K-Elk River 81(1)A

REPORT ON
THE 1980/81 DEVELOPMENT WORK
CARRIED OUT ON THE
ELK RIVER COAL PROJECT

~~CONFIDENTIAL~~
~~OPEN FILE~~
OPEN FILE

REPORT ON THE 1980/81 DEVELOPMENT WORK CARRIED OUT ON THE ELK RIVER COAL PROJECT

Coal Licence Numbers:	64, 65, 421-434 incl., 481-489 inc., 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:	Coal Licences are "Held in Trust" by Canada Permanent Trust Ltd. for the following owners: Elco Mining Limited 50% Stelco Inc. 25% Home Oil Company Limited 15% Scurry-Rainbow Oil Limited 10%
Operator:	Elco Mining Limited
Author of This Report:	G. F. Lawrence, K. H. Reicher
Work Performed From:	January - December 1981
Submitted to:	Ministry of Energy, Mines and Petroleum Resources, Victoria, British Columbia
Date:	May 26, 1982

TABLE OF CONTENTS

TABLE OF CONTENTS
(Text)

LIST OF FIGURES

LIST OF MAPS

LIST OF TABLES

SECTION 1.0
INTRODUCTION

1.1.0 General Geographic and Physiographic Position of Licences

The Elk River Coal Project is located in the East Kootenay regional district of southeastern British Columbia. Approximate centre of the project area, which consists of 7,782 ha of coal licences on Elk Provincial Forest land, is 50° 24' north latitude and 114° 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).

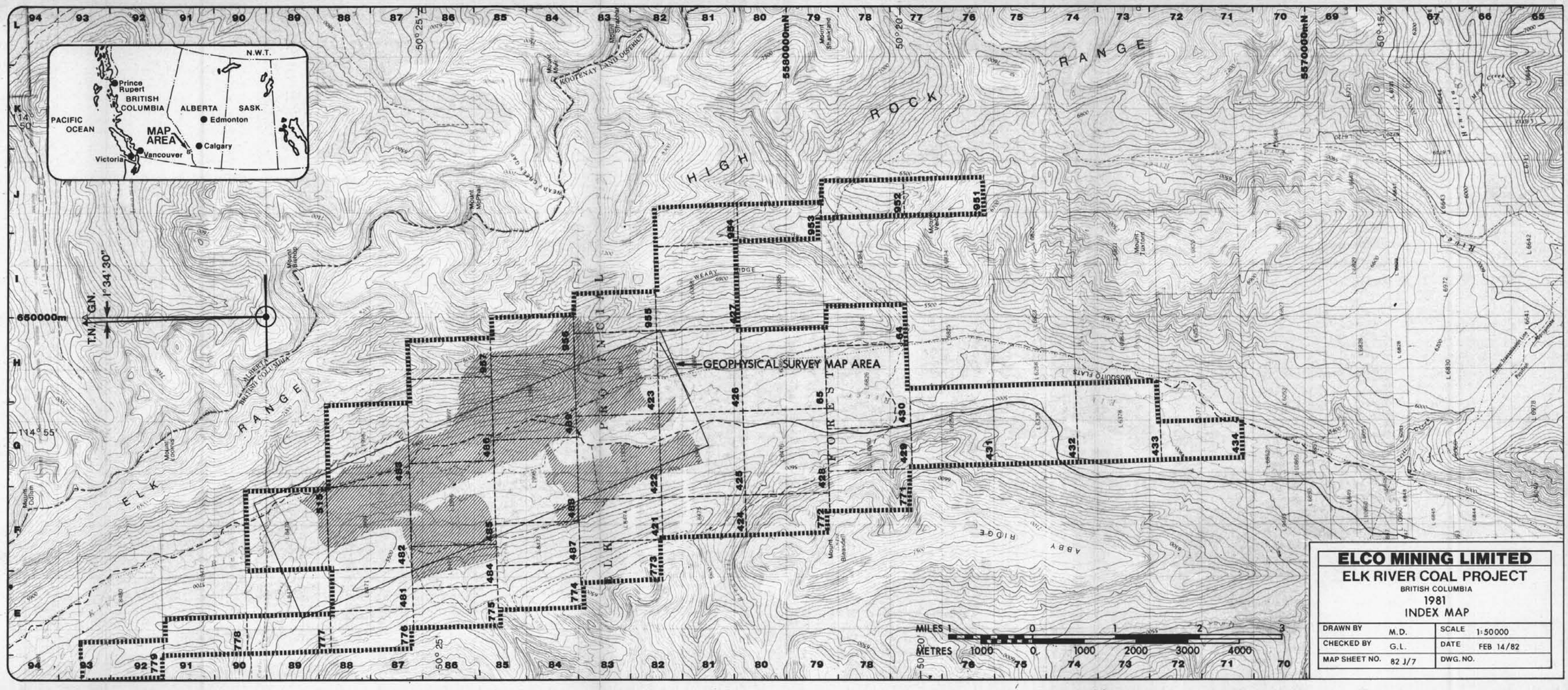
1.2.0 Property Definition

1.2.1 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, prospectors had uncovered 22 seams and by 1910, three coal companies had acquired leases in the area. The year 1920 was 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 the present Elk River licences. In 1968, North American Coal



ELCO MINING LIMITED

ELK RIVER COAL PROJECT

BRITISH COLUMBIA

1981

INDEX MAP

DRAWN BY	M.D.	SCALE	1:50000
CHECKED BY	G.L.	DATE	FEB 14/82
MAP SHEET NO.	82 J/7	DWG. NO.	

Corporation, under an option agreement with Scurry-Rainbow Oil Ltd., undertook an exploration program centered primarily on the Big Weary Ridge Area. In 1969, when North American Coal Corporation did not exercise its option, Scurry-Rainbow Oil Ltd. independently extended exploration of the deposit north to include the Little Weary Ridge area.

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

1.2.2 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, concentrated mainly on the northern half of the valley's east flank which included Little Weary Ridge and part of Big Weary Ridge. Also, for the first time, detailed investigations were 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)].

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 work markets, especially in Europe.

1.2.3 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

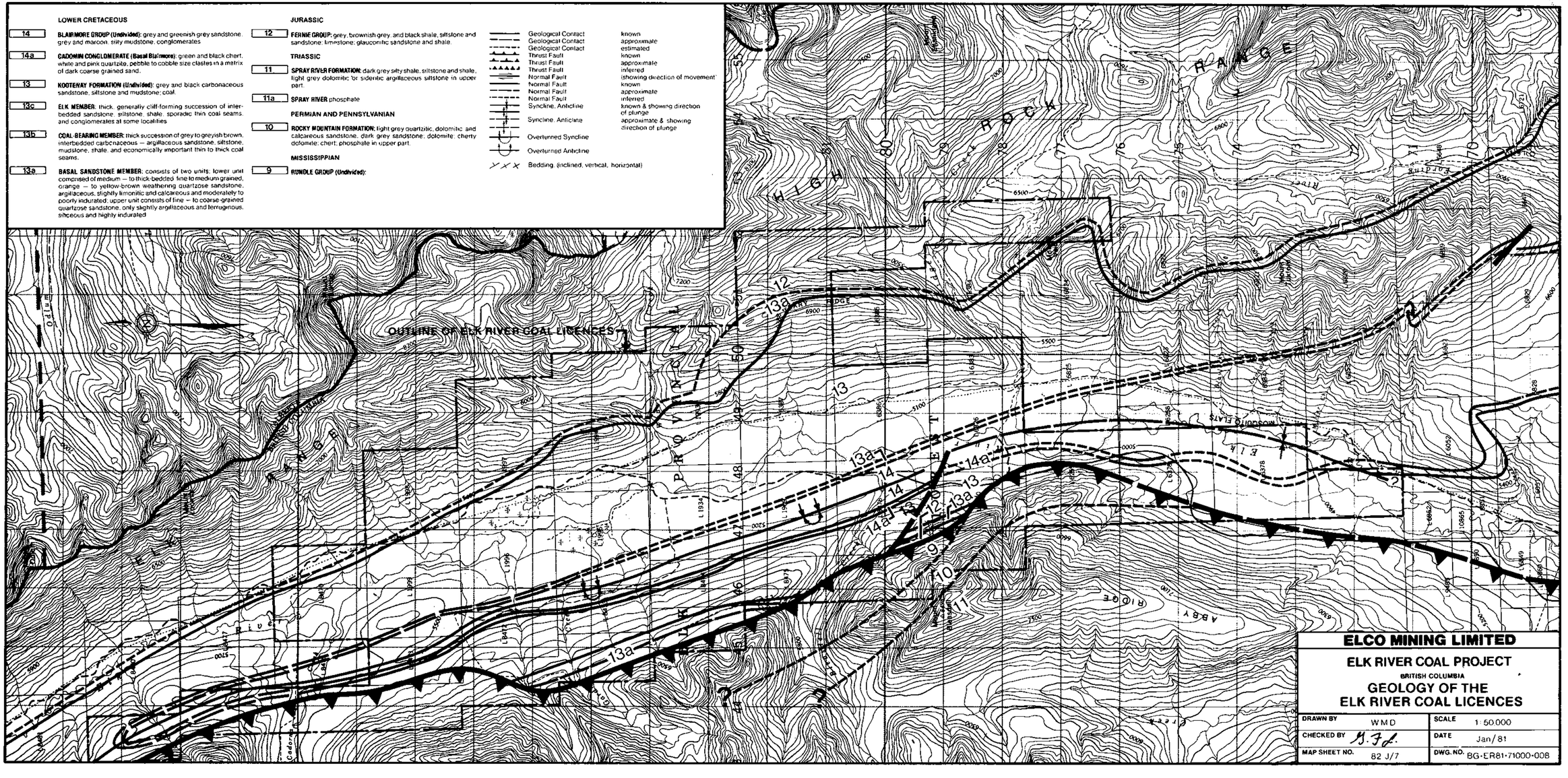
coal per year at an overall stripping ratio of 3.27 bm^3/t. This plan involves the mining and blending of more than 18 seams of varying quality to produce a low volatile, good cokeability product which will meet the requirements of most of the world's coking coal consumers. Furthermore, it has been proven that similar open pit reserves extend southwards into the Big Weary Ridge area 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).

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 6).

1.3.0 Summary of 1980/81 Development Work

A large portion of Elco's 1980/81 work expenditures were a result of work which had begun during the previous report period (1979/80). These 1980/81 expenditures were incurred for such things as final reports, final map productions, or in some cases, invoices which arrived after the 1979/80 report period. It is important to note here that none of these expenditures were included in the 1979/80 work report. Where expenditures are being claimed for 1979/80 work that extended into the 1980/81 report period, only brief descriptions and the appropriate references will be



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	W.F.L.	DATE	Jan/81
MAP SHEET NO.	82 J/7	DWG. NO.	BG-ER81-71000-008

made in this report since very comprehensive descriptions, maps and figures were provided in the 1979/80 report.

Exploration and development work that had begun in the previous report period$_{4)}$, for which expenditures extend into the present period, occurred in the following areas:

- Railway and Access Road Corridor Topographic Mapping,
- Railway Terrain Analysis Study,
- Mine and Mine Facility Overburden Geotechnical Investigations,
- Environmental Work Involving Fish Inventory Studies, Water Quality Tests and Reclamation Field Work.

In addition to these extended programs, Elco carried out new exploration and development work in the following areas:

- Geophysical Investigations of the Overburden and Bedrock Surfaces in the Elk River Diversion Area,
- Engineering Assessments involving Mine, Coal Preparation and Coal Transportation,
- Environmental Work Involving River Diversion Design, Hydrological, Climatological, Air Quality and Reclamation Monitoring,
- Stage II Submissions for Elco's Hostel at Mine Concept and Manpower Planning,
- Project Scheduling and Control Work,
- Project Economic Update Work,
- New Product Studies (Thermal Coal),
- Elco Program Support Work.

1.3.1 Summary of Work by Licences

See Table 1.3-1, "Summary of Work by Licences", Page 8.

1.3.1 Summary of Work by Licences

Table 1.3-1

SUMMARY OF WORK BY LICENCES

Licence Number	Type of Work						
	Mine Overburd. Geotech.	Topo Mapping	R.R. Terrain Analysis	Geophys. Survey	Ground Survey	Line Cutting	Environ-ment
64							X
65							X
421		X	X				X
422	X	X	X	X	X	X	X
423	X			X	X	X	X
424							X
425	X	X	X				X
426							X
427		X					X
428	X	X	X				X
429		X	X				X
430		X	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	X	X	X
484	X	X					X
485	X	X		X	X	X	X
486	X			X	X	X	X
487		X					X
488	X	X		X	X	X	X
489	X			X	X	X	X
515	X	X		X	X	X	X
771							
772							
773							X
774							X
775							X
776							
777							
778							
779							
951							
952							
953							
954							
955							X
956	X						X
957	X						X
Outside Licence Area		X	X				

2.1.1.2 Railway Terrain Analysis Study

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 preceeded by a preliminary air photo interpretation which delineated areas for field investigations. Soil samples were collected and analyzed. Results of this work were included in Elco's 1979/80 annual work report. Final invoicing was not received until November 1980.

2.1.1.3 Mine and Mine Facility Overburden Geotechnical Investigations

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.

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 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, 1980.

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.

Advance copies of final report graphics and other materials were received by Elco just prior to submission of the 1979/80 work report. Compiled versions of the final report and the majority of IECO's invoicing were not received until nearly July 1981, thus the reason for the large work expenditures being reported during this report period.

2.1.1.4 Environmental Work

The following paragraphs each briefly describe an environmental field program that had been completed during the 1980 field season but for which residual costs were incurred during the 1981 report period.

International Environmental Consultants Ltd. of Vancouver

B.C. carried out swim surveys (fish counting) on the Elk River within Elco's project area. A literature study of fish habitats for the species found during the survey, was to provide the Fish and Wildlife Branch (Ministry of Environment) with baseline data for Elco's impending river diversion.

Techman Ltd. of Calgary, Alberta were retained to collect water samples from the pumping wells that were installed during the geotechnical phase of Elco's 1980 field program. The purpose was to provide additional data on ground water quality from within the open pit area which will require dewatering. Since the dewatering scheme will cause mixing of groundwater with surface water, a quality baseline must first be well known before licencing procedures begin.

Techman Ltd. was also retained to provide reclamation liason with Elco's field crews during exploration. Proposed new disturbances were examined and guidelines for construction were given. Upon cessation of exploration activities, reclamation of all surface disturbances made during the program was undertaken.

New shelters were constructed to house the data recording instruments at the hydrologic and climatic monitoring stations within the project area. Since little or no records have been collected by either government or others on stream flows and climatic conditions within the area, Elco has been obliged to carry out continuous monitoring of these eco systems in order that baseline conditions be established. The baseline data will be used for two purposes:

1. Design of river and creek diversions, settling ponds and drainage systems,
2. The acquisition of the necessary pollution control permets and water licences.

In the past, severe winter weather and vandals have caused frequent data losses. It is hoped that the new shelters will prevent this in future.

2.1.2 1981 Exploration Work

During the 1980/81 term of licence, Elco again seen a reduction in terms of exploration and/or engineering field work. Investigations of the overburden materials (surficial geology deposits) within the proposed river diversion channel area were, however, continued. The investigations were geophysical in nature and consisted of electromagnetic surveys supported by ground control surveys and line cutting.

2.1.2.1 Survey Control and Line Cutting

Two separate contractors were employed to handle these components of the geophysical program. McElhanney Surveying and Engineering Ltd. undertook the survey control work while F.P. O'Grady of Kimberley, B.C. undertook the line cutting. In total, 22.9 km of line, one meter in width, was cut to baseline standards (see Figure 2.1.2.1-1, "Geophysical Line Location Map, Page 14).

It was decided that the Haul Road Survey and the Settling Pond Dyke Alignment Survey, both undertaken in the 1980 program, would provide the control for the establishing of the geophysical grid. This grid followed the original Exploration Baseline System which had been used to control the early exploration drilling programs. The advantage being that a vast amount of subsurface data resulting from this drilling, which was carried out "on-section", was available to assist the geophysical interpretations.

Execution of the Survey

The intersection of the gridlines with the Haul Road Survey


ELK RIVER
ELK RIVER
GEOPHYSICON
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
GEOPHYSICAL LINE LOCATION MAP
SCALE 1:10000
DRAWN BY
CHECKED BY
DWG. NO. 2
MAP SHEET NO.
SCALE
800 METRES

FIG. 2.1.2.1-1

and the Settling Pond Dyke Alignment Survey were computed using an HP-9825 desk computer system prior to field work. Diagrams of each grid intersection were prepared and the information required for establishing the intersection of the gridline on the haul road was recorded on the diagrams.

The task for the field crews was to establish the gridline intersection with the haul road and settling pond dyke alignment survey and to turn off the angle required for the gridline. A line cutter would cut approximately 50 meters of the gridline and the surveyors would place a mark on line. At each gridline/haul road intersection, the surveyors left laths marked with the distances that had to be line cut to the east and west of the haul road, along the gridlines.

Once all the gridlines were marked, the field crews began the establishing of the stations along the cut lines. Twelve inch spikes were used to mark the stations and a lath, with the Exploration Baseline Grid westing value marked on it, was placed by the nail. A tag was left on a nearby tree or attached to the lath if there were no trees close by. When no tags were available, numbers were written on the laths.

The six gridlines at the north end of the investigation area were surveyed out to the transmission line and connections were made between the ends of the lines. Elevations were established by spirit levels. All level loops were closed and observations were done to third order standards. The horizontal work was carried out using 20" theodilites and short range electronic distance meters.

Results

In total, 22,560 meters of survey line, including the

extension to the haul road centre line, was established. A total of 579 stations were placed and satisfactory closures were obtained on the ties at the north end of the project (see Figure 2.1.2.1-2 "Plan of 1981 Cross-Section Survey", Page 17 for final results).

2.1.2.2 Geophysical Survey

During the last two weeks in November 1981, Geo-Physi-Con Ltd. of Calgary, Alberta carried out a geophysical field program on Elco's Elk River diversion site. Electromagnetic methods that measure the electrical conductivity of the ground to various depths were used to develop overburden grain size and thickness models of the surficial deposits in the investigation area.

The purpose of the program was to identify, other than by extensive drilling of the entire channel alignment, potential aquiferous zones, such as buried river channels or coarse-grained alluvial deposits that could allow seepage from either ground water sources or the proposed river diversion channel into the nearby open pit. Once identified, suspect zones would then be physically investigated by either drilling or excavation.

The objectives of the elctro-magnetic surveys therefore were to:

1. Determine overburden type,
2. Determine depth to bedrock.

Execution of the Program

Measurements were made in the field along some existing and newly opened cut lines. The location of the survey lines and the direction of the lines are shown on Figure

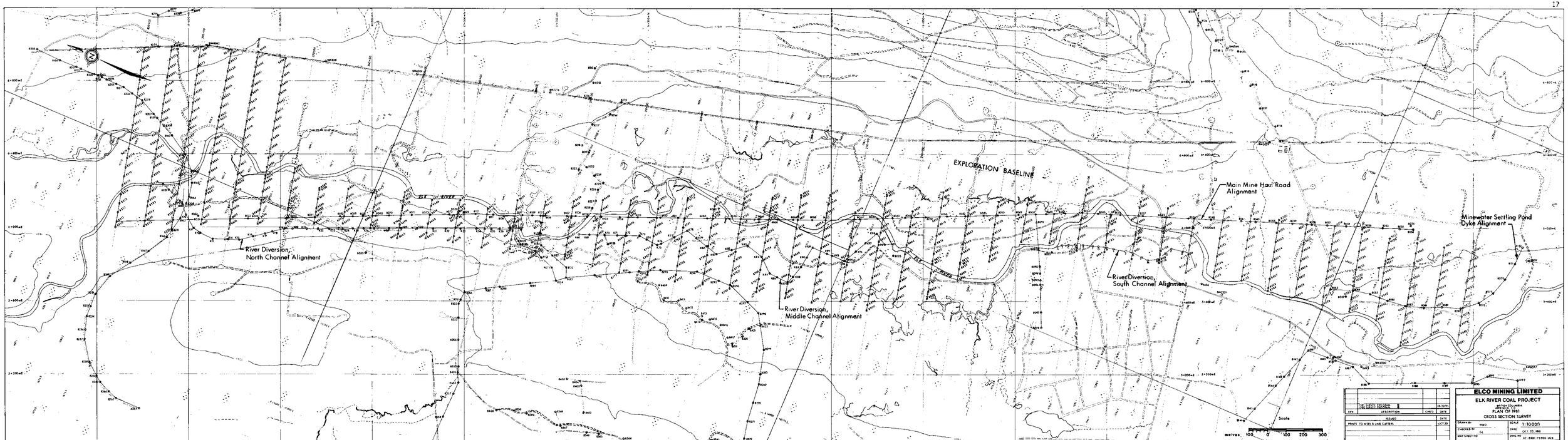

EXPLORATION BASELINE
ELK RIVER
River Diversion,
North Channel Alignment
River Diversion,
Middle Channel Alignment
River Diversion,
South Channel Alignment
Main Mine Haul Road
Alignment
Minewater Settling Pond
Dyke Alignment
Scale
metres 100 0 100 200 300
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
PLAN OF 1981
CROSS SECTION SURVEY
ISSUED
PRINTS TO MSRS & LINE CUTTERS
DATE
OCT.20
Drawn BY MMD
SCALE 1:10000
CHECKED BY GL
DATE OCT. 20, 1981
MAP SHEET NO.
DWG. NO. EC 4481-75900-023

FIG. 2.1.2.1-2

2.1.1.1-1. Fifty-one geophysical lines, having a total of 22.9 km, were surveyed.

Along the majority of these lines, five sets of measurements were made:

a. Measurements with the EM31 on the ground with coils in a horizontal co-planar mode (effective exploration depth about 7 m),
b. Measurements with the EM31 on the ground with coils in a vertical co-planar mode (effective exploration depth about 3 m),
c. Measurements with the EM31, 0.8 m above the ground with coils in a horizontal co-planar mode (this measurement was not plotted on the line profiles. The effective exploration depth about 5 m),
d. Measurements with the EM34-3 at 20 m coil separation with coils in the vertical co-planar mode (effective exploration depth about 20 m),
e. Measurements with the EM34-3 at 40 m coil separation with coils in the vertical co-planar mode (effective exploration depth about 30 m).

Measurements were taken with the EM34-3 at previous stations surveyed by McElhanney Surveying and Engineering Ltd. approximately 50 m apart. A hip chain with an accuracy of $\pm$ 5% was used to take measurements with the EM31 at 20 m intervals and to note changes of roads, river and survey stations.

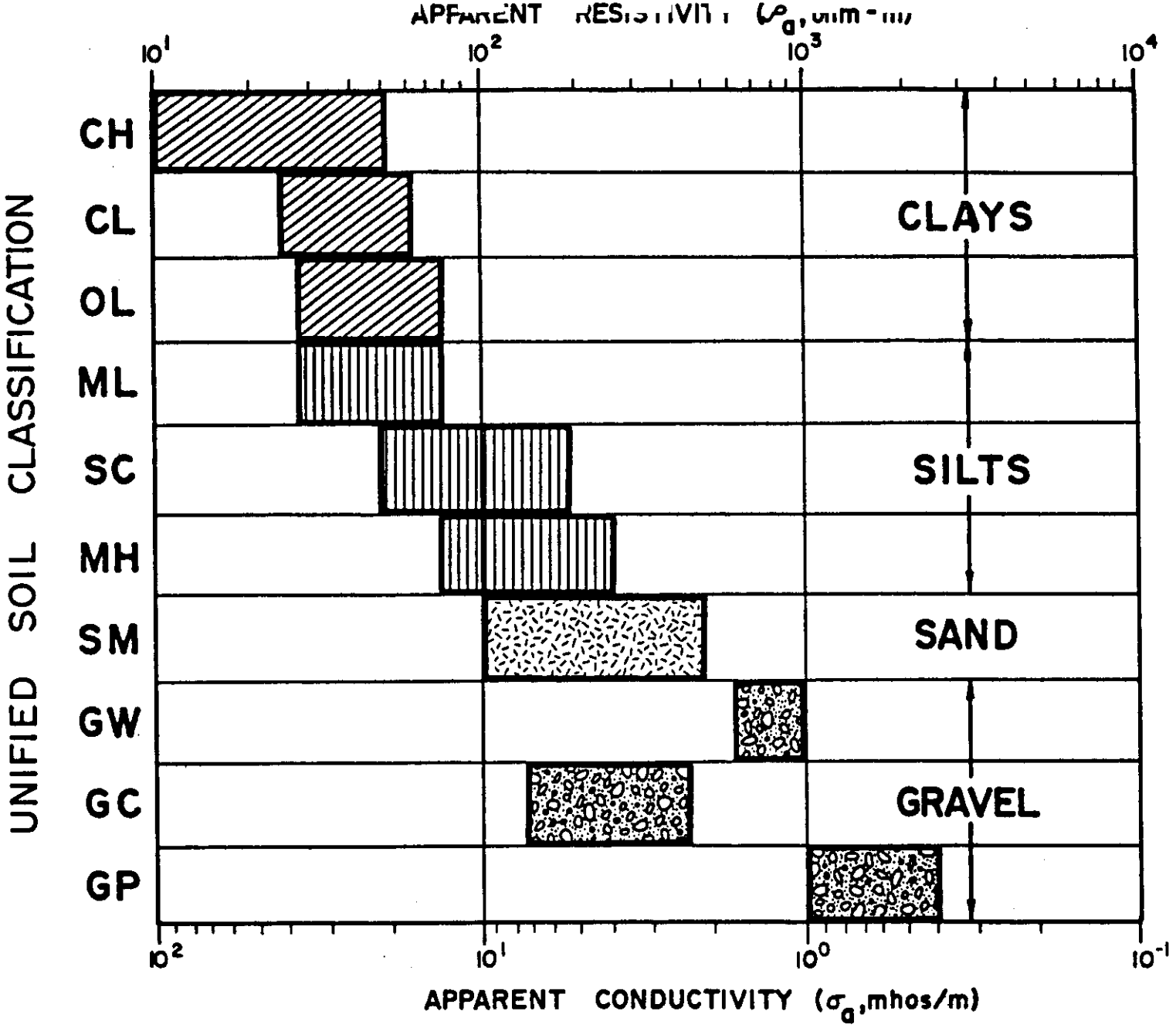
Method of Interpretation

The basis of electrical conductivity surveying is the fact that soil and rock types often have a characteristic range of conductivity values. Typical ranges of conductivities for the various soil types of the unified soil classifica-

tion are shown in Figure 2.1.2.2-1, Page 20. In general, the conductivity increases with increasing clay content. For characterizing soil types between coarse and fine-grained materials, 10 mmhos/m was chosen as a dividing line.

An important concept in the interpretation of magnetic induction measurements with the EM31 and EM34-3 are the instrument's geometric functions. The geometric function approach to data interpretation in magnetic induction sounding is possible only when instrument parameters (transmitter operation frequency, transmitter and receiver separation) are carefully selected. This was done in the design of the EM31 and EM34-3. The concept of the geometric functions is that the secondary megnetic field measured at the surface (by the receiver) can be considered as a simple summation of the contributions of horizontal strata (see Figure 2.1.2.2-2, Page 21). This allows one to see any linear correlations in the form of depth, versus apparent conductivity for different overburden types (see Figure 2.1.2.2-3, Page 22). From this approach, there were three primary linear relationships which allowed approximately 60% of the project area to be modeled.

Most of the remaining area was a more complex three-layer case where inverse borehole solutions were used. For the purpose of explanation, review the following example where at least three different instrument readings must be used to solve individual layer conductivities for the three layers. Assuming σ_a (EM31(HG) = 4.5 mmhos/m, σ_a EM34-3, 20 m separation = 4.0 mmhos/m, and σ_a EM34-3, 40 m separation = 3.5 mmhos/m; at a drill hole location with a first layer depth of 5 m and a depth to bedrock of 10 m. With this information, conductivities of each layer can be calculated, which would then allow the area to be modeled, provided the conductivities remain constant. This calculation can be performed by the following relationships:



GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

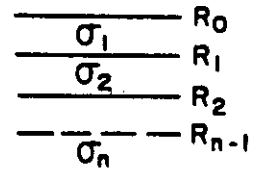
CONDUCTIVITY vs SOIL TYPE

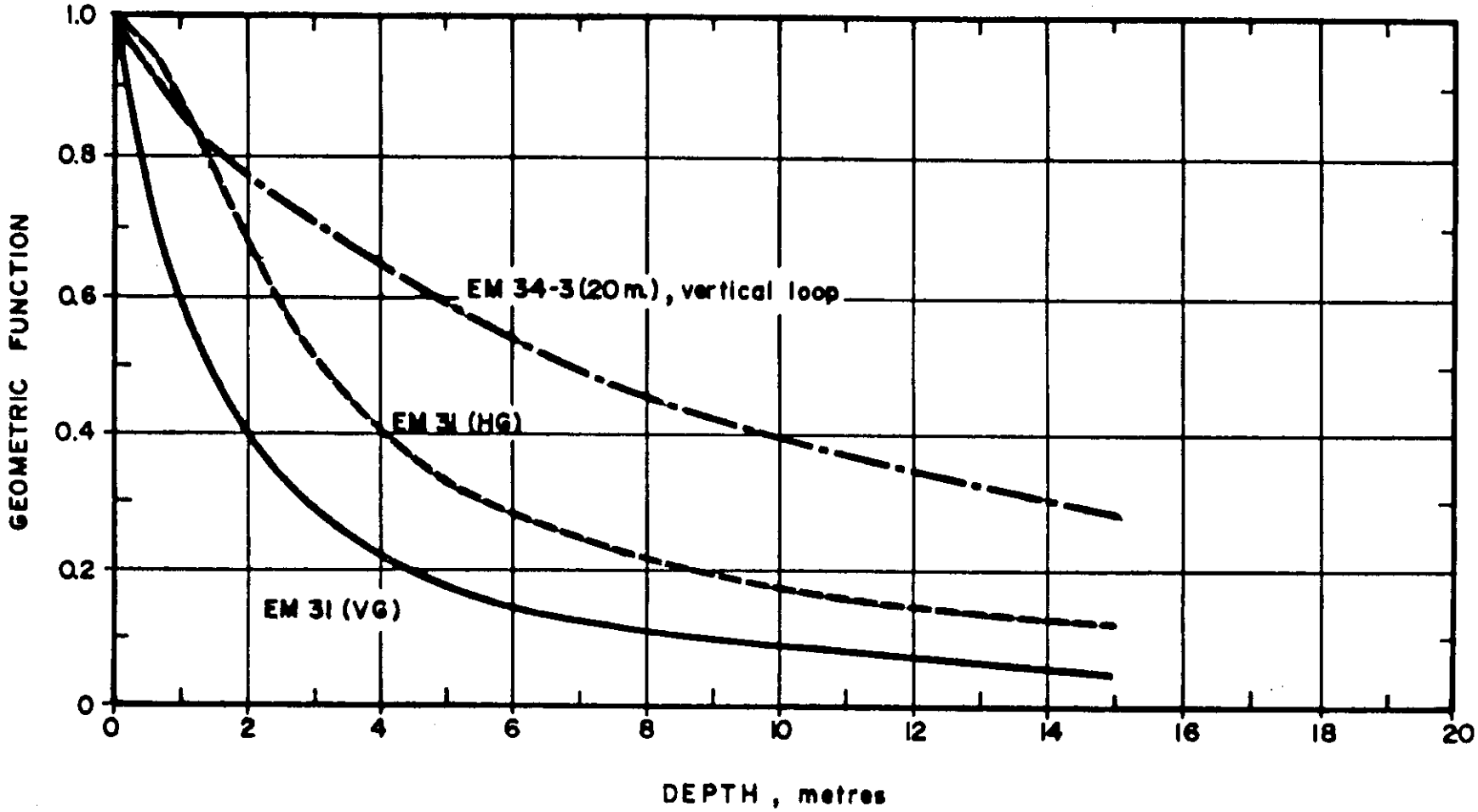
81-40

Figure 2.1.2.2-1

$$\sigma_a = R_0\sigma_1 + R_1(\sigma_2 - \sigma_1) + \ldots + R_{n-1}(\sigma_n - \sigma_{n-1})$$

R = Geometric Function of Depth for Given Instrument



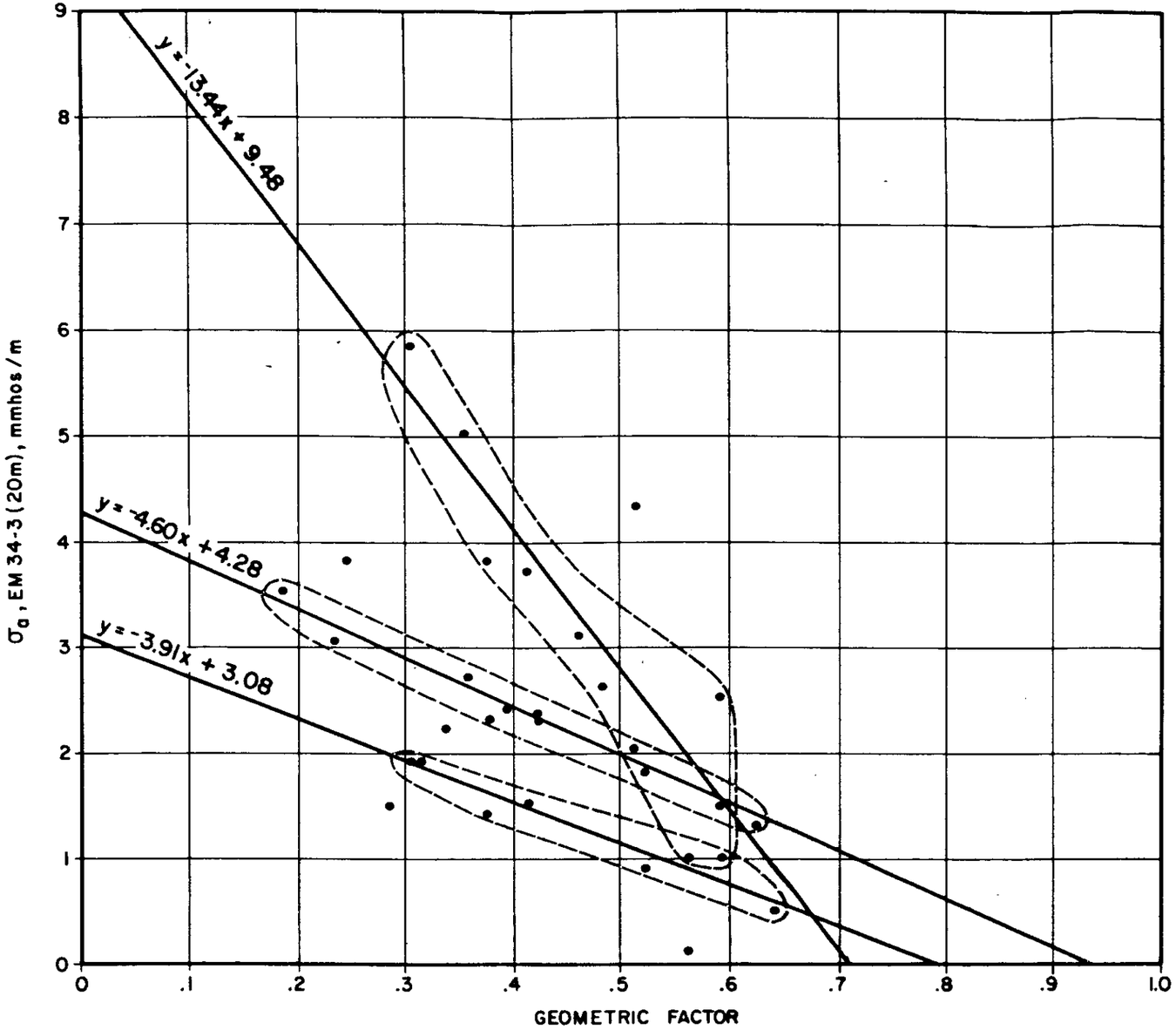


GEO-PHYSI-CON

PIONEERING GEOPHYSICAL CONSULTANTS

GEOMETRIC FUNCTIONS

81-40 Figure 2.1.2.2-2



GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

EM 31 (GH) / EM 34-3 (20m) > 1
CORRELATION PLOT

81-40 Figure 2.1.2.2-3

$$\sigma_a = (R_0 - R_1)\,\sigma_1 + (R_1 - R_2)\,\sigma_2 + (R_2 - R_3)\,\sigma_3$$
$$= R_0\,C_1 + R_1\,C_2 + R_2\,C_3 \text{ (for a three-layer case)}$$

where σ_a = apparent conductivity
$\sigma_1, \sigma_2, \sigma_3$, = conductivities of each layer
$C_1 = \sigma_1$
$C_2 = \sigma_2 - \sigma_1$
$C_3 = \sigma_3 - \sigma_2$
and R = geometric factor

The geometric factor can be calculated by one of two equations, depending on whether the instrument was used in the vertical or horizontal co-planar mode. For the vertical co-planar mode:

$$R = \left[\frac{2D}{S} + \sqrt{\left(\frac{2D}{S}\right)^2 + 1} \right]^{-1}$$

For the horizontal co-planar mode:

$$R = \frac{S}{\sqrt{4D^2 + S^2}}$$

where S = loop separation
$D = d + h_o$
d = depth
h_o = loop height above ground

From the previous information, there are now three equations with only three unknowns for our example. These now are:

EM31(HG) = 4.5 = $C_1 + .344\,C_2 + .180\,C_3$
EM34-3-20 = 4.0 = $.963\,C_1 + .598\,C_2 + .403\,C_3$
EM34-3-40 = 3.5 = $.981\,C_1 + .767\,C_2 + .608\,C_3$

Using simultaneous solution:

$$C_1 = 4.2$$
$$C_2 = 4.0$$
$$C_3 = -6.1$$

therefore, $\sigma_1 = 4.2$
$\sigma_2 = 8.2$
$\sigma_3 = 2.1$

With the values of σ_1, σ_2, and σ_3, calculations for depth from apparent conductivities in adjacent areas can be solved, provided that the layer conductivities remain constant.

In areas with no drill hole information, the same method of analysis was used. The geophysical signatures in an area with no drill holes were compared with signatures in sections with drill holes to find analogous signatures.

Results

Complete interpretation of data was possible on 74% of the lines. Of the analyzed line sections, 74% (solid line contacts to bedrock on line profiles (see Figures 2.1.2.2-8 to 58, Pages 31 to 98) are expected to have an error of less than ±15%; 18% (dashed line contacts to bedrock on line profiles) may have an error greater than 15%; and 8% indicates depths greater than the depth of exploration of the instruments used (>20 m). By linear regression analysis, the actual depth versus interpreted depth was found to have a correlation factor of $r = .88$ (see Figure 2.1.2.2-4, Page 26).

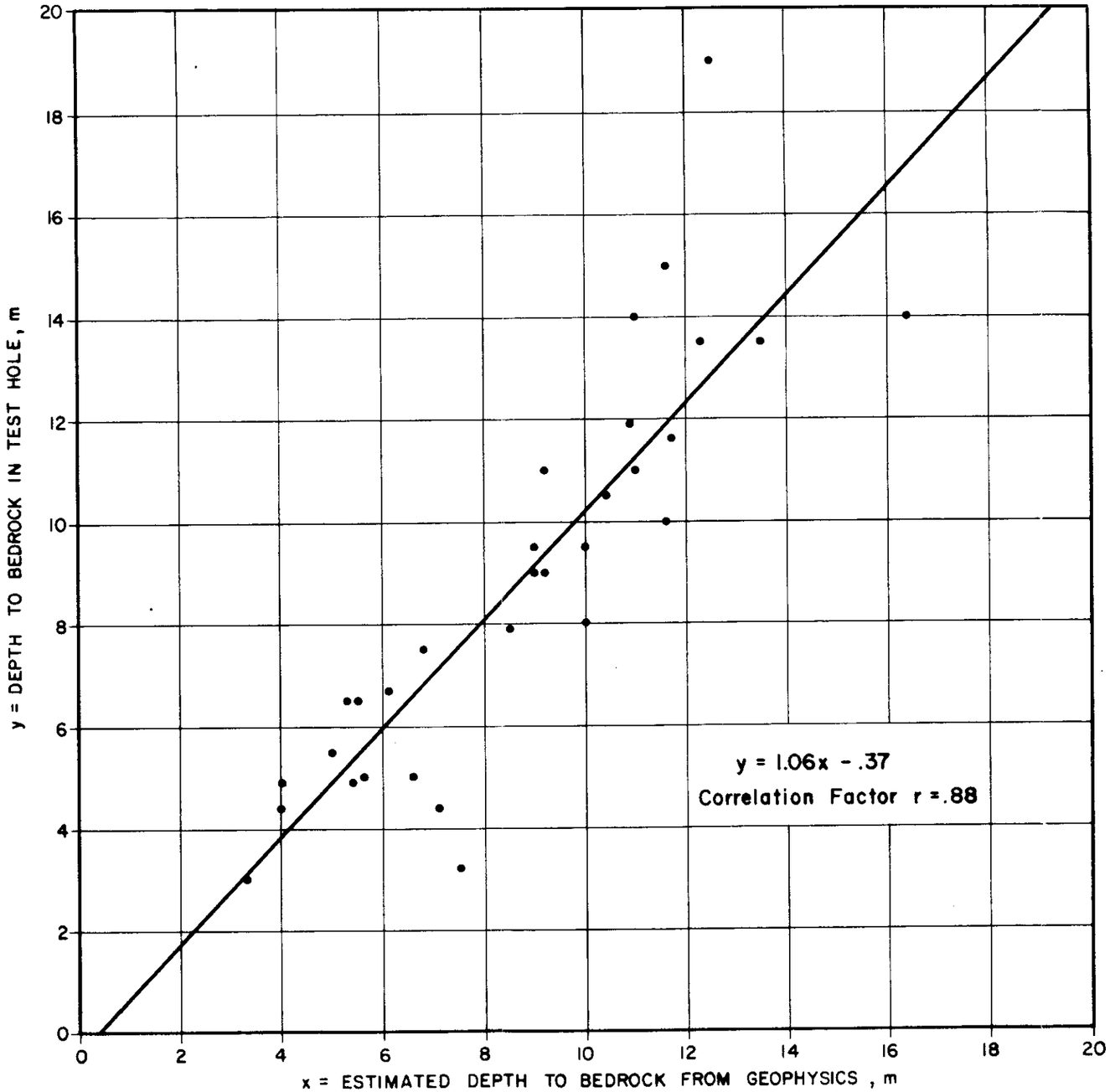
For delineating overburden type, an apparent conductivity of 10 mmhos/m was used as the dividing line between fine

and coarse grain overburden. As shown in Figure 2.1.2.2-1, Page 20, this is the approximate general division between clay and silts on the one hand, and sand and gravels on the other hand. The site results indicate a predominant overburden of coarse grain material for approximately 92% of the surveyed area. Only minor areas of fine grain overburden were found over the site (approximately 8%). These minor fine grain areas are mainly restricted to the south end of the site (part of lines 45 to 49), and part of the marsh area on the west end of lines 27 to 29. Figure 2.1.2.2-5, Page 27 (Surface Overburden Type Map) and Figure 2.1.2.2-6, Page 28 (Areas of Fine Grain Overburden/Bedrock Contact) give the general overburden type for the site.

Depth to bedrock was found to range from less than 1 m to greater than 20 m. An isopach map showing depth of overburden is given in Figure 2.1.2.2-7, Page 29. This isopach map has been shaded to indicate depth greater than 12 m, and depths of 8 to 12 meters.

Individual line profiles are shown in Figures 2.1.2.2-8 to 58, Pages 31 to 98. The results are divided into two sections on each sheet. The upper section contains the geophysical readings measured in the field on a scale of 1 cm = 5 mmhos/m. The lower section contains such features as topography and data interpretation, with overburden thickness presented on a scale of 1 cm = 5 m.

Most areas of the survey indicated coarse grained overburden (σ_a EM31(GH) <10 mmhos/m), with only minor areas of fine grained overburden. An example of this is shown on line 50, Figure 2.1.2.2-57d, Page 89. The fine grained section of overburden is indicated on line 50 from chainages 42+80 to 43+40 by an increase in the apparent conductivity measured with the EM31(GH, GV), from 6 mmhos/m to 15 mmhos/m. To calculate depth to bedrock in these areas



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

LINEAR REGRESSION ANALYSIS

81-40 Figure 2.1.2.2-4

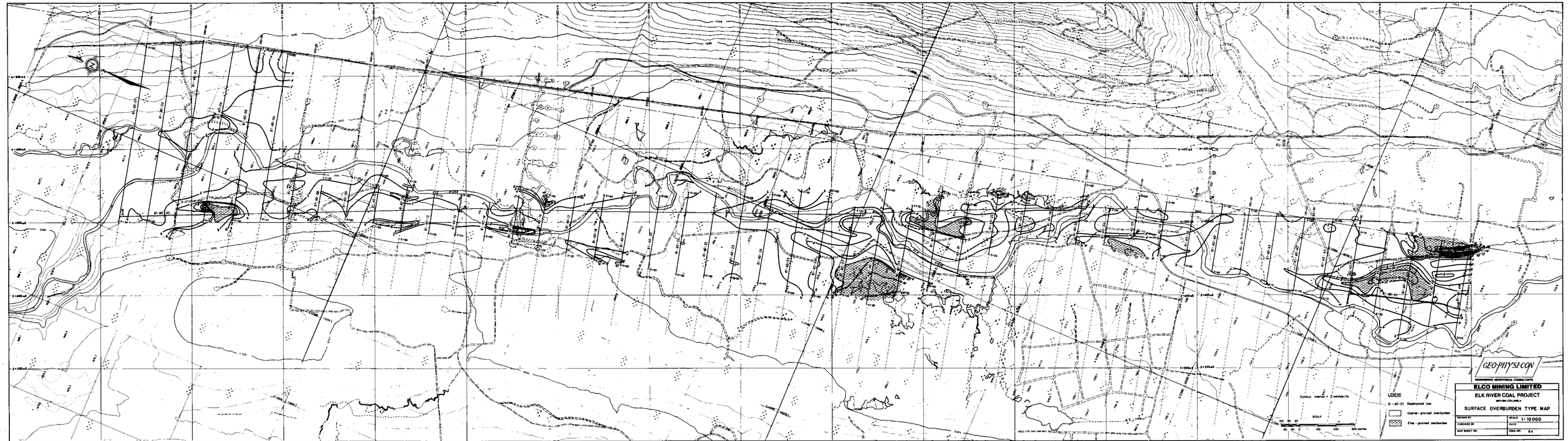

GEOPHYSICON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
SURFACE OVERBURDEN TYPE MAP
DRAWN BY:
CHECKED BY:
MAP SHEET NO.
SCALE 1:10000
DATE
DWG. NO. 6a
LEGEND
81-40-01 Geophysical line
Coarse-grained overburden
Fine-grained overburden
Contour interval = 2 metres/m
SCALE
100 50 0 100 200 300 metres

FIG. 2.1.2.2.-5

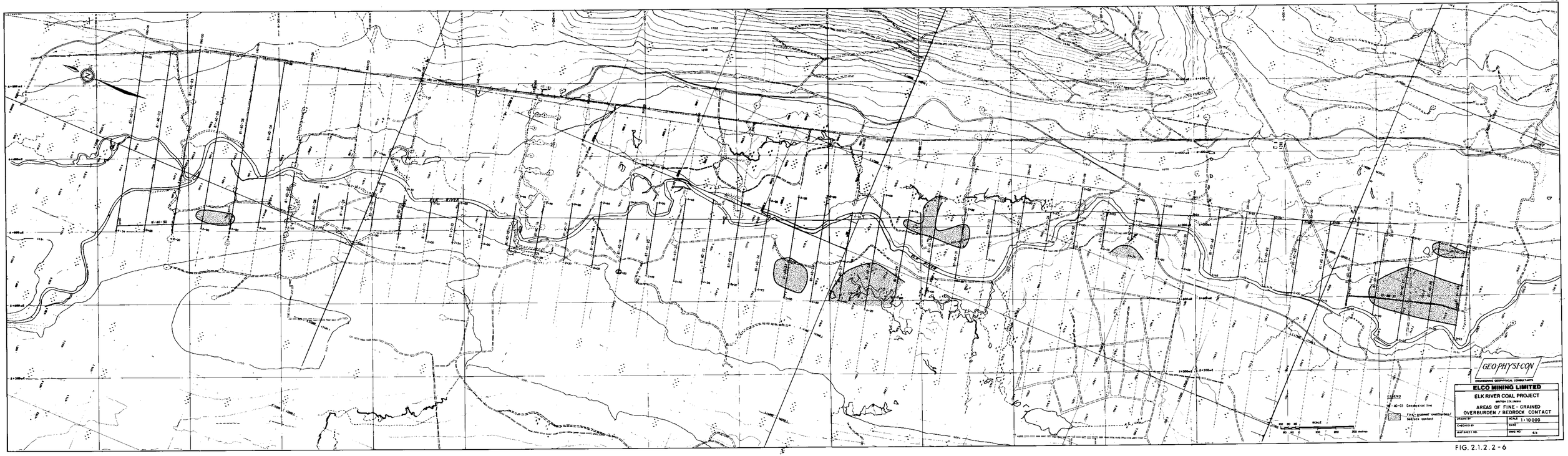

GEOPHYSICON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
AREAS OF FINE - GRAINED
OVERBURDEN / BEDROCK CONTACT
DRAWN BY
SCALE 1:10 000
CHECKED BY
DATE
REF SHEET NO.
DWG NO. 6.5
LEGEND
81-40-01 Geophysical line
Fine - grained overburden/ bedrock contact
SCALE
80 40 0 100 200 300 metres

FIG. 2.1.2.2 - 6

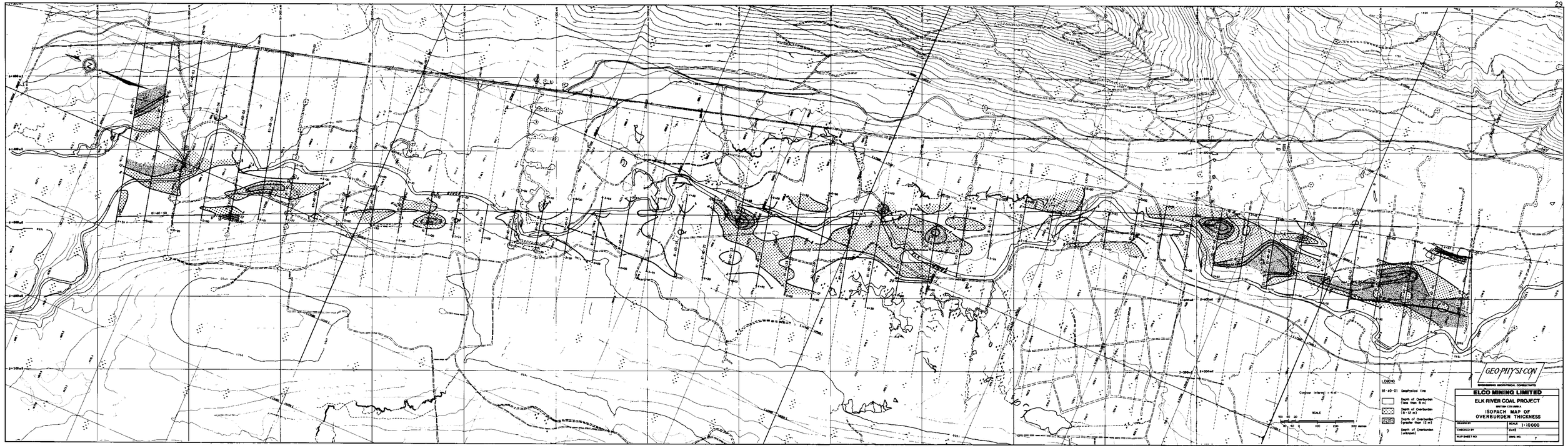
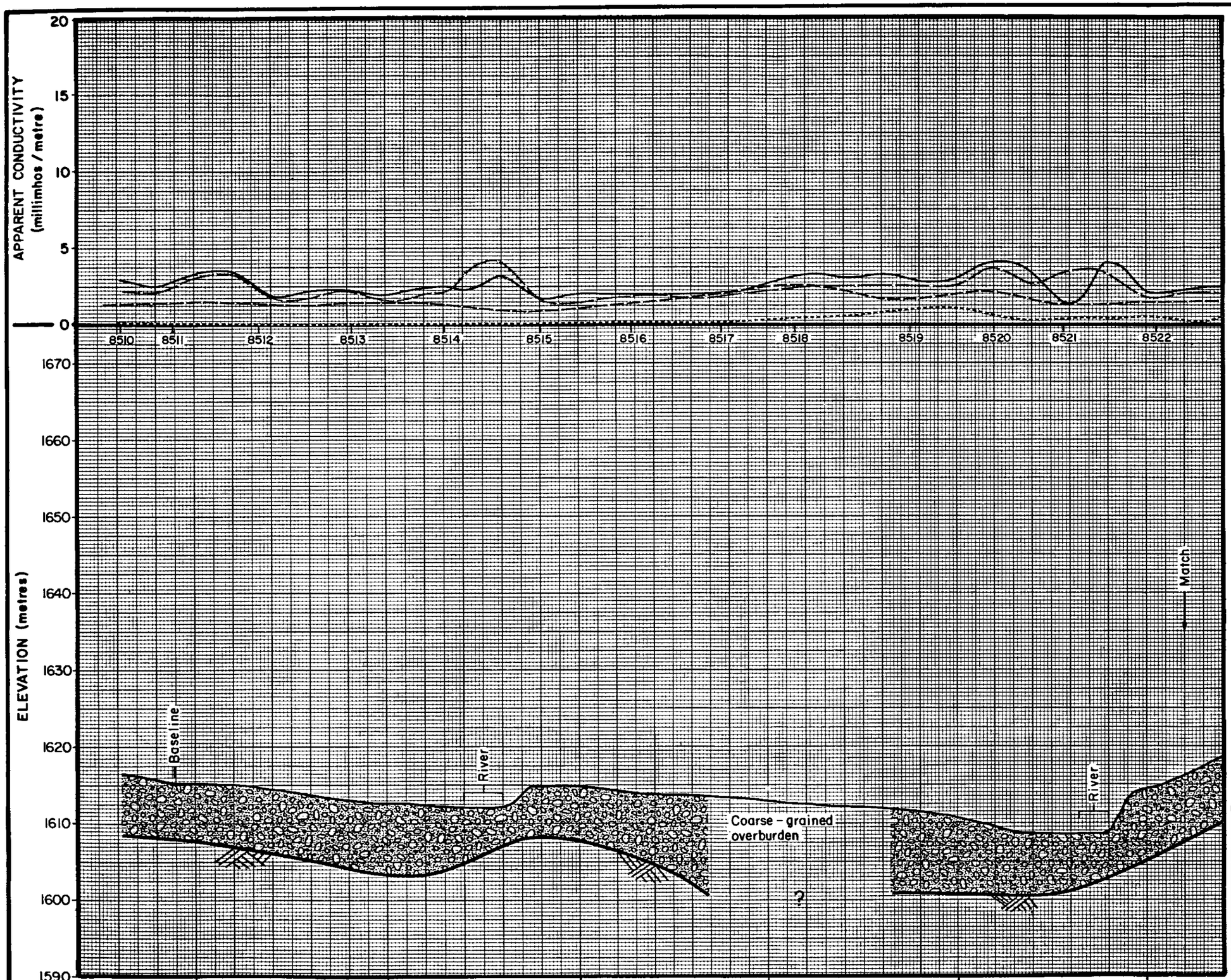

LEGEND
81-60-01 Geophysical line
Depth of Overburden (less than 5 m)
Depth of Overburden (5 - 12 m)
Depth of Overburden (greater than 12 m)
Depth of Overburden (unknown)
Contour interval = 4 m
SCALE
100 40 0 100 200 300 metres
GEOPHYSICON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELCO MINING LIMITED
ELK RIVER COAL PROJECT
BRITISH COLUMBIA
ISOPACH MAP OF OVERBURDEN THICKNESS
DRAWN BY
SCALE 1:10000
CHECKED BY
DATE
MAP SHEET NO.
DWG. NO. 7

FIG. 2.1.2.2 - 7

of fine grained sediments, different conductivity stratification had to be used in the models. The apparent readings over the fine grained area produces a similar depth to bedrock as in the adjacent coarse grain sections. The increase in apparent conductivities of the EM31, and only a slight increase in the EM34, are, therefore, likely produced by an increase in the conductivity of the first layer (hence increase in fine content) instead of an increase in depth to bedrock.



LEGEND

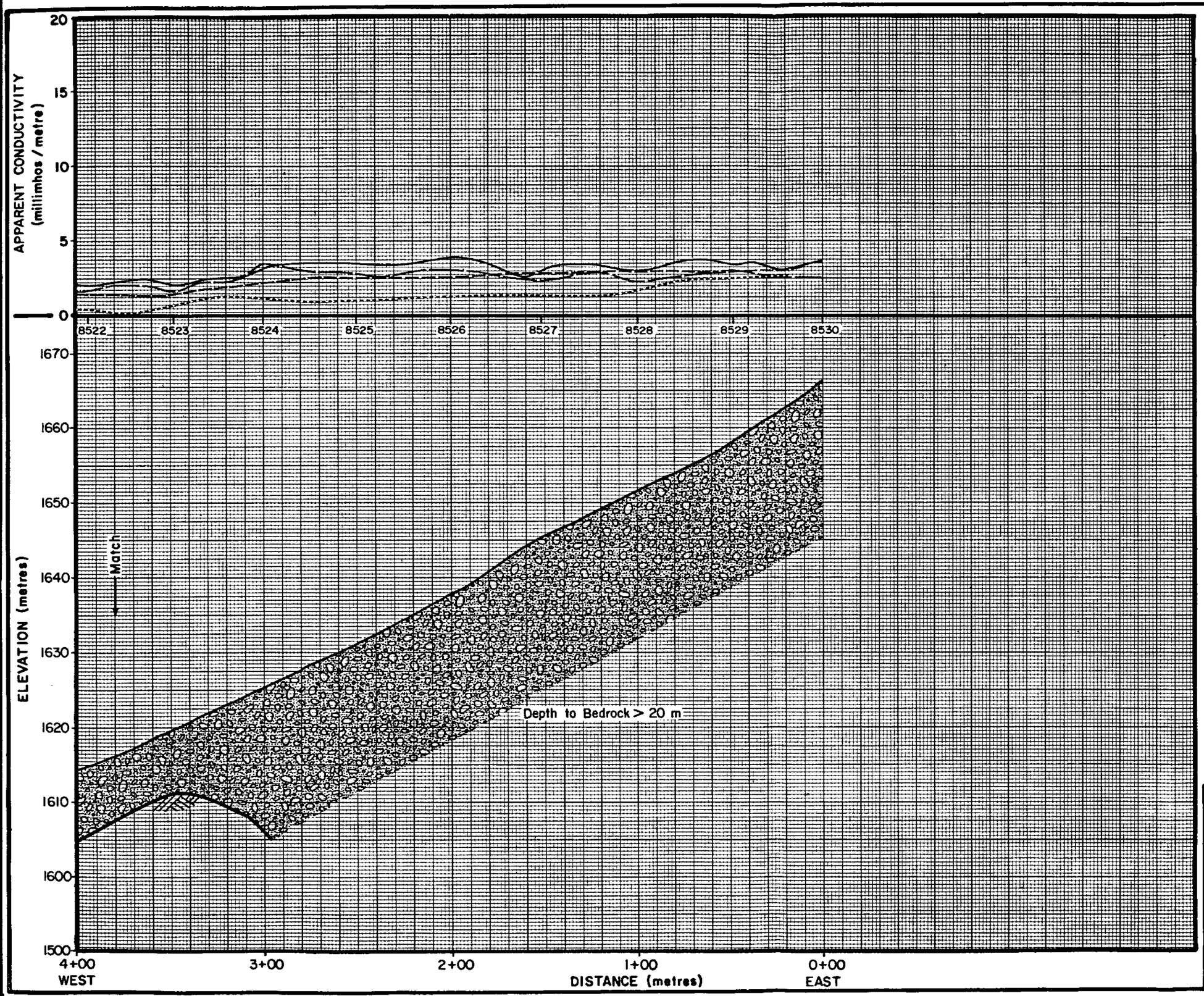
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine - grained overburden
- Coarse - grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-01

81-40 Figure 8a



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-01

81-40 Figure 8b

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8532 8533 8534 8535 8536 8537 8538 8539 8540 8541 8542 8543 8544 8545

1660
1650
1640
1630
1620
1610
1600
1590

ELEVATION (metres)

Baseline
TPIRD DH11
River
Coarse - grained overburden
?
?
River
Road
Match

0+00 WEST
1+00
2+00
3+00
4+00
5+00
6+00 EAST
DISTANCE (metres)

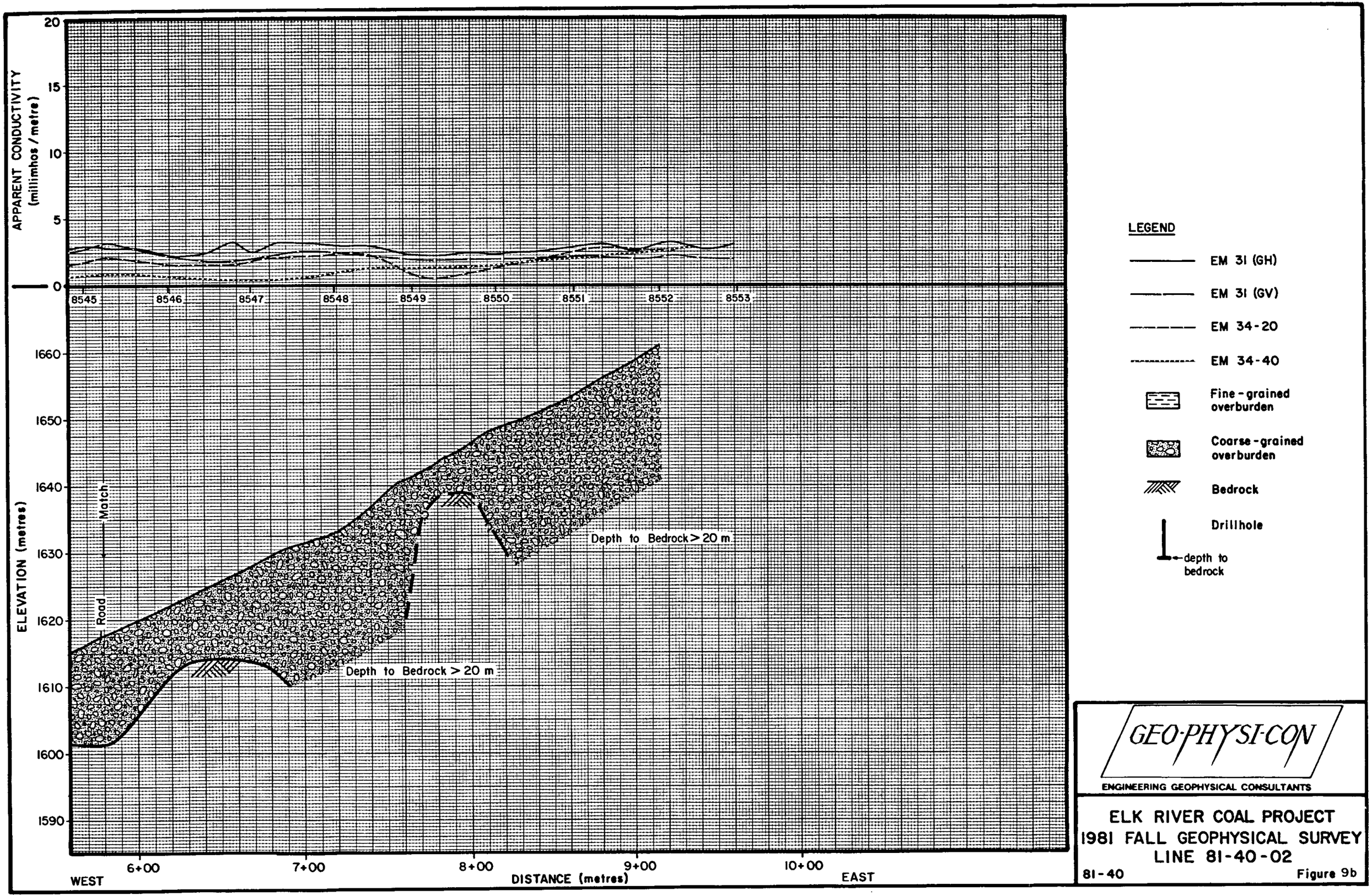
LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine - grained overburden
Coarse - grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-02

81-40 Figure 9a


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8545
8546
8547
8548
8549
8550
8551
8552
8553
ELEVATION (metres)
1660
1650
1640
1630
1620
1610
1600
1590
Match
Road
Depth to Bedrock > 20 m
Depth to Bedrock > 20 m
6+00
7+00
8+00
9+00
10+00
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-02
81-40
Figure 9b

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8556 8557 8558 8559 8560 8561 8562 8563 8564 8565 8566 8567

ELEVATION (metres)

1660
1650
1640
1630
1620
1610
1600
1590
1580

Baseline
DH 129
DH 128
River
River
DH 127
Cutline
DH 126
Match

Coarse - grained overburden

Depth to Bedrock > 20 m

End of hole 25m

?

10+00 WEST 9+00 8+00 7+00 6+00 5+00 4+00 EAST

DISTANCE (metres)

LEGEND

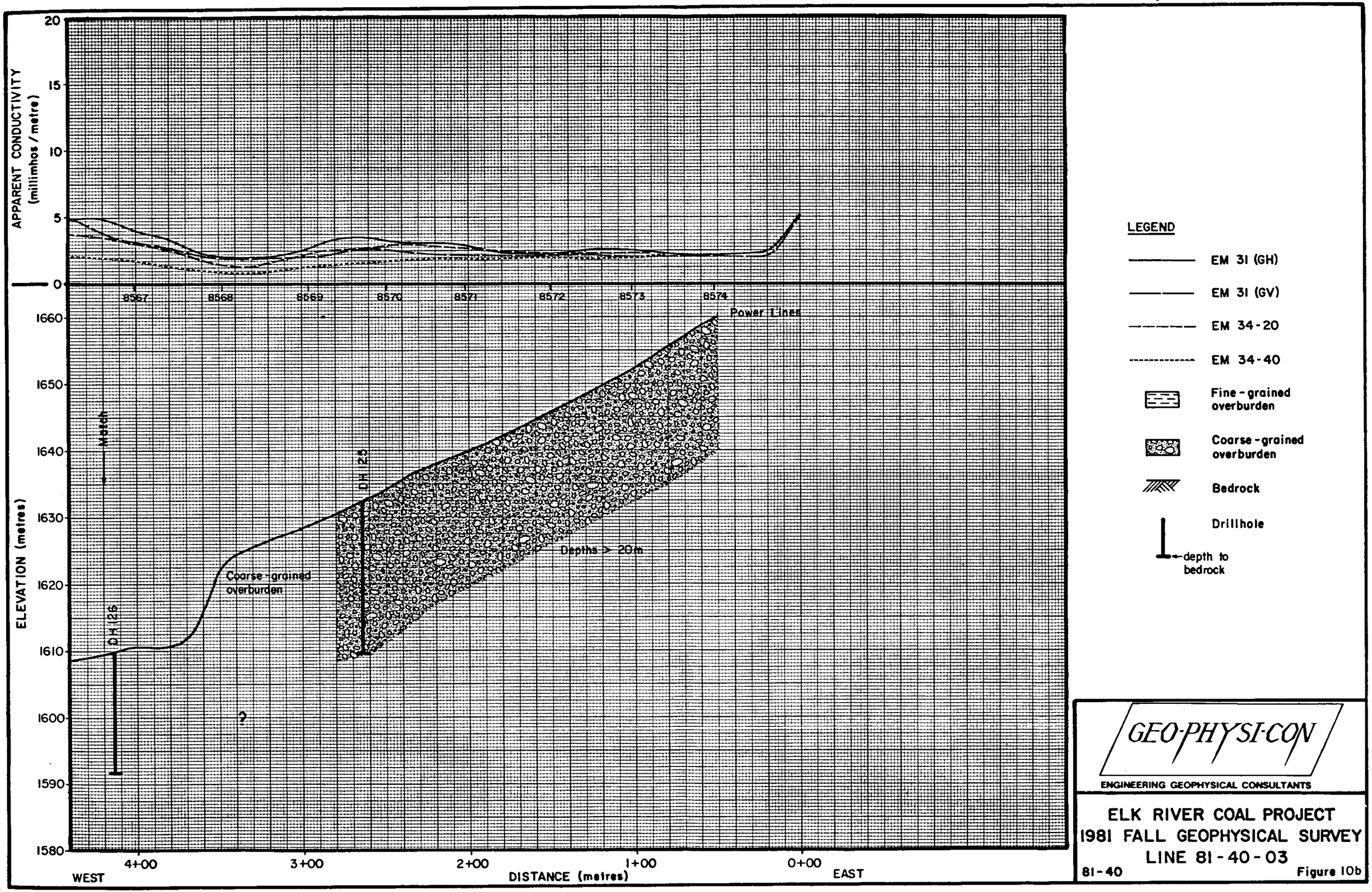
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine - grained overburden
- Coarse - grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81 - 40 - 03

81-40 Figure 10a



GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-03

81-40 Figure 10b

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8601 8602 8603 8640 8641 8642 8643 8644 8645 8646 8647 8648 8649 8650 8651

ELEVATION (metres)

1660
1650
1640
1630
1620
1610
1600
1590

Baseline
Road
Coarse - grained overburden
?
River
Road
Match

0+00 WEST
1+00
2+00
3+00
4+00
5+00
6+00 EAST

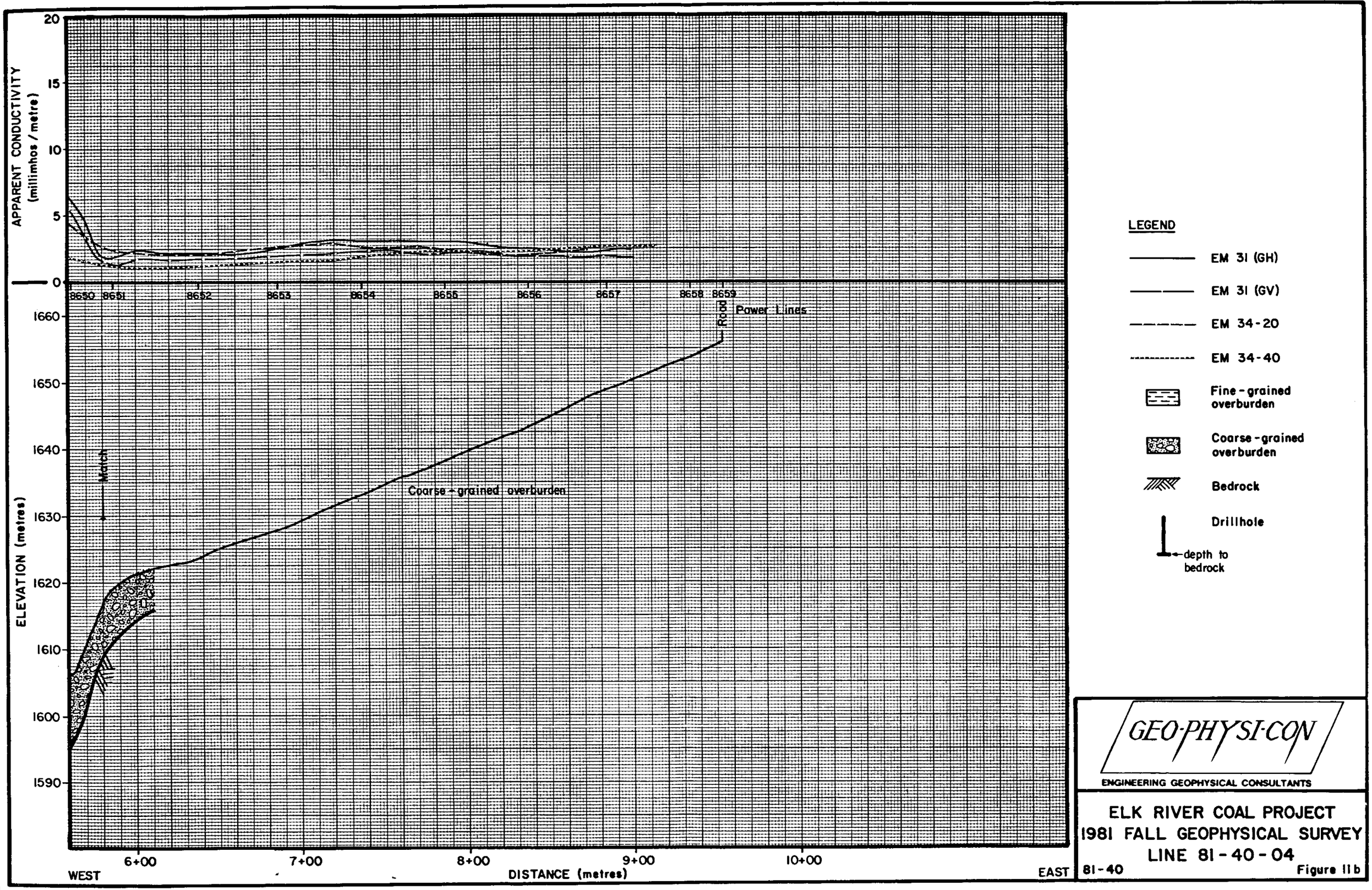
DISTANCE (metres)

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine - grained overburden
Coarse - grained overburden
Bedrock
Drillhole
depth to bedrock

GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81 - 40 - 04
81 - 40 Figure 11a



GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-04

81-40 Figure 11b

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8604 8605 8606 8607 8608 8609 8610 8611 8612 8613 8614 8615 8616 8617

ELEVATION (metres)

1650
1640
1630
1620
1610
1600
1590
1580

Baseline
DH 81
Road
DH 80
Creek
River
M71-32C
M70-26C
Marsh
Coarse - grained overburden
?
?

0+00 WEST
1+00
2+00
3+00
4+00
5+00
6+00 EAST

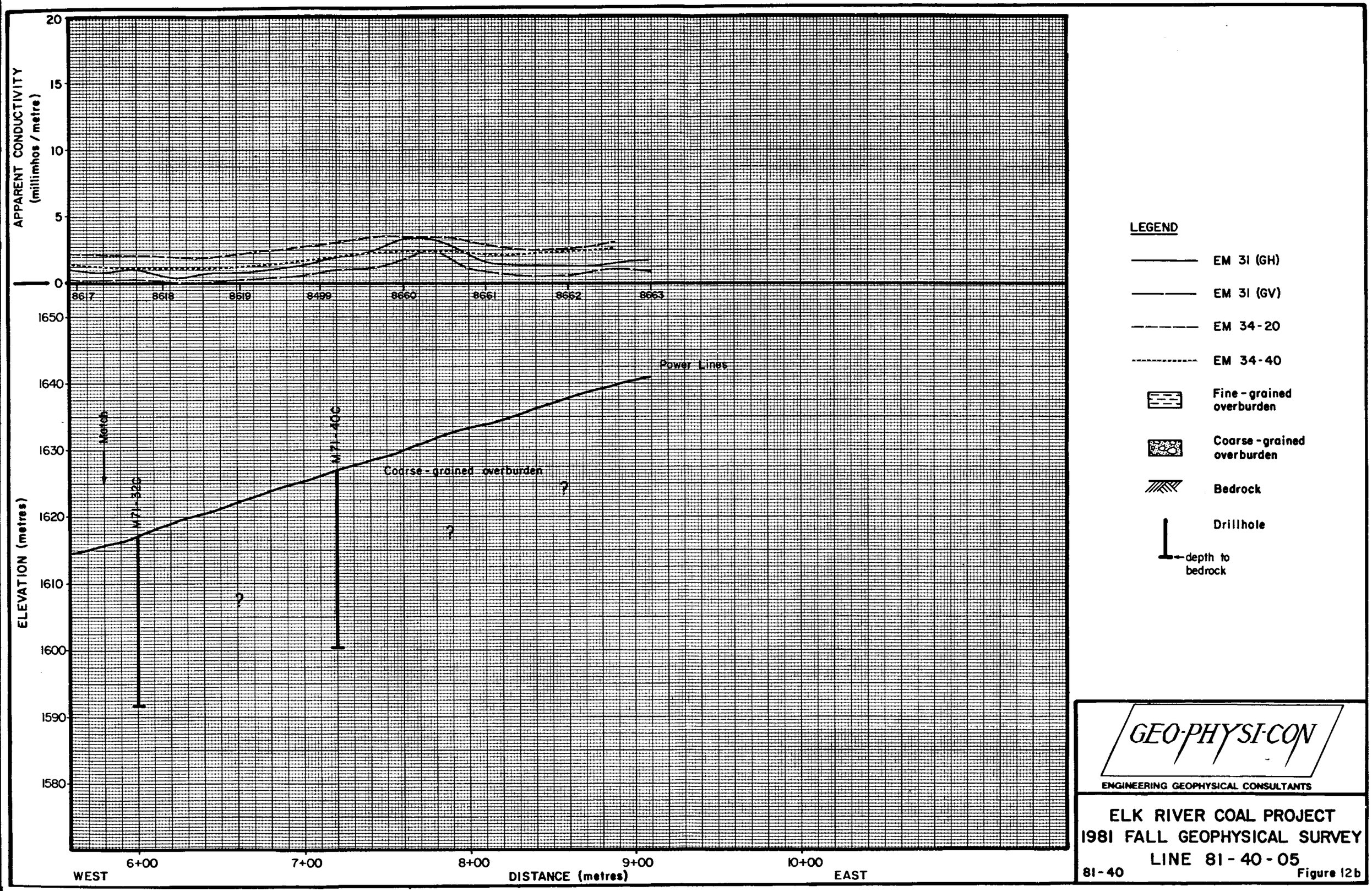
DISTANCE (metres)

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine - grained overburden
Coarse - grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81 - 40 - 05
81-40 Figure 12a

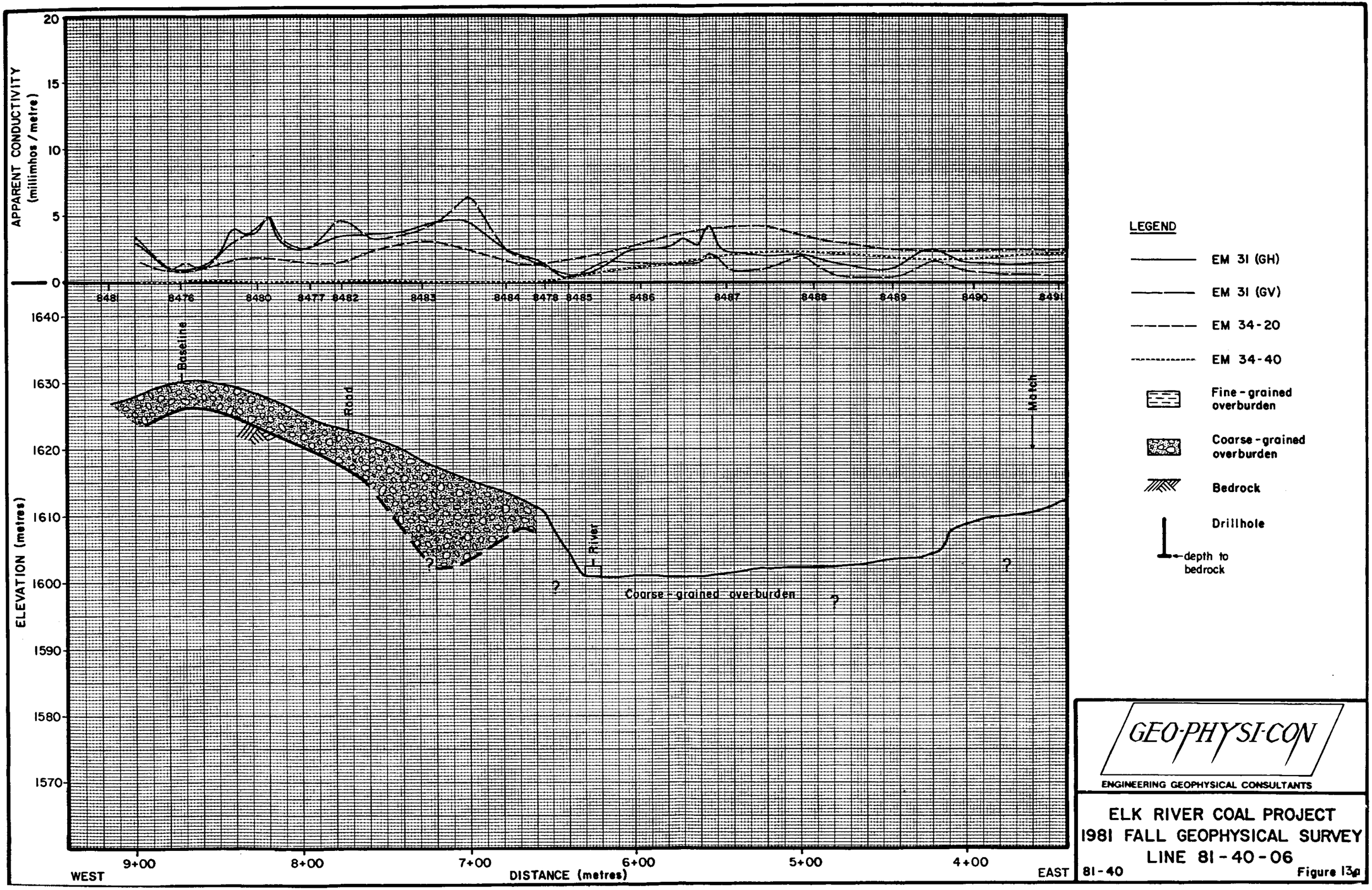


GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

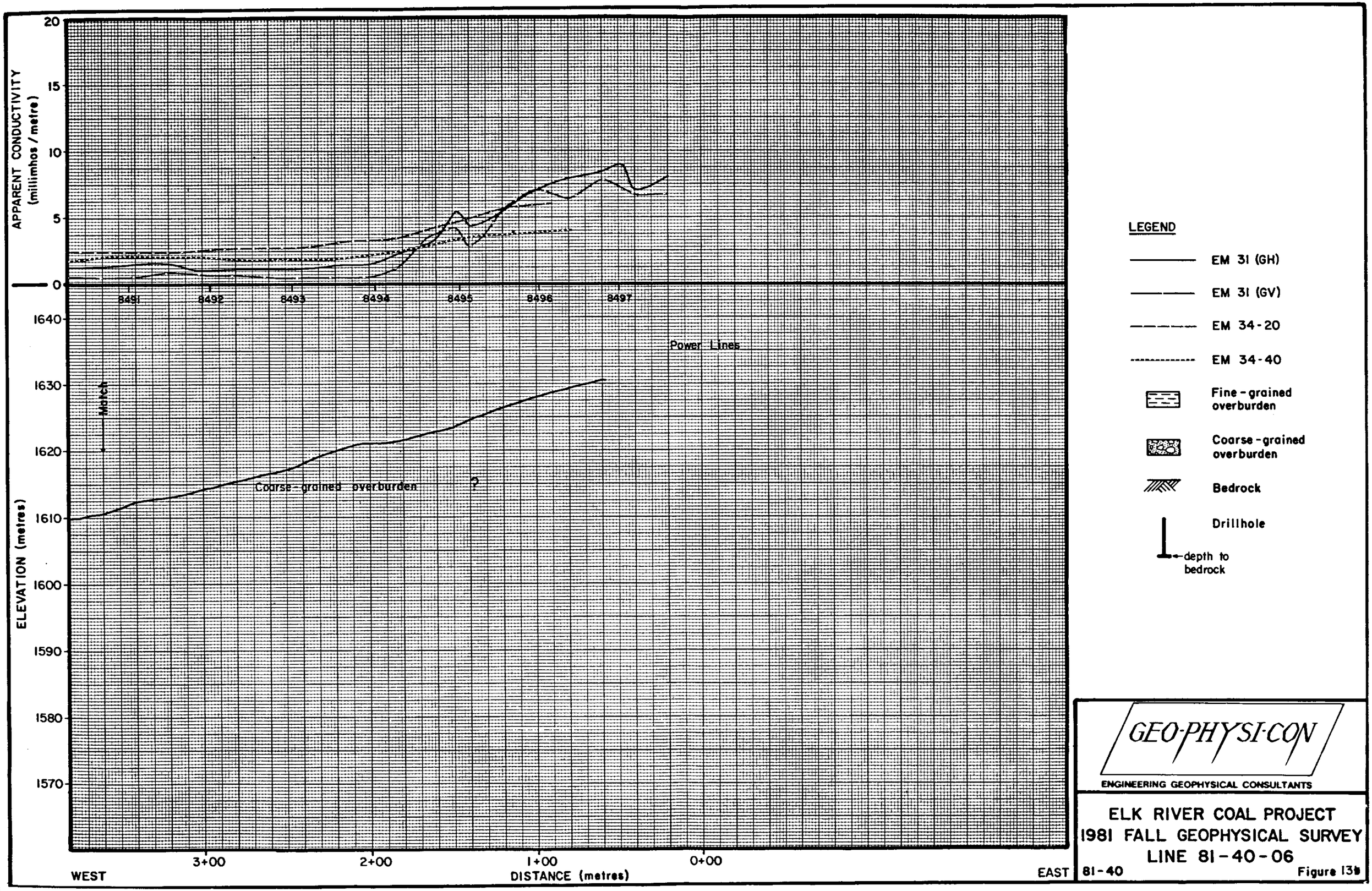
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-05

81-40 Figure 12b



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-06
81-40 Figure 13a

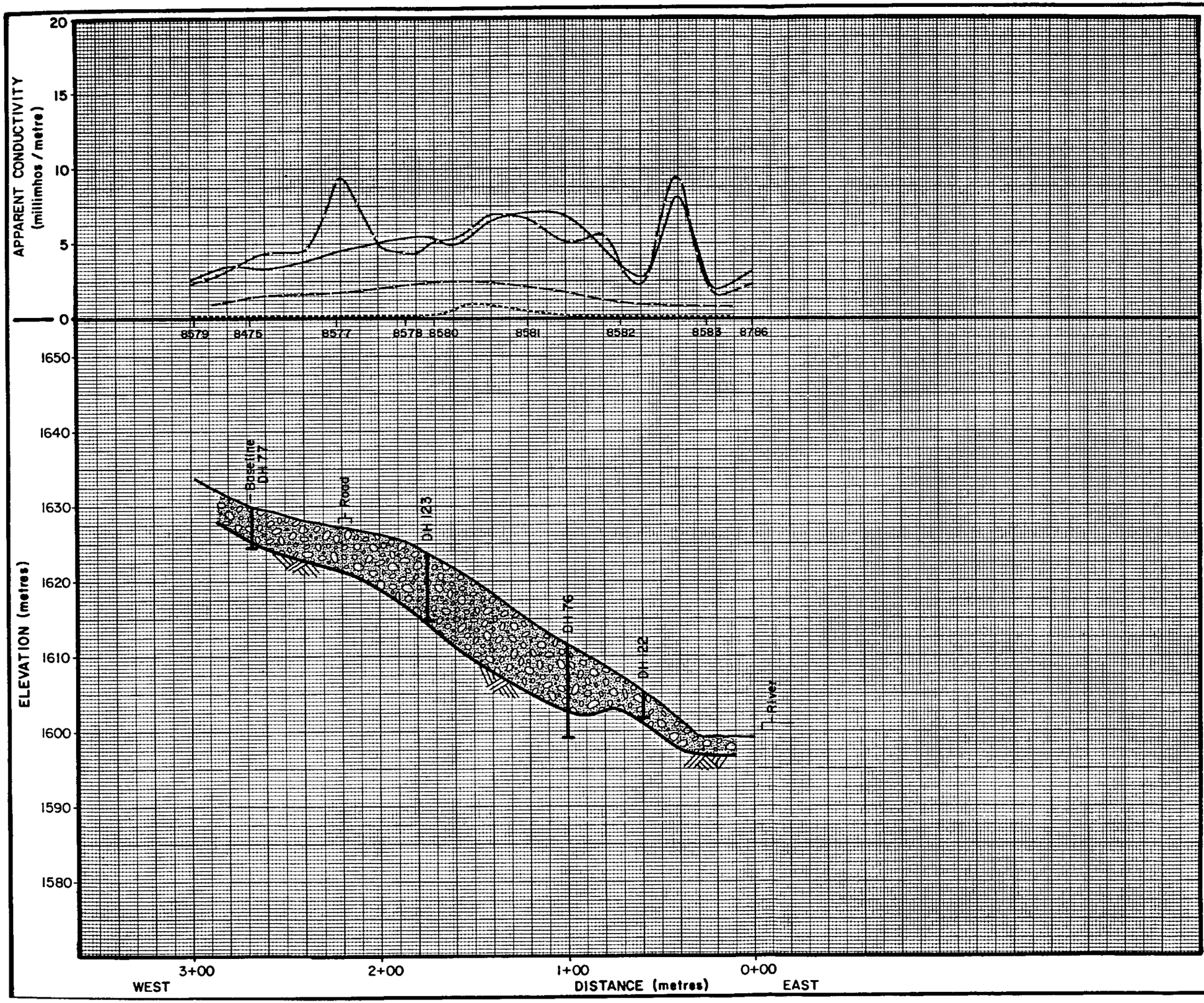


GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-06

81-40 Figure 13b



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-07

81-40 Figure 14

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8584 8479 8585 8586 8587 8588 8589

1650
1640
1630
1620
1610
1600
1590
1580

Base line

ELEVATION (metres)

0+00 WEST
1+00
2+00
DISTANCE (metres)
EAST

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-08
81-40 Figure 15

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8593 8795 8796 8590 8591 8592

ELEVATION (metres)

1650
1640
1630
1620
1610
1600
1590
1580

Baseline

Road

WEST 0+00 1+00 2+00 EAST

DISTANCE (metres)

LEGEND

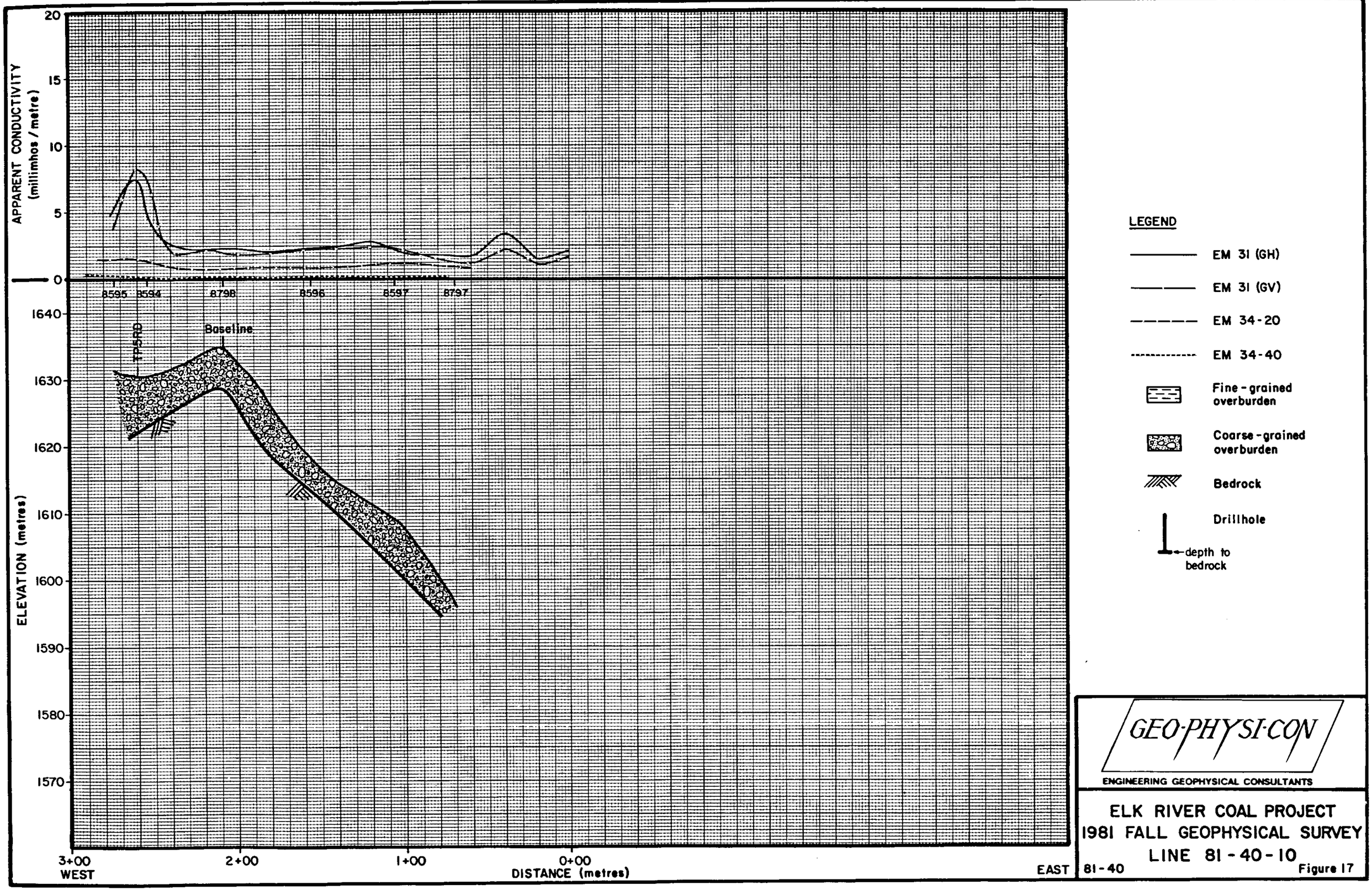
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

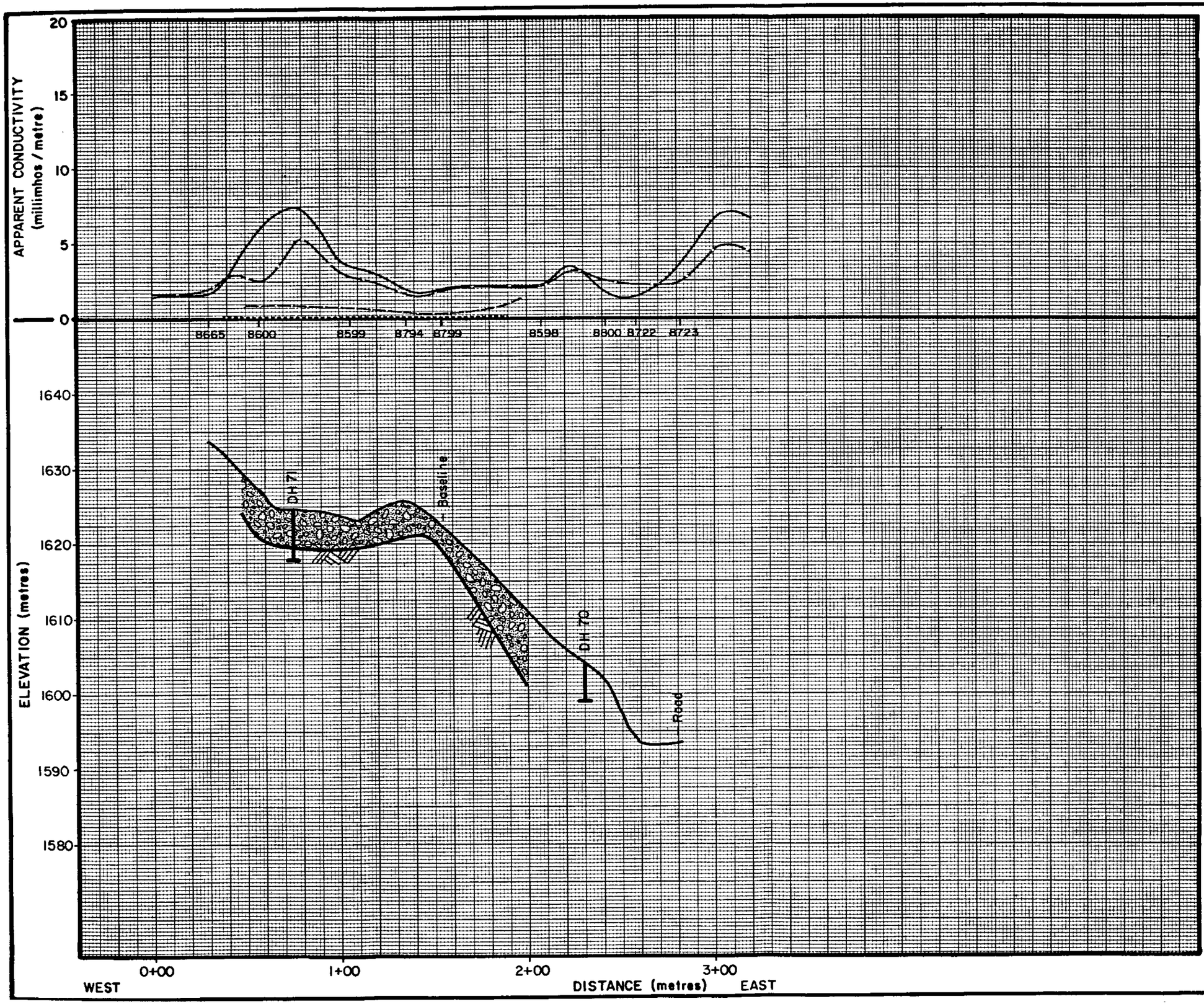
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-09

81-40 Figure 16



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-10
81-40 Figure 17



LEGEND

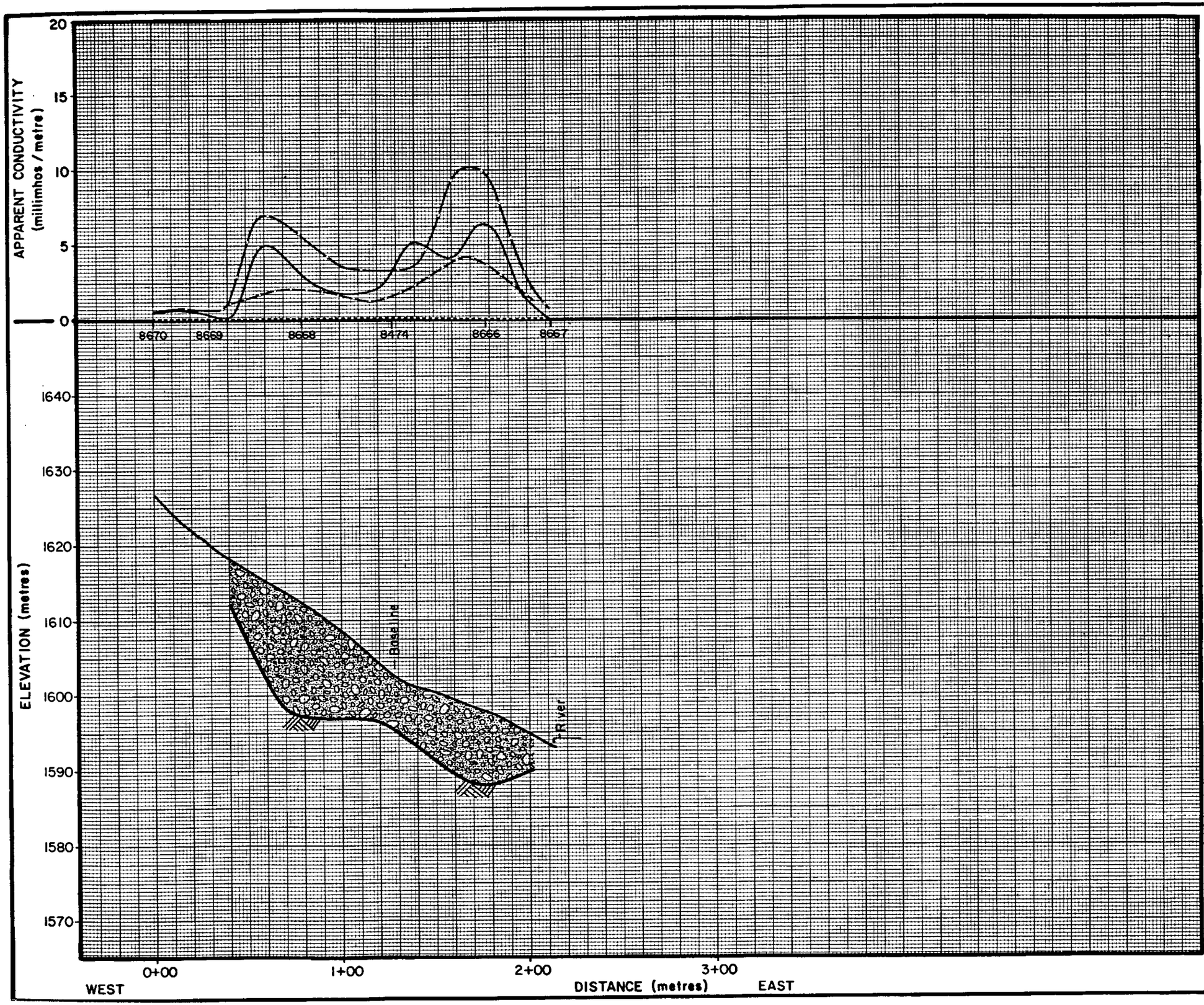
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-11

81-40 Figure 18



LEGEND

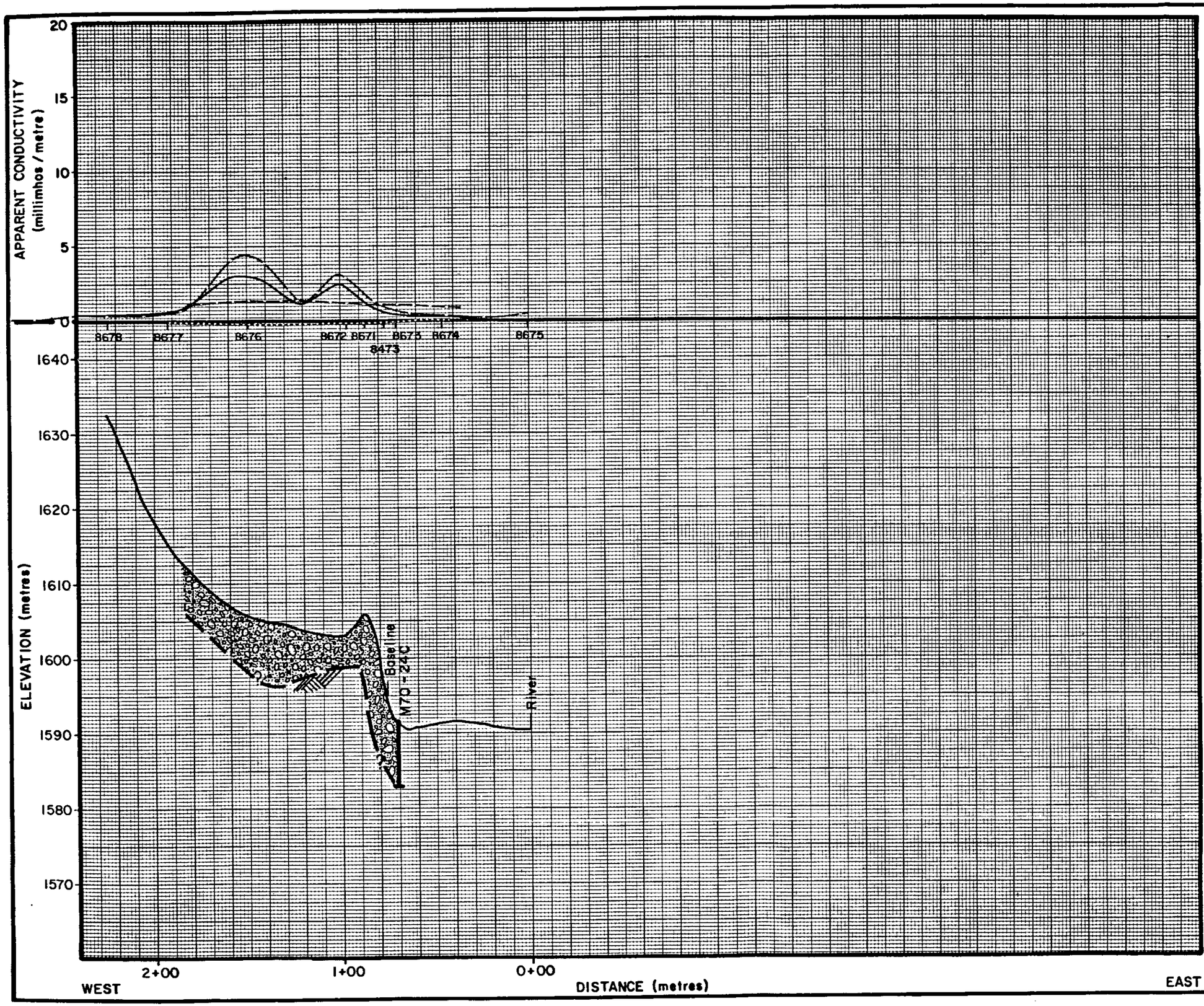
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-12

81-40 Figure 19



LEGEND

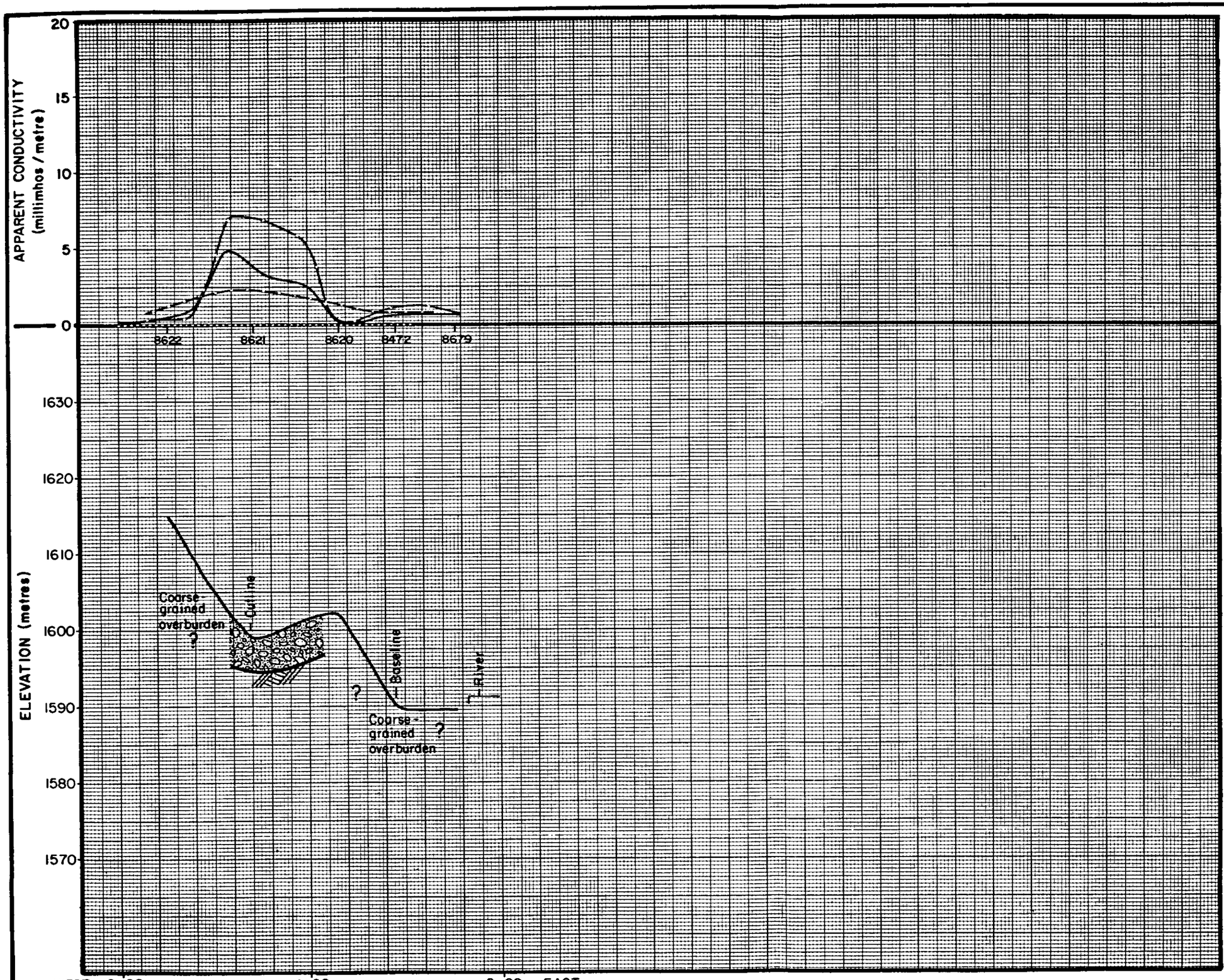
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-13

81-40 Figure 20



LEGEND

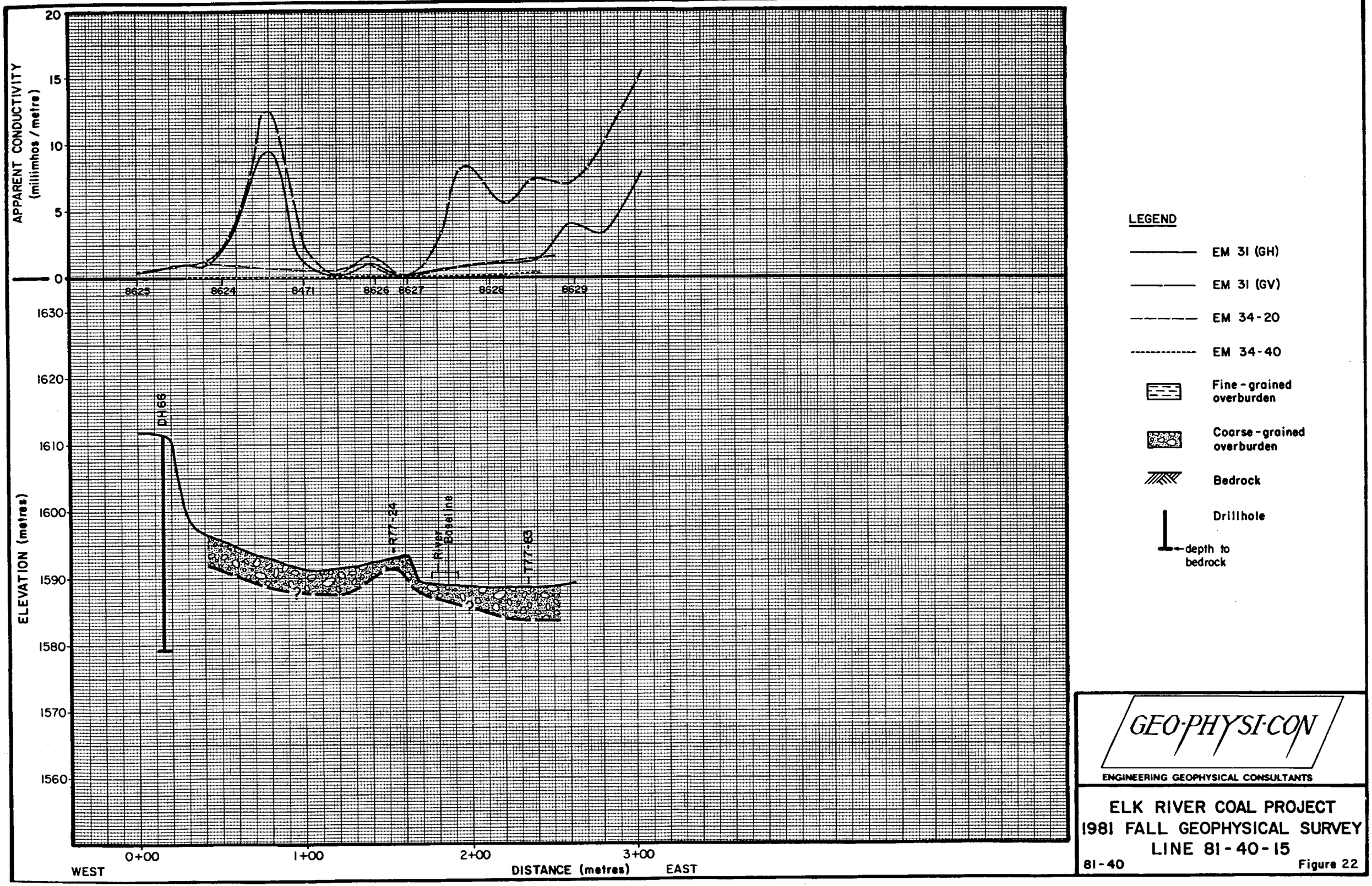
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

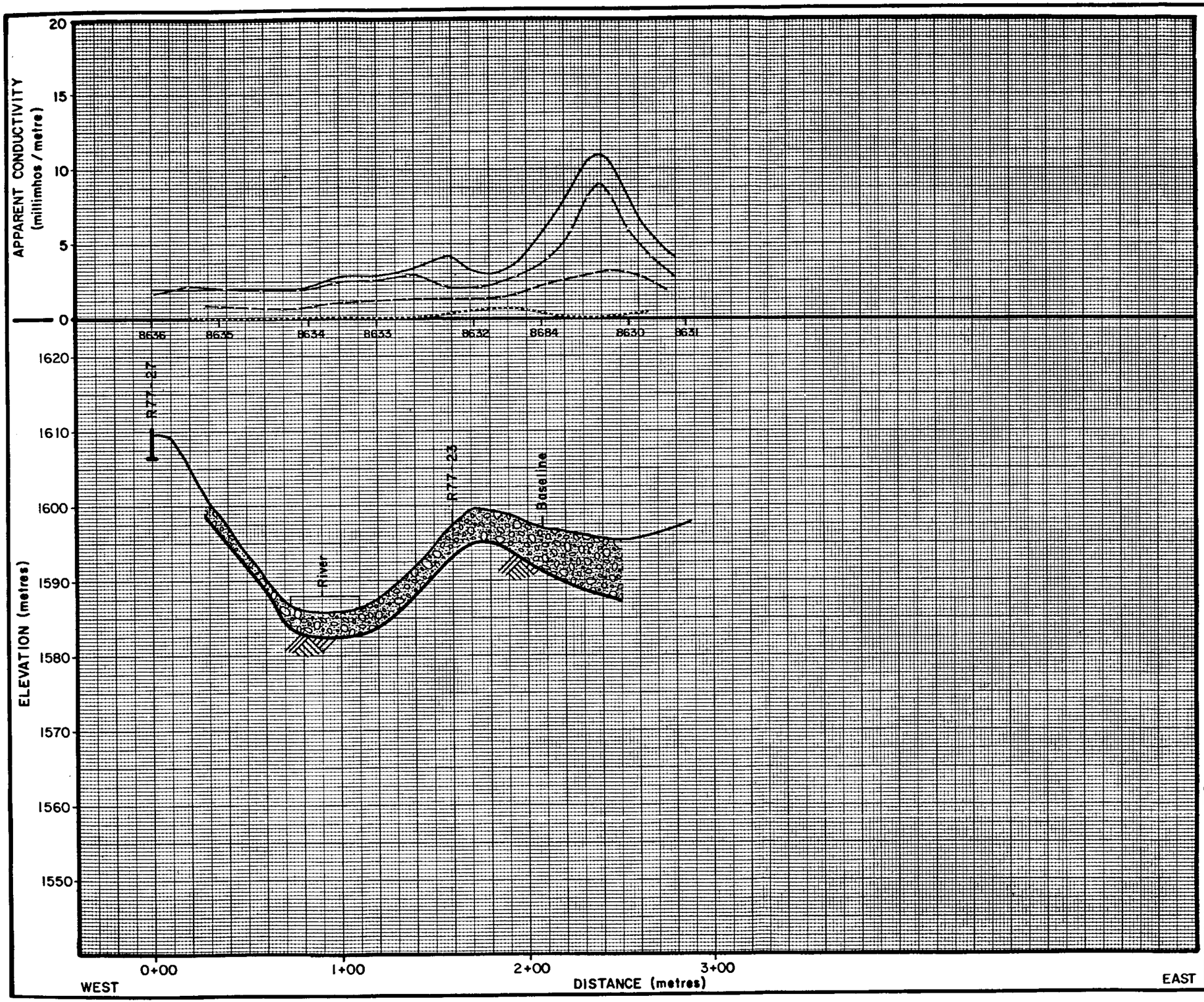
GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-14

81-40 Figure 21


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8623
8624
8471
8626
8627
8628
8629
ELEVATION (metres)
1630
1620
1610
1600
1590
1580
1570
1560
DH66
RT7-24
River Baseline
TT7-83
0+00
1+00
2+00
3+00
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-15
81-40
Figure 22



LEGEND

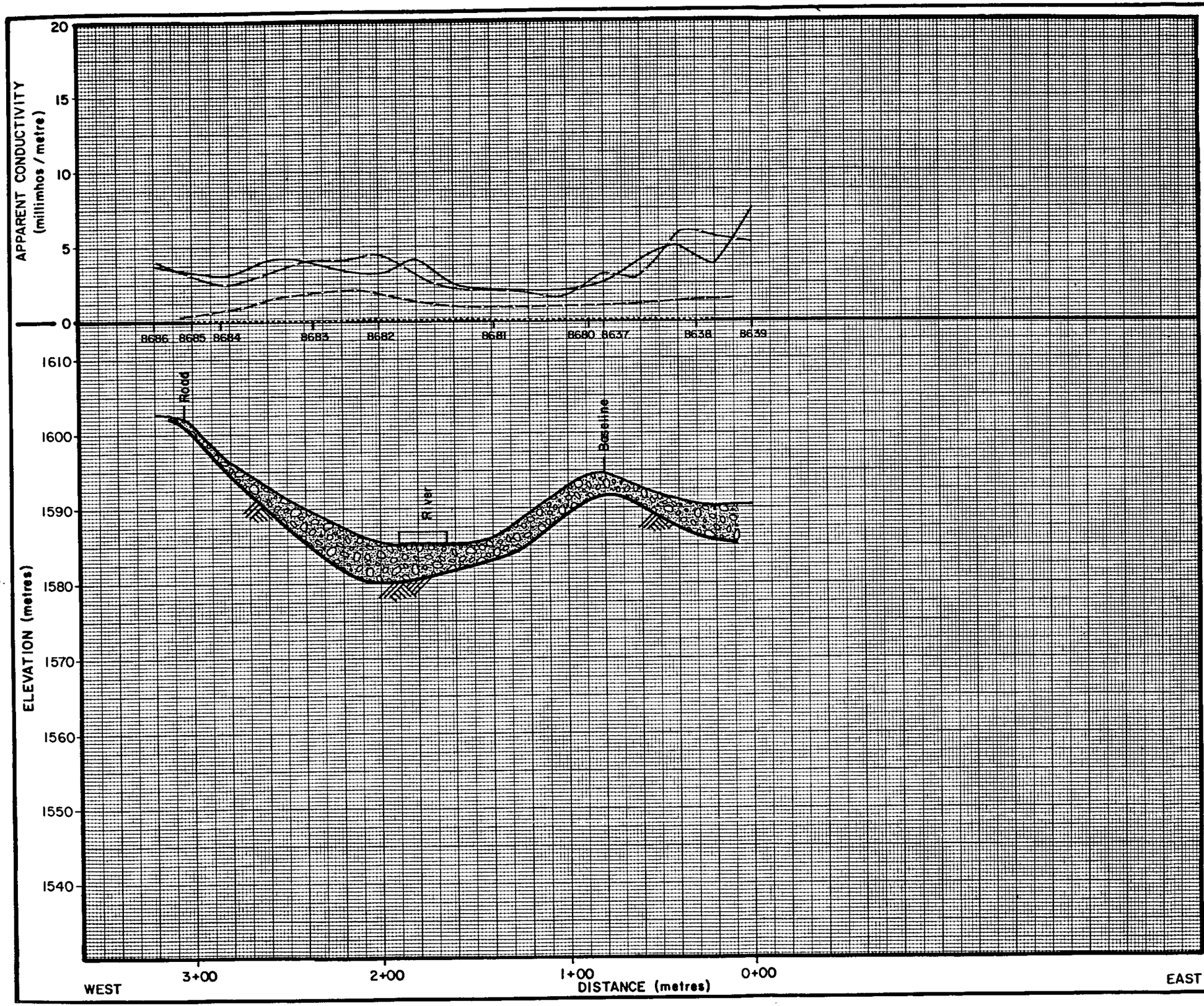
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-16

81-40 Figure 23



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-17

81-40 Figure 24

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8695 8694 8693 8692 8691 8690 8689 8687 8688

ELEVATION (metres)

1610
1600
1590
1580
1570
1560
1550
1540

Road
Cutline
Road T 77-67
DH 77-67 Baseline
River

0+00 1+00 2+00 3+00

WEST DISTANCE (metres) EAST

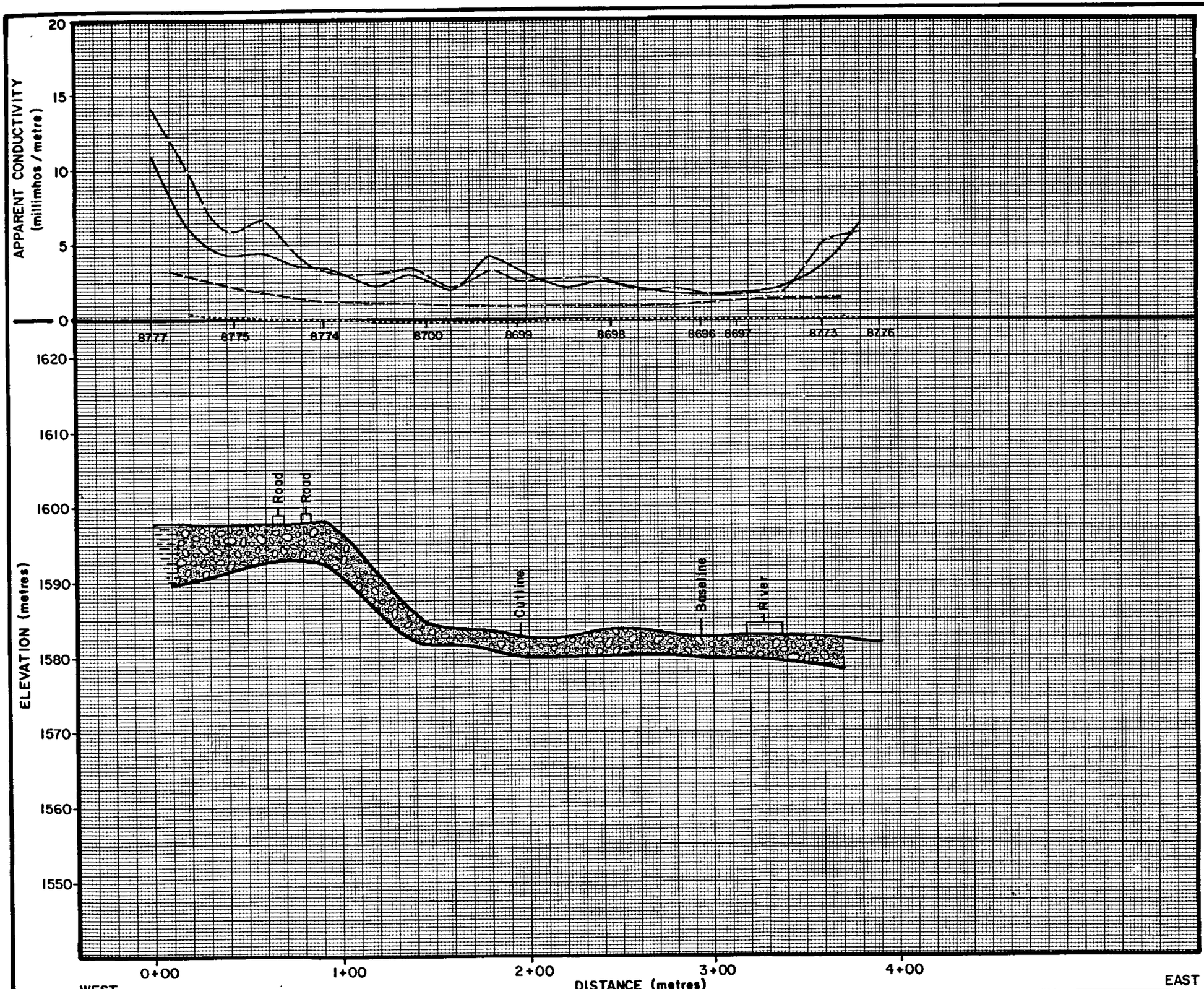
LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-18

81-40 Figure 25



LEGEND

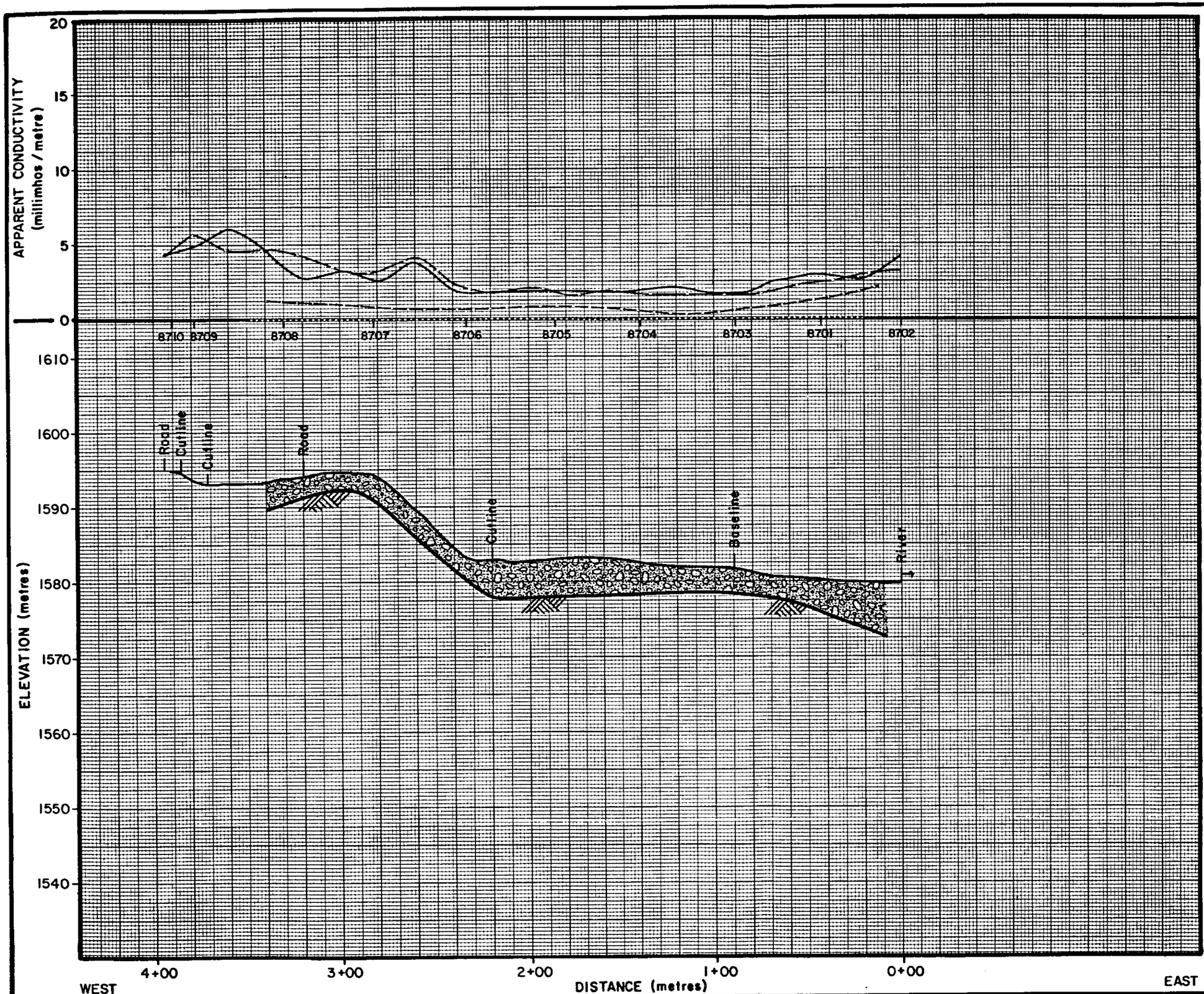
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-19

81-40 Figure 26



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-20

81-40 Figure 27

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8757 8756 8755 8745 8744 8743 8742 8741 8714 8711 8712 8713

1600
1590
1580
1570
1560
1550
1540
1530

ELEVATION (metres)

Cutline
Road
Baseline
EM12
?

WEST
0+00
1+00
2+00
3+00
4+00
EAST
DISTANCE (metres)

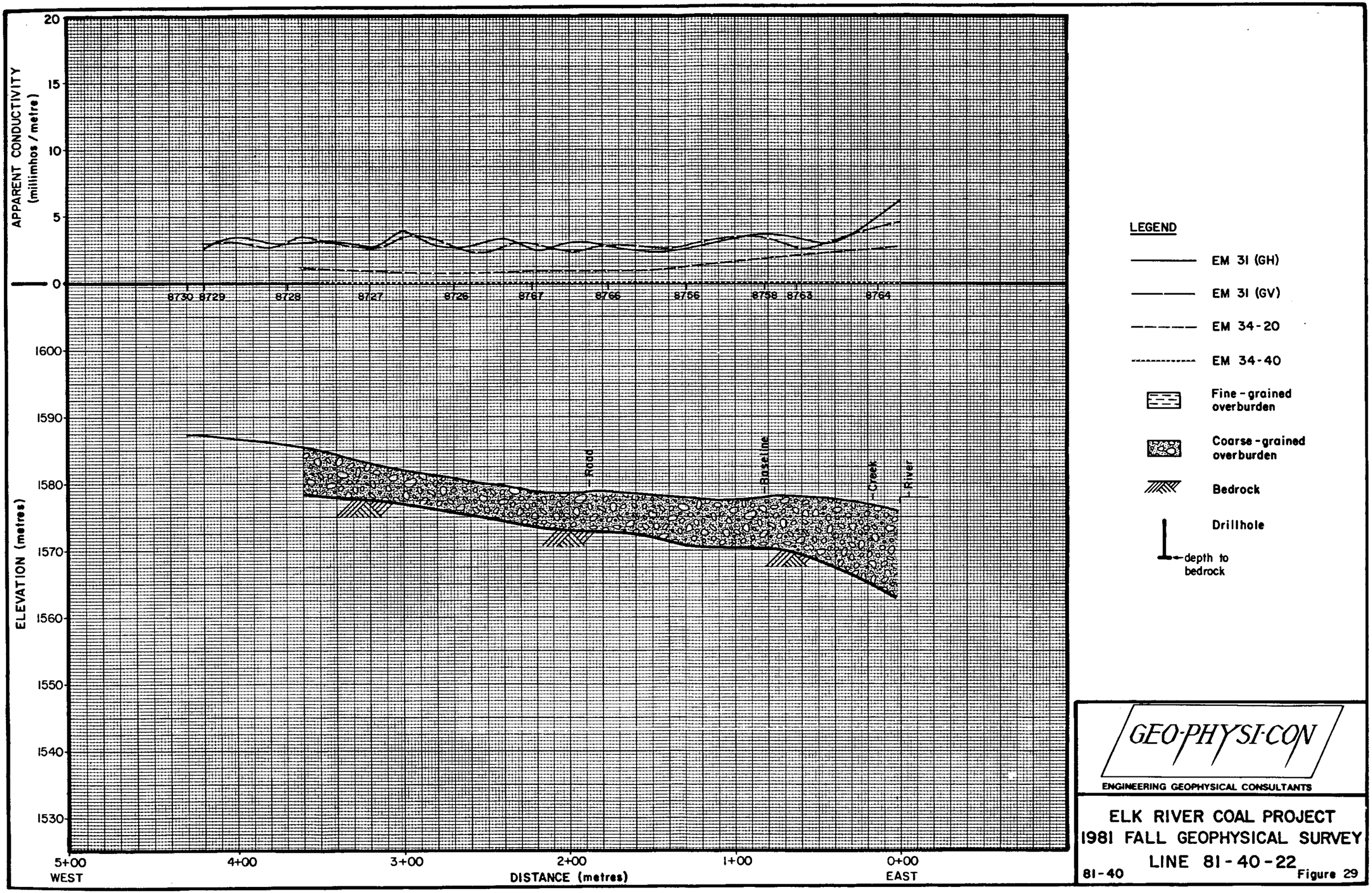
LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-21

81-40 Figure 28



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-22
81-40 Figure 29

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8788 8787 8771 8770 8769 8768 8762 8754 8752 8751 8732

1600
1590
1580
1570
1560
1550
1540
1530

ELEVATION (metres)

Creek
Creek
Road
DH55
River
Baseline
DH54
Creek

Depth to Bedrock > 20m

0+00 1+00 2+00 3+00 4+00

WEST DISTANCE (metres) EAST

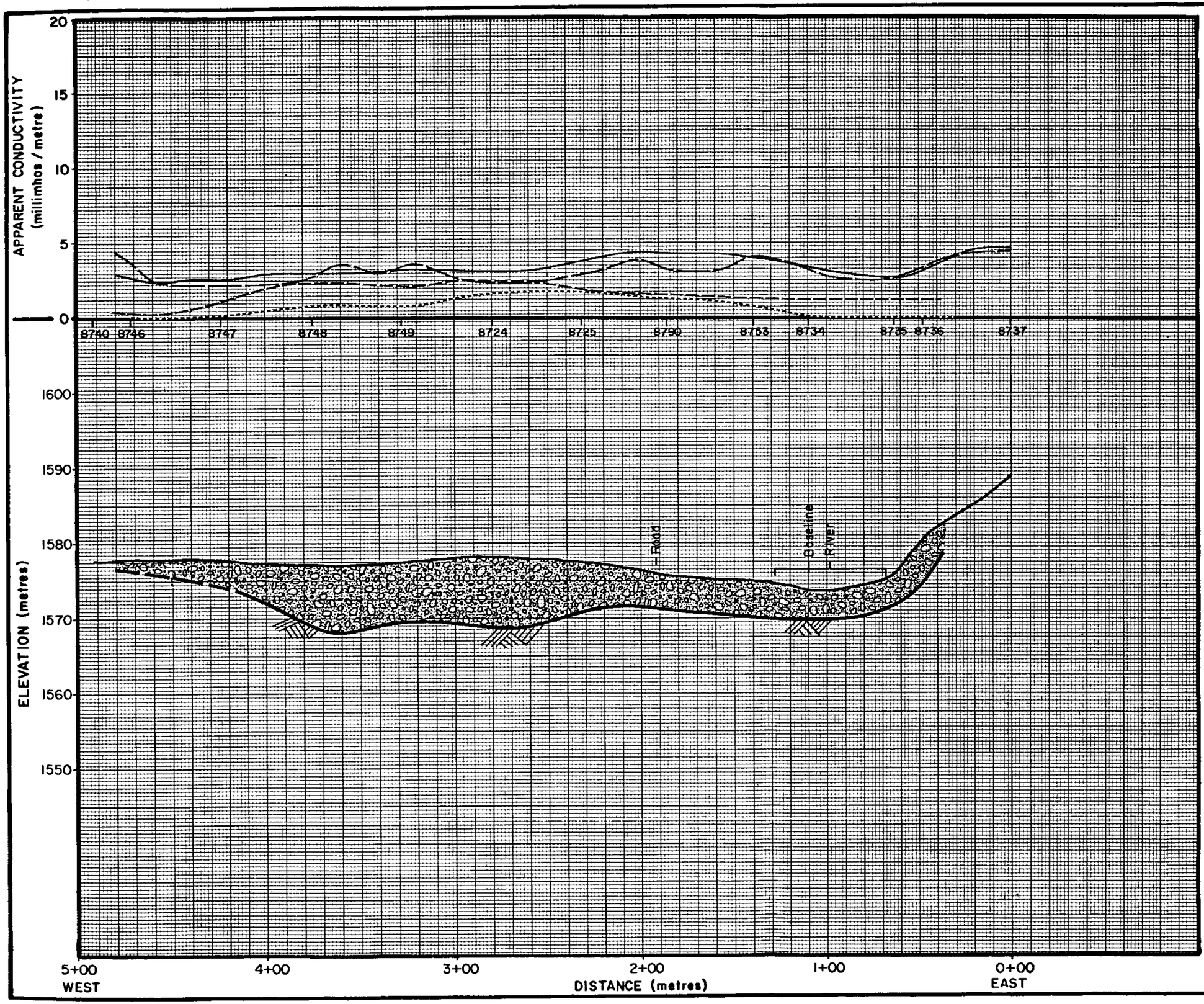
LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-23

81-40 Figure 30



LEGEND

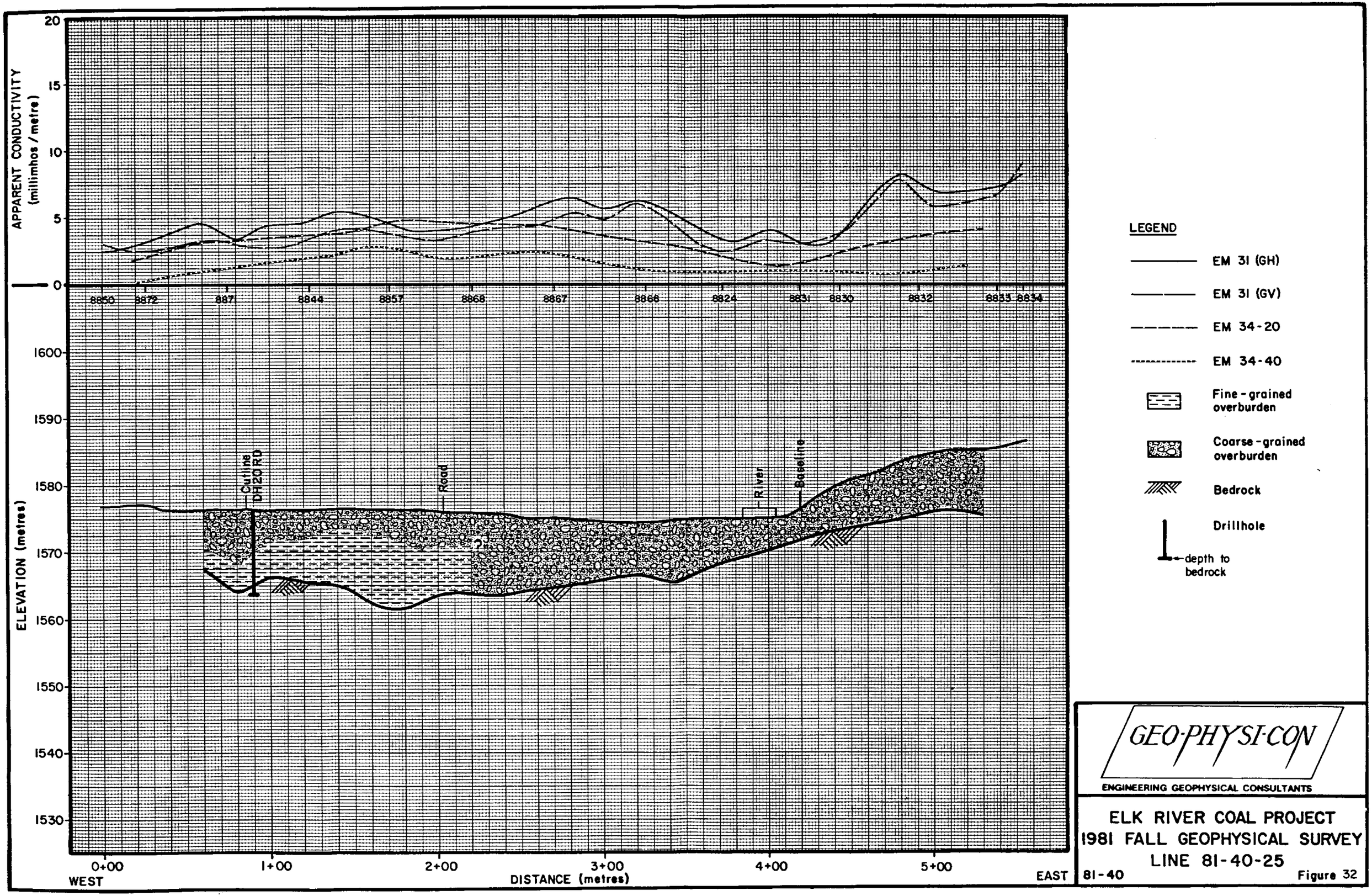
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-24

81-40 Figure 31

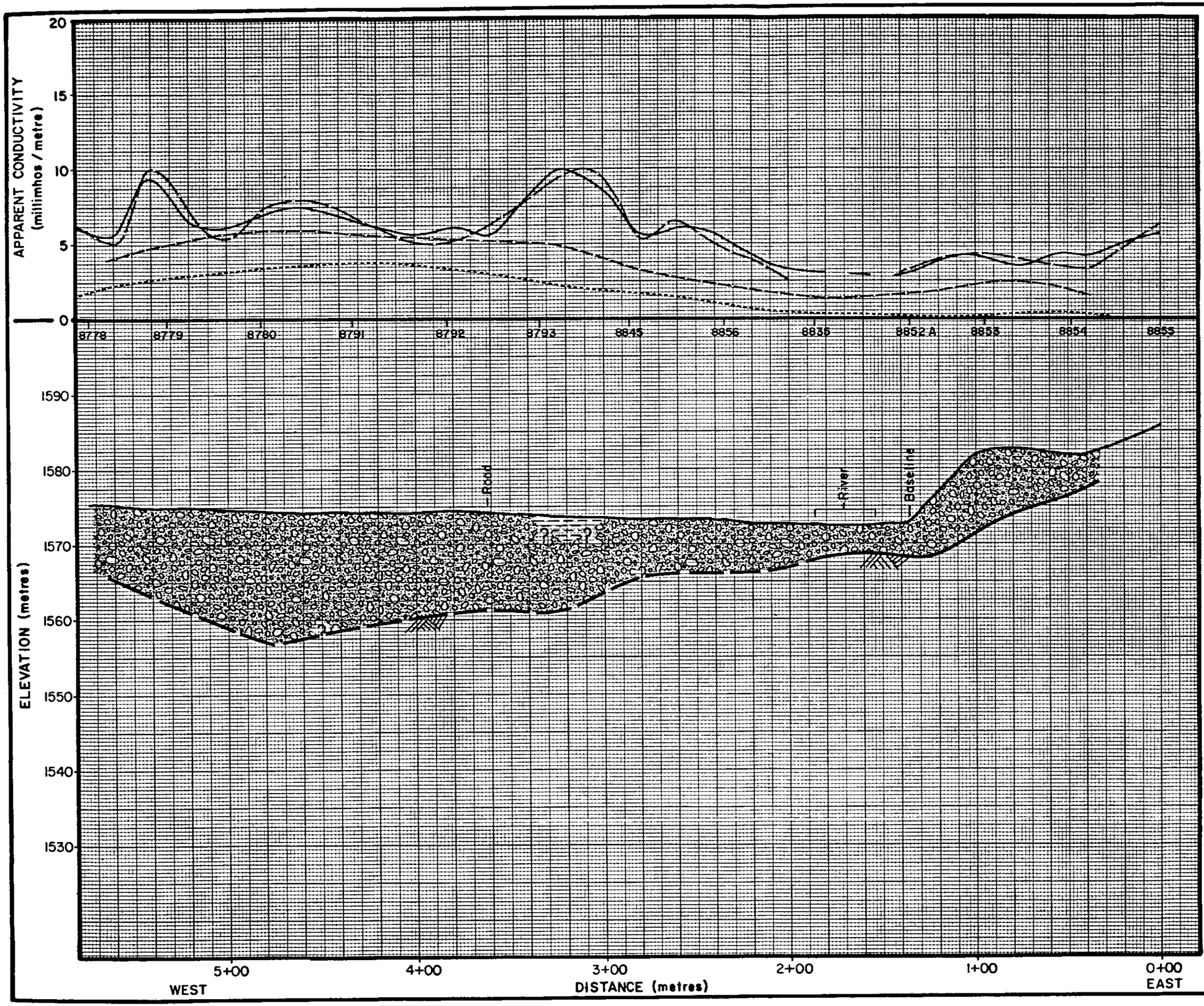


GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-25

81-40 Figure 32



LEGEND

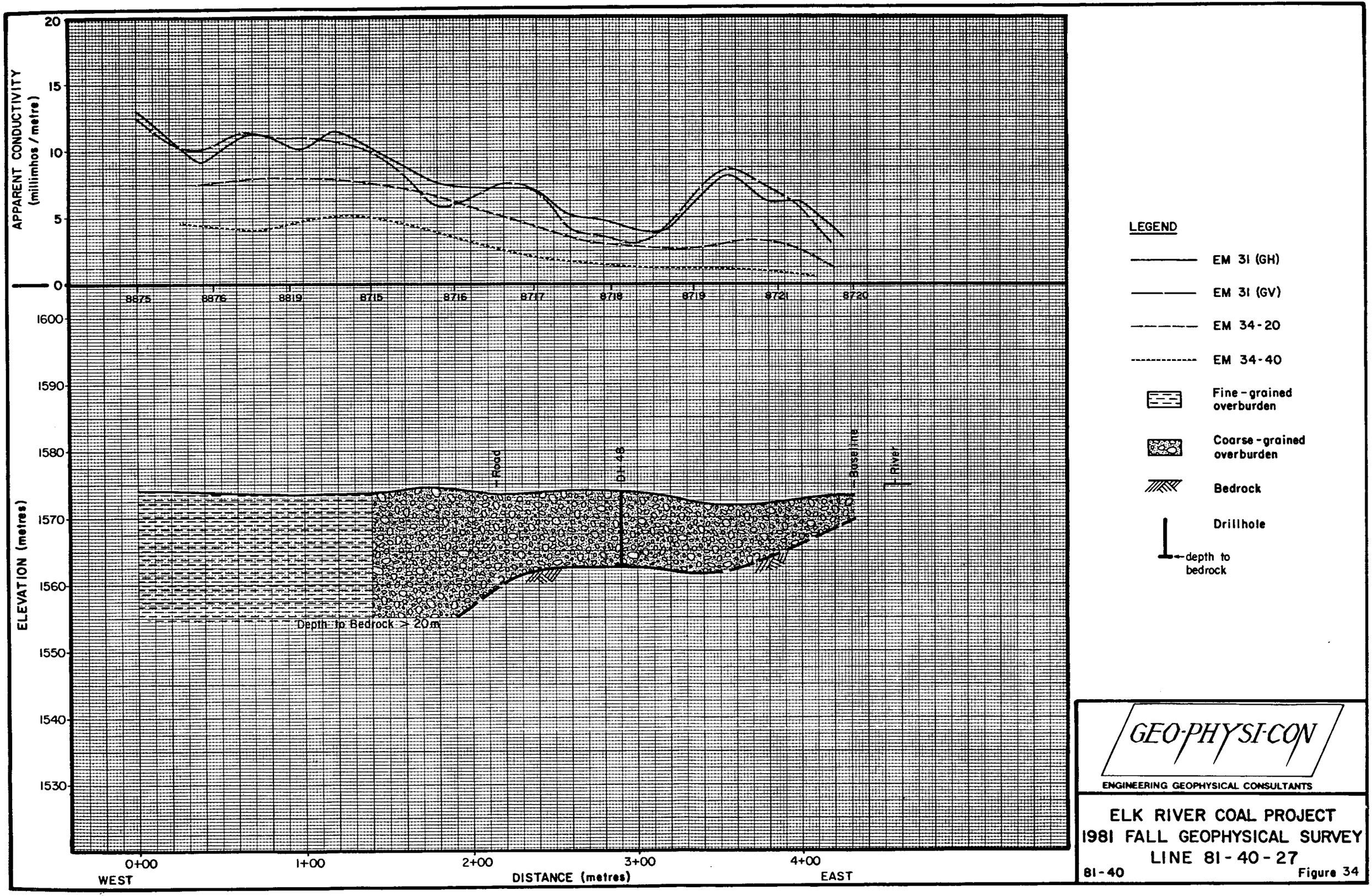
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

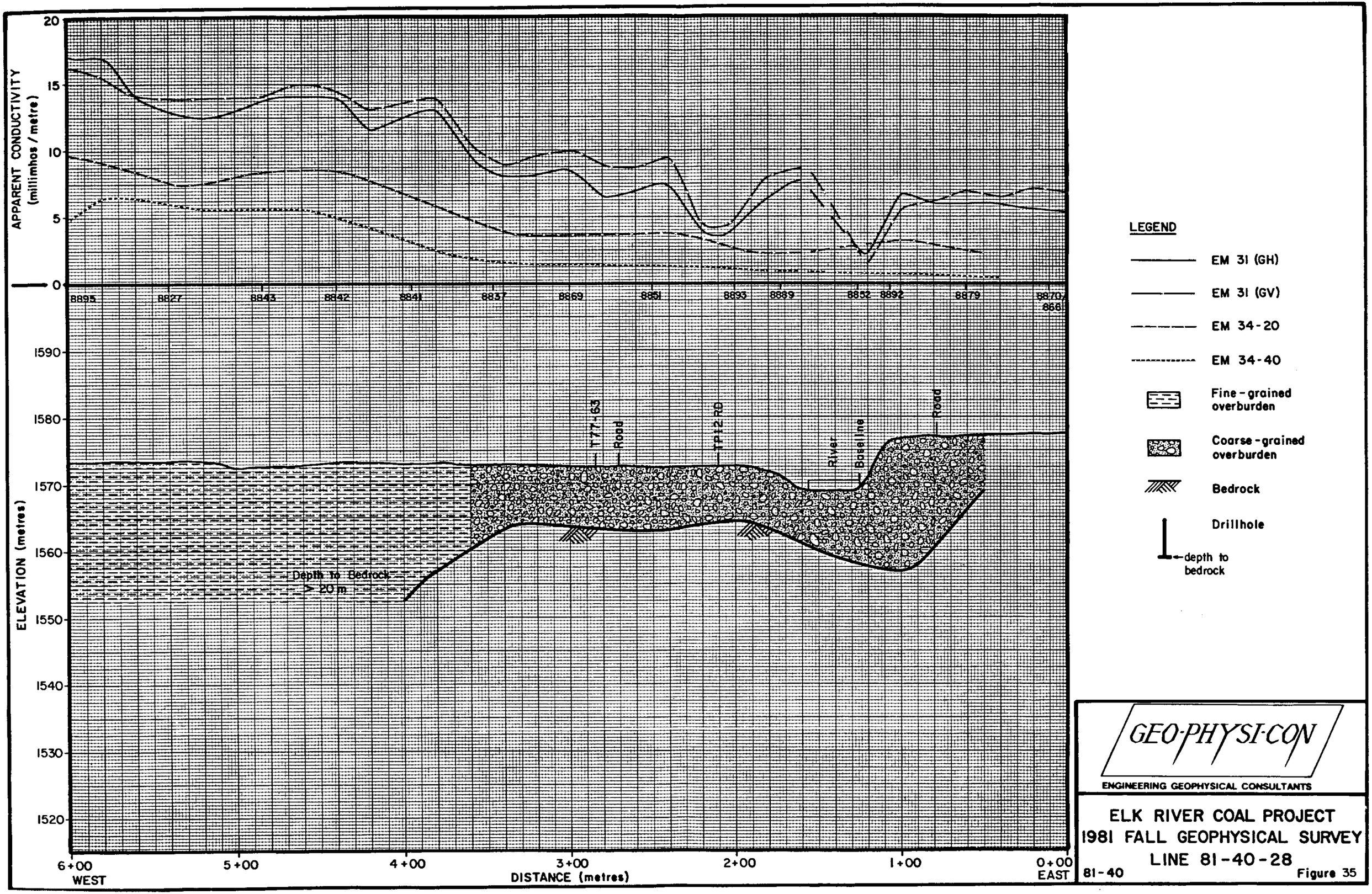
GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-26

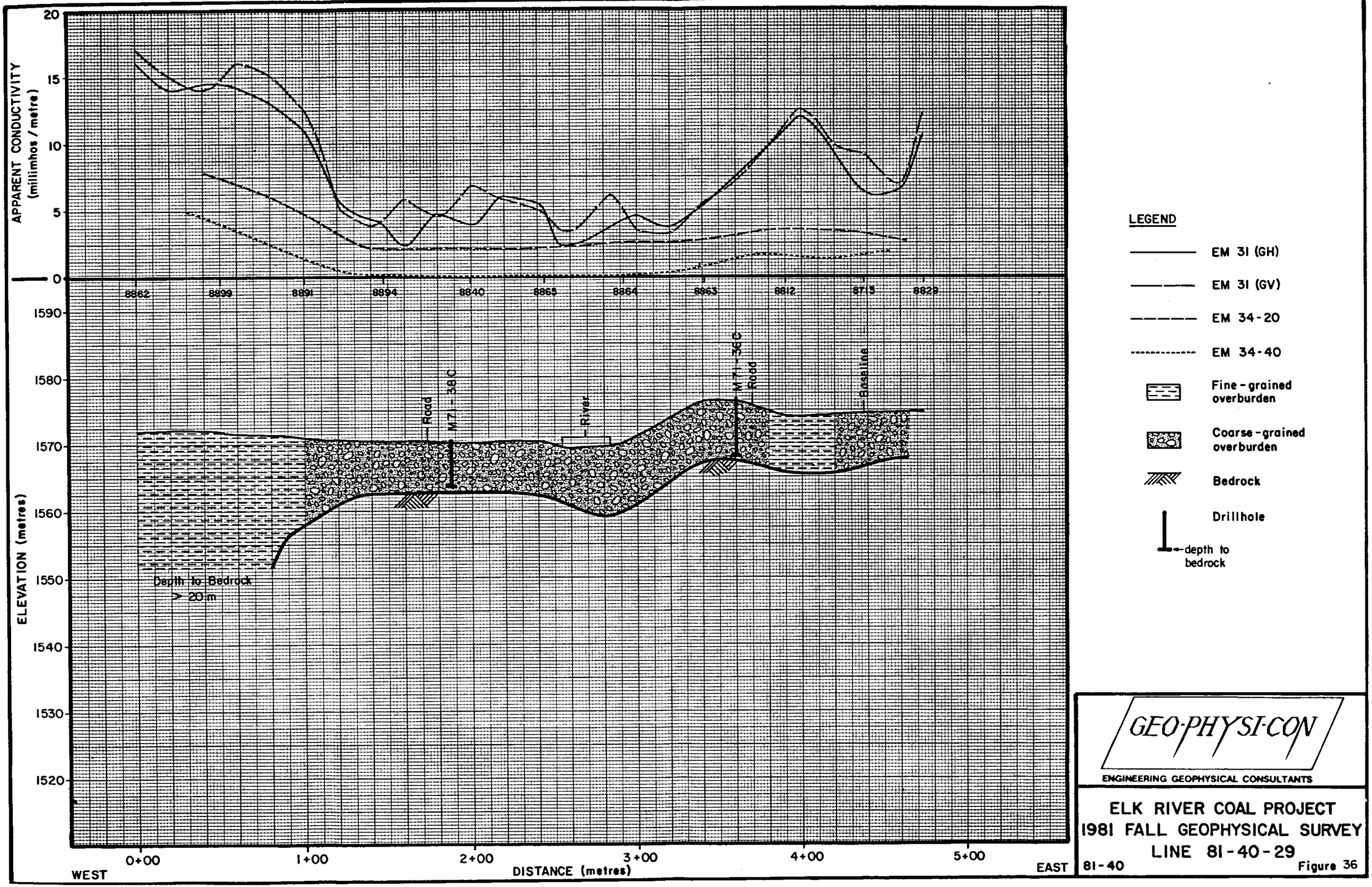
81-40 Figure 33

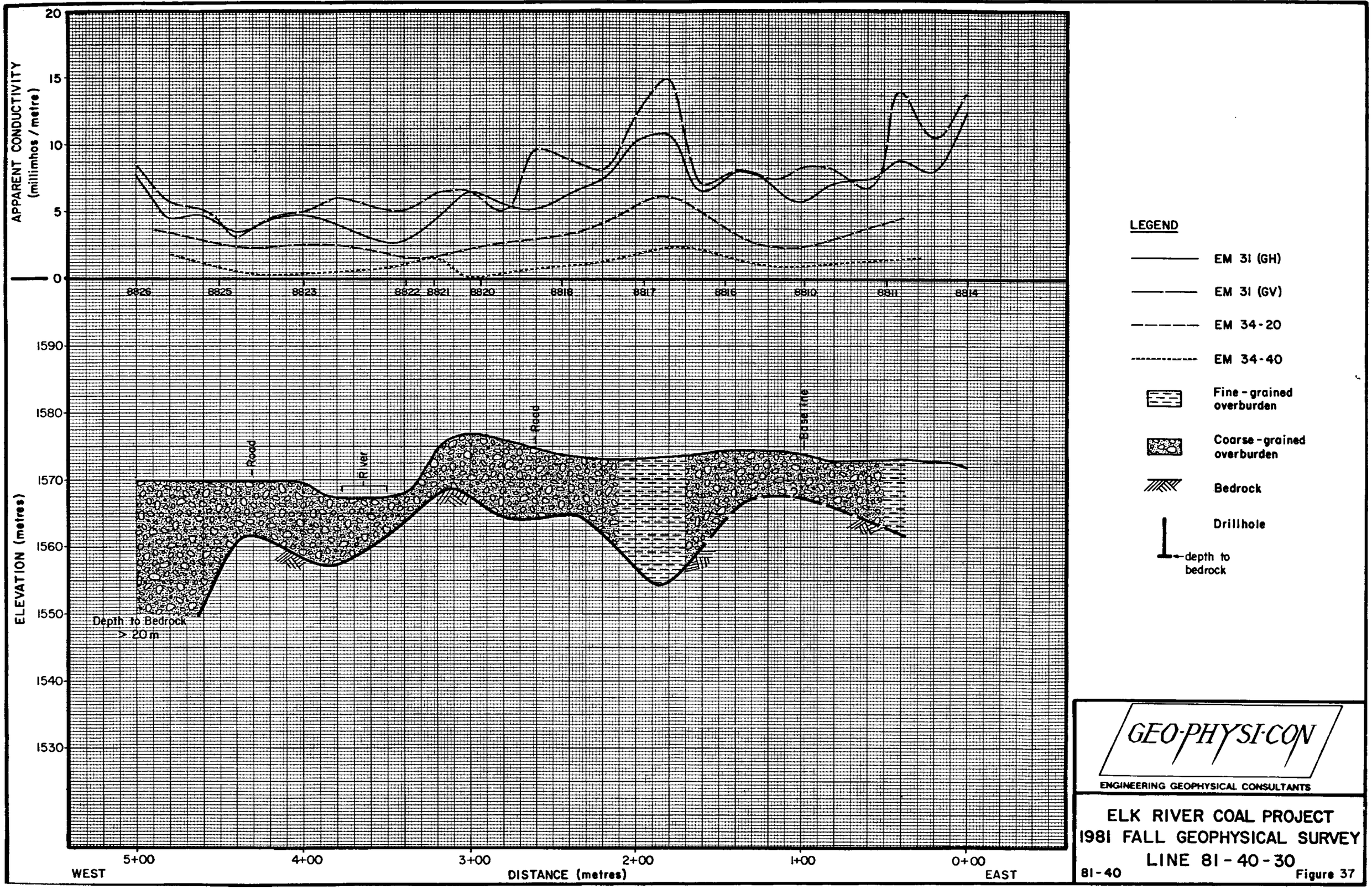

APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8875
8876
8819
8715
8716
8717
8718
8719
8721
8720
1600
1590
1580
1570
1560
1550
1540
1530
ELEVATION (metres)
T-Road
D.H. 48
T-Baseline
T-River
Depth to Bedrock > 20m
0+00
1+00
2+00
3+00
4+00
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-27
81-40
Figure 34



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-28
81-40 Figure 35


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8862
8899
8891
8894
8840
8865
8864
8863
8812
8715
8829
1590
1580
1570
1560
1550
1540
1530
1520
M7-38
Road
M7-38C
River
M7-36C
Road
Gasline
Depth to Bedrock > 20 m
ELEVATION (metres)
0+00
1+00
2+00
3+00
4+00
5+00
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-29
81-40
Figure 36


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8826
8825
8823
8822
8821
8820
8818
8817
8816
8810
8811
8814
ELEVATION (metres)
1590
1580
1570
1560
1550
1540
1530
Road
River
Road
Baseline
Depth to Bedrock > 20 m
5+00
4+00
3+00
2+00
1+00
0+00
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-30
81-40
Figure 37

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8881 8880 8859 8858 8850 8849 8848 8847 8838 8839 8846

1590
1580
1570
1560
1550
1540
1530
1520

ELEVATION (metres)

Road
River
DH43
Road
DH42
Base line

0+00 1+00 2+00 3+00 4+00

WEST DISTANCE (metres) EAST

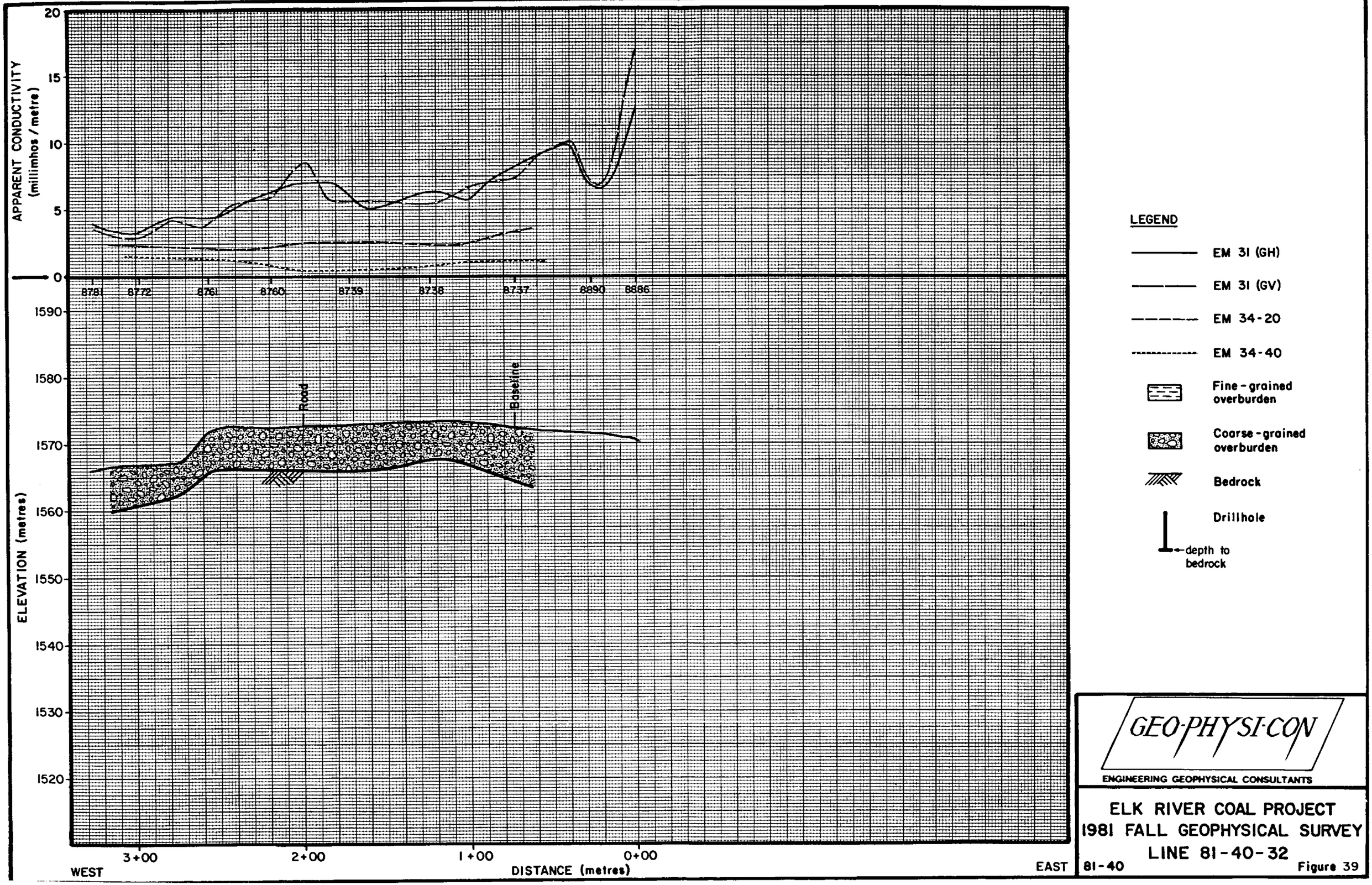
LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-31

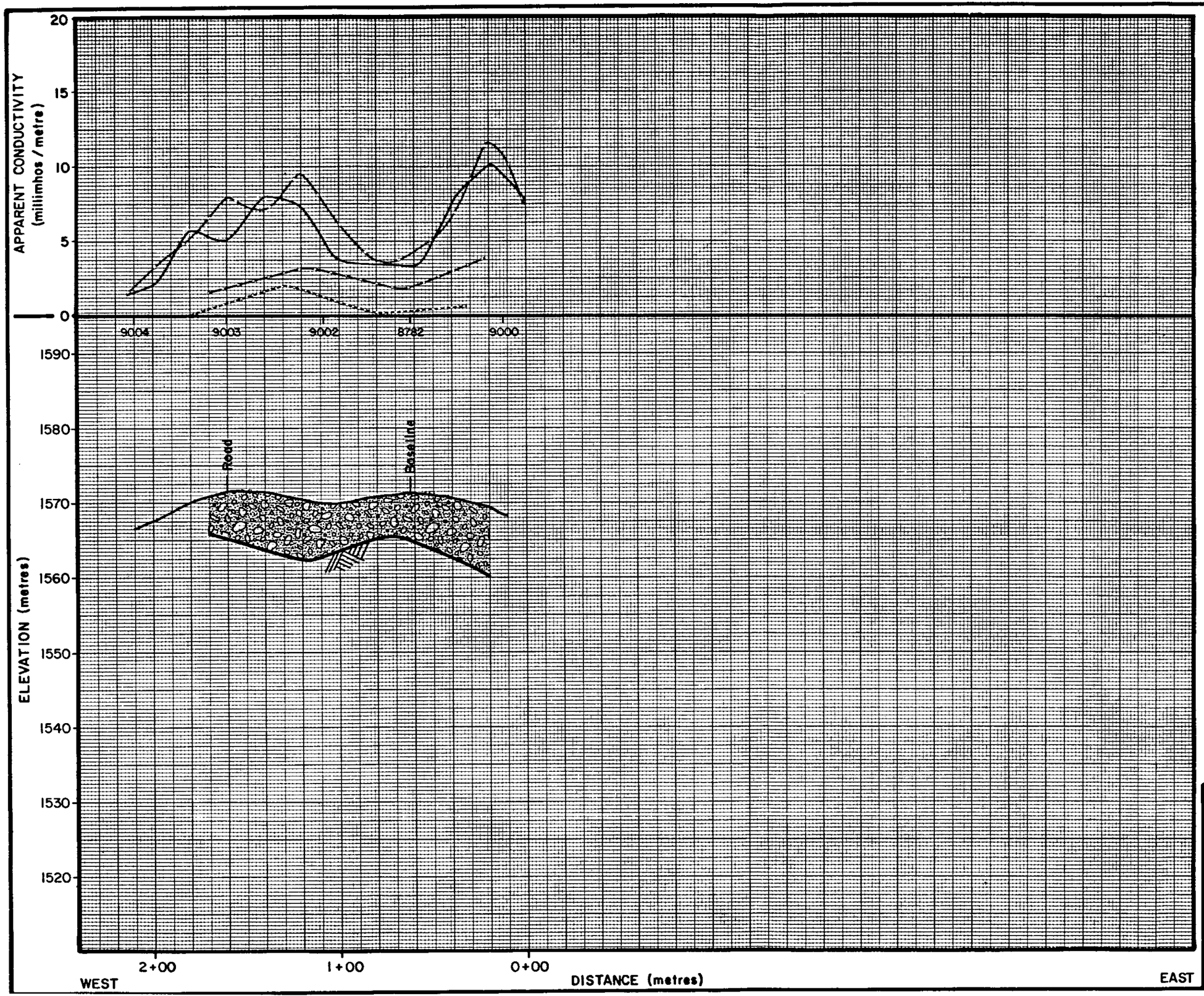
81-40 Figure 38



GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-32

81-40 Figure 39



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-33

81-40 Figure 40

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9009 9008 9007 9005 9006

ELEVATION (metres)

1590
1580
1570
1560
1550
1540
1530
1520

Road
Baseline

0+00 1+00

WEST

DISTANCE (metres)

EAST

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-34

81-40 Figure 41

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9018 9017 9016 9014 9011 9015 9010 9012

ELEVATION (metres)

1580
1570
1560
1550
1540
1530
1520
1510

Road
DH 34
River
Baseline
Road
DH 33
Creek

1+00 0+00 1+00 0+00

WEST DISTANCE (metres) EAST

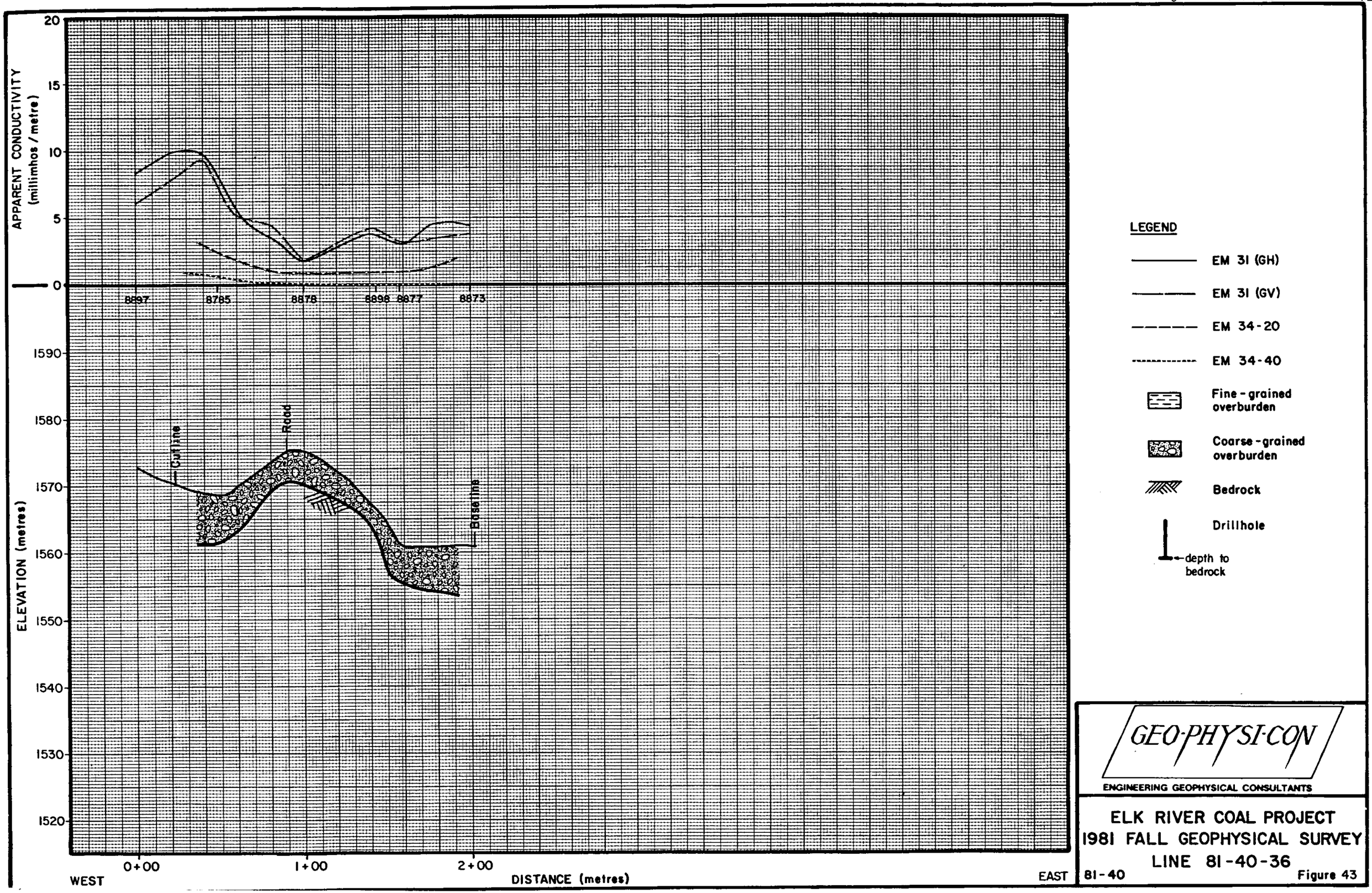
LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-35

81-40 Figure 42

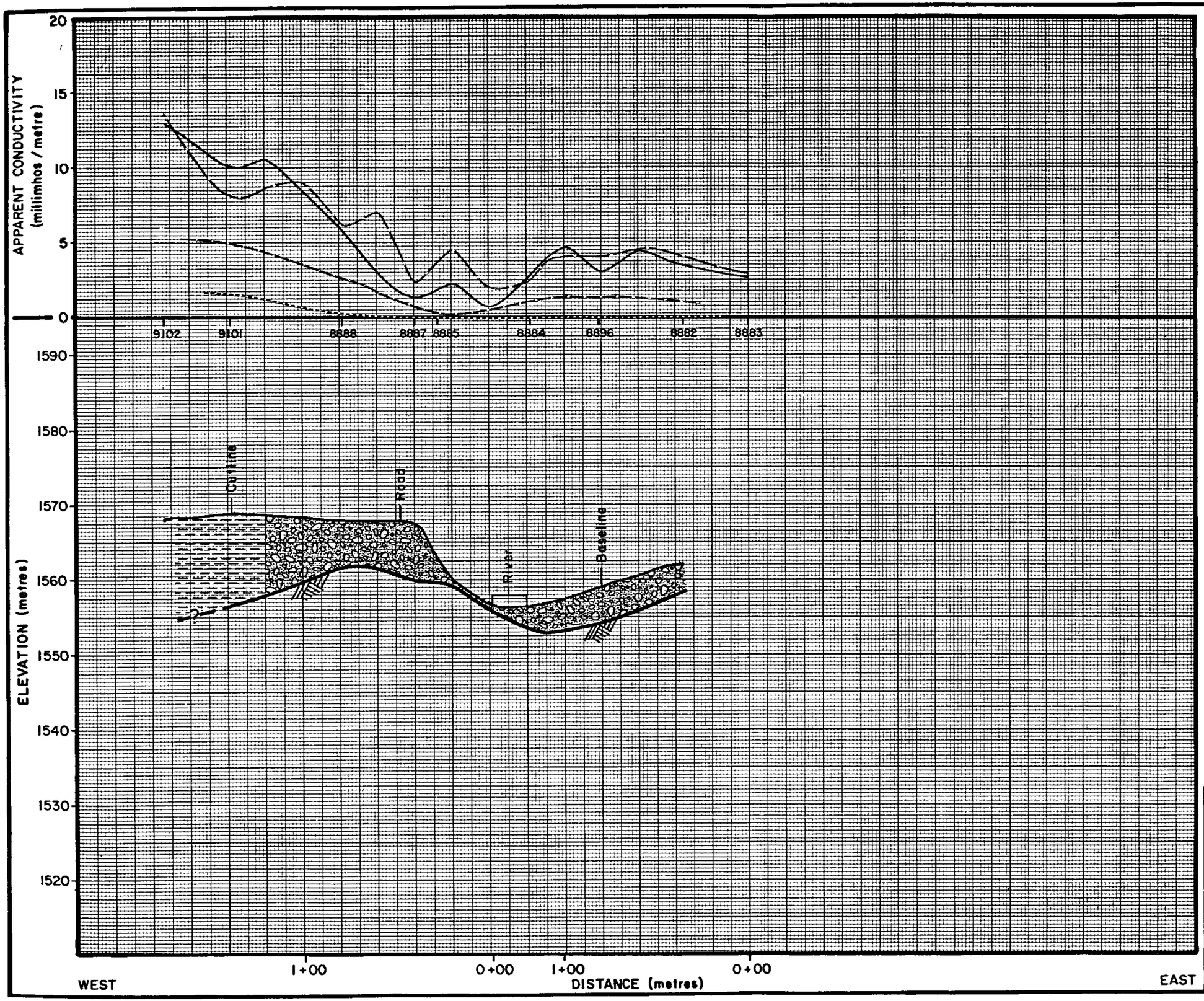


GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-36

81-40 Figure 43



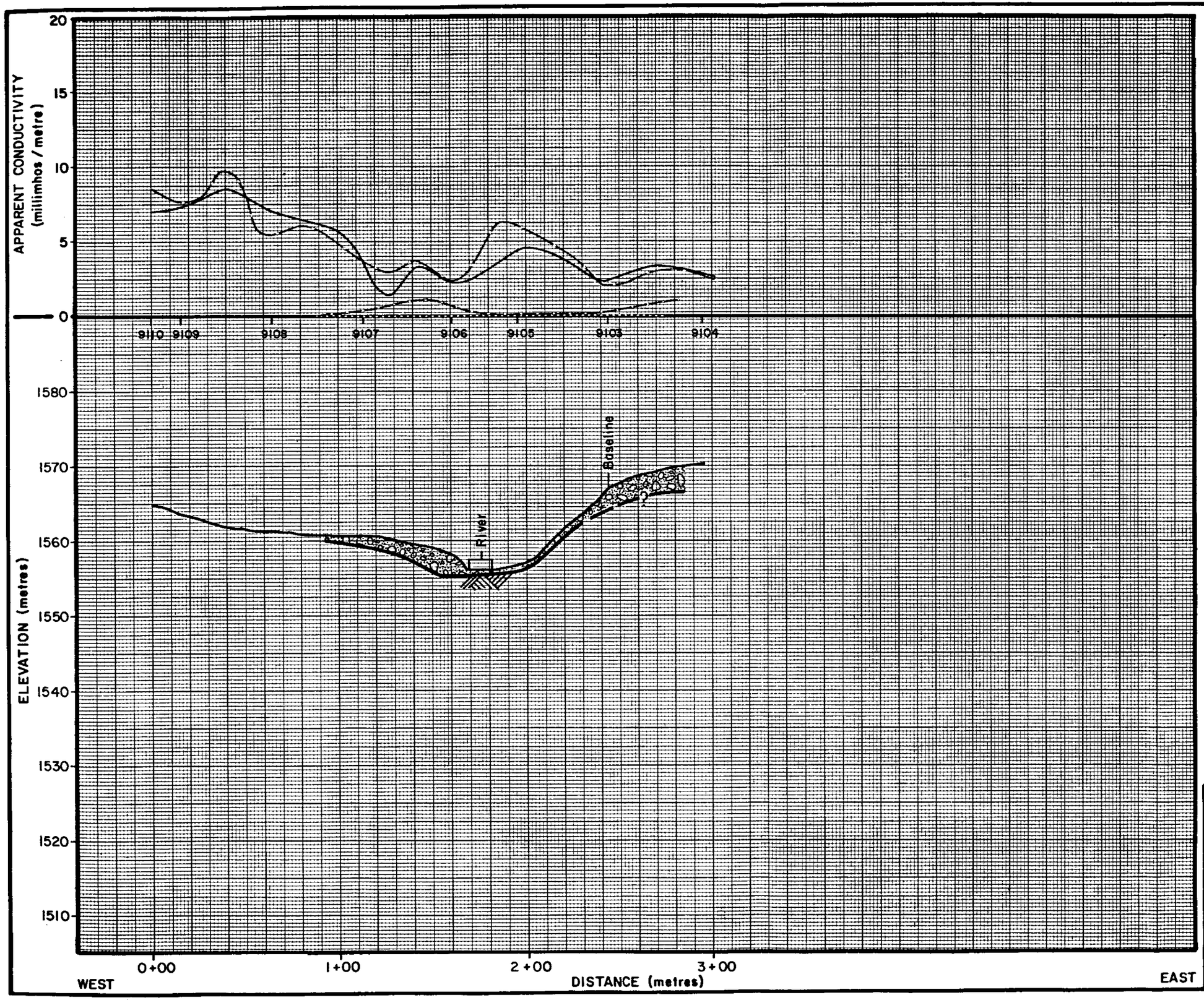
LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-37

81-40 Figure 44



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

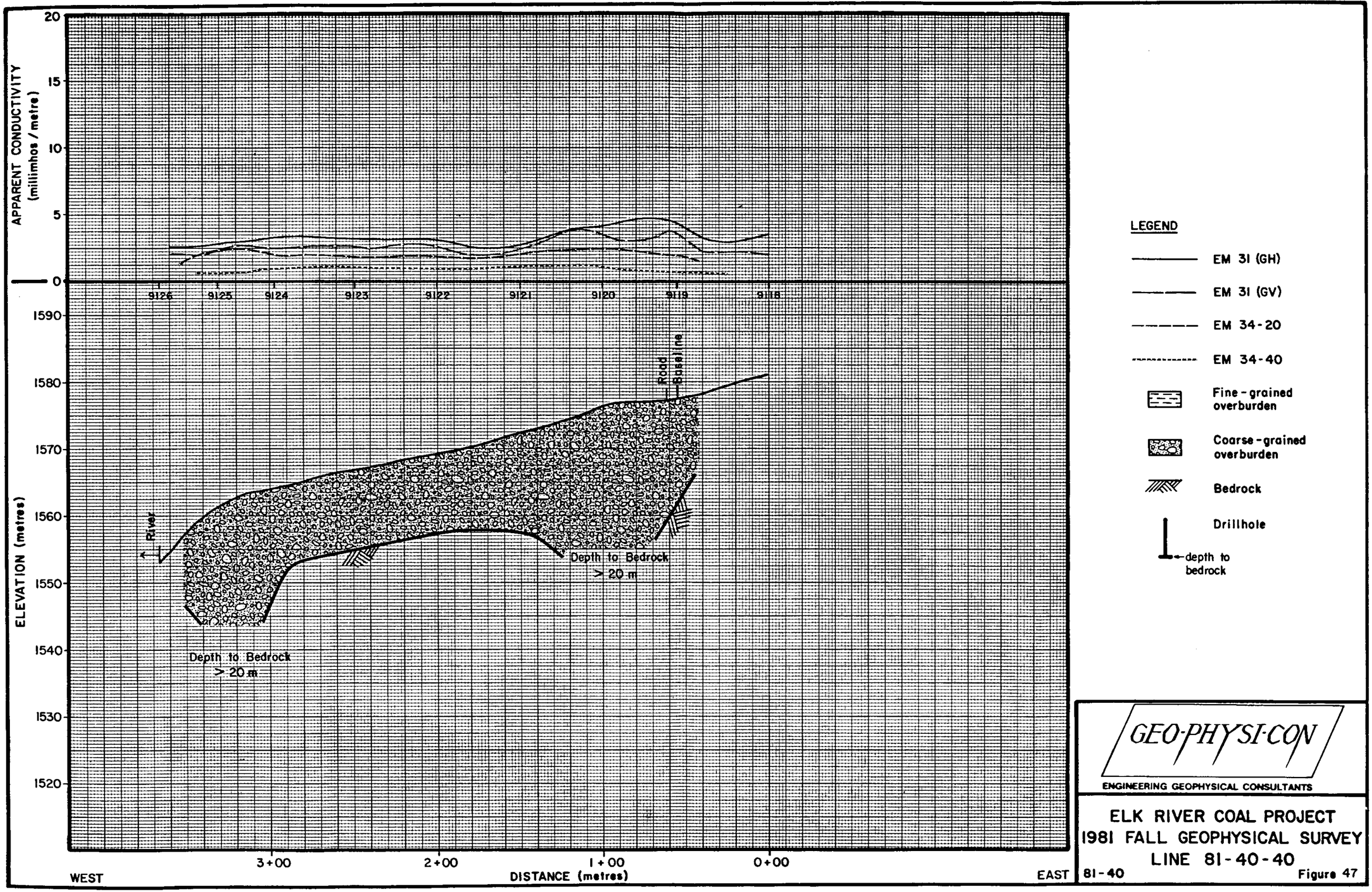
GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-38

81-40 Figure 45


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
9117
9116
9115
9114
9113
9112
9111
ELEVATION (metres)
1580
1570
1560
1550
1540
1530
1520
1510
DH26
Baseline
River
DH27
0+00
1+00
2+00
2+60
3+02
WEST
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-39
81-40
Figure 46

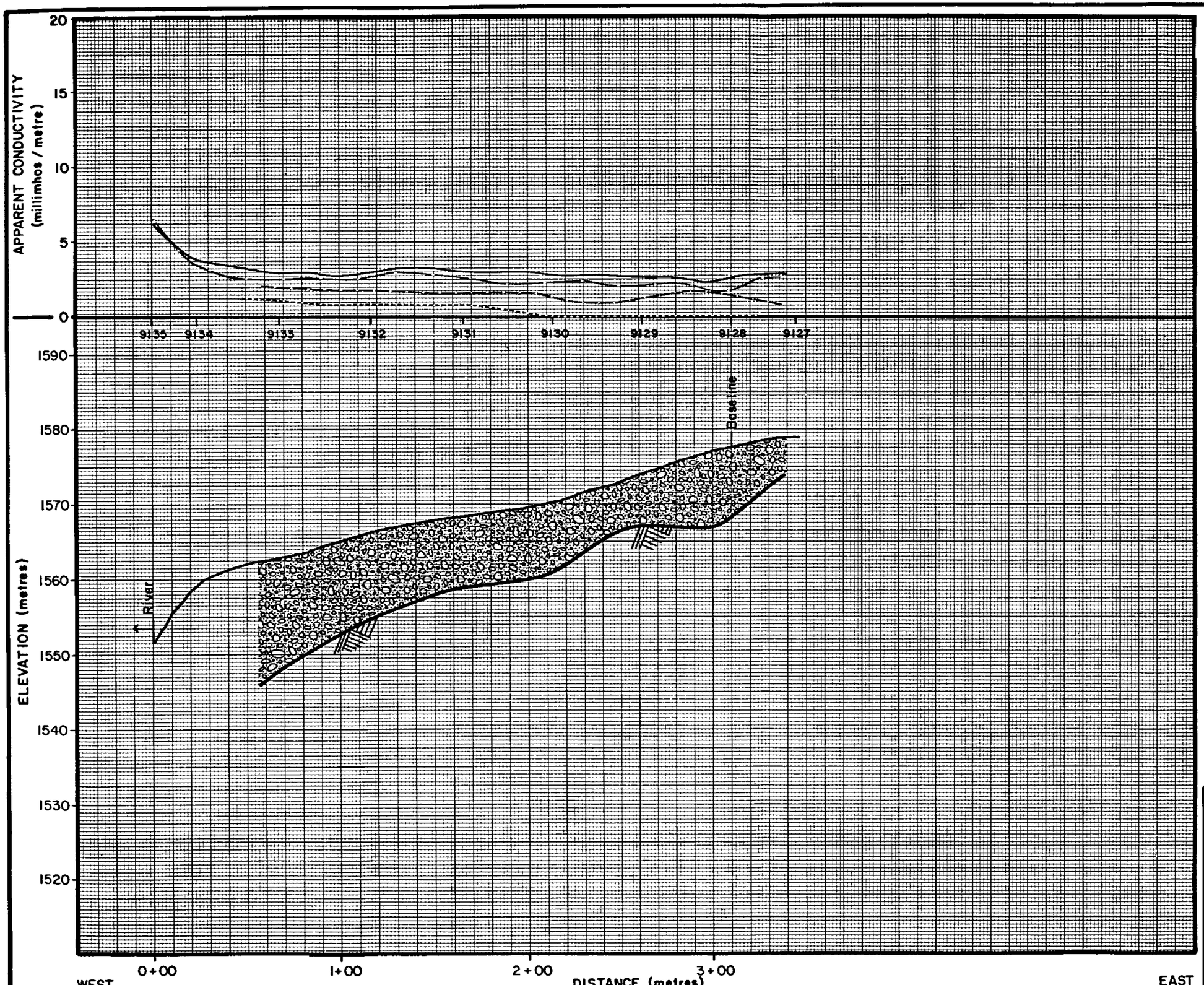


GEO·PHYSI·CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-40

81-40 Figure 47



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-41

81-40 Figure 48

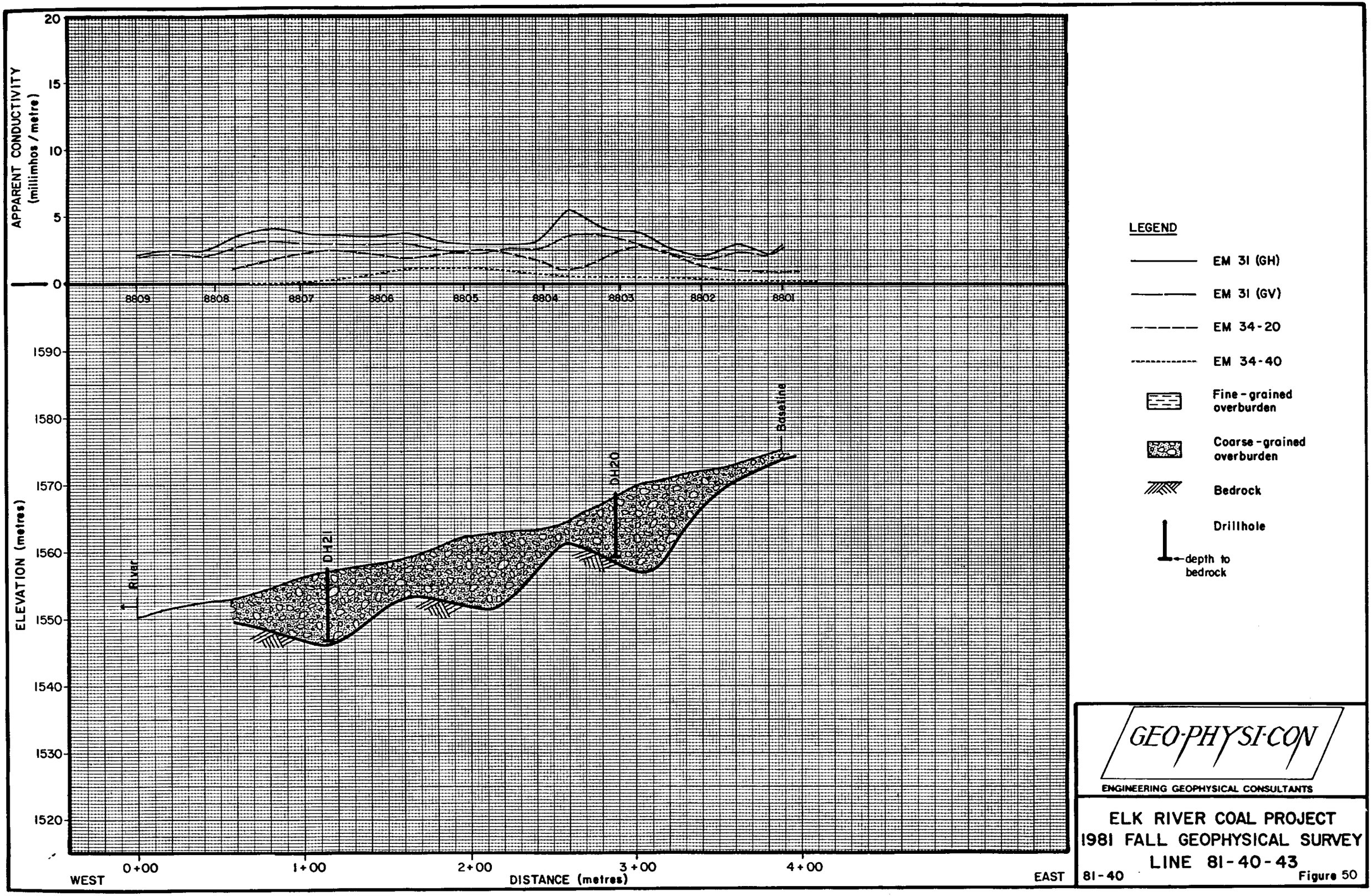
LEGEND

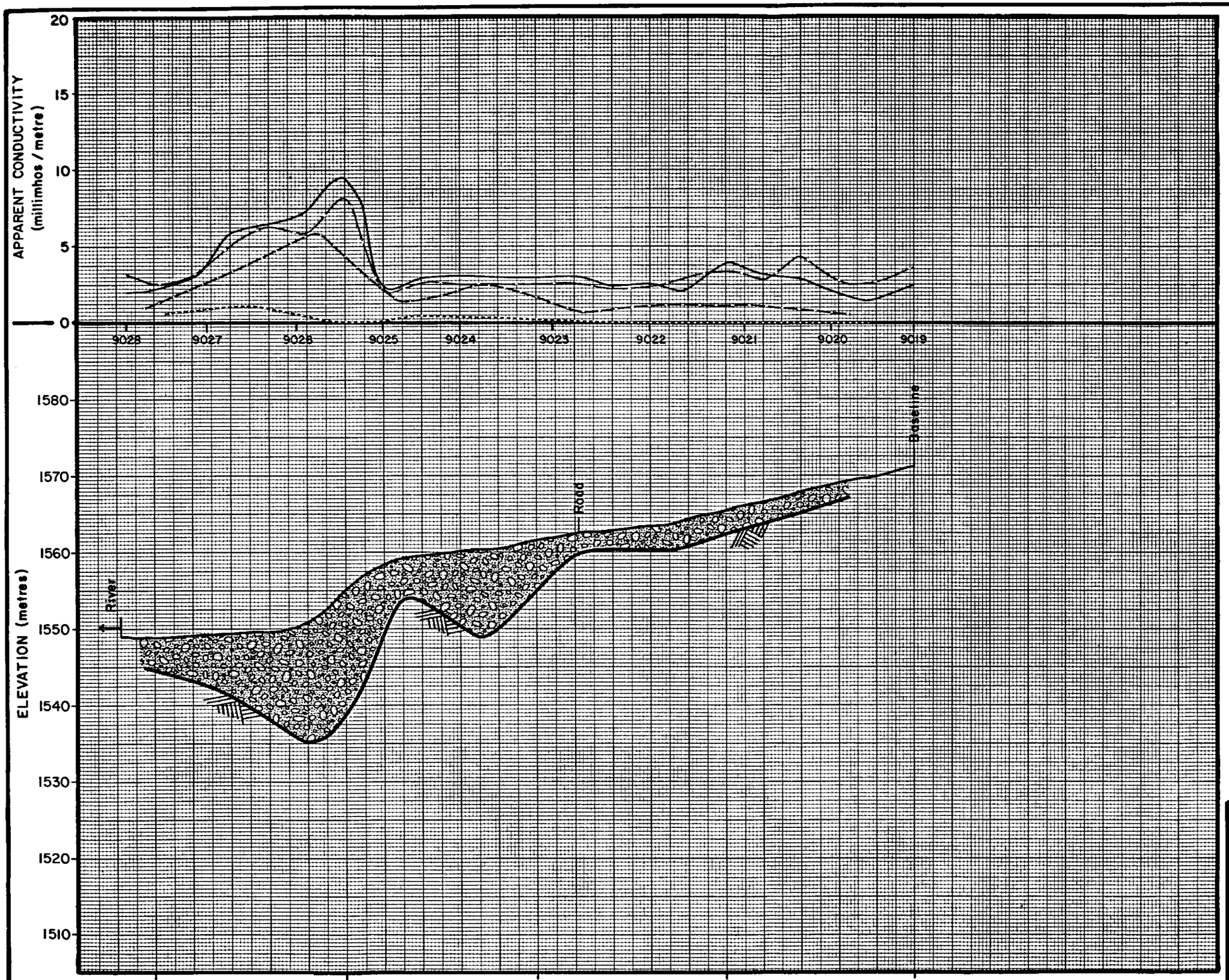
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-42

81-40 Figure 49


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8809
8808
8807
8806
8805
8804
8803
8802
8801
ELEVATION (metres)
1590
1580
1570
1560
1550
1540
1530
1520
River
DH21
DH20
Baseline
WEST
0+00
1+00
2+00
3+00
4+00
DISTANCE (metres)
EAST
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-43
81-40
Figure 50



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-44

81-40 Figure 51

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9034 9033 9031 9032 9029 9030 9035 9036 9037 9038 9039

ELEVATION (metres)

1570
1560
1550
1540
1530
1520
1510
1500

River
Road
Line 81-40-51
Road
M70-300
?
?

0+00 1+00 2+00 3+00 4+00

WEST
DISTANCE (metres)
EAST

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-45

81-40 Figure 52

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9044 9043 9042 9040 9041 9045 9046 9047 9048 9049 9050 9051

ELEVATION (metres)

1580
1570
1560
1550
1540
1530
1520
1510

River
Road, Line 81-40-51
DH2SP
TP1GSP
Road

?
?
?
?

WEST
4+00
3+00
2+00
1+00
0+00
EAST
DISTANCE (metres)

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-46

81-40 Figure 53

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9057 9056 9055 9054 9053 9052 9059 9060 9061 9062 9063 9064

ELEVATION (metres)

1580
1570
1560
1550
1540
1530
1520
1510
1500

River
Road
Line 81-40-5
DH 6
DH 15
Road
DH 14
?
?

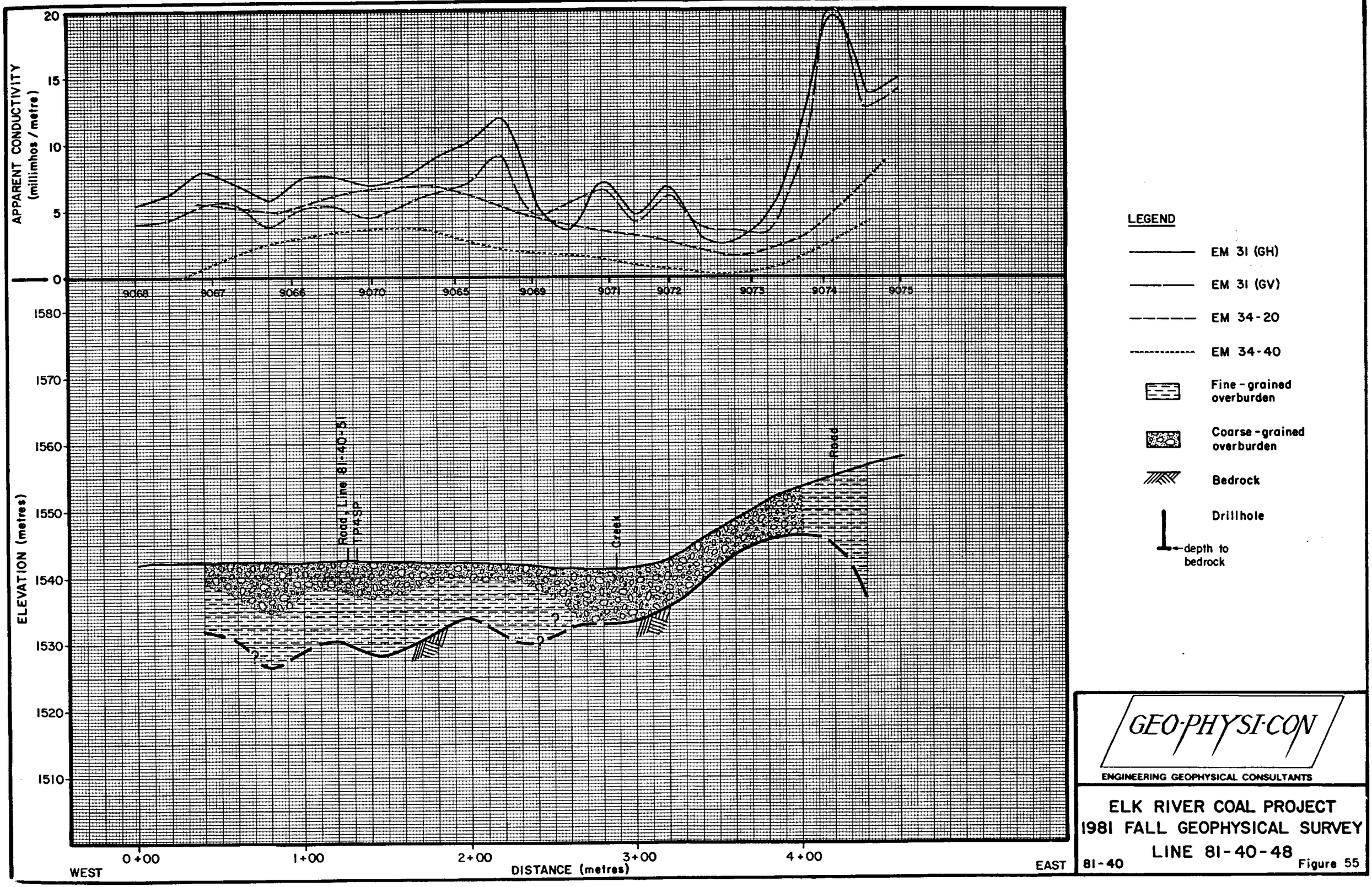
0+00 1+00 2+00 3+00 4+00 5+00
WEST
DISTANCE (metres)
EAST

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-47
81-40 Figure 54



GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-48
81-40 Figure 55

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

9081 9080 9079 9078 9077 9076 9082 9083 9084 9085 9086

1570
1560
1550
1540
1530
1520
1510

ELEVATION (metres)

Elk River
Road
Line 81-40-51
Road
Elk River
?
?

5+00 4+00 3+00 2+00 1+00 0+00

WEST

DISTANCE (metres)

EAST

LEGEND

EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-49
81-40 Figure 56

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8038 8801 8501 8055 9128 8041 9119 8042

1610
1600
1590
1580
1570
1560
1550
1540

ELEVATION (metres)

Marsh

Road — Line 81-40-43 — Line 81-40-42 — Creek — Line 81-40-41 — Road — Road — Line 81-40-40 — Road

63+00 62+00 61+00 60+00 59+00 58+00

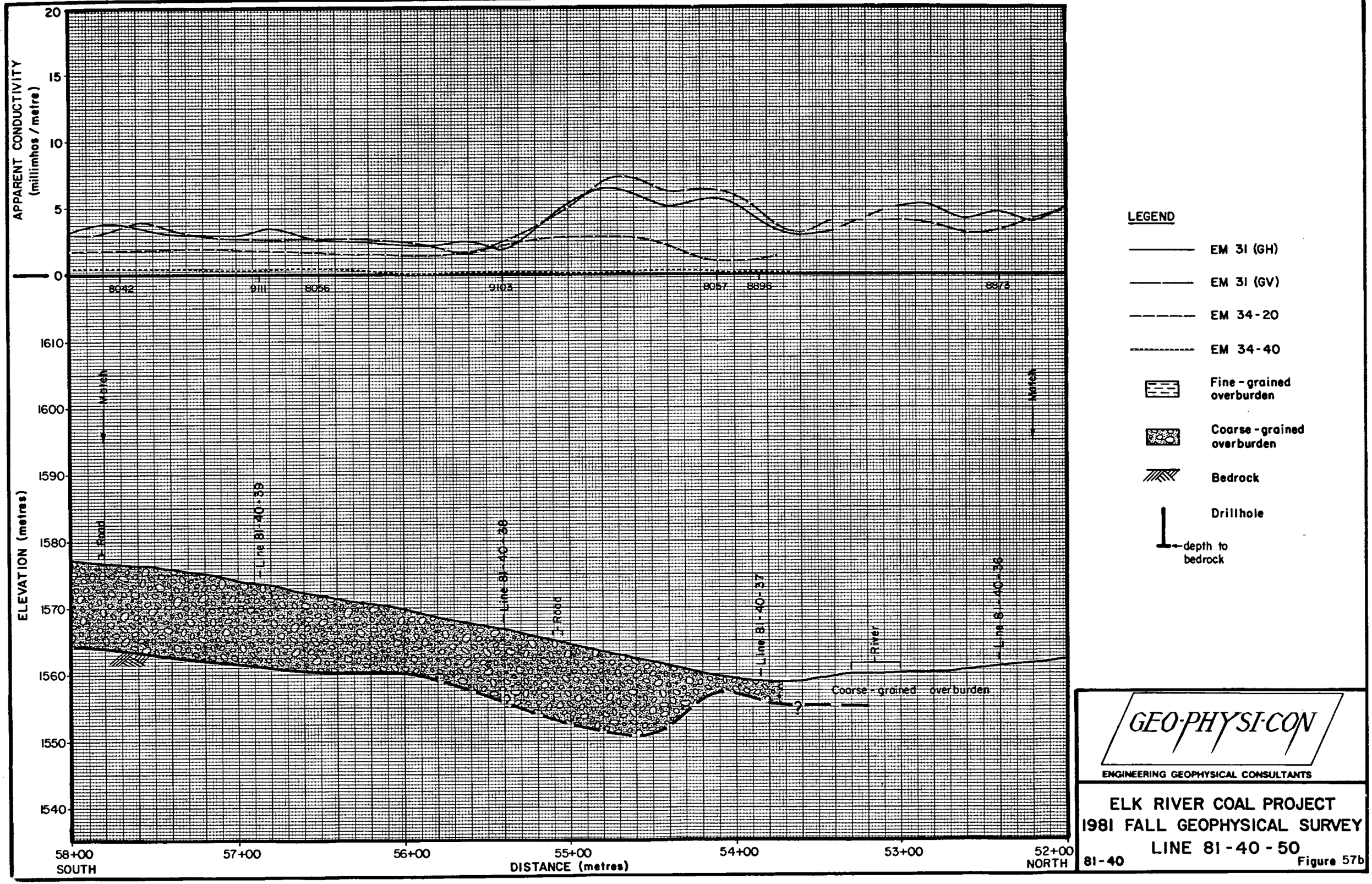
SOUTH DISTANCE (metres) NORTH

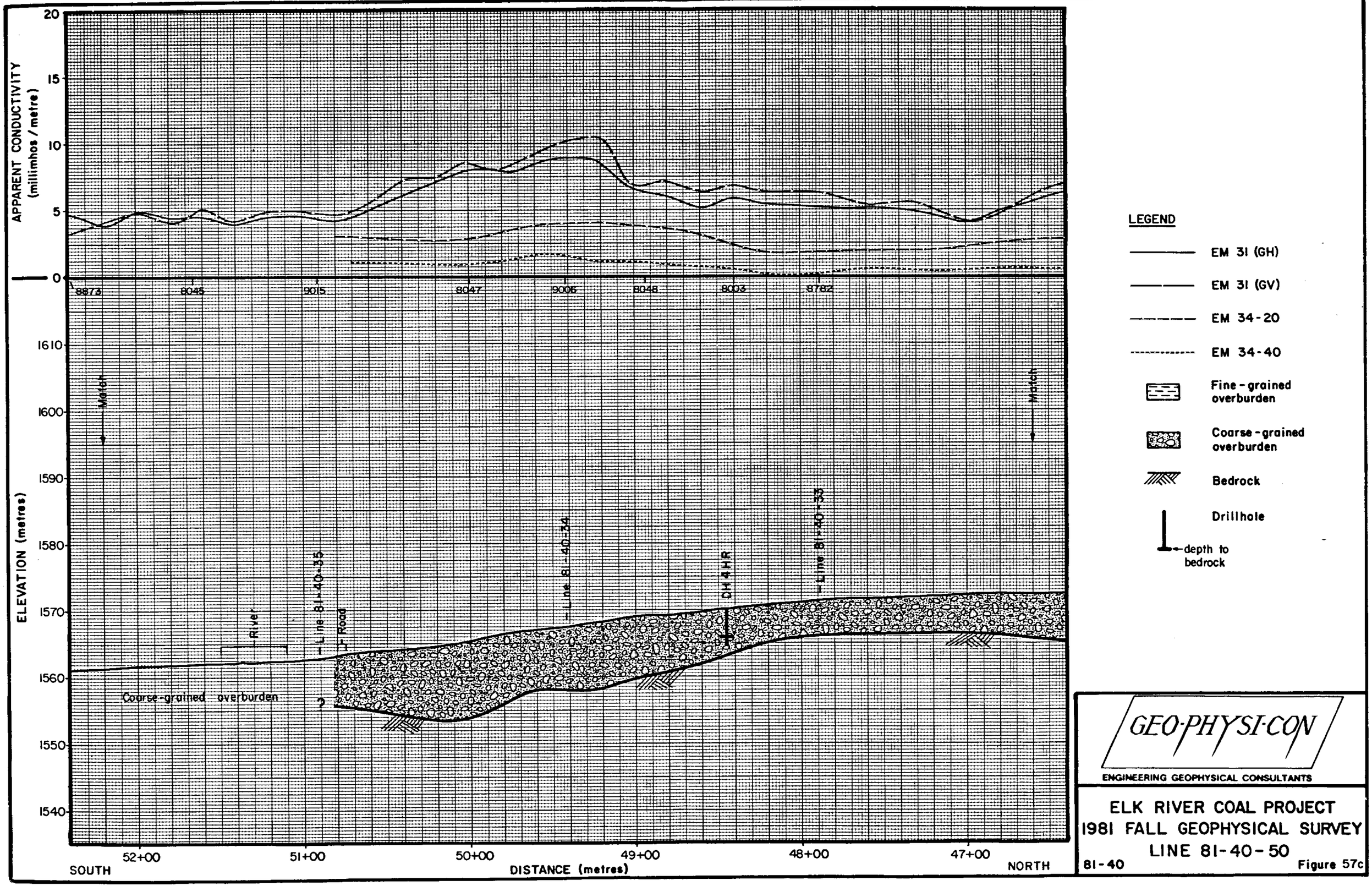
LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40 Figure 57a


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8042
9111
8056
9103
8057
8895
8873
ELEVATION (metres)
1610
1600
1590
1580
1570
1560
1550
1540
Watch
Watch
L Road
Line 81-40-39
Line 81-40-39
T Road
Line 81-40-37
River
Line 81-40-36
Coarse - grained overburden
?
58+00
SOUTH
57+00
56+00
55+00
DISTANCE (metres)
54+00
53+00
52+00
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine - grained overburden
Coarse - grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57b


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8873
8045
9015
8047
9006
8048
8003
8782
1610
1600
1590
1580
1570
1560
1550
1540
Match
Match
ELEVATION (metres)
River
Line 81+40-35
Road
Line 81+40-34
DH 4HR
Line 81+40-33
Coarse-grained overburden
52+00
51+00
50+00
49+00
48+00
47+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57c

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8737 8839 8052 8058 8810 8059 8713 8060 8062

ELEVATION (metres)

1610
1600
1590
1580
1570
1560
1550
1540

March — March

Line 81-40-32 — Road — Line 81-40-31 — Line 81-40-30 — Swamp — Road DH3HR — Line 81-40-29 — Road

SOUTH 46+00 45+00 44+00 43+00 42+00 41+00 NORTH

DISTANCE (metres)

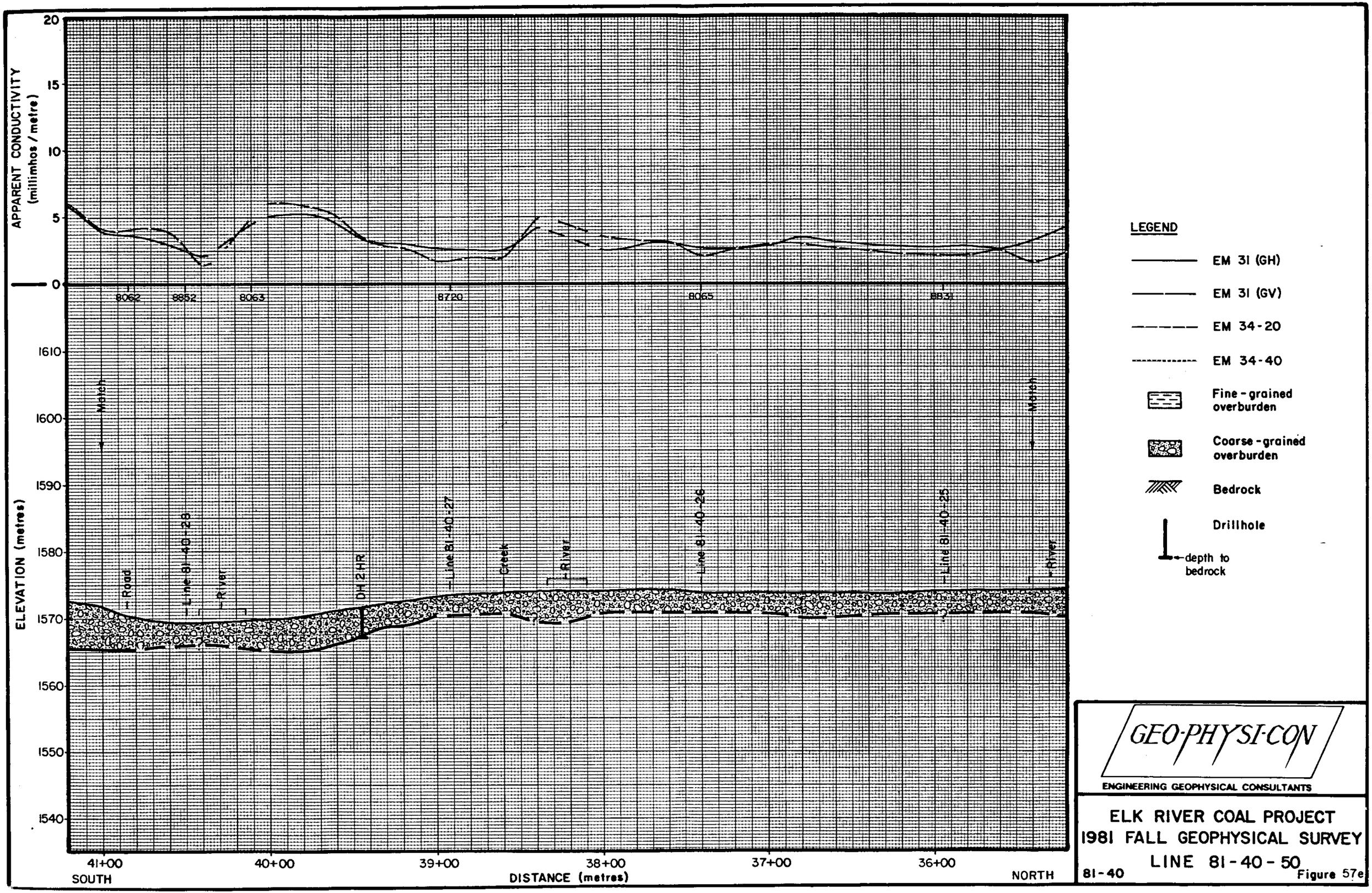
LEGEND

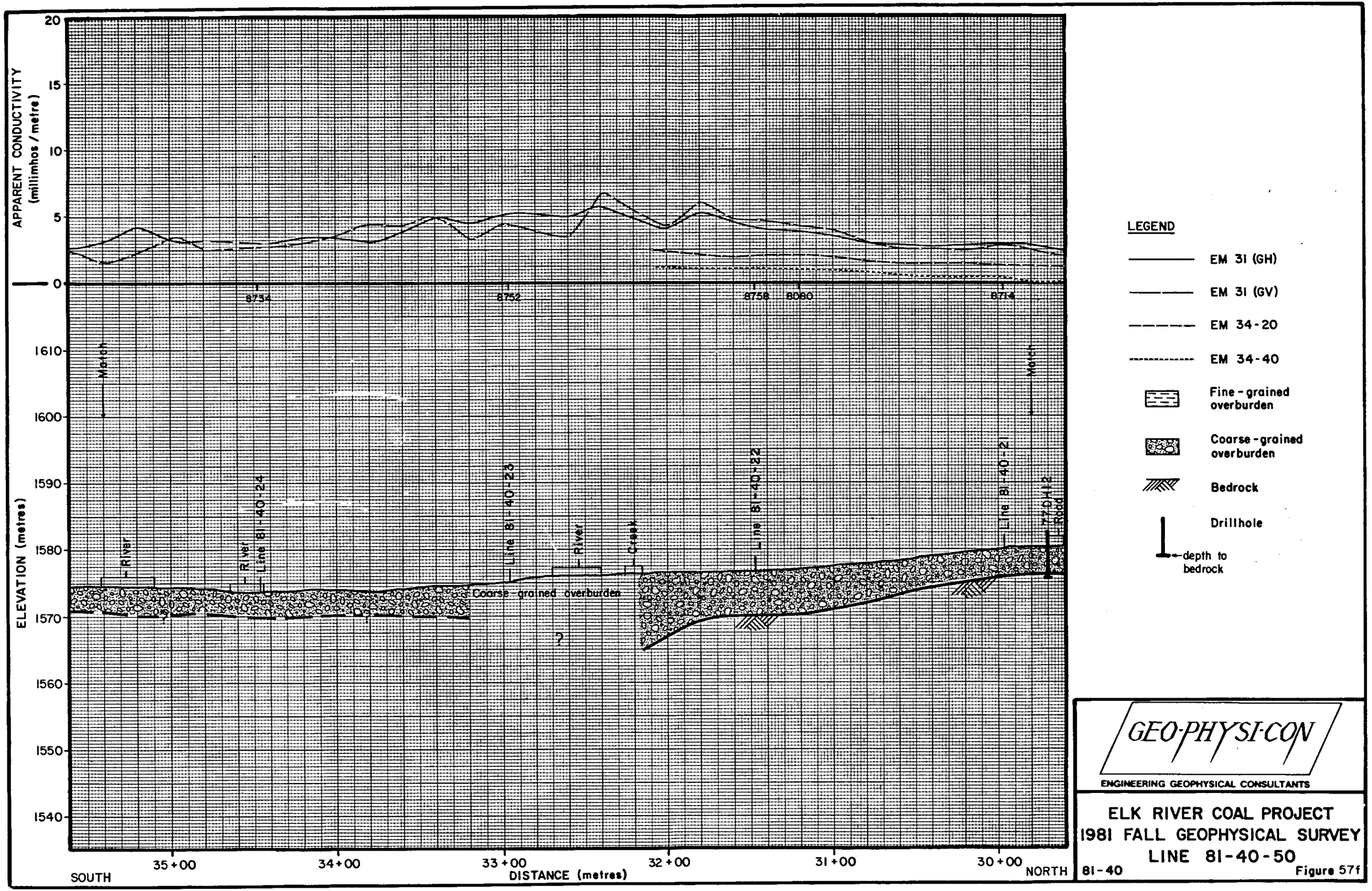
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

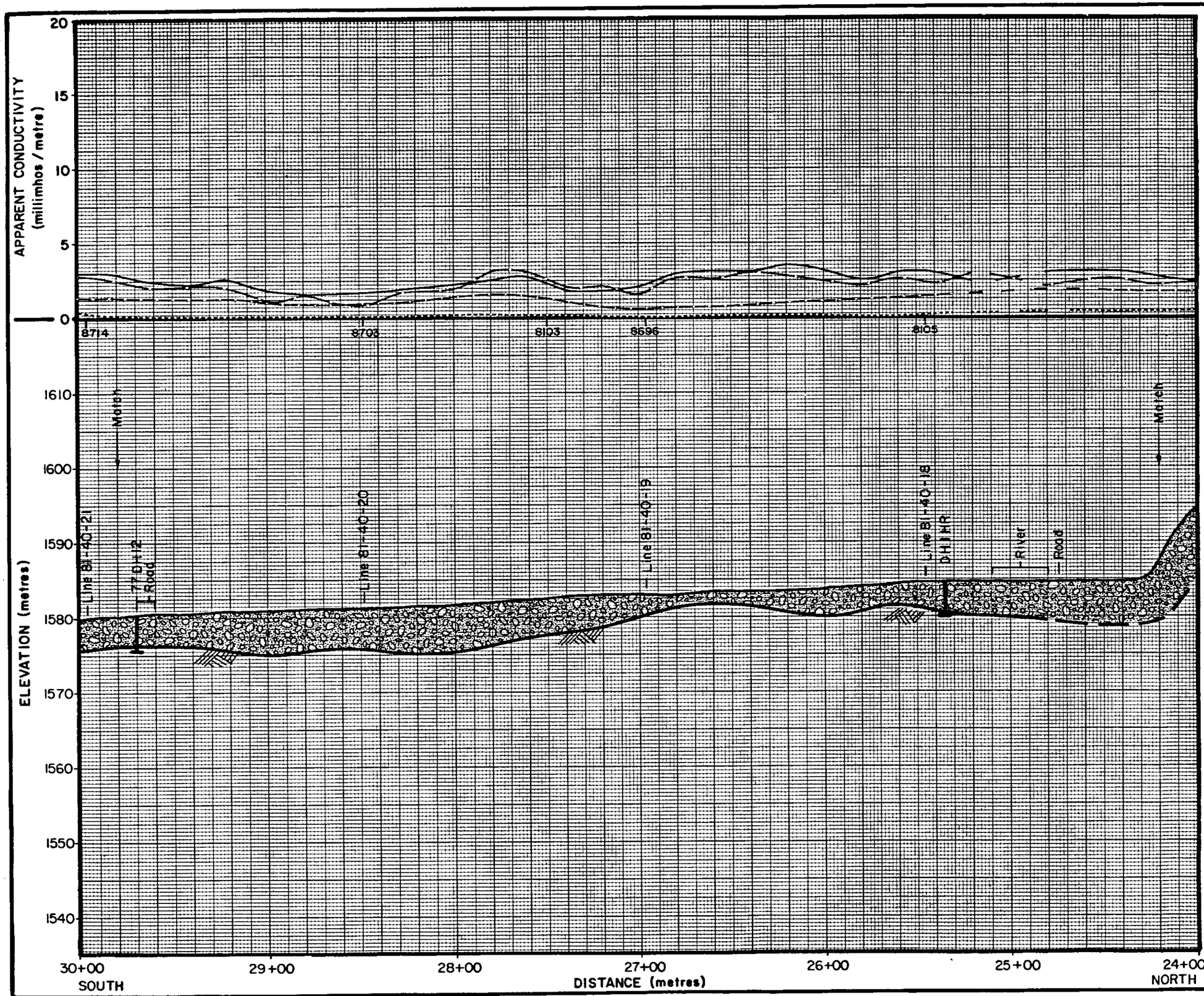
GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50

81-40 Figure 57d


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8062
8852
8063
8720
8065
8831
1610
1600
1590
1580
1570
1560
1550
1540
ELEVATION (metres)
Match
Match
Road
Line 81-40-28
River
DH 2HR
Line 81-40-27
Creek
River
Line 81-40-26
Line 81-40-25
River
41+00
40+00
39+00
38+00
37+00
36+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57e


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8734
8752
8758
8080
8714
March
March
1610
1600
1590
1580
1570
1560
1550
1540
ELEVATION (metres)
River
River
Line 81-40-24
Line 81-40-23
River
Creek
Line 81-40-22
Line 81-40-21
Coarse-grained overburden
?
?
35+00
34+00
33+00
32+00
31+00
30+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57f



LEGEND

- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

GEO-PHYSI-CON

ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50

81-40 Figure 57g

APPARENT CONDUCTIVITY (millimhos / metre)

20
15
10
5
0

8637 8684 8110 8472

Match — Line 81-40-17 — Line 81-40-16 — Road — Line 81-40-15 — River — Line 81-40-14 — Match

1610
1600
1590
1580
1570
1560
1550
1540

ELEVATION (metres)

Coarse-grained overburden

?

24+00 23+00 22+00 21+00 20+00 19+00

SOUTH DISTANCE (metres) NORTH

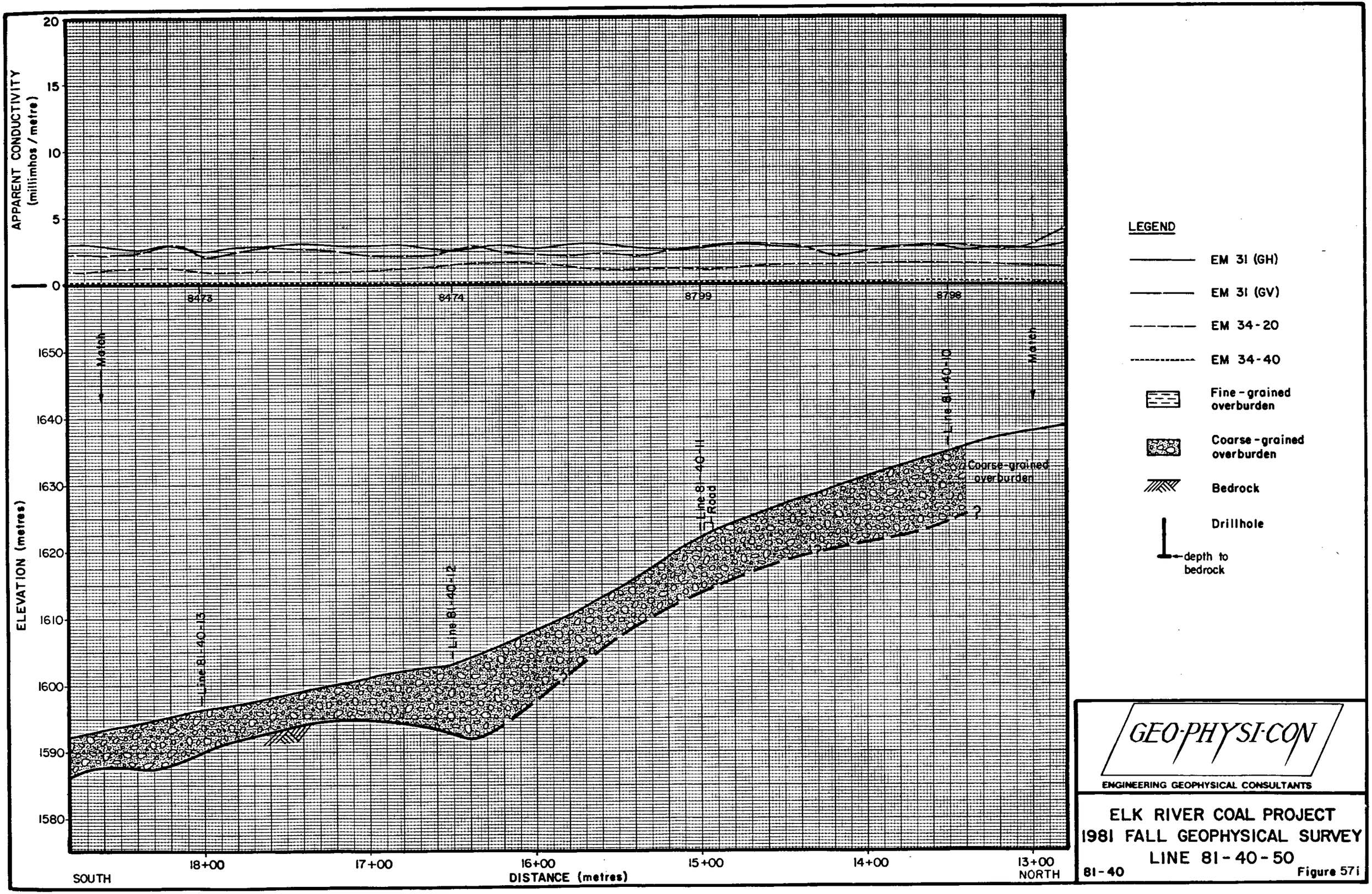
LEGEND

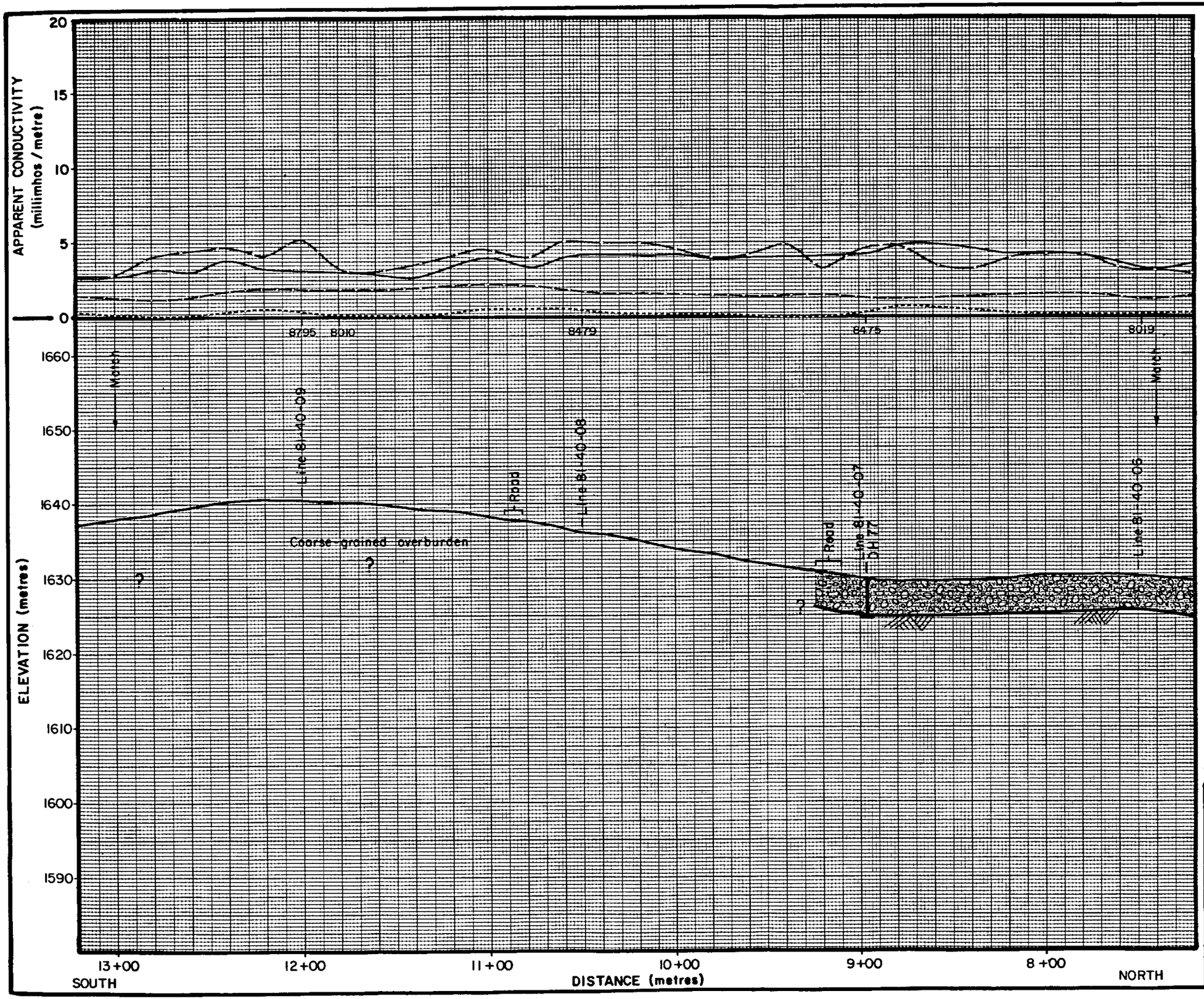
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
  - depth to bedrock

GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50

81-40 Figure 57h


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8473
8474
8799
8798
Match
Match
Line 81-40-10
Line 81-40-11
Line 81-40-12
Line 81-40-13
Road
Coarse-grained overburden
?
ELEVATION (metres)
1650
1640
1630
1620
1610
1600
1590
1580
18+00
17+00
16+00
15+00
14+00
13+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO·PHYSI·CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57i



LEGEND

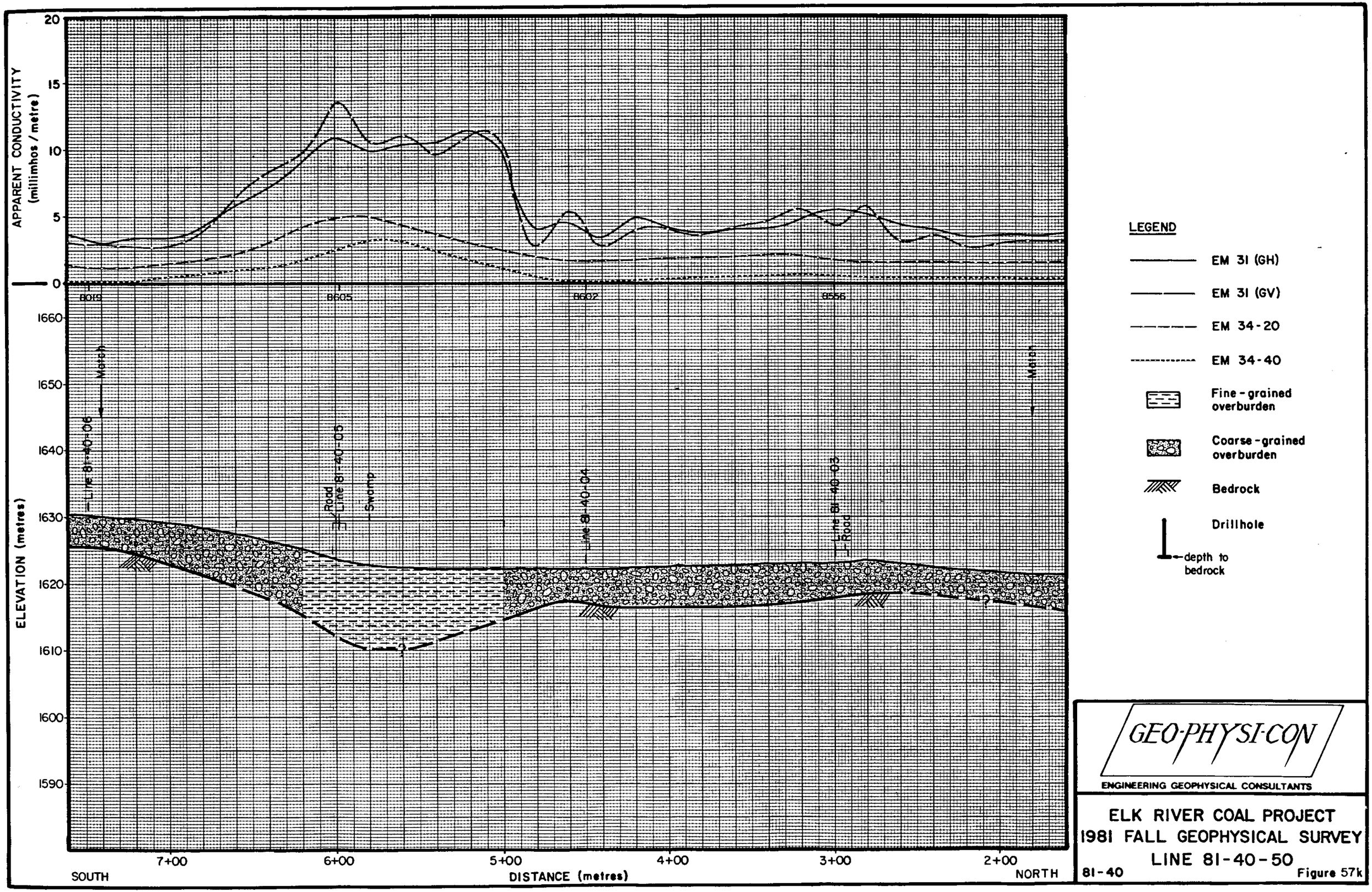
- EM 31 (GH)
- EM 31 (GV)
- EM 34-20
- EM 34-40
- Fine-grained overburden
- Coarse-grained overburden
- Bedrock
- Drillhole
- depth to bedrock

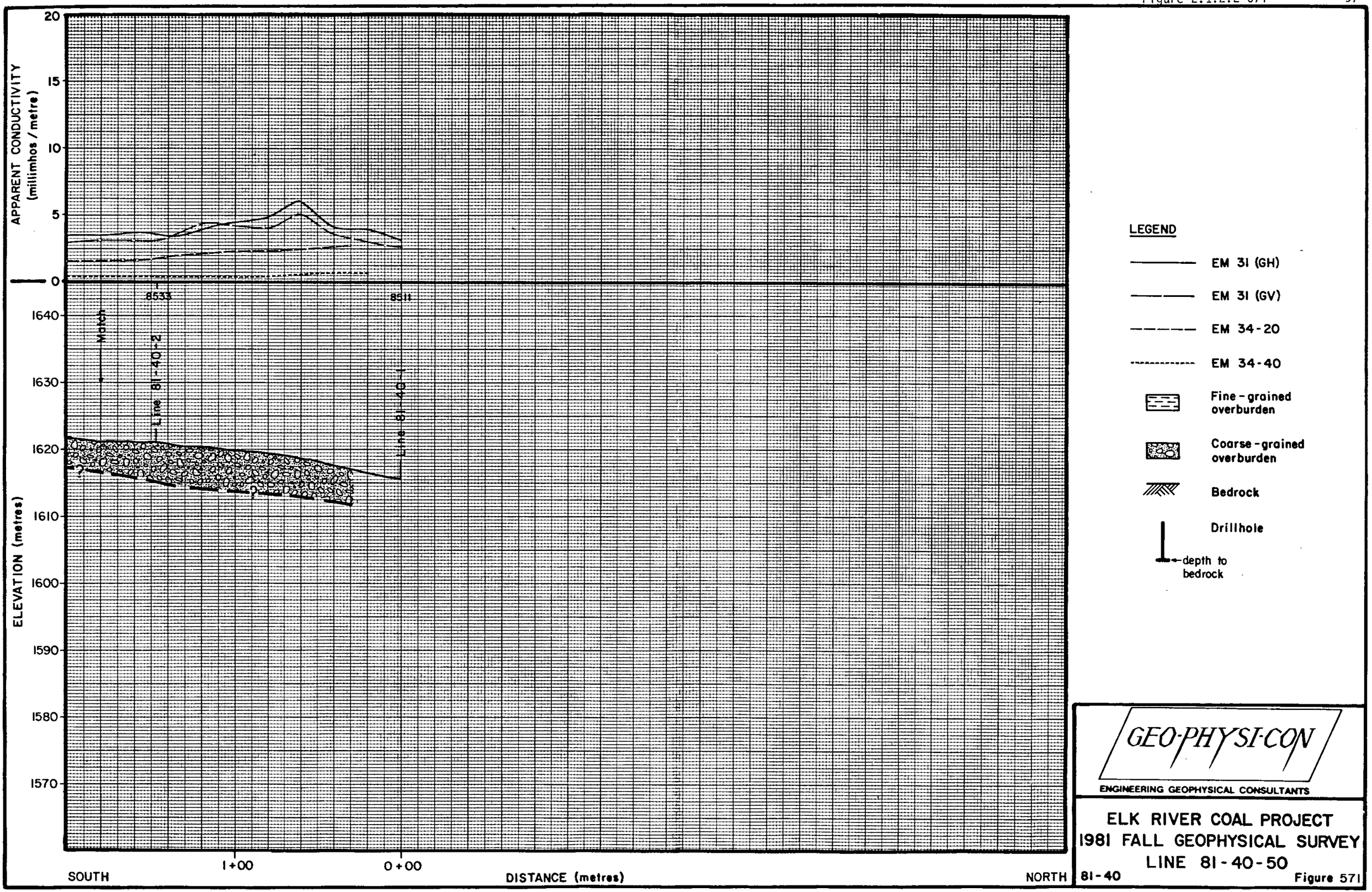
GEO-PHYSI-CON

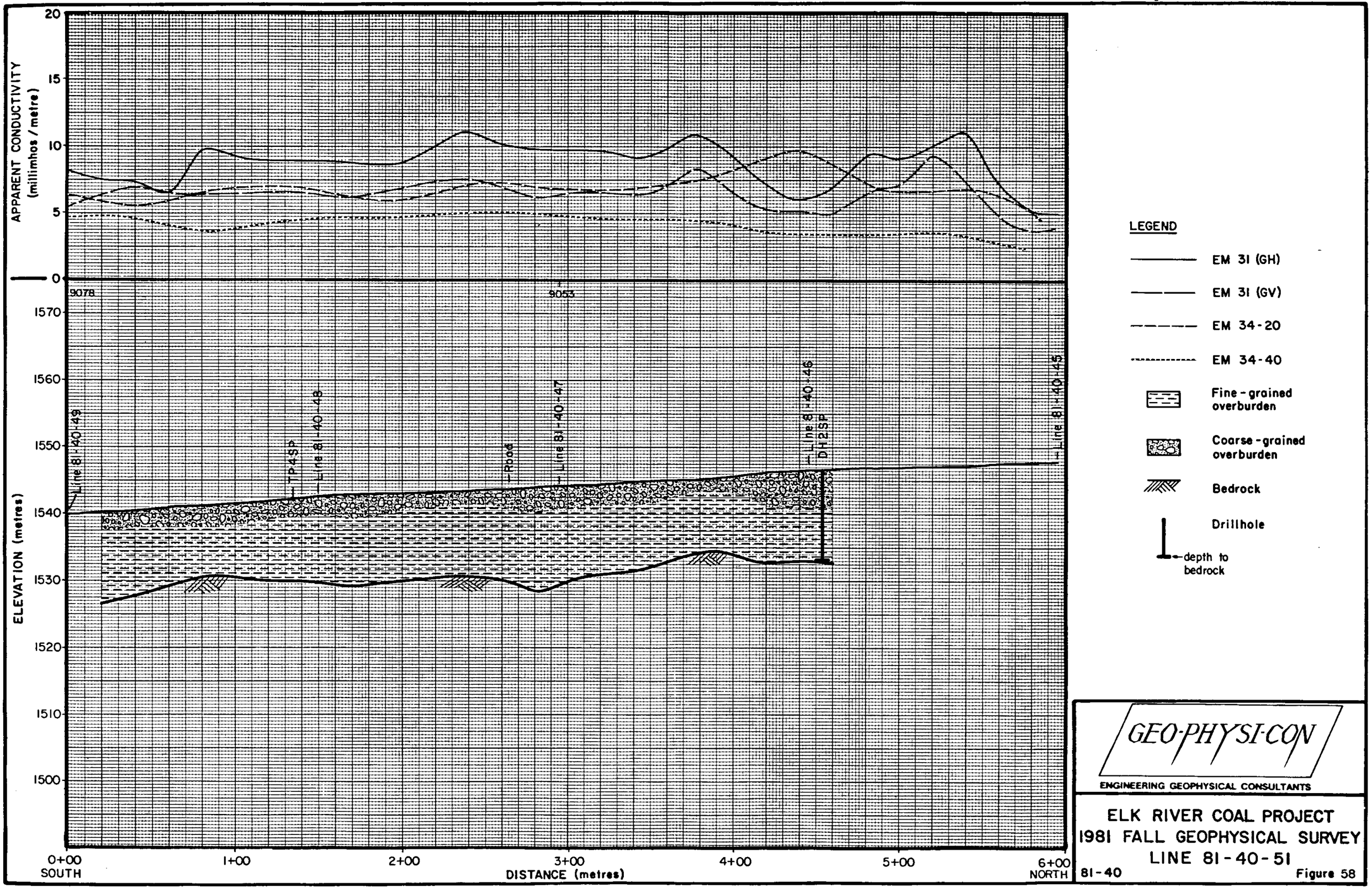
ENGINEERING GEOPHYSICAL CONSULTANTS

ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50

81-40 Figure 57j


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8019
8605
8602
8556
1660
1650
1640
1630
1620
1610
1600
1590
ELEVATION (metres)
Meter
Meter
Line 81-40-06
Road
Line 81-40-05
Swamp
Line 81-40-04
Line 81-40-03
Road
7+00
6+00
5+00
4+00
3+00
2+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 57k


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
8533
8511
Line 81-40-2
Line 81-40-1
Notch
ELEVATION (metres)
1640
1630
1620
1610
1600
1590
1580
1570
1+00
0+00
SOUTH
DISTANCE (metres)
NORTH
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-50
81-40
Figure 571


APPARENT CONDUCTIVITY (millimhos / metre)
20
15
10
5
0
9078
9053
1570
1560
1550
1540
1530
1520
1510
1500
ELEVATION (metres)
Line 81-40-49
TP 4 SP
Line 81-40-48
Road
Line 81-40-47
Line 81-40-46
DH 2 SP
Line 81-40-45
0+00 SOUTH
1+00
2+00
3+00
4+00
5+00
6+00 NORTH
DISTANCE (metres)
LEGEND
EM 31 (GH)
EM 31 (GV)
EM 34-20
EM 34-40
Fine-grained overburden
Coarse-grained overburden
Bedrock
Drillhole
depth to bedrock
GEO-PHYSI-CON
ENGINEERING GEOPHYSICAL CONSULTANTS
ELK RIVER COAL PROJECT
1981 FALL GEOPHYSICAL SURVEY
LINE 81-40-51
81-40
Figure 58

2.2.0 Engineering Work

Work performed during 1980/81 is summarized below.

2.2.1 Mine Engineering

Refinement of a conceptual mine plan including various alternatives regarding production levels and waste coal ratios to determine equipment list and subsequent investment and operating costs for conceptual west flank thermal coal operations.

Establish preliminary quality parameters of thermal coal.

Follow-up of technological improvements of mining equipment and its integration in the coking coal project.

2.2.2 Coal Preparation

Final analysis of the 1979/80 studies related to flotation and crushing of middlings and its applicability to Elco's coking coal project.

Establish preliminary flowsheet for a thermal coal wash plant based upon west flank coal product.

Establish investment and operating costs for a conceptual thermal coal wash plant.

2.2.3 Coal Transportation

Elco, as a member of the Roberts Bank Bulk Terminal Consortium, participated in the work to obtain the lease of pads 3 and 4 at Roberts Bank. The consortium is presently awaiting the call for tenders by the National Harbours Board.

2.3.0 Environmental Work

2.3.1 Hydrological Monitoring

Elco's hydrological monitoring (stream gauging) program continued throughout this report period. Eight field trips for the purpose of servicing Elco's four permanent hydrometric stations and conducting detailed in-stream flow measurements were made by Elco's hydrology consultant, Hydrocon Engineering (Continental) Ltd. of Calgary, Alberta.

An additional field trip, over and above the normal monitoring trips, had to be made in order to carry out shelter repairs and instrument replacement at the Weary Creek Station due to vandalism.

Hydrocon was also contracted to review and update the stage-discharge relations for each hydrometric station and produce new rating curves for each.

Fourteen flow measurements at each of the four streamflow gauging stations in the Elk Valley have been taken since December 1980, which was the most recent update of the rating curves. It is appropriate to further update these curves each year considering the number of new data points available and the relative location of this plotted data with respect to the previously developed rating curves.

The stage discharge rating curves were developed using a regression analysis of the following form:

$$\log Q = a + b \log (S + K)$$

where S = staff gauge reading
Q = discharge
a,b & k = constants

Station EL 76.4, Elk River (Figure 2.3.1-1, Page 102)

The discharge measurements taken since June 1981 are higher by an average of 25% to the calculated discharges of the equation developed in December 1980. This disparity indicates a need for a revised rating curve which better represents the data obtained during the period of June to September 1981. A total of eleven data points were used in the analysis of the revised rating curve. The developed equation is:

$$\log Q = 1.235 + 2.449 \log (S + 0.11) \qquad (1)$$

where S = staff gauge readings in the well

Correlation coefficient, r = 0.9945

The average error of the measured discharges during the interval of June to September 1981 using equation (1) is 3.4%.

Station CA 0.1, Cadorna Creek (Figure 2.3.1-2, Page 103)

Flow measurements taken since the beginning of June 1981 average 15% higher than the developed rating curve of December 1980. The plotted points of Figure 2.3.1-2 indicate that the river conditions in the vicinity of the station are in a transitive state.

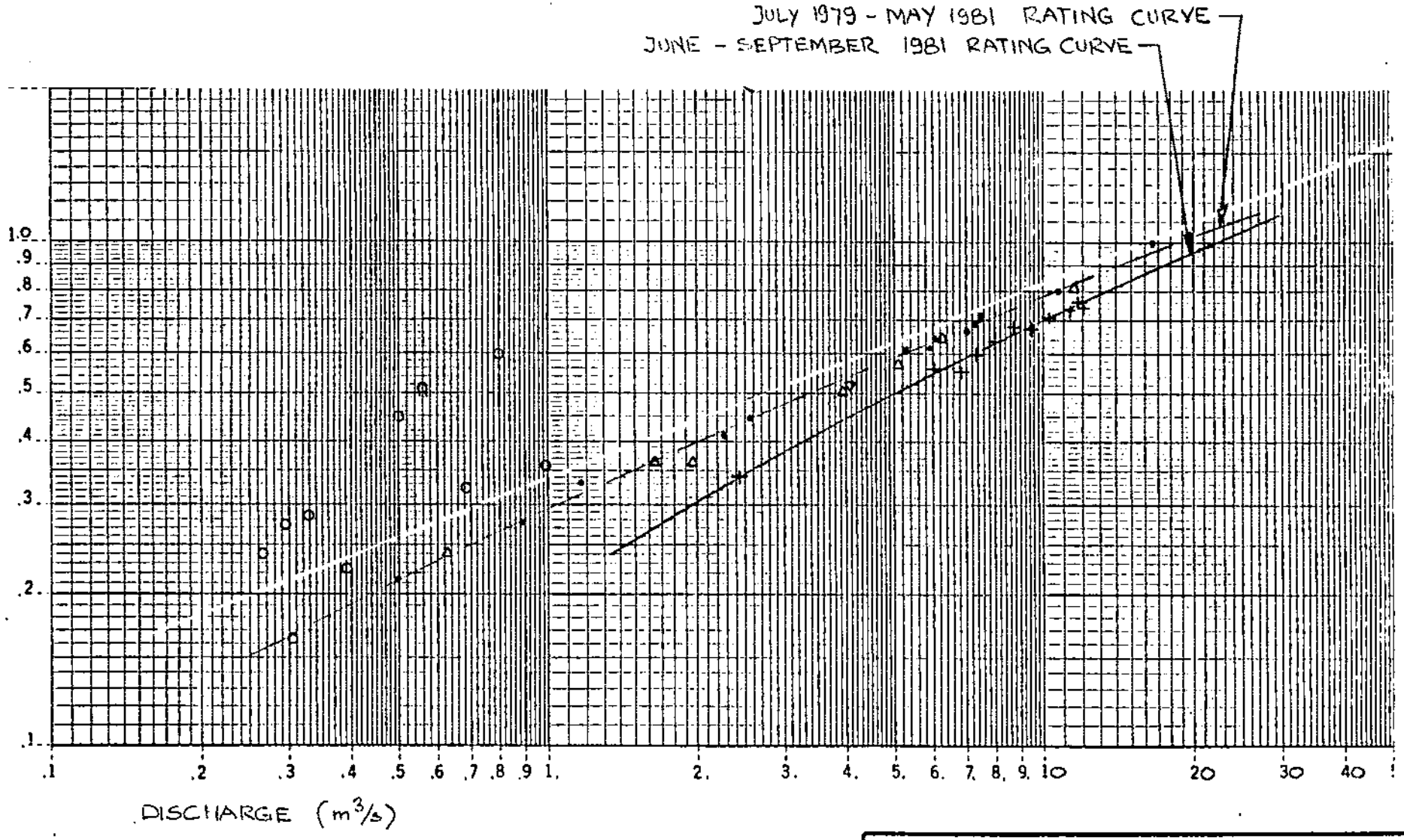
A revised rating curve for June 1981 was developed using the nine measured flows from:

$$\log Q = 1.511 + 2.396 \log (S + 0.10) \qquad (2)$$

where S = staff gauge reading in the well

correlation coefficient, r = 0.9936

The average error of the measured discharges using equation (2) was 2.2%



• PRE JUNE, 1979 MEASUREMENTS.
△ JULY 1979 - MAY 1981 MEASUREMENTS.
o MEASUREMENTS EXCLUDED FROM ANALYSIS.
+ JUNE 1981 - SEPTEMBER 1981 MEASUREMENTS.

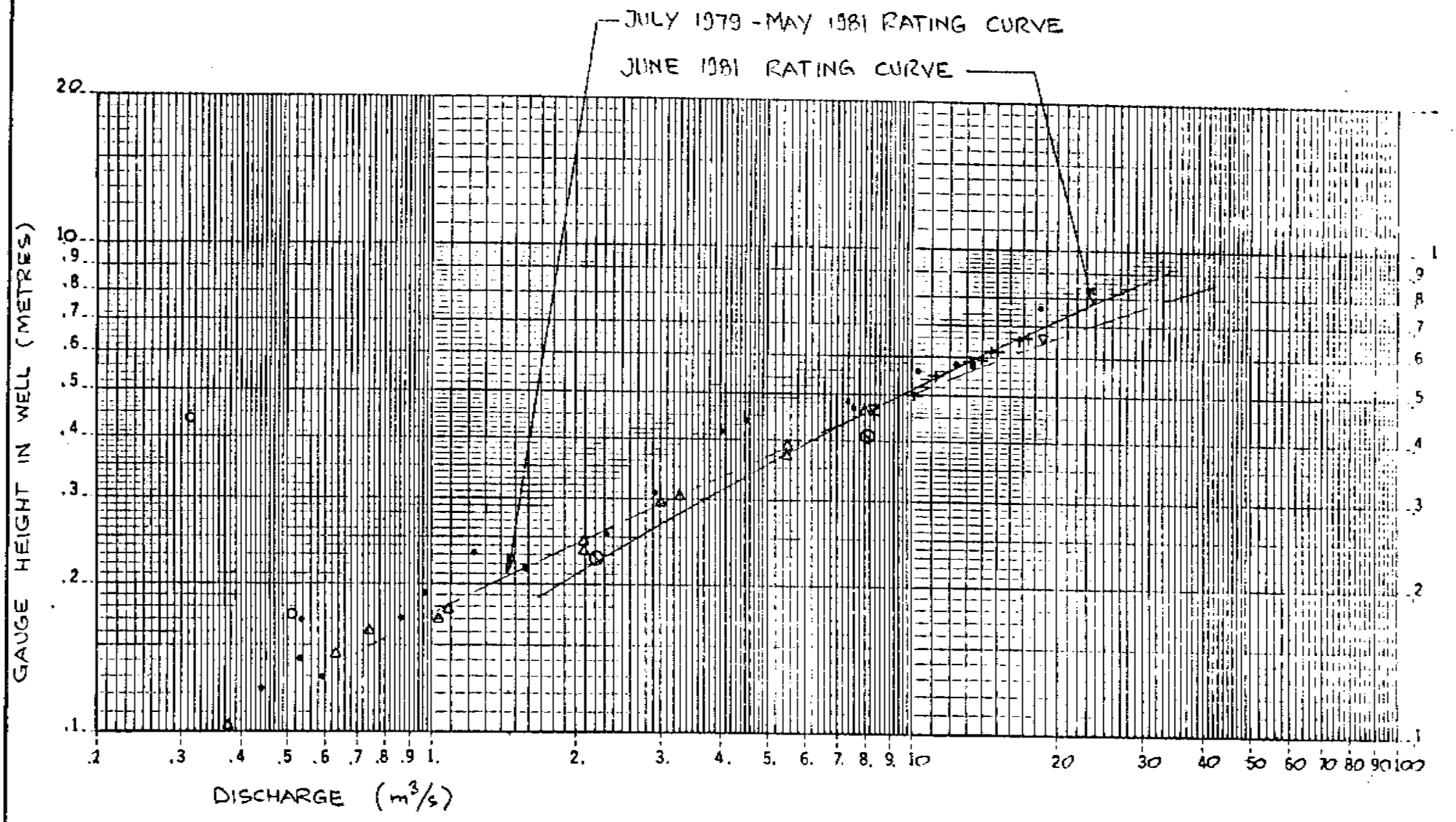
ELCO MINING LTD

Figure 2.3.1-1
STATION EL 76.4
RATING CURVE

REV.	BY	DESCRIPTION	DATE	APPR'D

DRAWN: M.N. | DESIGNED: D.C. | DRAWING No.: 29-19.1 - 13 | REV 0
DATE: OCT. 1981 | APPROVED:

HYDROCON ENGINEERING (Continental) LTD.



• PRE JUNE, 1979 MEASUREMENTS.
△ JULY 1979 - MAY 1981 MEASUREMENTS.
o MEASUREMENTS EXCLUDED FROM ANALYSIS.
+ JUNE 1981 MEASUREMENTS.
⊗ POST JUNE 1981 MEASUREMENTS

ELCO MINING LTD

Figure 2.3.1-2
STATION CA 0.1
RATING CURVE

REV.	BY	DESCRIPTION	DATE	APPR'D

DRAWN: M.N. | DESIGNED: D.C. | DRAWING No.: 29-19.1 – 14 | REV 0
DATE: OCT. 1981 | APPROVED:

HYDROCON ENGINEERING (Continental) LTD.

Station WE 1.0, Weary Creek (Figure 2.3.1-3, Page 105)

Flow measurements taken during May 1981 to September 1981 produce an average error of 28% when compared to calculated values of the rating curve produced in December 1980. A new rating curve has been developed based on the data since May 1981. Twelve points were used in the analysis and produced the following equation:

$$\log Q = 0.420 + 4.772 \log (S + 0.31) \qquad (3)$$

where S = staff gauge reading in the stream

correlation coefficient, r = 0.9957

The average error for the flow measurements from May 14, 1981 to September 16, 1981, using equation (3) is 5.5%.

Station EL 52.5, Elk River (Figure 2.3.1-4, Page 106)

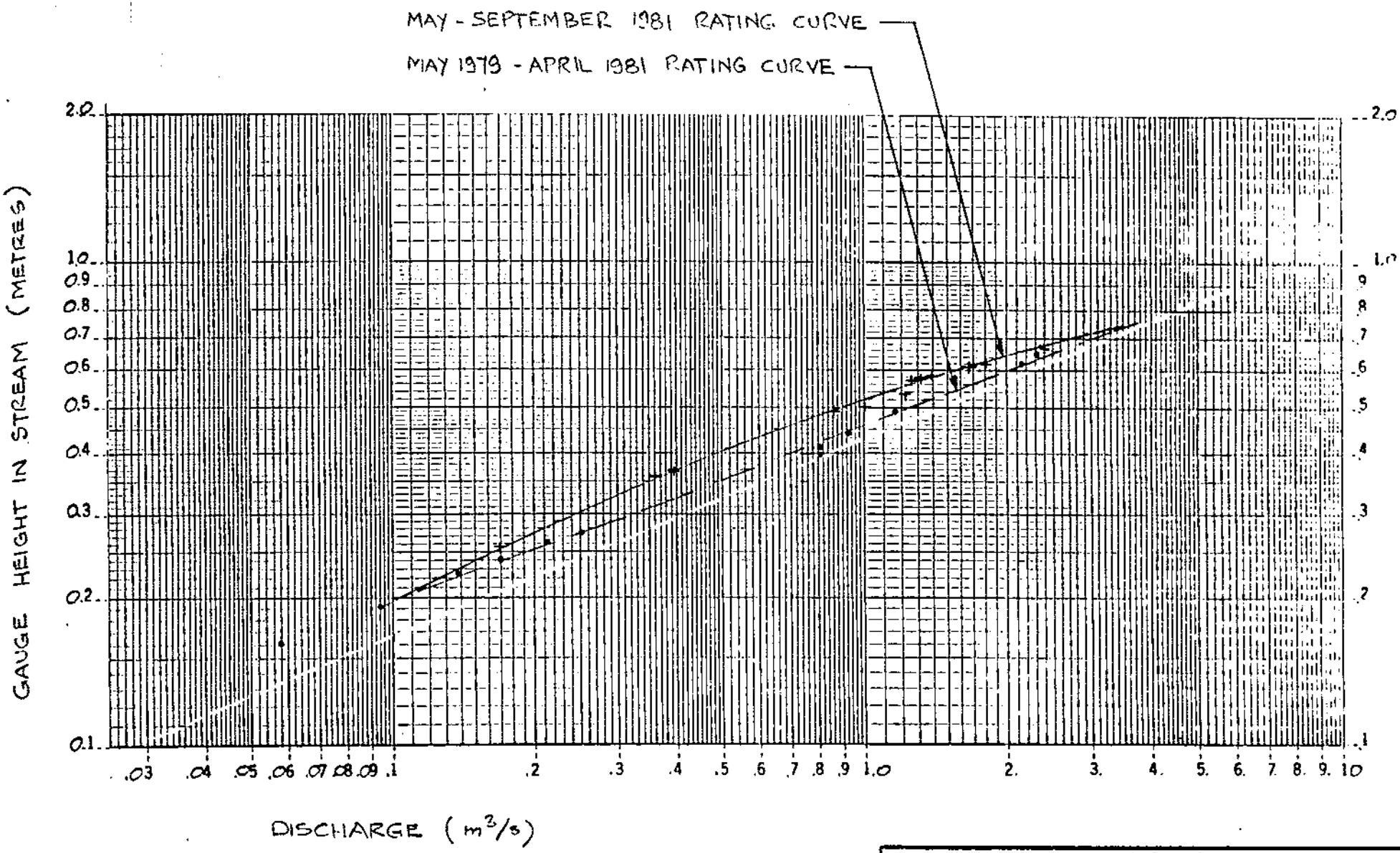
The measured discharges of 1981 produce an average 10% error when compared to the calculated values of the rating curve developed in December 1980. Since it is felt that the change in the stage-discharge relationship is due to degradation of the riverbed during high flows, a revised rating curve was developed for the most recent high flow period. The flow measurement taken in May 1981 yielded an error within acceptable limits of the established rating curve, therefore only the June to September 1981 measurements were used in the analysis. The developed equation is:

$$\log Q = 1.665 + 1.678 \log (S + 0.06) \qquad (4)$$

where S = staff gauge reading in the well

coefficient of correlation, r = 0.9984

The average error in the readings was 2.5%.



• MAY 1979 - APRIL 1981 MEASUREMENT POINTS.
+ MAY 1981 - SEPTEMBER 1981 MEASUREMENT POINTS

ELCO MINING LTD

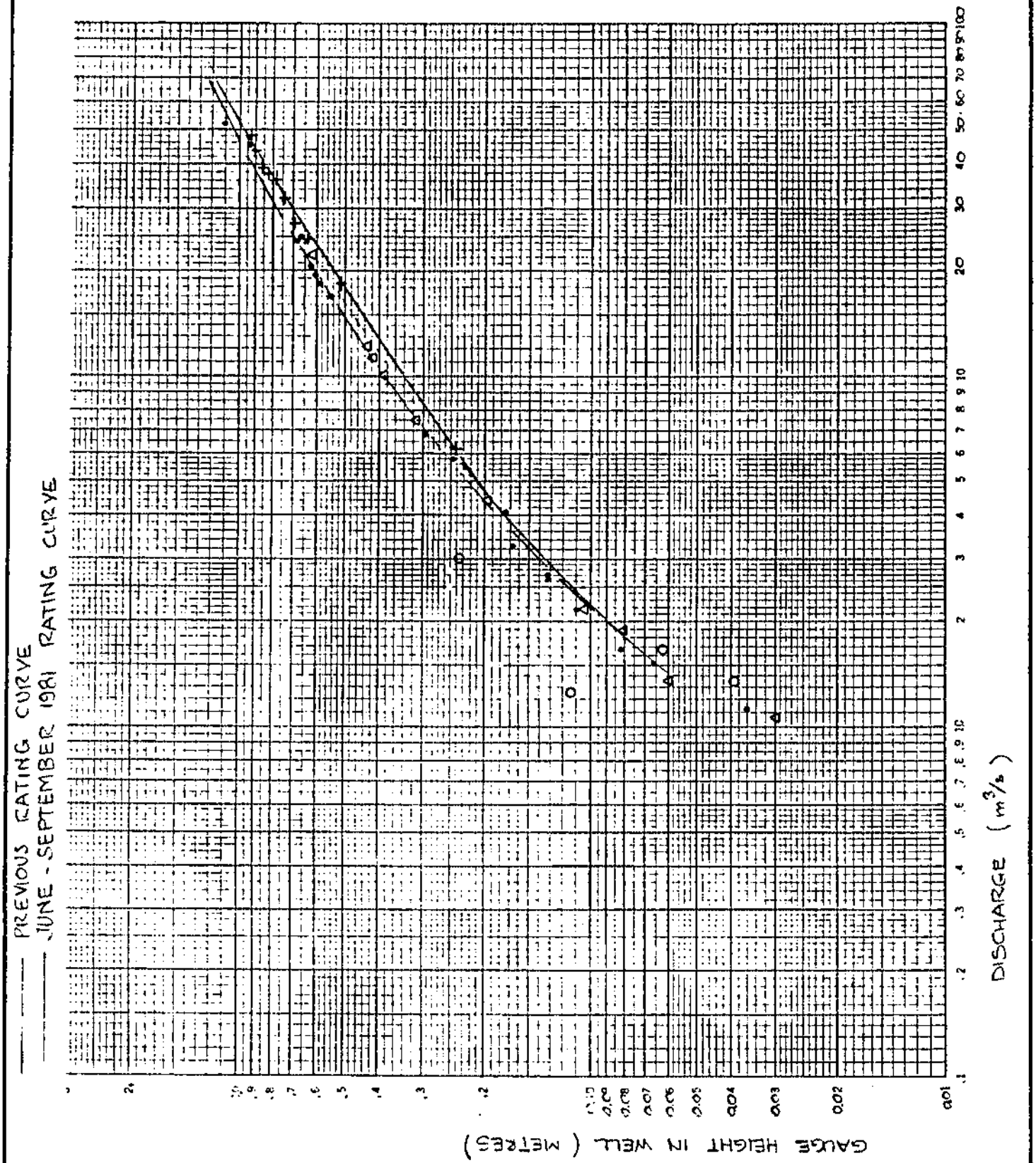
Figure 2.3.1-3
STATION WE 1.0
RATING CURVE

REV.	BY	DESCRIPTION	DATE	APPR'D

DRAWN: M.N.	DESIGNED: D.C.		DRAWING No.:	REV
DATE: OCT. 1981	APPROVED:		29-19.1-15	0

HYDROCON ENGINEERING (Continental) LTD.

HYDROCON ENGINEERING (Continental) LTD.



- PRE JUNE, 1979 MEASUREMENTS.
- ∆ JULY 1979 – MAY 1981 MEASUREMENTS.
- O MEASUREMENTS EXCLUDED FROM ANALYSIS.
- \+ JUNE - SEPT, 1981 MEASUREMENTS.

ELCO MINING LTD

Figure 2.3.1-4
STATION EL 52.5
RATING CURVE

REV.	BY	DESCRIPTION	DATE	APPR'D

DRAWN: M.N. | DESIGNED: D.C. | DATE: OCT. 1981 | APPROVED:

DRAWING No.: 28-19.1-16 | REV. 0

Significant changes in the rating curves have appeared to occur since the spring of 1981. This is probably due to the sustained higher flows which have occurred since installation of the gauging stations. Future observations will determine whether the monitoring sections will continue to shift or stabilize.

2.3.2 Climatological Monitoring

Elco's climatological monitoring, which commenced June 1979, at the request of several B.C. Government regulatory agencies, continued throughout this report period.

Elco contracted PROMET Environmental Group Ltd. of Calgary, Alberta to operate and service its climatic and dustfall monitoring network.

Results of these monitoring activities, which are documented from June to May of the following year* are summarized in the following.

Two meteorological and six dustfall stations (see Figure 2.3.2-1, Page 109) were operated to provide background climatological and air quality data to be used in the design and operation of the proposed coal mining project.

Wind speed and direction, temperature, relative humidity, and precipitation were monitored continuously at Station 5 located on the valley floor and at Station 3, located on Little Weary Ridge, 287 m higher in altitude. Significant improvements in the data acquisition equipment were effected during 1980/81. Digital microloggers were installed to replace chart recorders as the primary recording systems.

* Climatological results for this report period will, therefore, cover June 1980 to May 1981.

The wind characteristics were similar to the observations of previous study periods. Winds at the valley station are channelled by the local topography. Winds at the ridge station have more frequent east or west components due to slope and exposure effects. Wind speeds on the ridge are stronger than on the valley floor with annual averages of 7.5 and 4.5 km/h, respectively.

The gustiest winds occur in spring. Over the day, the strongest gusts occur in the late afternoon.

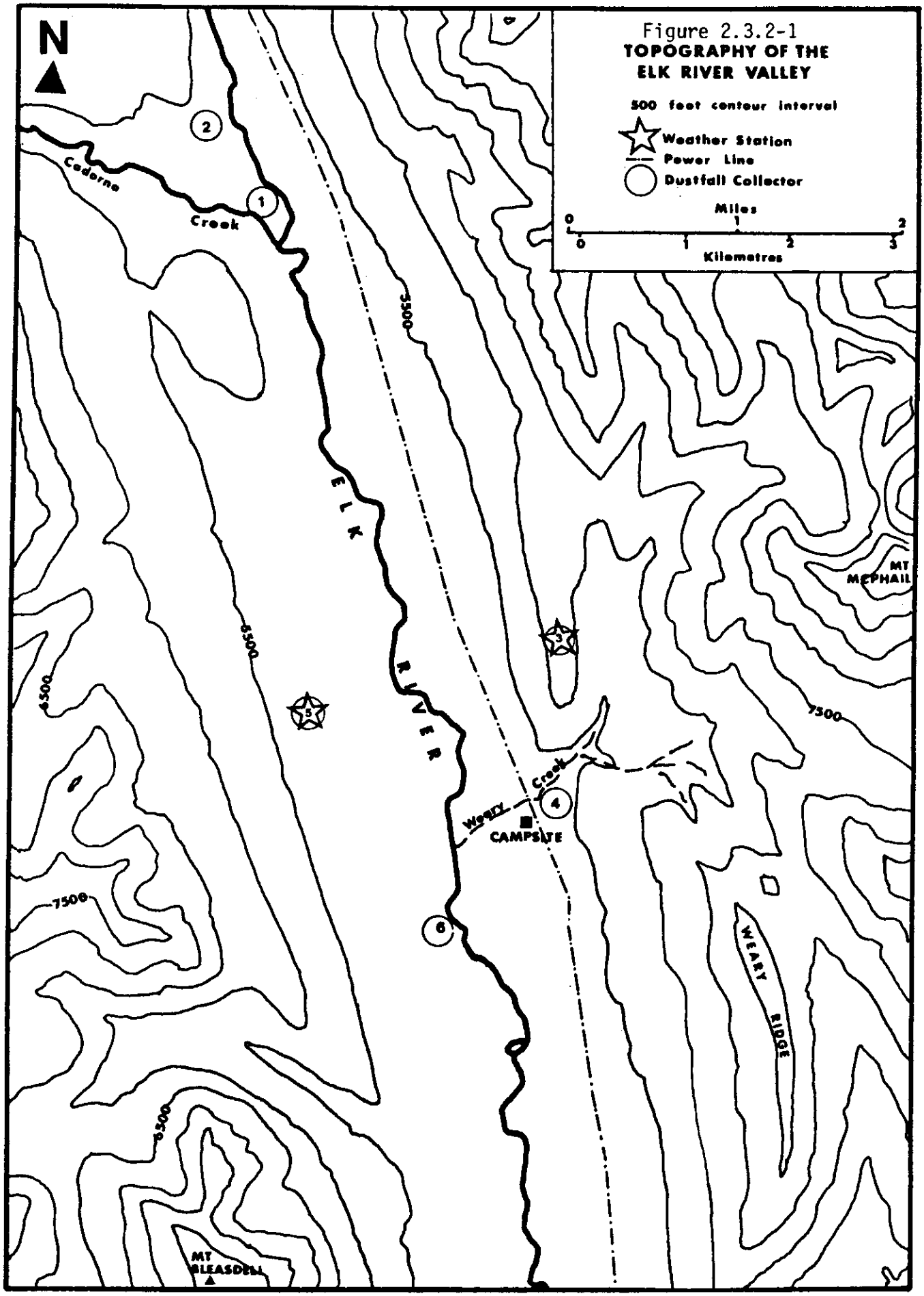
The previous estimate of the long term normal temperatures in the valley was improved using the 1980/81 data. The year 1980/81 featured a cool spring, near normal summer, and a mild fall and winter.

The temperature difference between the two stations was examined to assess the occurrence of inversions, cases in which the temperature increases with height. Inversions occurred about 70% of the time in the early morning based upon the comparison of minimum temperatures.

A visual observation program during the summer and fall of 1980 found only five days with fog reported. This indicated that the algorithm based upon humidity and wind speed used in the previous calculations, grossly overestimates the occurrence of fog.

Precipitation amounts were similar at the two stations despite the difference in altitide. The last half of 1980 had considerably more precipitation than the corresponding period in 1979.

Evaporation was estimated by an empirical method developed by Thornthwaite (1948). The calculated annual evapo-


N
Figure 2.3.2-1
TOPOGRAPHY OF THE
ELK RIVER VALLEY
500 feet contour interval
Weather Station
Power Line
Dustfall Collector
Miles
0 1 2
0 1 2 3
Kilometres
Cadorna
Creek
ELK
RIVER
5500
6500
6500
7500
7500
6500
MT
MCPHAIL
Wesley
Creek
CAMPSITE
WEARY
RIDGE
MT
BLEASDELL

ration compared well with climatological values for 50°N 115°W in Hare (1980).

A first estimate was made of ventilation in the valley from the mean wind components in the north-south direction. The occurrence of inversions aloft which also affects the ventilation was not taken into account.

The 1980/81 dustfall observations over the network showed a trend similar to that of 1979/80. Values were highest in the early autumn and lowest in winter.

2.3.3 Reclamation Work

Pursuant to Elco's exploration Reclamation Permit C-49 requirements, a reclamation field assessment study was undertaken. Elco contracted International Environmental Consultants Ltd. of Richmond, B.C. to make the field assessment and prepare a report[5] based on their findings. The work was carried out during September 1981.

In addition to the assessment work, Elco incurred preparation and reproduction costs for the compilation of the 1981 Annual Reclamation Report[6].

2.4.0 Socio-Economic Planning Work

A hostel-at-mine concept, based upon Elco's latest manpower assessment has been submitted to the Coal Guidelines Steering Committee for approval.

Several ministries involved in the reviewing process have requested further information before a final decision would be made. Mainly involved are the Ministry of Municipal Affairs and the Ministry of Labour. Discussions are ongoing with these ministries.

2.5.0 Project Planning, Promotion and Presentation Work

2.5.1 Scheduling and Project Control

The project schedule has been updated in accordance with the decision by the joint venture partners to delay the project implementation until:

- A satisfactory return on investment would be achieved,
- The end of the continuing recession in the steel industry.

Other tasks which continued to be followed up were:

- Maintain the status of the project,
- Unresolved items remaining from the Stage II approval-in-principle,
- Limited engineering to improve the economics of the project,
- Refine 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,
- Administration of the project.

2.5.2 Project Economic Update

The coking coal project has been updated in using the latest coking coal price and updated investment and operating cost figures. The economic returns are reflecting the negative impact of high interest rates and the high inflation figures.

2.5.3 New Product Studies

Several case studies for hypothetical thermal coal operations have been carried out through computer simulation. Results show that rather low waste/coal ratios are required to make a thermal coal project economically viable.

For this reason, Elco is continuing to propose an exploration program on the West Flank of the Elk River project area to prove whether or not the required reserves at a low waste/coal ratio can be found.

2.6.0 Elco Support Work

2.6.1 Earth Moving

Very little earth moving work was carried out during 1981. The exception being the removal of dirt blockages and/or filling in of trenches that were placed across access roads into the licence area in the fall of 1980 to keep public traffic off the newly reseeded areas. Clarkson Construction of Elkford, B.C. was contracted in October 1981 to carry out the backfilling so that access was available for the geophysical program which has been described earlier in this report.

2.6.2 Field Work Accommodation

Elco provided rental motor homes for the survey crews until colder weather made this mode of accommodation too impractical. Room and board was then arranged for at the National Caterers' camp in Elkford for both survey and geophysical crews. The line cutters, however, lived in their own tent camp on site.

2.6.3 Field Transportation

During fair weather, Elco and its contractors used overland vehicles for field transportation. An occassional trip to the site was necessary during the winter months in order to service and retrieve data from the various monitoring stations. In these cases, helicopters were used.

2.6.4 Field Communication

During the geophysical field program, Elco supplied its contractors with a portable mobile telephone.

2.6.5 Drafting and Reproduction Services

Elco uses contract draftspersons for its drafting requirements. Drafting and reproduction in previous reports has been divided between the various activity accounts. This year, however, these expenses are reported separately.

A certain amount of drafting and reproduction services were performed for each of the before described work activities, however, the largest amount in any one activity was for government reporting. For example, the 1979/80 Term of Licence Work Report, the Annual Reclamation Report and the Stage II, Hostel-at-Mine Report all accounted for considerable drafting and reproduction costs.

SECTION 3.0
SCHEDULE OF 1980/81 DEVELOPMENT WORK EXPENDITURES FOR THE ELK RIVER COAL LICENCES

TABLE 3.0-1
(Sheet 1)

ELCO MINING LIMITED
SCHEDULE OF 1980/81 EXPLORATION AND 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 1980 TO DECEMBER 1981

Category of Work	Total Phase Ib	Licence Group 318	Licence Group 319	Licence Group 320	Licence Group 321
EXPLORATION AND DEVELOPMENT WORK					
Exploration Work					
Surveying and Mapping					
- McElhanney	39,279.00	10,468.34	7,202.66	12,441.88	9,166.11
- Pacific Surveys	14,043.00	3,742.63	2,575.09	4,448.21	3,277.06
Surficial Geology Mapping of Railway Corridor					
- Thurber	3,894.73	3,583.15	-	-	311.58
Geotechnical Investigations of Mine Overburden					
- IECO	168,973.31	45,033.49	30,984.95	53,523.41	39,431.45
- Other	206.25	54.97	37.82	65.33	48.13
Geophysical Survey of River Diversion Area					
- Line Cutting - F.P. O'Grady	12,615.35	3,362.15	2,313.30	3,996.00	2,943.91
- GP Surveys - Geo-Physi-Con Ltd.	23,182.11	6,178.32	4,250.95	7,343.09	5,409.75

TABLE 3.0-1
(Sheet 2)

ELCO MINING LIMITED
SCHEDULE OF 1980/81 EXPLORATION AND DEVELOPMENT WORK EXPENDITURES
ON THE ELK RIVER COAL LICENCES
REPORTED PURSUANT TO SECTION 18, COAL ACT AND SECTION 15, COAL ACT REGULATIONS

Category of Work	Total Phase Ib	Licence Group 318	Licence Group 319	Licence Group 320	Licence Group 321
Engineering Work					
Mine Engineering					
- Consultants - E & B	7,338.80	1,955.88	1,345.73	2,324.61	1,712.57
Coal Preparation					
- Consultants - E & B	22,016.40	5,867.65	4,037.19	6,973.84	5,137.73
Coal Transportation					
- Harbour Study	22,548.16	6,009.37	4,134.70	7,142.28	5,261.82
- Consultants	4,370.00	1,164.66	801.33	1,384.23	1,019.78
Environmental Work					
Stream Gauging					
- Consultants - Hydrocon	34,135.89	9,097.64	6,259.56	10,812.77	7,965.92
- 1980 Residual Station Shelter Construction Costs	3,252.18	866.75	596.36	1,030.15	758.93
- Data Compilation and Computing	2,500.00	666.28	458.43	791.89	583.40
- Other	228.95	61.02	41.98	72.52	53.43
Water Quality Monitoring					
- Consultants - Techman	6,889.89	1,836.24	1,263.41	2,182.42	1,607.82
Climatic Monitoring					
- Consultants - PROMET	55,346.97	14,750.66	10,149.08	17,531.52	12,915.71
- 1980 Residual Station Shelter Construction Costs	3,557.72	948.18	652.39	1,126.93	830.23
- Data Compilation and Computing	2,816.06	750.51	516.39	892.01	657.15
- Other	19.19	5.11	3.52	6.08	4.48

TABLE 3.0-1
(Sheet 3)

ELCO MINING LIMITED
SCHEDULE OF 1980/81 EXPLORATION AND 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 1980 TO DECEMBER 1981

Category of Work	Total Phase Ib	Licence Group 318	Licence Group 319	Licence Group 320	Licence Group 321
Air Quality Monitoring					
- Consultants - PROMET	10,069.66	2,683.69	1,846.49	3,189.63	2,349.85
River Diversion and Design					
- Consultations - KWL	1,322.06	352.35	242.43	418.77	308.51
Fish Inventory Studies					
- 1980 Residual Consultant Costs - IEC	218.04	58.11	39.98	69.07	50.88
Reclamation					
- 1980 Residual Field Costs	9,688.35	2,582.07	1,776.57	3,068.85	2,260.86
- 1980 Annual Reclamation Report - Techman	2,913.80	776.56	534.31	922.97	679.92
- 1981 Field Assessment Study - IEC	8,560.47	2,281.47	1,569.75	2,711.59	1,997.66
Socio-Economic Planning Work					
Hostel Concept and Manpower Planning					
- Consultants - UMA	10,000.00	2,665.13	1,833.72	3,167.57	2,333.59
- Computor Modeling - CGE	5,812.13	1,549.00	1,065.78	1,841.03	1,356.31
Project Planning, Promotion and Presentation Work					
Scheduling and Progress Control	10,873.84	2,898.01	1,993.96	3,444.36	2,537.51

TABLE 3.0-1
(Sheet 4)

ELCO MINING LIMITED
SCHEDULE OF 1980/81 EXPLORATION AND 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 1980 TO DECEMBER 1981

Category of Work	Total Phase Ib	Licence Group 318	Licence Group 319	Licence Group 320	Licence Group 321
Project Economic Update					
- Consultants - E & B	29,355.20	7,823.53	5,382.92	9,298.45	6,850.30
- Consultants - Other	23,511.78	6,266.18	4,311.40	7,447.51	5,486.69
- Data Computing	4,974.68	1,325.81	912.22	1,575.76	1,160.89
New Product Studies (Thermal Coal)					
- Consultants - E and B	14,677.60	3,911.76	2,691.46	4,649.23	3,425.15
- Consultants - Other	15,674.52	4,177.45	2,874.27	4,965.01	3,657.79
- Data Computing	3,316.46	883.88	608.15	1,050.51	773.93
Elco Support Work					
Earth Moving	465.00	123.93	85.27	147.29	108.51
Living and Accommodation (Field)	7,379.18	1,966.64	1,353.13	2,337.40	1,722.00
Field Transportation - Vehicle	3,449.83	919.42	632.60	1,092.76	805.05
Field Transportation - Aircraft	1,957.29	521.64	358.91	619.99	456.75
Field Communications	214.87	57.27	39.40	68.06	50.14
Drafting and Reproduction Services	26,163.29	6,972.84	4,797.61	8,287.39	6,105.44
Other	297.28	79.23	54.51	94.17	69.37
SUB TOTAL: EXPLORATION AND DEVELOPMENT WORK	618,109.29	167,278.99	112,629.68	194,556.53	143,644.09

TABLE 3.0-1
(Sheet 5)

5....

ELCO MINING LIMITED

SCHEDULE OF 1980/81 EXPLORATION AND 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 1980 TO DECEMBER 1981

Category of Work	Total Phase Ib	Licence Group 318	Licence Group 319	Licence Group 320	Licence Group 321
ADMINISTRATION					
Salaries	343,100.13	91,440.46	62,914.92	108,679.24	80,065.51
Temporary Staff	34,592.67	9,219.38	6,343.32	10,957.46	8,072.51
Office Supplies	22,465.34	5,987.29	4,119.51	7,116.05	5,242.49
Vehicle - Lease	16,196.58	4,316.59	2,970.00	5,130.37	3,779.62
Vehicle - Operating/Maintenance	2,589.17	690.05	474.78	820.14	604.21
Legal Fees	33,654.98	8,969.47	6,171.38	10,660.44	7,853.69
Audit Fees	7,100.00	1,892.24	1,301.94	2,248.97	1,656.85
Accounting Fees	19,980.00	5,324.92	3,663.77	6,328.80	4,662.51
Data Processing	9,490.22	2,529.26	1,740.24	3,006.09	2,214.63
Travel Expenses and Meetings	50,185.47	13,375.05	9,202.60	15,896.58	11,711.23
Taxes	23,009.77	6,132.39	4,219.35	7,288.50	5,369.54
Office Rent, Utilities and Maintenance	86,757.63	23,121.99	15,908.91	27,481.05	20,245.68
Equipment Rental	2,501.46	666.67	458.70	792.35	583.74
Office Copying	15,285.19	4,073.69	2,802.87	4,841.69	3,566.94
Postage and Freight	2,734.15	728.69	501.37	866.06	638.04
Telephone and Telex	23,414.57	6,240.27	4,293.57	7,416.72	5,464.00
Insurance	2,964.69	790.13	543.64	939.09	691.84
SUB TOTAL: ADMINISTRATION	696,022.02	185,498.54	127.630.87	220,469.58	162,423.03
GRAND TOTAL	1,314,131.31	352,777.53	240,260.55	415,026.11	306,067.12

SECTION 4.0
REFERENCES

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
   March 3, 1981: Report on the 1979/80 Development Work Carried Out on the Elk River Coal Project

5. International Environmental Consultants Ltd.
   September 1981: Reclamation Assessment Report

6. Elco Mining Limited
   February 1982: Annual Reclamation Report for 1981