilling 1100 Drilling with REVERT additive in circ. water					0.0 - 6.25m ALLUVIUM. SANDY GRAVEL, GRAVELLY SILTY SAND. Wet, 0-15% nonplastic fines, 40-75% fine to coarse, poorly graded sand, 10-60% hard to mod. hard, subrounded to subang. gravel to 5cm. max., loose, gray to brn. (GP-SP).
SPT 1	162	0.3		1150				1	
0.14m tricone						5			SPT 1: Sandy gravel SPT 2: Gravelly silty sand
SPT 2	100	0.3		1230				2	6.25 - 18.44m GLACIAL TILL SANDY, GRAVELLY SILT. Moist, 15-80% non plastic fines, 0-60% fine-coarse, poorly sorted sand, 20-45% hard, ang. gravel to 5cm. max., mod compact, brn to black. (ML-SM, ML-GM, with SP-GP lense).
0.14m tricone									
SPT 3	154	0.3		1325				3	
0.14m tricone									
SPT 4	92	0.3		1350				4	
0.14m tricone						10			SPT 3: Gravelly, sandy silt SPT 4: Silty gravelly sand SPT 5: Sandy, gravelly silt SPT 6: Sandy, gravelly silt SPT 7: Gravelly silt SPT 8: Gravelly silt
SPT 5	100			1430				5	
0.14m tricone									
SPT 6	1001	.05		1500				6	

HOLE NO. DH-4-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-4-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
									GLACIAL TILL continued
0.14m tricone						15			
SPT 7	100	.08		1545				7	
0.14m tricone									
SPT 8	100	.08		1610				8	
0.14m tricone									18.44-20.43m ALLUVIUM. SILTY GRAVEL. Moist, 45% sl. plas. fines, 55% hard, subang. to subrounded grav. to 2.5cm max., mod. compact, black. (GM-ML)
SPT 9	100	.08		1705		20		9	
0.14m tricone									20.43-21.34m SILTSTONE. Cuttings were hard, fresh carb. siltstone
				Bottom of borehole 21.34m					Installed 2.5cm ID PVC to bottom of borehole; backfilled borehole with river gravel; slugged well. Completed installation 0915 8/29/80

HOLE NO. DH-4-RD

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-5-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	7/29/80	7/29/80	0.16m - 0.12m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18929.56 6441.70	1.92m 1602.88	1604.80m	19.82m 1584.98m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	11	1	21.34m 1583.46m

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
0.16m tricone				Set up on site 0930				
				Considerable rig vibration were boulders encountered. 1040				
SPT 1	112	0.3		* Drilling with REVERT additive in circ. water				1
0.16m tricone						5		
SPT 2	85	0.3		1115				2
0.14m tricone								
SPT 3	70	0.3		1140				3
0.12m tricone								
SPT 4	69	0.3		1205				4
0.12m tricone						10		
SPT 5	48	0.3		1250				5
0.12m tricone								
SPT 6	58	0.3		1320				6
0.12m tricone								
SPT 7	114	.03		1335				7

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 14.48m ALLUVIUM. SANDY GRAVEL, GRAVELLY SAND. Wet, 0-5% nonplastic fines, 5-75% fine to coarse, poorly graded sand, 20%-65% hard, ang. to subrounded gravel to 7.5 cm. max., loose to compact, gray brn to brn. (GP-SP, SP-GP).

SPT 1: Sandy gravel
SPT 2: Sandy gravel
SPT 3: Gravelly sand
SPT 4: Gravelly sand
SPT 5: Sandy gravel
SPT 6: Silty gravelly sand
SPT 7: Silty gravelly sand

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-5-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone									
				1410 tried to push Shelby - material too dense		15			14.48 - 19.82m. GLACIAL TILL. GRAVELLY SILT. Moist, 55-85% non-plastic fines, 15-45% ang. to subrounded gravel to 5cm. max., compact to loose. (ML-GM).
SPT 8	152	.25						8	
0.12m tricone									SPT 8: Gravelly silt
SPT 9	100/.14			1440				9	SPT 9: Gravelly silt
0.12m tricone									SPT 10: Gravelly silt
SPT 10	148/.30			1520				10	
0.12m tricone									
SPT 11	100/.02							11	
0.12m tricone						20			19.82 - 21.34m. SILTSTONE & COAL Cuttings of hard siltstone & soft frac. coal.
				Bottom of borehole completed 1000 7/29/80	21.34m				Installed 2.5cm PVC to BOH; bottom 12.2m were slotted, borehole backfilled with river gravel & pea gravel from Elkford pit; material bridged before boring filled; well slugged after PVC installed.

HOLE NO DH-5-RD

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-6-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	7/30/80	7/31/80	0.16m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18956.69 6498.66	1.74m 1604.11 m	1605.85m	13.72m 1592.13m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	6	1	15.24m 1590.61m

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
0.16m				Set up on site 0745 0815 - began drilling 0900 - began casing many boulders setting casing very difficult				
SPT 1	99	0.3						1
0.16m tricone				* Drilled using REVERT additive to circ. water.		5		
SPT 2	20	0.3						2
0.16m tricone								
SPT 3	7	0.3		1145; 8.08m tried to push Shelby, material fell out of tube				3
0.16m tricone						10		
SPT 4	21	0.3		1345				4
Shelby 1		0.3		9.15m; tried to push Shelby; material fell out of tube				5
0.16m tricone								
SPT 5	165	0.3		1500				6
0.16m tricone				12.2m - tried to push Shelby material too dense				7
SPT 6	100	0.4						

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 5.18m ALLUVIUM SANDY GRAVEL
Wet, 20% med-coarse, poorly graded sand, 80% hard, subangular gravel to 5cm. max., loose, gray-brn. (GP-SP)

5.18 - 12.50m GLACIAL TILL; CLAYEY, GRAVELLY SILT
Wet to moist 90 - 100% sl. plastic fines, 0-10% hard, angular grav. to 2.5cm. max., compact, brn. (ML-GM, ML).

SPT 2: Clayey, gravelly silt
SPT 3: Clayey, gravelly silt
SPT 4 Clayey silt
Shelby 1: Sandy silt

12.50 - 13.72m. SILTY ALLUVIUM or GRAVELLY TILL; SILTY GRAVEL. Moist, 50% nonplastic fines, 50% subrounded grav. to 1.5cm max. compact, brn (GM-GA)

13.72 - 15.24 SILTSTONE

HOLE NO.: DH-6-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-6-RD

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS (WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH)	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION
				cased to 14.6m		15			Cutting of hard, fresh carbonaceous siltstone w/ coal specks.
				Bottom of borehole completed 07/31/80 1100	15.24m				2.5cm PVC installed to BOH; bottom 12.20 m slotted; borehole backfilled with river gravel, sealed w/ bentonite and slugged.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: OH-7-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/5/80	8/6/80	0.16m - 0.12m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18966.85 6434.39	1.80m	1605.07m	21.04m 1583.67m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	13	1	21.34m 1583.73m

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS (WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH)	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION
0.16m tricone				Started drilling 0900					0-16.00m ALLUVIUM; SANDY GRAVEL, GRAVELLY SAND, GRAVEL. Moist, <5% fines throughout, 15-85% fine to coarse sand composed of black lithic frags & minor quartz., 15%-75% hard, subrounded to subangular gravel to 5cm. max., composed of limestone & siltstone, loose to mod. compact, gray to dark gray. (SP-GP, GP-SP, GP).
SPT 1	60	0.2		* Using REVERT additive to circ. water.				1	
0.16m tricone				0955 boulder at 1.52m so did not take SPT					
SPT 2	135	0.3		1030				2	
0.16m tricone									
SPT 3	79	0.3		1105		5		3	
0.12m tricone									
SPT 4	75	0.3		1140				4	
0.12m tricone									
SPT 5	54	0.3		1210				5	
0.12m tricone				drove casing to 9.70m.					
SPT 6	61	0.3		0800		10		6	
0.12m tricone									
SPT 7	102	0.3		0930 water inflow 12.50m				7	
0.12m tricone									
SPT 8	100/.08							8	

SPT 1: Gravelly sand
SPT 2: Sandy gravel
SPT 3: Sandy gravel
SPT 4: Sandy gravel
SPT 5: Sandy gravel
SPT 6: Gravelly sand
SPT 7: Gravelly sand
SPT 8: Gravel
SPT 9: No recovery

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-7-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING, DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone				drilling smoothly casing installed to 14.63m					Alluvium continued
SPT 9	25	0		1030		15		9	
0.12m tricone				sampler bouncing sand & black rock fragments in cuttings					16.00-21.04m GLACIAL TILL. SANDY GRAVELLY SILT.
SPT 10	118	.23		1100				10	Moist, 40-85% nonplastic fines, no dilatancy reaction, 5%-20% fine-crse poorly graded sand, 10%-40%, hard, subang. gravel to 5cm max., compact, dense, brn. to black. (ML-GH, GM-ML)
0.12m tricone									SPT 10: Sandy, gravelly silt
SPT 11	150	0.3		1230				11	SPT 11: Silty gravel
0.12m tricone									SPT 12: Gravelly silt
SPT 12	118	.23		1250		20		12	
0.12m tricone				driller reports rock at 21.04m.					
SPT 13	50	0		1325				13	21.04-21.34 SILTSTONE; hard, fsh, carb.
				bottom of borehole. 21.34m					2.5cm PVC installed to BOH with plug; bottom 6.10m slotted. borehole caved immediately after casing pulled; no gravel packed around slotted section; sealed at about 12.2m with bentonite; well slugged.

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG	PROJECT Elk River Coal Mine	JOB NO. 2037	HOLE NO. DH-7A-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/6/80	8/7/80	0.16 m	90° —

COORDINATES	DEPTH/EL GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18967.17 6431.78	1.79m 1603.29m	1605.08m	Not reached

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	0	—	14.94m 1590.14m

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH Meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.16m tricone				Set up on site at 16 15 * Using REVERT additive to circ. water.		5 10			0-14.94m ALLUVIUM GRAVEL & SAND; BOULDERS COMMON. 6.10-7.62: pervious gravel, lost circulation water. 12.20m: pervious gravel, lost circ. water; regained by thickening REVERT.

HOLE NO. DH-7A-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-7A-RD

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.16m tricone									Completed boring on boulder.
				Bottom of Borehole; completed 1100. 14.94 m		15			Installed 2.5cm. PVC to BOH; bottom 9.15m were slotted. backfilled with gravel to 3 m, installed bentonite seal. well slugged and W.L. dropping slowly.

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-8-RD

SITE: River Diversion	BEGUN: 8/7/80	COMPLETED: 8/8/80	HOLE SIZE: 0.12m	ANGLE FROM HORIZ. & BEARING: 90° —
COORDINATES: 18969.46 6419.90	DEPTH/EL. GROUND WATER: 1.58m. 1603.73	GROUND EL.: 1605.31		DEPTH/EL. TOP OF ROCK: 21.19m 1584.12
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: 2	CORE BOXES: 1	DEPTH/EL. BOTTOM OF HOLE: 21.34m 1583.97
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: R. Raidl			

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone				Set up on site 1230 began drilling 1250 * Using REVERT additive to circ. water.		5 10			0-14.94m. ALLUVIUM. SAND & GRAVEL w/ BOULDERS. (See SPT 1 descrip.) Boulders: 2.13-2.44m 3.96-4.05m 14.02-14.63m
SPT 1	70	0.3						1	SPT 1: GRAVELLY SAND, moist, 5% fines, 80% med-crse sand, 15% subang to subrounded grav. to 4cm max. compact, brn., (SP-GP).
0.12m tricone									

HOLE NO. DH-8-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 2 OF 2

DRILL LOG | PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-8-RD

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
									Alluvium continued.
						15			14.34 - 21.19m GLACIAL TILL SILT w/ SANDY & GRAVELLY LENSES. (see SPT 2 descrip.)
SPT 2	BD	1.5						2	SPT 2: GRAVELLY SILT; moist, 75% nonplastic fines, 25% hard, angular gravel to 2.5cm max., compact, black. (ML-GM)
0.12m tricone						20			
									21.19 - 21.34m SILTSTONE; hard, fsh, carb silts.
				Bottom of Borehole 21.34 m.					Installed 2.5cm PVC to BOH, slotted bottom 7.5m at 15cm intervals; backfilled to 3m w/grav. sealed with bentonite & slugged well.

HOLE NO. DH-8-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-8A-RD
SITE: River Diversion	BEGUN: 8/9/80	COMPLETED: 8/9/80	HOLE SIZE: 0.12m	ANGLE FROM HORIZ. & BEARING: 90° —	
COORDINATES: 18969.90 6417.07	DEPTH/EL. GROUND WATER: 1.91 m 1603.41		GROUND EL.: 1605.32	DEPTH/EL. TOP OF ROCK: Not reached	
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: —	CORE BOXES: —	DEPTH/EL. BOTTOM OF HOLE: 14.02 m 1591.30	
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: R. Raidl				

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone				Started drilling 0700 * Using REVERT additive to circ. water.		5 10			0.0 - 13.72 m ALLUVIUM SAND & GRAVEL w/OCCAS. BOULDER (Described from cuttings) Mixed sand & gravel with boulders to 0.3m max. (SP-GP) 8.23: very gravelly w/considerable rig vib. 13.72-1402 m Till, 90% fines 10% grav. to 2cm max. (ML-GM)

Bottom of borehole 14.02 m; Installed 2.5 cm PVC to BOH, slotted bottom 7.6 m; backfilled w/grav. to 3.1 m; sealed w/ bent. slugged well.

HOLE NO. DH-8A-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: OH-9-RD
SITE: River Diversion	BEGUN: 8/10/80	COMPLETED: 8/11/80	HOLE SIZE: 0.14m - 0.12m	ANGLE FROM HORIZ. & BEARING: 90° —	
COORDINATES: 18950.73 6443.49	DEPTH/EL. GROUND WATER: 1.93m 1603.11m		GROUND EL.: 1605.04	DEPTH/EL. TOP OF ROCK: 20.27m 1584.77	
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: —	CORE BOXES: —	DEPTH/EL. BOTTOM OF HOLE: 20.43m 1584.61	
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: R. Raidl				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up 0830; added 1 bag REVERT; began drilling 0915					0-14.94m ALLUVIUM SAND & GRAVEL. Description of cuttings: 0.0-3.05m: Ang. gravel to 4cm max. w/crse sand
				smooth drilling					3.05-10.37m: Med-crse sand, mostly black lithic frags. w/minor qtz., minor gravel to 1cm. max.
0.12m tricone				1120-1320 drove 8.08m casing		5			
				9.90m lost 50% circ. considerable rig vibration		10			10.37-10.98: Boulder prob. sltstone
				8/11/80 started drilling 0800					10.98-11.43: Gravelly sand, grav. to 1cm. max., minor sand.
				smooth drilling					11.43-12.80: Med.-coarse sand
									12.80-13.41: Boulder
									13.41-14.94: Med-coarse sand.

HOLE NO. OH-9-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG | PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-9-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
									Alluvium continued
				Rig motion indic. gravelly material		15			14.94 - 20.27m GLACIAL TILL SILTY SAND, SILTY GRAVEL.
0.12m tricone				Smooth drilling					14.94 - 15.24: Silty gravel 15.24 - 20.27: Silty sand.
				19.8m - drilling rate slows significantly but still smooth.		20			20.27 - 20.43: SILTSTONE; fresh, black, hard
				Bottom of Borehole 20.43 m					Installed 2.5 cm PVC to BOH; plugged bottom of PVC; slotted bottom 7.5 m.; back filled w/gravel to top of till; installed bentonite plug back filled w/gravel to 3 m, installed bentonite plug; filled to surface; slugged well.

HOLE NO. DH-9-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-9A-RD
SITE: River Diversion	BEGUN: 8/12/80	COMPLETED: 8/12/80	HOLE SIZE: 0.12 m	ANGLE FROM HORIZ. & BEARING: 90° —	
COORDINATES: 18947.68 6443.79	DEPTH/EL. GROUND WATER: 1.65m. 1603.42	GROUND EL.: 1605.07	DEPTH/EL. TOP OF ROCK: Not reached		
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: —	CORE BOXES: —	DEPTH/EL. BOTTOM OF HOLE: 15.24m 1589.83	
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: C.C. Payton				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.12m tricone				Samples are cuttings from tricone bit, 0.12m diam.; sampled at 0.75m intervals Till in DH-9-RD was found at 14.90 m. ±		5 10			0.0 - 15.24 m ALLUVIUM. SILTY SANDY GRAVEL. Wet to moist, occ. boulders, subrounded sand & gravel, fresh, hard; 10% fines, 35% sand, 55% gravels & cobbles. Increase in fines at 9m

HOLE NO. DH-9A-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-9A-RD

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
									Alluvium continued
						15			
				Bottom of Borehole 15.24m					Installed 2.5cm PVC to BOH; slotted with hacksaw from 3m to 13.72m; backfilled with gravel and sand to 1m; bentonite seal to surface; slugged well.

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-10-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Haul Road; Damsite #2	8/12/80	8/13/80	0.14m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
	1.62m		Not reached

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	4	1	7.62m

DRILL MAKE AND MODEL: Failing 1500

LOGGED BY: C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				On Left Bank of Elk River; drilling w/0.14m tricone and REVERT					0-2.59m ALLUVIUM; SANDY GRAVEL; Est. 30% med. to coarse sand, < 5% fines, 65% gravel & cobbles, gravel subrounded, fsh, hard. 1.22m: increased in moisture saturated sand & grav.
SPT 1	80	0.3						1	
0.14m tricone				Borehole site 12m from river					
SPT 2	145	0.3						2	
0.14m tricone									2.59-4.73m GLACIAL TILL SANDY GRAVEL; Wet, 5% fines (NP), 30% sand, 65% grav. sized rock frags. subang. to ang.
SPT 3	100/.08							3	Top of rock
0.14m tricone				SPT refusal drilling smooth cased to ± 5m		5			4.73-7.62m SILTSTONE & MUDSTONE Fine-grained, soft, with thin coal seams, gray to black
SPT 4	150	.13						4	SPT 4: Mudstone; soft to very soft, easily bkn by finger pressure, black. local coal seams
0.12m cracker-jack bit		1.65	0	Cored 1.65m w/crackerjack bit no recov.; 100% return of circ. water; black					
				Bottom of borehole 7.62m		10			Installed 2.5 cm PVC to 6.7m, slotted .6m to 3.65m; stick up 0.28m; backfilled w/grav to near surface and sealed w/bent.

HOLE NO. DH-10-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	DH-11-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/17/80	8/17/80	0.14m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
	2.90m		7.62m

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	5	1	8.23m

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Using REVERT additive to circ. water					0.0-4.57m ALLUVIUM; GRAVEL & SAND wet, 0% fines, 50-65% medium to coarse sand, 35% to 50% ang. to subang. gravel to 4cm max., brn to gray, loose. (GP-SP, SP-GP)
SPT 1	50	.02		1008 sampler bouncing				1	SPT 1 Sandy gravel
0.14m tricone									SPT 2 Gravelly sand
SPT 2	96	.15		1040				2	
0.14m tricone									
SPT 3	79	0.3		1145		5		3	4.57-7.62m GLACIAL TILL; SANDY SILT w/ CARBONACEOUS LENSES. Moist, 25-75% nonplastic fines, 20-75% med-crse sand, 5%-75% coal or carb. siltst. in lenses, mod. compact, brn-bl. (ML-SM)
0.14m tricone									SPT 3 Coal & Silt
SPT 4	63	0.3		1215				4	SPT 4 Sandy silt
0.14m tricone									
SPT 5	50	0		1230 sampler bouncing				5	7.62-8.23m SILTSTONE; hard, fresh carb. siltstone cuttings.
0.14m tricone									
				Bottom of borehole 8.23m.					Installed 2.5cm PVC to BOH; slotted bottom 4.6m; washed boring and gravel packed to 1m.; installed 0.3m bentonite seal. filled to surface.

HOLE NO. DH-11-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-12-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/18/80	8/18/80	0.14m - 0.12m	90° ——

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
19024.97 6228.04	1.89 m 1605.40	1607.29	6.15m 1601.14

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	——	4	1	7.93m 1599.36

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
SPT 1	10	0		Added 1 bag REVERT to circ. water; sampler bouncing				1	0.0-2.29m ALLUVIUM; SAND & GRAVEL, boulder @4.52m. Open 1-1.5m where circ. lost. SPT 1: no sample rec.
SPT 2	150	.15						2	2.29-6.15m GLACIAL TILL; SILT w/ SAND & GRAVEL. Moist, 65-75% nonplastic fines, quick to no dilatancy reaction, 15-20% med. to coarse sand, 5-20% gravel to 2.5cm max., mod. compact, brn. (ML-6M-ML-SM). SPT 2: Gravelly, sandy silt. SPT 3: Sandy, gravelly silt. SPT 4: Gravelly silt
SPT 3	100	.10		1300				3	
				boulder: 5.64-5.95 m		5			
SPT 4	100	.06		1345				4	
0.12m tricone									6.15-7.93m SILTSTONE: Hard, fresh, carbonaceous siltstone.
				Bottom of borehole 7.93 m.		10			Installed 2.5cm PVC to BOH, bottom 6.1m slotted, boring washed, backfilled with gravel to 1m; installed bentonite seal; filled to surface w/gravel; slugged well. 0.23m stickup

HOLE NO. DH-12-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	DH-13-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/19/80	8/20/80	0.14-0.12m	90° —

COORDINATES	DEPTH/EL GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18993.65 6184.48	1.98m 1605.69	1607.67	2.59m 1605.08

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	1	1	4.12m 1603.55

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up 0800 Added 1 bag REVERT additive to circ. water					0.0-0.92m ALLUVIUM & SLOPEWASH Silt and gravel to 4cm max, sub-rounded to subang., loose
SPT 1	85	0.3		0915				1	0.92-2.59m GLACIAL TILL; SANDY SILT. Wet, 90% sl. plastic fines, quick dilatancy reac; 10% med-crse sand, minor gravel. (ML-SM)
0.12m tricone				Cased to 4.12m where casing bounced					2.59-4.12m SILTSTONE Carb. siltstone w/minor sandstone & coal; hard & fresh cuttings
				Bottom of borehole 4.12m		5			Installed 2.5 cm PVC to BOH; slotted bottom 2.45 m; boring washed, gravel packed to 1.5 m sealed with bentonite 0.5-1.5m, gravel filled to surface, slugged well.

HOLE NO. DH-13-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-14-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion	8/20/80	8/20/80	0.14 - 0.12m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
18984.50 6240.72	1.72m 1604.82	1606.54	8.23m 1598.31

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	5	1	9.15m 1597.39

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up 1130 added 1 bag REVERT to pit.					0.0 - 3.35m ALLUVIUM SANDY GRAVEL. Moist, sl. cohesive, <5% fines, 20% med. - crse sand, 75% ang. to subang. gravel (slst., lms) loose to sl. compact, brn. (GP).
SPT 1	98	0.3		0.0-2.0m fast smooth drilling				1	
0.14m tricone									contact in SPT 2
SPT 2	120	0.3						2	3.35 - 8.23m GLACIAL TILL GRAVELLY SILT. Moist, 70-90% nonplastic fines with a quick dilatancy reaction to no reaction, minor sand, 10%-30% angular to subangular gravel to 2 cm. max., compact, dk. brn to black (ML-GM)
0.14m tricone									SPT 2: Gravelly silt
SPT 3	136	.30		boulder: 4.8-5.64m				3	SPT 3: Gravelly silt
0.12m tricone						5			SPT 4: Gravelly silt
SPT 4	100	.10						4	SPT 5: Gravelly silt
0.12m tricone									
SPT 5	100	.13						5	
0.12m tricone									SANDSTONE and SILTSTONE 8.23-9.15m. Hard & fresh cutting med. gr. Ss & carb. siltstone.
				Bottom of borehole 9.15m		10			Installed 2.5cm. PVC to BOH, slotted 7.6m, washed boring, packed with gravel to 1.5m; bentonite seal 0.6-1.5m; gravel filled to surface; slugged well

HOLE NO. DH-14-RD

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-15-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion (Island)	8/21/80	8/22/80	0.14 - 0.12m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
19089.48 6255.81	2.83m 1604.92	1607.75	15.10m 1592.65

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	—	11	1	18.29m 1589.46

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
				1000 began drilling; added 1 bag REVERT to pit.				
				1230 Cobble gravel on surface				
SPT 1	131	0.3						1
SPT 2	87	0.3						2
SPT 3	68	0.3		14.30		5		3
				5.48m - drilling rate increased				
SPT 4	38	0.3		1500				4
				6.10 - 7.63 m. drilled very smoothly				
SPT 5	52	0.3		1790 1500 - 1700 drove 6.10m casing.				5
SPT 6	12	0.3		0835 8/22/80		10		6
SPT 7	21	0.3		0850				7
SPT 8	45	0.3		0910				8
SPT 9	67	0.3		0930				9

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 8.08m ALLUVIUM; SANDY GRAVEL to GRAVELLY SAND. Moist, sl. cohesive to 10% nonplastic fines, 20% - 70% med - crse sand, 20% - 80% subrounded to subang., fresh, hard gravel to 5cm. max., mod. compact, brn. (GP-SP, SM-GM).

SPT 1: Sandy gravel
SPT 2: Sandy gravel
SPT 3: Sandy gravel
SPT 4: Gravelly sand
SPT 5: Sandy gravel

8.08 - 15.10m GLACIAL TILL; SILT, SANDY SILT, SILTY GRAVEL. Moist, 30% - 100% nonplastic fines, quick to no dilatancy reaction, minor to 40% fine sand, minor to 70% angular gravel to 2.5cm. max., compact, brn. (ML, ML-SM, GM-ML).

SPT 6: Silt
SPT 7: Silt
SPT 8: Sandy silt
SPT 9 Silty gravel

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-15-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
SPT 9	67	0.3						9	GLACIAL TILL continued
						15			top of rock
SPT 10	25	0		1000 Sampler bouncing					15.10 - 17.07m SILTSTONE Fresh, hard, carbonaceous cuttings
SPT 11	25	0		1120 Sampler bouncing					17.07 - 18.29m MUDSTONE and COAL Fresh, soft to moderately hard mudstone with coal specks.
				Bottom of borehole 18.29m.					Installed 2.5cm PVC to 18.29m (BOH); slotted bottom 12.2m and backfilled with gravel to 1.5m; 0.3-1.5m bentonite seal; slugged well.

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-16-RD
SITE: River Diversion	BEGUN: 8/22/80	COMPLETED: 8/23/80	HOLE SIZE: 0.14-0.12m	ANGLE FROM HORIZ. & BEARING: 90° —	
COORDINATES: 18989.50 6214.96	DEPTH/EL. GROUND WATER: 1.93m 1604.88		GROUND EL.: 1606.81	DEPTH/EL. TOP OF ROCK: 3.51m 1603.31	
DRILLING CONTRACTOR: All kind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: 1	CORE BOXES: 1	DEPTH/EL. BOTTOM OF HOLE: 6.10m 1600.71	
DRILL MAKE AND MODEL: Failing 1500	LOGGED BY: R. Raidl				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up 1500 started drilling 1545 added 1 bag REVERT to circ. pit					0.0-2.29m ALLUVIUM 0-1.85m. Gravel and sand 1.85-2.29m: Boulder
SPT 1	94	0.3		8/23/80 0840				1	2.29-3.51m GLACIAL TILL; GRAVELLY SILT. Moist, 80% nonplastic fines, quick dilatancy reaction, low toughness & dry strength, minor sand, 20% hard grav. Type 2.5cm max. Dia. (ML-GM)
0.12m tricone				3.51-5.49m drilling mod. fast 5.49-6.10m: drilling rate slowed.		5			3.51-6.10m SILTSTONE & MUDSTONE 3.51m-5.49m: Carb. mudstone w/coal specks 5.49-6.10m - Carb. siltstone cuttings samples taken at 4.27, 5.18, 5.64, 6.10m.
				Bottom of borehole 6.10m					Installed 2.5cm. PVC to 6.10m, slotted bottom 4.6m; backfilled with gravel to 1.5m; sealed with bentonite 0.6-1.5m; gravel cap 0-0.6m; slugged well.

HOLE NO. DH-16-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-17-RD
SITE: River Diversion - Middle Section	BEGUN: 8-22-80	COMPLETED: 8-22-80	HOLE SIZE: 0.18m.	ANGLE FROM HORIZ. & BEARING: 90°	
COORDINATES: 17309.7 5991.5	DEPTH/EL. GROUND WATER: 0.7m. 1594.9	GROUND EL.: 1595.62	DEPTH/EL. TOP OF ROCK: 3.4m. 1592.2		
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: —	SAMPLES: 3	CORE BOXES: —	DEPTH/EL. BOTTOM OF HOLE: 4.3m. 1591.3	
DRILL MAKE AND MODEL: BOA-M6	LOGGED BY: M. Stoffel				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1350 set up 8-22-80					0.0 - 0.6 m. PEAT, saturated.
SPT 1	5	0.3	67%	1400				1	0.6 - 3.4 m. GLACIAL TILL SILT, clayey, sandy moist to wet, plastic fines, soft to med. stiff, gravels to 2 cm., fine sand, gray to brown.
hollow stem auger				grinding while drilling					← increase in sand, gravels
SPT 2	35	0.3	33%	1415				2	
hollow stem auger									3.4 - 4.3 m. SILTSTONE
SPT 3	20	0.07	—	1500 refusal				3	
						5			Bottom of borehole

HOLE NO. DH-17-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-18-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion - Middle Section	8-21-80	8-22-80	0.18 m	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
	3.1 m		5.8m.

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	1.1m. / 90%	3	1	7.0m.

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	M. Stoffel

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1710 set up 8-21-80 hard drilling					0.0 - 5.8 m. GLACIAL TILL SILT, fine sandy to clayey moist to wet, plastic fines, none to slight dilat., stiff to mod. compacted, stratified, gray to brown (ML).
SPT 1	40	0.17		1720 SPT 1 - 30/0.025m. refusal				1	
hollow stem auger									4.6 - 5.8 m. Gravel lense, moist to wet, est. 5-10% plastic fines, 20-40% fine sand, gravels to 2.5 cm. max., angular to subangular, mod cohesive, gray to brown, (GM).
SPT 2	17	0.3	0%	1815 SPT 2 - no recovery					
hollow stem auger									
SPT 3	63	0.3		1820				2 3	
hollow stem auger				SPT - refusal 1020		5			
BX core bit		0.5	80%						5.8 - 7.0 m. SILTSTONE fresh, hard, bedding plane 40°, numerous joints 40-60°, along, across bedding plane, some healed joints.
		0.7	96%						
				Bottom of borehole					Installed 0.025 m. I.D. PVC standpipe to bottom, slotted from 0.9 - 3.4 m.

HOLE NO. BH-18-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-19-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion - Middle Section	8-20-80	8-21-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
15939.1 5914.7	4.1m. 1574.2	1578.25	10.4m. 1567.9

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	1.0m. / 85%	6	1	12.3m. 1566.0

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	C.C. Payton, M. Stoffel

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1430 set up 8-20-80 difficult drilling					0.0 - 0.2m SILT, sandy, loose, damp, non-plastic organic mat'l.
SPT 1	50	0.15	100%	1500 SPT-1 refusal on gravel				1	0.2 - 6.7m. ALLUVIUM GRAVEL, sandy, silty moist to saturated below 3.4m., up to 5% plastic to non-plastic fines, sl. dilat, low to med. toughness; 10-40% med. to coarse sand; 55-85% gravel to boulders, fresh, hard, subrounded to subangular, loose to compact, cohesive, brown, brown to gray. (GM)
hollow stem auger									
SPT 2	50	0.07	100%	SPT-2 - refusal				2	
hollow stem auger				drilling became easier at 3.4m.					
SPT 3	34	0.3	100%	1616				3	
hollow stem auger				sand and gravel inside augers prevented SPT at 5.6m.		5			
SPT 4	10	0.3	33%	0910 8-21-80				4	6.7 - 10.5m. TILL SPT 4 - SAND, v. fine, silty, moist to wet, soft to mod. compacted, non-plastic, high dilat., gray to brown. (ML) SPT 5 - SILT, clayey, moist, plastic, stiff, no dilat., med. dry strength, with fine sand lenses, gray to brown, (ML)
hollow stem auger									
SPT 5	12	0.3						5	
hollow stem auger						10			
SPT 6 hollow stem auger	50	0.12	100%	1015 refusal				6	10.5 - 11.0m. MUDSTONE
BX core bit		0.5	53%	BX casing seated at 11.3m.				Box 1	11.0 - 12.3m. SILTSTONE dark gray, fresh, mod. hard, bedding plane 40°, joints, slickensided // along bedding plane; core breaks easily along bedding plane.
		0.8	100%						
				Bottom of borehole					Installed 0.025 m. I.D. PVC standpipe to 12.3 m., slotted from 2.7 - 8.2 m.

HOLE NO. DH-19-RD

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-20-RD
SITE: River Diversion - Middle Section	BEGUN: 8-22-80	COMPLETED: 8-23-80	HOLE SIZE: 0.18 m.	ANGLE FROM HORIZ. & BEARING: 90°	
COORDINATES: 15729.5 5705.3	DEPTH/EL. GROUND WATER: 3.1m. 1573.2	GROUND EL.: 1576.34	DEPTH/EL. TOP OF ROCK: 11.9m. 1564.4		
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: 0.8m. / 100%	SAMPLES: 7	CORE BOXES: 1	DEPTH/EL. BOTTOM OF HOLE: 12.8m. 1563.5	
DRILL MAKE AND MODEL: BOA-M6	LOGGED BY: M. Staffel				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1700 set up 8-22-80 hard drilling, grating against gravels					0.0 - 5.8m. ALLUVIUM GRAVEL, SAND wet to saturated, loose, coarse sand, gravels to 2.5 cm. angular. (GP, SP)
SPT 1	4	0.3	67%	1800				1	
hollow stem auger									
SPT 2	42	0.3	67%	0845 8-23-80				2	
hollow stem auger						5			
SPT 3	30	0.3	100%	0920				3	5.8 - 11.1 m. TILL SILTY SAND to SILTY CLAY SPT 3 - very fine sand, silty, wet, mod. compacted to dense, high dilat, low dry strength. (ML)
hollow stem auger									
SPT 4	10	0.3	100%	0940				4	SPT 4 - Silty Clay, moist, stiff, plastic, med to high dry strength, gray to brown (CL)
hollow stem auger									
SPT 5	15	0.3	100%	0955				5	SPT 5 - Clayey Silt, moist, stiff, plastic, med to high dry strength, v.f. sand, gray to brown (ML)
hollow stem auger						10			SPT 6 - same as SPT 5
SPT 6	38	0.3						6	
hollow stem auger				11.1 m. auger refusal - gravels, cobbles					
BX core bit		0.8	37%					7	11.1 to 11.9 m. ALLUVIUM Silty GRAVEL, COBBLES
SPT 7	50	0.05	—	11.9 - 12.0m. soft mat'l.					
BX core bit		0.8	37%	SPT refusal - no recovery				Box 1	11.9 to 12.8 m. SILTSTONE, fresh, bedding from 40° - 60°, numerous jts. along, across bedding.
				Bottom of borehole					Installed 0.025 m. ID PVC standpipe to bottom, slotted from 1.8 - 4.3 m.

HOLE NO. DH-20-RD

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 2

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-21-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion - Middle Section	8-24-80	8-24-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
15675.3 5805.4	2.1 m. 1573.1	1575.20	18.1 m. 1557.1

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling, Ltd.	—	11	—	18.1 m. 1557.1

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	M. Stoffel

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
hollow stem auger				0730 set up 8-24-80				
SPT 1	8	0.3						1
hollow stem auger								
SPT 2	23	0.3						2
hollow stem auger								
SPT 3	27	0.3						3
hollow stem auger						5		
SPT 4	13	0.3		0900 no recovery				
hollow stem auger								
SPT 5	6	0.3	100%	0915				4
hollow stem auger								
SPT 6	6	0.3	10%					5
hollow stem auger						10		
SPT 7	12	0.3	100%	1015				6
hollow stem auger								
SPT 8	16	0.3	100%	1045				7
hollow stem auger								
SPT 9	37	0.3	10%	1100				8

MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION

0.0 - 6.7 m. ALLUVIUM
SAND, silty
moist to saturated, 25-40% fines, plastic to non-plastic, plastic fines stick to sand and gravel; few gravels to 3 cm., loose, gray to brown (SM).

6.7 - 17.2 m. TILL
Silty CLAY to Cloyey SILT
damp to moist, plastic, slight to med. dilatency, med. to high dry strength, some very fine sand, none to few gravels, 3cm. max, med. to very stiff, gray to brown, (ML).

HOLE NO. DH-21-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-21-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger									TILL (continued)
SPT 10	47	0.3	100%	1200		15		9	
hollow stem auger									← increase in gravels
SPT 11	44	0.3	67%	1245 hard drilling, grinding				10	
hollow stem auger				SPT 12- 75/0.1m. refusal					17.2 - 18.1m. ALLUVIUM SAND, silty, gravelly, moist, loose, cohesive, siltstone fragments. (SM)
SPT 12				1330				11	
				Bottom of Borehole		20			Installed 0.025 m I.D. PVC to bottom, slotted from 3.0 - 9.1 m.

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	DH-22-RD

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
River Diversion - Middle Section	8-18-80	8-19-80	0.18m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
15440.7 5833.8	2.0m. 1572.4	1574.38	18.0m. 1556.4

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	0.5m. / 50%	10	1	19.3m. 1555.1

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	M. Staffel, C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO
hollow stem auger				1545 set up 8-18-80				
SPT 1	16	0.3	75%	1550				1
hollow stem auger								
SPT 2	26	0.3	30%	1605				2
hollow stem auger								
SPT 3	11	0.3	90%	1615		5		3
hollow stem auger								
SPT 4	10	0.3	75%	1645				4
hollow stem auger								
SPT 5	10	0.3	70%	1700				5
hollow stem auger								
SPT 6	13	0.3	75%	1745				6
hollow stem auger						10		
SPT 7	21	0.3	60%	1735				7
hollow stem auger								
SPT 8	18	0.3	100%	1810				8
hollow stem auger								
SPT 9	27	0.3	100%	0840 8-19-80				9

MATERIAL CLASSIFICATION

PHYSICAL DESCRIPTION

0.0 - 18.0m. GLACIAL TILL
SILT to CLAY
Clayey silt to silty clay, very fine sandy, moist, plastic fines, none to slight dilatency, med. to high dry strength, 0-5% coarse sand, 0-10% gravel, 1 cm. max, subangular to subrounded, soft to stiff, gray to brown. (ML)

1.5 - 4.5m. coarse sand lense, saturated, loose, gravels to 2.5 cm. max., subangular to subrounded, fresh, hard. (SP, GP)

HOLE NO. DH-22-RD

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-22-RD

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger									GLACIAL TILL (continued) 14.6 - 18.0 m. Sand lense. wet, soft, cohesive, silty, gravelly gravels increase with depth to clean sand and gravels approx. 17m.
SPT 10	19	0.3	0	no recovery		15			
hollow stem auger									
SPT 11	5	0.3	30%					10	
hollow stem auger				sand flowed up into hollow stem auger @ 0.6m.					
SPT 12	100	0.1	10%	splitspoon refusal					18.0 - 18.9 m. MUDSTONE, dk. gray, fresh, soft, with coal, very soft, drills to small gravel and sand sizes. 40° bedding plane contact.
BX core bit		0.2	33%	BX casing				Box 1	18.9 - 19.3 m. SILTSTONE, gray, fresh, med hard, bedding dip avg. 40°
		0.8	62%						
				Bottom of borehole		20			Installed 0.025m. I.D. PVC standpipe to bottom.

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-1-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	7-28-80	7-29-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
12648.91 5635.62	2.8m. 1544.6	1547.40	10.8m. 1536.6

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.		6	1	11.7m. 1535.7

DRILL MAKE AND MODEL: 1980 BOA-6M

LOGGED BY: R.W. Heneks

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				set up 0900 7-28-80					started drilling in alluvium in area with shallow soil. 0.0-3.9m. ALLUVIUM GRAVEL, sandy moderately dense to dense, with boulders, dry to wet, < 10% non-plastic fines. (GP)
SPT 1	105	0.3							
hollow stem auger				Drilling became easier at 3.9 m.					
SPT 2	33	0.3						1	3.9-9.5m. ALLUVIUM SILT, clayey wet, stiff, med. plastic, gray, with gravel. (ML)
hollow stem auger						5			
SPT 3	22	0.3						2	
hollow stem auger									
SPT 4	23	0.3						3	
hollow stem auger									
SPT 5	28	0.3						4	
hollow stem auger									
SPT 6	76	0.15		refusal		10		5	9.5-10.8 m. GRAVEL, sandy, silty dense, wet (GM)
hollow stem auger									
SPT 7	100	0.125		100 blows 0.125m.				6	10.8-11.7m. SANDSTONE gray, fresh, fine grained, mod. hard to hard.
BX core bit									
									Bottom of Borehole Installed 0.025m. I.D. PVC standpipe

HOLE NO. DH-1-SP

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-2-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	7-29-80	8-3-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
12523.27 5600.43	3.3m. 1543.5	1546.84	13.5m. 1533.3

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	1.8 m / 86 %	6	3	15.6 m. 1531.2

DRILL MAKE AND MODEL	LOGGED BY:
1980 BOA-6M	R.W. Heneks & M. Staffel

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				set up 1030 7-29-80					0.0-4.2 m. ALLUVIUM GRAVEL, sandy, silty dry dense, <10% non-plastic fines, with cobbles and boulders. (GM)
SPT 1	50	0.3							
hollow stem auger									
SPT 2	62	0.15		no recovery					
hollow stem auger				drilling less difficult at 14.2 m.					
SPT 3	33	0.3						1	4.2-13.5 m. ALLUVIUM SILT, clayey damp to moist, slight to med. plastic, firm, gray
hollow stem auger						5			
SPT 4	21	0.3						2	
hollow stem auger									
SPT 5	18	0.3						3	
hollow stem auger									
SPT 6	18	0.3						4	
hollow stem auger						10			
SPT 7	15	0.3						5	SILT, clayey, with fine sand.
hollow stem auger									
SPT 8	14	0.3						6	SILT, moist to wet, soft to firm, sandy and gravelly towards base.
hollow stem auger									
BX core bit		0.6	50%	auger refusal				Box 2	13.5-15.6 m. SILTSTONE 71°

HOLE NO.: DH-2-SP

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-2-SP

SAMPLE DATA: TYPE TOOL AND DIA.	SAMPLE DATA: METHOD N-BLOW COUNT	SAMPLE DATA: ADVANCE	RECOVERY	REMARKS (WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH)	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION
BX core bit		1.5	100%			15		Box 2 Box 3	SILTSTONE gray, fresh, mod. hard, thin irreg. bedding; dip ranges from 25°-40°; core breaks along bedding planes ← healed joint, calcite.
									Bottom of borehole Installed 0.025m. I.D. PVC standpipe to 14.6m. slotted from 5.0 to 14.6m.

HOLE NO. DH-2-SP

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-3-SP

SITE: Settling Pond	BEGUN: 8-3-80	COMPLETED: 8-3-80	HOLE SIZE: 0.18 m.	ANGLE FROM HORIZ. & BEARING: 90°
COORDINATES: 12325.94 5614.15	DEPTH/EL. GROUND WATER: 2.0m. 1541.2	GROUND EL.: 1543.18	DEPTH/EL. TOP OF ROCK: 9.9m. 1533.3	
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: 1.0m. / 100%	SAMPLES: 3	CORE BOXES: 1	DEPTH/EL. BOTTOM OF HOLE: 11.2m. 1532.0
DRILL MAKE AND MODEL: BOA - M6	LOGGED BY: M. Staffel			

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				set up 1010 8-3-80					0.0 - 3.9 m. ALLUVIUM SILT, sandy moist, 90% non-plastic fines, 5% fine sand, no dilatency reaction, approx. 5% peat, loose, brown. (ML)
SPT 1	15	0.3		1025					
hollow stem auger									
SPT 2	32	0.3		1045 no recovery					
hollow stem auger									3.9 - 9.9 m. ALLUVIUM SILT, sandy, clayey moist, 70 - 100% non-plastic to sl. plastic fines, no dilatancy reaction, dense to stiff, 0-20% fine sand, gray-brown to brown. (ML, ML-SP).
SPT 3	29	0.3		1105 no recovery no material on auger flights		5			
hollow stem auger									
SPT 4	17	0.3		1125				1	
hollow stem auger									
SPT 5	23	0.3						2	
hollow stem auger									
SPT 6	23	0.3						3	
BX core bit		1.0	100%	set augers at 10.2m.		10		Box 1	9.9 - 11.2 m. SILTSTONE Physical Condition - mod. fractured, max 0.4m, min. ∠ 2cm., mostly 12-15cm., natural frac. with 2mm. calcite coating, fresh, hard, strong.
				Bottom of borehole					Lithology - carbonaceous siltstone, gray, fine grained, bedding dip approx. 50°, bedding thickness 2-6 mm., one prom. 70° joint, calcium coated, one incipient 70° joint, possibly rehealed. Installed 0.025m. I.D. PVC to 10.5m., bottom 9m. slotted, backfilled with gravel and slugged.

HOLE NO.: DH-3-SP

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-4-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	8-4-80	8-5-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
12040.25 5493.74	2.2 m. 1537.5	1539.70	15.3 m. 1524.4

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	0.9 m. / 72%	9	1	17.1 m. 1522.6

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				0900 set up 8-4-80					0.0 - 3.6m. ALLUVIUM Sandy SILT and Sandy GRAVEL damp to wet, 5-70% non-plastic fines, 5-20% med. to coarse sand, 25-75% hard, angular to subrounded gravel particles, loose (ML, GP)
SPT 1	57	0.3		0925				1	SPT 1 - Sandy Silt SPT 2 - Sandy Gravel
hollow stem auger									
SPT 2	39	0.3		0940 no return of cuttings to surface by auger flights				2	
hollow stem auger									3.6 - 15.3m. ALLUVIUM SILT, sandy, clayey, gravelly moist, 55-100% non-plastic to sl. plastic fines, quick dilat. to no reac., 0-10% med coarse sand, 0-45% hard angular gravel to 3cm. max., compact and generally stiff, brown to dark gray or black. (ML, ML-SM, ML-GM).
SPT 3	11	0.3		1030 no return of cuttings to surface		5		3	SPT 3 - Clayey Silt
hollow stem auger									
SPT 4	8	0.3		1055				4	SPT 4 - Clayey Silt
hollow stem auger									
SPT 5	8	0.3						5	SPT 5 - Sandy Clayey Silt
hollow stem auger				8.1m. cuttings beginning to appear at surface					
SPT 6	27	0.3		1140				6	SPT 6 - Gravelly Sandy Silt
hollow stem auger						10			
SPT 7	22	0.3		1210				7	SPT 7 - Sandy Gravelly Silt
hollow stem auger									
SPT 8	29	0.3						8	SPT 8 - Sandy Gravelly Silt
hollow stem auger									
SPT 9	27	0.3		1340 no recovery					

INTERNATIONAL ENGINEERING CO., INC.

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-4-SP

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING, DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO.	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger									continued
SPT/0	130	0.2				15		9	
hollow stem auger				hollow stem auger drilled to 16.2m to help seal augers for water return					SILTSTONE
BX core bit		0.5	50%					Box 1	bluish gray, 50% stained lt brown along open joints, mod. hard, drilled to gravel sizes. Thin irregular bedding; dip varies 30°-48°, some healed bedding plane jts, average spacing 3cm, calcite.
		0.4	100%	drill water return 20-40% light brown. Bottom of borehole					Installed 0.025m. I.D. PVC standpipe.
						20			

HOLE NO. DH-4-SP

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-5-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	8-5-80	8-5-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
11924.14 5729.07	1.9 m. 1536.7	1538.55	5.4 m. 1533.2

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	0.6 m. / 100%	3	1	6.0m. 1532.6

DRILL MAKE AND MODEL: BOA-M6

LOGGED BY: C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1230 set up 8-5-80 no cuttings return on auger flights.					0.0 - 4.8m ALLUVIUM GRAVEL, sandy, silty damp to wet; 20-25% fines, NP at nat. moist. content, plastic at higher moist. cont., low to high dilatency, low to med dry strength; 30-35% sand, 40-50% gravel, hard, subrounded; cohesive, brown, lt. gray to gray. (GM)
SPT 1	47	0.3	75%					1	
hollow stem auger									
SPT 2	21	0.3	50%	gravels appeared at surface.				2	
hollow stem auger									
SPT 3	19	0.3	100%					3	4.8-5.4 m. ALLUVIUM CLAY, sandy, gravelly dk. gray, plastic, no dilatency, med. to high dry strength. (CL)
hollow stem auger						5			
SPT 4		0.2	100%	SPT 4 - refusal 100 blows/.03m				Bor 1	5.4-6.0 m. SILTSTONE dark gray, fresh, mod. hard, massive to irreg. bedded, no open jts. core broke during drilling to 15 cm lengths.
BX core bit		0.4	100%						
				Bottom of borehole					Installed 0.025m. I.D. PVC standpipe.
						10			

HOLE NO.: DH-5-SP

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-6-SP

SITE: Settling Pond

BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
8-6-80	8-6-80	0.18 m.	90°

COORDINATES: 11884.86 5664.08

DEPTH/EL GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
2.3m. 1535.5	1537.77	8.1m. 1529.7

DRILLING CONTRACTOR: Allkind Drilling Ltd.

CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
1.07m / 98%	5	1	9.8m. 1528.0

DRILL MAKE AND MODEL: BOA - M6

LOGGED BY: C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				0800 set up 8-6-80					0.0 - 8.1m. ALLUVIUM
SPT 1	50	0.1ft		0815 refusal on a boulder				1	GRAVEL, silty, sandy, damp, est. 10% non-plastic fines, 30% med. to coarse sand, 60% gravels, fresh, hard, subrounded; loose, med. dilat., low dry strength, brown to gray. (GM)
hollow stem auger									thin lense of silty sand, moist, loose, plastic fines (SM)
									increase in large sized gravel and cobbles.
SPT 2	40	0.3	75%	0835				2	SAND, silty, moist, loose, plastic fines, no dilat, slight toughness, slight dry strength, (SM)
hollow stem auger									
SPT 3	18	0.3	100%	0902 rapid advance with auger; no mat'l return on auger flights.		5		3	Increase in moisture to wet brown clay sandy gravels, loose, plastic fines stick to gravels.
hollow stem auger									decrease in gravels.
SPT 4	22	0.3	80%	0920				4	SILT, clayey, sandy, wet, est. 10% plastic fines, med dilat., slight toughness, slight dry strength, 60% silt, 30% fine to med. sand, mod. stiff, mat'l becomes softer with remolding, gray. (ML)
hollow stem auger									
SPT 5	33	0.3		0957 very slow drilling.				5	increase in plastic fines and small pea-sized gravel, dk gray. est 20% small gravel, 20% sand, 60% plastic fines (silt and clay mixed), very slight dilat, mod toughness, med. dry strength, mod. stiff, gravel is subrounded to angular, fresh, hard.
hollow stem auger				SPT 6 - refusal					
BX core bit		1.1	98%	100% drill water return; gray				Box 1	8.1 - 9.8m. SILTSTONE dark gray, fresh, mod. hard, irreg. bedding, avg. dip 40-45°; core broken along bedding planes during drilling, carbonaceous mat'l on surface, no open joints
				Bottom of borehole		10			

Installed 0.025m. I.D. PVC standpipe to 9.8m slotted 2.1 - 8.8 m.

HOLE NO. DH-6-SP

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-7-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	8-7-80	8-7-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
11787.21 5920.06	none	1553.28	4.0m. 1549.3

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	1.1m. / 92%	3	1	5.2m. 1548.1

DRILL MAKE AND MODEL	LOGGED BY:
BOA - M6	C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				0800 set up 8-7-80 material difficult to excavate with hand shovel.					0.0-4.0 SLOPE WASH, TILL SILT, gravelly, sandy damp to moist, 90-95% non-plastic fines, 5-10% coarse sand, 0-5% gravels, subrounded to subangular, hard, 50% weathered brown, mostly < 1cm., some to cobble size; soft to compact, black, brown, mottled. (ML)
SPT 1	16	0.3		0810				1	SPT 1 Sandy Silt, soft
hollow stem auger									
SPT 2	42	0.3		0825				2	SPT 2 Gravelly Silt coarse sand sized, black, soft.
hollow stem auger				grinding, broken rock frag.; grab sample from cuttings. SPT 3 refusal				3	
Bx core bit		0.9	93%	water return - gray, 50-70%. Trouble with cuttings in hole - not enough water				Box 1	4.0-5.2m. SANDSTONE gray, fresh, fine to med. grained, thinly bedded, cross-bedded, numerous black carbonaceous mtl. on bedding planes, core breaks along bedding, ranges 30° to 60°, mod. hard, slickensides on some of the carbonaceous material
		0.3	100%			5			
				Bottom of Borehole					
						10			

HOLE NO. DH-7-SP

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO. 2037 | HOLE NO. DH-8-SP

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Settling Pond	8-7-80	8-10-80	0.18 m.	90°

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
12212.25 5667.20	2.5m. 1539.7	1542.18	6.2m. 1536.0

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	1.8m. / 100%	3	1	8.0m. 1534.2

DRILL MAKE AND MODEL: BOA - M6

LOGGED BY: C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION — PHYSICAL DESCRIPTION
hollow stem auger									0.0 - 6.2m. ALLUVIUM GRAVEL, silty, sandy. damp, est. 10% non-plastic fines, 30% sand, 60% gravels, loose, occ cobbles, subrounded. (GM)
SPT 1	20	0.3		no recovery					
hollow stem auger									← decrease in amount of gravels.
SPT 2	76	0.21		50/0.06 refusal on gravels				1	SPT 2 - Sand, wet, clean, fresh, coarse, occ small gravel, little or no fines (SP)
hollow stem auger									← increase in plastic fines, dk. gray, little or no gravels.
SPT 3	22	0.3						2	SPT 3 - Sand, silty, wet to saturated gray, some thin lenses of dk. gray clay, est. 20% plastic fines, 30% silt, 50% fine sand.
hollow stem auger				drilling rate of auger increased		5			← increase in rock fragments.
SPT 4	50	0.10		refusal with split spoon. In pulling rod out of auger got stuck - broke off lower 2m. of auger - moved ahead 4.5m. drilled a new hole to 6.75m. started casing					
BX core bit		1.8	100%					Box 1	6.2 - 8.0m. SANDSTONE gray, with thin bed of carbonaceous matl - black pencil like lines - fine grained Fresh, mod. hard. Dip ranges 25°-40°, some cross-bedding, calcite healed jts, dip ~60° to the east. bedding dips west. Core breaks with hammer blow along bedding planes. No open jts.
				Bottom of borehole		10			Installed 0.025 m. ID PVC to 6m., bottom 4.5 m. slotted.

HOLE NO. DH-8-SP

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT	JOB NO.	HOLE NO.
Elk River Coal Mine	2037	OH-1-HR

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Haul Road	8/14/80	8/16/80	0.14m	90° ——

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
16778.0 6055.8		1584.54	4.42m 1580.12

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	——	2	1	6.10m 1578.44

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	C.C. Payton, R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
SPT 1	9	0.3		1600 set up -				1	0.0-2.43m ALLUVIUM; SILTY SAND Damp, loose, nonplastic organics top 0.3m. 20% silt, 70% sand <10% grav. lenses of silt damp, cohesive, but nonplastic at natural moisture. 1m - increase in gravel 2m - increase in brown, plas fines (SM-&M)
0.14m tricone				1645					
SPT 2	44	0.3		Slow drilling in grav. w/tricone				2	
0.14m tricone									2.43-4.42m GLACIAL TILL; SILTY, SANDY GRAVEL. Moist to wet, 25% plastic fines slow dil., med to low toughness & dry strength, 30% fine to med. sand, 45% gravel & cobbles, gray to brn. (GC-SC)
SPT 3	117	0.3		1715				3	
0.14m tricone									
SPT 4,	50,	.08		1750, refusal cased to 4.26 meters depth				4,	4.42-6.10m SILTSTONE Hard, fsh, carb. siltstone as indicated by cuttings.
0.14m tricone						5			
				Bottom of borehole 6.10m					Installed 2.5cm PVC to 6.10m (BOH); slotted bottom 4.6m; backfilled with gravel to 1m.; installed bentonite seal to 0.3m, gravel cap to surface; slugged well.

HOLE NO. OH-1-HR

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-2-HR

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Haul Road - west side of river	8/18/80	8/18/80	0.18m - BX	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
15321.1 6046.9	1.36m 1571.99	1573.35	3.05m 1570.30

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	76% 0.96m	1	1	4.32m 1569.03

DRILL MAKE AND MODEL	LOGGED BY:
Boa Track M-6	M. Stoffel, C.C. Payton

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.18m auger									0.0-2.75m ALLUVIUM SAND & GRAVEL; 5cm max.
SPT 1	25	0		0910; refusal sampler bouncing				1	
0.18m auger									
SPT 2	97	0.3		eased to 3.58m w/ BX casing				2	2.75-3.05: GLACIAL TILL; SILT, sandy, damp
BX core bit.									3.05-4.11m COAL & SANDSTONE Gray, fine to med. grained, fresh, mod. hard, numerous thin black carb. layers, cross bedded, 40° dip, open joints
									4.11-4.32m: MUDSTONE; fsh, soft, grey
				Bottom of borehole 4.32m		5			Installed 2.5cm PVC to 4.32m slotted from 1.5 to 3.05 meters depth; stick up 0.4m.; gravel packed to 1m and sealed to bentonite to surface.

HOLE NO. DH-2-HR

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: DH-3-HR

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Haul Road - East side of river	8/23/80	8/23/80	0.14-0.12m	90° —

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
14991.4 6061.5		1574.83	3.2m 1571.63

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
All kind Drilling Ltd.	—	6	1	6.10m 1568.73

DRILL MAKE AND MODEL: Failing 1500 | LOGGED BY: R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Set up on site 1330 Started drilling 1415					0.0-3.20m GLACIAL TILL; GRAVELLY SILT. Moist, 60% sl. plastic fines, mod. dry strength, low toughness, minor sand, 40% hard, subang. grav. to 4cm. max. compact, brn. (ML-GM) SPT 1: Gravelly silt SPT 2: Gravelly silt Top of bedrock
SPT 1	64	0.3		Added 1 bag REVERT to circ. pit.				1	
0.14m tricone SPT 2	50/0.15			2.5g: circ. water changed color 1455				2	
0.14m tricone				sampler bouncing					3.20-6.10m SILTSTONE & SHALY SILTSTONE Carb. siltstone and shaly siltstone; hard & fresh, tabular to platy chips to 6.5cm. max. cuttings samples at 5.18, 5.64, 6.10m. SPT 3: chips of shaly siltst.
SPT 3	25	0		sampler bouncing		5		3	
0.12m tricone									
				Bottom of borehole 6.10m					Installed 2.5cm. PVC to 6.10m; slotted bottom 4.5m.; backfilled w/gravel to 1.22m; bentonite seal 0.3-1.22m; gravel cap 0.0-0.3m. slugged well.

HOLE NO. DH-3-HR

INTERNATIONAL ENGINEERING CO., INC. SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine | JOB NO.: 2037 | HOLE NO.: OH-4-HR

SITE	BEGUN	COMPLETED	HOLE SIZE	ANGLE FROM HORIZ. & BEARING
Haul Road - East side of river	8/24/80	8/24/80	0.14 - 0.12m	90° ——

COORDINATES	DEPTH/EL. GROUND WATER	GROUND EL.	DEPTH/EL. TOP OF ROCK
14384.0 6070.4	0.94m 1567.98	1568.92	4.42m 1564.50

DRILLING CONTRACTOR	CORE RECOV. LENGTH/%	SAMPLES	CORE BOXES	DEPTH/EL. BOTTOM OF HOLE
Allkind Drilling Ltd.	——	6	1	6.10m 1562.82

DRILL MAKE AND MODEL	LOGGED BY:
Failing 1500	R. Raidl

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
0.14m tricone				Started drilling 0820; added 1 bag REVERT to circ. pit. 0840					0-4.42m GLACIAL TILL; GRAVELLY SILT, SILTY GRAVEL. Moist, 35-70% nonplastic fines, no dil. reac., minor sand, 30-65% subang to ang. gravel to 2cm max., sl.-mod. compact, brn. (ML-GM, GM-ML). 0.0-0.6 Silt & sand; 0.6-0.76 Gravel; 0.76-1.37 Sand & gravel; 1.37-1.83 Boulder. SPT1: Gravelly silt. SPT2: Silty gravel
SPT 1	85	0.3						1	
0.14m tricone				2.75m. consid. rig vibration 0900; sampler bouncing					
SPT 2	25	0						2	
0.14m tricone				4.42-5.49: fast drilling		5			4.42-6.10m CARBONACEOUS SILTSTONE w/COAL. cuttings at 4.57 and 5.18: carb. siltstone w/coal. cuttings at 5.64 & 6.10: carb. siltst.
0.12m tricone				5.49-6.10m drilling rate slow					
				Bottom of borehole					Installed 2.5cm. PVC to 6.10m (BOH); slotted bottom 5.2m; gravel packed to 1m; bentonite seal 0.15-1.0m; gravel cap 0.0-0.15m; slugged well.

INTERNATIONAL ENGINEERING CO., INC.

SHEET 1 OF 1

DRILL LOG

PROJECT: Elk River Coal Mine				JOB NO.: 2037	HOLE NO.: DH-1-SL
SITE: Sewage Lagoon (swamp)	BEGUN: 8-24-80	COMPLETED: 8-24-80	HOLE SIZE: 0.18 m.	ANGLE FROM HORIZ. & BEARING: 90°	
COORDINATES	DEPTH/EL. GROUND WATER		GROUND EL.	DEPTH/EL. TOP OF ROCK: –	
DRILLING CONTRACTOR: Allkind Drilling Ltd.	CORE RECOV. LENGTH/%: –	SAMPLES: 6	CORE BOXES: –	DEPTH/EL. BOTTOM OF HOLE: 9.3 m.	
DRILL MAKE AND MODEL: BOA-M6	LOGGED BY: M. Stoffel				

SAMPLE DATA: TYPE TOOL AND DIA.	METHOD N-BLOW COUNT	ADVANCE	RECOVERY	REMARKS: WATER LEVELS, WATER RETURN, DRILLING FLUID, CASING DEPTH	ELEVATION	DEPTH meters	GRAPHIC LOG	BOX/SAMPLE NO	MATERIAL CLASSIFICATION: PHYSICAL DESCRIPTION
hollow stem auger				1645 set up 8-24-80					0.0 - 1.2 m. PEAT saturated.
SPT 1	4	0.3	33%	1655				1	1.2 - 9.3 m. GLACIAL TILL
hollow stem auger									SILT to CLAY damp to wet, non-plastic to plastic, none to slight dilatency, med. to high dry strength, none to few gravels, 1 cm. max., soft to v. stiff, gray to brown, (ML, CL)
SPT 2	27	0.3	33%	1700				2	SPT 1 - Sandy Silt, med. stiff, wet, few gravels, org. matter, non-plastic, v.f. sand
hollow stem auger									SPT 2 - Clayey Silt, moist, v. stiff, plastic sl. dilat, med to high dry strength
SPT 3	18	0.3	100%	1710		5		3	SPT 3 - Silty Clay - moist, med. to v. stiff, plastic, no dilat., some gravels, 1 cm. max., med. to high dry strength.
hollow stem auger									SPT 4 - same as SPT 3.
SPT 4	12	0.3	30%	1725				4	SPT 5 - same as SPT 3
hollow stem auger									
SPT 5	60	0.3	100%	1740				5	Sandy gravelly Silt, wet, cohesive, soft.
hollow stem auger				grab sample from cuttings				6	
SPT 6	59	0.3	30%	1815					SPT 6 - Sandy, gravelly Silt, damp, stiff
						10			Bottom of borehole

HOLE NO. DH-1-SL

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-1-WC
SITE LOCATION: Weary Valley Waste Dump	BEGUN: 17 Aug. 1980	TEST PIT SIZE: 6.7m. x 3.7 m.	
COORDINATES LOCATION: 13474.85 7182.29	GROUND ELEVATION: 1644.8	COMPLETED: 17 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION: 1640.8 (4.0 m.)	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SM		SAND, damp, loose, with roots.	
0.5 – 4.0		GM		GRAVEL, sandy, damp (saturated below 4.0 m.), loose, boulders to 0.8 m., subangular to subrounded. Caving.	
4.5 – 5.0				4.3 m. bottom of pit	

TEST PIT NO TP-1-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine	JOB NO.: 2037	TEST PIT NO.: TP-2-WC
	TEST PIT SIZE: 6.7m. x 3.0m.	
SITE LOCATION: Weary Valley Waste Dump	BEGUN: 17 Aug. 1980	COMPLETED: 17 Aug. 1980
COORDINATES LOCATION: 13687.60 7449.86	GROUND ELEVATION: 1669.0	GROUND WATER ELEVATION:
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, damp, loose, brown, with roots.	
1.0		GM		GRAVEL, sandy, damp, loose, brown, boulders to 0.6m., subangular to subrounded. Water inflow at 2.7m. Caving.	
3.0	Bag Sample	ML		SILT, damp, stiff, non-plastic, gray to brown, 5-20 % very fine sand lenses, few gravels < 1cm., glacial till.	
5.5				0.3 m. of water in pit after digging. Still filling.	
6.0				5.8 m. bottom of pit	

TEST PIT NO. TP-2-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST . . LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST ... NO.: TP-3-WC
		TEST PIT SIZE: 6.0 m. x 3.0 m.	
SITE LOCATION: Weary Valley Waste Dump	BEGUN: 19 Aug. 1980	COMPLETED: 19 Aug. 1980	
COORDINATES LOCATION: 13941.92 7532.03	GROUND ELEVATION: 1685.8	GROUND WATER ELEVATION: 1684.3 (1.5 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
				SAND, moist, loose, brown, with roots, organic material.	
0.5		GM		GRAVEL, sandy, moist (saturated below 1.5m.), loose, boulders to 0.6 m., subrounded to subangular. Caving.	
1.0					
1.5					
2.0				1.8 m. bottom of pit	

TEST PIT NO. TP-3-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO: TP-4-WC
SITE LOCATION: Weary Valley Waste Dump	BEGUN: 19 Aug. 1980	TEST PIT SIZE: 6.7m. x 2.7 m.	
COORDINATES LOCATION: 14087.63 7607.10	GROUND ELEVATION: 1698.2	COMPLETED: 19 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
				SAND, moist, loose, brown, some gravels, with roots, organic material	
0.5 1.0 1.5 2.0 2.5 3.0 3.5		GM		GRAVEL, sandy, moist (saturated below 3.2 m.), loose, < 5% fines, est. 20% coarse sand, boulders to 1 m., subangular to subrounded. Some caving. Water inflow at 3.1 m.	
4.0 4.5		ML-SP		SILT, sandy, moist, med. stiff to stiff, cohesive, non-plastic fines, 20% fine to med. sand, less near bottom, few gravels < 1 cm., glacial till.	
5.0				4.6 m. bottom of pit	

TEST PIT NO. TP-4-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-5-WC
		TEST PIT SIZE: 6.7 m. x 2.4 m.	
SITE LOCATION: Weary Valley. Waste Dump	BEGUN: 19 Aug. 1980	COMPLETED: 19 Aug. 1980	
COORDINATES LOCATION: 14525.76 7773.43	GROUND ELEVATION: 1732.3	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SP		SAND, gravelly, moist, loose, brown, with roots, organic material.	
0.5 1.0 1.5 2.0	Bag Sample	GM		GRAVEL, sandy, moist (saturated below 1.4 m.), loose, mostly < 10cm., some boulders to 1.2 m, subangular to subrounded. Water inflow at 1.3m. Distance from Weary Creek approx. 3 m.	
2.5 3.0 3.5		SM		SILT, sandy, saturated, soft, non-plastic, gray to brown, glacial till. SILT, gravelly, moist, very stiff, crumbles, non-plastic, gray to brown, hard till. Backhoe refusal at 3.7 m.	
4.0				3.7 m. bottom of pit	

TEST PIT NO TP-5-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO. TP-1-TD
		TEST PIT SIZE:	
SITE LOCATION: Tailings Dam	BEGUN: 30 July 1980	COMPLETED: 30 July 1980	
COORDINATES LOCATION:	GROUND ELEVATION:	GROUND WATER ELEVATION: 3.7m.	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, wet, soft, brown, organic, with peat.	
1.0		ML		SILT, wet, firm, slightly plastic, olive to gray.	
1.5					
2.0		GM		GRAVEL, sandy, with silt, wet, dense, with boulders to 0.3m, glacial till.	
2.5					
3.0					
3.5					
4.0				3.7 m. bottom of pit	

TEST PIT NO TP-1-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-2-TD
		TEST PIT SIZE:	
SITE LOCATION: Tailings Dam	BEGUN: 30 July 1980	COMPLETED: 30 July 1980	
COORDINATES LOCATION:	GROUND ELEVATION:	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		OL		SILT, damp, brown, organic, with peat.	
0.5	bag sample	ML		SILT, damp, firm, gray to olive, with some gravel.	
1.0					
1.5					
2.0		GM		GRAVEL, moist, dense, olive gray, till.	
2.5					
3.0					
3.5					
4.0				3.7 m. bottom of pit	

TEST PIT NO. TP-2-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 203T	TEST PIT NO.: TP-3-TD
SITE LOCATION: Tailings Dam.	BEGUN: 30 July 1980	TEST PIT SIZE:	COMPLETED: 30 July 1980
COORDINATES LOCATION:	GROUND ELEVATION:		GROUND WATER ELEVATION:
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		OL		SILT, damp, brown, soft, organic.	
0.5		ML		SILT, sandy, damp, firm, brown, with gravel.	
1.0					
1.5		ML		SILT, sandy, alive, with bedded zones. Water entering at 1.2 m.	
2.0		GM		GRAVEL, sandy, with silt, damp to moist, very dense, with boulders.	
2.5					
3.0					
3.5					
4.0				3.7 m. bottom of pit.	

TEST PIT NO TP-3-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-4-TD
		TEST PIT SIZE:	
SITE LOCATION: Tailings Dam	BEGUN: 30 July 1980	COMPLETED: 30 July 1980	
COORDINATES LOCATION:	GROUND ELEVATION:	GROUND WATER ELEVATION: 3.7 m.	
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0		Pt		PEAT	
0.5 – 1.0		ML		SILT, moist, firm, medium plastic, olive to gray.	
1.5 – 2.0 – 2.5 – 3.0 – 3.5		GM		GRAVEL, sandy, with silt, gray to olive, till.	
4.0				3.7 m. bottom of pit	

TEST PIT NO TP-4-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST LOG

JOB NO.: 2037 | TEST PIT NO.: TP-5-TD

PROJECT: Elk River Coal Mine | TEST PIT SIZE: 6.7 m. x 1.2 m.

SITE LOCATION: Tailings Dam | BEGUN: 5 Aug. 1980 | COMPLETED: 5 Aug. 1980

COORDINATES LOCATION: | GROUND ELEVATION: | GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe | LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, moist, moderately compacted, tan, with roots.	
0.5	Bag Sample	ML		SILT, moist, stiff, non-plastic, gray to brown, some gravels mostly 0.5 to 1.5 cm.	
1.0					
1.5					
2.0		ML		SILT, same as above layer with gravels mostly 7 to 15 cm., some to 0.3 m.	
2.5					
3.0					
3.5		SM		SAND, fine, silty, wet, loose, black, some organic material. Water inflow	
4.0		ML		SILT, moist, stiff, gray to brown, with gravels, mostly 7 to 15 cm., some to 0.3 m.	
4.5					
5.0		GM		GRAVEL, silty, loose, subangular to subrounded, mostly 2-10 cm. High water inflow at 4.6 m. at 0.5 m./30 min.	
5.5				5.5 m. bottom of pit	

TEST PIT NO TP-5-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037 | TEST PIT NO.: TP-6-TD

PROJECT: Elk River Coal Mine | TEST PIT SIZE: 6.7 m. x 1.2 m.

SITE LOCATION: Tailings Dam | BEGUN: 5 Aug. 1980 | COMPLETED: 5 Aug. 1980

COORDINATES LOCATION: | GROUND ELEVATION: | GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe | LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, moist, moderately compacted, tan, with roots, some peat.	
0.5 – 1.0 – 1.5		ML		SILT, moist, dense, non-plastic, impervious, gray to brown, with some gravels mostly < 1 cm.	
2.0 – 2.5 – 3.0 – 3.5		ML		SILT, moist, dense, gray to brown, with gravels mostly < 1 cm. and 7-15 cm, some boulders to 0.5 m.	
4.0 – 4.5	Bag Sample	ML-GP		SILT, moist, dense, gray to brown, gravels mostly 7-15 cm. Water inflow at 4.2 m.	
5.0				4.9 m. bottom of pit	

TEST PIT NO. TP-6-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-7-TD
SITE LOCATION: Tailings Dam	BEGUN: 5 Aug. 1980	TEST PIT SIZE: 6.7 m. x 2.1 m.	
COORDINATES LOCATION:	GROUND ELEVATION:	COMPLETED: 5 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, moist, tan, with roots, organic material.	
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0	Bag Sample	ML-GP		SILT, moist to wet, brown to gray, impervious fines, firm. Some fine sand lenses. Gravels mostly < 1 cm. and 2-7 cm. Some boulders to 0.3 m. % gravel increases with depth, angular to subrounded. Backhoe refusal at 4.0 m.	
				4.0 m. bottom of pit	

TEST PIT NO TP-7-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-8-TD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7m. x 1.2m.

SITE LOCATION: Tailings Dam

BEGUN: 5 Aug. 1980

COMPLETED: 5 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, dry, loose, tan, with roots, some gravels mostly 2-15 cm.	
1.0					
1.5	Bag Sample	ML		SILT, damp to moist, firm, gray to brown, some med. sand, gravel mostly < 1cm. and 2-7cm., some 15-20 cm., few to 0.5m., subangular to subrounded. % larger gravels increases with depth.	
2.0					
2.5					
3.0					
3.5				Backhoe refusal at 3.7 m.	
4.0				3.7 m. bottom of pit	

TEST PIT NO. TP-8-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-9-TD
SITE LOCATION: Tailings Dam	BEGUN: 8 Aug. 1980	TEST PIT SIZE: 6.7 m. x 2.1 m.	
COORDINATES LOCATION:	GROUND ELEVATION:	COMPLETED: 8 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, moist, non-plastic, tan, with roots, organic material.	
0.5		ML-GP		SILT, gravelly, moist, stiff, non-plastic, brown to gray, density increases with depth. Angular to subrounded gravels; boulders to 0.5 m., size and % gravel increases with depth.	
1.0					
1.5					
2.0					
2.5					
3.0	Bag Sample				
3.5					
4.0				Backhoe refusal at 4.0 m.	
				4.0 m. bottom of pit	

TEST PIT NO. TP-9-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-10-TD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7 m. x 2.1 m.

SITE LOCATION: Tailings Dam

BEGUN: 8 Aug. 1980

COMPLETED: 8 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0		OL		SILT, wet, black, with roots, peat.	
0.5		ML		SILT, moist, loose, non-plastic, tan, with roots.	
1.0		ML-GP		SILT, gravelly, moist, soft, non-plastic fines, brown to gray, angular to subrounded gravels, boulders to 0.5 m., till.	
1.5	Bag Sample 1				
2.0					
2.5	Bag Sample 2	GM		GRAVEL, silty, damp, loose, non-plastic fines, angular to subrounded, boulders to 0.6 m., dense in place.	
3.0				3.0m. bottom of pit	

TEST PIT NO. TP-10-TD

PLATE

INTEF''ATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-12-TD
		TEST PIT SIZE: 6.7m. x 2.1m.	
SITE LOCATION: Tailings Dam	BEGUN: 8 Aug. 1980	COMPLETED: 8 Aug. 1980	
COORDINATES LOCATION:	GROUND ELEVATION:	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, moist, non-plastic, tan, with roots.	
0.5		ML		SILT, sandy, moist, med. stiff to stiff, non-plastic, gray to brown, approx. 5 % fine sand, few gravels to 10 cm. Glacial Till.	
1.0					
1.5	Bag Sample 1				
2.0					
2.5		GM		GRAVEL, silty, moist, very dense in place but easily crumbled, non-plastic fines, angular to subrounded gravels, boulders to 0.3 m., % increases with depth, till. Backhoe refusal at 3.7 m.	
3.0	Bag Sample 2				
3.5					
4.0				3.7 m. bottom of pit	

TEST PIT NO TP-12-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-11-TD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7m. x 2.1m.

SITE LOCATION: Tailings Dam

BEGUN: 8 Aug. 1980

COMPLETED: 8 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, damp, loose, non-plastic, tan, with roots.	
0.5		ML-GP		SILT, gravelly, damp, med. stiff to stiff, density increases with depth, brown to gray. Non-plastic fines, subangular to subrounded gravels, boulders to 0.6 m. % gravel increases with depth. Some oxidation. Glacial till.	
1.0					
1.5					
2.0	Bag Sample 1				
2.5					
3.0					
3.5	Bag Sample 2			Backhoe refusal at 3.7m.	
4.0				3.7m. bottom of pit	

TEST PIT NO TP-11-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-13-TD
SITE LOCATION: Tailings Dam	BEGUN: 8 Aug. 1980	TEST PIT SIZE: 8.8 m. x 2.1 m.	
COORDINATES LOCATION:	GROUND ELEVATION:	COMPLETED: 8 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0		Pt		PEAT, damp, brown-black, roots, organic material.	
0.5		ML		SILT, fine sandy, moist, mod. compacted, non-plastic, tan.	
1.0		ML		SILT, fine sandy, moist, soft, non-plastic, slight dilatency, gray to brown, fine sand seams to 1mm., few gravels to 1cm., till. Water inflow at 1.5 m.	
1.5					
2.0	Bag Sample	ML-GP		SILT, gravelly, damp, stiff, non-plastic, brown to gray, subangular to subrounded gravels, boulders to 0.6 m. Density and % gravel increases with depth. Till.	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO. TR13-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-14-TD
		TEST PIT SIZE: 4.3m. x 1.8m.	
SITE LOCATION: Tailings Dam	BEGUN: 10 Aug. 1980	COMPLETED: 10 Aug. 1980	
COORDINATES LOCATION:	GROUND ELEVATION:	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		Pt		PEAT, wet. Water inflow from this layer.	Swamp.
		ML		SILT, wet, non-plastic, tan, with roots.	
1.0		ML		SILT, gravelly, damp to moist, soft to med. stiff, non-plastic, gray to brown, gravels to 10 cm., till. Caving.	
1.5					
2.0					
2.5		ML-GP		SILT, gravelly, damp, med. stiff to stiff, non-plastic, gray to brown, boulders to 0.3m.	
3.0				2.7m. bottom of pit	

TEST PIT NO TP-14-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-15-TD
SITE LOCATION: Tailings Dam	BEGUN: 8 Aug. 1980	TEST PIT SIZE: 6.7m. x 1.2m.	
COORDINATES LOCATION:	GROUND ELEVATION:	COMPLETED: 8 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, damp, brown, non-plastic, with roots.	
1.0 – 1.5 – 2.0 – 2.5 – 3.0 – 3.5 – 4.0	Bag Sample	GM		GRAVEL, silty, damp to moist, dense, non-plastic fines, subangular to subrounded gravels, boulders to 0.6 m.	
				4.0 m. bottom of pit	

TEST PIT NO. TP-15-TD

PLATE

INTE IATIONAL ENGINEERING CO. INC.

T 1 OF 1

TEST PIT LOG

JOB NO.: 2037 | TEST PIT NO.: TP-16-TD

PROJECT: Elk River Coal Mine | TEST PIT SIZE: 7.2m. x 2.1m.

SITE LOCATION: Tailings Dam | BEGUN: 10 Aug. 1980 | COMPLETED: 10 Aug. 1980

COORDINATES LOCATION: | GROUND ELEVATION: | GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe | LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry to damp, loose, non-plastic, brown, roots and organic material, few gravels to 15cm.	
1.0					
1.5		ML		SILT, damp, med. stiff, non-plastic, gray to brown, few gravels to 15 cm., subrounded. Till.	
2.0					
2.5					
3.0		SP		SAND, fine, wet, loose, gray to brown. Water inflow from this layer.	
3.5		GM		GRAVEL, silty, damp, non-plastic fines, med. stiff to stiff, gray to brown; subangular to subrounded gravels,	
4.0	Bag Sample			dense to very dense, boulders to 0.3m. Till.	
4.5					
5.0				Backhoe refusal at 5.5 m.	
5.5				5.5m. bottom of pit	

TEST PIT NO TP-16-TD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-6-WC
		TEST PIT SIZE: 6.7m. x 3.0m.	
SITE LOCATION: Weary Valley Waste Dump	BEGUN: 19 Aug. 1980	COMPLETED: 19 Aug. 1980	
COORDINATES LOCATION: 14850.98 8011.71	GROUND ELEVATION: 1760.5	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		GP		GRAVEL, sandy, moist, loose, brown, with roots, organic material.	
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0		GM		GRAVEL, sandy, moist, loose, < 5% fines, 20% med. to coarse sand, boulders to 1m, angular to subrounded. Caving.	
		SP		SAND, gravelly, saturated, loose, soft, 5-10% cohesive fines, gray to brown. Water inflow from sand layer.	
4.5 5.0 5.5	Bag Sample	GM		GRAVEL, sandy, saturated, loose, 5-10% soft plastic fines, cohesive, gray to brown, gravels mostly < 15 cm., some to 0.6 m., glacial till.	
6.0				5.7 m. bottom of pit	

TEST PIT NO. TP-6-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO: 2037	TEST PIT NO: TP-7-WC
SITE LOCATION: Weary Valley Interceptor Ditch	BEGUN: 19 Aug. 1980	TEST PIT SIZE: 6.7 m x 2.4m.	
COORDINATES LOCATION: 13265.26 7884.06	GROUND ELEVATION: 1764.88	COMPLETED: 19 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		Pt		PEAT, saturated, brown and tan. Water inflow from this layer.	Swamp.
1.0		ML		SILT, clayey, moist, soft, cohesive, plastic, gray.	
1.5		ML		SILT, sandy, gravelly, moist, soft, cohesive, gray to brown, boulders to 0.5m., subangular to subrounded, soft till.	
2.0					
2.5					
3.0				SILT, gravelly, moist, very stiff, crumbles, non-plastic, gray to brown, gravels mostly < 8 cm., some boulders to 0.5m., hard till.	
3.5					
4.0					
4.5					
5.0				4.6 m. bottom of pit	

TEST PIT NO. TP-7-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP- 8-WC
		TEST PIT SIZE: 6.7 m. x 2.4 m.	
SITE LOCATION: Weary Valley Interceptor Ditch	BEGUN: 19 Aug. 1980	COMPLETED: 19 Aug. 1980	
COORDINATES LOCATION: 13289.84 8138.05	GROUND ELEVATION: 1779.23	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SP		SAND, gravelly, moist, loose, brown, with roots, organic material.	
0.5 – 6.0	Bag Sample	GP		GRAVEL, sandy, damp to moist, loose, brown, < 5% fines, boulders to 0.5m., angular to subrounded.	
6.5				6.1 m. bottom of pit	

TEST PIT NO TP-8-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-9-WC
		TEST PIT SIZE: 6.7 m. × 2.4 m.	
SITE LOCATION: Weary Valley Interceptor Ditch	BEGUN: 19 Aug. 1980	COMPLETED: 19 Aug. 1980	
COORDINATES LOCATION: 13706.67 7954.09	GROUND ELEVATION: 1797.41	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SP		SAND, gravelly, moist, loose, with roots, organic material.	
1.0				SILT, gravelly, moist, moderately compacted, brown, tan.	
1.5					
2.0		GP		GRAVEL, sandy, moist, loose, brown, boulders to 0.3 m., subangular to subrounded.	
2.5				Water inflow at 3.0 m.	
3.0					
3.5		GM		GRAVEL, silty, sandy, wet to saturated, soft to med. hard, 20% cohesive fines, 10-20 % med. to coarse sand, boulders to 0.3 m., subangular to subrounded.	
4.0	Bag Sample 1				
4.5					
5.0					
5.5					
6.0	Bag Sample 2			SILT, gravelly, moist, very stiff, crumbles, non-plastic at natural moisture content, gravels mostly < 1cm., some to 15cm., few to 0.3m., hard till.	
6.5					
7.0				6.4 m. bottom of pit	

TEST PIT NO. TP-9-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-10-WC
		TEST PIT SIZE: 6.0 m × 2.4 m.	
SITE LOCATION: Weary Valley Interceptor Ditch	BEGUN: 20 Aug. 1980	COMPLETED: 20 Aug. 1980	
COORDINATES LOCATION: 13545.15 7954.51	GROUND ELEVATION: 1801.35	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Staffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, moist to wet, soft, brown, with roots, peat, organic material.	
1.0	Bag Sample	GP		GRAVEL, sandy, damp, loose, < 5% non-plastic fines, 20-40% sand, gravels mostly < 10cm., some to 60 cm., mostly towards bottom, angular to subangular, brown.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0				5.8 m. bottom of pit	

TEST PIT NO TP-10-WC

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST NO.: TP-11-WC
SITE LOCATION: Weary Valley Interceptor Ditch	BEGUN: 20 Aug. 1980	TEST PIT SIZE: 6.7 m. x 1.5 m.	
COORDINATES LOCATION: 13680.82 7958.60	GROUND ELEVATION: 1795.20	COMPLETED: 20 Aug. 1980	
EXCAVATION METHOD: Back hoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SM		SAND, silty, damp, loose, brown, with roots, organic material.	
0.5 – 1.0 – 1.5 – 2.0 – 2.5 – 3.0	Bag Sample 1	ML-GP		SILT, gravelly, damp, very stiff, dense, can be crumbled, non-plastic, brown, gravels mostly ∠ 5 cm., some to 15cm., subangular	Depth from top of road c
3.5 – 4.0 – 4.5 – 5.0	Bag Sample 2	ML-GP		SILT, gravelly, damp, very stiff, dense, can be crumbled, non-plastic gray, gravels mostly ∠ 5cm., some to 30 cm., subangular.	
5.5				FERNI SHALE, fragmented.	
6.0					

TEST PIT NO. TP-11-WC

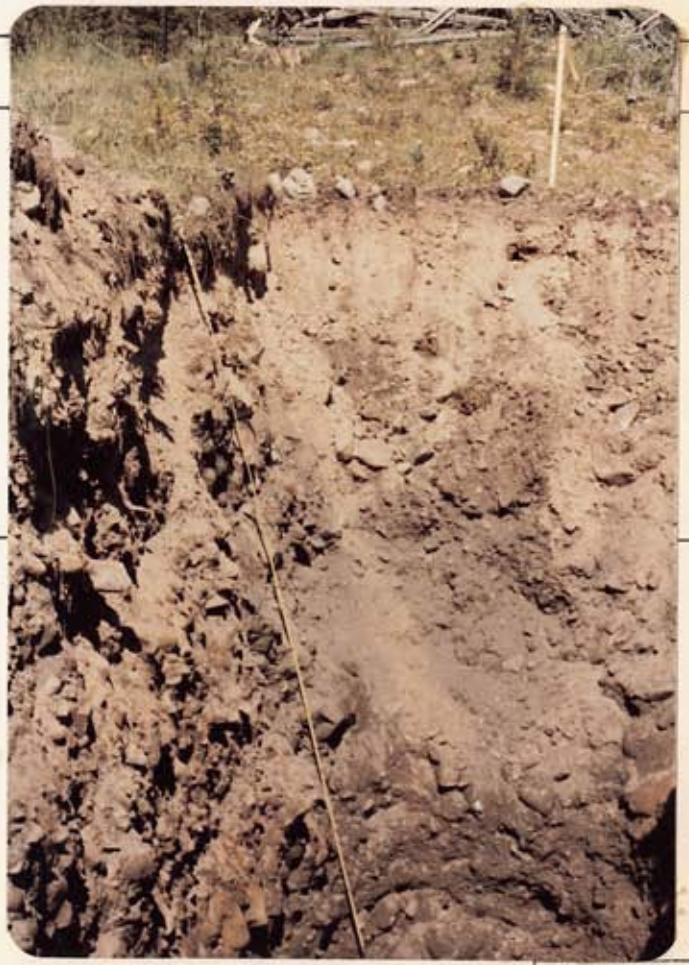
PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-1-SP
		TEST PIT SIZE: 8.2 m × 2.4 m.	
SITE LOCATION: Settling Pond	BEGUN: 22 July 1980	COMPLETED: 22 July 1980	
COORDINATES LOCATION: 12753.54 5743.62	GROUND ELEVATION: 1557.84	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		GP-GM		GRAVEL, silty, sandy, dry, loose, brown, with roots, angular rock fragments.	
1.0		GP		GRAVEL, sandy, dry to damp, loose, tan to brown, some roots.	
1.5 – 2.5	Bag Sample	GP		GRAVEL, sandy, damp to wet, with boulders to 0.5m. diameter.	
5.5 – 6.0				5.5 m. bottom of pit	



TEST PIT NO TP-1-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO: TP-2-SP
		TEST PIT SIZE: 6.0m. × 2.4m.	
SITE LOCATION: Settling Pond	BEGUN: 22 July 1980	COMPLETED: 22 July 1980	
COORDINATES LOCATION: 12603.39 5665.69	GROUND ELEVATION: 1547.30	GROUND WATER ELEVATION: 1544.6 (2.7m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, dry, loose, brown, with roots. Minor sand lenses with gravel to 5 cm. diameter, subangular to subrounded.	
1.0	Bag Sample				
1.5		GM		GRAVEL, sandy, moist to wet, loose to moderately dense, with boulders to 0.5m. diameter, subangular to subrounded.	
2.0					
2.5					
3.0					
3.5					
4.0				3.4 m. bottom of pit	

TEST PIT NO TP-2-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-3-SP
		TEST PIT SIZE: 6.0 m × 2.4 m.	
SITE LOCATION: Settling Pond	BEGUN: 22 July 1980	COMPLETED: 22 July 1980	
COORDINATES LOCATION: 12320.79 5506.05	GROUND ELEVATION: 1543.30	GROUND WATER ELEVATION: 1541.2 (2.1m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry to damp, loose, brown, with roots.	
1.0		GM		GRAVEL, sandy, mostly large subrounded boulders to 15cm. diameter with some to 0.5m. Lenses of smaller size gravels and a lense of coarse sand.	
1.5					
2.0					
2.5					
3.0				2.4 m. bottom of pit	

TEST PIT NO TP-3-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037	TEST PIT NO.: TP-4-SP		
PROJECT: Elk River Coal Mine	TEST PIT SIZE: 6.7m. x 2.4m.		
SITE LOCATION: Settling Pond	BEGUN: 22 July 1980	COMPLETED: 22 July 1980	
COORDINATES LOCATION: 12200.49 5561.34	GROUND ELEVATION: 1540.96	GROUND WATER ELEVATION: 1539.8 (1.2 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, loose, with roots.	
0.5		GP		GRAVEL, sandy, dry, loose, mostly angular to subangular fragments < 5cm.	
1.0		GP		GRAVEL, sandy, damp to wet, loose to moderately dense.	
1.5	Bag Sample				
2.0					
2.5				2.1 m. bottom of pit	
3.0					

TEST PIT NO TP-4-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-5-SP

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.0 m. x 2.4 m.

SITE LOCATION: Settling Pond

BEGUN: 22 July 1980

COMPLETED: 22 July 1980

COORDINATES LOCATION: 12011.31 5703.63

GROUND ELEVATION: 1540.96

GROUND WATER ELEVATION: 1536.7 (4.3 m.)

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		GM		GRAVEL, sandy, dry, loose, with silt, roots.	
1.0		GM		GRAVEL, sandy, with silt, dry, loose, subangular to subrounded, boulders mostly < 15 cm. diameter.	
1.5					
2.0		GP		GRAVEL, sandy, dry, loose.	
2.5		GP		GRAVEL, sandy, moist to wet, loose to dense, with boulders to 0.5 m. diameter.	
3.0					
3.5					
4.0					
4.5					▽ W.L. 4.5m. 1 Aug. 1980
5.0	Bag Sample	ML		SILT, clayey, moist, slightly plastic, glacial till.	
5.5					
6.0				5.2 m. bottom of pit	

TEST PIT NO. TP-5-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST P. LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-6-SP
SITE LOCATION: Settling Pond	BEGUN: 22 July 1980	TEST PIT SIZE: 8.2 m. x 1.2 m.	
COORDINATES LOCATION: 11588.22 5846.53	GROUND ELEVATION: 1546.13	COMPLETED: 22 July 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Heneks	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry, loose, brown, with roots, some angular rock fragments.	
1.0		ML		SILT, sandy, with gravel, damp to moist, firm, brown.	
1.5					
2.0	Bag Sample	ML		SILT, clayey, gravelly, moist to wet, dense, gray, with subangular to subrounded boulders to 0.5 m., glacial till.	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0				5.5 m. bottom of pit	

TEST PIT NO TP-6-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-7-SP
SITE LOCATION: Settling Pond	BEGUN: 29 July 1980	TEST PIT SIZE:	COMPLETED: 29 July 1980
COORDINATES LOCATION: 11883.14 5764.21	GROUND ELEVATION: 1537.70		GROUND WATER ELEVATION: 1535.3 (2.4 m.)
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, with gravel, dry, loose, with roots.	
1.0		GP		GRAVEL, sandy, loose to compact, gray, mostly < 3 cm., with some to 10 cm., subrounded to subangular.	
1.5		GP		GRAVEL, sandy, with cobbles and boulders, Much larger particles than overlying gravel. Numerous boulders to 15 cm. with some to 0.6 m., subangular to subrounded.	▽ W.L. 1.8m 31 July 198
2.0					
2.5					
3.0				3.0 m. bottom	

TEST PIT NO. TP-7-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-8-SP

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: Settling Pond

BEGUN: 29 July 1980

COMPLETED: 29 July 1980

COORDINATES LOCATION: 11995.86 5824.63

GROUND ELEVATION: 1550.06

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, dry, loose, brown, with angular boulders to 15 cm.	
1.0		ML		SILT, damp, firm, brown, with angular to subangular boulders to 15 cm.	
1.5		ML		SILT, damp to moist, dense, med. plastic, gray, with gravel. Laminated in part. Glacial till.	
2.0					
2.5					
3.0					
3.5					
4.0	Bag Sample				
4.5					
5.0				4.6 m. bottom of pit	

TEST PIT NO TP-8-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-9-SP

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: Settling Pond

BEGUN: 29 July 1980

COMPLETED: 29 July 1980

COORDINATES LOCATION: 12317.69 5714.45

GROUND ELEVATION: 1544.76

GROUND WATER ELEVATION: 1538.8 (6.0 m.)

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, brown, with roots and some subangular to subrounded boulders.	
0.5 1.0 1.5 2.0		GP		GRAVEL, sandy, with silt, damp, loose, brown, with boulders to 0.5 m. Small lenses of coal at 2.1 m.	
2.5 3.0		GP		GRAVEL, sandy, loose to moderately dense, tan with rusty zones, water flowing at base of gravel at 3.0 m.	
3.5 4.0 4.5 5.0	Bag Sample	ML		SILT, clayey, moist, stiff, gray, laminated.	
5.5 6.0				5.2 m. bottom of pit	

TEST PIT NO TP-9-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine	JOB NO.: 2037	TEST PIT NO.: TP-10-SP
	TEST PIT SIZE:	
SITE LOCATION: Settling Pond	BEGUN: 29 July 1980	COMPLETED: 29 July 1980
COORDINATES LOCATION: 12475.70 5773.65	GROUND ELEVATION: 1549.40	GROUND WATER ELEVATION: 1543.4 (6.0 m.)
EXCAVATION METHOD: Backhoe	LOGGED BY: R. W. Henecks	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, loose, with subangular boulders to 15cm, roots and wood.	
0.5		ML		SILT, damp, loose, tan, with roots.	
1.0		GP		GRAVEL, sandy, silty, mostly < 8 cm., some boulders to 15 cm.	
1.5					
2.0					
		SP		SAND, fine, wet, firm, brown, with some pea size gravel.	
2.5		GP		GRAVEL, sandy, silty, moist, moderately dense.	
3.0					
3.5					
4.0				3.7 m. bottom of pit	

TEST PIT NO. TP-10-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-11-SP
SITE LOCATION: Settling Pond	BEGUN: 4 Aug. 1980	TEST PIT SIZE: 6.0 m. × 2.4 m.	
COORDINATES LOCATION: 11541.17 5752.04	GROUND ELEVATION: 1534.35	COMPLETED: 4 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION: 1531.7 (2.7 m.)	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, damp, loose, brown, with roots.	
0.5 1.0		GP		GRAVEL, sandy, damp, loose, brown, mostly 2-8 cm., some boulders to 0.3m., subrounded.	
1.5 2.0 2.5 3.0		GP		GRAVEL, sandy, wet, mostly 8-15 cm., some boulders to 0.5m., subrounded.	
				3.0m. bottom of pit	

TEST PIT NO. TP-11-SP

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-1-H

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: Plant Site - Hostel Area

BEGUN: 24 July 1980

COMPLETED: 24 July 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION: 3.7 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Henecks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		OL		SILT, dry to moist, soft, dark brown, with roots, with tan silt lenses	
1.0		ML		SILT, wet, firm, olive, with some gravel.	
1.5	Bag Sample				W.L. ▽ 3.7m. 10 AUG. 19
2.0					
2.5		GM		GRAVEL, silty, wet, dense, gray, glacial till.	
3.0					
3.5					
4.0		GM		GRAVEL, silty, wet, very dense, gray, glacial till.	
4.5					
5.0					
5.5				5.5 m. bottom of pit	
6.0					

TEST PIT NO TP-1-H

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-2-H

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: Plant Site - Hostel Area

BEGUN: 24 July 1980

COMPLETED: 24 July 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION: 2.4 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: R. W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		OL		SILT, wet, dark brown, organic, with roots and peat.	▽ W.L. 0.2m. 10 Aug. 1980
1.0		OL		SILT, clayey, wet, dark brown, with roots.	
1.5		ML		SILT, gravelly, wet, soft, grey, glacial till.	
2.0	Bag Sample				
2.5				2.4m. bottom of pit	
3.0					

TEST PIT NO TP-2-H

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037 | TEST PIT NO: TP-1-WW

PROJECT: Elk River Coal Mine | TEST PIT SIZE:

SITE LOCATION: West Waste Dump | BEGUN: 24 July 1980 | COMPLETED: 24 July 1980

COORDINATES LOCATION: 15916.0 4699.3 | GROUND ELEVATION: 1651.463 | GROUND WATER ELEVATION: 1547.8 (3.7 m.)

EXCAVATION METHOD: Backhoe | LOGGED BY: R. W. Henecks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry, with roots, some organic material and some boulders.	
1.0		ML		SILT, sandy, dry, tan, with roots.	
1.5		GM-GP		GRAVEL, sandy, dry, with boulders to 15 cm.	
2.0		GP		GRAVEL, sandy, damp, brown, with many large boulders, some to 1.0 m.	
2.5					
3.0					
3.5		GM		GRAVEL, silty, moist to wet, dense, gray, with boulders, glacial till.	W.L. 3.1 m. 6 Aug. 1980
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO TP-1-NW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-2-WW
		TEST PIT SIZE:	
SITE LOCATION: West Waste Dump	BEGUN: 24 July 1980	COMPLETED: 24 July 1980	
COORDINATES LOCATION: 16427.8 4768.7	GROUND ELEVATION:	GROUND WATER ELEVATION: (3.7 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry, loose, tan, with roots.	
1.0		ML		SILT, gravelly, dry to damp, loose, brown, with roots.	
1.5		GP		GRAVEL, sandy, moist, loose to moderately dense, with boulders to 15 cm.	
2.0					
2.5					
3.0		GP		GRAVEL, sandy, with much angular material.	W 3 6 Aug.
3.5					
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO. TP-2-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-3-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: West Waste Dump

BEGUN: 24 July 1980

COMPLETED: 24 July 1980

COORDINATES LOCATION: 16640.2 4851.2

GROUND ELEVATION:

GROUND WATER ELEVATION: –

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, dry, loose, with roots.	
1.0		GP		GRAVEL, sandy, brown, angular, with subangular to subrounded boulders to 0.2 m.	
1.5		GP		GRAVEL, sandy, moist, gray, dense, with angular rock fragments.	
2.0					
2.5					
3.0					
3.5					
4.0					
4.5				4.3 m. bottom of pit	
5.5					

TEST PIT NO TP-3-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-4-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: West Waste Dump

BEGUN: 24 July 1980

COMPLETED: 24 July 1980

COORDINATES LOCATION: 16851.8 4923.0

GROUND ELEVATION:

GROUND WATER ELEVATION: –

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, loose, brown, with roots.	
0.5		ML		SILT, sandy, brown, with gravel, angular fragments and boulders.	
1.0		GP		GRAVEL, sandy, dry, dense, with angular fragments to 0.3m., slope wash.	
1.5		GM		GRAVEL, silty, damp, gray, with boulders to 0.6 m., glacial till.	
2.0				North end of test pit may be bedrock or a very large boulder of Cadomin conglomerate.	
2.5					
3.0					▽ W.L. 3.3m 6 Aug. 19
3.5				3.3 m. bottom of pit	

TEST PIT NO TP-4-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-5-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE:

SITE LOCATION: West Waste Dump

BEGUN: 25 July 1980

COMPLETED: 25 July 1980

COORDINATES LOCATION: 17090.2 4996.6

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: R.W. Heneks

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, loose, brown to tan, with roots.	
0.5		GM		GRAVEL, sandy, silty, moist, dense, with boulders, mostly < 15 cm., with some to 0.8 m.	
1.0					
1.5					
2.0					
2.5					
3.0					
3.0					
4.0					
4.5				4.3 m. bottom of pit	

TEST PIT NO TP-5-WW

PLATE

INTE ATIONAL ENGINEERING CO. INC.

T 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-6-WW
		TEST PIT SIZE:	
SITE LOCATION: West Waste Dump	BEGUN: 25 July 1980	COMPLETED: 25 July 1980	
COORDINATES LOCATION: 17344.7 5628.4	GROUND ELEVATION: 1641.628	GROUND WATER ELEVATION: 1638.6 (3.0 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: R.W. Heneks		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, sandy, dry, loose, tan, with roots.	
0.5		GM		GRAVEL, sandy, dark brown with angular to subangular boulders to 0.8 m., slope wash.	
1.0					
1.5					
2.0					
2.5					
3.0					▽ W.L. 3.1m 6 Aug. 1
3.5				3.4 m. bottom of pit	

TEST PIT NO TP-6-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037	TEST PIT NO.: TP-7-WW		
PROJECT: Elk River Coal Mine	TEST PIT SIZE: 6.0 m. × 3.0 m.		
SITE LOCATION: West Waste Dump	BEGUN: 11 Aug. 1980	COMPLETED: 11 Aug. 1980	
COORDINATES LOCATION: 16728.2 5159.6	GROUND ELEVATION:	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, moist, loose, non-plastic, tan, with roots.	
1.0		GM		GRAVEL, silty, sandy, moist, angular to subrounded, boulders to 0.8 m., glacial till.	
1.5					
2.0					
2.5	Bag Sample				
3.0				Water inflow at 3.0 m.	
3.5				3.2 m. bottom of pit	

TEST PIT NO. TP-7-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO: 2037 | TEST PIT NO: TP-9-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7 m. x 3.0 m.

SITE LOCATION: West Waste Dump

BEGUN: 14 Aug. 1980

COMPLETED: 14 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		Pt		PEAT, wet, with roots. Water inflow from this layer.	
1.0		ML		SILT, very fine sand, moist, loose, tan.	
1.5		Pt		PEAT, wet, brown and off white, with roots. Caving. Water inflow at 1.8 m.	
2.0		SP		SAND, gravelly, wet, loose, quick dilatency, gray to brown, boulders ∠0.3m, subrounded to subangular. Some pockets of hard till.	
2.5	Bag Sample				
3.0					
3.5					
4.0				4.0 m. bottom of pit	

TEST PIT NO TP-9-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST . . LOG

JOB NO.: 2037

TEST P... NO.: TP-10-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7m. x 3.0 m.

SITE LOCATION: West Waste Dump

BEGUN: 14 Aug. 1980

COMPLETED: 14 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION:

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, damp, loose, non-plastic, lt. brown, with roots, organic materi	
1.0		ML-GP		GRAVEL, silty, damp, stiff, gray to brown, boulders to 0.6 m., hard till.	
1.5					
2.0		GP		GRAVEL, sandy, damp to moist (saturated below 2.7 m.), loose, gray to brown, angular to subrounded, boulders to 0.6m. Soft coal at bottom, Water inflow at 2.7 m. Caving.	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5					
6.0				5.8 m. bottom of pit	

TEST PIT NO TP-10-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST LOG

JOB NO.: 2037

TEST NO.: TP-11-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.0m. x 3.0 m.

SITE LOCATION: West Waste Dump

BEGUN: 14 Aug. 1980

COMPLETED: 14 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION: 4.7 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, gravelly, damp, loose, non-plastic, brown, with roots.	
1.0		GM		GRAVEL, sandy, damp (saturated below 4.7m.), loose, brown, subangular to subrounded, boulders to 0.3m., alluvium.	
1.5					
2.0				Fine sand silt seam, damp, tan, with peat, approx. 15cm. thick at 3.2 m.	
2.5					
3.0					
3.5	Bag Sample				
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO TP-11-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST P.. LOG

JOB NO.: 2037

TEST P.. NO. TP-12-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7m. × 3.0 m.

SITE LOCATION: West Waste Dump

BEGUN: 14 Aug. 1980

COMPLETED: 14 Aug. 1980

COORDINATES LOCATION: 16512.2 5616.0

GROUND ELEVATION:

GROUND WATER ELEVATION: 4.3 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, peat, damp, loose, brown, with roots.	
1.0					
1.5		SM		SAND, fine, silty, damp, loose, yellow to tan.	
2.0		GP		GRAVEL, sandy, damp, loose, brown, subangular to subrounded, boulders to 0.2 m. Water inflow at 2.7 m.	
2.5					
3.0		GP		GRAVEL, sandy, saturated, loose, lt. gray - brown.	
3.5					
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO. TP-12-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-13-WW
SITE LOCATION: West Waste Dump	BEGUN: 14 Aug. 1980	TEST PIT SIZE: 6.7m. x 3.0m.	COMPLETED: 14 Aug. 1980
COORDINATES LOCATION: 16072.2 5292.0	GROUND ELEVATION:	GROUND WATER ELEVATION: (2.1m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SP		SAND, moist, brown, with roots, peat.	
1.0		GM		GRAVEL, sandy, moist to wet (saturated below 2.1m.), loose, quick dilatency, brown-gray, boulders to 0.5m., subangular to subrounded:	Drainage ditch approx. 30.m. beyond pit shows hard till just below surface.
1.5					
2.0					
2.5					
3.0				2.7m. bottom of pit	

TEST PIT NO. TP-13-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-14-WW

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7 m. x 3.0 m.

SITE LOCATION: West Waste Dump

BEGUN: 14 Aug. 1980

COMPLETED: 14 Aug. 1980

COORDINATES LOCATION:

GROUND ELEVATION:

GROUND WATER ELEVATION: 4.3 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5 – 1.0		Pt		PEAT, wet, roots, organic material. Water inflow from this layer.	
1.5 – 2.0 – 2.5		ML		SILT, sandy, moist to wet, soft, gray-brown, some gravels, few boulders to 0.6 m., subrounded.	
3.0 – 3.5 – 4.0 – 4.5		GM		GRAVEL, sandy, wet (saturated below 4.3 m.), loose, pervious, angular to subangular, boulders to 0.6 m. Water inflow from this layer.	
5.0				4.6 m. bottom of pit	

TEST PIT NO TP-14-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037	TEST PIT NO.: TP-15-WW		
PROJECT: Elk River Coal Mine	TEST PIT SIZE: 6.7 m. × 2.4 m.		
SITE LOCATION: West Waste Dump	BEGUN: 14 Aug. 1980	COMPLETED: 14 Aug. 1980	
COORDINATES LOCATION: 16299.7 5553.4	GROUND ELEVATION:	GROUND WATER ELEVATION: (4.0m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, damp, loose, brown, with roots.	
1.0		SM		SAND, very fine, damp, loose, tan.	
1.5		ML-GP		SILT, gravelly, damp (saturated below 4.0 m.), very stiff, impervious, gray-brown, subangular to subrounded gravels, size and % gravel increases with depth, boulders to 1.2 m., sandier towards bottom.	
2.0	Bag Sample				
2.5					
3.0					
3.5					
4.0					
4.5				4.3 m. bottom of pit	

TEST PIT NO
TP-15-WW

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-1-NEI
		TEST PIT SIZE: 6.7m. x 3.4m.	
SITE LOCATION: North East Interceptor Ditch	BEGUN: 7 Aug. 1980	COMPLETED: 7 Aug. 1980	
COORDINATES LOCATION: 19191.47 6582.37	GROUND ELEVATION: 1619.21	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		OL		SILT, damp, non-plastic, brown, with roots, organic material.	
0.5		GM		GRAVEL, silty, damp to moist, loose, coarse sand, gravel to 0.6 m., subangular to subrounded.	
1.0					
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5	Bag Sample				
5.0					
5.5				5.5m. bottom of pit	
6.0					

TEST PIT NO. TP-1-NEI

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037	TEST PIT NO: TP-1-RD		
PROJECT: Elk River Coal Mine	TEST PIT SIZE: 6.0m. × 3.0 m.		
SITE LOCATION: River Diversion - North Section	BEGUN: 12 Aug. 1980	COMPLETED: 12 Aug. 1980	
COORDINATES LOCATION: 19217.6 6204.4	GROUND ELEVATION: 1619.21	GROUND WATER ELEVATION: 1616.8 (2.4 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, damp, brown, with roots.	
1.0		GM		GRAVEL, sandy, moist to wet, loose, brown to gray, subrounded, boulders to 0.6 m., sand at bottom.	
1.5					
2.0					
2.5					
3.0				2.6 m. bottom of pit	

TEST PIT NO. TP-1-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO.: TP-2-RD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.0m.× 2.4m.

SITE LOCATION: River Diversion - North Section

BEGUN: 12 Aug. 1980

COMPLETED: 12 Aug. 1980

COORDINATES LOCATION: 18324.0 5997.5

GROUND ELEVATION: 1637.4

GROUND WATER ELEVATION: 1636.2 (1.2m.)

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		OL		SILT, peat, moist.	
0.5	Bag Sample	ML		SILT, gravelly, moist, soft to med. stiff, gray to brown, few gravels, some boulders to 0.3m., glacial till, coal at 1.2m.	
1.0					
1.5				1.2 m. bottom of pit	
2.0					

TEST PIT NO TP-2-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-3-RD
		TEST PIT SIZE: 6.0m. x 2.4m.	
SITE LOCATION: River Diversion - North Section	BEGUN: 12 Aug. 1980	COMPLETED: 12 Aug. 1980	
COORDINATES LOCATION: 18462.7 5993.3	GROUND ELEVATION: 1638.84	GROUND WATER ELEVATION: –	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, damp, brown, with roots.	
0.5 – 4.5	Bag Sample	ML-GP		SILT, gravelly, damp, very stiff, non-plastic, gray to brown, gravels to 0.6m., subangular to subrounded, glacial till. Rock at bottom.	
5.0				4.6 m. bottom of pit	

TEST PIT NO. TP-3-RD

PLATE

INTE[illegible]ATIONAL ENGINEERING CO. INC.

TEST[illegible]LOG

JOB NO.: 2037

TEST: TP-4-RD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7m. × 2.4 m.

SITE LOCATION: River Diversion - North Section

BEGUN: 13 Aug. 1980

COMPLETED: 13 Aug. 1980

COORDINATES LOCATION: 18207.9 6000.7

GROUND ELEVATION: 1636.51

GROUND WATER ELEVATION: -

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, damp, tan, with roots.	
1.0	Bag Sample	ML-GP		SILT, gravelly, damp, stiff, non-plastic, impervious, gray to brown, sharp to subrounded boulders to 0.5m. Small pockets of moist, soft sandy silt. Sandier, pervious at bottom. Glacial till.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					
5.5				Water inflow at 5.7 m.	
6.0				5.9 m. bottom of pit	

TEST PIT NO. TP-4-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO: TP-5-RD
SITE LOCATION: River Diversion - North Section	BEGUN: 13 Aug. 1980	TEST PIT SIZE: 6.7 m. × 2.4 m.	
COORDINATES LOCATION: 18018.8 5997.1	GROUND ELEVATION: 1631.75	COMPLETED: 13 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION: –	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		Pt		P , moist to wet.	
1.0		ML-GP		SILT, gravelly, damp, very stiff, non-plastic, gray to brown, boulders to 0.3m., subangular to subrounded, hard till.	
1.5		ML		SILT, sandy, moist to wet, soft to med. stiff, non-plastic, gray to brown, soft till.	
2.0					
2.5		ML-GP		SILT, gravelly, damp, very stiff, non-plastic, gray to brown, subangular to subrounded boulders to 0.6m., hard till.	
3.0					
3.5	Bag sample				
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO TP-5-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-6-RD
		TEST PIT SIZE: 6.7m. x 3.0m.	
SITE LOCATION: River Diversion - North Section	BEGUN: 13 Aug. 1980	COMPLETED: 13 Aug. 1980	
COORDINATES LOCATION: 17889.3 6001.8	GROUND ELEVATION: 1624.64	GROUND WATER ELEVATION: -	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		OL		SILT, damp, loose, with peat, roots.	
1.0		ML-GP		SILT, gravelly, damp, stiff, gray to brown, subangular to subrounded boulders to 0.5m., hard till.	
1.5					
2.0				High water inlow at 2.4 m. Filling at 15cm./10min. Caving.	
2.5					
3.0	Bag Sample	GM		GRAVEL, sandy, wet, loose, gray to brown, some silt (hard till) pockets; rock at bottom.	
3.5					
4.0				4.0m. bottom of pit	

TEST PIT NO TP-6-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO: TP-7-RD
SITE LOCATION: River Diversion - Middle Section	BEGUN: 13 Aug. 1980	TEST PIT SIZE: 6.0 m. x 3.0 m.	COMPLETED: 13 Aug. 1980
COORDINATES LOCATION: 16741.3 5947.6	GROUND ELEVATION: 1585.11	GROUND WATER ELEVATION: 1581.9 (3.2 m.)	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5 1.0 1.5		SM		SAND, silty, dry to damp, loose, non-plastic, brown, with roots.	
2.0 2.5 3.0		GM		GRAVEL, sandy, dry to damp. (saturated below 3.2 m.), loose, subrounded, boulders to 0.3 m., % gravel increases with depth. Alluvium. Caving.	
3.5 4.0				3.4 m. bottom of pit	

TEST PIT NO TP-7-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-8-RD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.0 m. x 3.0 m.

SITE LOCATION: River Diversion - Middle Section

BEGUN: 13 Aug. 1980

COMPLETED: 13 Aug. 1980

COORDINATES LOCATION: 16646.8 5978.2

GROUND ELEVATION: 1584.06

GROUND WATER ELEVATION: 1581.1 3.0 m.

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, dry to damp, loose, brown, with roots, subangular to subrounded gravel to 0.3 m.	
1.0		GM		GRAVEL, sandy, dry to damp (saturated below 3.0 m.), loose, subrounded, some boulders to 0.3 m., % gravel increases with depth. Alluvium. Caving.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0				3.7 m. bottom of pit	

TEST PIT NO TP-8-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037

TEST PIT NO: TP-9-RD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7 m. x 2.4 m.

SITE LOCATION: River Diversion - Middle Section

BEGUN: 15 Aug. 1980

COMPLETED: 15 Aug. 1980

COORDINATES LOCATION: 16457.2 5916.2

GROUND ELEVATION: 1583.39

GROUND WATER ELEVATION: -

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, damp, loose, brown, with roots.	
1.0		GM		GRAVEL, sandy, damp, loose, brown, mostly < 15 cm., larger near bottom, subrounded, alluvium. Rock at bottom.	
1.5					
2.0					
2.5					
3.0				3.0 m. bottom of pit	

TEST PIT NO TP-9-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO. TP-10-RD
SITE LOCATION: River Diversion - Middle Section	BEGUN: 15 Aug. 1980	TEST PIT SIZE: 6.7m. × 3.0 m.	
COORDINATES LOCATION: 16348.5 5965.6	GROUND ELEVATION: 1581.65	COMPLETED: 15 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION: 1578.2 (3.5 m.)	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SP.		SAND, damp, brown, with roots, few gravels.	
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0		GM		GRAVEL, sandy, damp (saturated below 3.5 m.), loose, mostly < 15cm., some to 0.6 m., subrounded to subangular, more angular towards bottom; size and % gravel increases with depth. Alluvium. Caving.	
				4.0 m. bottom of pit	

TEST PIT NO TP-10-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST LOG

JOB NO: 2037

TEST PIT NO: TP-11-RD

PROJECT: Elk River Coal Mine

TEST PIT SIZE: 6.7 m. x 2.4 m.

SITE LOCATION: River Diversion - Middle Section

BEGUN: 15 Aug. 1980

COMPLETED: 15 Aug. 1980

COORDINATES LOCATION: 16280.6 5940.6

GROUND ELEVATION: 1579.20

GROUND WATER ELEVATION: 1575.2 (4.0 m.)

EXCAVATION METHOD: Backhoe

LOGGED BY: M. Stoffel

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		SM		SAND, silty, damp, loose, brown, with roots, organic material.	
1.0		GM		GRAVEL, silty, damp, very, stiff, very dense, gray to brown, some tree trunks, gravels to 0.3 m., subangular to subrounded. Pervious sand seam at 1.2 m. and near bottom. Size and % gravel increases with depth, more angular towards bottom. Water inflow from sand seam.	
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5				4.3 m. bottom of pit	

TEST PIT NO TP-11-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-12-RD
SITE LOCATION: River Diversion - Middle Section	BEGUN: 15 Aug. 1980	TEST PIT SIZE: 6.0 m. x 3.0 m.	
COORDINATES LOCATION: 15250.0 5969.5	GROUND ELEVATION: 1573.80	COMPLETED: 15 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION: 1572.1 (1.7 m.)	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		SP		SAND, fine, damp to moist, loose, tan, with roots.	
0.5 1.0 1.5 2.0		GM		GRAVEL, sandy, damp (saturated below 1.7m.) loose, brown, mostly 2 - 10 cm., boulders to 0.3 m., subrounded to subangular, alluvium. Caving.	
2.5 3.0				2.4 m. bottom of pit	

TEST PIT NO TP-12-RD

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-1-FB
		TEST PIT SIZE: 6.0m. x 3.0 m.	
SITE LOCATION: Forestry Bypass Road	BEGUN: 11 Aug. 1980	COMPLETED: 11 Aug. 1980	
COORDINATES LOCATION: 19272.61 4996.87	GROUND ELEVATION: 1680.47	GROUND WATER ELEVATION: –	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		OL		SILT, moist, with roots and organic material.	
0.5		GM		GRAVEL, silty, moist, dense, gray to brown, glacial till.	
1.0					
1.5	Bag Sample				
2.0					
2.5		GP		GRAVEL, wet, sharp to subangular, to 1.2 m.	
3.0					
3.5					
4.0				4.0 m. bottom of pit	

TEST PIT NO
TP-1-FB

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-2-FB
SITE LOCATION: Forestry Bypass Road	BEGUN: 12 Aug. 1980	TEST PIT SIZE: 6.0 m × 3.0 m	
COORDINATES LOCATION: 19416.05 5085.25	GROUND ELEVATION: 1683.14	COMPLETED: 12 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, sandy, damp to moist, tan, with roots.	
1.0	Bag Sample	GM		GRAVEL, silty, damp to moist, very dense, gray to brown, sharp to subangular, glacial till.	
1.5					
2.0		GM		GRAVEL, moist to wet, loose, boulders to 60 cm., sharp to subangular.	
2.5					
3.0					
3.5					
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO. TP-2-FB

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-3-FB
SITE LOCATION: Forestry Bypass Road	BEGUN: 12 Aug. 1980	TEST PIT SIZE: 6.7m. × 3.0m.	
COORDINATES LOCATION: 19558.90 5348.42	GROUND ELEVATION: 1671.28	COMPLETED: 12 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		OL		SILT, moist, loose, tan, with peat.	
1.0 – 5.5	Bag Sample	GM		GRAVEL, silty, damp to moist, very dense, easily crumbled, gray to brown, non-plastic fines, boulders to 0.6 m, sharp to subangular, % gravel increases with depth, glacial till. Water inflow at 3.0m.	
6.0				5.5 m. bottom of pit	

TEST PIT NO TP-3-FB

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

JOB NO.: 2037	TEST PIT NO.: TP-4-FB		
PROJECT: Elk River Coal Mine	TEST PIT SIZE: 6.7 m. x 2.4 m.		
SITE LOCATION: Forestry Bypass Road	BEGUN: 12 Aug. 1980	COMPLETED: 12 Aug. 1980	
COORDINATES LOCATION: 19558.41 5511.51	GROUND ELEVATION: 1661.71	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		ML		SILT, damp, loose, tan, with roots.	
1.0	Bag Sample	GM		GRAVEL, silty, damp to moist, very dense, crumbles easily, gray to brown, some sand, boulders to 1.2 m., sharp to sub-angular, % gravel increases with depth, glacial till.	
5.5				5.1 m. bottom of pit	
6.0					

TEST PIT NO TP-4-FB

PLATE

INTERNATIONAL ENGINEERING CO. INC.

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO: TP-5-FB
		TEST PIT SIZE: 6.0m. x 2.4m.	
SITE LOCATION: Forestry Bypass Road	BEGUN: 12 Aug. 1980	COMPLETED: 12 Aug. 1980	
COORDINATES LOCATION: 19441.34 5720.11	GROUND ELEVATION: 1655.59	GROUND WATER ELEVATION:	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel		

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
		ML		SILT, fine sandy, damp, loose, tan, with roots.	
0.5		GM		GRAVEL, silty, damp, dense in place but crumbles when dropped from bucket, grey to brown, non-plastic fines, boulders to 0.6 m., sharp to subangular, glacial till.	
1.0					
1.5					
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0				4.9 m. bottom of pit	

TEST PIT NO TP-5-FB

PLATE

INTERNATIONAL ENGINEERING CO. INC.

SHEET 1 OF 1

TEST PIT LOG

PROJECT: Elk River Coal Mine		JOB NO.: 2037	TEST PIT NO.: TP-1-RR
SITE LOCATION: Plant Site - Railroad Loop	BEGUN: 10 Aug. 1980	TEST PIT SIZE: 6.4 m x 1.2 m	
COORDINATES LOCATION:	GROUND ELEVATION:	COMPLETED: 10 Aug. 1980	
EXCAVATION METHOD: Backhoe	LOGGED BY: M. Stoffel	GROUND WATER ELEVATION:	

DEPTH IN METERS	SAMPLE NO.	UNIFIED SOIL CLASSIFICATION	GRAPHIC LOG	MATERIAL CLASSIFICATION PHYSICAL DESCRIPTION	REMARKS
0.5		Pt		PEAT, wet to saturated. Water inflow from this layer.	
1.0	Bag Sample	ML		SILT, gravelly, moist, soft, non-plastic, gray to brown, few gravels to 10 cm., glacial till.	
2.5	Bag Sample	ML-GP		SILT, gravelly, damp, stiff, non-plastic, gray to brown, gravels to 30 cm., sharp to subrounded, glacial till. Backhoe refusal at 3.4 m.	
3.5				3.4 m. bottom of pit	
4.0					

TEST PIT NO TP-1-RR

PLATE

SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name · ELK RIVER COAL Feature RIVER DIVERSION Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w	Optimum γ_d	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d	k	Consolidation C_v	C_r	P_c'	Notes
77-67		4'	5'	GW	86	9	5																			
TP1RD		0.6m	2.6m	GM	45	38	17			2.564	9.2															
TP2RD		0.3m	1.2m	CL-ML	11	23	66	20.5	5.0		20.1															
TP4RD		0.6m	5.9m	CL	9	22	69	21.5	7.5	2.618	13.1															
TP5RD		2.1m	4.9m	CL	12	10	78	23.6	10.1		17.5															
TP11RD		0.6m	4.3m	CL-ML	12	31	57	19.2	6.2		15.4															
DH17-RD		1.2m					88				25.6															
DH18-RD		4.3m					90				19.8															
DH19-RD		7.3m					88				20.1															
DH19-RD		8.8m		CL			90	31.3	14.9		22.6															
DH20-RD		5.8m					70				17.3															
DH20-RD		7.3m	8.8m	CL			94	24.6	12.1	2.646	19.8															
DH20-RD		10.4m		CL			86	24.9	10.6	2.675	22.3															
DH21-RD		7.3m		CL-ML			86	22.4	7.2	2.604	19.7															
DH21-RD		8.8m	10.4m	CL			86	23.3	10.2	2.634	18.5															
DH21-RD		11.9m					72				17.3															
DH22-RD		1.2m					78				31.7															
DH22-RD		4.3m	5.8m				92				20.4															
DH22-RD		7.3m	10.4m	CL			82	18.8	9.3	2.672	11.6															
DH-127		0'	4'	ML	0	28	72																			
DH-131		4'	6'	SM	17	35	48	16.6	11.5																	
DH-83		1'	3'	SM-ML	20	30	50																			
DH-130		4'		CL	0	2	98	40.1	25.3																	
DH-129		2'	5'	GC	50	17	33	26.3	19.0																	

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UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature RIVER DIVERSION Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w	Optimum γ_d	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d	k	Consolidation C_v	C_r	P_c'	Notes
DH 3-RD	1	3.0m	3.5m	GW	87	9	4				4.1															
DH 3-RD	2	6.1m	6.6m	GW-GM	64	26	10				5.5															
DH 3-RD	3	7.6m	8.1m	GW-GM	62	30	8				7.2															
DH 3-RD	4	9.1m	9.6m	GW-GM	59	33	8				7.6															
DH 3-RD	5	10.7m	11.0m	GW-GM	63	29	8				7.4															
DH 3-RD	6	12.2m	12.6m	GM	59	27	14				7.5															
DH 3-RD	7	13.7m	14.1m	GM	40	34	26				7.8															
DH 3-RD	8	15.2m	15.5m	ML-SM	17	36	47				8.2															
DH 3-RD	9	16.8m	16.9m	GM-SM	47	27	26				9.3															
DH 3-RD	10	18.3m		SM-GM	29	41	30				18.4															
DH3-RD	11	19.8m		ML-CL	2	7	91				18.4															
DH-126		6'	7'	SM	0	59	41																			
DH-126		2'	6'	GW	78	18	4																			
DH-80		1'	3'	CL	3	7	90	35.9	24.2																	
DH-81		1'	2'	GC	51	27	22	28.9	22.0																	
EB-8		1'	3'	GM	43	38	19																			
DH-124		2'	6'	GW-GM	69	22	9	27.0	20.2																	
DH-32		0'	2'	ML	18	22	60	40.9	30.1																	
DH-82		2'	4'	GM	60	26	14																			
DH-94		1'	3'	GC	31	26	43	30.9	20.6																	
DH-23		3'	5'	GW-GM	67	25	8	28.9	22.0																	

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature WEST WASTE DUMP Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w	Optimum γ_d	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d	k	Consolidation C_v	C_r	P_c'	Notes
77-64		4'		CL	2	15	83	21	14.8																	
77-73		7'		GW-GM	72	21	7																			
TP 7 WW		2.5m	3.0m	SM	31	49	20	NP	NP		9.4															
TP 8 WW		1.0m	2.0m	SM-SC	23	35	42	17.8	6.7		13.1															
TP 12 WW		1.3m	1.5m	CL-ML	19	21	60	17.4	4.6		28.4															
TP 15 WW		2.0m	2.5m	CL	2	4	94	34.6	14.0		23.7															

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature PLANT SITE Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w_{opt} %	γ_d Kg/m^3	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d Kg/m^3	Permeability k cm/sec	Consolidation C_c	Consolidation C_r	Consolidation $\bar{P}_o$ Kg/cm^2	Notes
76-1N		1.5'	9'	GM	42	39	19																			
76-2N		1'	8'	CL-ML	9	34	57	17.1	11.7																	
76-12		0'	4'	CL-ML	22	18	60	20.4	14.2	2.68																
77-5		12'	13'	CL	12	15	73	28.0	14.3																	
77-12		10'	14'	CL	14	14	72	21.0	13.7																	
77-14		4'		CL-ML	27	23	50	22.0	15.5																	
77-30		8'	10'	GM-GC	27	23	50	17.0	13.3																	
77-33		2'	3'	CL	10	16	74	32.0	20.7																	
77-14		4'	9'	GM	50	32	18							5.5	2223											
77-98		4'	12'	CL-ML	23	21	56	21.0	14.4																	
77-4,7, 9,13,34	comb.			ML	25	22	53							8.8	2045											
TP 1H		1.2m	2.4m	CL	19	23	58	19.0	7.5	2.583	15.1										1990	2.3×10^{-11}	0.052		1.3	
TP 2H		0.6m	2.1m	SM	32	40	28	NP	NP		16.1															

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature RAILROAD LOOP Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w	Optimum γ_d	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d	k	Consolidation C_v	C_c	P_c'	Notes
76-5		4'	8'	CL	27	23	50	21.2	12.1																	
76-7		1'	9'	SM-SC	26	27	47	18.2	13.2																	
77-1		12'	15'	GM	42	28	30																			

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature TAILINGS CONFINEMENT Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w%	Optimum γ_d Kg/m^3	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d Kg/m^3	Permeability k cm/sec	Consolidation C_c	Consolidation C_r	Consolidation P_o Kg/cm^2	Notes
77-45		3'		CL-ML	1	18	81	21	17																	
77-46		6'	9'	CL-ML	21	19	60	20	14.3																	
TP2TD		0.5m	1.5m	ML-SM	12	34	54	15.0	3.0		9										1968	$1x10^{-10}$				
TP5TD		0.5m	1.0m	CL	1	7	42	25.0	9.8	2.591	19.5															
TP11TD	1	1.5m	2.5m	ML-CL	13	27	60	17.6	6.6		11.3															
TP12TD	1	1.0m	2.0m	CL	2	11	87	21.6	8.0		15.5															
TP16TD		3.5m	4.5m	ML-CL	9	25	66	17.2	6.7		9.4										2087	$7.4x10^{-9}$				
TP5TD TP12TD	C-4			CL										13.8	1815						1934	$6.1x10^{-9}$				
TP5TD TP12TD	P-5			CL																			.050		1.25*	
TP5TD TP12TD	C-3			CL																						

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* Disturbed Sample

SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature Settling Pond Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Sand	Fines	Atterberg Limits LL	PI	Specific Gravity G	Natural w %	γ_d	Compaction Test	Optimum w %	Optimum kg/m3	Shear Strength Test	Initial w	Initial γ_d	C	ϕ	Permeability γ_d Kg/m3	Permeability k cm/sec	Consolidation C_c	Consolidation C_r	Consolidation P_c Kg/cm2	Notes
77-92				GW	78	19	3																			
TP ISP		2 m	3 m	GW	65	29	6				4.4															
TP 2SP		1.0 m	1.5 m	SM	0.5	54.5	45	NP	NP		25.0															
TP 5SP		4.6 m	5.2 m	CL			88	26.3	10.2		20.2			15.3	1763						1856	1.7×10^{-6}	0.057		0.995	
TP 6SP		1.7 m	2.5 m	CL			90	28.5	15.1		11.2			14.2	1806						1883	6.1×10^{-11}	0.064		1.25	
TP 8SP		3.5 m	4.0 m	CL			92	27.3	14.8	2.685	15.1															
TP 9SP		3.0 m	4.0 m	CL			100	36.4	20.6	2.650	19.2															
DH 3-SP	5-3	6.0 m	8.1 m	CL				28.0	13.9	2.618	24.2															
DH 3-SP		9.1 m	9.6 m								22.7															
DH 4-SP	5-5	4.6 m	6.6 m	CL				31.2	15.7	2.577	27.7															
DH 4-SP		7.6 m	8.1 m								25.9															
DH 4-SP		10.7m	12.6m	CL				20.0	11.2	2.674	10.7															
DH 6-SP	5-1	4.6 m		CL				25.0	10.5		25.2															
DH 6-SP	5-2	6.0 m	7.6 m	CL-ML				21.4	7.8	2.632	12.1															

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature WEARY VALLEY Date

Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Mechanical Analysis Sand	Mechanical Analysis Fines	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity G	Natural w %	Natural γ_d	Compaction Test	Compaction Optimum w	Compaction Optimum γ_d	Shear Strength Test	Shear Strength Initial w	Shear Strength Initial γ_d	Shear Strength C	Shear Strength ϕ	Permeability γ_d	Permeability k	Consolidation C_v	Consolidation C_r	Consolidation P_c	Notes
77-95		3'	5'	GM	65	27	8																			
TP 2 WC		3m	5.8m	CL-ML				17.	1.8		11.9															
TP 4 WC		3.7m	4.6m	CL				25.2	11.9		16.7															
TP 5 WC		0.3m	2.4m	GW	67	30	3																			
TP 8 WC		0.3m	6.1m	GM	56	32	12																			
TP 9 WC		5.8m	6.4m	CL-ML				20.4	5.3		8.1															
TP 11 WC		3.4m	5.3m	CL				20.9	10.2		8.1															
DH 21		1'	3'	GW-GM	62	30	8																			

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature N.E. INTERCEPTOR DITCH Date

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
		From	To		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	Optimum w	Optimum γ_d	Test	Initial w	Initial γ_d	C	ϕ	γ_d	k	C_v	C_r	P'_o	
TP1-NFI		4.0m	5.0m	GW-GM	73	20	7				8.8															

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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature FORESTRY BYPASS ROAD Date

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
		From	To		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	Optimum w	Optimum γ_d	Test	Initial w	Initial γ_d	C	ϕ	γ_d	k	C_v	C_c	P'_o	
TP 2 FB		1.0m	1.5m	CL	0	1	99	43.8	25.2		26.7															
TP 4 FB		2.0m	2.5m	ML	23	34	43	15.6	3.2		9.1															

* Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature CONSTRUCTION MATERIAL Date

Hole or Trench Number	Sample Number	Depth		Laboratory Classification	Mechanical Analysis			Atterberg Limits		Specific Gravity G	Natural		Compaction			Shear Strength					Permeability		Consolidation			Notes
		From	To		Gravel	Sand	Fines	LL	PI		w %	γ_d	Test	Optimum w	Optimum γ_d	Test	Initial w	Initial γ_d	C	ϕ	γ_d	k	C_c	C_r	P_c'	
76-GP1		Surf.		GW	55	40	5																			
N.W. Terrace		Surf.		SM	40	47	13																			
Section Line 360		Surf.		GM	52	30	18																			
Bingay Creek		Surf.		GW-GM	52	42	6																			
Elkford Pit		Surf.		GW	83	17	0																			

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SP = Standard Proctor
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SUMMARY OF SOIL TEST RESULTS

Job No 2037 Project Name ELK RIVER COAL Feature Mine Pit Date

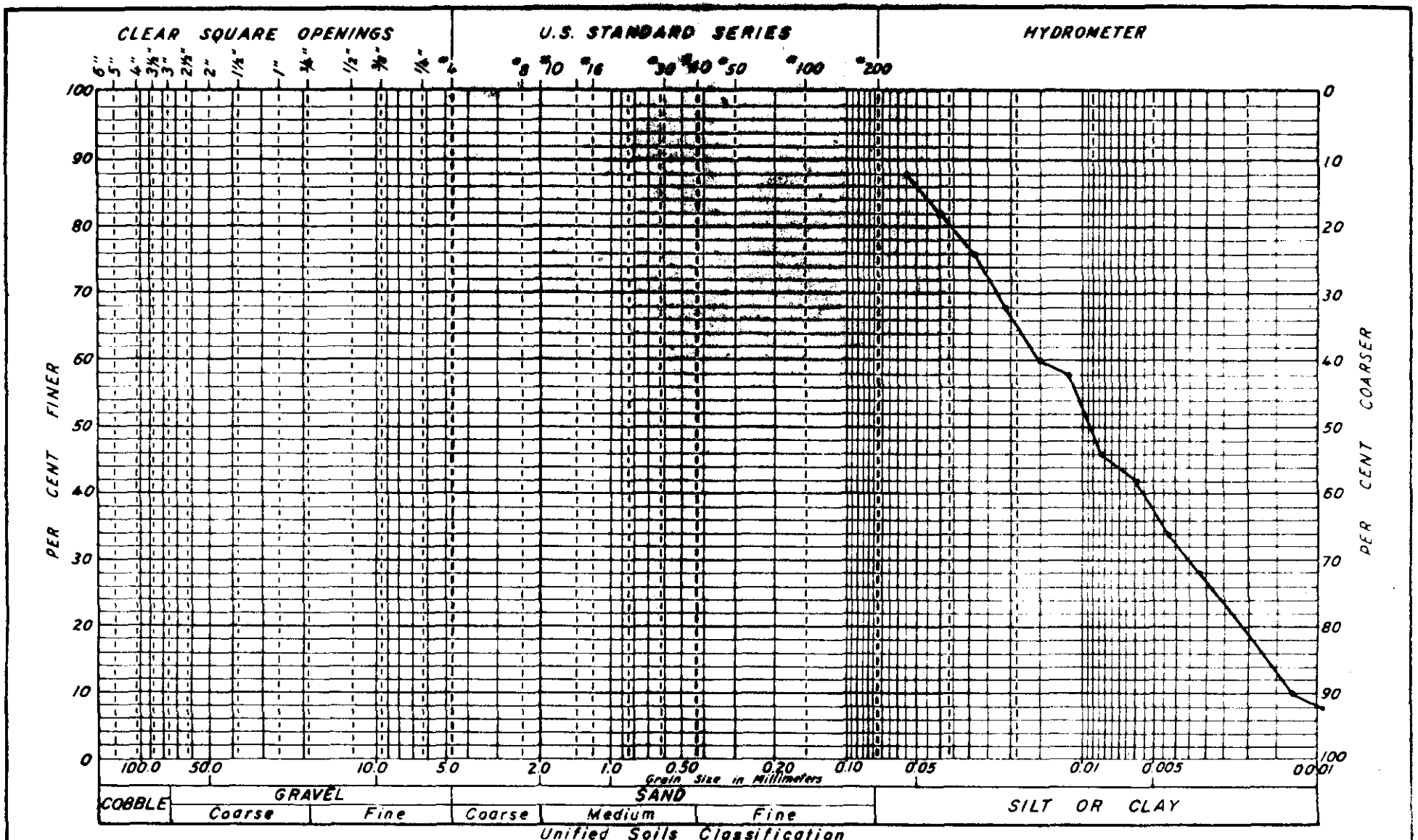
Hole or Trench Number	Sample Number	Depth From	Depth To	Laboratory Classification	Mechanical Analysis Gravel	Mechanical Analysis Sand	Mechanical Analysis Fines	Atterberg Limits LL	Atterberg Limits PI	Specific Gravity G	Natural w %	Natural γ_d	Compaction Test	Compaction Optimum w	Compaction Optimum γ_d	Shear Strength Test	Shear Strength Initial w	Shear Strength Initial γ_d	Shear Strength C	Shear Strength ϕ	Permeability γ_d	Permeability k	Consolidation C_c	Consolidation C_r	Consolidation P_c	Notes
77-79		2'		GM	40	39	21				25.5															
77-80		4'		GM	48	36	16				18.0															
77-81		5'		GM	65	21	14				15.8															
77-83		2'	3'	GW-GM	55	40	5				24.3															
77-86		4'		GM	39	32	29				16.2															
77-87		4'		SM	34	48	18				19.8															
77-88		3.5'		SM	25	51	24																			
DH-125	17	2'	3'	GW	55	40	5																			

*Visual Classification

SP = Standard Proctor
MP = Modified Proctor
S = Special - See Text

TC = Triaxial Compression
UC = Unconfined Compression
DS = Direct Shear

UU = Unconsolidated Undrained
CU = Consolidated Undrained
CD = Consolidated Drained

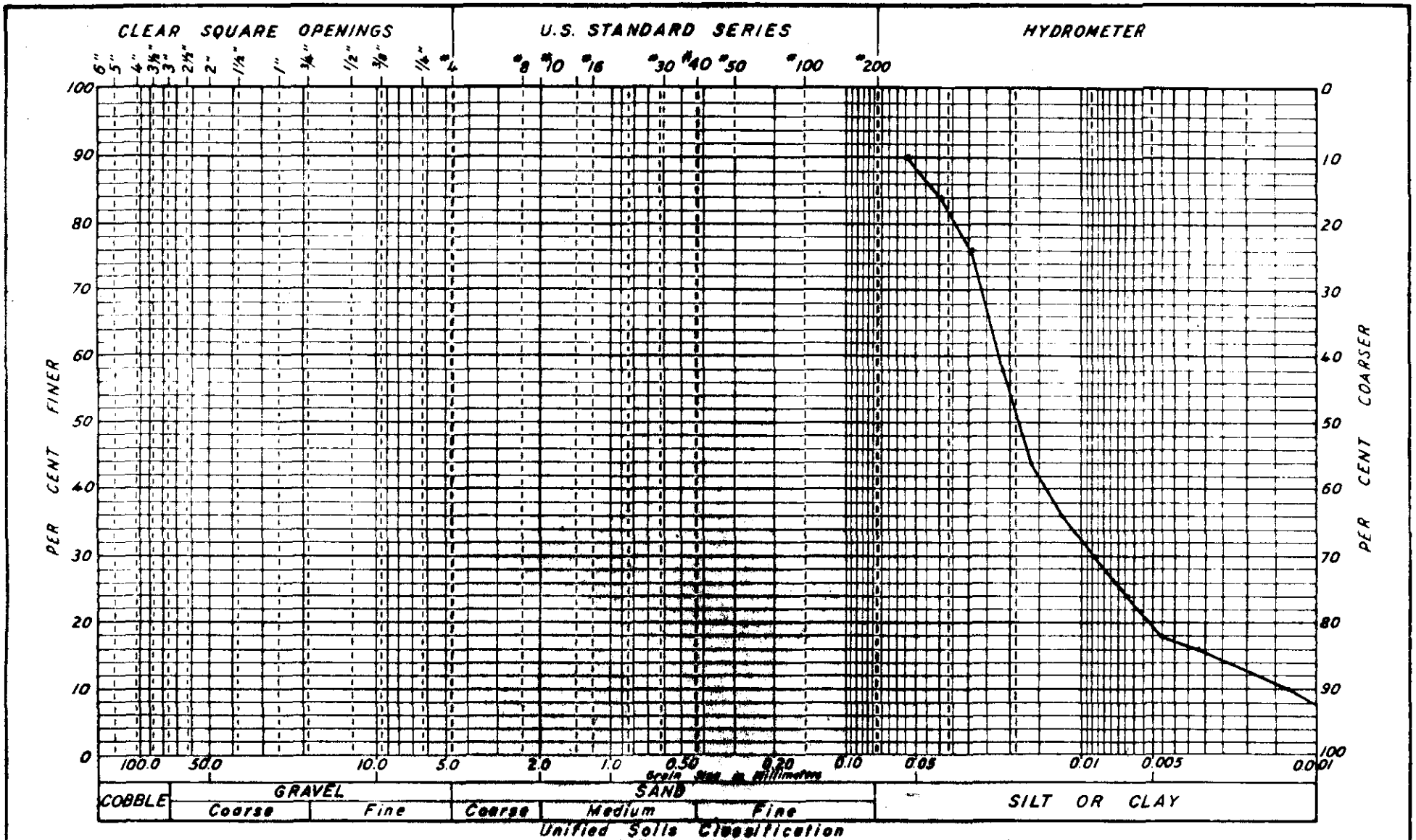


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-17-RD		1.2 m		25.6				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-30

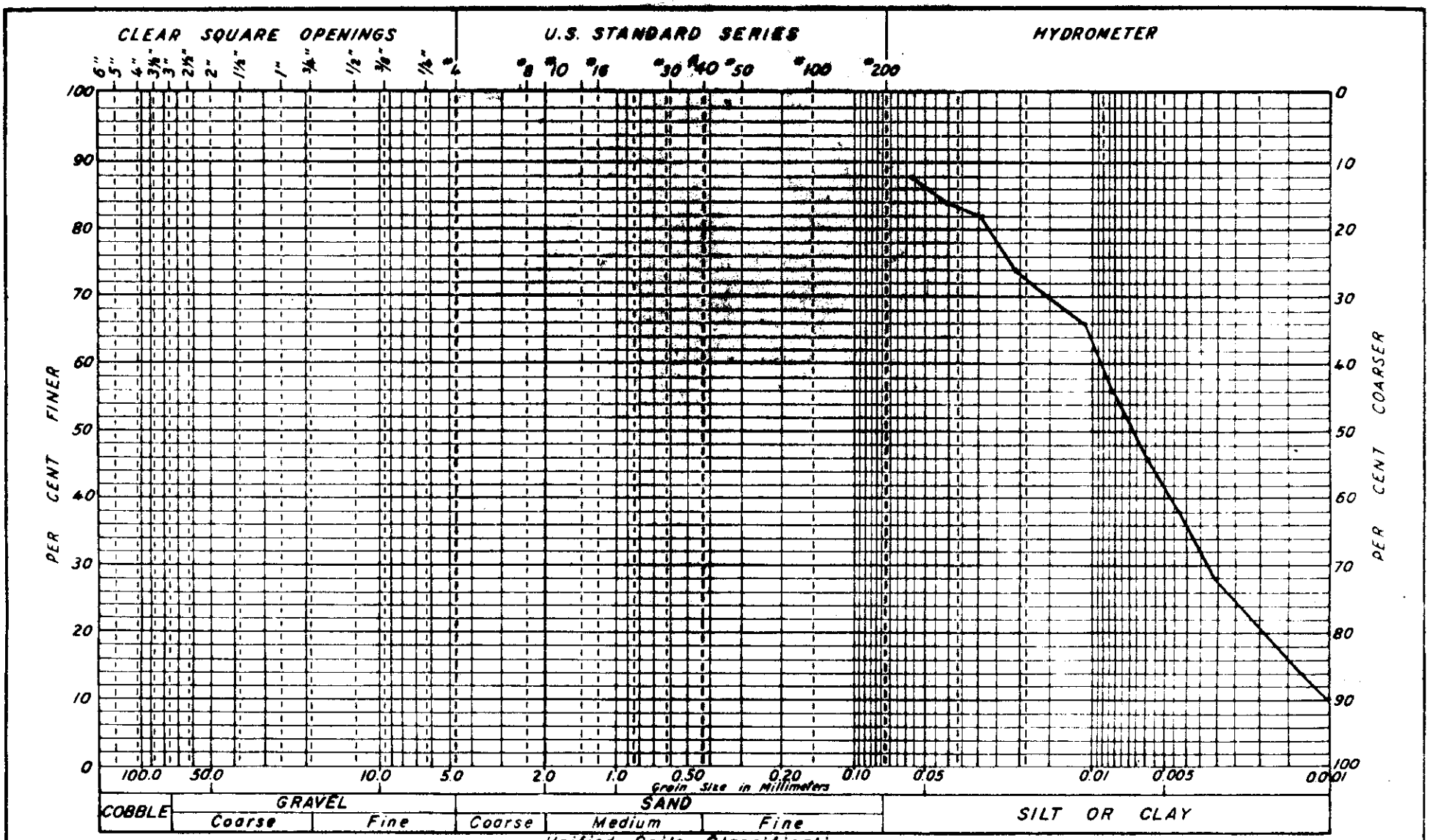


Boring No.	Sample No.	El. or depth	Classification	Nat. W%	G	LL	PL	PI
DH-18-RD		4.3 m		15.8				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

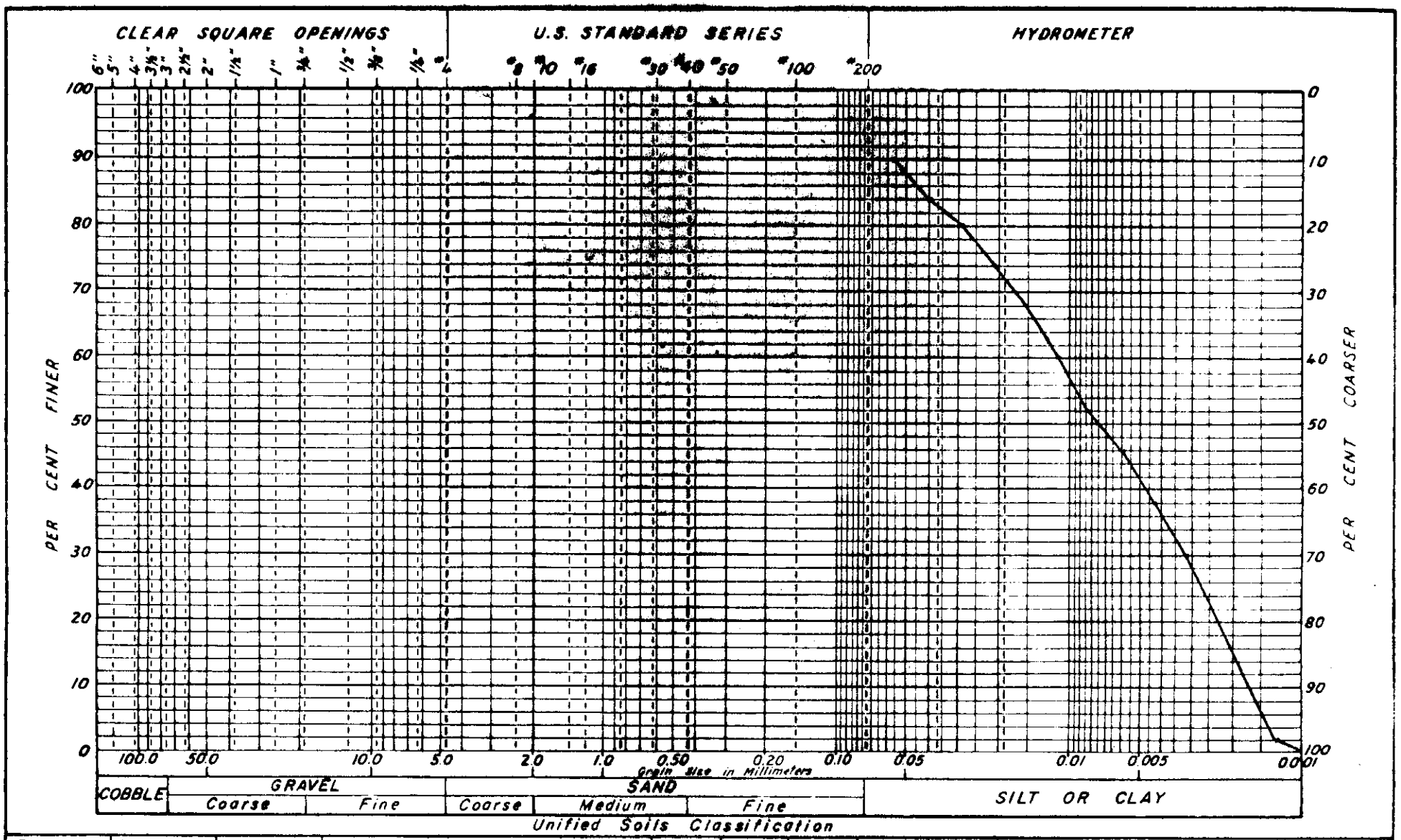


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-19-RD		7.3 m		20.1				

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 19-15-80

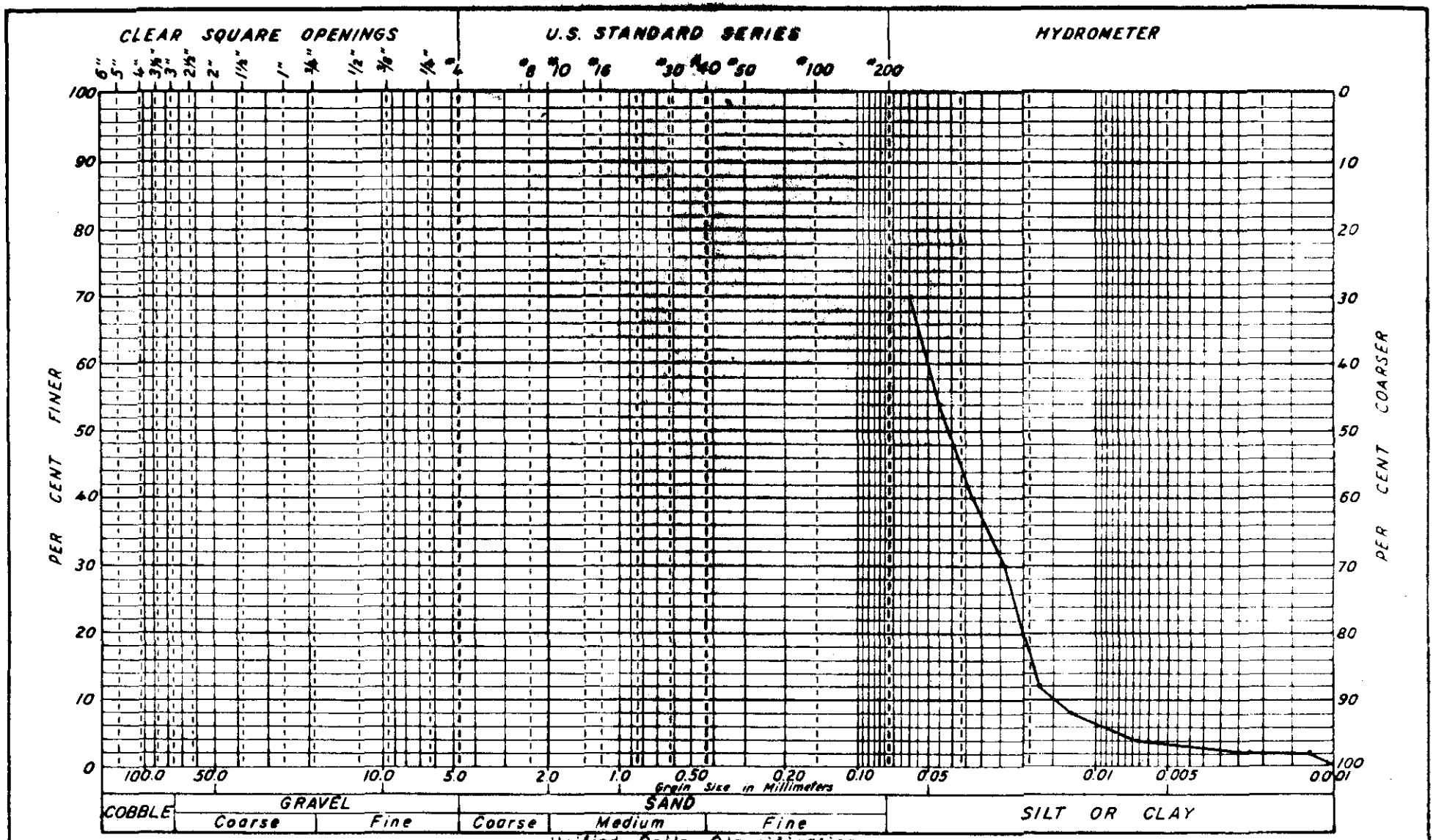


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-19-RD		8.8 m	CL	22.6		31.3	16.4	14.9

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

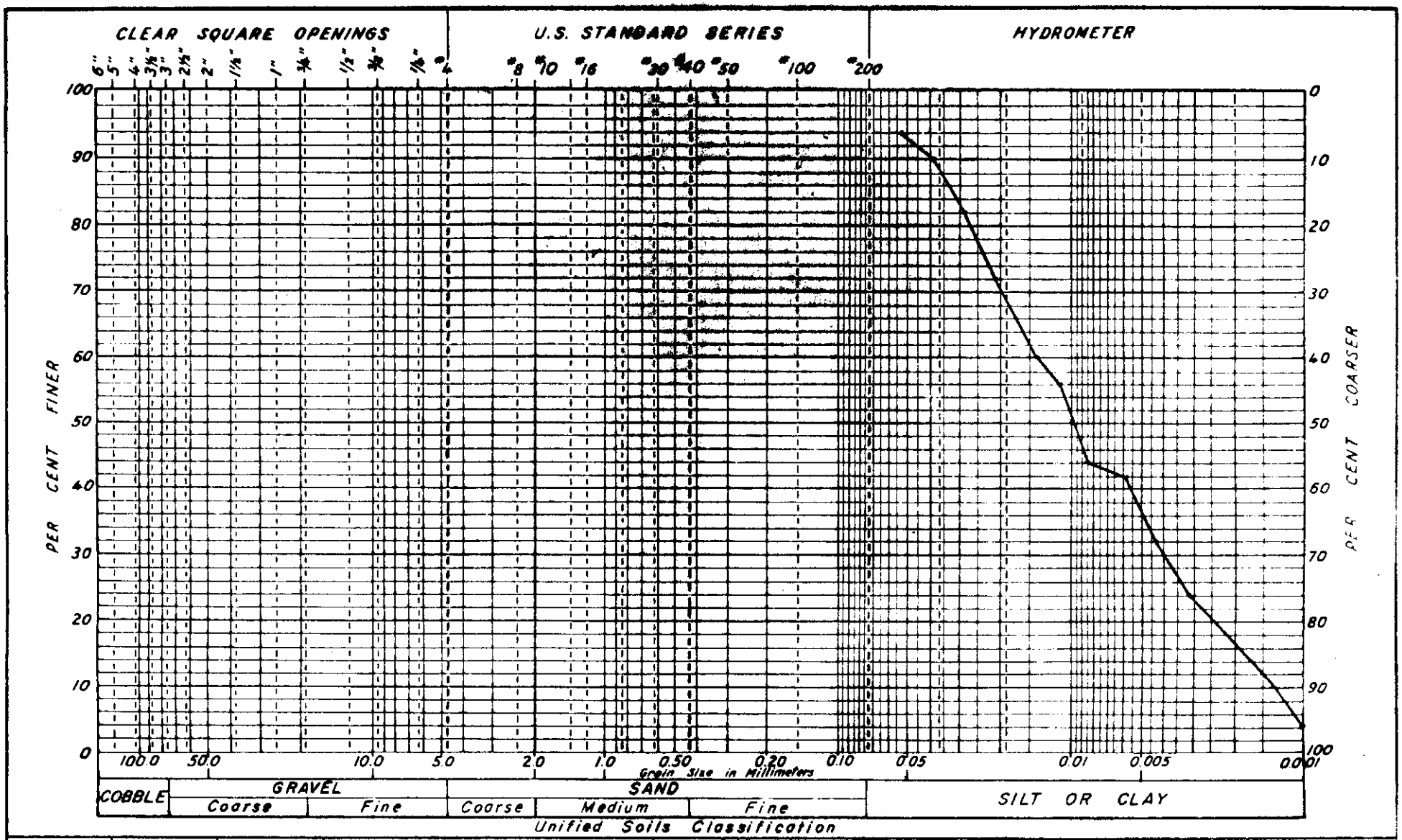


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-20-RD		5.8 m		17.3				

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

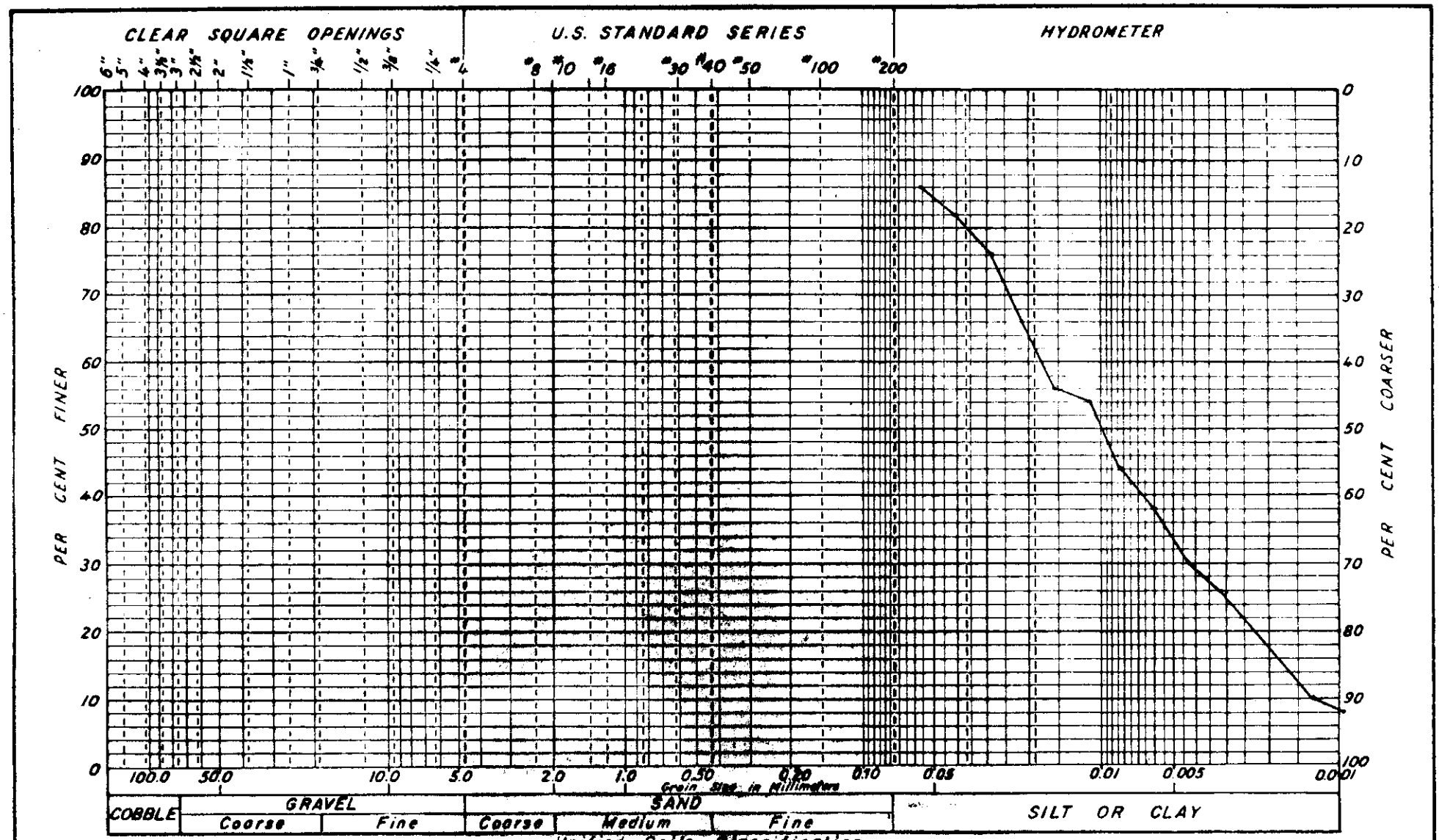


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-20-RD		7.3-8.8 m	CL	19.8		24.6	12.5	12.1

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

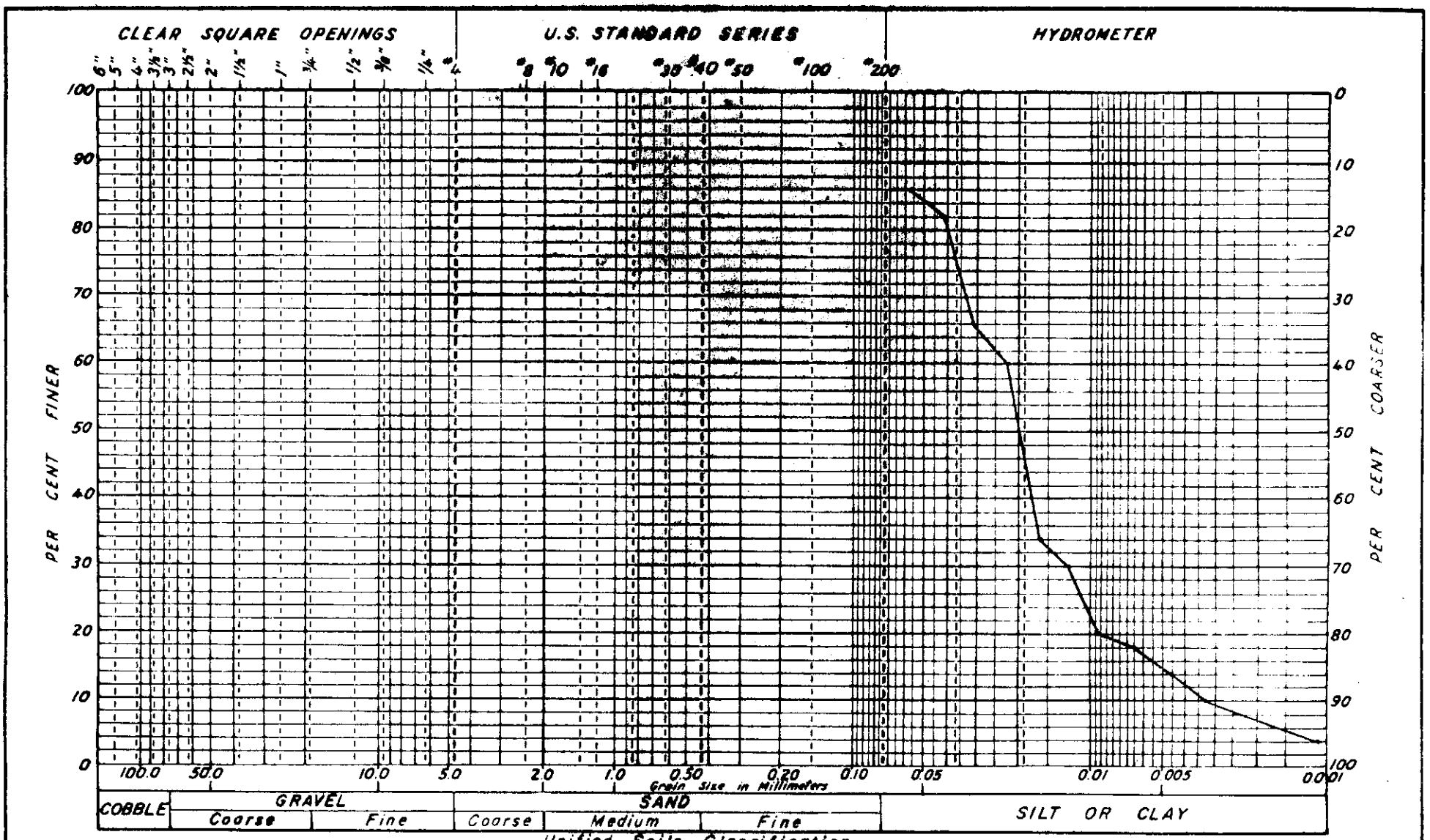


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-20-RD		10.4 m	CL	22.3	2.68	24.9	14.3	10.6

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

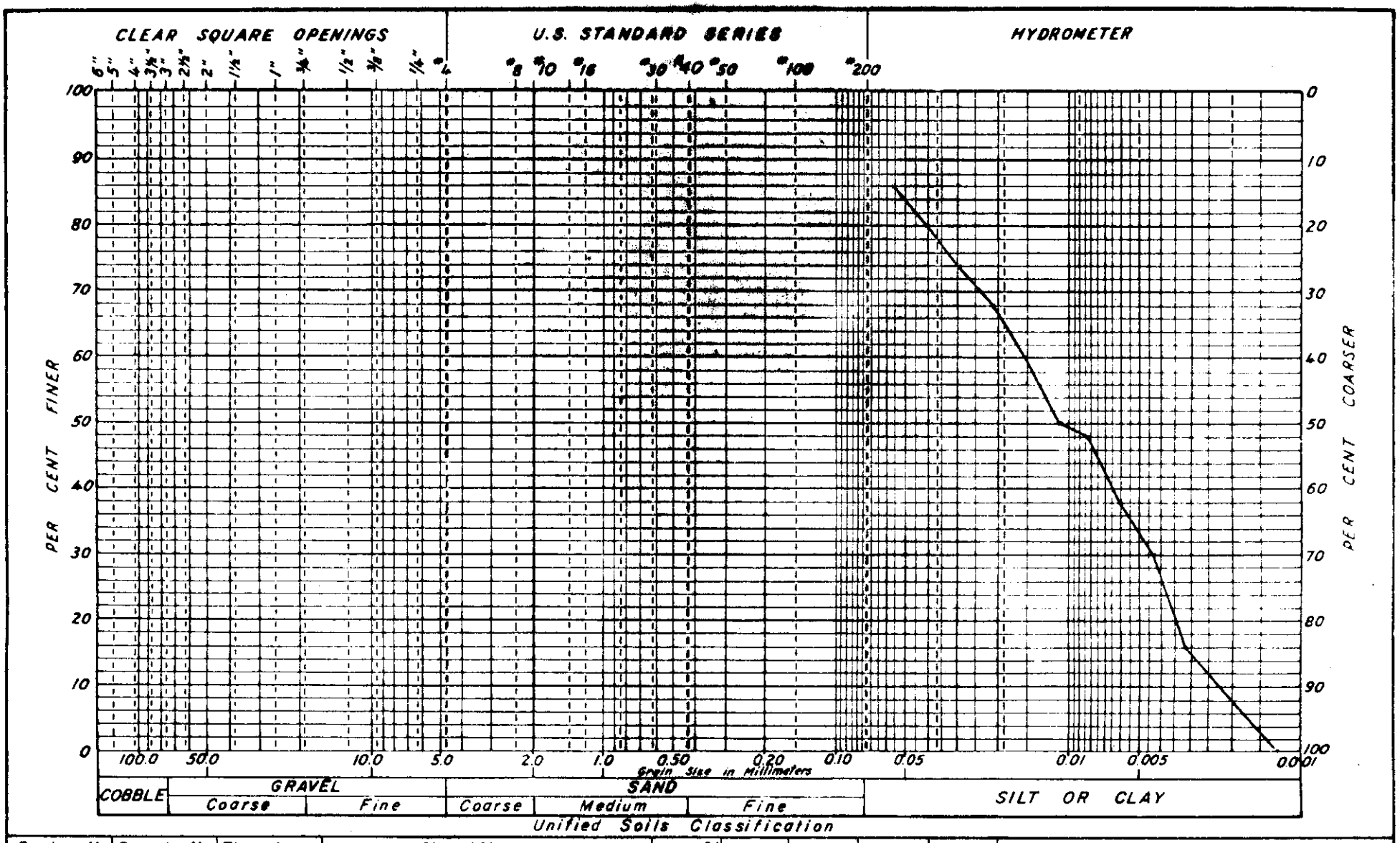


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-21-RD		7.3 m	CL-ML	19.7	2.60	22.4	15.2	7.2

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

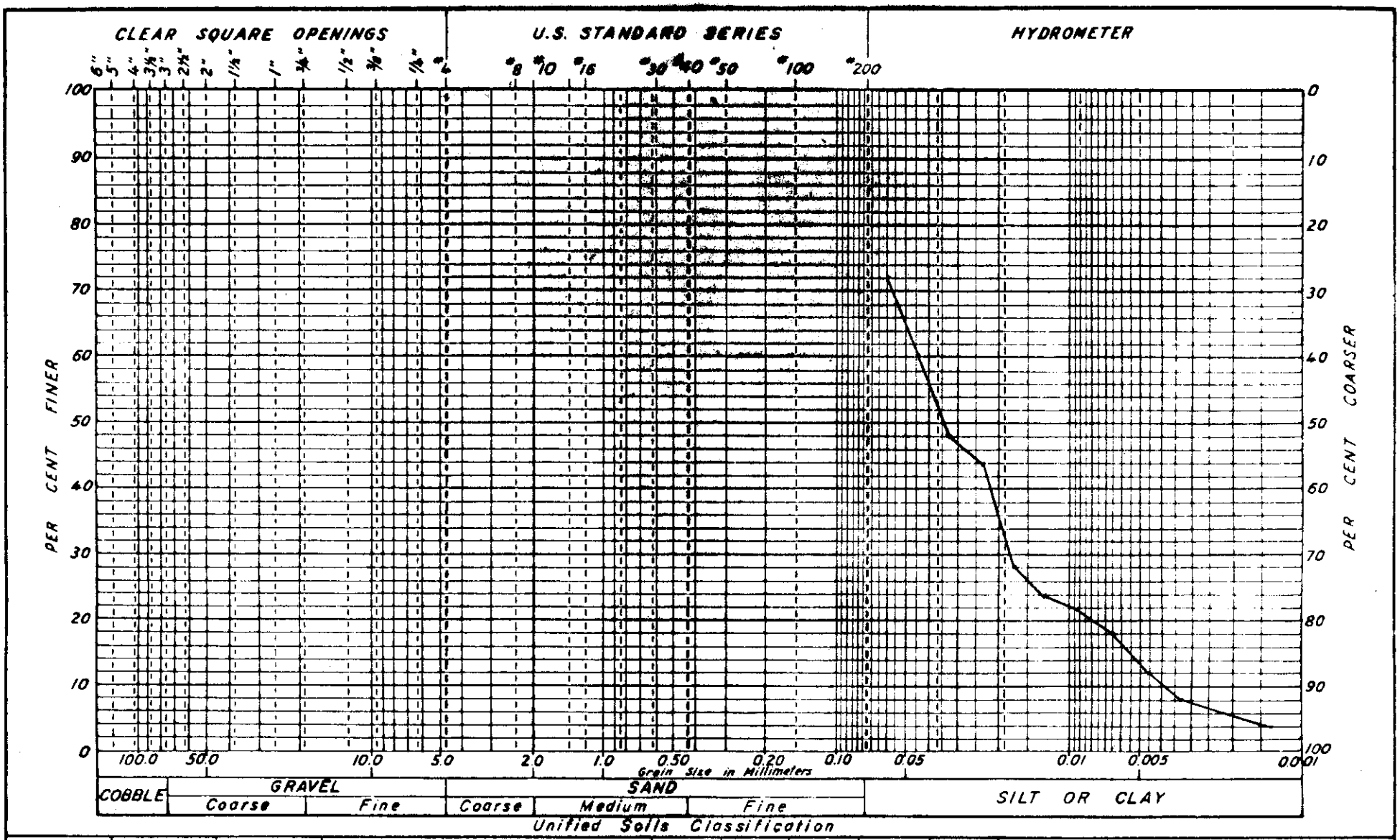


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-21-RD		88-104 m	CL	18.5	2.63	23.3	13.1	10.2

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

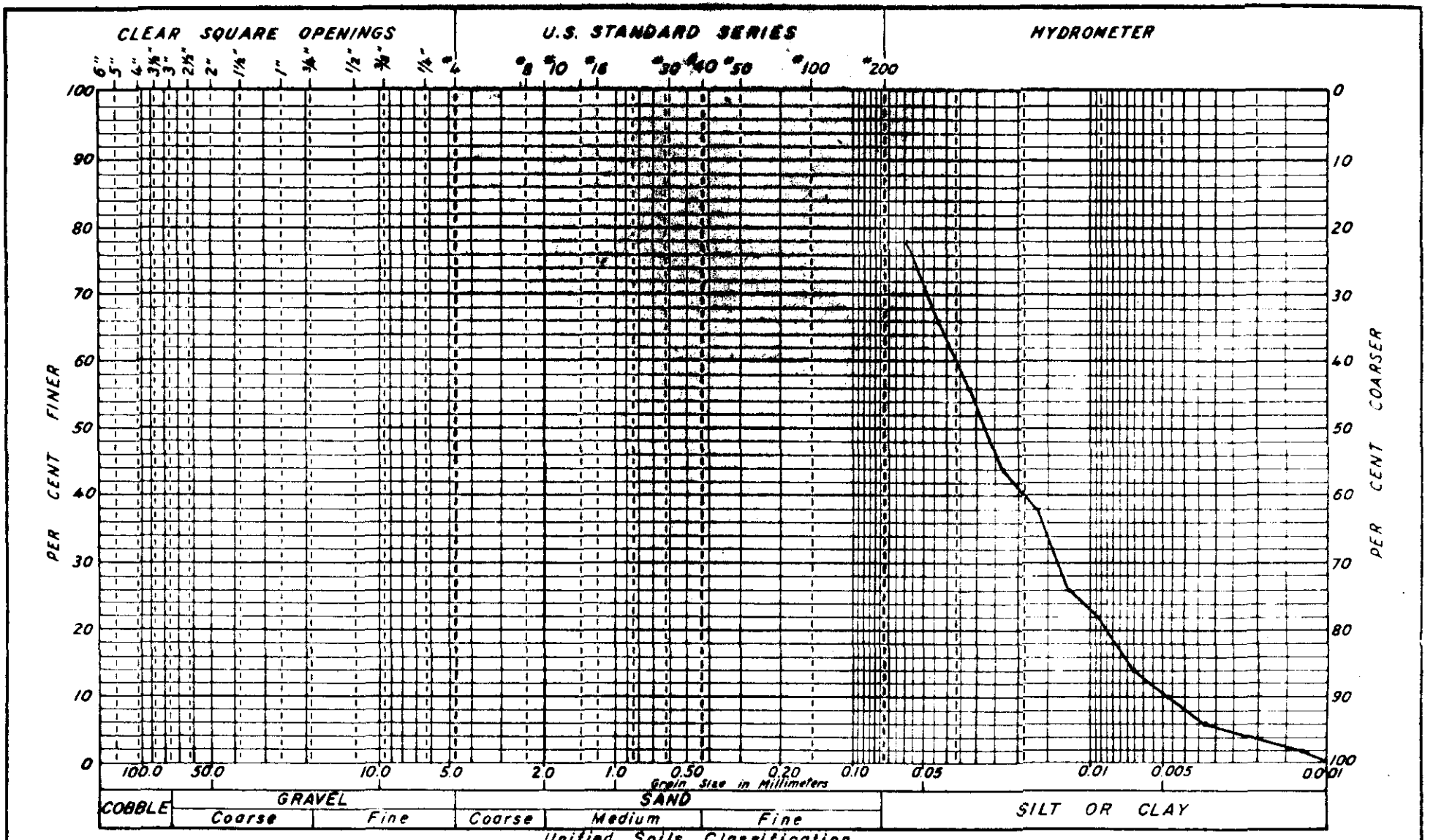


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-21-RD		11.9 m		17.3				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

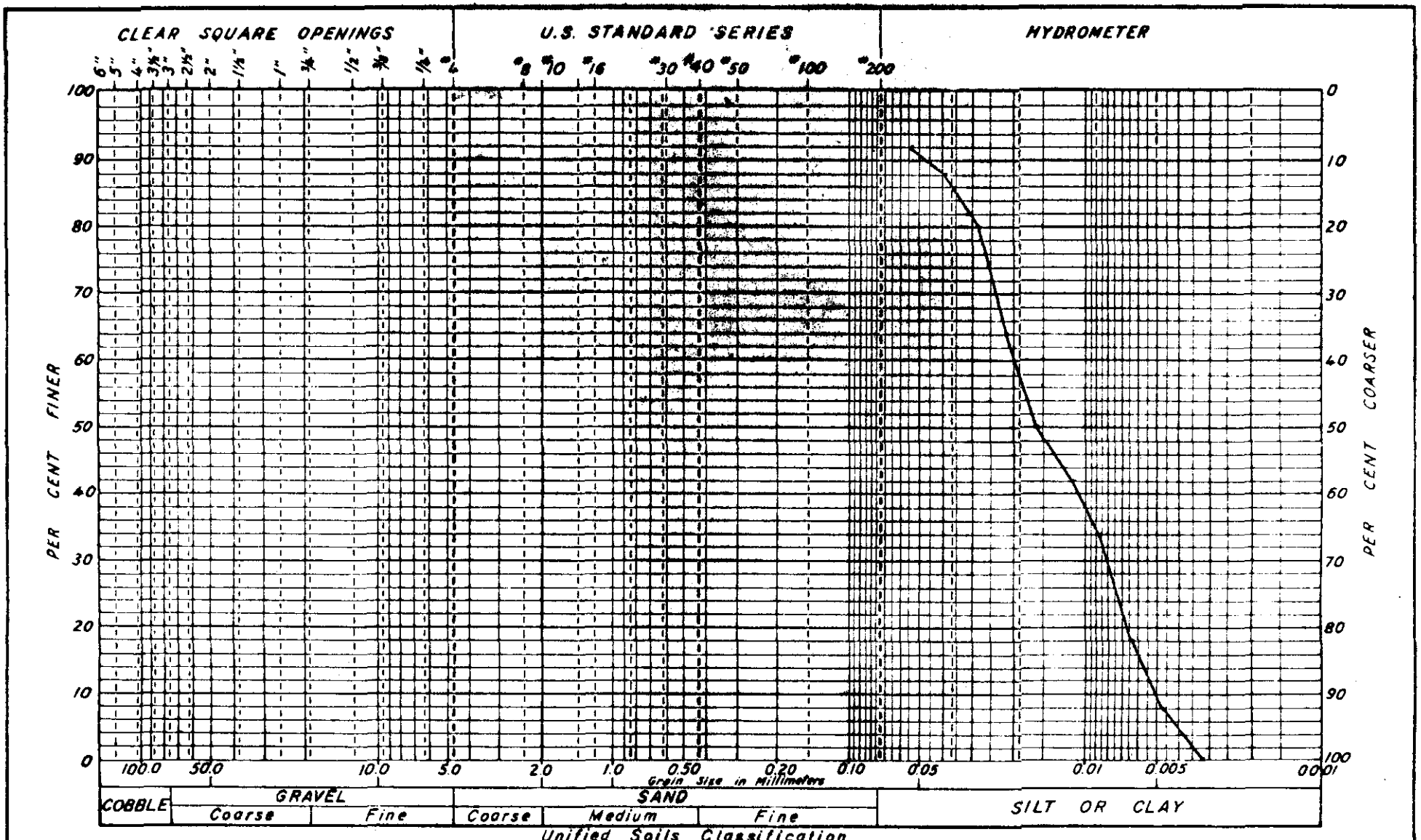


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-22-RD		1.2 m		31.7				

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

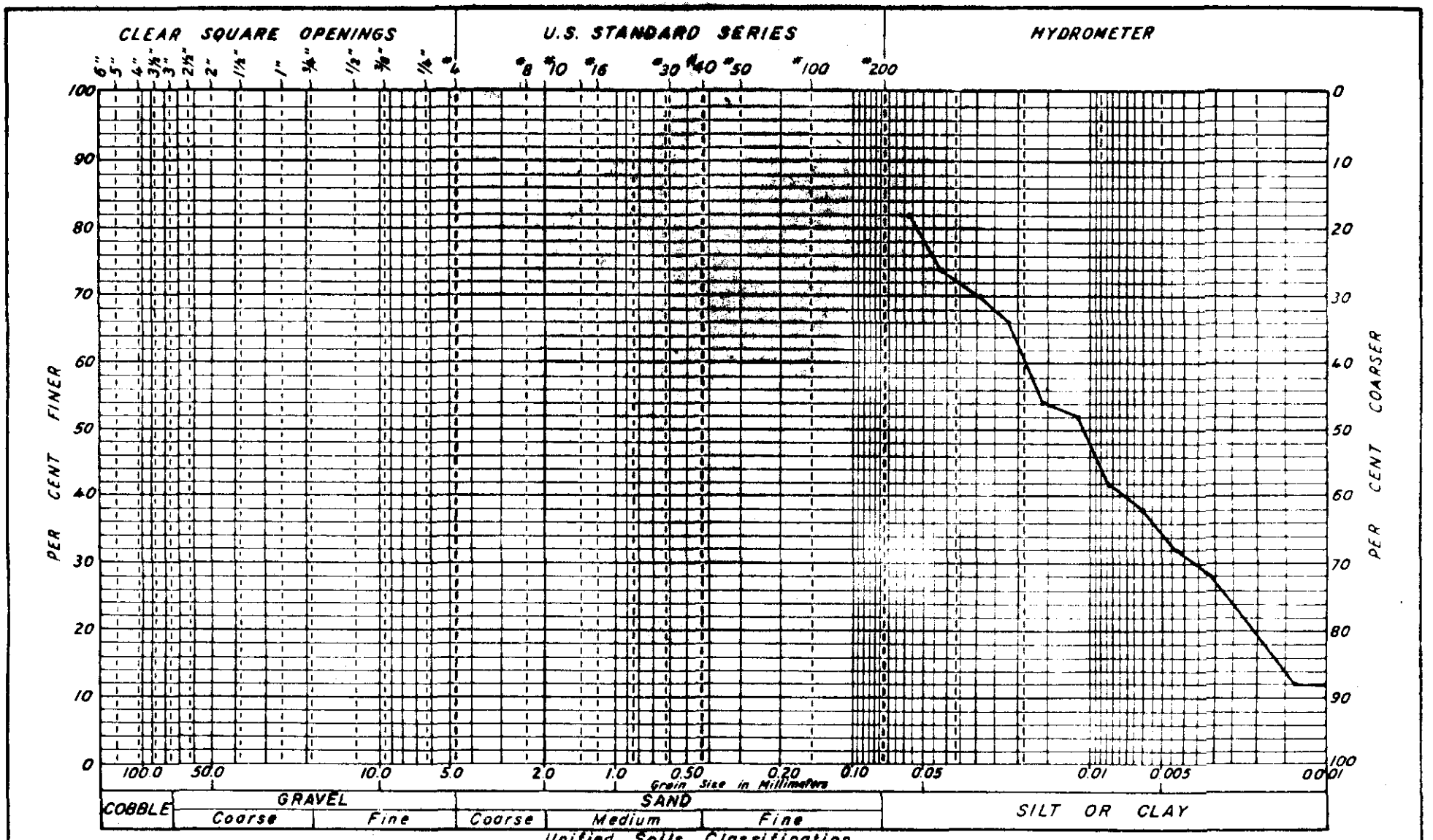


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-22-RD		4.3-5.8 m		20.4				

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

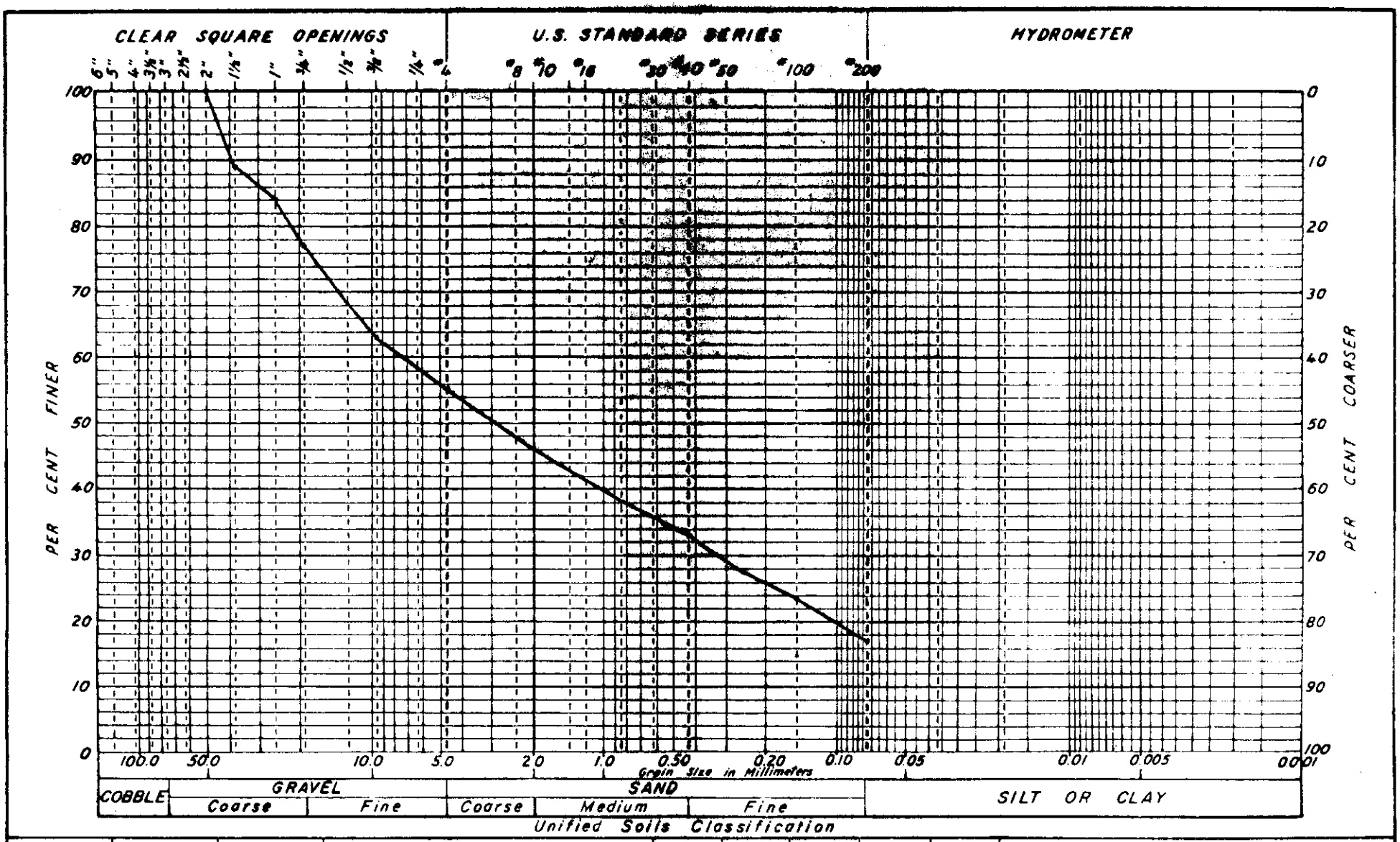


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-22-RD		7.3-10.4 m	CL	11.6	2.67	18.9	9.5	9.4

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

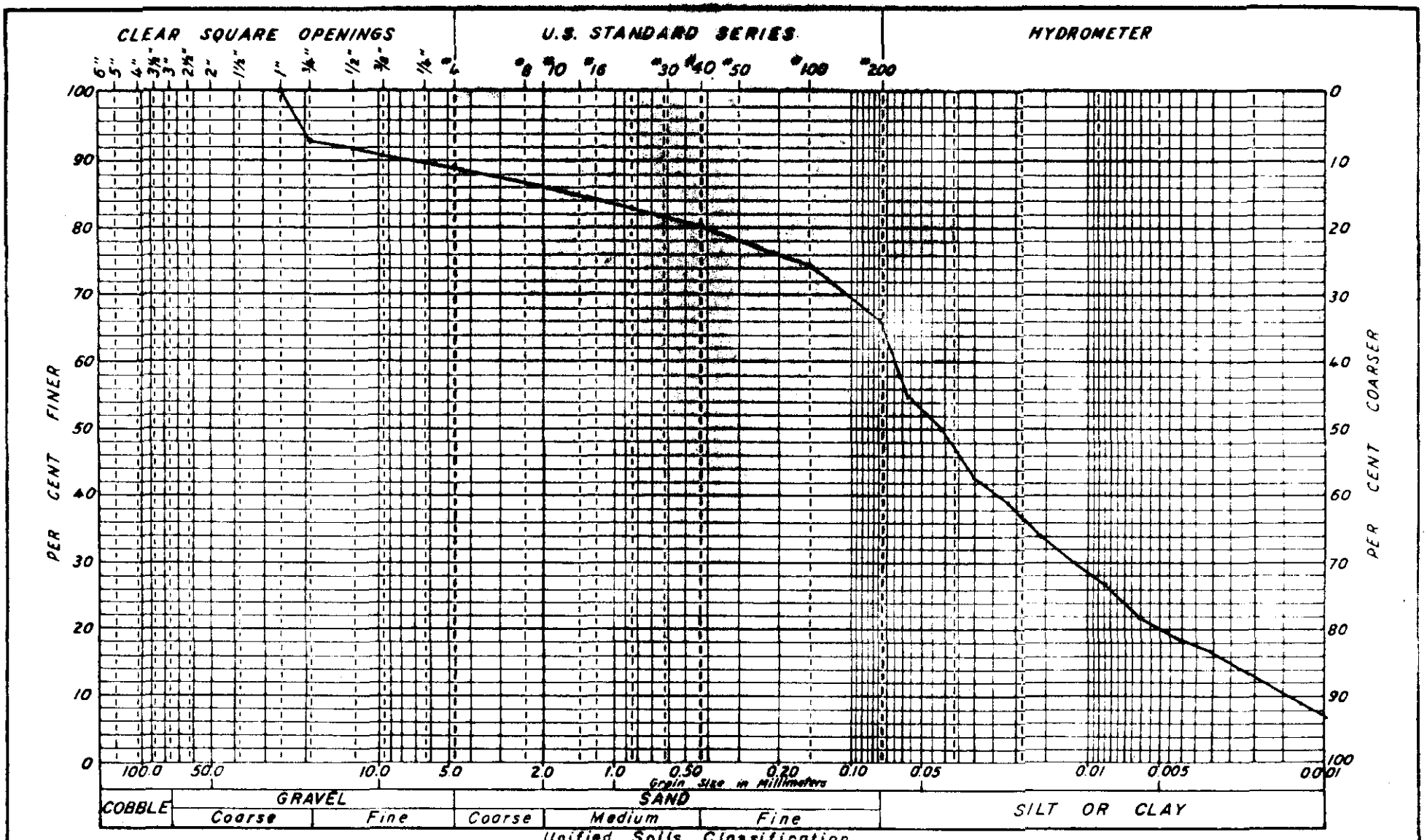


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-1-RD		0.6 - 2.6m	GM	9.2	2.56			

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

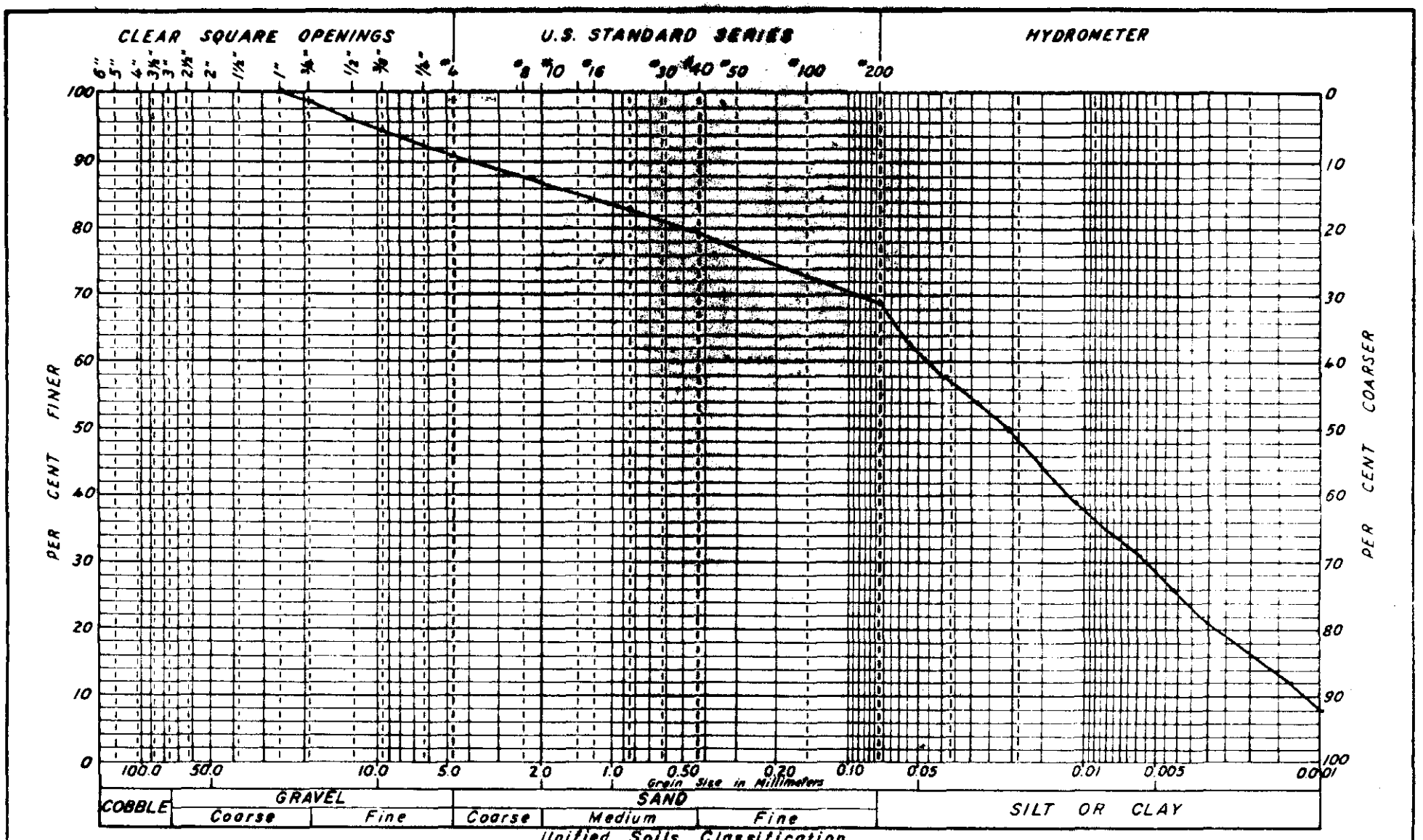


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-2-RD		0.3-1.2m	CL-ML	20.1		20.5	15.5	5.0

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

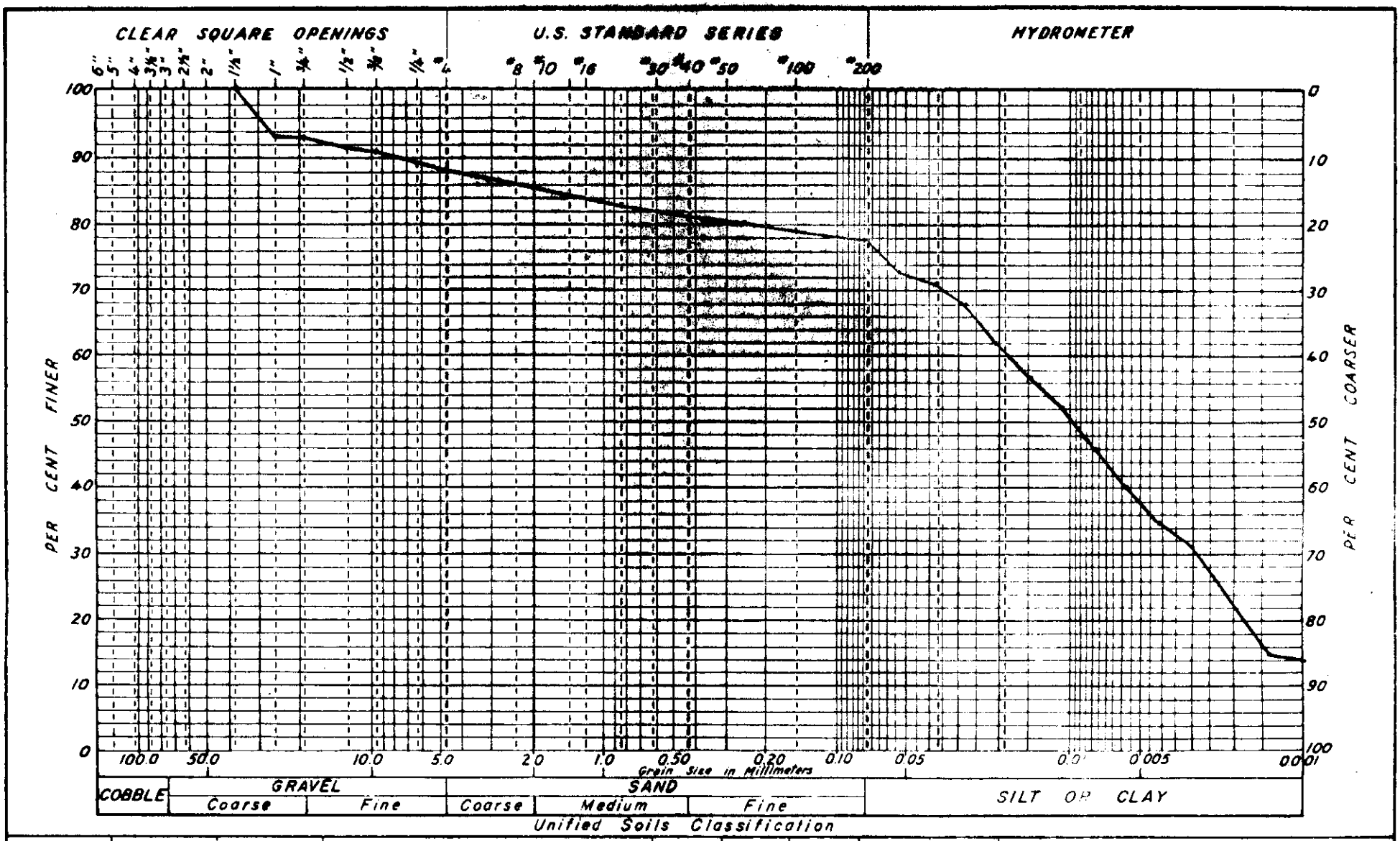


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-4-RD		0.6 - 5.9m	CL	13.1	2.62	21.5	14.0	7.5

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

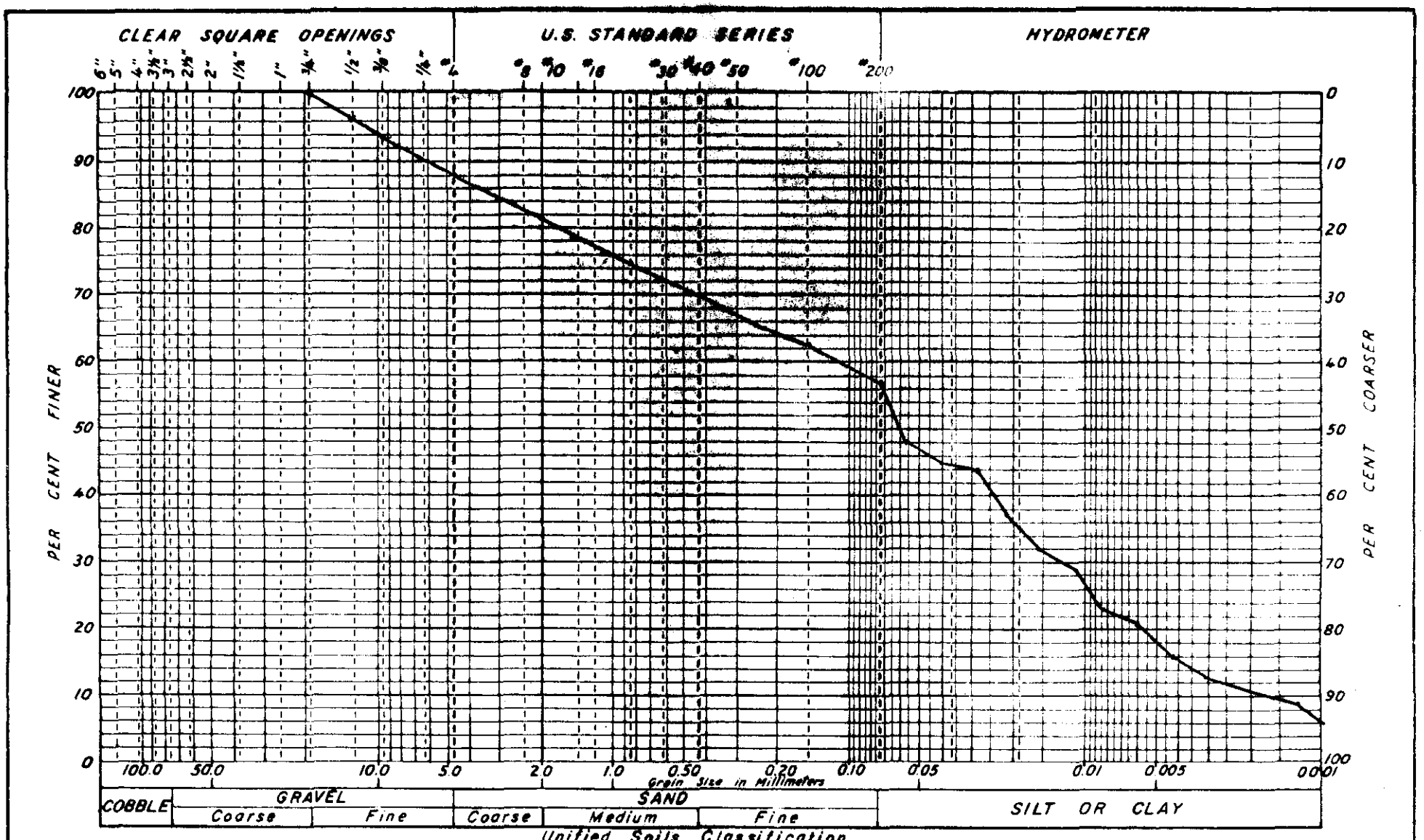


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-5-RD		2.1 - 4.9m	CL	17.5		23.6	13.5	10.1

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

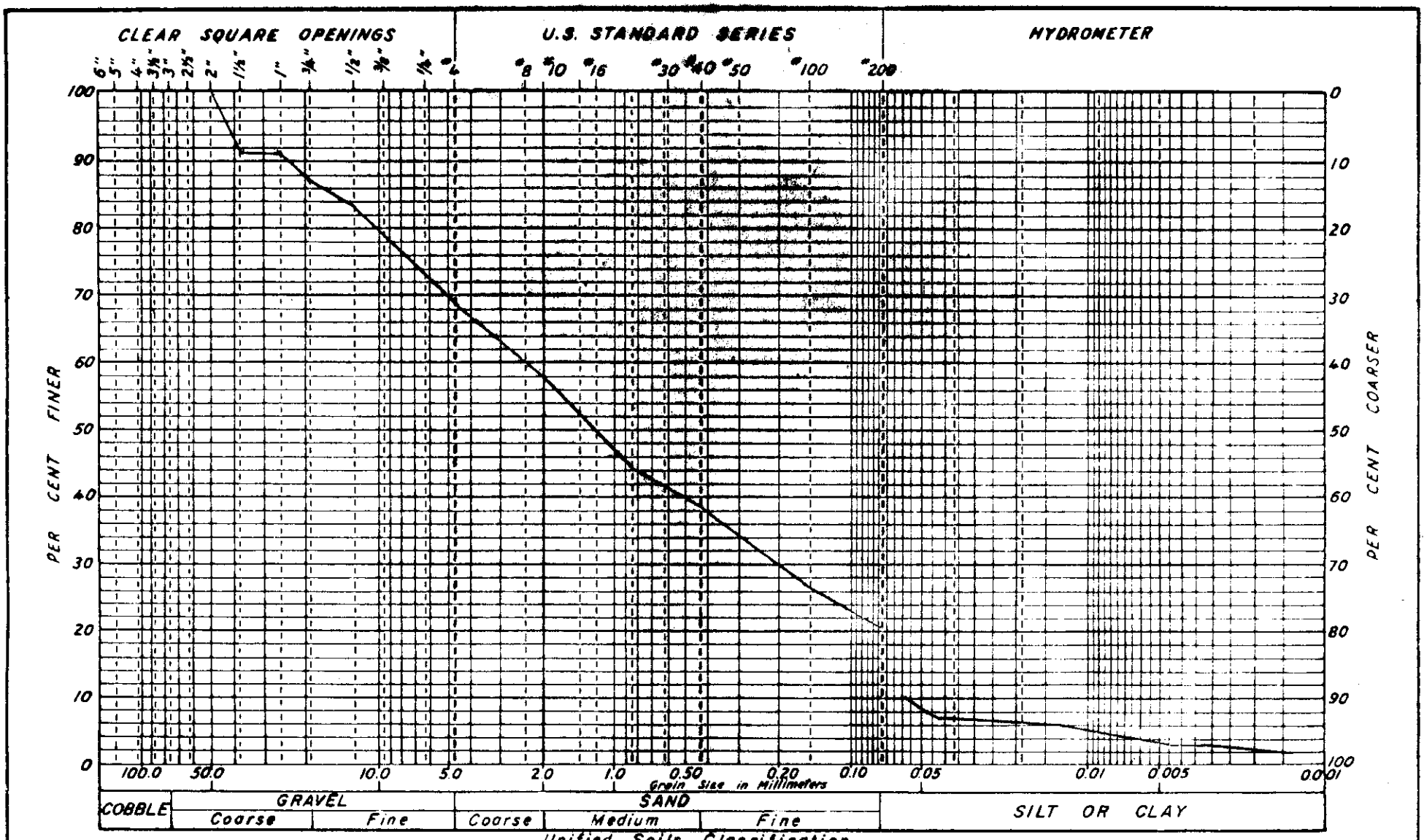


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP-11-RD		0.6-4.3m	ML-CL	15.4		19.2	13.0	6.2

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: FG Date: 10-15-80

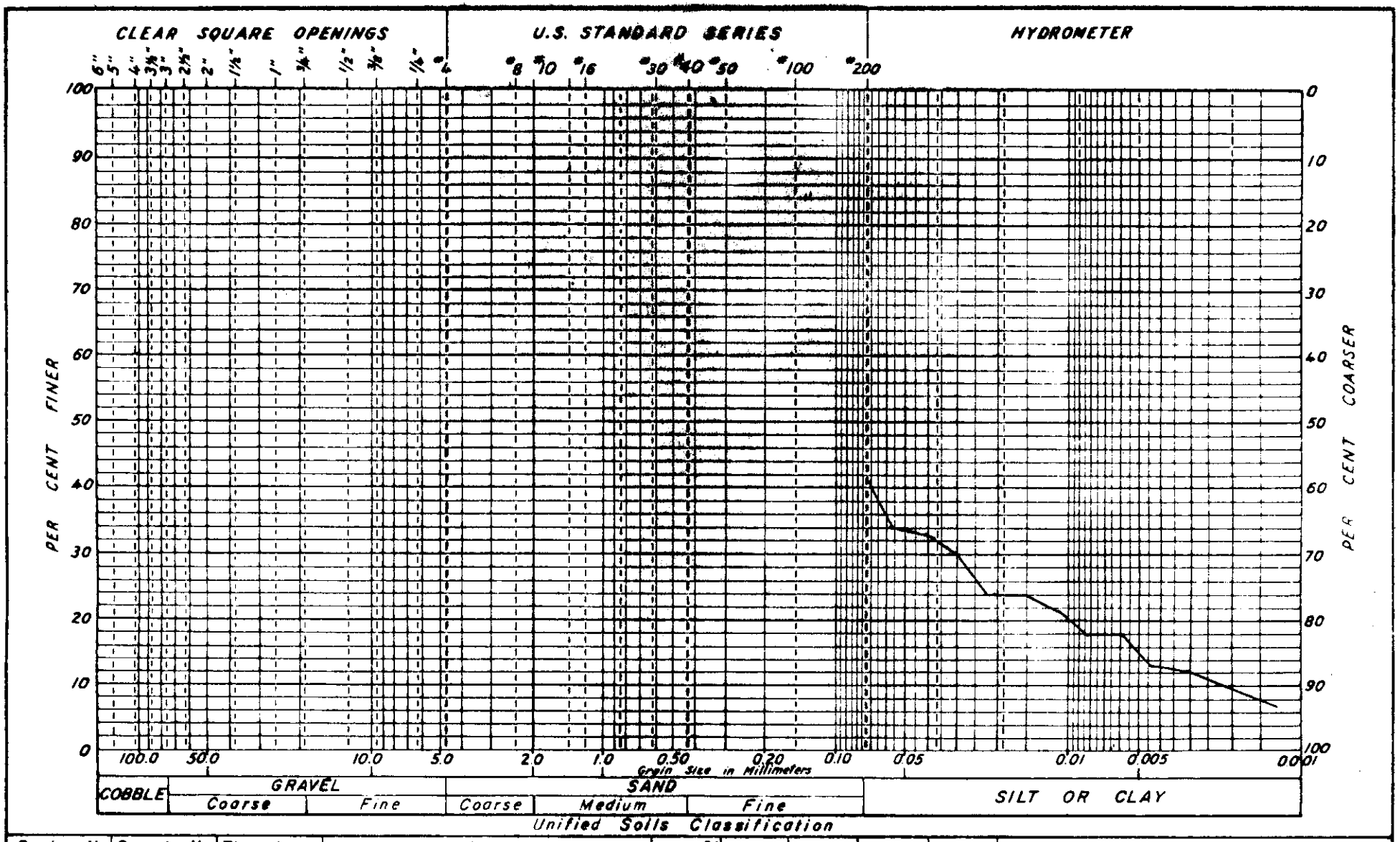


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 7 WW		2.5-3.0m	SM	9.4				

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date 18-9-80

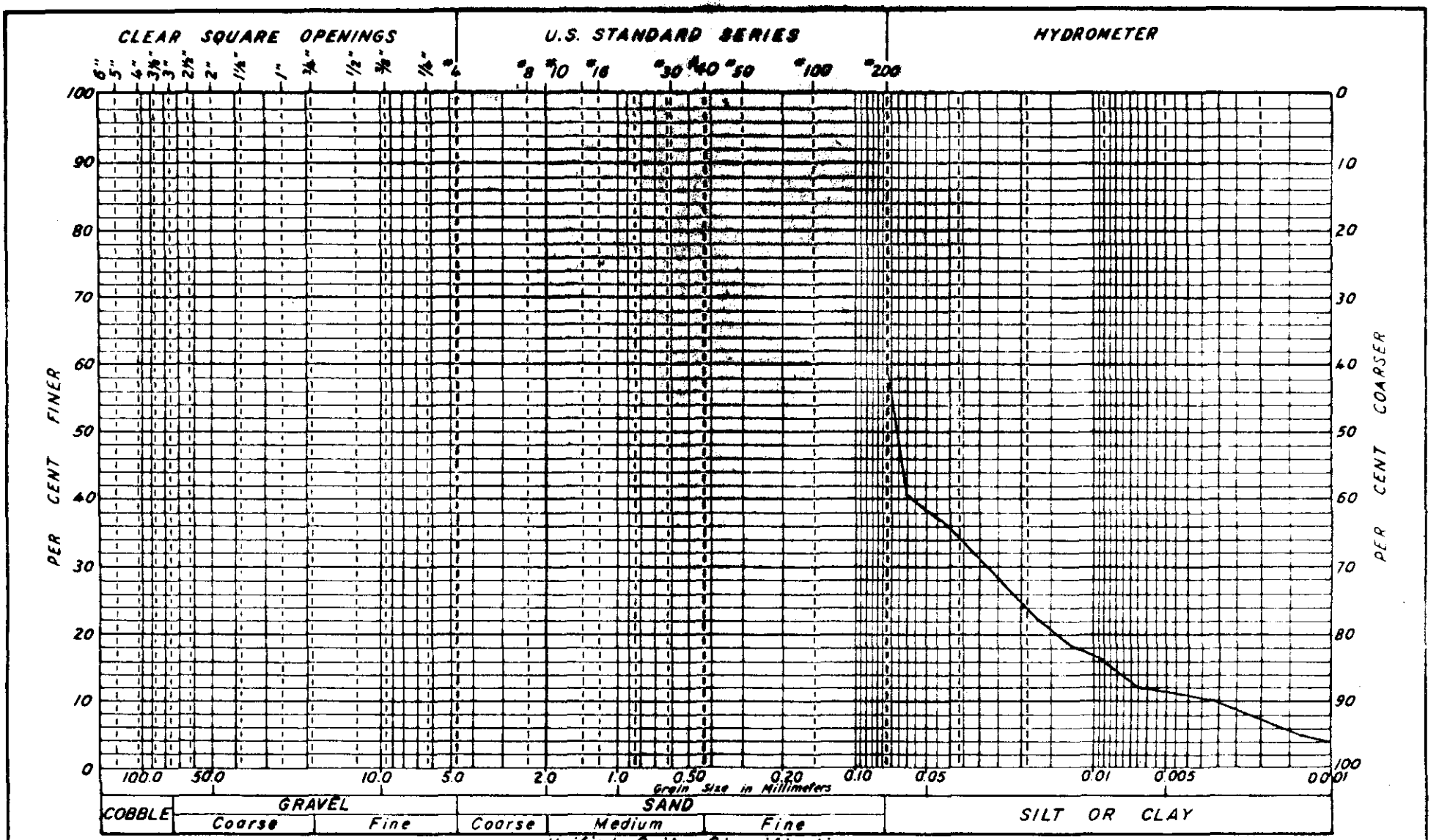


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 8 NW		1.0-2.0 m	SM-SC	13.1		17.8	11.1	6.7

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

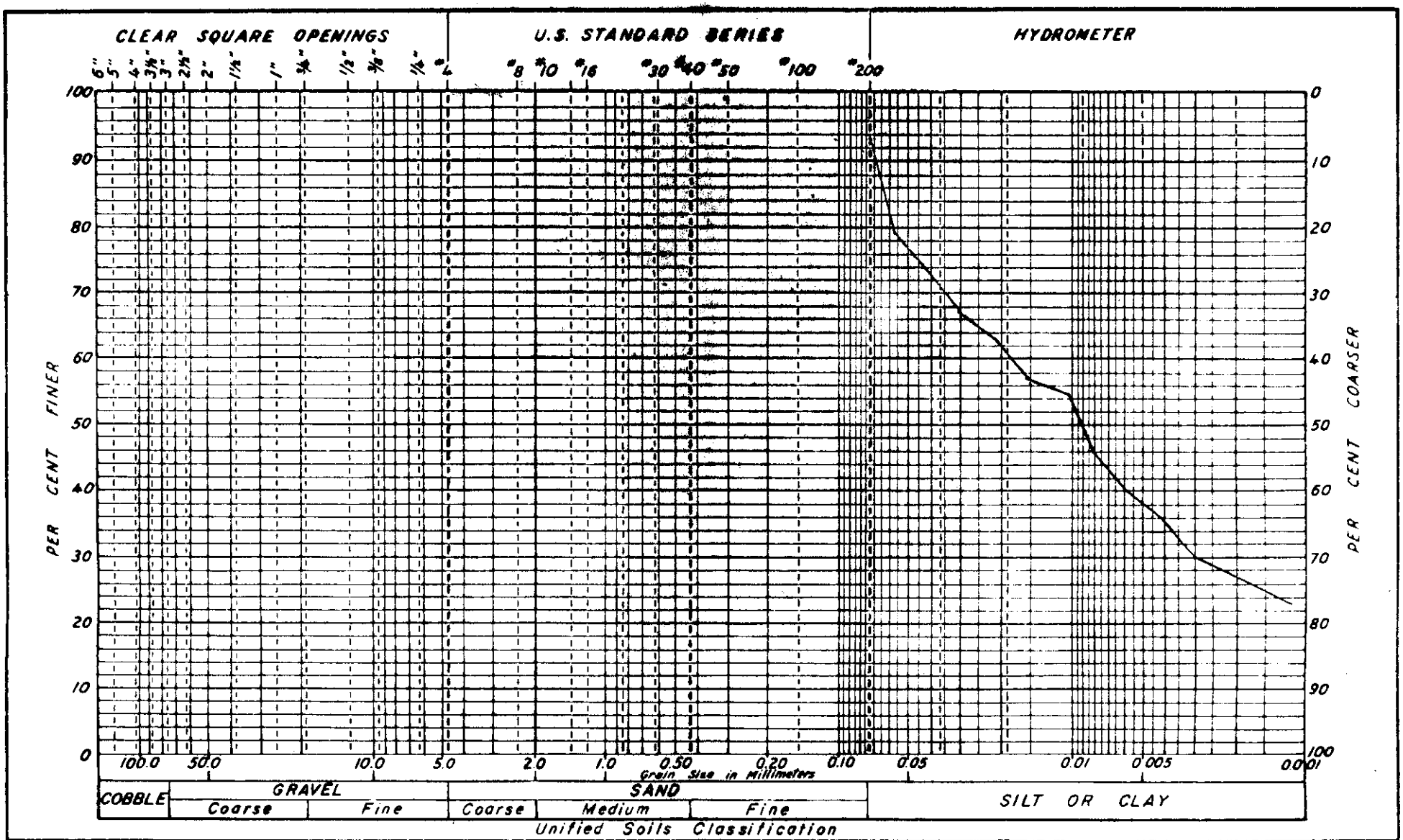


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 12 WW		1.3-1.5m	CL-ML	28.4		17.4	12.8	4.6

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 10-9-80

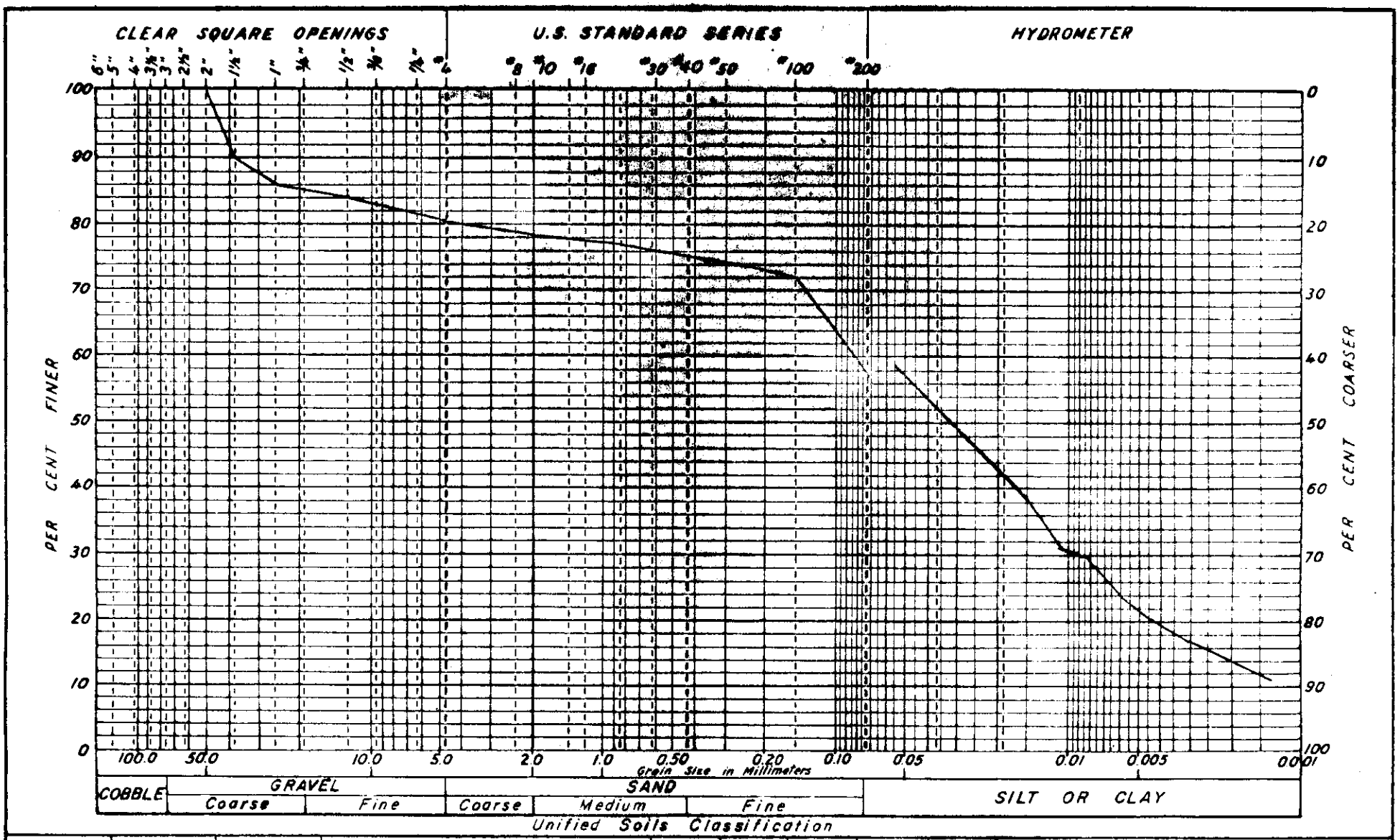


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 15 WW		2.0-2.5 m	CL	23.6		34.6	20.6	14.0

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

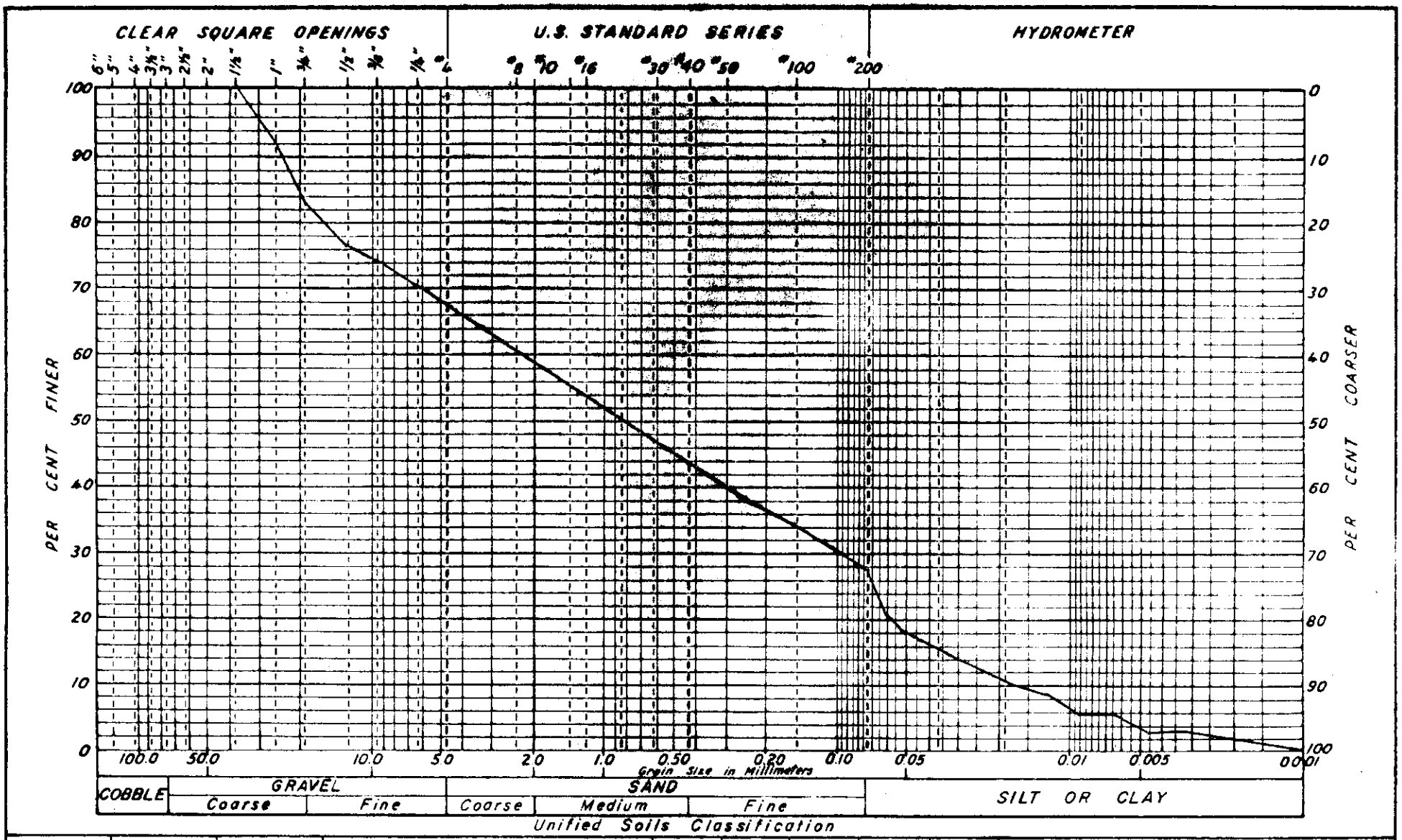


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 1 H		1.5-2.6 m	CL	15.1	2.582	19.0	11.5	7.5

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

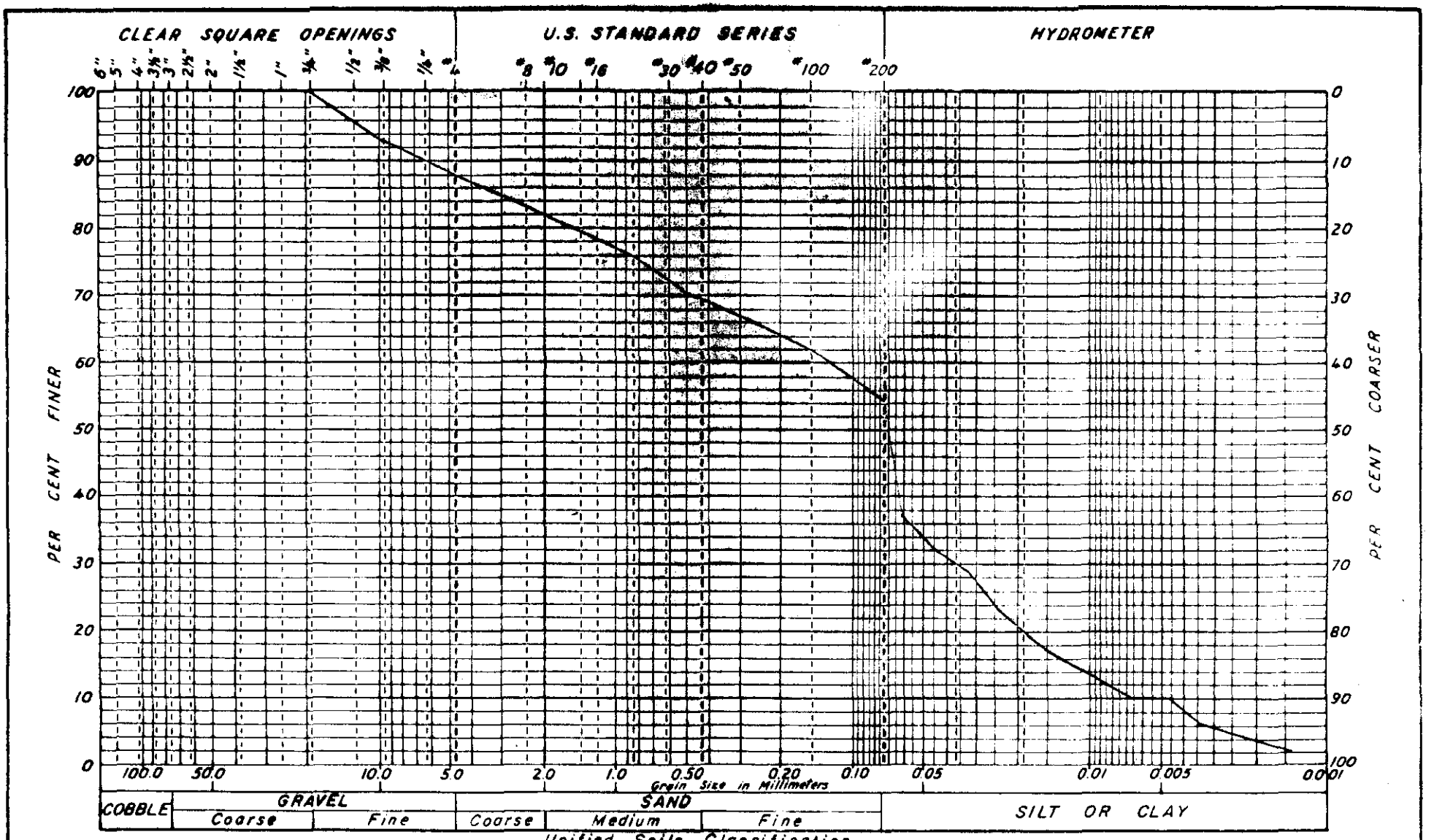


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 2 H		2.0-2.4m	SM	16.1		NP		

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

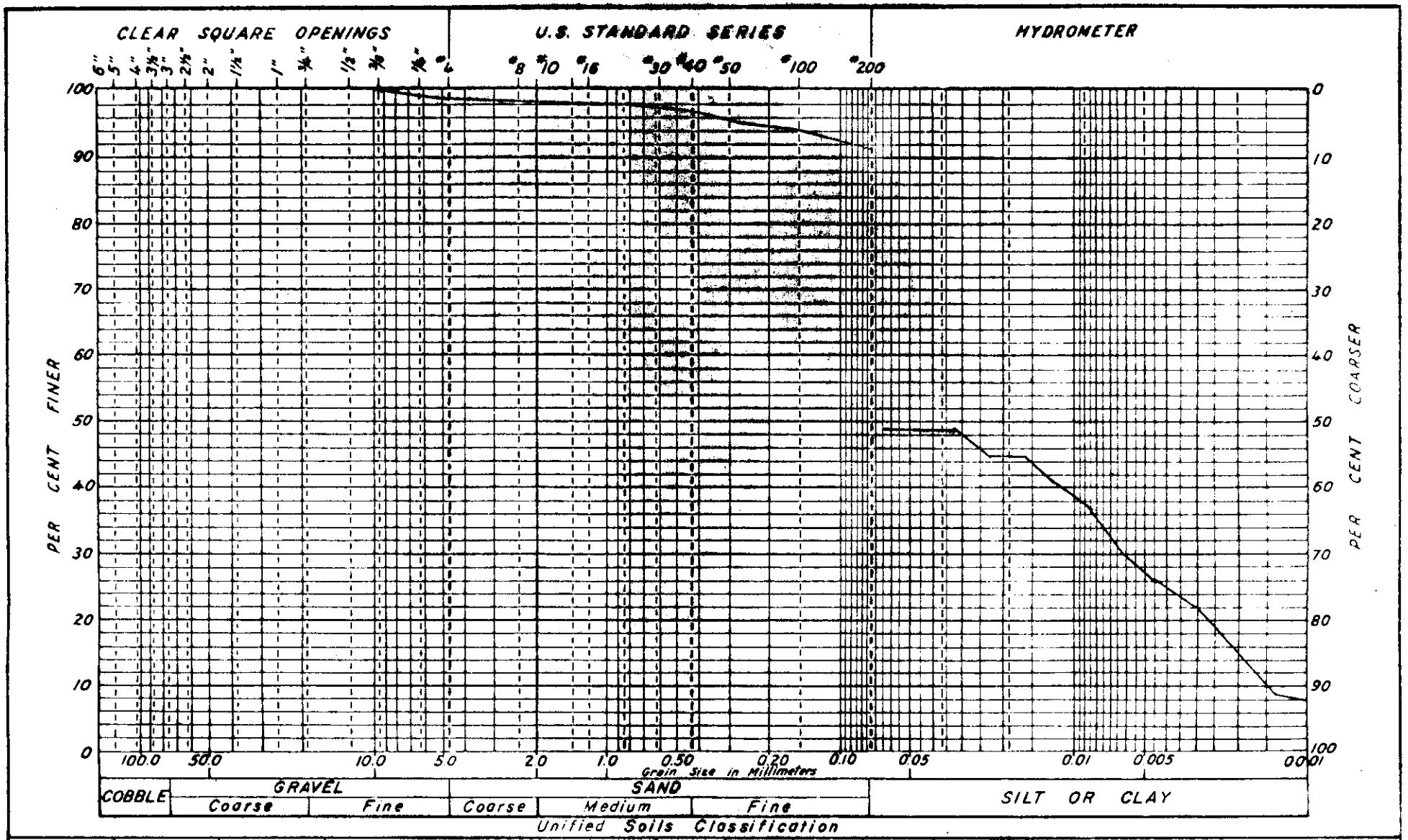


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 2 TD		0.5-1.5m	ML-SM	9.0		15.0	12.0	3.0

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

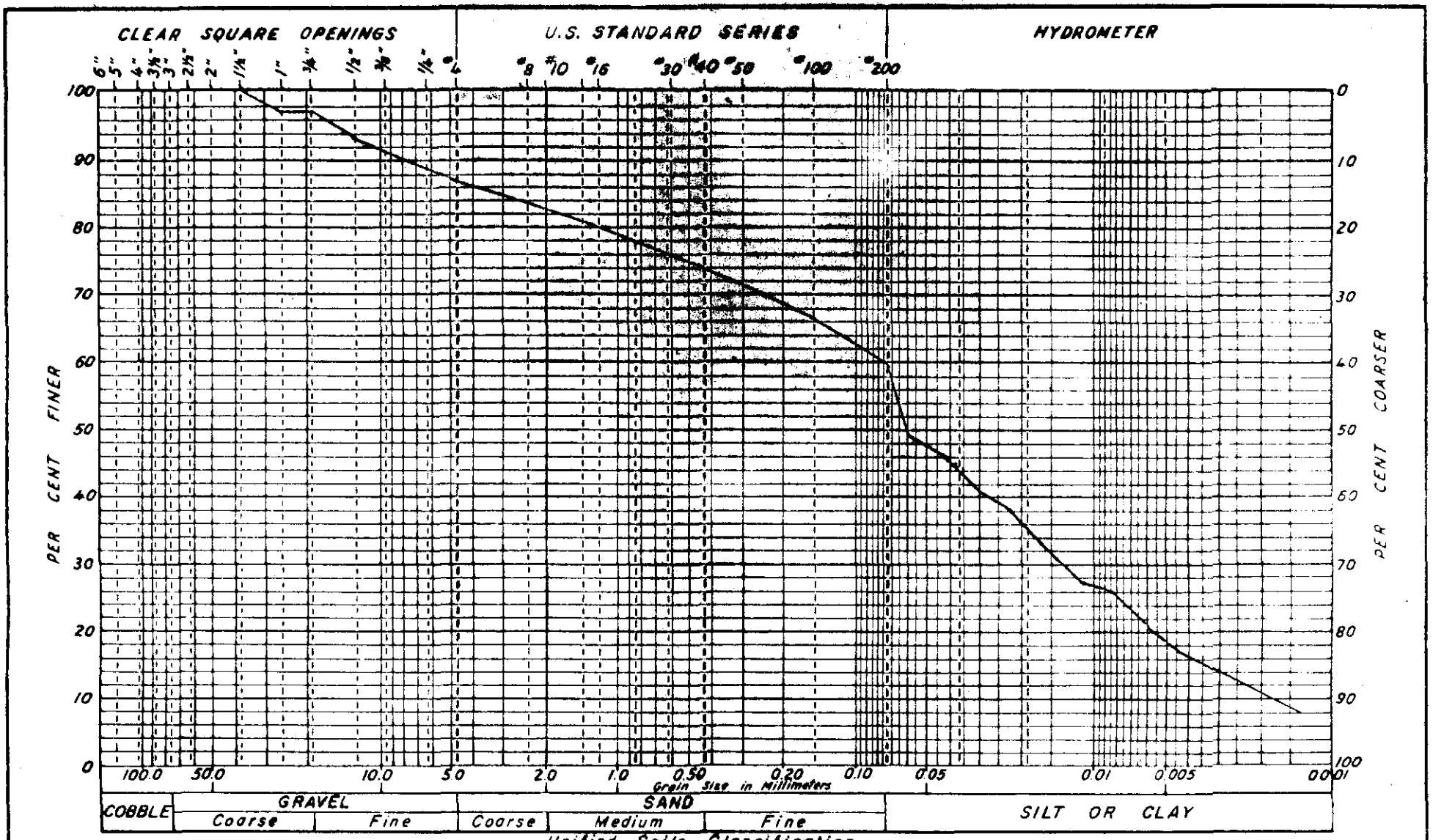


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 5 TD		0.5-1.0m	CL	19.5	2.591	25.0	15.2	9.8

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-2-80

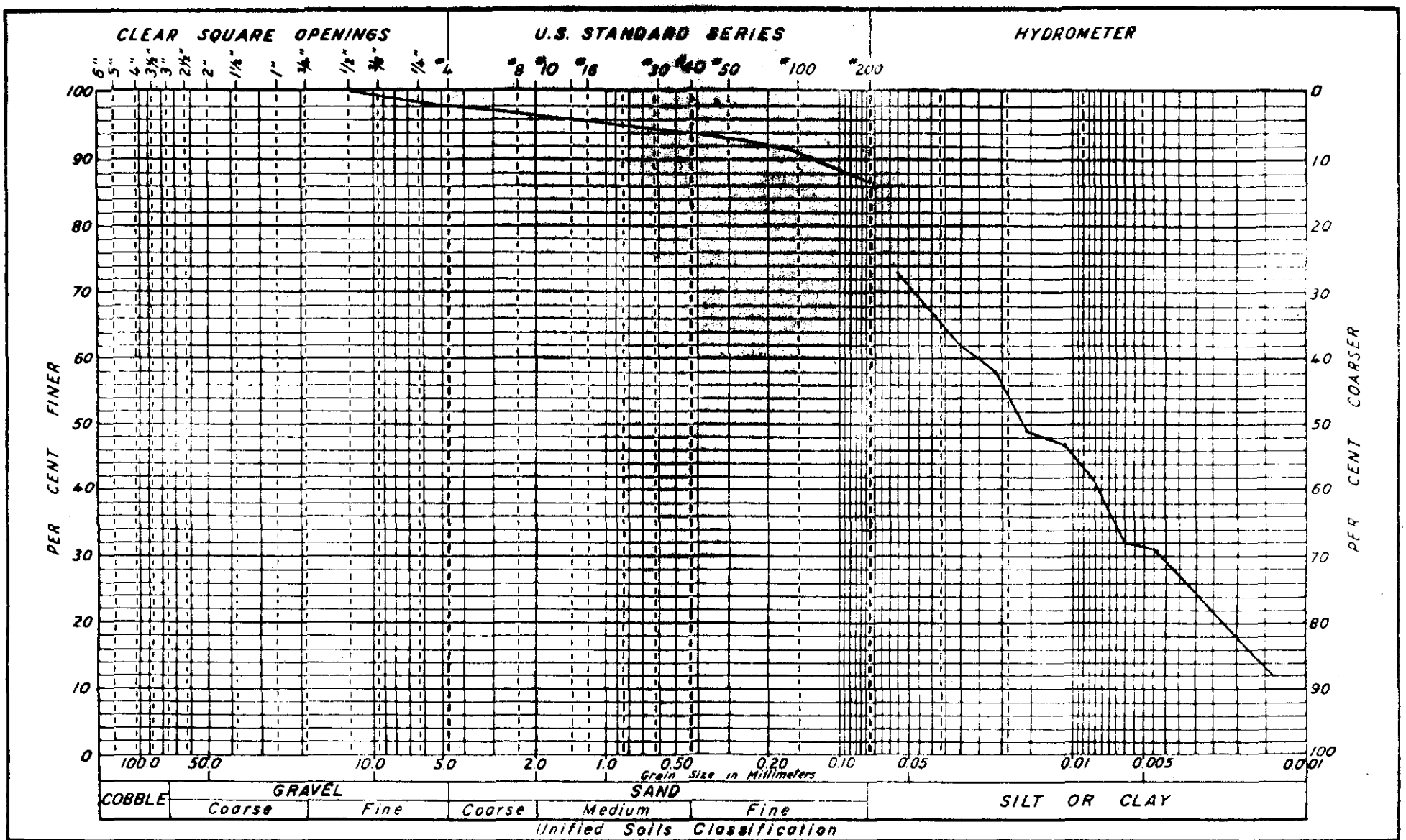


Boring No.	Sample No.	El. or depth	Classification	Nat. W%	G	LL	PL	PI
TP 11 TD		1.5-2.5 m	CL	11.3		17.6	11.0	6.6

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

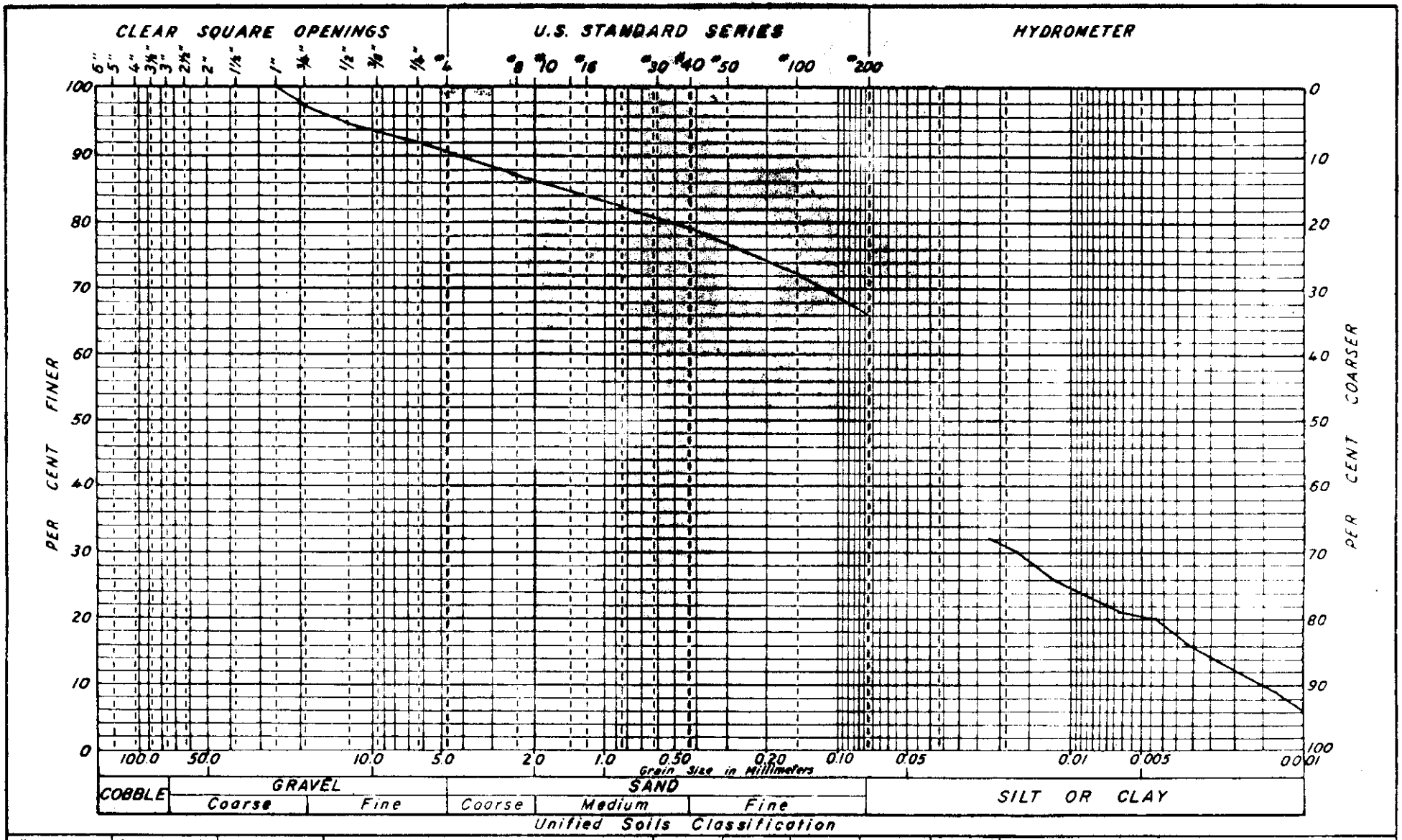


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 12 TD		1.0-2.0m	CL	15.5		21.6	13.6	8.0

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn MAS Date 18-9-80

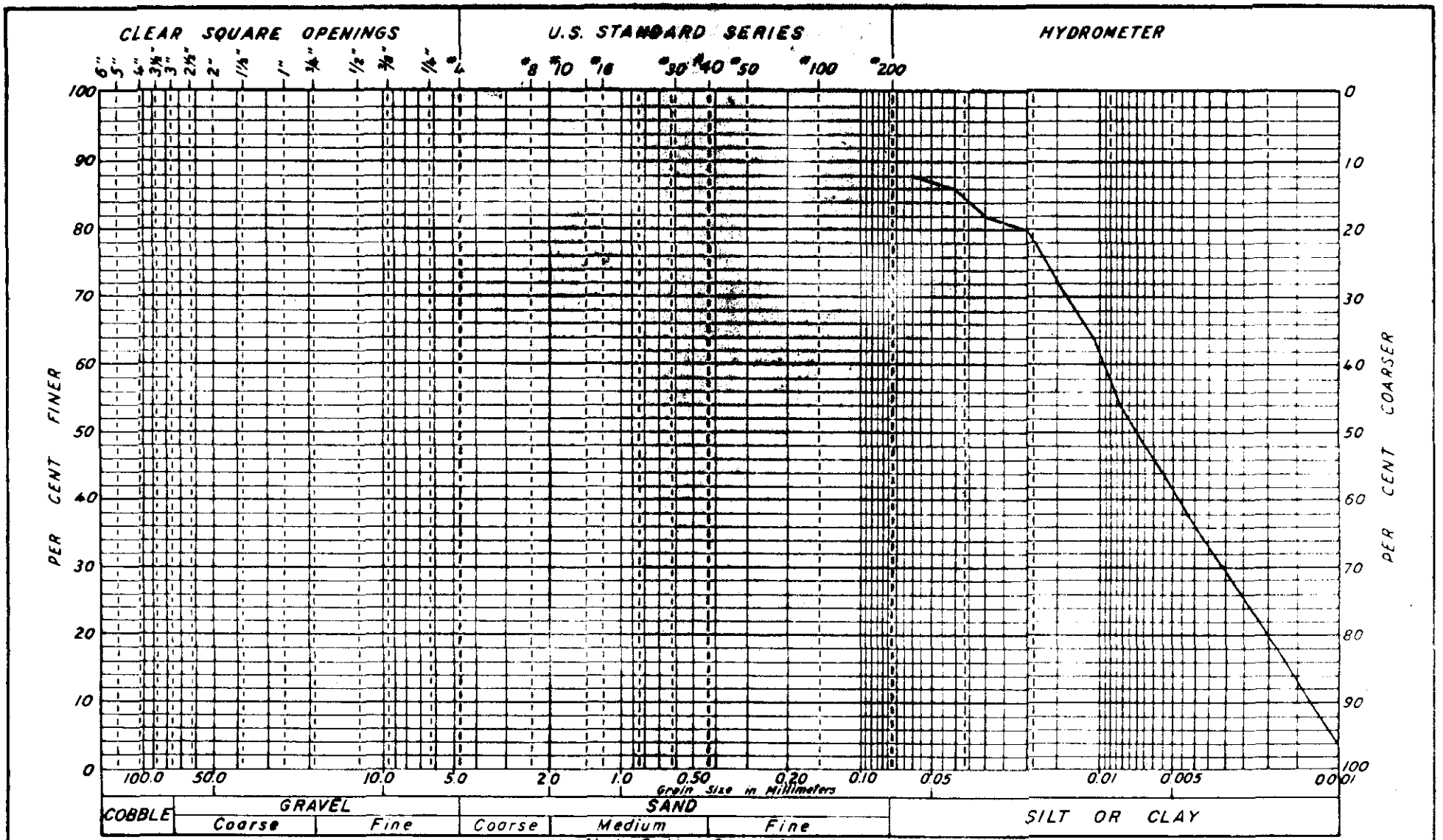


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 16 TD		3.5-4.5m	CL	9.4		17.2	10.5	6.7

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

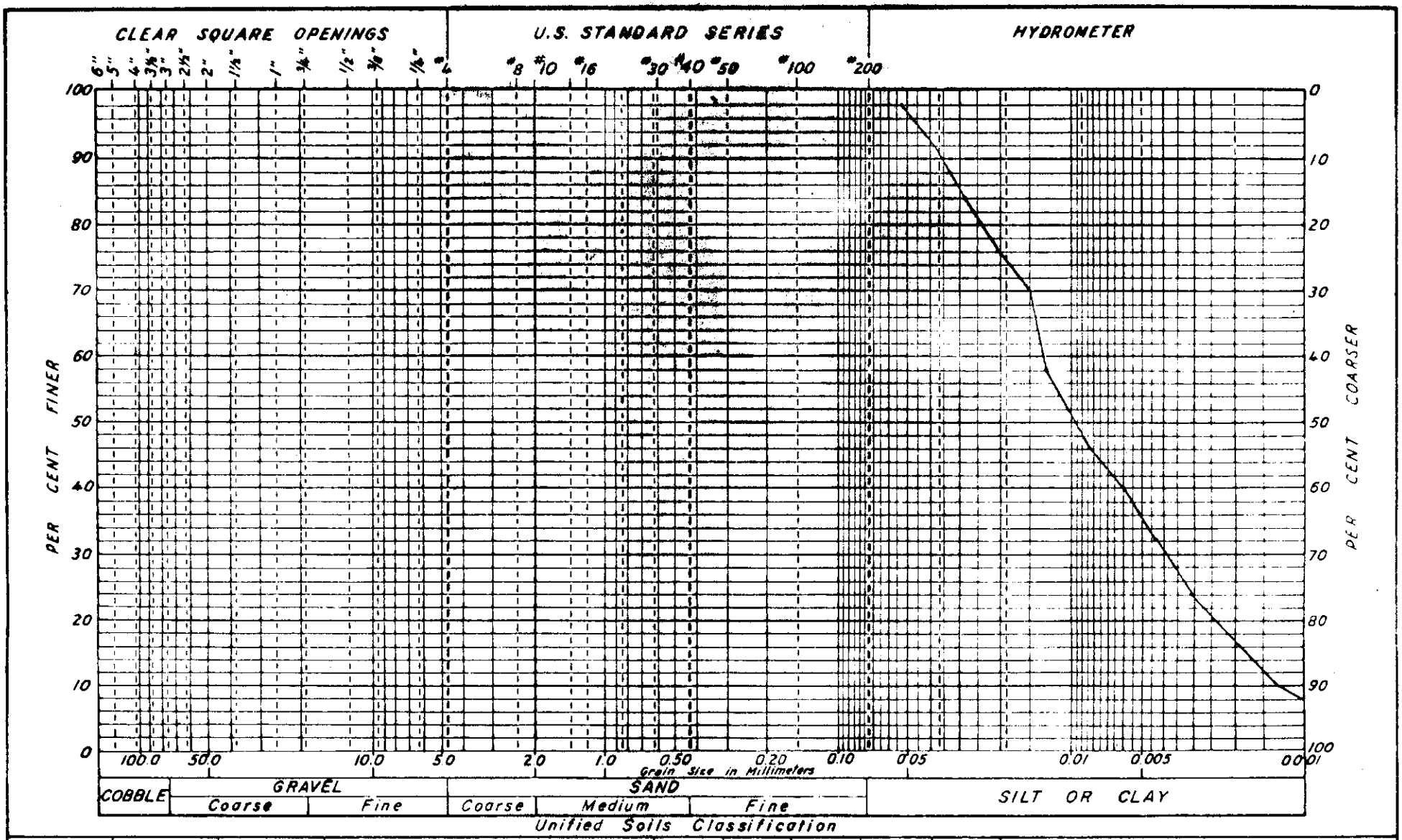


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-3-SP		6.1-8.1m.	CL	24.2	2.618	28.0	14.1	13.9

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn MAS Date 15-10-80

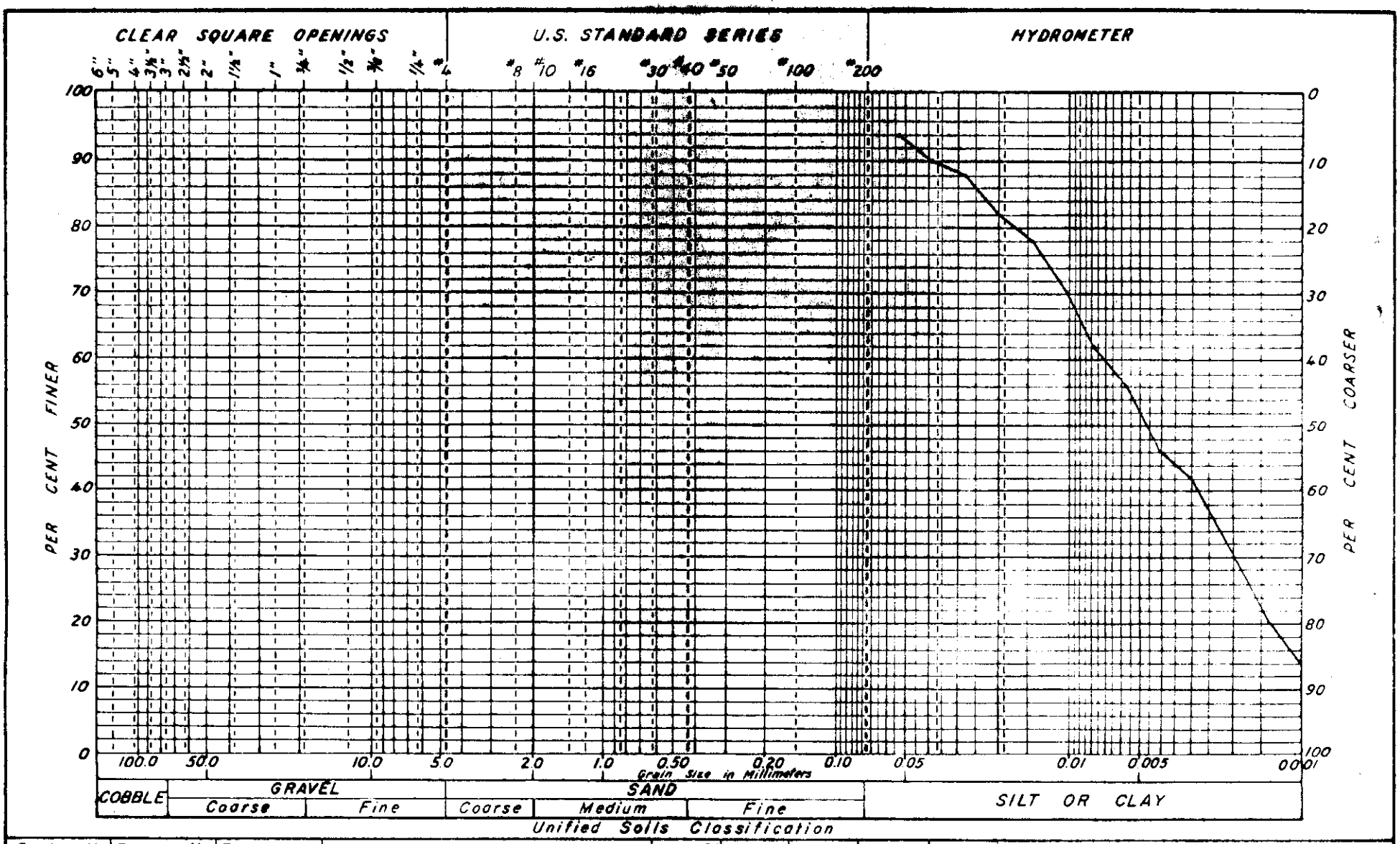


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-3-SP		9.1 - 9.6m.		22.7				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

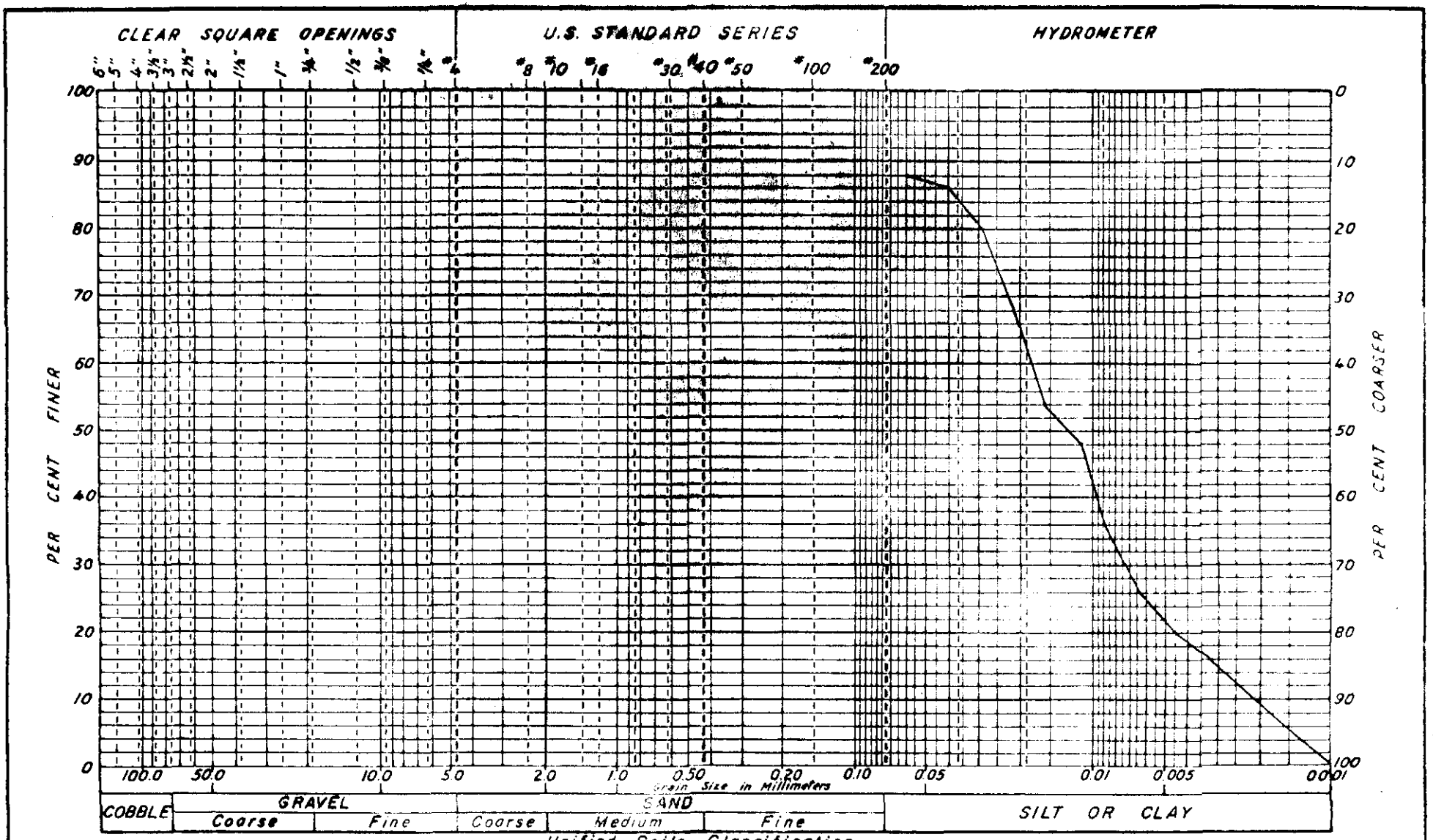


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-4-SP		4.6 - 6.6m.	CL	27.7	2.577	31.2	15.5	15.7

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

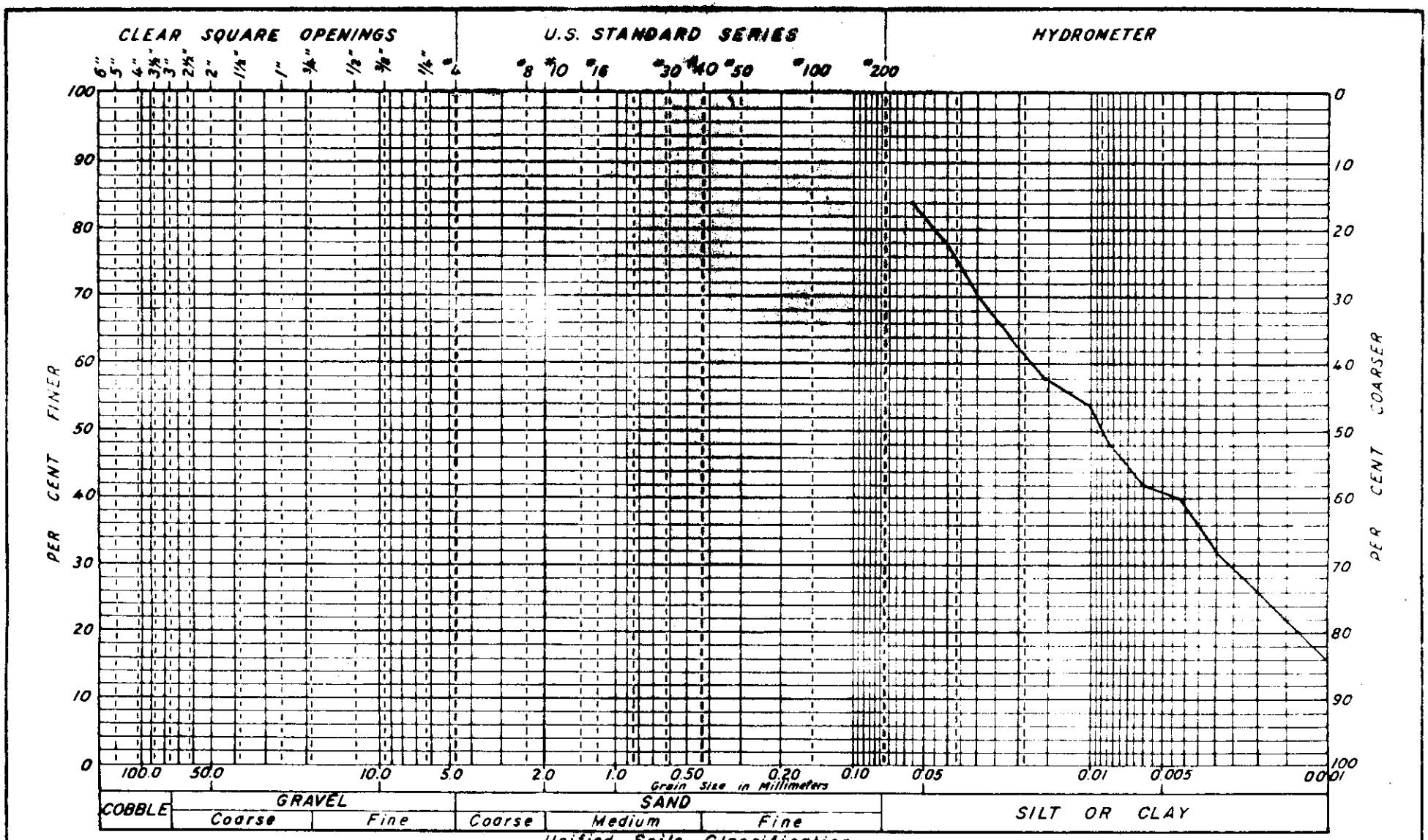


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
DH-4-SP		76-8.1m.		25.9				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

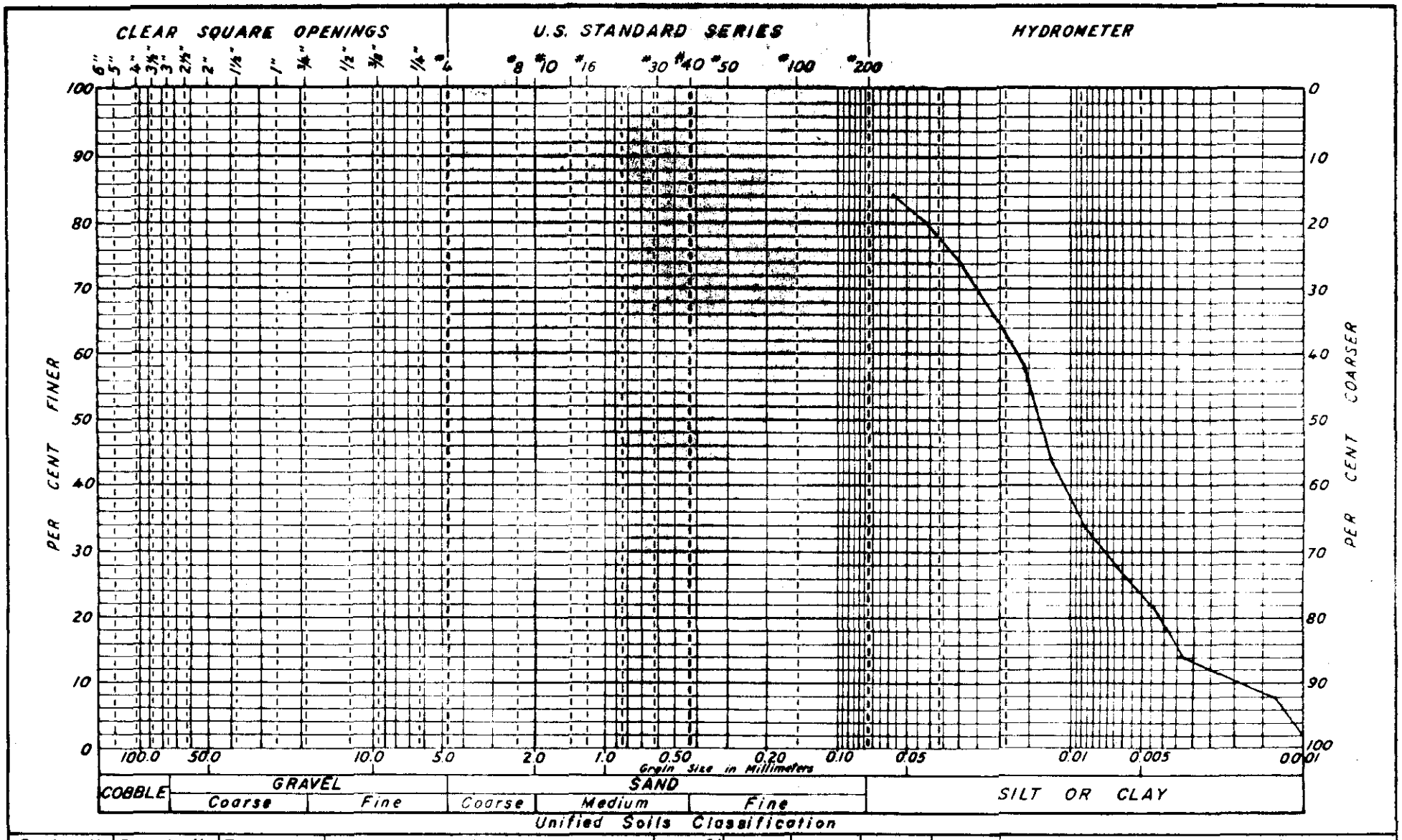


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-4-SP		10.7-12.6m.	CL	10.7	2.674	20.0	8.8	11.2

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn MAS Date 15-10-80

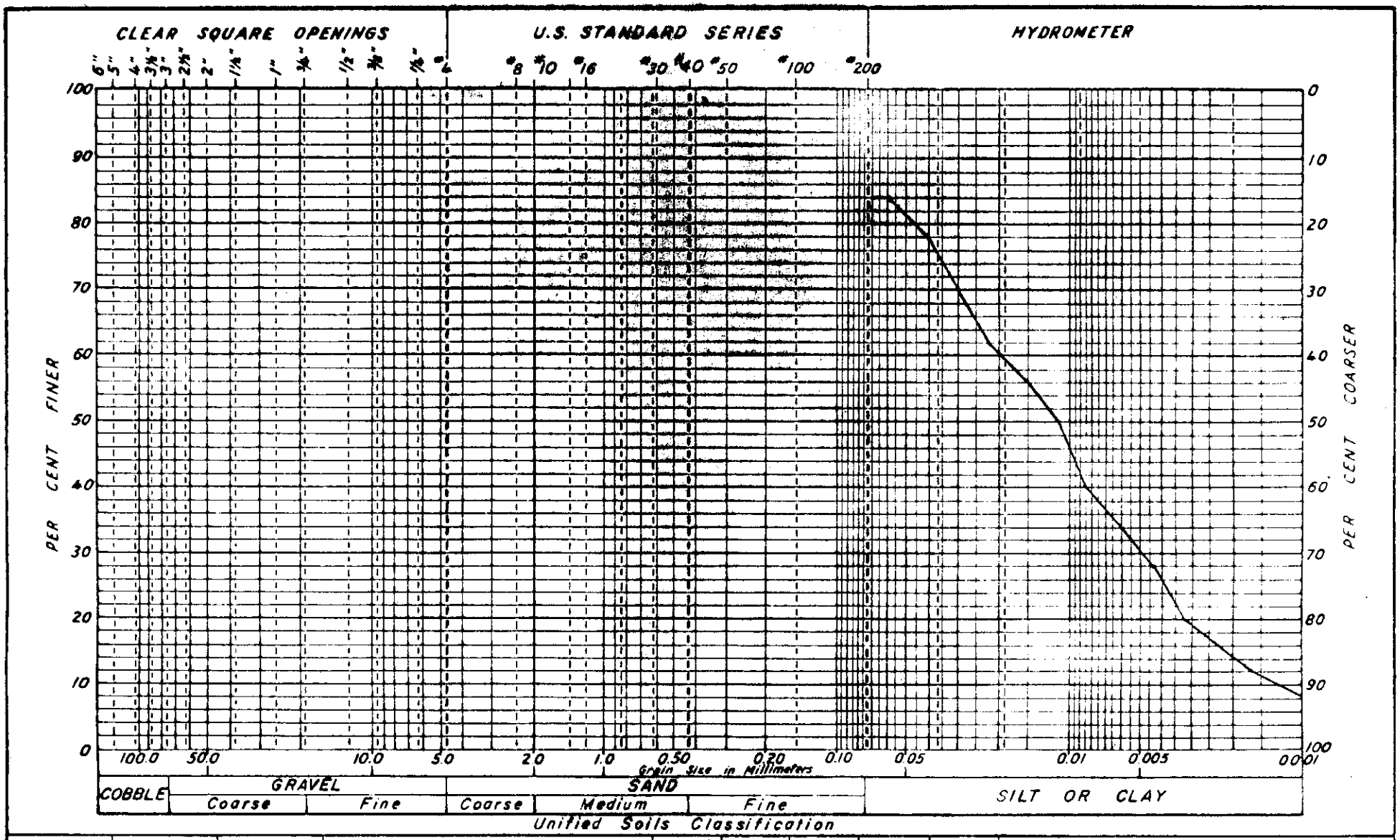


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-6-SP		4.6m.	CL	25.2		25.0	14.5	10.5

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

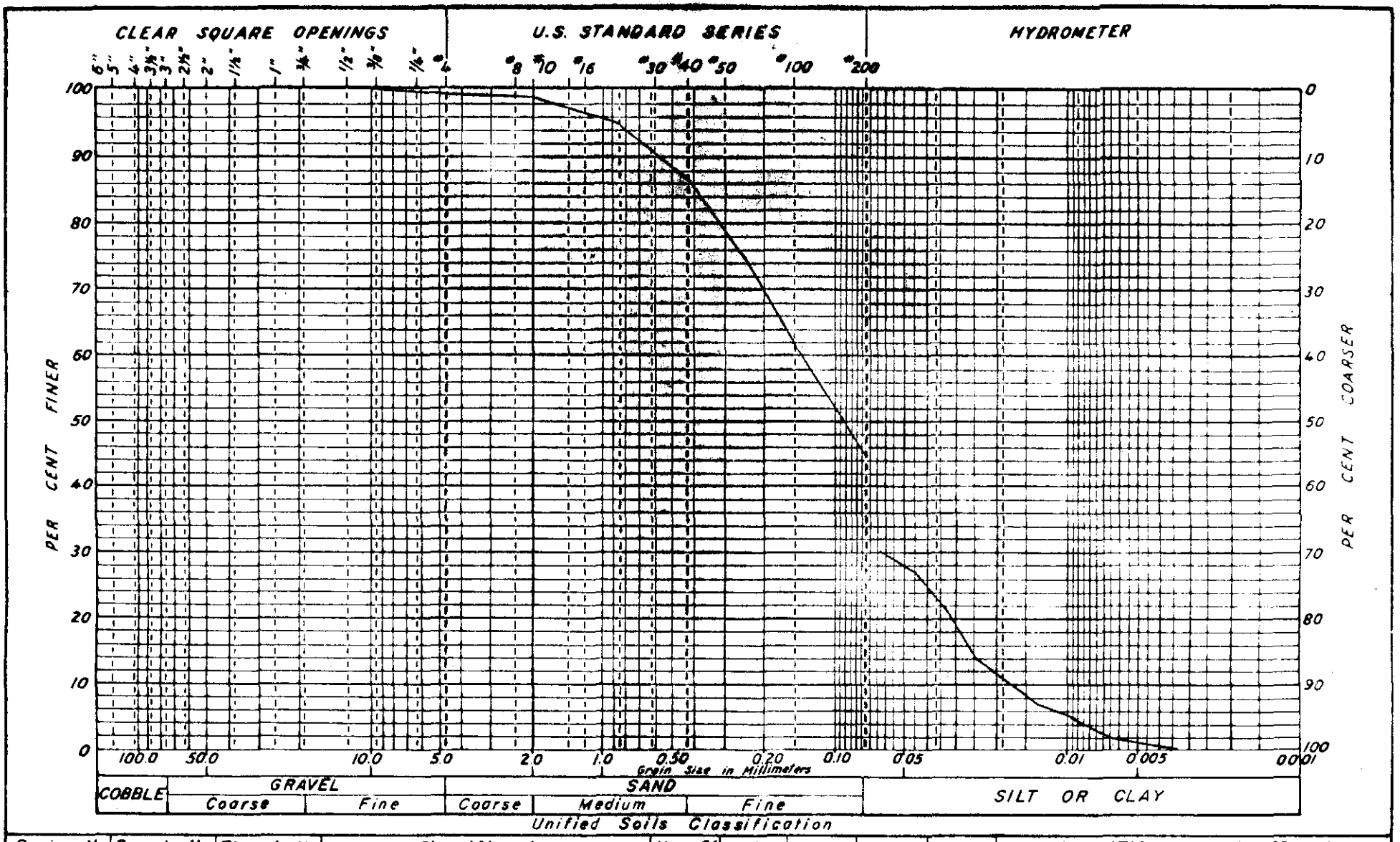


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
DH-6-SP		6.1-7.6m.	CL	12.06	2.632	21.4	13.6	7.8

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

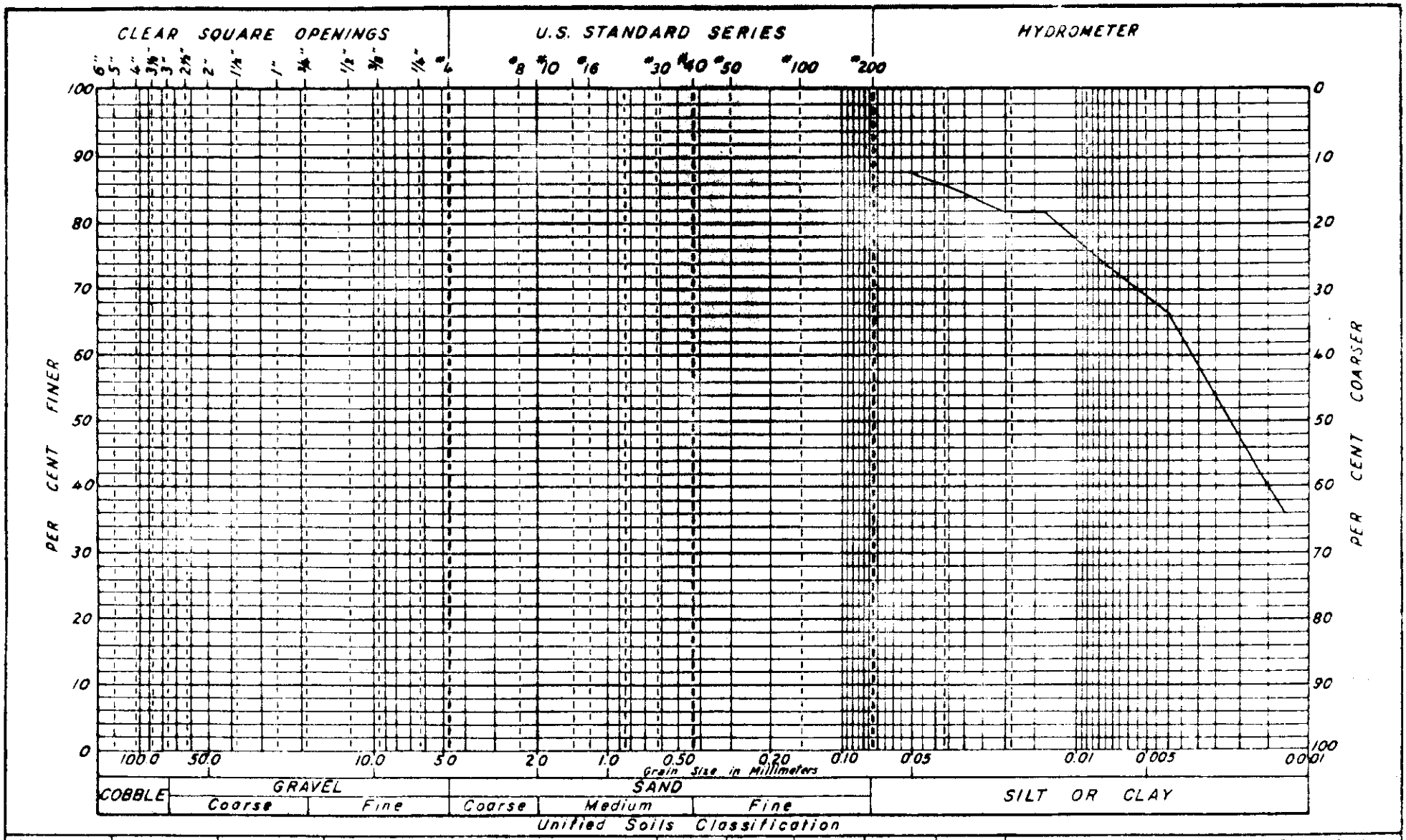


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 2 SP		1.0-1.5m	SM	25.0		NP		

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

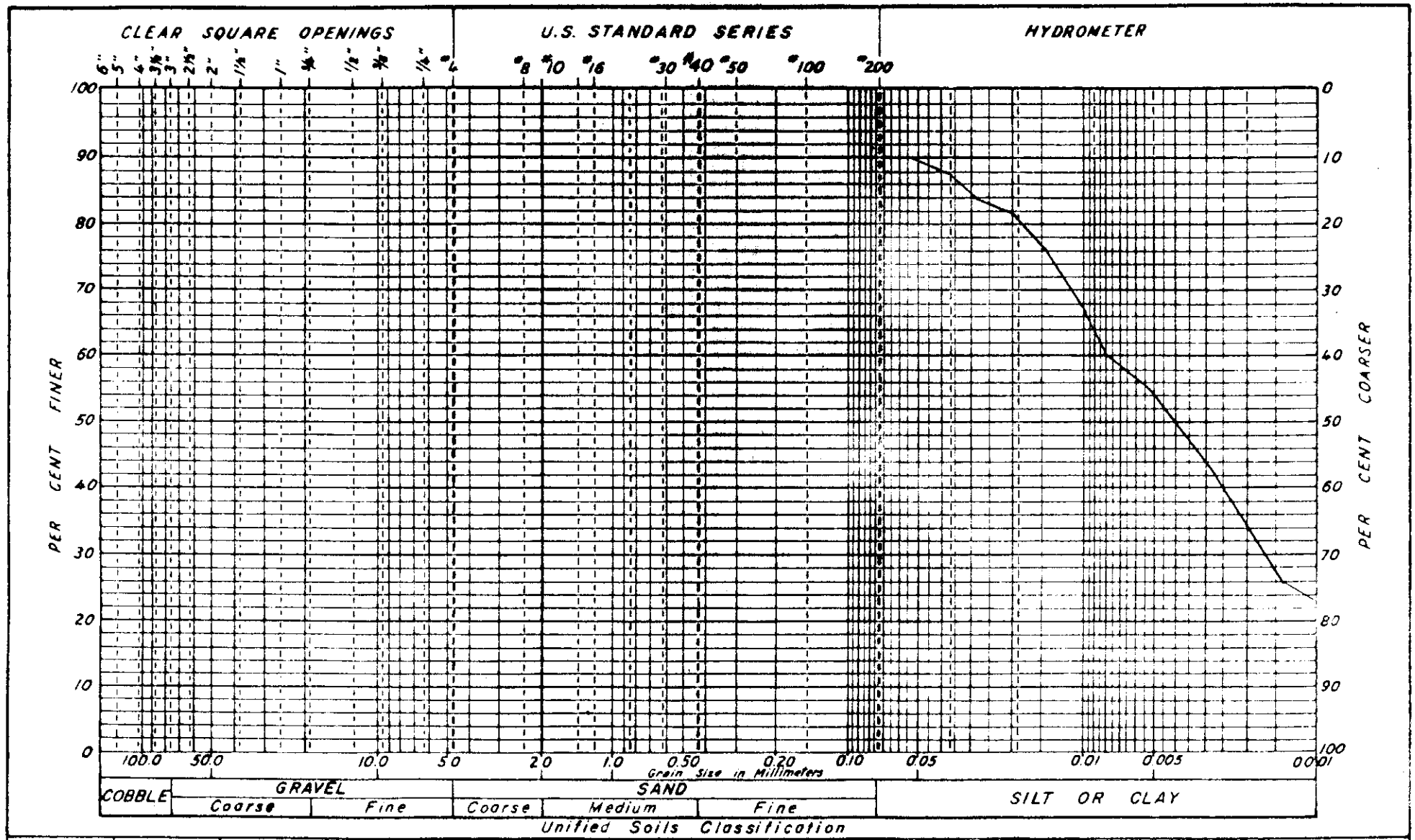
Drawn: MAS Date: 18-9-80



Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 5 SP		4.6 - 5.2 m	CL	20.2	2.685	26.3	16.1	10.2

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine
Drawn MAS Date 18-9-80

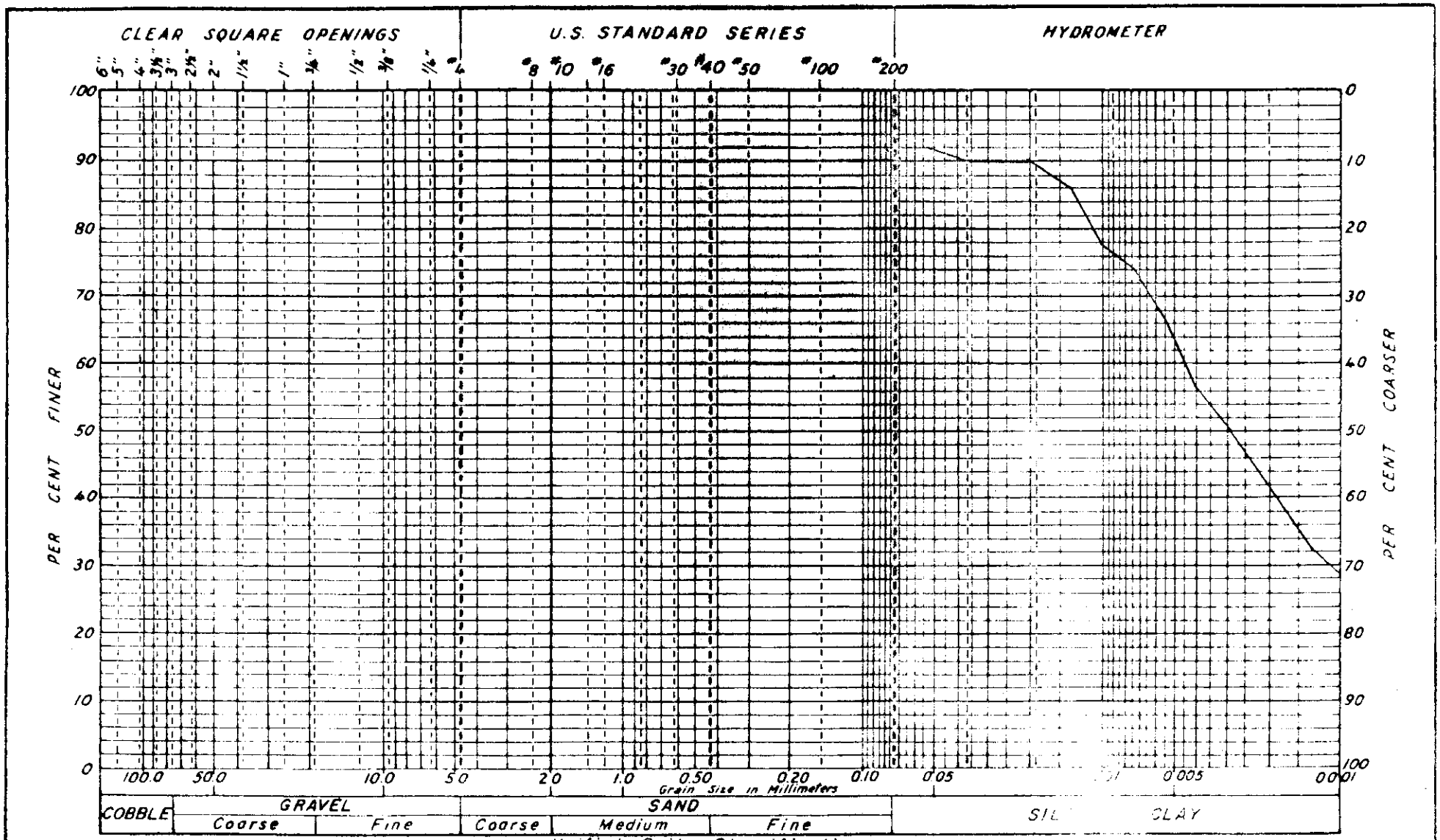


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 6 SP		1.7-2.5m	CL	11.2	2.650	28.5	13.4	15.1

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn MAS Date 18-9-80

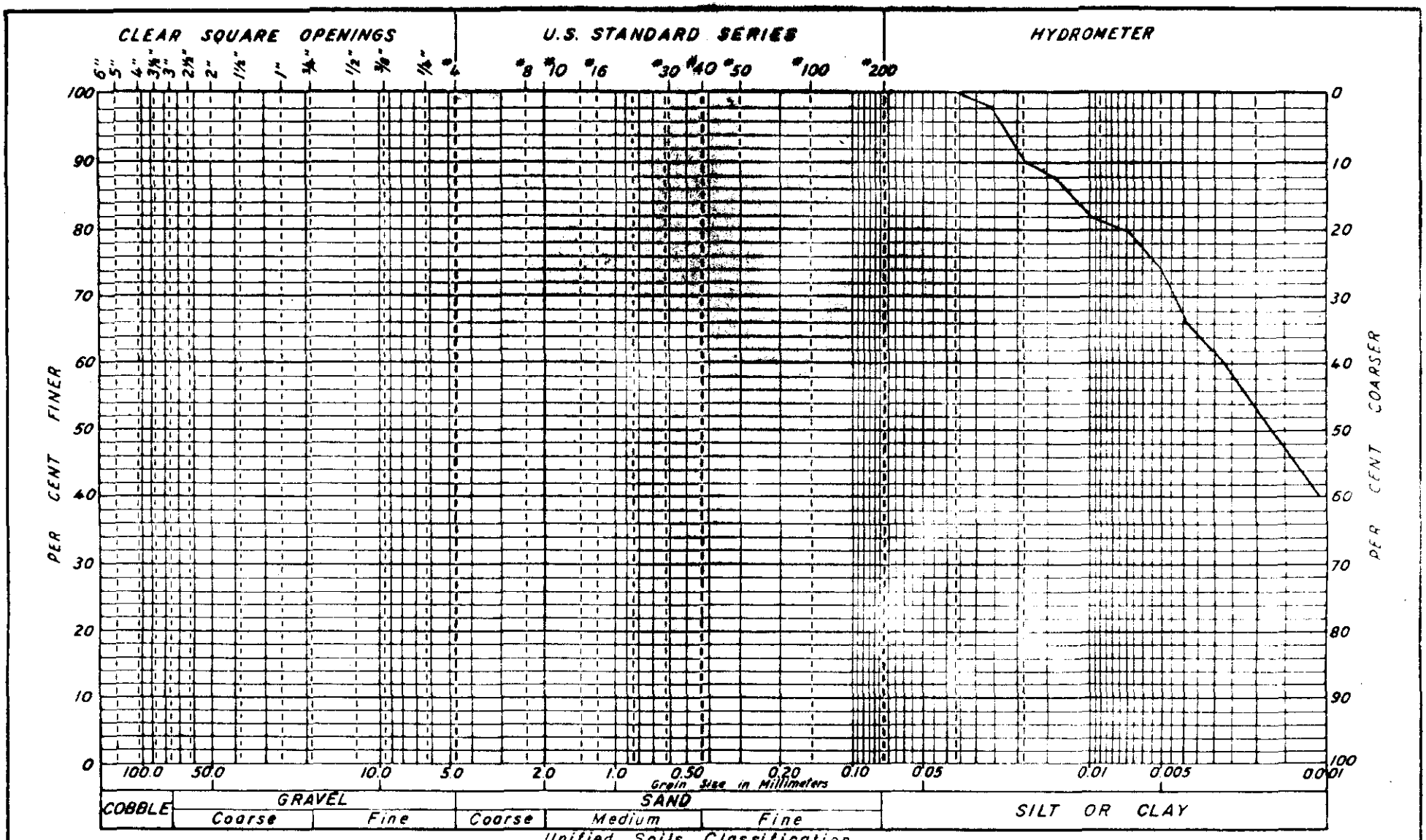


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 8 SP		3.5-4.0m	CL	15.1	2.685	27.3	12.5	14.8

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project Elk River Coal Mine

Drawn MAS Date 18-9-80

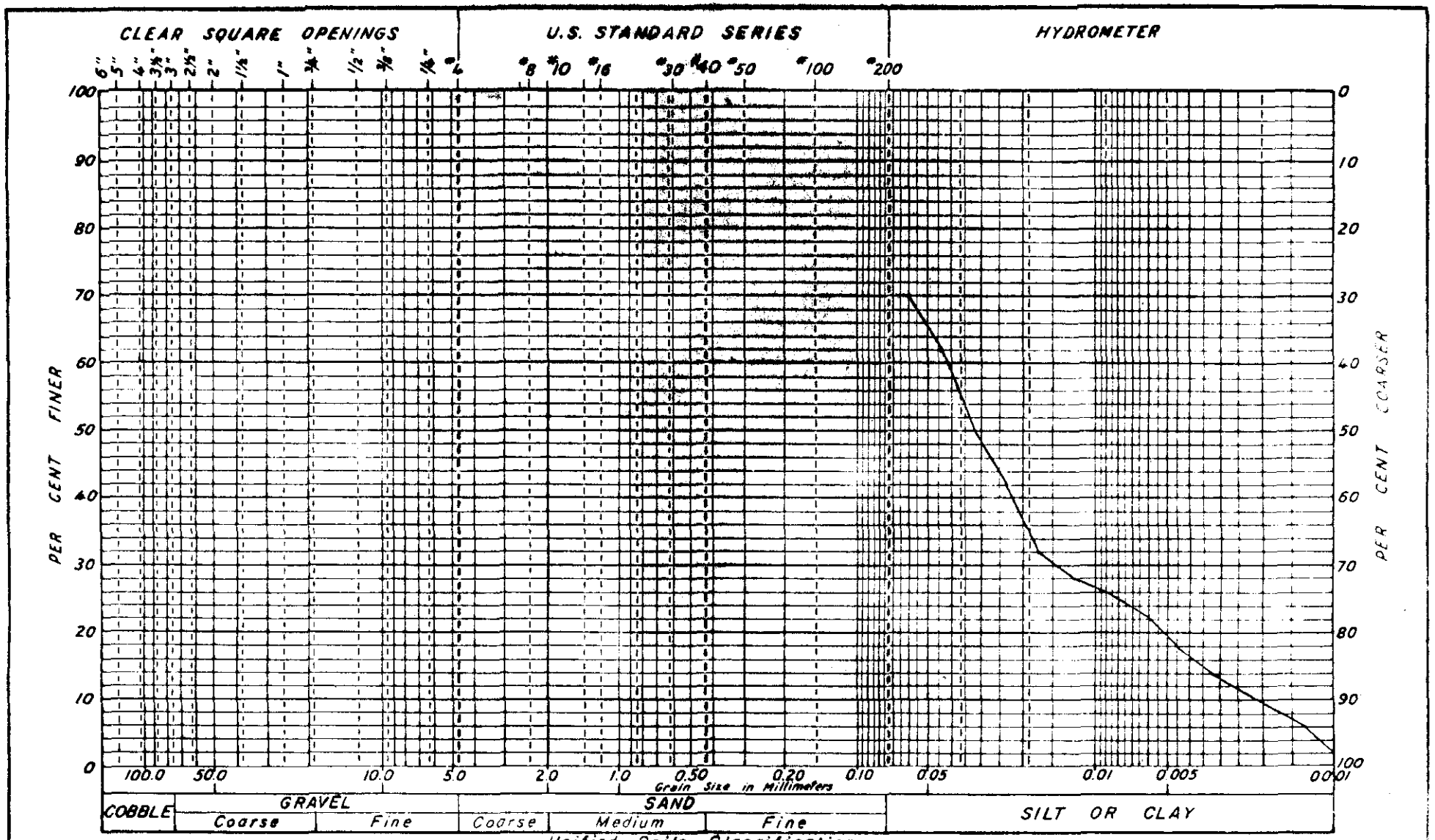


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP 9 SP		3.0-4.0 m	CL	19.2	2.650	36.4	15.8	20.6

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

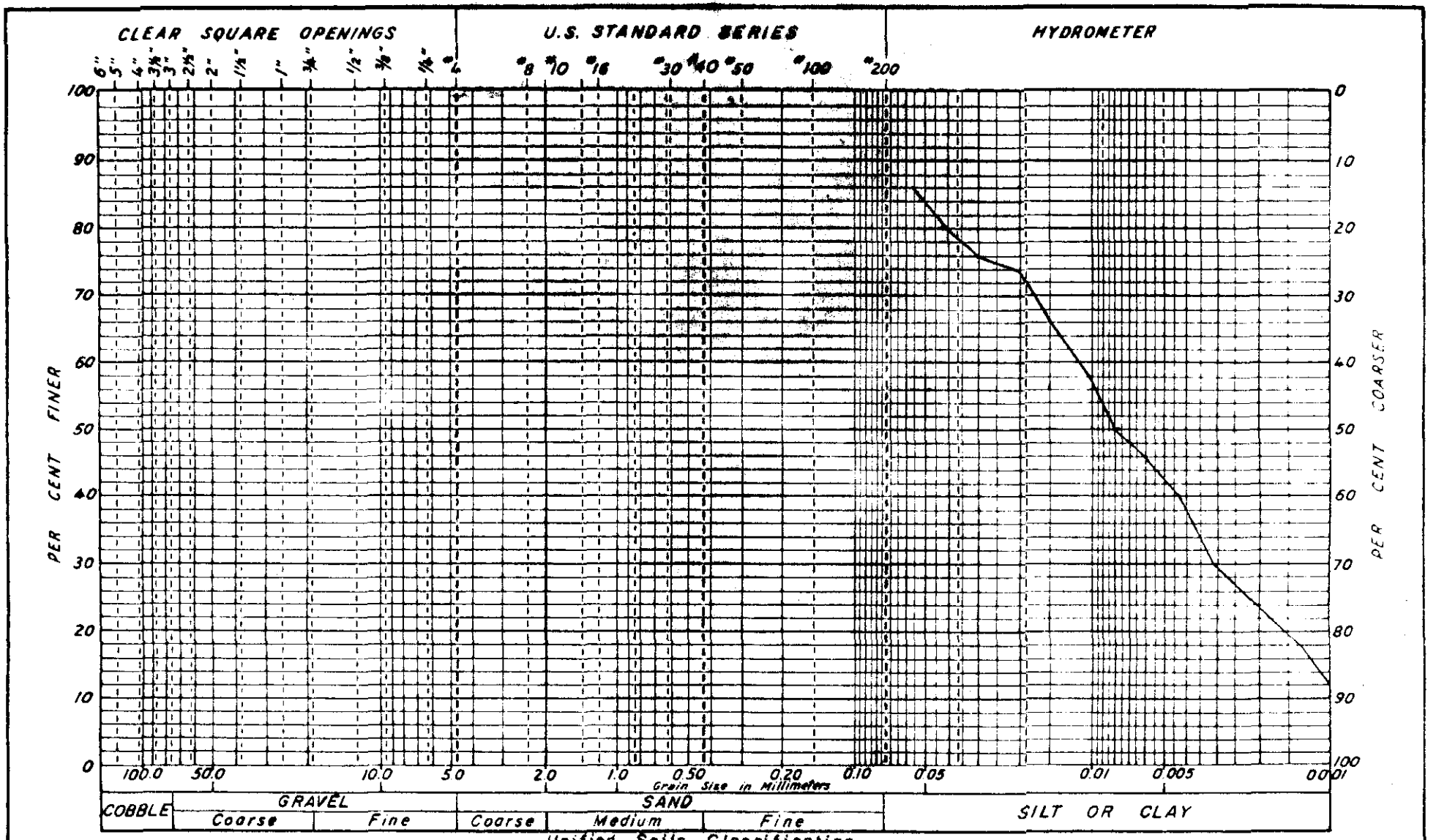


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP-2-WC		3-5.8 m	ML	11.9		17.0	15.2	1.8

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

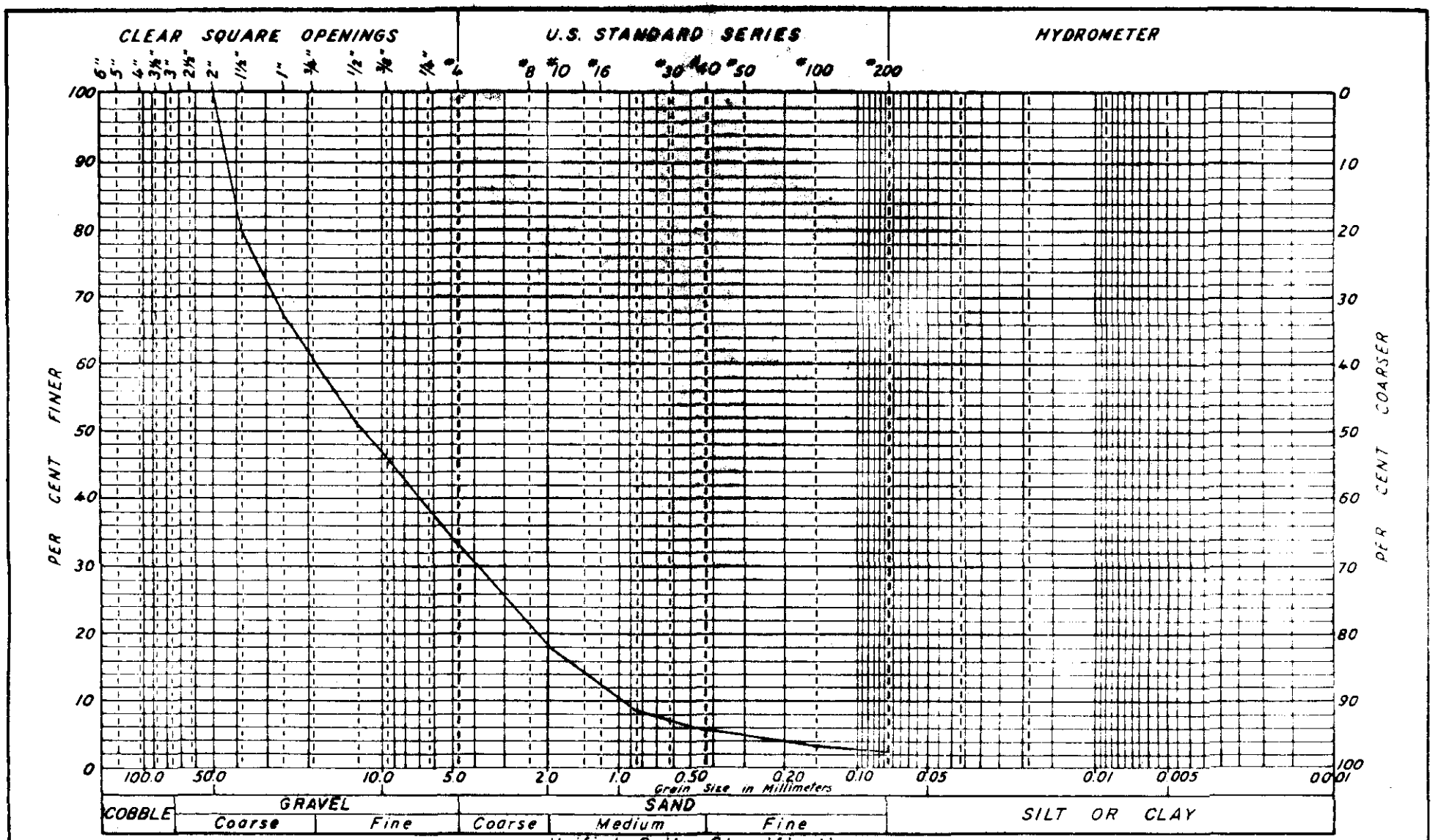


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP-4-WC		3.7 - 4.6 m	CL	16.7		25.2	13.3	11.9

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

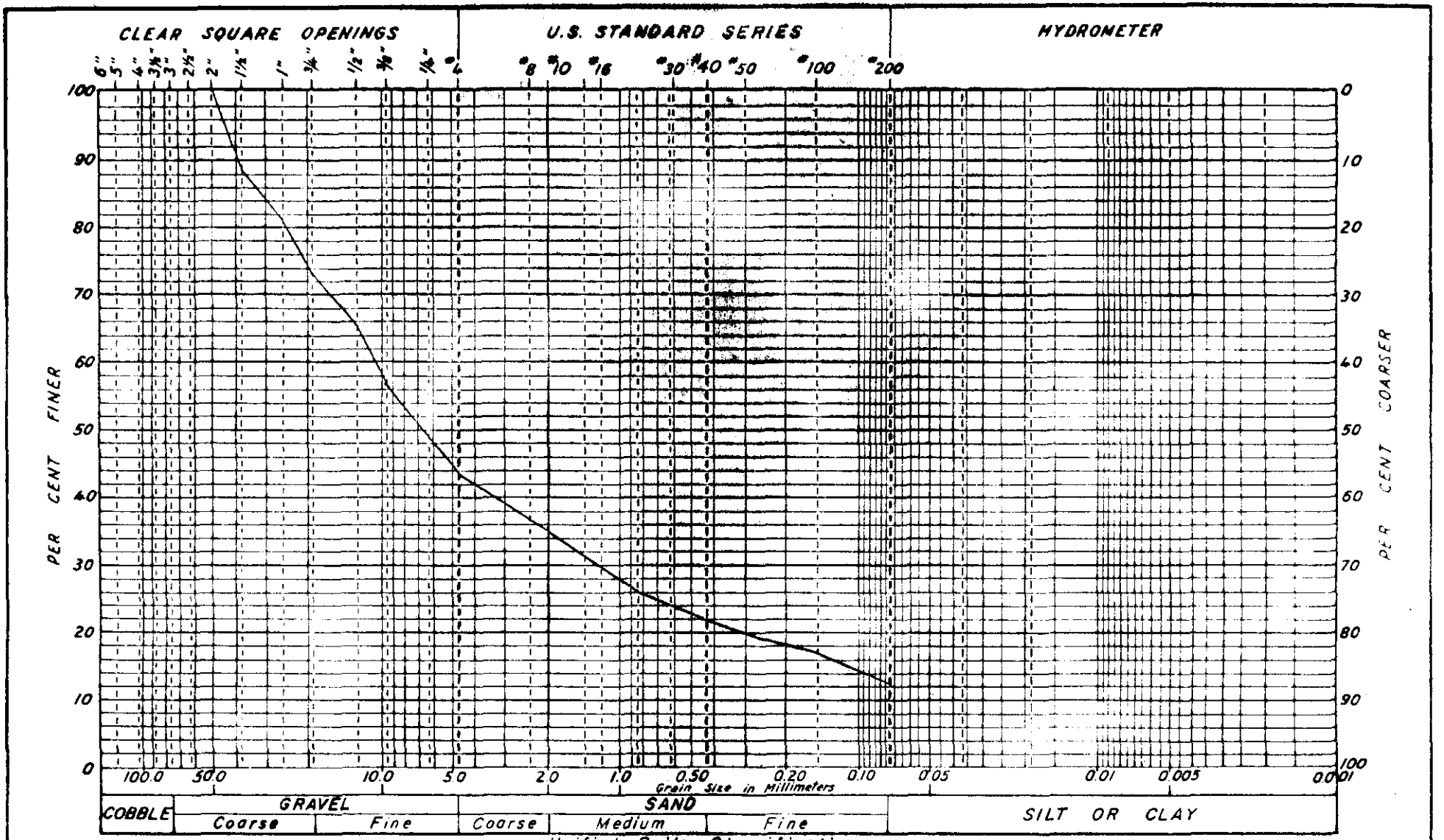


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP-5-WC		0.3 - 2.4 m	GW					

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

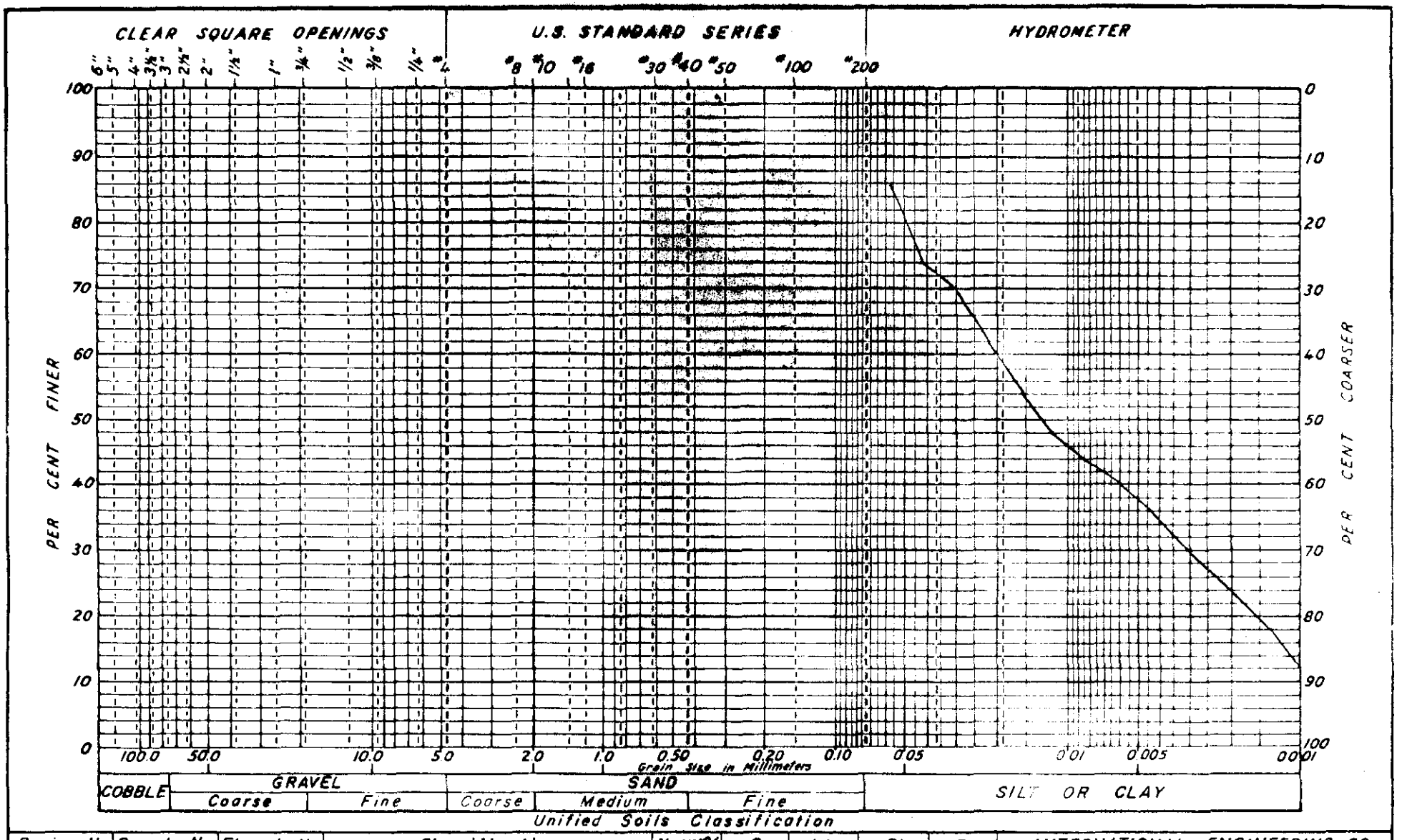


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-8-WC		0.3-6.1m	GM					

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

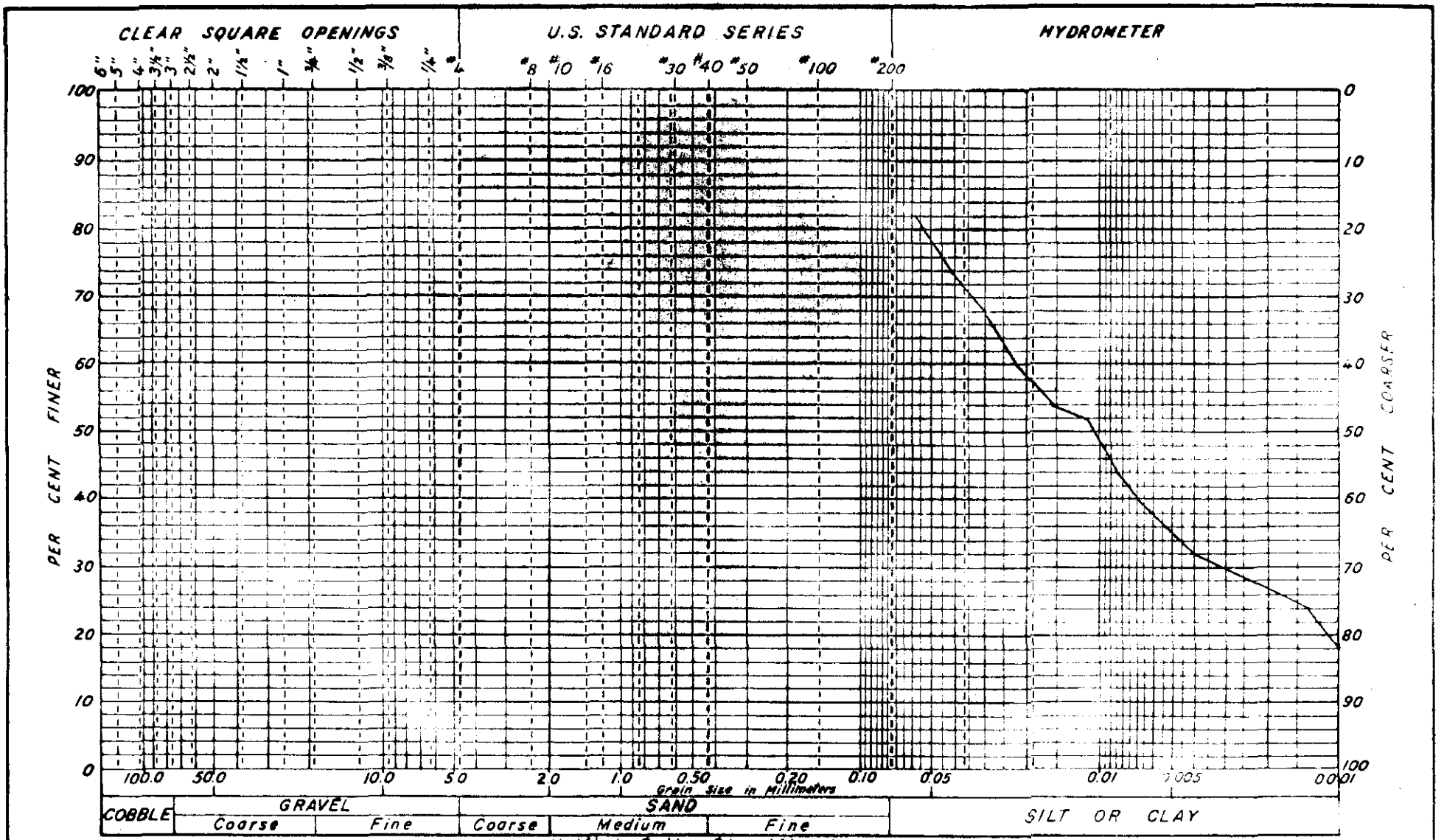


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-9-WC		5.8 - 6.4m	CL-ML	8.1		20.4	15.1	5.3

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

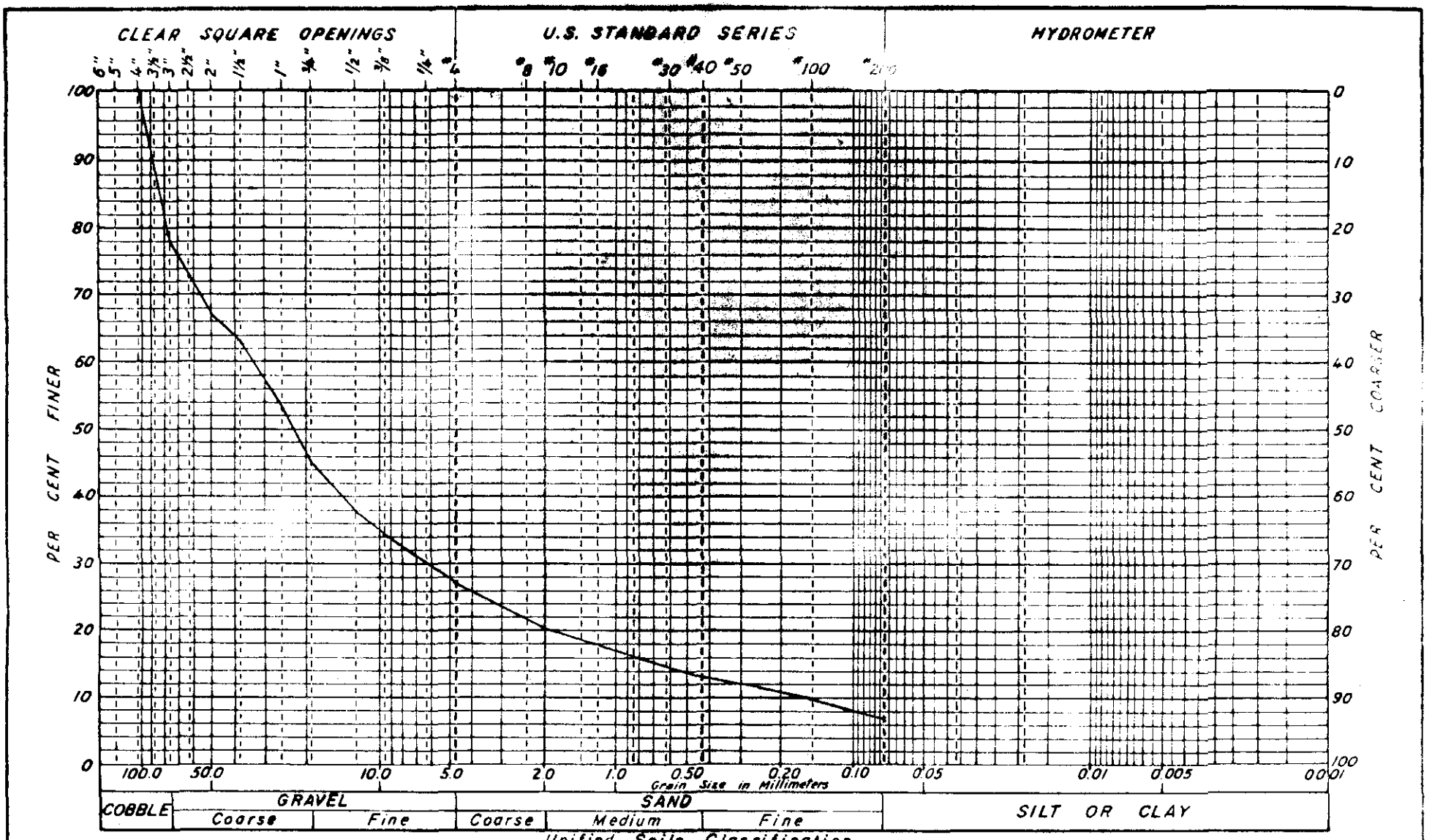


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP-11-WC		3.4 - 5.3m	CL	8.1		20.9	10.7	10.2

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 15-10-80

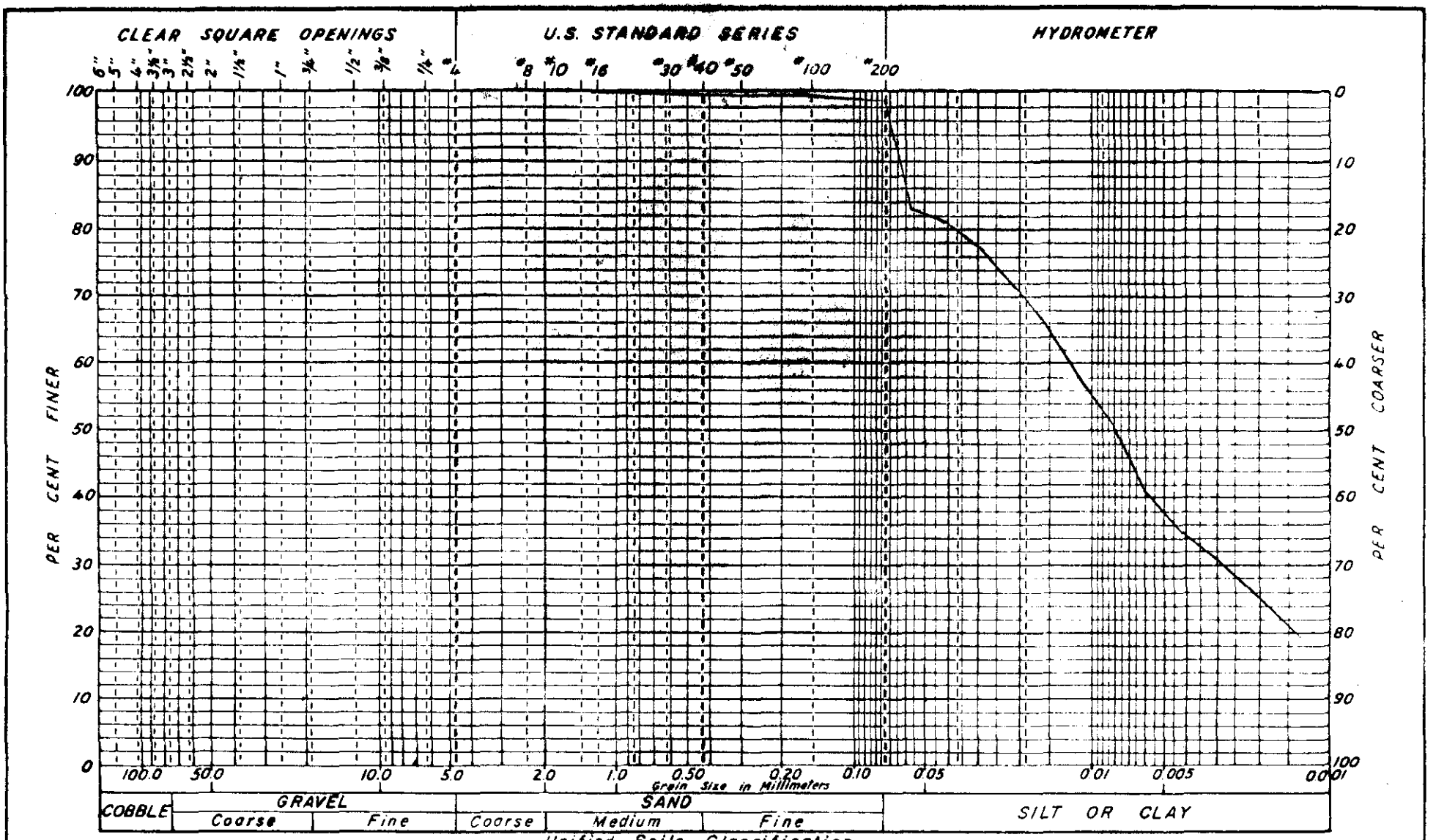


Boring No.	Sample No.	El. or depth	Classification	Nat.W%	G	LL	PL	PI
TP-1-NEI		4.0-5.0m	GW-GM	8.8				

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn MAS Date 10-15-80

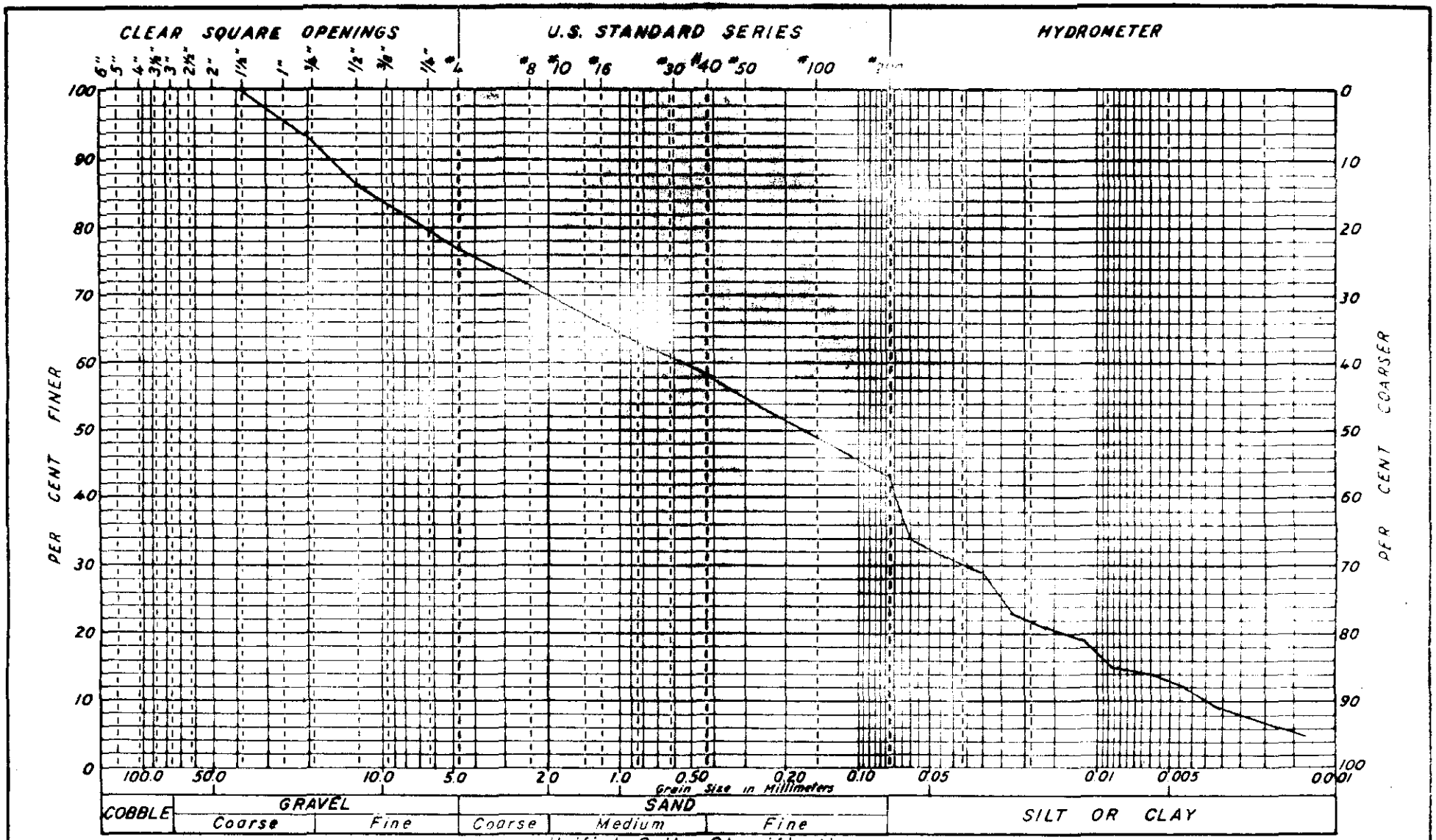


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 2 FB		1.0-1.5m	CL	26.7		43.8	18.6	25.2

INTERNATIONAL ENGINEERING CO.
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

Drawn: MAS Date: 18-9-80

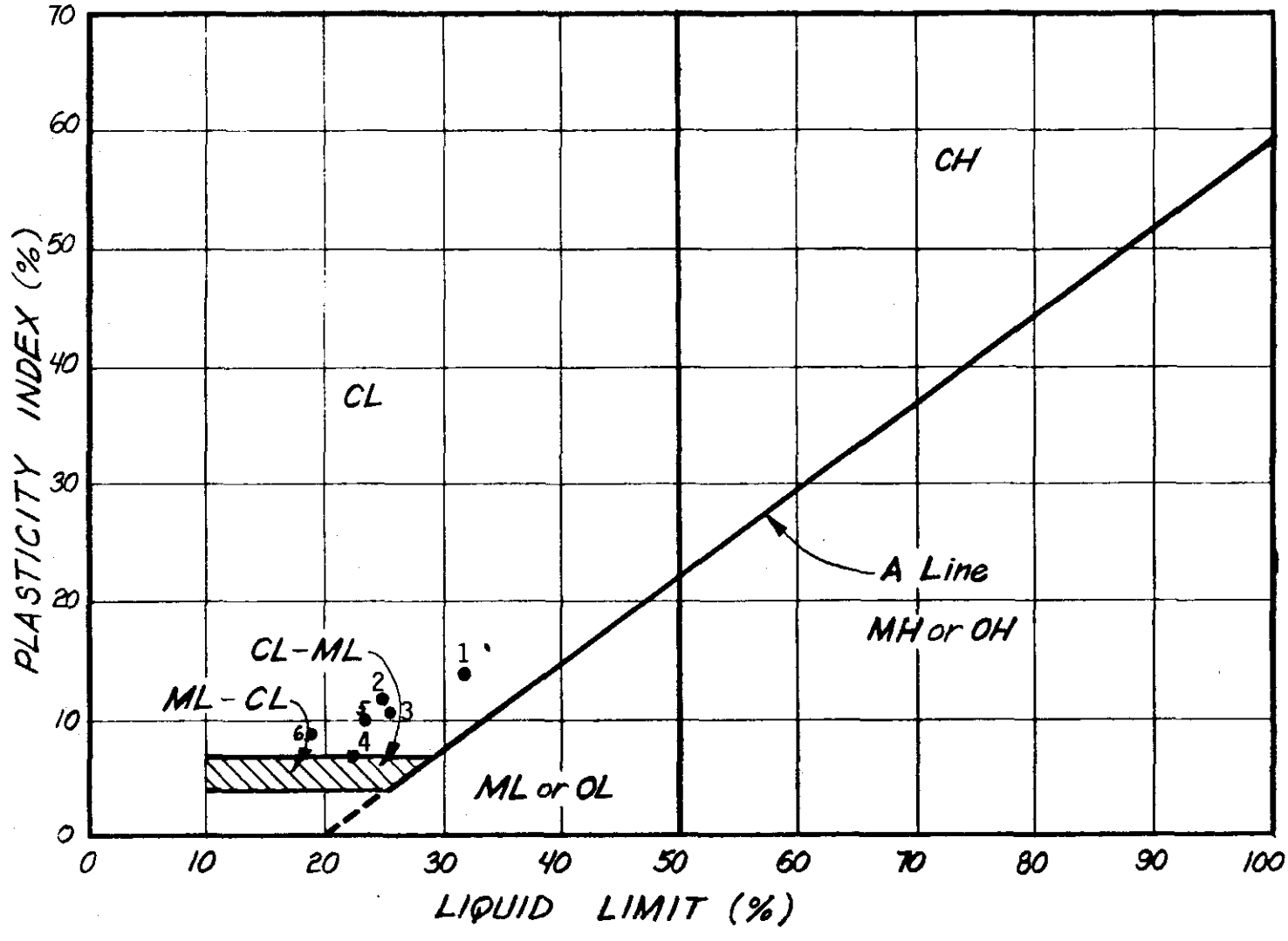


Boring No.	Sample No.	El. or depth	Classification	Nat W%	G	LL	PL	PI
TP 4 FB		2.0 - 2.5m	SM	9.1		15.6	12.4	3.2

INTERNATIONAL ENGINEERING CO
GRAIN SIZE ANALYSIS

Project: Elk River Coal Mine

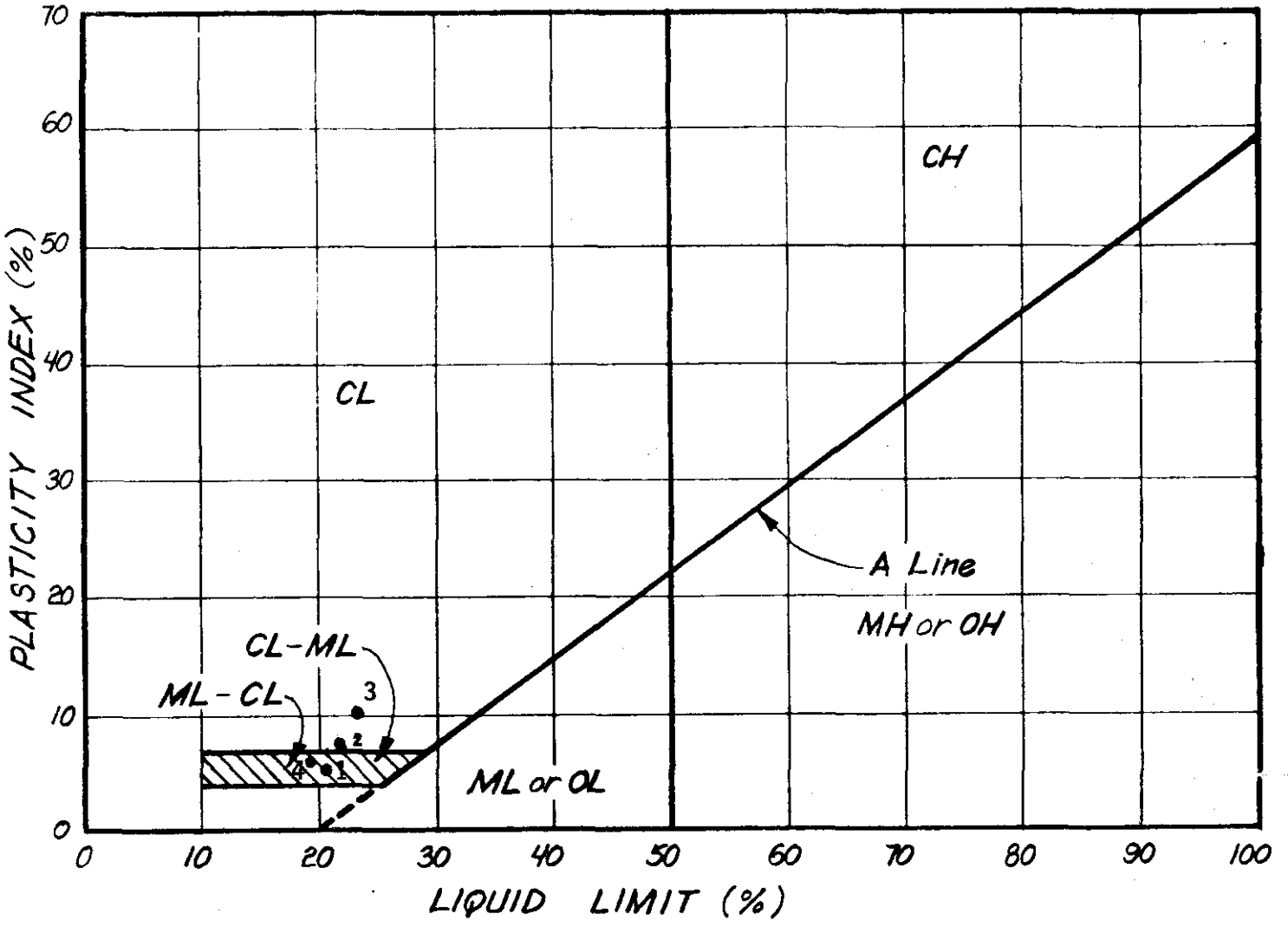
Drawn MAS Date 18-9-80



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	DH-19-RD	8.8 m	31.3	16.4	14.9	92
2	DH-20-RD	7.3-8.8 m	24.6	12.5	12.1	96
3	DH-20-RD	10.4 m	24.9	14.3	10.6	88
4	DH-21-RD	7.3 m	22.4	15.2	7.2	88
5	DH-21-RD	8.8-10.4 m	23.3	13.1	10.2	88
6	DH-22-RD	7.3-10.4 m	18.9	9.5	9.4	84

ELK RIVER COAL PROJECT

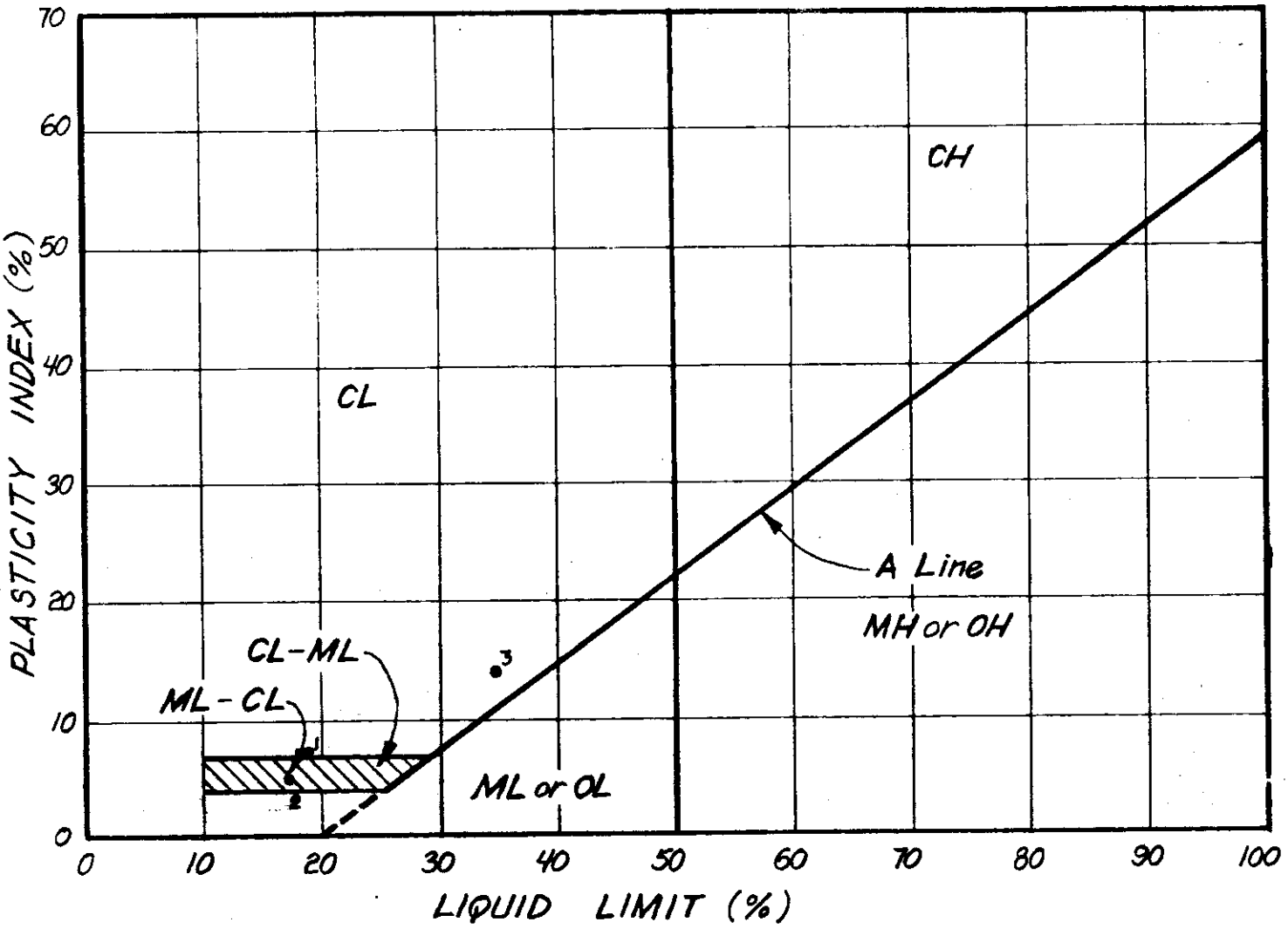
RIVER DIVERSION



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-2-RD	0.3-1.2 m	20.5	15.5	5.0	66
2	TP-4-RD	0.6-5.9 m	21.5	14.0	7.5	69
3	TP-5-RD	2.1-4.9 m	23.6	13.5	10.1	78
4	TP-11-RD	0.6-4.3 m	19.2	13.0	6.2	57

ELK RIVER COAL PROJECT

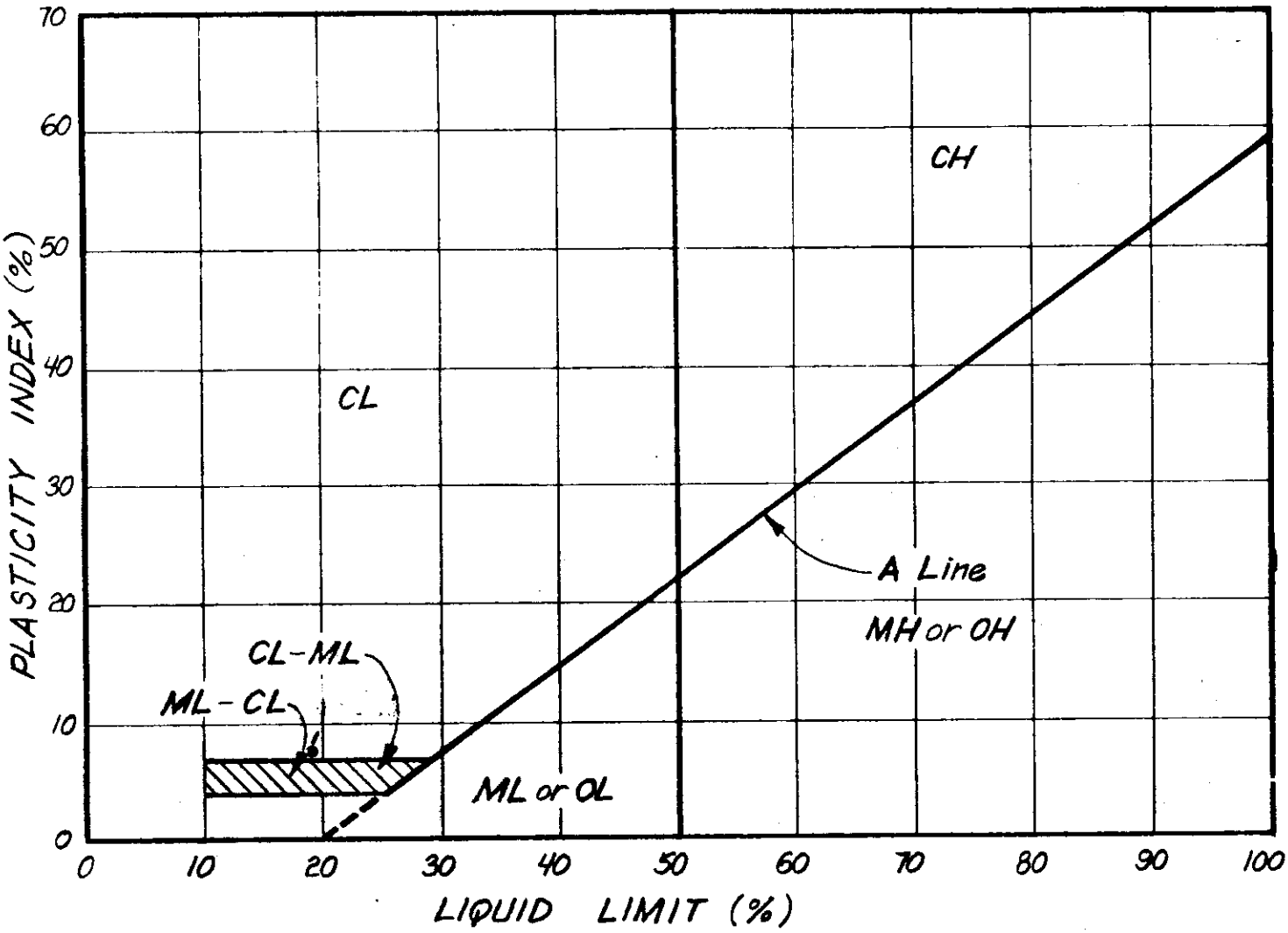
RIVER DIVERSION



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-8-WW	1.0-2.0 m	17.8	11.1	6.7	42
2	TP-12-WW	1.3-1.5 m	17.4	12.8	4.6	60
3	TP-15-WW	2.0-2.5 m	34.6	20.6	14.0	94

ELK RIVER COAL PROJECT

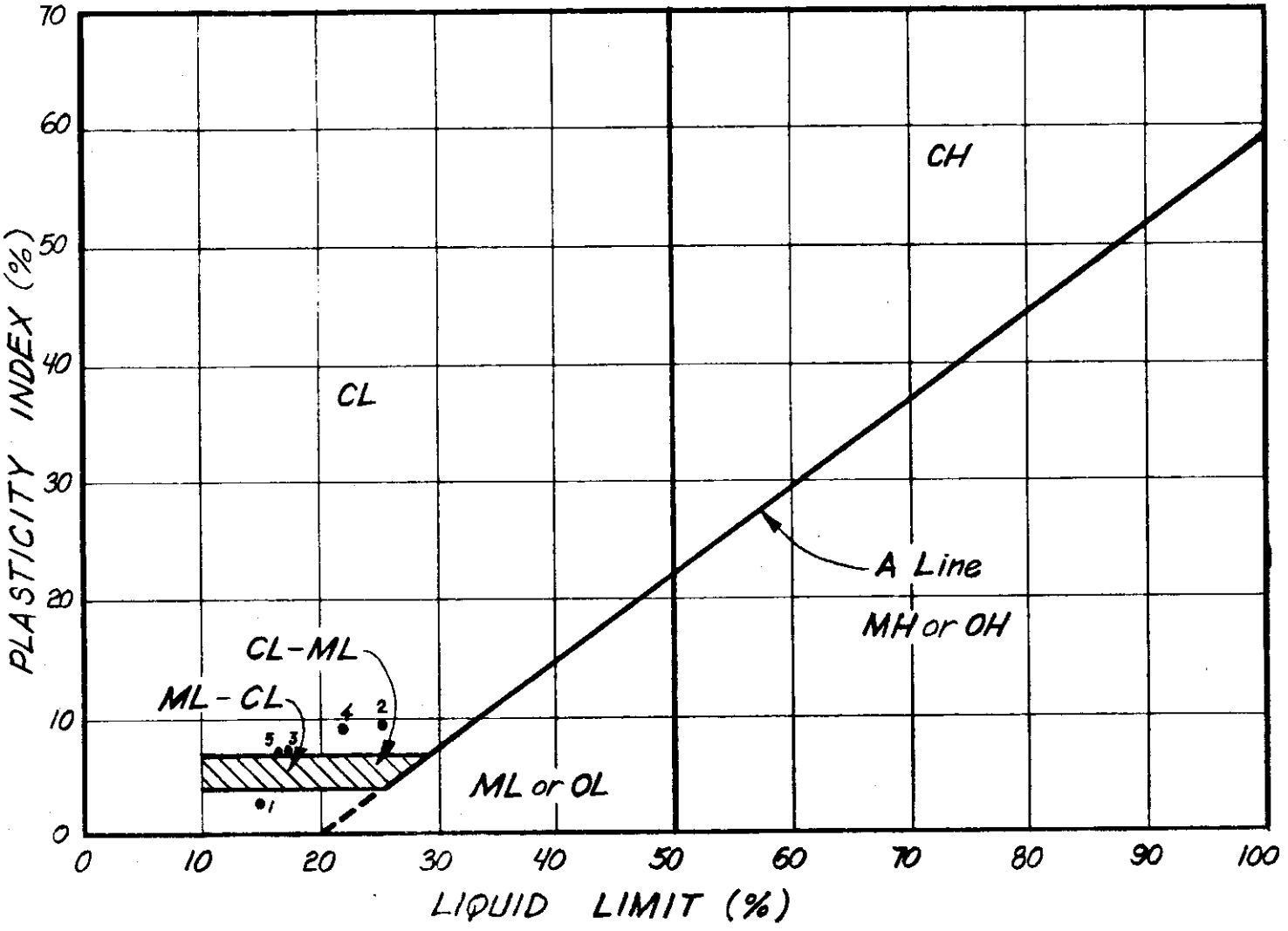
WEST WASTE DUMP



SYMBOL	CLASSIFICATION AND SOURCE	LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-1-H 1.5 - 2.6 m	19.0	11.5	7.5	58

ELK RIVER COAL PROJECT

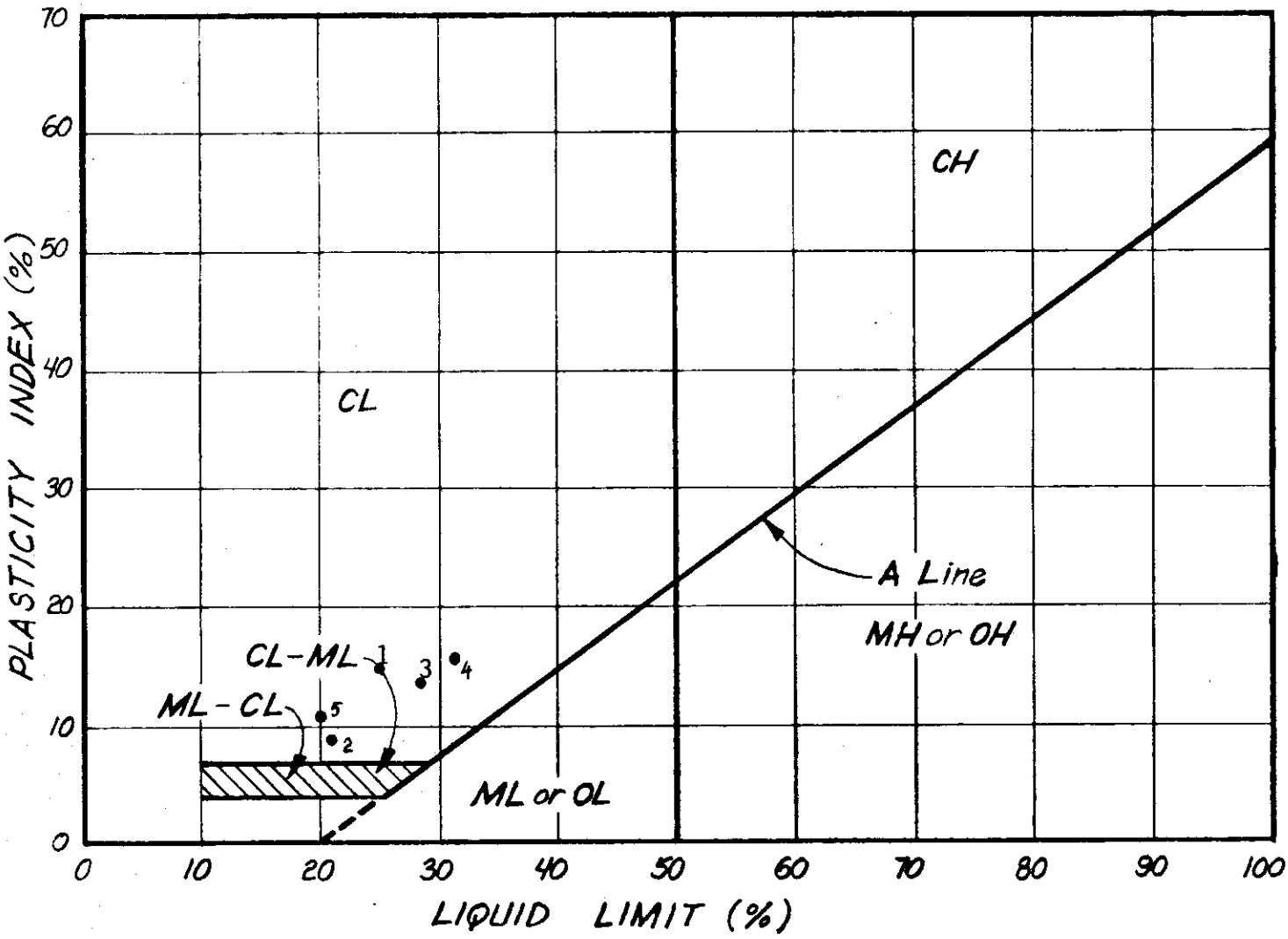
PLANT SITE



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-2-TD	0.5-1.5m	15.0	12.0	3.0	54
2	TP-5-TD	0.5-1.0m	25.0	15.2	9.8	42
3	TP-11-TD	1.5-2.5m	17.6	11.0	6.6	60
4	TP-12-TD	1.0-2.0m	21.6	13.6	8.0	87
5	TP-16-TD	3.5-4.5m	17.2	10.5	6.7	66

ELK RIVER COAL PROJECT

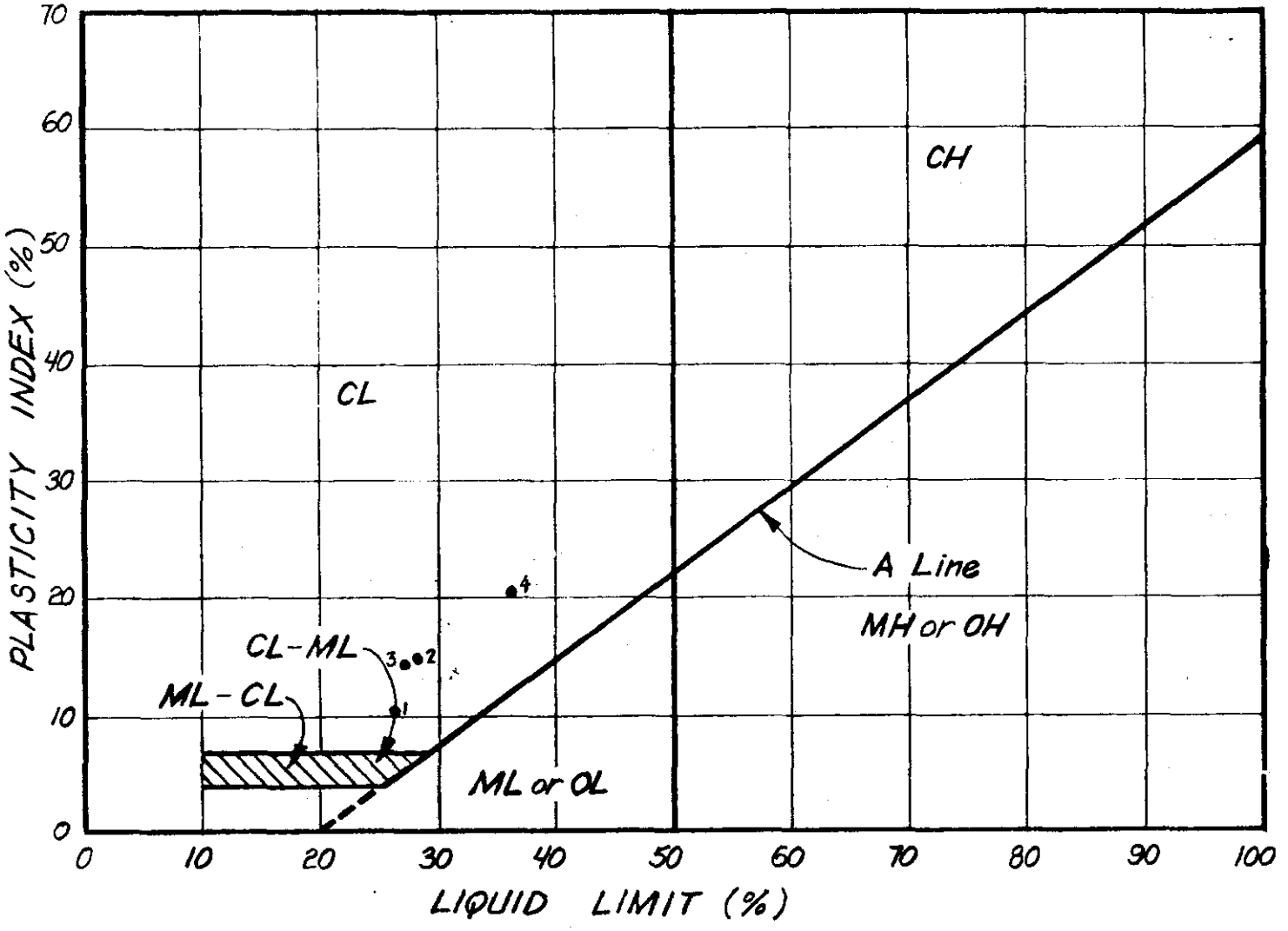
TAILINGS CONFINEMENT



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	DH-6-SP	4.6 m	25.0	14.5	10.5	84
2	DH-6-SP	6.1-7.6 m	21.4	13.6	7.8	84
3	DH-3-SP	6.1-8.1 m	28.0	14.1	13.9	88
4	DH-4-SP	4.6-6.6 m	31.2	15.5	15.7	94
5	DH-4-SP	10.7-12.6 m	20.0	8.8	11.2	84

ELK RIVER COAL PROJECT

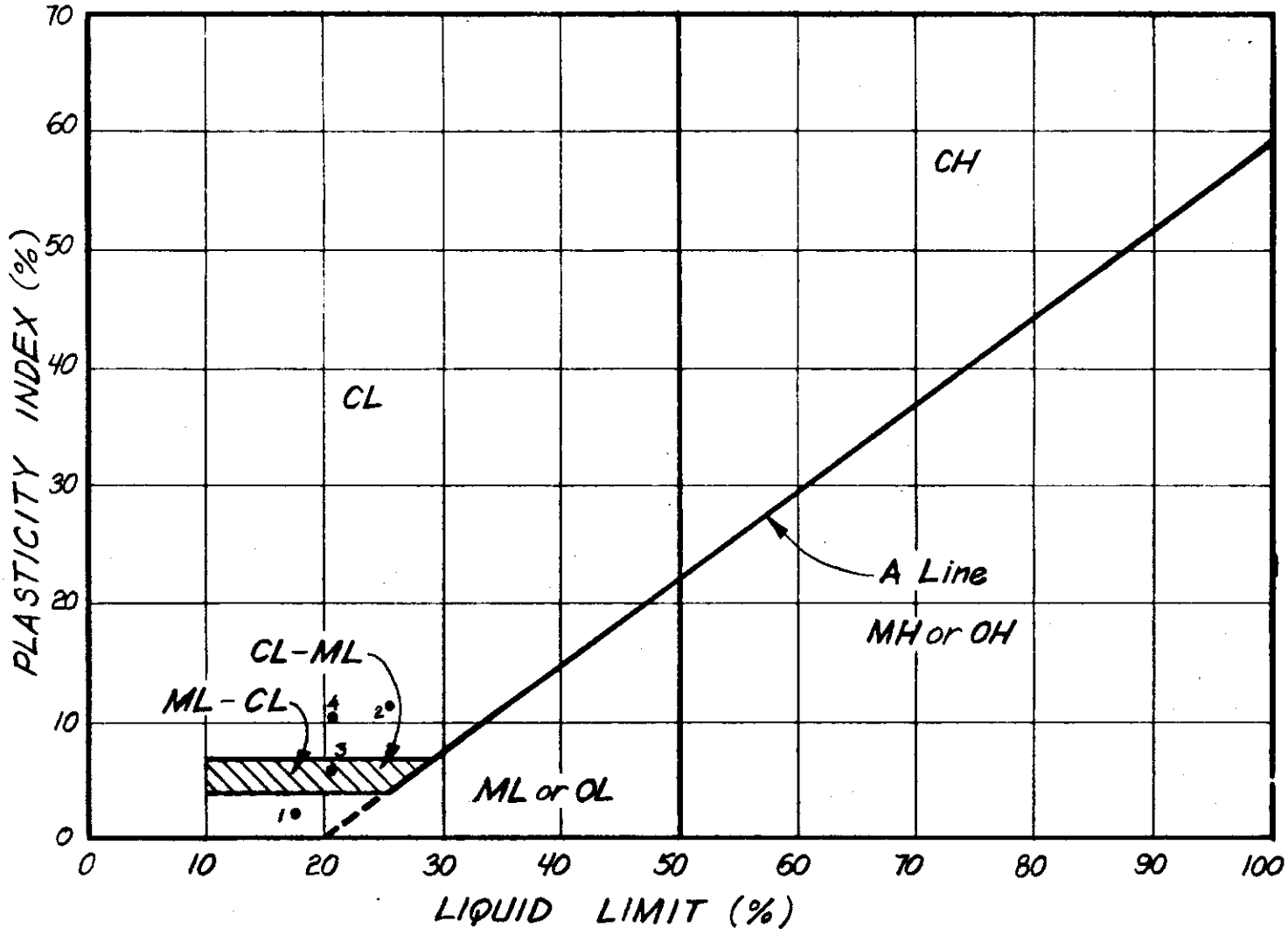
SETTLING POND



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-5-SP	4.6-5.2 m	26.3	16.1	10.2	88
2	TP-6-SP	1.7-2.5 m	28.5	13.4	15.1	90
3	TP-8-SP	3.5-4.0 m	27.3	12.5	14.8	92
4	TP-9-SP	3.0-4.0 m	36.4	15.8	20.6	100

ELK RIVER COAL PROJECT

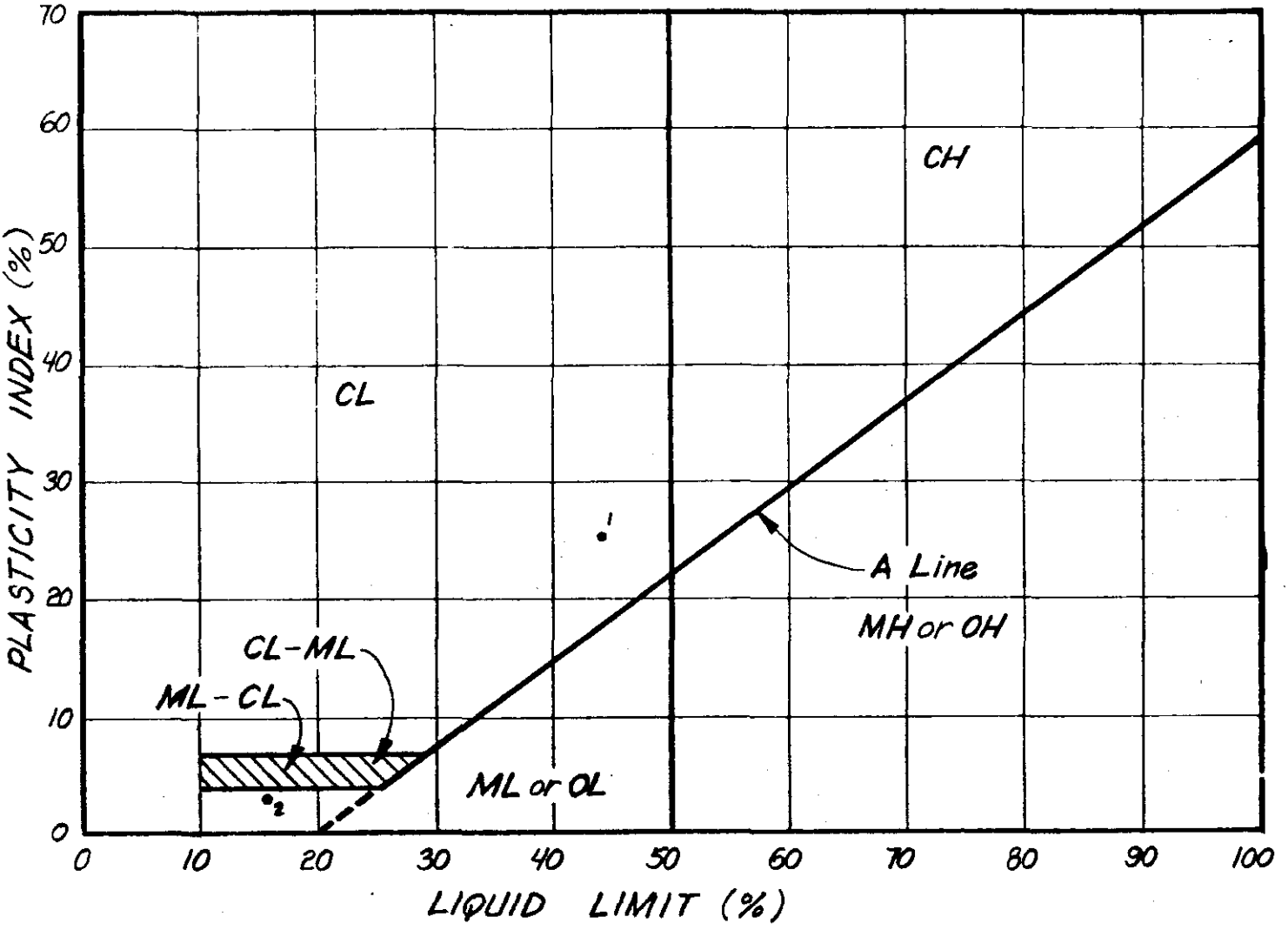
SETTLING POND



SYMBOL	CLASSIFICATION AND SOURCE		LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP-2-WC	3-5.8 m	17.0	15.2	1.8	70
2	TP-4-WC	3.7-4.6 m	25.2	13.3	11.9	86
3	TP-9-WC	5.8-6.4 m	20.4	15.1	5.3	86
4	TP-11-WC	3.4-5.3 m	20.9	10.7	10.2	82

ELK RIVER COAL PROJECT

WEARY VALLEY



SYMBOL	CLASSIFICATION AND SOURCE	LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	% PASSING #200 SIEVE
1	TP 2 FB 1.0 - 1.5 m	43.8	18.6	25.2	99
2	TP 4 FB 2.0 - 2.5 m	15.6	12.4	3.2	43

ELK RIVER COAL PROJECT

FORESTRY BYPASS ROAD

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT Elco Mining
JOB No. 9530-005-11-07
SITE (Batch #1)
SAMPLE P-1
LOCATION
HOLE TP-5-SP DEPTH 15'
TECHNICIAN BM DATE Aug. 18/80

SAMPLE DESCRIPTION Clay Till
(mix @ optimum moisture = 15.3%)

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^3
– final _____ cm^3
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	15.9	16.1

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ_W	2141	2155
DRY DENSITY γ_D	1848	1856

CONSTANT HEAD = (h) 21.6 psi=1524 cms (50')
HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	OUTFLOW ml ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
20/8/80	3:40pm			0			
	4:00pm			21 ml			
	5:00pm		4800 s	91 ml			

$\frac{h}{l} = i$; $\frac{Qt}{t \cdot h \cdot a} = \frac{91\ (11.43)}{4800\ (1524)\ (81)} = K = 1.7 \times 10^{-6}$ cm/sec.

$\frac{\text{S.G} \times \text{Dens of water} \times \text{Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐ UP ☒ DOWN ; SAMPLE: ☐ LOOSE ☐ SEMI-COMPACTED ☒ COMPACTED

COMMENTS _____

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT Elco Mining
JOB No. 9530-005-11-07
SITE (Batch #1)
SAMPLE P-2
LOCATION
HOLE TP-6-SP DEPTH 15'
TECHNICIAN BM DATE Aug 18/80

SAMPLE DESCRIPTION Clay Till
(mix @ optimum moisture = 14.2%)

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^3
– final _____ cm^3
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	13.7	15.8

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ W	2152	2180
DRY DENSITY γ D	1893	1883

CONSTANT HEAD = (h) 21.6psi = 1524 cms (50')

HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	OUTFLOW ml ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
21/8/80	11:00am		0	0 ml			
	11:28			17 ml			
	1:10pm			61 ml			
	3:30pm		16,200 s	106 ml			

$\frac{h}{l} = i$; $\frac{Ql}{t \cdot h \cdot a} = \frac{106\ (11.43)}{16{,}200\ (1524)\ (81)} = K = 6.1 \times 10^{-11}$ cm/sec.

$\frac{\text{S.G. x Dens of water x Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐ UP ☒ DOWN ; SAMPLE: ☐ LOOSE ☐ SEMI-COMPACTED ☒ COMPACTED

COMMENTS _____

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT	Elco Mining
JOB No.	9530-005-11-07
SITE	(Batch #2)
SAMPLE	P-3
LOCATION	
HOLE	TP-1-H DEPTH
TECHNICIAN	B.M. DATE Aug.22/80

SAMPLE DESCRIPTION Clay Till
(mix @ plastic limit = 11.5%)

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^3
– final _____ cm^3
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	11.1	12.5

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ W	1826	2239
DRY DENSITY γ D	1643	1990

CONSTANT HEAD = (h) 21.6 psi = 1524 cms (50)

HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	OUTFLOW ml ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
22/8/80	10:45am			0 ml			
	11:20			9 ml			
	11:45			14 ml			
	1:00pm			30 ml			
	2:00			39 ml			
	3:00			46 ml			
	4:00			54 ml			
	5:00		22,500 s	57 ml			

$\frac{h}{l} = i$; $\frac{Q l}{t \cdot h \cdot a} = \frac{57\ (11.43)}{22{,}500\ (1524)\ (81)} = K = 2.3 \times 10^{-11}$ cm/sec.

$\frac{\text{S.G. x Dens of water x Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐ UP ☒ DOWN ; SAMPLE: ☐ LOOSE ☐ SEMI-COMPACTED ☒ COMPACTED

COMMENTS _____

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT Elco Mining
JOB No. 9530-005-11-07
SITE (Batch #2)
SAMPLE
LOCATION P-4
HOLE TP-2-TD DEPTH
TECHNICIAN BM DATE Aug.26/80

SAMPLE DESCRIPTION Clay Till
(mix @ plastic limit = 12.0%)

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^3
– final _____ cm^3
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	11.5	11.9

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ W	2215	2203
DRY DENSITY γ D	1987	1968

CONSTANT HEAD = (h) 21.6psi = 1524 cms (50') HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	OUTFLOW ml ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
26/8/80	8:00pm		0 s	0 ml			
	2:40pm			4 ml			
27/8/80	8:00am			10 ml			
	2:00pm		108,000 s	12 ml			

$\frac{h}{l} = i$; $\frac{Q l}{t \cdot h \cdot a} = \frac{12\ (11.43)}{108{,}000\ (1524)\ (81)} = K = 1.0 \times 10^{-10}$ cm/sec.

$\frac{\text{S.G. x Dens of water x Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐UP ☒DOWN ; SAMPLE: ☐LOOSE ☐SEMI-COMPACTED ☒COMPACTED

COMMENTS Note: A plastic limit of 12.0% for this sample appears to be about 4% above the optimum moisture content.

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT	Elco Mining
JOB No.	9530-005-11-07
SITE	(Batch #2)
SAMPLE	P-5
LOCATION	
HOLE	(See comments) DEPTH
TECHNICIAN	B.M. DATE September 9, 1980

SAMPLE DESCRIPTION Clay till
(Mix @ plastic limit = 13.8%) NOTE: Opt. moist = 13.8% also.

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^2
– final _____ cm^2
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	13.8	15.1

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ W	2199	2226
DRY DENSITY γ D	1933	1934

CONSTANT HEAD = (h) 21.6 psi = 1524 cms (50 ft.)

HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	OUTFLOW ml ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
5/9/80	3:00pm			0			
8/9/80	11:00am			9 ml			
9/9/80	8:00am		320,400 s	21 ml			

$\frac{h}{l} = i$; $\frac{Ql}{t \cdot h \cdot a} = \frac{21\ (11.43)}{320{,}400\ (1524)(81)} = K = 6.1 \times 10^{-9}$ cm/sec.

$\frac{\text{S.G. x Dens of water x Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐ UP ■ DOWN ; SAMPLE: ☐ LOOSE ☐ SEMI-COMPACTED ■ COMPACTED

COMMENTS Combined sample of TP-5-ID and TP-12-ID

PERMEABILITY TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

PROJECT	Elco Mining
JOB No.	9530-005-11-07
SITE	(Batch #2)
SAMPLE	P-6
LOCATION	
HOLE	TP-16-TD DEPTH
TECHNICIAN	B.M. DATE September 12, 1980

SAMPLE DESCRIPTION Clay till
(Mix @ plastic limit = 10.5%)

SAMPLE DIAMETER _____ cm
SAMPLE LENGTH – initial (l_i) _____ cm
– final (l_f) 11.43 cm

CROSS SECTION AREA 81 cm^2
– initial _____ cm^2
– final _____ cm^2
– change _____ %

MOISTURE DETERMINATION	BEFORE	AFTER
CONTAINER NO.		
WT. WET SAMPLE & TARE		
WT. DRY SAMPLE & TARE		
TARE OF CONTAINER		
WT. OF WATER		
WT. OF DRY SOIL		
MOISTURE CONTENT	9.8	10.8

DENSITY	BEFORE	AFTER
MOLD NUMBER		
WT. SAMPLE & MOLD		
WT. MOLD		
WT. WET SAMPLE		
VOLUME OF MOLD		
WET DENSITY γ W	2303	2313
DRY DENSITY γ D	2098	2087

CONSTANT HEAD = (h) 21.6 psi = 1524 cms (50 ft.)

HYDRAULIC GRADIENT = (i) _____

DATE	TIME	ELAPSED TIME Δt sec	TOTAL ELAPSED TIME	OUTFLOW ml READING	ΔQ	K cms/sec. INITIAL	K cms/sec. AVERAGE
9/9/80	7:30am			0			
	2:00pm			2 ml			
10/9/80	10:00am			7 ml			
11/9/80	4:30pm		162,000 s	13 ml			

$\frac{h}{l} = i$; $\frac{Ql}{t \cdot h \cdot a} = \frac{13\ (11.43)}{162{,}000\ (1524)(81)} = K = 7.4 \times 10^{-9}$ cm/sec.

$\frac{\text{S.G. x Dens of water x Vol.}}{\text{Dry wt.}}$ = Void ratio

DIRECTION OF HYDRAULIC FLOW: ☐ UP ■ DOWN ; SAMPLE: ☐ LOOSE ☐ SEMI-COMPACTED ■ COMPACTED

COMMENTS _____

CONSOLIDATION TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

Project: Elco Mining
Site: Job #9530-005-11-07
Sample: Batch #1
Location:
Hole: TP-5-SP Depth:
Technician: B.M. Date: 11/9/80

Specific Gravity of Soil Solids G_s = 2.685 Height of Soil Solids H_s = 0.656 ins.

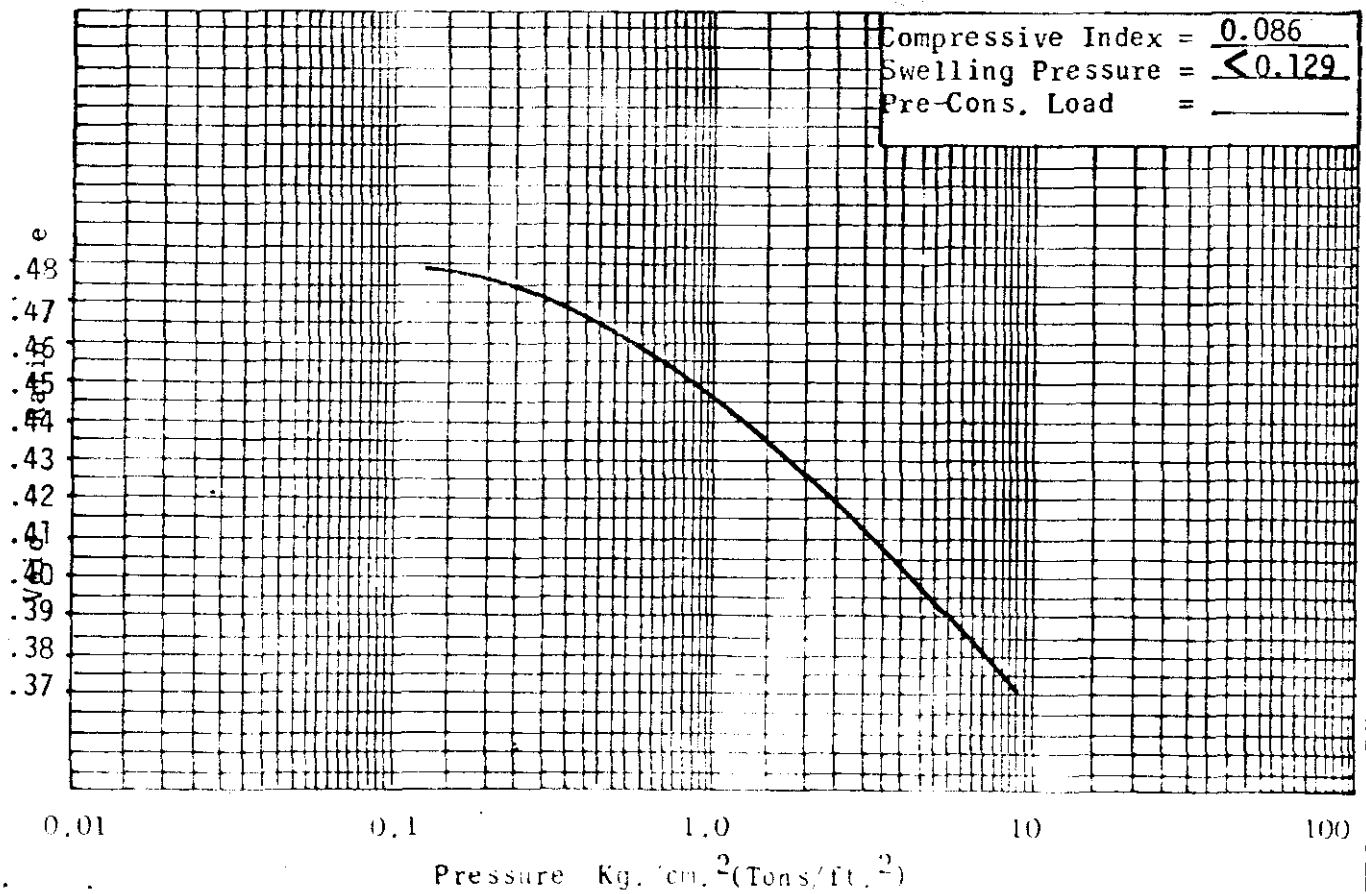
Void Ratio e(End) = 0.139 x 2.685 = 0.3732

Void Ratio e(Start)=

Void Ratio e(Start Dimensions)=

e(End)=W%(End) x G_s $H_s = \left(\frac{\text{Wt. Soil}}{G_s \times \text{Area} \times 2.54}\right)$ ins. e=previous e $\pm \frac{\text{Defl.}}{H_s}$

Time Interval	Load on Pan (gms)	Corr. Dial Reading(ins)	Deflection (ins.)	$\frac{\text{Deflection}}{H_s}$	Void Ratio e	Pressure $Kg/cm^2 = T/ft^2$
	0	1213				0
24 hour	500	1344	-.0131	+0.0200	.4785	0.129
Intervals	1000	1388	-.0044	0.0067	.4718	0.258
	2000	1462	-.0074	0.0113	.4605	0.517
	4000	1572	-.0110	0.0168	.4437	1.033
	8000	1691	-.0119	0.0181	.4256	2.067
	16,000	1837	-.0146	0.0222	.4034	4.134
	32,000	2035	-.0198	0.0302	.3732	8.268



CONSOLIDATION TEST

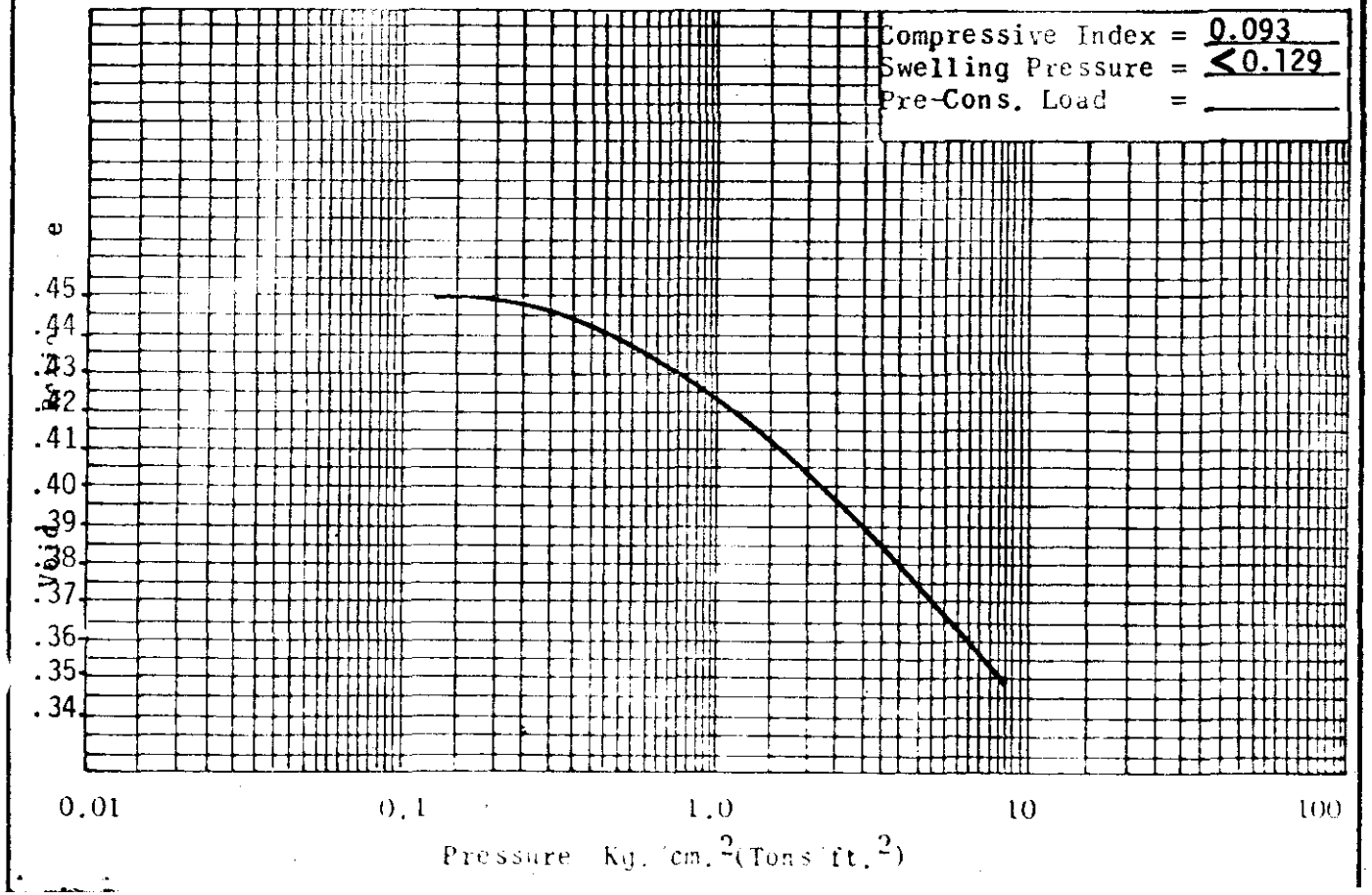
Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

Project: Elco Mining
Site: Job #9530-005-11-07
Sample: Batch #1
Location:
Hole: TP-6-SP Depth:
Technician: B.M. Date: 11/9/80

Specific Gravity of Soil Solids G_s = 2.650 Height of Soil Solids H_s = 0.678 ins.
Void Ratio e(End) = 0.132 x 2.650 = 0.3498
Void Ratio e(Start)=
Void Ratio e(Start Dimensions)=

e(End)=W%(End) x G_s $H_s = \left(\frac{\text{Wt. Soil}}{G_s \times \text{Area} \times 2.54}\right)$ ins. e=previous e $\pm \frac{\text{Defl.}}{H_s}$

Time Interval	Load on Pan (gms)	Corr. Dial Reading(ins)	Deflection (ins.)	$\frac{\text{Deflection}}{H_s}$	Void Ratio e	Pressure $Kg/cm^2 = T/ft.^2$
	0	0771				0
24 hour	500	0861	-0.0090	+0.0133	0.4499	0.129
intervals	1000	0899	-0.0038	+0.0056	0.4443	0.258
	2000	0962	-0.0063	+0.0093	0.4350	0.517
	4000	1064	-0.0102	+0.0150	0.4200	1.033
	8000	1186	-0.0122	+0.0180	0.4020	2.067
	16,000	1347	-0.0161	+0.0237	0.3783	4.134
	32,000	1540	-0.0193	+0.0285	0.3498	8.268



CONSOLIDATION TEST

Job: 9530-005-11-07

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

Project:	Elco Mining
Site:	Batch #2
Sample:	C-4
Location:	
Hole:	TP-1-H Depth:
Technician:	B.M. Date: 23/09/80

Specific Gravity of Soil Solids G_s = 2.583 Height of Soil Solids H_s = 0.727 ins.

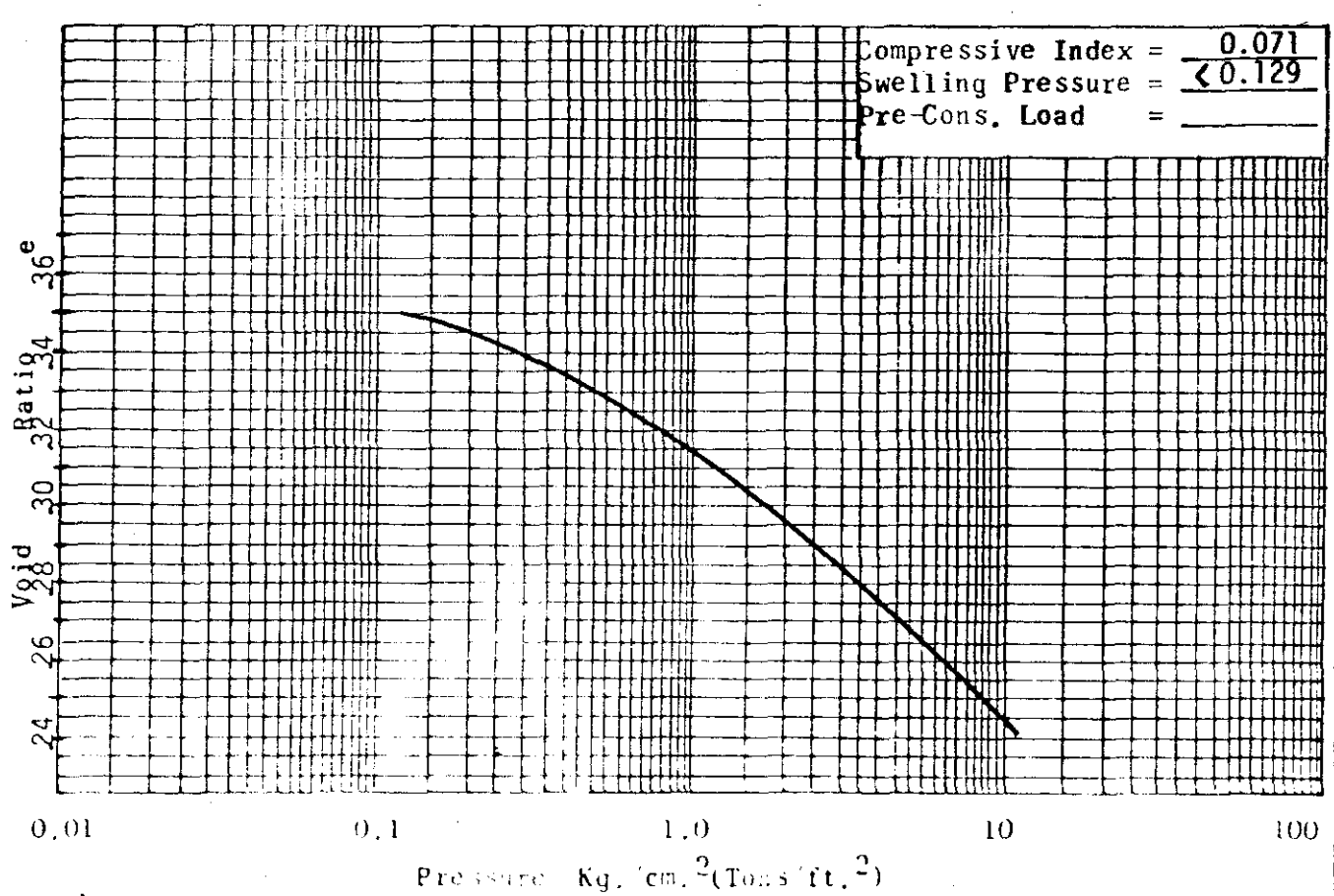
Void Ratio e(End) = .099 x 2.583 = 0.2557

Void Ratio e(Start) =

Void Ratio e(Start Dimensions) =

e(End) = W%(End) x G_s $H_s = \left(\frac{\text{Wt. Soil}}{G_s \times \text{Area} \times 2.54}\right)$ ins. e = previous e $\pm \frac{\text{Defl.}}{H_s}$

Time Interval	Load on Pan (gms)	Corr. Dial Reading (ins)	Deflection (ins.)	Deflection / H_s	Void Ratio e	Pressure $Kg/cm^2 = T/ft^2$
24	0	1595			0.3696	0
HOUR	500	1751	0.0156	0.0214	0.3482	0.129
INTERVALS	1,000	1801	0.0050	0.0069	0.3413	0.258
	2,000	1914	0.0113	0.0155	0.3258	0.517
	4,000	2024	0.0110	0.0151	0.3107	1.033
	8,000	2145	0.0121	0.0166	0.2941	2.067
	16,000	2285	0.0140	0.0192	0.2749	4.134
	32,000	2425	0.0140	0.0192	0.2557	8.268



CONSOLIDATION TEST

Job: 9530-005-11-07

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta

Project: Elco Mining
Site: Batch #2
Sample: C-3
Location:
Hole: TP-5-TD & TP-12-TD Depth:
Technician: B.M. Date: 23/09/80

Specific Gravity of Soil Solids G_s = 2.591 Height of Soil Solids H_s = 0.697 ins.

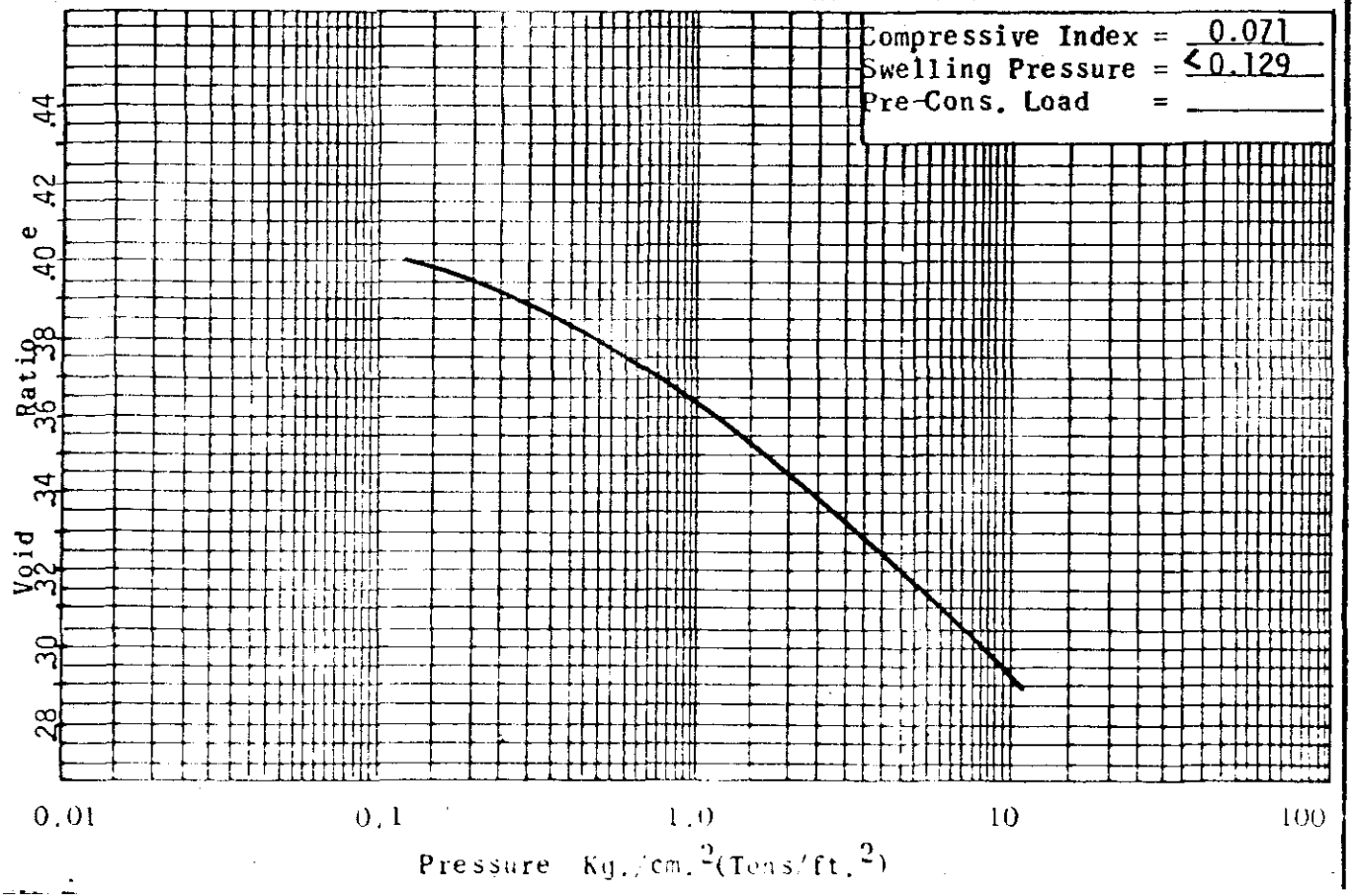
Void Ratio e(End) = .114 x 2.591 = 0.2954

Void Ratio e(Start) =

Void Ratio e(Start Dimensions) =

e(End) = W%(End) x G_s $\quad H_s = \left(\frac{\text{Wt. Soil}}{G_s \times \text{Area} \times 2.54}\right)$ ins. $\quad e = \text{previous } e \pm \frac{\text{Defl.}}{H_s}$

Time Interval	Load on Pan (gms)	Corr. Dial Reading (ins)	Deflection (ins.)	$\frac{\text{Deflection}}{H_s}$	Void Ratio e	Pressure $Kg/cm^2 = T/ft^2$
24	0	1414			0.4238	0
HOUR	500	1604	-0.0190	0.0273	0.3965	0.129
INTERVALS	1,000	1674	-0.0070	0.0100	0.3865	0.258
	2,000	1768	-0.0094	0.0135	0.3730	0.517
	4,000	1887	-0.0119	0.0171	0.3559	1.033
	8,000	2008	-0.0121	0.0174	0.3385	2.067
	16,000	2150	-0.0142	0.0204	0.3181	4.134
	32,000	2308	-0.0158	+0.0227	0.2954	8.268

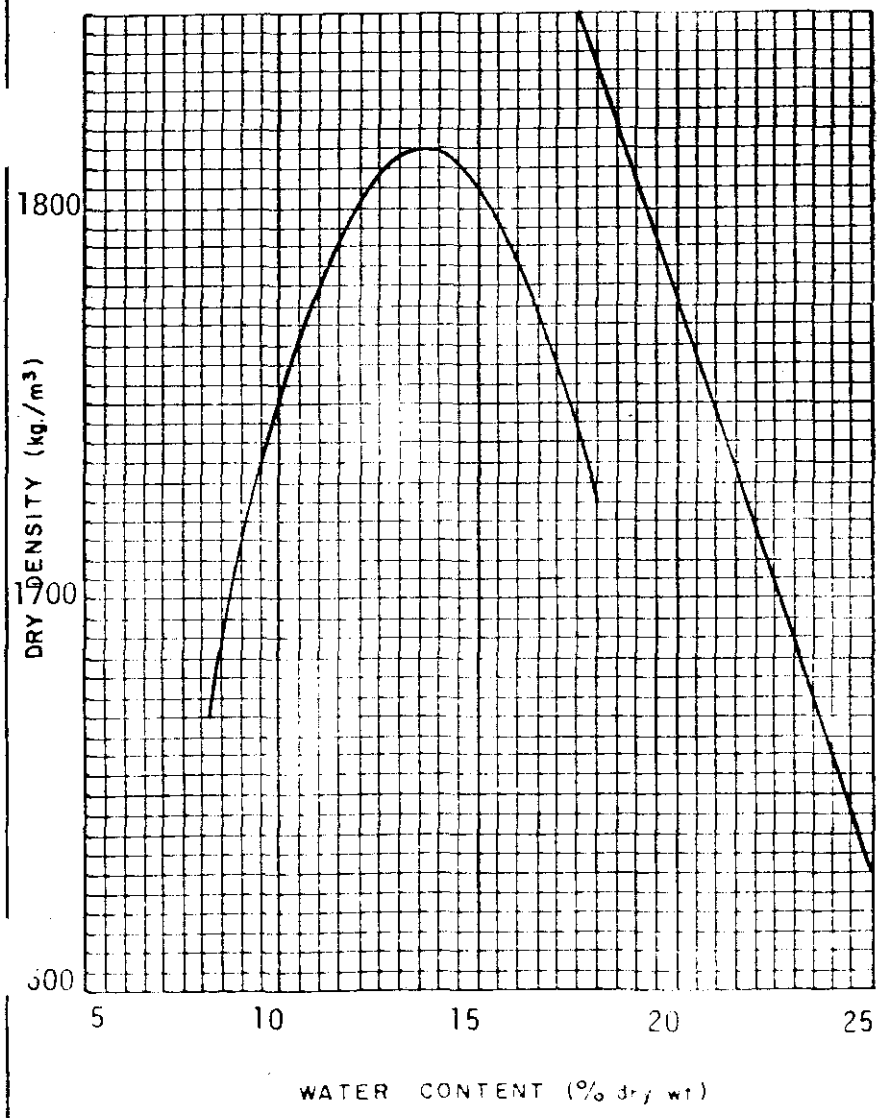


PROCTOR TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta
the uma group

PROJECT Elco Mining
JOB No. 9530-005-11-07
SITE
SAMPLE C-4
LOCATION
HOLE | DEPTH
TECHNICIAN G.M. | DATE Aug.20/80

TRIAL No.	1	2	3	4	5		
DENSITY DETERMINATION							
Mold Number							
Volume of Mold (c.c.)							
Wt. Sample wet + mold (g.)							
Wt. Mold (g.)							
Wet Density (kg./m.³)							
Dry Density (kg./m.³)	1654	1683	1790	1813	1740		
WATER CONTENT DETERMINATION							
Tare Number							
Wt. Sample wet + tare (g.)							
Wt. Sample dry + tare (g.)							
Wt. Tare (g.)							
Wt. Dry Soil (g.)							
Wt. Water (g.)							
Water Content (%)	8.3	9.7	12.0	14.1	16.4		



At Optimum –
w% 13.8%
γ 1815 kg/m³

Method of Compaction – standard proctor

Dia. of Mold (cm.) 10
No. of Layers 3
No. of Blows per Layer 25
Ht of Free Fall (cm.) 30
Wt. of Tamper (g.) 2500
Shape of Tamping Face Flat

Description of Sample –
organic clay till

NOTES:
Dry Density = $\gamma d \frac{\gamma t}{1+w}$
Wet Density = Wt. comp. soil − Wt. mold

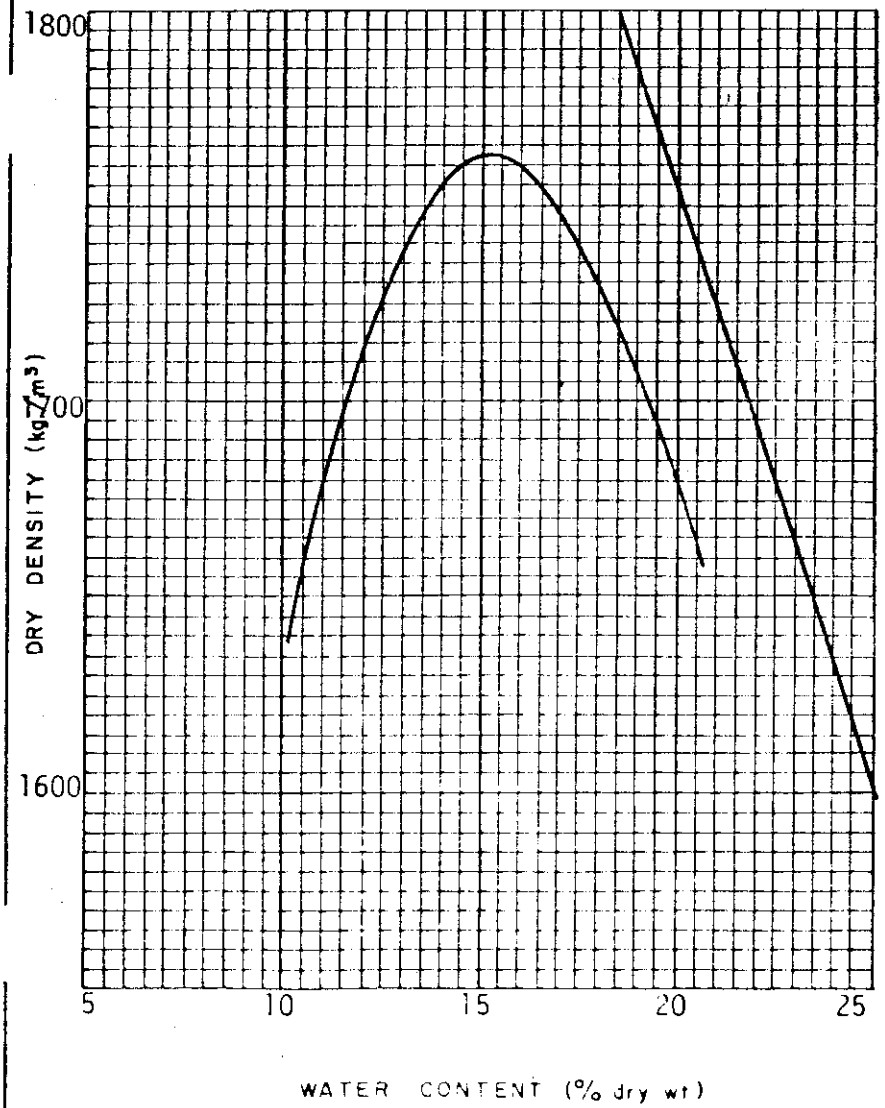
REMARKS:
combined sample of TP-5-TD and TP-12-TD

PROCTOR TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta
the UMA group

PROJECT	Elco Mining
JOB No.	9530-005-11-07
SITE	
SAMPLE	T.P. 5 SP
LOCATION	
HOLE	DEPTH
TECHNICIAN	C.N.
DATE	Aug. 12/80

TRIAL No.	1	2	3	4	5		
DENSITY DETERMINATION							
Mold Number							
Volume of Mold (c.c.)							
Wt. Sample wet + mold (g.)							
Wt. Mold (g.)							
Wet Density (kg./m.^{3})							
Dry Density (kg./m.^{3})	1623	1653	1759	1697	1667		
WATER CONTENT DETERMINATION							
Tare Number							
Wt. Sample wet + tare (g.)							
Wt. Sample dry + tare (g.)							
Wt. Tare (g.)							
Wt. Dry Soil (g.)							
Wt. Water (g.)							
Water Content (%)	10.2	12.6	15.8	18.7	19.9		



At Optimum –
w% 15.3%
γ 1763 kg/m^3

Method of Compaction – Standard Proctor

Dia. of Mold (cm.) 10
No. of Layers 3
No. of Blows per Layer 25
Ht of Free Fall (cm.) 30
Wt. of Tamper (g.) 2500
Shape of Tamping Face Flat

Description of Sample –
-silty clay till

NOTES:
Dry Density = $\delta d \frac{\delta t}{1+w}$

Wet Density = Wt. comp. soil − Wt. mold

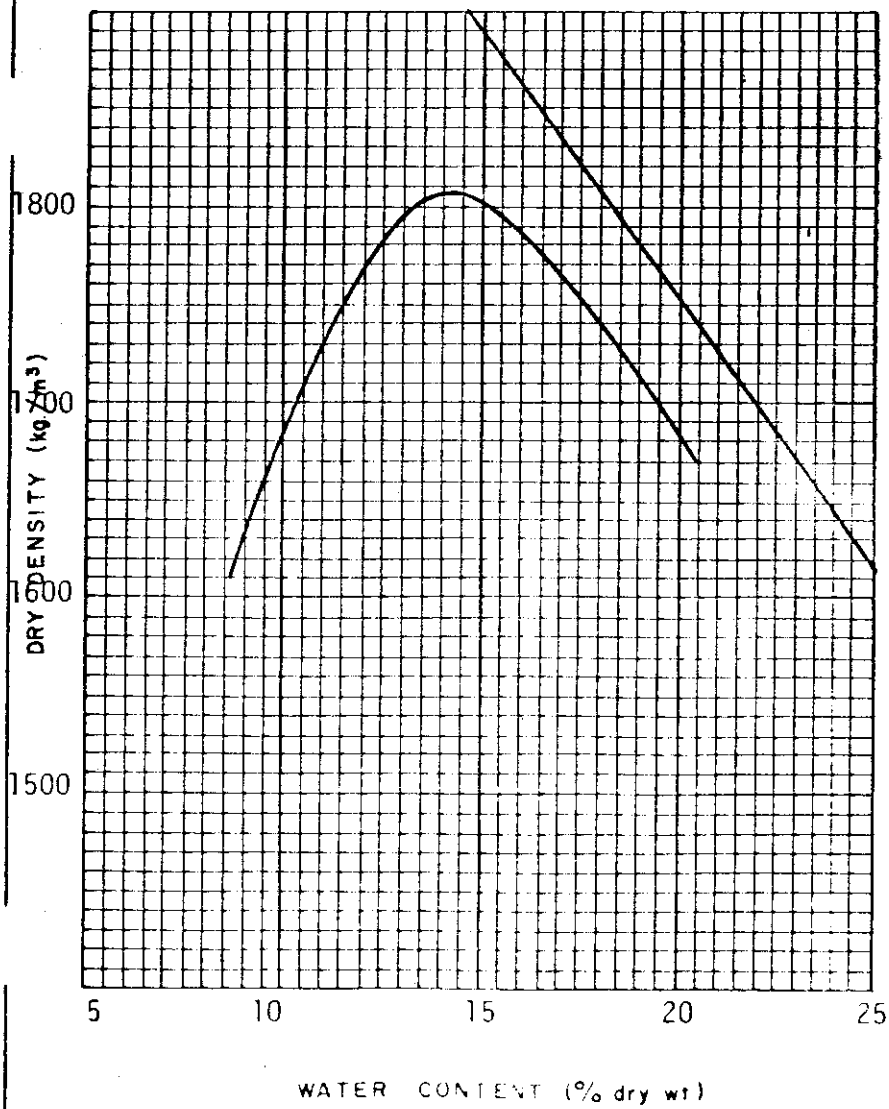
REMARKS:

PROCTOR TEST

Underwood McLellan Ltd.
Consulting Engineers and Planners
Calgary, Alberta
the UMA group

PROJECT	Elco Mining
JOB No.	9530-005-11-07
SITE	
SAMPLE	I.P. 6 SP
LOCATION	
HOLE	DEPTH
TECHNICIAN	T.Z.
DATE	Aug. 12/80

TRIAL No.	1	2	3	4			
DENSITY DETERMINATION							
Mold Number							
Volume of Mold (c.c.)							
Wt. Sample wet + mold (g.)							
Wt. Mold (g.)							
Wet Density (kg./m.^{3})							
Dry Density (kg./m.^{3})	1496	1806	1783	1723			
WATER CONTENT DETERMINATION							
Tare Number							
Wt. Sample wet + tare (g.)							
Wt. Sample dry + tare (g.)							
Wt. Tare (g.)							
Wt. Dry Soil (g.)							
Wt. Water (g.)							
Water Content (%)	8.2	14.0	16.3	18.1			



At Optimum –
w% 14.2%
γ 1806 kg/m^3

Method of Compaction – Standard Proctor

Dia. of Mold (cm.) 10
No. of Layers 3
No. of Blows per Layer 25
Ht of Free Fall (cm.) 30
Wt. of Tamper (g.) 2500
Shape of Tamping Face Flat

Description of Sample –
-silty clay till

NOTES:
Dry Density = $\delta d \frac{\delta t}{1+w}$

Wet Density = Wt. comp. soil − Wt. mold

REMARKS:

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/Pumpwell
Sheet 1 of 3

Job No. 802-1538

Project ELK RIVER COAL

Type of drilling Rotary

Rig Bucyrus-Erie 12R

Drilling fluid Air/Foam

Coordinates: E 6958.77
N 14601.64

Angle from horizontal Vertical

Bearing ____ ° Azimuth

Reference elevation 1733.11
Elevation type: surveyed [X] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments
GROUND SURFACE 0										
OVERBURDEN 7.0	7.0									
INTERBEDDED SLST-MDST AND COAL 10.7										
SILTSTONE 18.3										
20 INTERBEDDED SLST-MDST + COAL 21.3										
SANDSTONE 22.8										
INTERBEDDED SST + SLST 25.9										
30	152 mm									
SANDSTONE										
40 41.1										
SILTSTONE										
50	203 mm									
58.8										
60 #4 COAL										
68.0										
70 INTERBEDED SST-SLST + COAL 71.0										
#4A COAL 74.7										
SILTSTONE 77.7										
COAL 79.6										
80 INTERBEDDED SLST + SST 82.3										
SANDSTONE										
90										

Contractor: Drillwell
Date started: Aug. 10/80
Date finished: Aug. 16/80

Logged by: D.H.
Checked by: D.F.
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/Pumpwell
Sheet 2 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
90										
SANDSTONE 93.0										
SANDSTONE WITH SOME INTERBEDDED SILTSTONE										
100 100.6	203 mm									
SANDSTONE 102.1										
SILTSTONE 103.3	103.6									
#3 COAL 104.8										
INTERBEDDED SST AND SLST										
110										
112.8	113.0									
SILTSTONE 117.3										
SANDSTONE 118.8										
120 INTERBEDDED SLST + SST 121.9										
#2 COAL 125.3										
COAL + SLST 126.0										
SANDSTONE										
130	3, st, 3.2									
133.2										
#1 COAL 133.5										
SANDSTONE										
140										
144.8	152 mm									
SST - SOME SLST 146.3										
150										
160										
SANDSTONE										
170										
180										

Contractor

Logged by

Date started

Checked by

Date finished

Date

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale:

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/Pumpwell
Sheet 3 of 3

Job No.

Project .....

Type of drilling ..... Coordinates: E .....

Rig ..... N .....

Drilling fluid ..... Angle from horizontal .....

Bearing ..... °Azimuth

Reference elevation .....

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole .....

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
180										
SANDSTONE 182.9	3,BE,3.2 182.9									
END OF HOLE										

Contractor: ..... Logged by: .....

Date started: ..... Checked by: .....

Date finished: ..... Date: .....

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale:

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 1
Sheet 1 of 2

Job No. 802-1538

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus-Erie 128

Drilling fluid Air/Foam

Coordinates: E 6923.78
N 14612.35

Angle from horizontal Vertical

Bearing ____ *Azimuth

Reference elevation 1721.43

Elevation type: surveyed ☒ altimeter ☐ from map ☐

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN 3.0										
SANDSTONE										
10 10.7										
SHALE 11.9	11.2									
#7 COAL 13.7										
SILTSTONE										
20 19.8										
SANDSTONE 24.4										
COAL + SHALEY COAL 25.9										
30										
SILTSTONE	152 mm									
40 39.9										
SANDSTONE 45.4										
INTERBEDDED SST+SLST 47.2										
50										
SANDSTONE										
	58.7									
	59.0									
60	60.8(1)									
	62.8									
	63.6									
68.5										
70 SILTSTONE 73.2										
INTERBEDDED MDST+SLST 75.0										
SHALEY COAL 76.2										
#4 COAL										
80										
83.5	82.3									
SILTSTONE 85.3										
SANDSTONE 86.9										
MUDSTONE 88.3										
#4A COAL 90.0										
90										

Contractor: Drillwell
Logged by: D.M.

Date started: Aug. 4/80
Checked by: D.K.

Date finished: Aug. 7/80
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 1
Sheet 2 of 2

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
90										
MUDSTONE										
99.0										
100 SILTSTONE 100.5										
INTERBEDDED SST+SLST 102.0										
110										
SANDSTONE										
120 121.3										
#3 COAL 122.8										
MUDSTONE 123.4										
INTERBEDDED SLST + SST 126.4										
SANDSTONE 131.0	152 mm									
130										
SILTSTONE										
139.9										
140										
#2 COAL										
145.7										
150 SANDSTONE										
152.0										
#1 COAL 152.4										
	156.3 156.6(1)									
160	160.5 161.2									
SANDSTONE										
170										
	174.7 175.1 177.1(1)									
179.8	179.8									
180 END OF HOLE										

Contractor: Logged by:

Date started: Checked by:

Date finished: Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 2
Sheet 1 of 2

Job No. 802-1538

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus Erie 12R

Drilling fluid Air/Foam

Coordinates E 6961.80
N 14621.84

Angle from horizontal Vertical

Bearing ..... *Azimuth

Reference elevation 1732.81

Elevation type: surveyed [x] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability (8) Method	Permeability (8) Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN 4.3										
INTERBEDDED SANDSTONE AND SILTSTONE	7.0									
10										
13.7										
SILTSTONE 16.8										
SANDSTONE 18.3										
#4 COAL 19.5										
20										
30										
SANDSTONE										
40	152 mm									
47.2										
50										
SILTSTONE										
57.3										
COAL 57.9										
60 SILTSTONE 59.1										
#4 COAL										
67.0										
INTERBEDDED COAL AND										
70 SANDSTONE 70.1										
SLST 71.0										
#4A COAL 74.0										
MUDSTONE 77.7										
SLST 78.9										
80 COAL 80.1										
SILTSTONE 83.8										
SANDSTONE										
90										

Contractor: Drillwell
Logged by: D.M.
Date started: Aug. 7/80
Checked by: D.K.
Date finished: Aug. 9/80
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 2
Sheet 2 of 2

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing °Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments

90

SANDSTONE

100

105.2

#3 COAL 108.2

110 INTERBEDDED SLST AND SST 112.8

SANDSTONE 114.3 — 152 mm

SILTSTONE 115.8

INTERBEDDED SLST AND SST 118.8

120 SLST 120.3

SANDSTONE 122.8

SILTSTONE 124.7

#2 COAL

130 130.5

131.3
131.5
132.5(1)

SANDSTONE

135.5
136.2

136.8

#1 COAL 137.1

140

140.7
141.1

SANDSTONE

142.9(1)
144.3
144.7

146.3

INTERBEDDED SST AND SLST 149.4

150 SLST 150.9

SANDSTONE

160

163.2
163.7
165.3(1)

167.6

167.6

END OF HOLE

170

180

Contractor:

Logged by:

Date started:

Checked by:

Date finished:

Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 3
Sheet 1 of 2

Job No. 802-1538

Project: ELK RIVER COAL

Type of drilling: Rotary/Hammer

Rig: Bucyrus - Erie 12R

Drilling fluid: Air/Foam

Coordinates: E 6973.90
N 14700.78

Angle from horizontal: Vertical

Bearing: * Azimuth

Reference elevation: 1731.26
Elevation type: surveyed [X] altimeter [ ] from map [ ]

Purpose of hole: Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
0 GROUND SURFACE										
OVERBURDEN 4.4	5.9									
10 SANDSTONE										
20										
30										
35.4 SILTSTONE 36.5										
SST 38.1										
#1 COAL 38.4										
40 INTERBEDDED SLST AND SST 43.3										
#4 COAL	152 mm									
50										
53.9 INTERBEDDED SLST AND SST 56.7										
#4A COAL										
60 60.7 SILTSTONE										
66.1 COAL 66.4										
SLST 69.2										
70										
SANDSTONE										
80										
90 89.6										

Contractor: Drillwell
Logged by: D.M.
Date started: Aug. 13/80
Checked by: D.K.
Date finished: Aug. 15/80
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 3
Sheet 2 of 2

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing °Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
90										
#3 COAL 91.1										
SILTSTONE 94.5										
SANDSTONE 97.2										
SILTSTONE 98.7										
100 SANDSTONE 100.6										
INTERBEDDED SST AND SLST 102.4										
SILTSTONE 104.9										
SANDSTONE 107.2										
SLST 108.2	152 mm									
110										
#2 COAL 114.3										
SANDSTONE										
120 120.7										
#1 COAL 121.0										
SANDSTONE										
130										
137.1	137.1									
END OF HOLE										
140										

98.5
99.1
100.7(1)
102.5
103.0
116.0
116.4
118.0
119.5
120.1
124.5
125.2
126.7(1)
128.2
129.1

Contractor:
Logged by:
Date started:
Checked by:
Date finished:
Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 4
Sheet 1 of 2

Job No. 802-1338

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus Erie 12R

Drilling fluid Air/Foam

Coordinates: E 7047.88
N 14591.76

Angle from horizontal Vertical

Bearing ____ °Azimuth

Reference elevation 1774.49

Elevation type: surveyed [x] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN 4.6	4.0									
10 SANDSTONE										
20 21.0										
SHALE 22.9										
SANDSTONE 24.4										
SLST 25.2										
SANDSTONE 27.4										
SHALE 29.0										
30 #4 COAL 37.3										
MUDSTONE 39.0										
40 INTERBEDDED SST AND SLST 41.1										
#4A COAL 45.1										
MUDSTONE										
50 51.8	152 mm									
SILTSTONE 54.6										
INTERBEDDED SST AND SLST 57.9										
60 SANDSTONE										
70 78.0										
#3 COAL 79.9										
80 MUDSTONE 81.4										
SANDSTONE 87.2										
90 SILTSTONE										

Contractor: Drillwell
Date started: Aug. 1/80
Date finished: Aug. 4/80

Logged by: D.M.
Checked by: D.K.
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Footwall/O.W. 4
Sheet 2 of 2

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
90										
SILTSTONE 93.6										
SANDSTONE 96.0										
SILTSTONE 98.5										
100	100.3									
#2 COAL	100.8									
	102.1(1)									
104.2	103.0									
	103.8									
SANDSTONE										
110 110.0										
#1 COAL 110.3										
	114.6									
	115.1									
	115.8(1)									
	116.7									
	117.3									
120										
SANDSTONE										
130										
	152 mm									
140										
	147.8									
	148.9									
150	150.7(1)									
151.8	151.8									
END OF HOLE										

Contractor: Logged by:

Date started: Checked by:

Date finished: Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/Pumpwell
Sheet 1 of 3

Job No. 802-1538

Project: ELK RIVER COAL

Type of drilling: Rotary/Hammer
Rig: Bucyrus Erie 12R
Drilling fluid: Air/Revert

Coordinates: E 6438.55
N 18995.28
Angle from horizontal: Vertical
Bearing: ____ *Azimuth

Reference elevation: 1605.7
Elevation type: surveyed [x] altimeter [ ] from map [ ]
Purpose of hole: Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN	203 mm									
21.6	21.6									
SANDSTONE 25.9										
INTERBEDDED SILTSTONE AND MUDSTONE 30.5										
SILTSTONE 33.5										
INTERBEDDED SLST AND MDST 36.6										
SILTSTONE 49.4	48.8									
#10 COAL 51.8	3,st,3.2									
SILTSTONE 55.2	54.9									
INTERBEDDED SST AND SLST 57.9										
SANDSTONE 62.5	152 mm									
SILTSTONE 64.9	64.0									
#9 COAL 70.4										
SILTSTONE 76.2										
SST AND SLST 77.7										
SANDSTONE	3,st,3.2									
90										

Contractor: Drillwell
Date started: Aug. 31/80
Date finished: Sept. 7/80

Logged by: D.M.
Checked by: D.K.
Date: Oct. 30/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/Pumpwell
Sheet 2 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability (8) Method	Permeability (8) Value (cm/s)	Comments
90										
SST 91.4	3,st,3.2									
SILTSTONE	94.5									
100										
101.4 COAL 102.7										
SILTSTONE WITH SOME COAL	203 mm									
110 111.2 MUDSTONE 112.8	112.8									
SILTSTONE 118.6	152 mm									
120 #8 COAL 126.4	3,st,3.2									
130	131.0									
140 SILTSTONE										
150 157.0										
160 INTERBEDDED SILTSTONE AND SANDSTONE	164.6									
170 173.8	3,st,3.2									
SANDSTONE 180										

Contractor: Logged by:

Date started: Checked by:

Date finished: Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/Pumpwell
Sheet 3 of 3

Job No.

Project .....

Type of drilling ..... Coordinates: E .....

Rig ..... N .....

Drilling fluid ..... Angle from horizontal .....

Bearing ..... *Azimuth

Reference elevation .....

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole .....

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
180										
SANDSTONE	203 mm 3,st,3.2 152 mm									
184.4	184.4									
END OF HOLE										

Contractor: ..... Logged by: .....

Date started: ..... Checked by: .....

Date finished: ..... Date: .....

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 1
Sheet 1 of 3

Job No. 802-133A

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus Erie 12R

Drilling fluid Air/Foam

Coordinates: E 6480.61
N 18959.26

Angle from horizontal Vertical

Bearing ____ *Azimuth

Reference elevation 1606.01
Elevation type: surveyed [X] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN										
10										
16.8										
SANDSTONE 19.8	18.0									
20										
SILTSTONE 24.4										
#9 COAL 28.7										
INTERBEDDED SLST + MDST 30.5										
30										
SANDSTONE	152 mm									
40										
45.7										
SILTSTONE 51.8										
50										
SANDSTONE	51.5 52.4 53.9(1) 55.7 56.7									
59.1										
60 COAL 61.3										
70 SILTSTONE 73.1										
SLST SOME COAL 74.7										
INTERBEDDED SLST AND SST 77.7										
SLST 79.0										
80										
#8 COAL 84.7										
SLST 85.9										
#8 COAL 87.8										
COAL AND SHALE 89.9										
90										

Contractor: Drillwell
Logged by: D.M.
Date started: Aug. 28/80
Checked by: D.K.
Date finished: Aug.31/80
Date: Nov. 12/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 1
Sheet 2 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing °Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments

90

SILTSTONE

94.5

INTERBEDDED SLST AND SST

99.0

100 SST 100.6

SILTSTONE

109.7

110

INTERBEDDED SLST AND SST

114.3

120 SANDSTONE

123.4

SILTSTONE 125.0

130

SANDSTONE

140

143.3

INTERBEDDED MDST, SLST+COAL

144.8

#4 COAL

150

156.0

MUDSTONE

163.0

INTERBEDDED SLST AND COAL

173.7

SILTSTONE

152 mm

131.3
131.9
134.8
137.6(1)
139.2
140.2
146.2
147.0
148.1(1)
151.0
151.7
176.8

Contractor:

Logged by:

Date started:

Checked by:

Date finished:

Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 1
Sheet 3 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing °Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
180										
SILTSTONE 182.9	152 mm 182.9									
END OF HOLE										
190										

Contractor:

Logged by:

Date started:

Checked by:

Date finished:

Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 2
Sheet 1 of 3

Job No. 802-1538

Project: ELK RIVER COAL

Type of drilling: Rotary/Hammer
Rig: Bucyrus Erie 12R
Drilling fluid: Air/Foam

Coordinates: E 6422.3
N 18997.93
Angle from horizontal: Vertical
Bearing: *Azimuth

Reference elevation: 1605.6
Elevation type: surveyed [X] altimeter [ ] from map [ ]
Purpose of hole: Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	After Drilling: Permeability (8) Method	After Drilling: Permeability (8) Value (cm/s)	Comments
GROUND SURFACE										
OVERBURDEN (0 – 24.0)	152 mm									
SILTSTONE 24.0 – 25.0	24.7									
COAL 25.0 – 25.6										
SANDSTONE (25.6 – 44.8)										
	152 mm									
INTERBEDDED COAL AND SILTSTONE 44.8 – 55.8										
SILTSTONE 55.8 – 67.0										
COAL AND SLST 67.0 – 68.0										
#10 COAL 68.0 – 70.1										
INTERBEDDED COAL AND SLST 70.1 – 72.2										
#10 COAL 72.2 – 74.0										
COAL AND SLST 74.0 – 75.0										
SANDSTONE (75.0 – 80.8)										
SILTSTONE 80.8 – 82.3										
INTERBEDDED SST AND SLST 82.3 – 84.7										
INTERBEDDED COAL AND SLST 84.7 – 88.3										
#9 COAL 88.3 –										

Contractor: Drillwell
Date started: Aug. 24/80
Date finished: Aug. 27/80

Logged by: D.M.
Checked by: D.K.
Date: Nov. 12/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 2
Sheet 2 of 3

Job No.

Project

Type of drilling | Coordinates: E | Reference elevation

Rig | N | Elevation type: surveyed ☐ altimete ☐ from map ☐

Drilling fluid | Angle from horizontal | Purpose of hole

Bearing | *Azimuth

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments
90										
#9 COAL 95.4										
SANDSTONE 99.1	99.9									
100 INTERBEDDED SST+SLST 101.1	100.5									
SANDSTONE 105.4	104.0(1)									
	105.3									
SILTSTONE 109.7	106.0									
110 SANDSTONE 115.8										
SILTSTONE 117.3										
SANDSTONE 118.8										
120 SILTSTONE 126.5	152 mm									
INTERBEDDED SHALE + COAL 128.3										
COAL 129.5										
130 INTERBEDDED SST AND SLST 132.6										
SILTSTONE	136.4									
	137.3									
140	139.4(1)									
	141.3									
144.8	142.8									
INTERBEDDED MDST + SLST 148.6										
150 #8 COAL 154.2										
SILTSTONE 154.8										
#8 COAL 157.3										
160 SILTSTONE 164.6										
SANDSTONE 166.1										
INTERBEDDED SST AND SLST 169.8										
170 SILTSTONE 173.7										
SANDSTONE 176.8	176.7									
SILTSTONE	178.2									
180										

Contractor | Logged by

Date started | Checked by

Date finished | Date

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 2
Sheet 3 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
180										
SILTSTONE 182.9	180.8(1) 182.9									
END OF HOLE										

Contractor:

Logged by:

Date started:

Checked by:

Date finished:

Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 3
Sheet 1 of 3

Job No. 802-1538

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus Erie 12R

Drilling fluid Air/Foam

Coordinates E 6505.69
N 19036.96

Angle from horizontal Vertical

Bearing ____ *Azimuth

Reference elevation 1607.42
Elevation type: surveyed [x] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments

GROUND SURFACE

OVERBURDEN

10

13.7

SILTSTONE

20

21.3

INTERBEDDED SLST AND SST

22.9

SANDSTONE

27.4

30

SILTSTONE

40

48.5

50

#8 COAL

60

63.4

INTERBEDDED SST AND COAL

65.5

INTERBEDDED SLST AND COAL

68.6

70

SILTSTONE

80

80.8

SANDSTONE

82.3

SILTSTONE

86.9

SANDSTONE

88.4

SILTSTONE

13.7

152 mm

34.0

35.0

38.7(1)

40.2

Contractor: Drillwell

Logged by: D.M.

Date started: Aug. 18/80

Checked by: D.K.

Date finished: Aug. 19/80

Date: Nov. 12/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 3
Sheet 2 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing * Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability: Method	Permeability: Value (cm/s)	Comments
90										
SILTSTONE										
97.5										
SST AND SLST 99.0										
100 SANDSTONE 102.1										
SILTSTONE										
106.7										
110 SANDSTONE										
112.8										
SILTSTONE	152 mm									
117.3										
SANDSTONE 118.9										
120 SLST 120.4										
SANDSTONE										
126.5										
SANDSTONE WITH SOME COAL										
130 132.5										
SST AND SLST 133.8										
#4 COAL	135.6 136.0 138.7(1) 140.0 140.5 141.0 141.4									
140 142.6										
SILTSTONE										
150 150.3										
COAL 150.6										
SILTSTONE 153.6										
COAL 154.5										
INTERBEDDED SST, SLST AND COAL										
160 163.0										
INTERBEDDED SLST AND COAL										
170 171.6	169.8(1)									
COAL 172.5										
SILTSTONE	174.9									
180	179.5									

Contractor: Logged by:

Date started: Checked by:

Date finished: Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 3
Sheet 3 of 3

Job No.

Project .....

Type of drilling ..... Coordinates: E .....

Rig ..... N .....

Drilling fluid ..... Angle from horizontal .....

Bearing ..... *Azimuth

Reference elevation .....

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole .....

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
180										
SILTSTONE 182.9	152 mm 182.9									
END OF HOLE										
190										

Contractor: ..... Logged by: .....

Date started: ..... Checked by: .....

Date finished: ..... Date: .....

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 4
Sheet 1 of 3

Job No. 802-1538

Project ELK RIVER COAL

Type of drilling Rotary/Hammer

Rig Bucyrus Erie 12R

Drilling fluid Air/Foam

Coordinates: E 6436.44
N 18965.76

Angle from horizontal Vertical

Bearing ____ *Azimuth

Reference elevation 1605.1

Elevation type: surveyed [X] altimeter [ ] from map [ ]

Purpose of hole Hydrogeology

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	After Drilling: (2)(7) Water Level (m)	Permeability (8): (2) Depth (m)	Method	Value (cm/s)	Comments

GROUND SURFACE

10

OVERBURDEN

20

21.3

SANDSTONE

24.4

INTERBEDDED SILTSTONE MUDSTONE AND COAL

30

32.0

INTERBEDDED SHALE AND COAL

36.6

40

SILTSTONE

47.5

#10 COAL 50.0

50

INTERBEDDED COAL + SST 52.4

#10 COAL 53.6

SANDSTONE

60

61.0

INTERBEDDED SST, SLST, AND COAL

64.0

INTERBEDDED SLST AND COAL

67.0

#9 COAL

70

72.2

INTERBEDDED MUDSTONE AND COAL

76.2

INTERBEDDED SLST AND SST

79.2

80

SANDSTONE

90

89.9

21.9

152 mm

Contractor: Drillwell

Date started: Aug. 20/80

Date finished: Aug. 23/80

Logged by: D.M.

Checked by: D.K.

Date: Nov. 12/80

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 4
Sheet 2 of 3

Job No.

Project

Type of drilling

Rig

Drilling fluid

Coordinates: E

N

Angle from horizontal

Bearing *Azimuth

Reference elevation

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling: (2) Depth (m)	During Drilling: (2)(4) Water Level (m)	During Drilling: (5) Water Flow (l/s)	During Drilling: (6) Other	After Drilling: (2)(7) Water Level (m)	After Drilling: Permeability (8) (2) Depth (m)	Permeability (8) Method	Permeability (8) Value (cm/s)	Comments
90										
SILTSTONE 97.5										
100 SANDSTONE 100.6										
SILTSTONE 102.7										
COAL 103.3										
SHALE 104.2										
COAL 104.9										
SLST 106.7										
SANDSTONE	104.5									
110 111.3	105.4									
	108.5(1)									
SILTSTONE	110.3									
	110.8									
120 120.4										
#8 COAL	125.2									
	126.0									
	126.5(1)									
130	128.0									
	129.0									
132.0										
SILTSTONE 137.2										
INTERBEDDED SST AND SLST 140										
143.3										
150	152 mm									
SILTSTONE										
160										
170										
176.8	177.3									
SANDSTONE	178.4									
180	180.0									

Contractor: Logged by:

Date started: Checked by:

Date finished: Date:

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC

HYDROGEOLOGIC LOG

DRILLHOLE No. Endwall/O.W. 4
Sheet 3 of 3

Job No.

Project .....

Type of drilling ..... Coordinates: E .....

Rig ..... N .....

Drilling fluid ..... Angle from horizontal .....

Bearing ..... °Azimuth

Reference elevation .....

Elevation type: surveyed ☐ altimeter ☐ from map ☐

Purpose of hole .....

(1) (2) * Lithology	(2) (3) Completed Construction	During Drilling				After Drilling				Comments
		(2) Depth (m)	(2)(4) Water Level (m)	(5) Water Flow (l/s)	(6) Other	(2)(7) Water Level (m)	Permeability (8) (2) Depth (m)	Method	Value (cm/s)	
180										
SANDSTONE 182.9	152 mm 182.9									
END OF HOLE										

Contractor: .....

Date started: .....

Date finished: .....

Logged by: .....

Checked by: .....

Date: .....

* NOTE: Bracketed numbers refer to notes preceding the logs.

Golder Associates

Scale: 1:500 METRIC