



REPORT ON  
 A TURAM ELECTROMAGNETIC SURVEY  
 WATSON LAKE AREA, YUKON TERRITORY  
 ON BEHALF OF  
 BOSWELL RIVER MINES LTD.

by  
 P. J. Fominoff, B.A.Sc.  
 &  
 Jon G. Baird, B.Sc., P.Eng.

February 15, 1971

CLAIMS:

Name	
LUX	14, 16
LUX	18 - 24
OMO	5 - 10
OMO	37 - 42
OMO	69 - 75

LOCATION:

About 80 miles west of Watson Lake, Yukon Territory  
 Watson Lake Mining Division

~~130°~~ ~~60°~~ SW  
 131°  
 131°-00' 60°-09' MWM

DATES:

January 4 to January 28, 1971

This report has been examined by the Geological Evaluation Unit and is recommended to the Commissioner to be considered as representation work in the amount of \$ 15,210.00

*D. B. Craig*

Resident Geologist of  
 Resident Mining Engineer

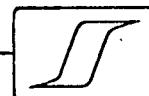
Considered as representation work under  
 Section 53 (4) Yukon Quartz Mining Act.

*[Signature]*

Commissioner of Yukon Territory

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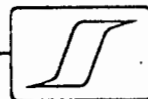


### SUMMARY

The present Turam electromagnetic survey has revealed high background responses typical of low resistivity overburden or bedrock.

Nine electromagnetic conductors some with associated magnetic correlation have been distinguished. The resistivity/thickness ratios of the conductors are within the range normally expected for massive sulphides or graphite.

If geological opinion is such that diamond drilling of conductors with associated ground magnetic correlation appears warranted, the locations for two drill holes, each 450' in length, are herein given. More drill holes could be recommended on the basis of the present data if the results of the first two holes warrant further drilling.



P 1

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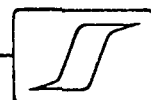
INTRODUCTION

During the period from January 4 to January 28, 1971, a geophysical field party executed a Turam electromagnetic survey in the Watson Lake area, Yukon Territory, on behalf of Boswell River Mines Ltd. The field work was under the direction of Mr. Peter Fominoff, B.A.Sc. and Mr. Peter Werder, both experienced geophysical operators on the staff of Seigel Associates Limited.

As shown on Plate 1, the survey area is located about 80 miles west of Watson Lake. The topography of the property is hilly and covered by glacial overburden. Deep snow and extremely cold weather extended the duration of the survey.

The claims covered in whole or part by the present survey are listed on the front of the report and are shown on Plate 2, on the scale of 1" = 400'.

The Turam fixed source compensation method was chosen for the electromagnetic survey since, in comparison with other electromagnetic techniques, it is relatively unaffected by orientation errors caused by rough topography, provides deep penetration and allows accurate interpretation of anomaly characteristics. The attached copy of a paper by R. A. Bosschart and H. O. Seigel entitled "Some Aspects of the Turam Electromagnetic Method" describes the equipment, the field procedures, the nature of results and the interpretative procedures involved in this type of survey.



Electromagnetic methods detect massive sulphide bodies by means of measurement of the secondary electromagnetic field produced by eddy currents induced by a transmitted or primary electromagnetic field. The Turam method employs a large closed loop of wire as transmitter, while the field strength ratio and phase difference at two nearby observation points are measured by means of two receiver coils.

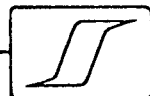
The presence of a subsurface conductor will be indicated by abnormal field strength ratios and phase differences. A typical anomaly will show a correspondence between high values of the field strength ratio and negative phase differences. The depth of burial of the current axis is reflected in the shape of the anomaly, and the ratio of the maximum amplitudes of field strength and phase is a measure of the resistivity/thickness (r/d) ratio of the body.

Approximately 15.3 line miles of profile were covered. Readings were taken every 100' along lines oriented in a northerly direction on two adjacent grids as illustrated on Plate 2.

A Scintrex SE-71 instrument was employed with a receiving coil separation of 100'. Six transmitting loops approximately 3000' by 4000' were used. The locations of their leading edges are shown on Plate 3. The loops were energized mainly with 200 Hz current but some readings were also taken with 400 Hz energization.

GEOLOGY

The regional geology of the area including the present property is shown on the Geological Survey of Canada Map 10-1960, Wolf Lake, Yukon Territory. Discussions about the geology were also held with H. Wober of MacDonald Consultants Ltd.



P 3

Much of the survey area is covered by Pleistocene to Recent glacial till. The underlying rocks could include Paleozoic slates and phyllites, grey limestone and minor dolomite as well as greenstones and chlorite schists. It is also possible that the northern part of the survey grid extends over onto the acidic intrusive rocks of the Cassiar Batholith. Regional faults have been mapped as traversing the survey grid subparallel to the baselines.

Sedimentary rocks such as schists and phyllites and faults filled with conductive gouge may all produce electromagnetic responses which may be difficult to distinguish from sulphide mineralization.

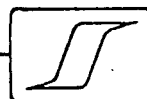
This survey was undertaken as a ground follow-up to locate conductors detected by a recently completed air electromagnetic and magnetic survey which is discussed in a report by R. O. Crosby of Seigel Associates Limited dated November 29, 1970. A ground magnetometer survey carried out by MacDonald Consultants Limited was made available to the writers.

#### DISCUSSION OF RESULTS

Plate 2 is a grid and claim map on a scale of 1" = 400' showing the interpreted locations of the most important conductor axes.

Plate 3 shows the results of the electromagnetic survey on the scale of 1" = 400'. The parameters plotted in profile form are the field strength ratios on a scale of 1" = 40% and the phase differences on a scale of 1" = 20°. Symbols, explained in the legend, have been used to indicate the relative definition of the conductor axis intersections.

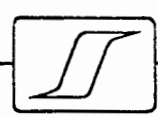
Except for the north ends of lines 16 W through 84 W where the profiles have very near normal non-conductive response, field strength



ratios up to 120% and negative phase shifts up to  $-10^{\circ}$  are common over the property. The generally high background readings are interpreted to originate from overburden and/or bedrocks of low resistivity. In addition to giving rise to abnormal responses, such conductors affect the primary electromagnetic field so that the length of traverses is reduced.

Nine conductors, all exhibiting above background conductivity, have been defined. Their conductor axes are shown on Plate 2. All of the defined conductors have resistivity/thickness ratios within the range normally expected for massive sulphides or graphite. The conductors are described in the following table:

<u>Conductor</u>	<u>Minimum Length Ft.</u>	<u>r/d ratio ohm-cm/m</u>	<u>Depth to current Axis - Ft.</u>	<u>Correlation with other Geophysical Parameters</u>
A	1600	2	250	-within ground magnetic high -coincident with Air EM conductor
B	1100	2.8	200	-within ground magnetic high
C	2000	2.8	200	-coincident with Air EM conductor -no correlation with ground magnetics
D	2000	1.4	150	-coincident with Air EM conductor -follows magnetic contours
E	750	0.2	150	-coincident with Air EM conductor -no corresponding ground magnetic correlation
F	2400	2.4	250	-no other definite geophysical correlation
G	3700	2	230	-generally follows ground magnetic contours



<u>Conductor</u>	<u>Minimum Length Ft.</u>	<u>r/d ratio ohm-cm/m</u>	<u>Depth to current Axis - Ft.</u>	<u>Correlation with other Geophysical Parameters</u>
H	3700	4	150	-generally follows ground magnetic contours
I	1500	1.4	200	-generally follows ground magnetic contours

Conductors A and B are thought to be the best targets for diamond drilling since they have magnetic correlation and may therefore contain magnetite and/or phrrhotite. Neither of the conductors is completely delimited and both may be considerably longer than stated in the table.

Both the ground magnetic low and the low electromagnetic responses at the northern ends of the survey lines suggest that the northern edge of the grid may be underlain by an intrusive formation probably of the Cassiar Batholith as shown on the Wolf Lake geology map. It is possible that conductors D and H are at the contact between the sediments and the intrusive.

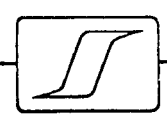
CONCLUSIONS AND RECOMMENDATIONS

The present Turam electromagnetic survey has revealed high background responses typical of low resistivity overburden or bedrock.

Nine electromagnetic conductors within the massive sulphide or graphite conductivity range have been distinguished.

If geological evidence warrants diamond drilling of any of these conductors, A and B would appear to be optimum from the present results. Two initial drill holes are recommended.

<u>COLLAR</u>	<u>ANGLE</u>	<u>DIRECTION</u>	<u>MINIMUM LENGTH</u>
L 48 W, 6 + 00 S	-45°	Northerly along grid line	450'
L 52 E, 9 + 50 N	-45°	Northerly along grid line	450'



Further drilling would depend upon the results of the first two holes, but more drill holes either on conductors A and B or on any of the others could be recommended on the basis of the present data.

Respectfully submitted

SEIGEL ASSOCIATES LIMITED

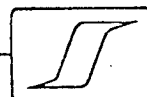
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Vancouver, B. C.  
February 15, 1971



# Some Aspects of the Turam Electromagnetic Method

Robert A. Bosschart  
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Harold O. Seigel

Harold O. Seigel & Associates,  
Geophysical Contractors and  
Consultants,  
Downsview, Ontario

Transactions, Volume LXIX, 1966, pp. 156-161

## ABSTRACT

Most electromagnetic methods presently used in mining exploration are of the moving source type; i.e., the primary field source is moved simultaneously and in a fixed configuration with the receiver.

Of the fixed-source methods, which employ a stationary primary field and a moving receiver, the Turam method is the most effective and has marked advantages over alternative electromagnetic methods.

The results are little affected by topographic relief, and a high degree of resolution can be obtained because of the constant relation between source field and investigation area.

Another inherent advantage of the Turam configuration is that it provides more favourable dimensional relations. Thus, the primary field attenuates at a much lower rate than in moving-source configurations and, secondly, the method is size sensitive; i.e., conductor size affects the strength of the response, which is not the case with moving-source methods.

These factors result in a considerably better potential depth penetration.

## Introduction

IN the period following the first world war, Scandinavia became the cradle of geo-electrical prospecting. The Swedish "Tvaram" (Sundberg, 1931) and "Compensator" (Sundberg & Hedstrom, 1933) were the forerunners of the large majority of present-day electromagnetic methods. From the Compensator method were derived, in quick succession, the "Turam" (Hedstrom, 1937) and the "Slingram" (Hedstrom, 1945) methods. Both techniques are still being used in virtually unmodified form, although the "Slingram" has been adapted to a variety of airborne applications and has, in the course of time, assumed a confusing array of pseudonyms, such as "Loop Frame," "Horizontal Loop," "E.M. Gun," "Minigun," "Ronka," "Magniphase," etc., as well as a number of names for the airborne adaptations. The Slingram-derived methods are characterized by a constant transmitter-receiver configuration, which is moved over the target area. They are called "Moving Source Compensation Methods."

The Turam method has been in active use since its development in 1932. In principle, it comprises a fixed transmitting layout of large dimensions and a moving receiver system which measures the gradients of phase and amplitude of the induced electromagnetic field. The coupling between the field source and a conductor, which is variable in the moving-source systems, is constant in the Turam or related configurations, resulting in a response of a somewhat different character. Therefore, a distinction is made between "Fixed Source" and "Moving Source" Compensation methods.

A typical Turam layout (*Figure 1*) consists of a rectangular transmitting loop of insulated wire with sides several thousand feet long, to which alternating current of one or more frequencies between  $10^2$  and  $10^3$  c.p.s. is fed by a gasoline-engine-driven alternator. The receiver system embodies two induction coils, carried at a constant separation (e.g., 100 ft.) and connected to a compensator which measures the intensity ratio and the phase difference between the fields received by the two coils.

As a rule, profiles are measured outside the transmitting loop, perpendicular to the long axis of the loop and not exceeding the length of the short axis.

The intensity of the induced primary field depends on the size and shape of the transmitting loop and the location of the observation point. The free air field strength ratios between stations successively occupied by the receiving coils are determined by calculation, and the observed ratios are normalized through division by these values. The presence of secondary fields is characterized by abnormal field strength ratios and phase differences.

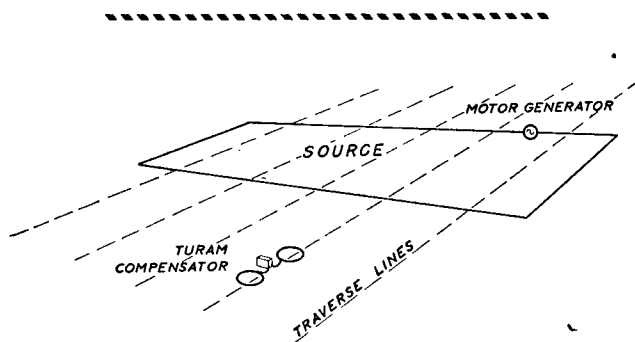


Figure 1.—General layout of the Turam method.

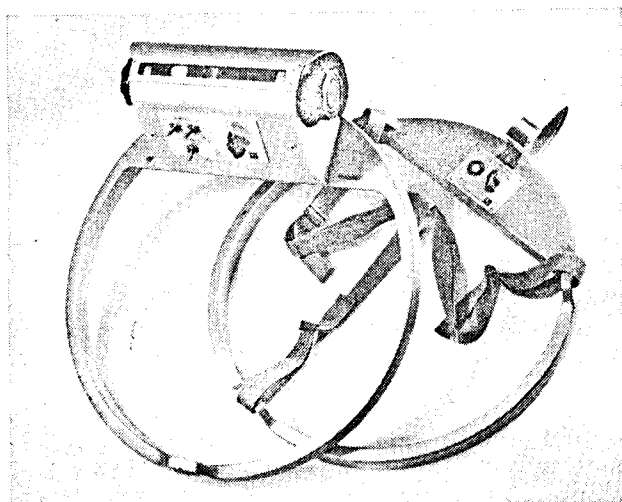


Figure 2.—Three-frequency Turam receiving system (Sharpe SE-700).

Although in practice Turam measurements are, because of the light, mobile receiving system (*Figure 2*), made rapidly (at the rate of 3 to 6 miles per day), a change of primary layout at least each alternate day is required under average conditions. In order to maintain this rate of coverage, a crew of four men is employed—two to measure and two to lay out and recover loops. In terms of line miles per man-day, the Turam method is therefore rather less efficient than the moving-source methods. On the other hand, it has specific advantages in results over the latter, as will be shown below.

### Quantitative Interpretation

When a block of ground is energized by means of an alternating electromagnetic (E.M.) field, the resulting field at the surface is, when conductors are present, elliptically polarized. This is because the secondary fields are phase-shifted relative to the primary field. With methods measuring a geometrical component (e.g., Vertical Loop E.M. methods), field ellipticity has the effect of blurring the observations; i.e., instead of a precise angle of zero induction a "null width" of minimum induction is obtained, and this null width widens with increasing phase shift. As a result, such methods may become less definitive in the presence of medium to poor conductors, such as conductive overburden or relatively disseminated mineralization.

A major advantage of Compensation methods is that phase shifts are compensated and field components can be measured accurately, independent of the degree of field ellipticity. Moreover, two related components are usually measured (either phase and amplitude, or in-phase and out-of-phase components), which greatly diminishes the possibility of obtaining spurious anomalies, and, more importantly, because the relation between these components depends on the conductor characteristics, renders possible a quantitative interpretation of the obtained data.

In recent years, much work has been done to investigate the response of mathematical or reduced-scale models of geological conductors in moving-source or fixed-source configurations and so provide a basis for the quantitative interpretation of field data (Wait, 1952, '53, '60; West, 1960; Hedstrom & Parasnis, 1958; Paterson, 1961; Bosschart, 1961, '64). As a result, some conductor characteristics can often be closely enough determined to discriminate between anomalies arising from potential ore conductors and those arising from electrolytic conductors (overburden, weathered shear zones, etc.) and the conducting bodies, even at considerable depth, can be accurately located for diamond drilling. The possibility of assigning significance to anomalies on the basis of amplitude ratios rather than on amplitude strength, and giving precedence to weak anomalies among larger and stronger ones, in itself signifies a considerable extension of the capabilities of these methods.

The response of conductors, calculated theoretically or observed in model experiments in a particular measuring configuration, are usually presented in the form of response diagrams showing a set of two curves which represent the variation of peak amplitudes of the in-phase and out-of-phase components with the variation of a response parameter. The latter includes, in some form, the exciting frequency and the relevant

conductor characteristics. For instance, for an infinite sheet the response parameter may be written as

$\lambda = 10^3 \frac{r}{fd}$ , in which  $r$  = resistivity in ohm-cm,  $f$  = frequency, and  $d$  = thickness in m.

Such a diagram, representing the response of a medium-size tabular conductor (1000 ft. strike length) in a Turam configuration, is shown in *Figure 3A*. The straight line marked Q is the in-phase to out-of-phase ratio. This ratio varies with the response parameter and the strike length and thus gives, for a determinate frequency, a value for the resistivity/thickness ratio of the conductor. The validity of this particular diagram is limited to the specified strike length, but it illustrates the general relations. As they show the relation between the relative amplitudes of the response and the frequency, an important function of such diagrams is to indicate how anomalies caused by bodies of different conductivity can be emphasized or de-emphasized by changing the exciting frequency. An example of this application is described below.

In some areas, the overburden is both conductive and of irregular configuration and thickness. At standard prospecting frequencies, the strong field distortion arising from this condition could mask the response of underlying conductors, even when these would have appreciably better conductivity. In *Figure 3B-1*, an example of extreme overburden distortion at a frequency of 800 c.p.s. is shown, with anomalies as strong as 40 per cent field strength ratio (R) and a 24-degree phase difference (P). The same traverse at a frequency of 200 c.p.s. is shown in the bottom profile. The field strength anomaly has almost disappeared; from 40 per cent it has decreased to 4.5 per cent. The phase difference is down to 7.5 from 24 degrees. When these results are compared with the response diagram (*Figure 3-1*) they appear to be entirely predictable. The overburden anomalies have a  $r/d$  value of approximately 50 ohm-cm./m. and thus  $\lambda$  equals 62 ohm-cm.sec./m. at 800 c.p.s. and 250 ohm-cm.sec./m. at 200 c.p.s. As the curves show, the in-phase component drops 80 per cent and the out-of-phase component 60 per cent with the change of  $\lambda$  from 62 to 250 ohm-cm.sec./m. This example shows that the overburden response can be drastically reduced by lowering the frequency. The process would, however, be futile if the response from underlying better conductors would be proportionally decreased. With the use of properly selected exciting frequencies, however, this is not the case; for a good conductor with, say, an  $r/d$  value of 1.5, the change in frequency would represent a change from  $\lambda = 2$  to  $\lambda = 8$ , with a corresponding drop of the in-phase amplitude of only 25 per cent and an actual gain in out-of-phase amplitude of 75 per cent (*Figure 3A-2*).

Under 200 ft. of cover, this conductor might (subject to size and over-all geometry), at a frequency of 800 c.p.s., give rise to a 22 per cent in-phase and a 4 per cent out-of-phase anomaly (approximately 20 per cent field strength ratio, 2.5 degree phase difference) (*Figure 3B-2*), and would be difficult to distinguish from the 800-c.p.s. overburden noise shown in *Figure 3B-1*. At the lower frequency, the anomaly would be 17 per cent in-phase and 7 per cent out-of-phase (15 per cent field strength ratio, 5-degree phase difference), and it would stand out clearly from the reduced overburden response.

### Potential Depth Penetration

In assessing the capabilities of electromagnetic methods, the effective depth penetration is among the most important factors to consider. It can be defined as the maximum depth at which the response of conductors of potential economic interest can be clearly distinguished from electromagnetic fields arising from other sources.

An examination of the descriptions of some fifty producing orebodies on the Canadian and Baltic Precambrian shields shows that the large majority are

steeply dipping sulphides, lenticular or tabular bodies of concentrated sulphides, with strike lengths varying from 300 to 3,000 ft. (see Figure 4A) and depth extensions, where known, of a comparable order of magnitude. An example of the response of good conductors within this size range in typical moving-source and fixed-source configurations is shown in the same diagram (Figure 4B). The conductor is a tabular body of good conductivity ( $\lambda = 10.3$  ohm-cm.sec./m.) at a depth of 60 ft. The strike length and height have been increased simultaneously from  $10^2$  to  $10^4$  feet. It can be seen that, up to a strike length of 400 ft.,

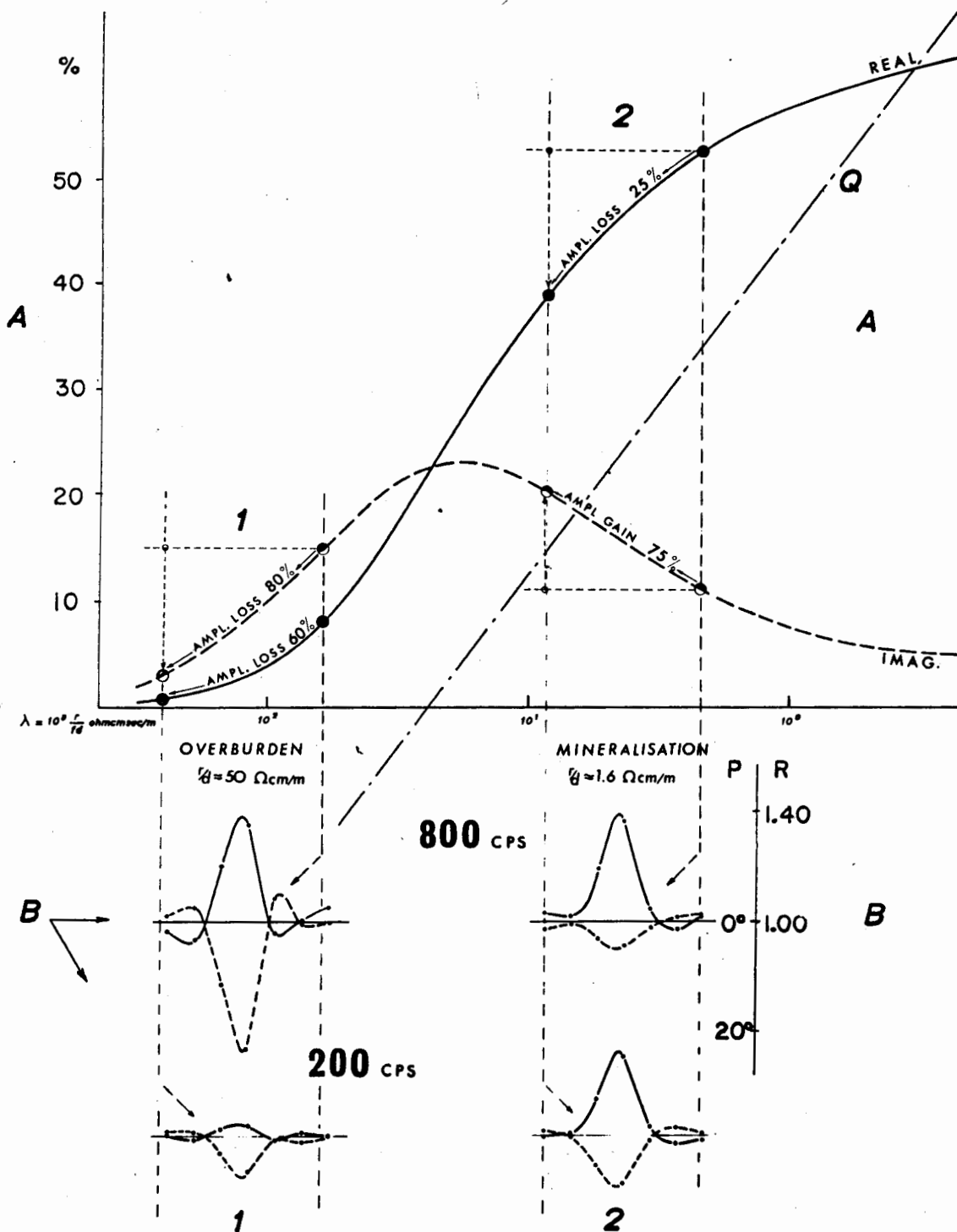


Figure 3.—Response of a thin, medium-size tabular conductor (1000-ft. strike length) in a fixed-source measuring configuration.

the response in both configurations is comparable. In the moving-source configuration (Horizontal Loop), a further increase in size results in very little gain in the response. Saturation is reached at a strike length of 600 to 800 ft.

In the fixed-source (Turam) configuration, the response shows its steepest gain where the moving-source response flattens off; for an increase in strike length from 300 to 3,000 ft., the fixed-source response increases from 6 per cent to 80 per cent, or

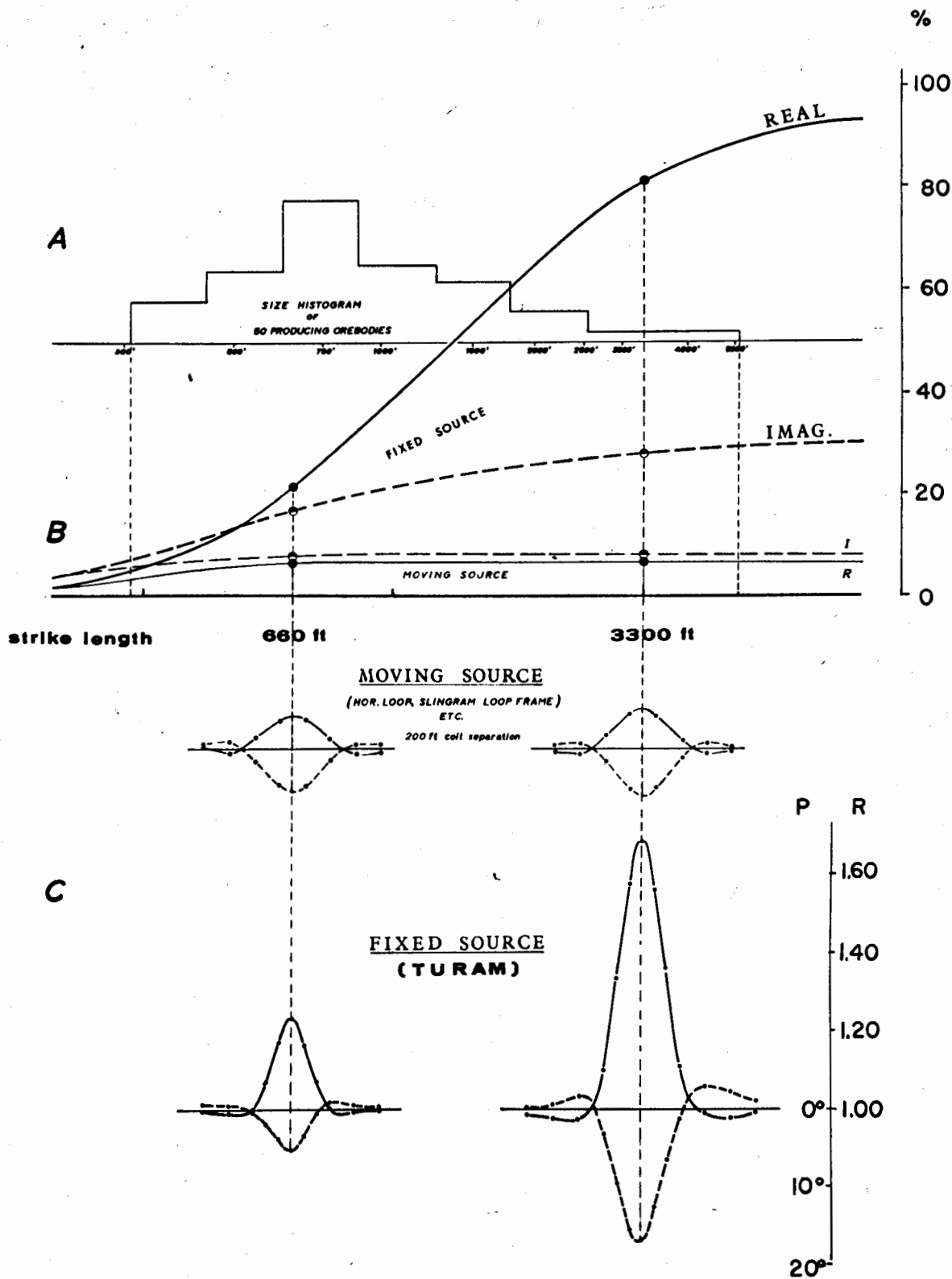


Figure 4.—A comparison of the response of conductors of varying size in moving-source and fixed-source measuring configurations.

more than 13 times, whereas the moving source response increases from 4 per cent to 7.5 per cent, or by a factor of less than 2.

In practical terms, this means that size has a negligible effect on the detectability of a conductor in a moving-source configuration, but contributes materially to its detectability in a fixed-source system. The larger the body, the greater the depth at which it can be found with the Turam method. A major reason for the observed difference in potential depth penetration of the two types of configuration is the different rate of fall-off of the response of bodies of the shapes and dimensions discussed above.

For moving-source configurations, this question has been examined by Hedstrom & Parasnis (1958). In a diagram, for instance, they show the variation of the response of a 2,000 by 2,000 ft. sheet conductor of good conductivity ( $\lambda = 4$  ohm-cm.sec./m.) with the depth. (Figure 5). Between depth to coil separation ratios of 0.2 and 0.8 the rate of fall-off increases from the 1st to the 5th power of the depth. In ground surveys, where the in-phase noise level is, under average conditions, rarely less than 2 per cent, a discernable anomaly will thus have to have an in-phase amplitude of at least 4 per cent. As the diagram shows, the response falls below this value at a depth to coil separation ratio of 0.57. At 300 ft., which is the largest separation practical, the potential depth penetration is therefore less than 170 ft.; at the standard 200 ft. separation, it is less than 115 ft.

The variation with depth of the response of a smaller conductor (1,000 by 1,000 ft) of comparable conductivity ( $\lambda = 3.5$ ) in a Turam configuration is

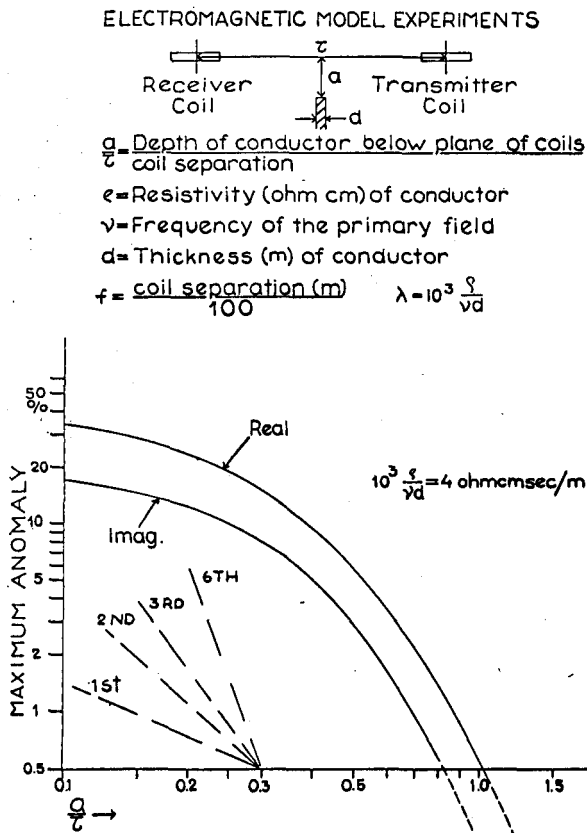


Figure 5.—Variation of the response with depth of a thin tabular conductor of infinite strike length in a moving source configuration. (Hedstrom and Parasnis, 1958).

shown in Figure 6. To a depth of 200 ft. the response falls off at a rate of less than the 1st power; to depths of well over 600 ft., it falls off at a rate of less than the 2nd power.

At a 600-ft. depth, the in-phase amplitude is still better than 4 per cent. For a 2,000 by 2,000-ft. body, it would be approximately 6 per cent, and, with a further increase in size, it could reach 8 per cent. The potential depth penetration can thus be conservatively estimated to be 600 ft.

Figure 7 is a field example of a 400-c.p.s. Turam traverse over two steeply dipping mixed graphite and sulphide conductors under 340 ft. of overburden (Timmins area). The field strength ratio anomaly of the strongest conductor is 23 per cent, which is approximately three times stronger than the field strength ratio anomaly of the smaller conductor shown in Figure 6 at the same depth of burial. This example indicates that the present body could be found at much greater depth and that the estimate of the potential depth penetration, based on the smaller body, is indeed conservative. It may be noted that the in-phase response in a moving-source system (300 ft. coil separation) would be less than 1 per cent and that the body would be undetectable with such a method.

### Effect of Topographic Relief

Neglecting external sources, the noise level of moving-source compensation methods is strongly dependent on the coupling between transmitter and receiver; i.e., if the configuration is not rigidly maintained during operation, spurious in-phase anomalies result. For instance, an error of 5 per cent in the

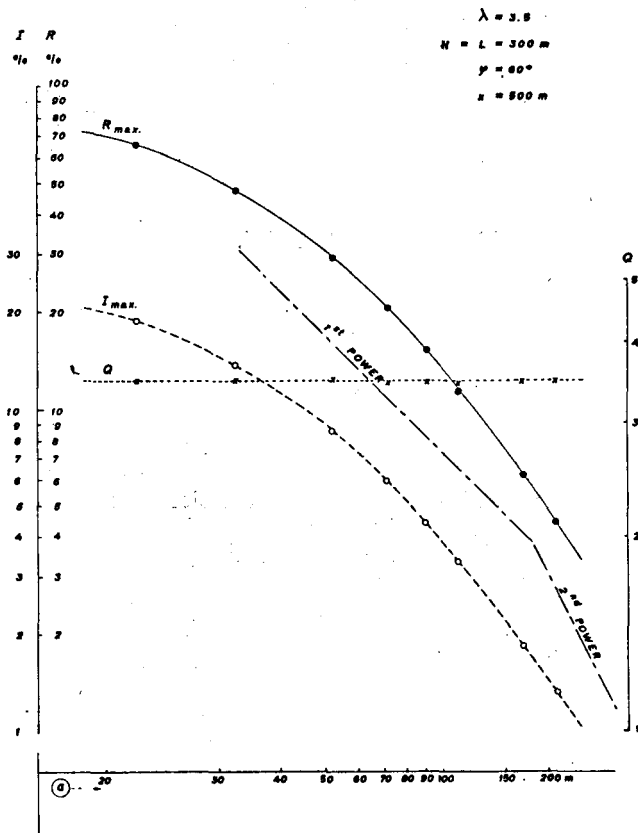


Figure 6.—Variation of the response with depth ( $a$ ) of a thin tabular conductor of finite strike length (1000 ft.) in a fixed-source measuring configuration.

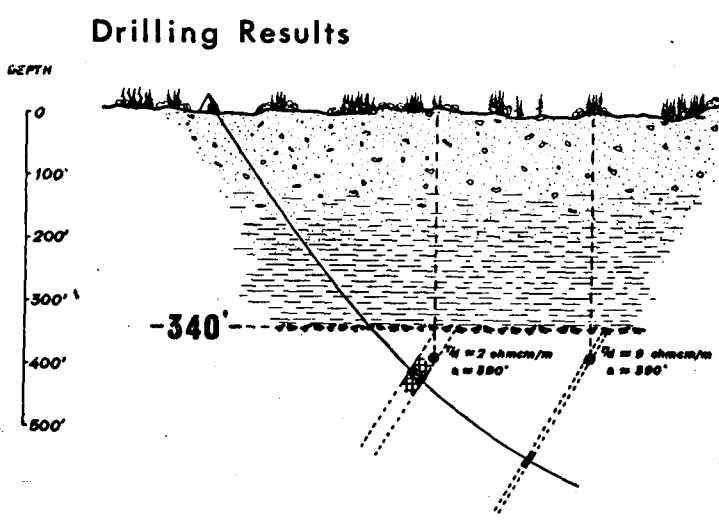
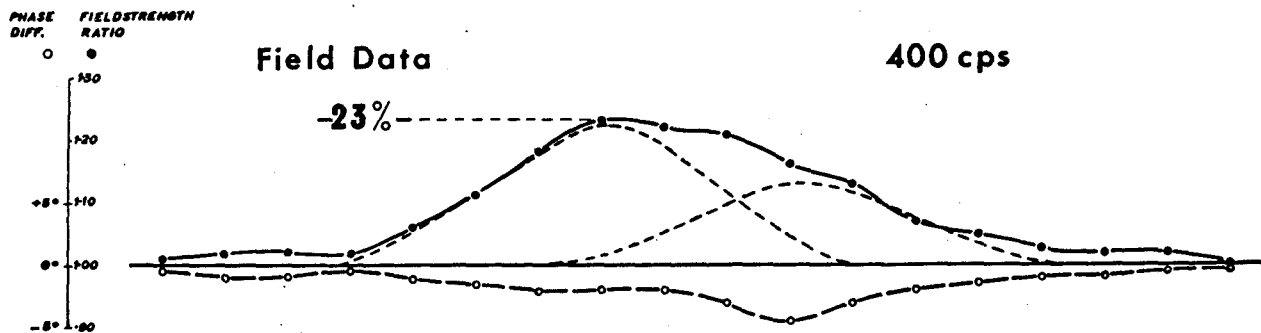


Figure 7.—Turam traverse over deeply buried conductors in the Timmins area.

coil separation causes a change of 15 per cent in the in-phase component. In the presence of secondary fields, both components are affected. Elevation differences between the coils produce a comparable effect. As a result, these methods become impractical in areas of appreciable topographic relief.

With the Turam system, a 5 per cent error in coil separation causes a change of 2 per cent at a distance of 300 ft. from the source, 0.5 per cent at 500 ft. and 0.2 per cent at 1000 ft. The effect of elevation differences between coils is, because the field at the surface is predominantly vertical, even smaller.

The effect of terrain relief on the measurements is therefore negligible, except in areas of very rugged topography. Moreover, where corrections are required, they can be made, because of the fixed relation between source and terrain, in a simple and straightforward manner.

### Conclusions

In the foregoing, those aspects of the Turam method that have marked advantages over alternative methods have been stressed. It is, at present, the most powerful electromagnetic prospecting tool at our disposal.

It is also a rather elaborate method and therefore does not necessarily represent the most efficient approach under all circumstances.

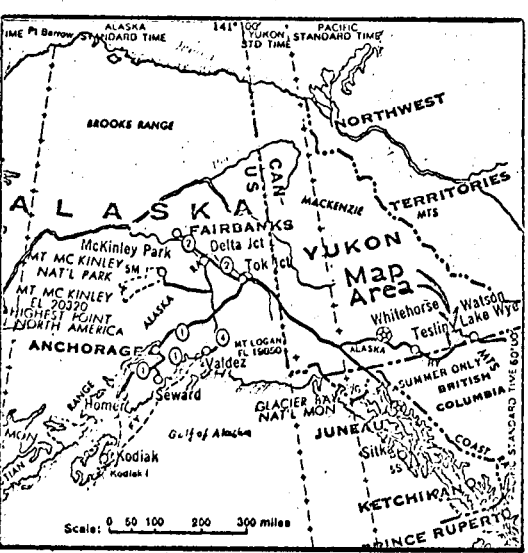
In areas of thin cover and level topography, systematic surveys may, for instance, be done more

economically with moving-source compensation methods. Also, for fast ground follow-up of airborne electromagnetic surveys, where the problem is usually confined to determining the accurate location of pre-selected anomalies, methods measuring geometrical components will yield the desired information more rapidly and at less expense.

The proper field of application of the Turam method lies where conditions are more difficult and the requirements severe; in particular in cases where a high degree of discrimination between conductors is desired, where the depth of overburden limits the use of other methods or where appreciable topographic relief occurs.

### References

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- (1958) Hedstrom, E. H., and Parasnis, D. S., "Some Model Experiments Relating to Electromagnetic Prospecting with Special Reference to Airborne Work," *Geophys. Prosp.*, Vol. VI, 4.
- (1964) Bosschart, R. A., "Analytical Interpretation of Fixed Source Electromagnetic Prospecting Data," Delft.



<b>BOSWEL RIVER MINES</b>	
<h2 style="margin: 0;">LOCATION MAP</h2> <p style="margin: 0;">Swift River Project</p>	
<b>SWIFT RIVER AREA - YUKON TERRITORY</b>	
<p style="margin: 0;">4 miles      0      4 miles</p>	
Survey by <b>SEIGEL ASSOCIATES LTD.</b> January, 1971	<b>PLATE 1</b>

060890

Report On The  
Exploration Work In 1971  
On The  
Swift River Property  
Of  
Boswell River Mines Ltd.  
By  
MacDonald Consultants Ltd.  
H. Wober, P. Eng.

February 22, 1972

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## INTRODUCTION

The following is a summary of all work carried out on the Swift River property of Boswell River Mines Ltd. (N.P.L.) during the year of 1971. The work was carried out during two separate periods, the first starting early in January and lasting until break up. Work was resumed at the end of June and lasted to the end of August.

All work was carried out under the guidance and supervision of the writer. Field supervision was under J. P. Henry, also of MacDonald Consultants Ltd.

## WORK PERFORMED IN 1971

### a) Ground Geophysics

#### i) Magnetometer Surveys

following up the results of an extensive airborne magnetometer and EM Survey carried out in the fall of 1970, linecutting and a ground magnetometer survey were carried out on the OMO and Lux group of claims north of Swift River (see accompanying map 294-2B). This work was carried out under extreme winter conditions and comprised 17.5 line miles.

Ground magnetometer work was also carried out during the summer season on OMO 58, 60, 91 & 93 mineral claims south of Swift River. This totalled 5.17 line miles with readings taken at 100' station intervals (see map 294-2D).

A small line grid was surveyed on the OLE 1, 2 and Max 33, 44 mineral claims, consisting of 4,200 feet of line with readings taken every 50' (see map 294-2E).

The magnetometer survey north of Swift River uncovered a distinct magnetic high trend which was followed up by a ground EM survey.

The survey on OMO 58, 60, 91 & 93 claims covered the area of a double peak airborne magnetometer anomaly discovered in the late fall of 1970. This anomaly was confirmed, but the more detailed ground survey discerned several more elongate magnetic highs resembling the anomalies in the Crescent Lake area where zinc-copper-phyrrhotite-magnetite mineralization is found in stratiform skarn zones.

ii) Ground EM Survey

Concurrently with the magnetometer survey on the OMO and Lux Group north of Swift River, Seigel and Associates carried out a Turam electromagnetic survey covering about 15.3 miles of cross-lines. A report by P. J. Fominoff and Jon G. Baird, dated February 15, 1971 covering this survey is attached.

b) Diamond Drilling

The results of the ground geophysical work on the Lux and OMO group were followed up by diamond drilling early in 1971. Three holes were drilled on locations shown on map 294-2B.

The drilling was hampered by the extremely cold temperatures at the time and by difficult ground to drill, both being reflected in high costs.

The total footage drilled was 1,630 feet of BQ core.

The Magnetometer and EM anomalies were found to be caused by a formation of graphitic-argillite and graphite schist containing an abundance of magnetite. The formational sequence was recovered well in the core, however, the core was crumbling soft and consisted of a fine grained equigranular black sand. Some sections contained abundant calcareous material.

Diamond drill hole no. 71-3 encountered a small intersection of silver-lead-zinc mineralization. The section, sampled and assayed from 442.0 to 443.5 feet, gave the following assay values:

Silver	3.7 ozs/ton
Lead	1.3%
Zinc	1.2%

The area of the drillholes is underlain by Cambrian rocks consisting of black argillite, graphitic-argillite, graphite schist, dolomite and limestone. These lie between two branches of the Swift River fault system which separate the area from the Cassiar Batholith to the north and Mississippian rocks to the south.

Vein type silver-lead-zinc deposits are known to exist in a similar environment on the eastern margin of the Cassiar Batholith. This is the first time that mineralization of this kind has been encountered in the same formation on the western fringe of the Batholith. The significance of the assay results lies mainly in the favourable silver-lead ratio of 2.85 to 1.

This belt of rocks now covered to a great extent by claims of Boswell River should be given particular attention when work is resumed on the property.

c) Geochemistry

The line grid on OMO 58, 60, 91 & 93 established over a double peak airborne Magnetometer anomaly was also covered by a geochemical survey. 127 samples were taken at 200' station intervals. All samples were assayed for copper, lead and zinc.

(Hot aqua regia digestion of - 80 mesh fraction, Atomic Absorption determinations).

Only weakly anomalous zinc values were encountered (see map 294-3D and 294-3E).

There is little or no outcrop in this area, bedrock is covered by a mantle of glacial till and the vegetation consists of a thick stand of alder, willow and wild cherry. In order to fully evaluate the geochemical response further field work is necessary.

A small geochemical survey was carried out on the extension of 20 + 00 W, 24 + 00 W and 28 + 00 W on the large grid on the OMO and Lux group of claims north of Swift River. This area is in line and stratigraphically further into the footwall of the formations intersected in DDH # 71-3. The survey was carried out in search for the type of silver-lead mineralization encountered in the drill hole and described earlier in this report. As mentioned above a more comprehensive and extensive exploration program should be carried out on this belt of rocks between two branches of the Swift River fault system.

To date only weekly anomalous zinc values were encountered on the three lines surveyed (see map 294-3C).

d) Road Repair, Road Construction and Trenching

During the winter program a fair amount of cat-work and grader work was necessary to keep the access road from the Alaska Highway into camp open.

After break up and with the beginning of the summer program, the road from camp to the Crescent Lake area had to be rehabilitated, washouts had to be filled and sloughing benches had to be cleared.

Apart from this rehabilitation and maintenance work, 3.41 miles

of access road was built from Swift River valley to the area of OMO 58, 60, 91 & 93 claims. The road could only be pushed as far as shown on map 294-2D, when the frame on the company's D8 broke and the cat was stuck in a swamp.

Prior to this work extensive trenching was carried out on a showing of sphalerite mineralization in a stratiform skarn zone at Crescent Lake (see map 294-2G). The trenches exposed a zone 6 feet to 10 feet wide over a strike length of approximately 200 feet in quartzite and phyllite.

Two samples about 150 feet apart across the true width of the zone gave the following assay results:

<u>Sample</u>	<u>Width</u>	<u>Silver</u>	<u>Zinc</u>	<u>Calcium</u>
A	6'	0.32 ozs/ton	4.94%	0.02%
C	10'	0.06 ozs/ton	5.27%	0.02%

Sample 'B' cut across a split in the zone across 13' assayed:

Silver	0.05 ozs/ton
Zinc	0.08%
Calcium	Trace

The zone is open on both ends, where it is covered by talus. Accompanying magnetite mineralization facilitated tracing of the zone by ground magnetometer surveys. The zone has been traced by a magnetometer anomaly over a strike length of about 1,700 feet (see 294-2F).

The above zone was earlier picked up by prospecting and a geochemical survey.

The results enhance the significance of the geochemical and zinc anomaly east of Gossan Lake on the same line grid, starting about one mile east of the above showing and extending for a strike

length of about 4,000 feet. This anomaly was located in 1970 below an extensive Gossan zone caused primarily by oxidizing pyrrhotite mineralization. The latter zone should be trenched next in order to investigate the tenor of the mineralization in place. Both zones should subsequently be drilled for their strike and down dip extension.

#### SUMMARY RECOMMENDATIONS

The exploration work carried out in 1971 resulted in defining two major target areas for further work. In order of priority they are:

- 1) The stratiform zinc-copper mineralization east of Gossan Lake and between Gossan Lake and Crescent Lake described above. Follow up work on the zone exposed by trenching and on the large geochemical anomaly in the form of trenching and diamond drilling is recommended.
- 2) The belt of lower and middle Cambrian rocks covered by the northern portion of the OMO claim group, the Neil, Lux and OLE claims north of the Swift River valley.

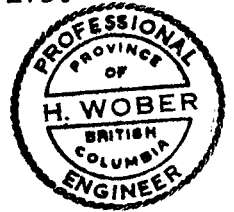
The rocks consisting of phyllites, black argillites, slates, grey limestones and dolomite are between two branches of the Swift River fault system, separating them from the Cassiar Batholith to the north and Devonian and Mississippian Rocks to the south. Silver-lead mineralization is known to exist in a corresponding environment on the eastern margin of the Cassiar Batholith and indications of such mineralization were found in diamond drill hole 71-3 with a silver-lead ratio of 2.85 to 1. Further work should consist of

Careful mapping and prospecting in conjunction with reconnaissance soil sampling and a stream-silt sampling program.

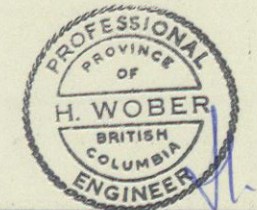
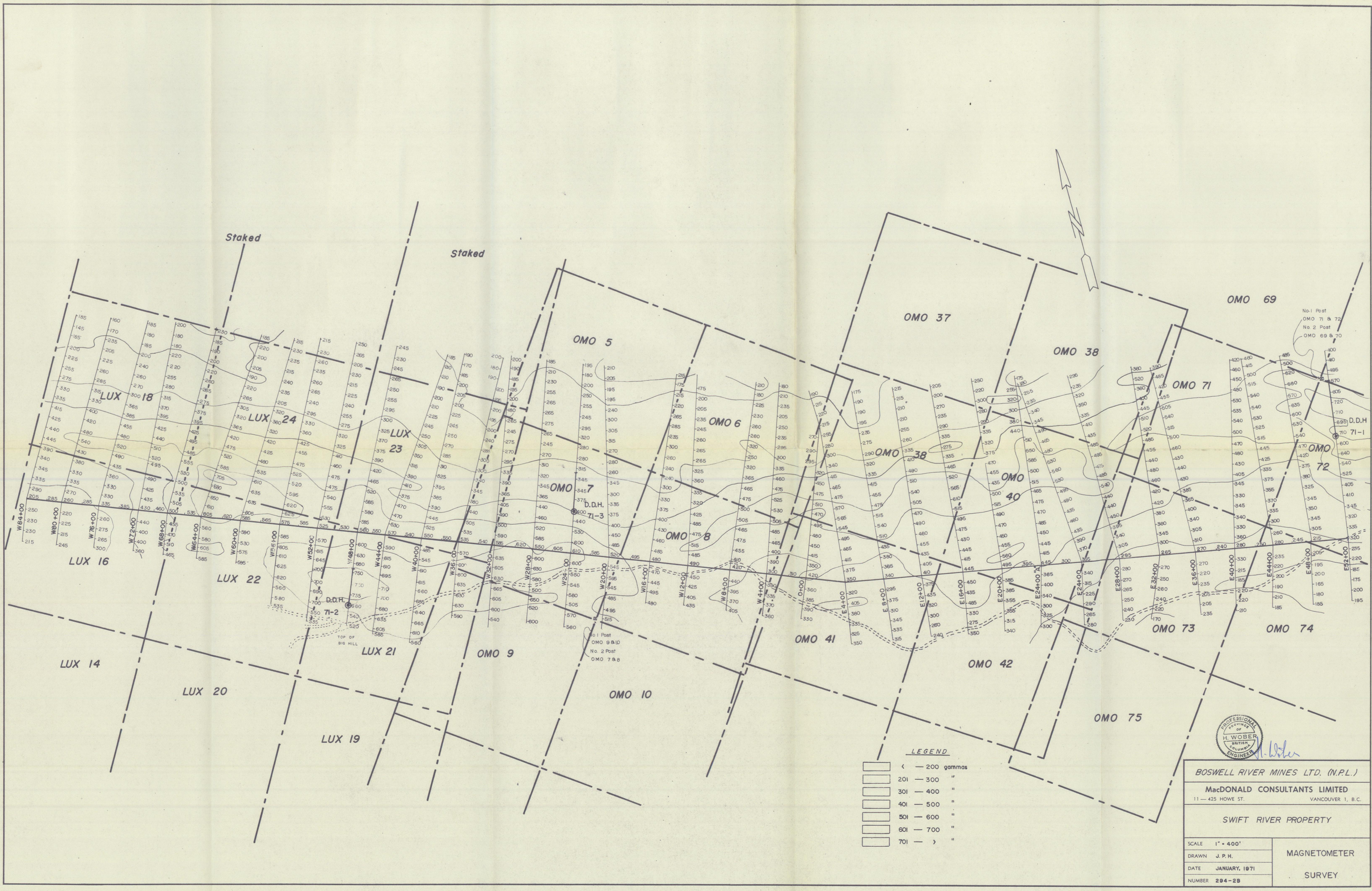
Respectfully submitted,  
MACDONALD CONSULTANTS LTD.



H. Wober, P. Eng.



HW/jr



BOSWELL RIVER MINES LTD. (N.P.L.)  
 MacDONALD CONSULTANTS LIMITED  
 11 - 425 HOWE ST. VANCOUVER 1, B.C.

SWIFT RIVER PROPERTY

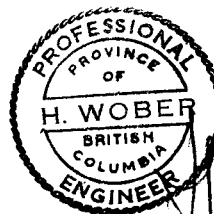
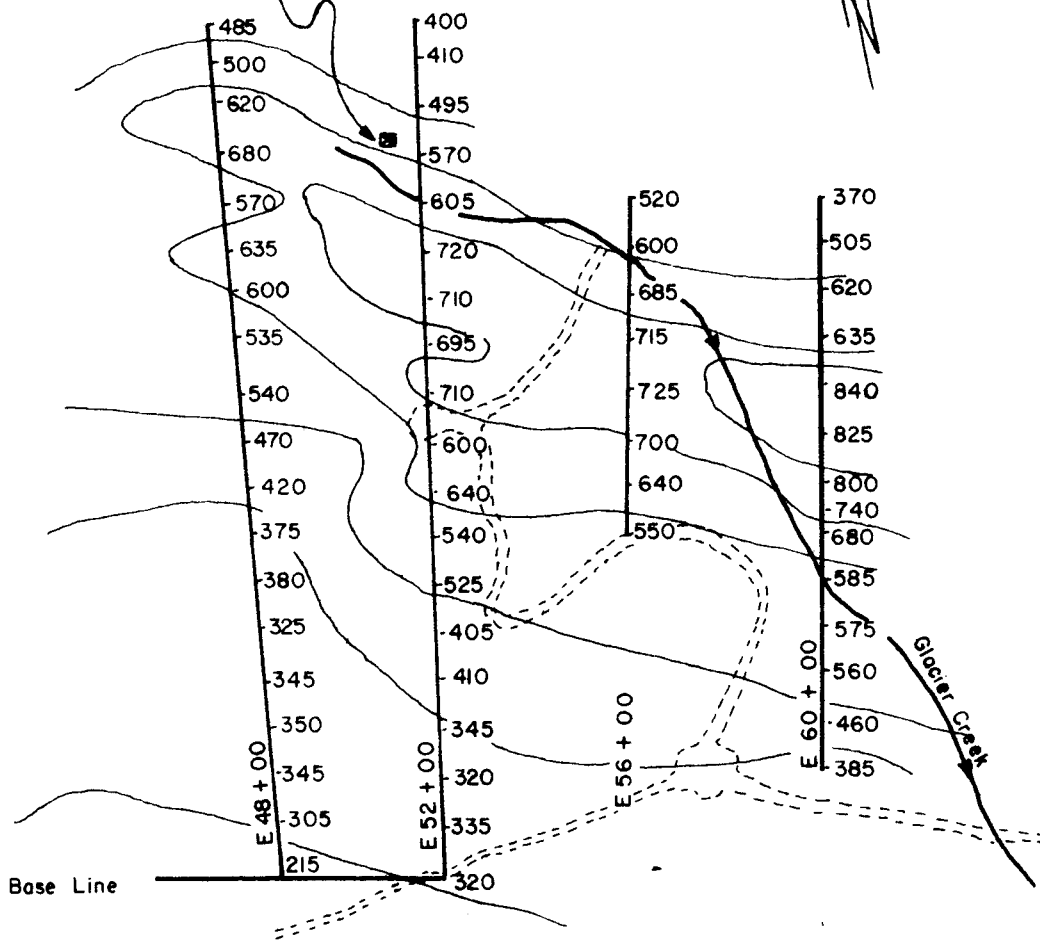
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[Line 301-400]	301 - 400 "
[Line 401-500]	401 - 500 "
[Line 501-600]	501 - 600 "
[Line 601-700]	601 - 700 "
[Line 701-800]	701 - > "

SCALE 1" = 400'	MAGNETOMETER SURVEY
DRAWN J. P. H.	
DATE JANUARY, 1971	
NUMBER 294-2B	

NO. 1 Post  
OMO 71 B 72

NO. 2 Post  
OMO 69 B 70



*H. Wober*

**MacDonald Consultants Ltd.**

SCALE	1" = 400'
DRAWN	E. B.
DATE	Jan 1971
NO.	294-2C

EXTENSION  
or  
GRID LINES  
EAST



**LEGEND**

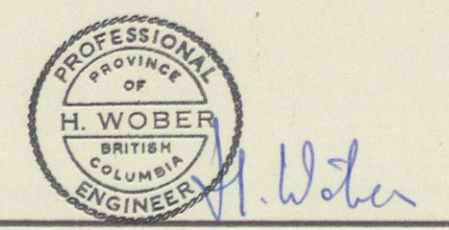
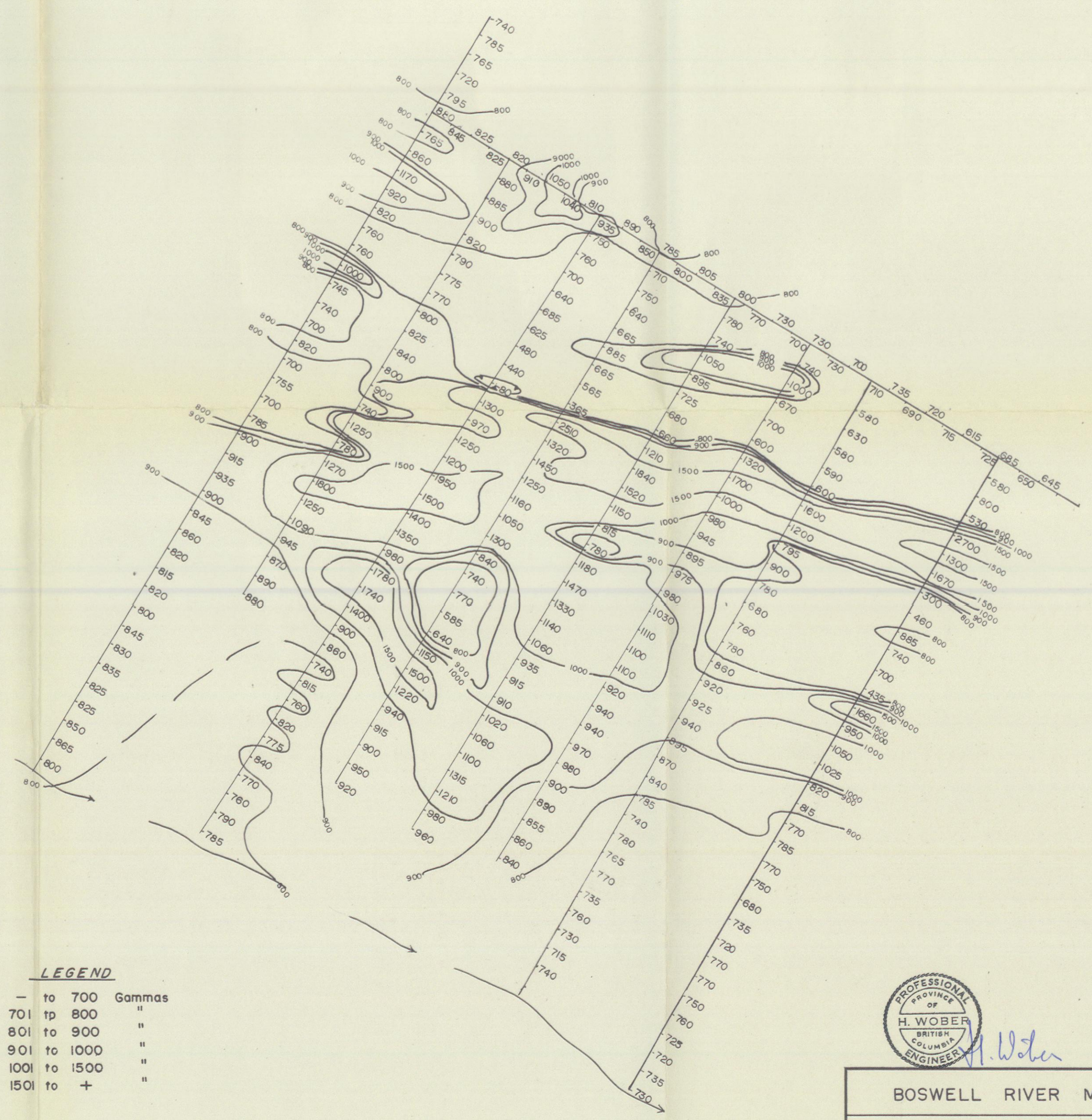
- - to 1000 Gammas
- ▨ 1001 to 1500 Gammas
- ▩ 1501 to + Gammas
- Surveyed Claim Post

SCALE 1" = 1320'

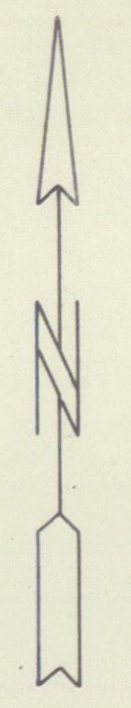
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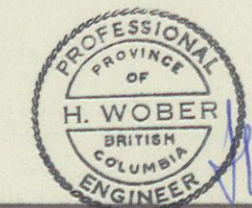
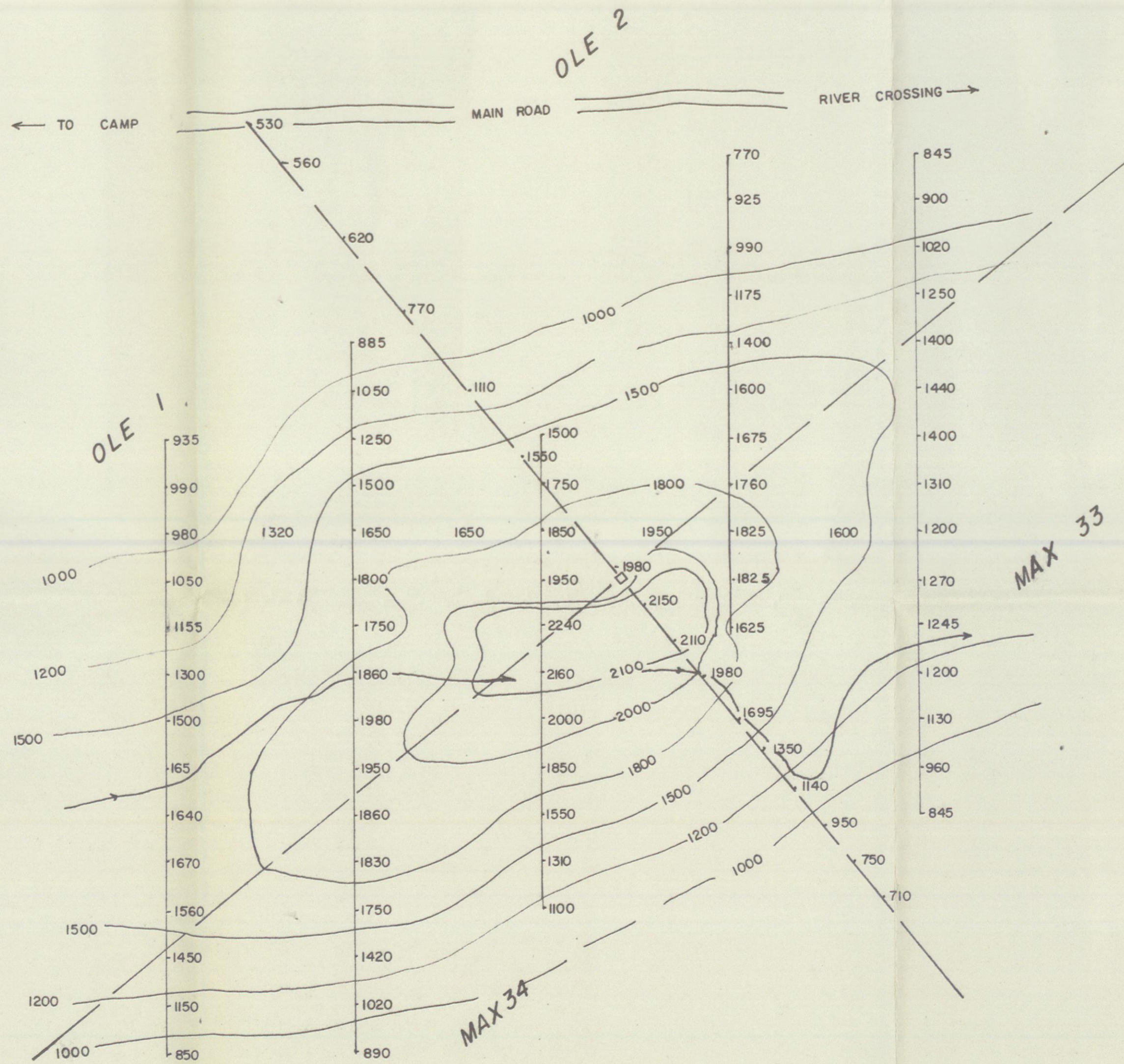
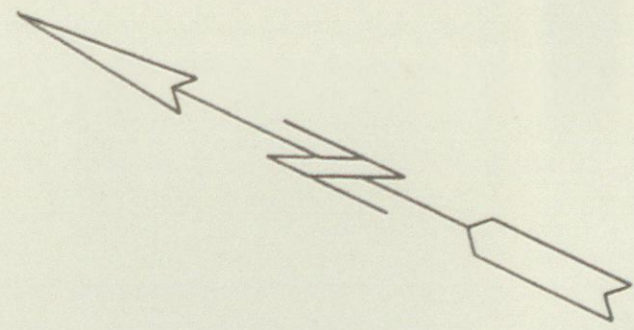
**LEGEND**

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- ▨ 701 to 800 "
- ▩ 801 to 900 "
- ▩ 901 to 1000 "
- ▩ 1001 to 1500 "
- ▩ 1501 to + "



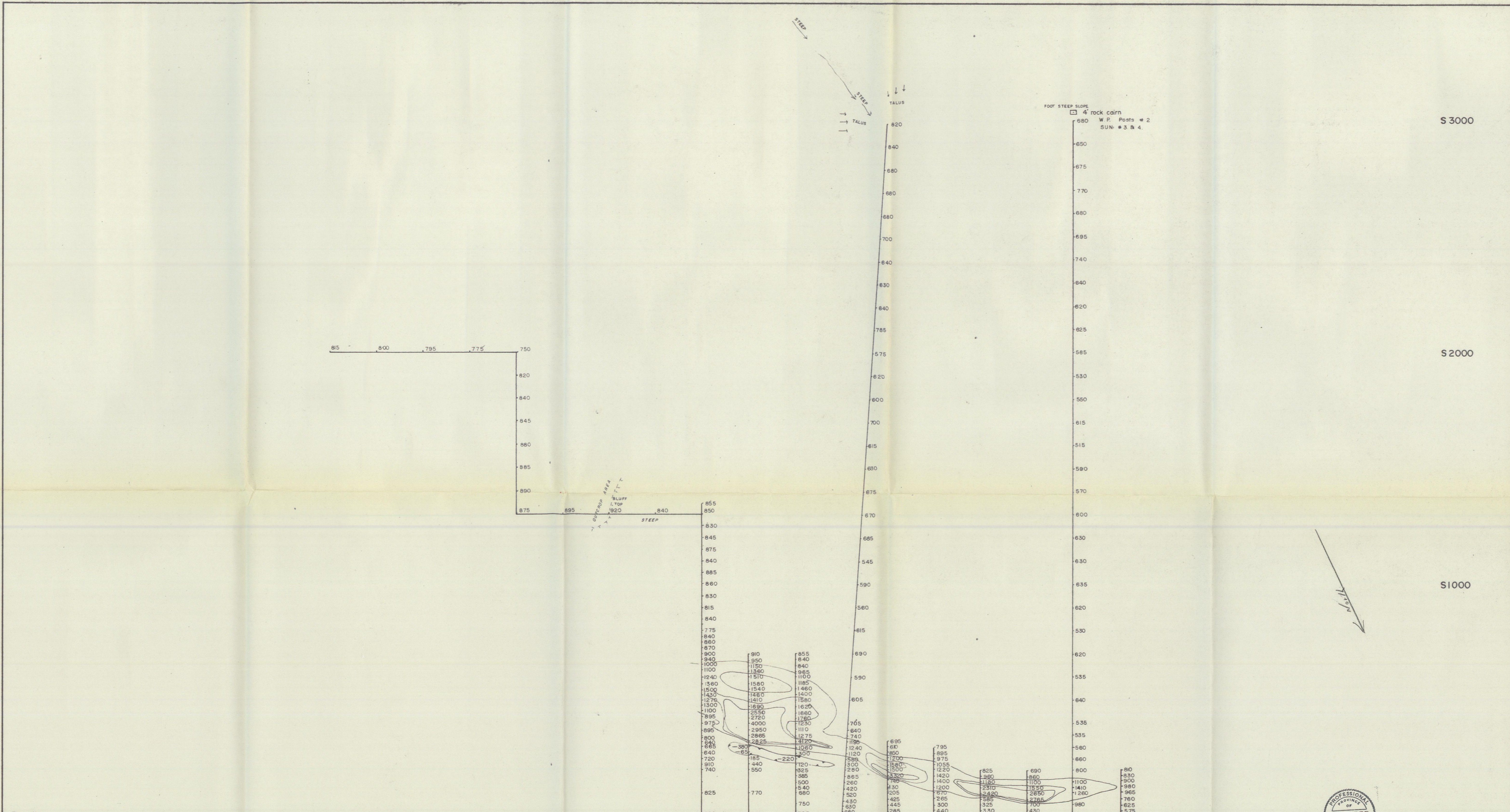
BOSWELL RIVER MINES LTD	
MacDONALD CONSULTANTS LIMITED	
11 - 425 HOWE ST. VANCOUVER 1, B.C.	
SWIFT RIVER PROPERTY	
SCALE 1" = 400'	MAGNETOMETER SURVEY
DRAWN J.P.H.	
DATE AUG. 1971	
NUMBER 294-2D	





*H. Wober*

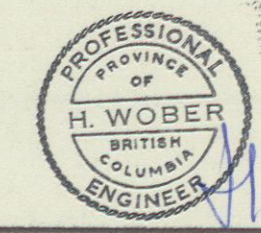
<b>BOSWELL RIVER MINES LTD. (N.P.L.)</b>	
<b>MacDONALD CONSULTANTS LIMITED</b>	
11 — 425 HOWE ST.	VANCOUVER 1, B.C.
<b>SWIFT RIVER PROPERTY</b>	
SCALE 1" = 100'	<b>MAGNETOMETER SURVEY</b>
DRAWN J. P. H.	
DATE AUG. 1971	
NUMBER 294-2E	



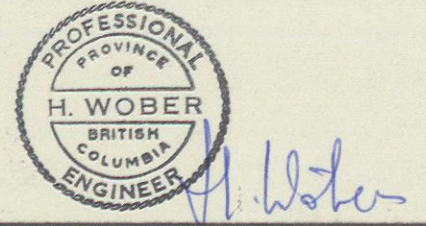
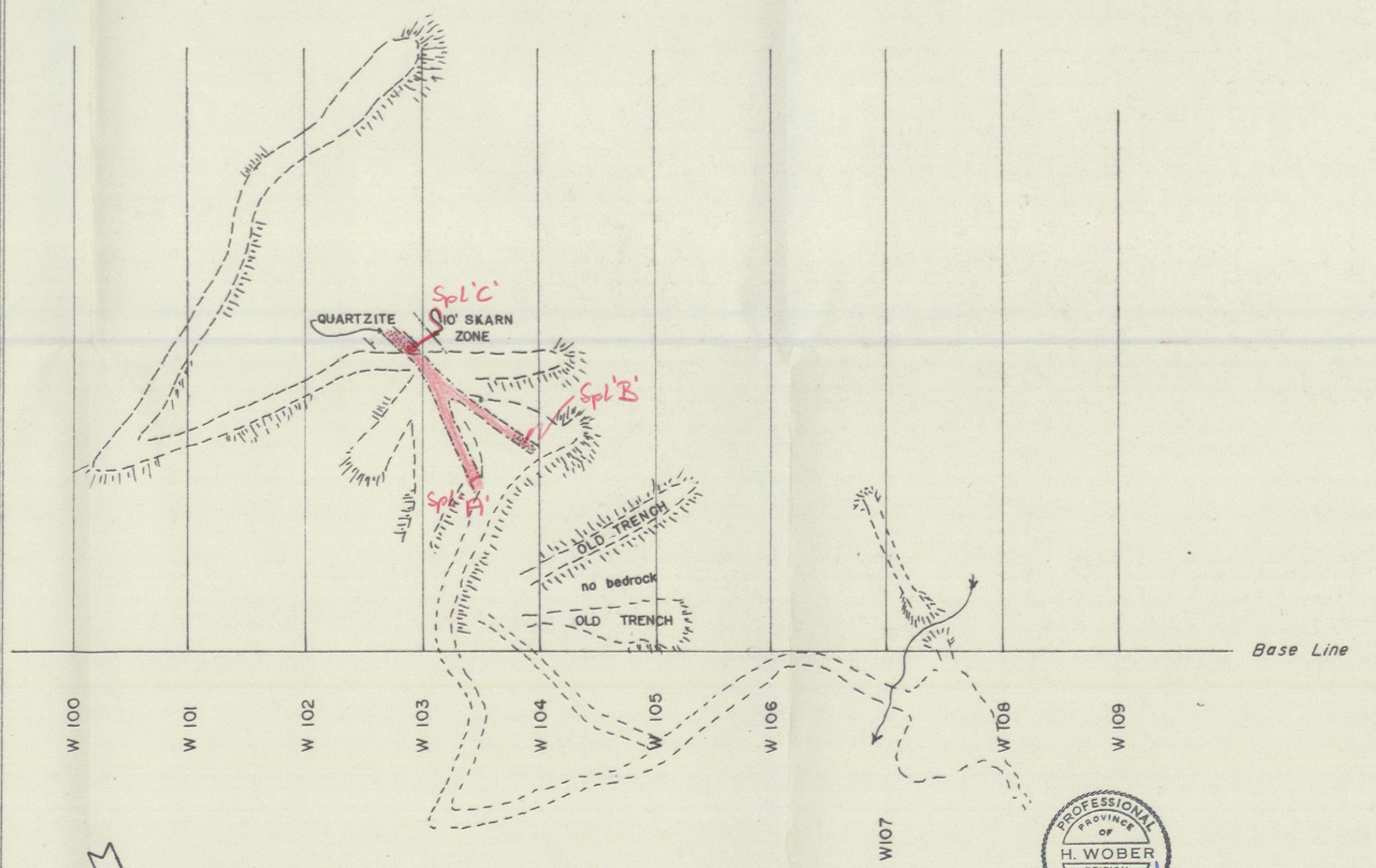
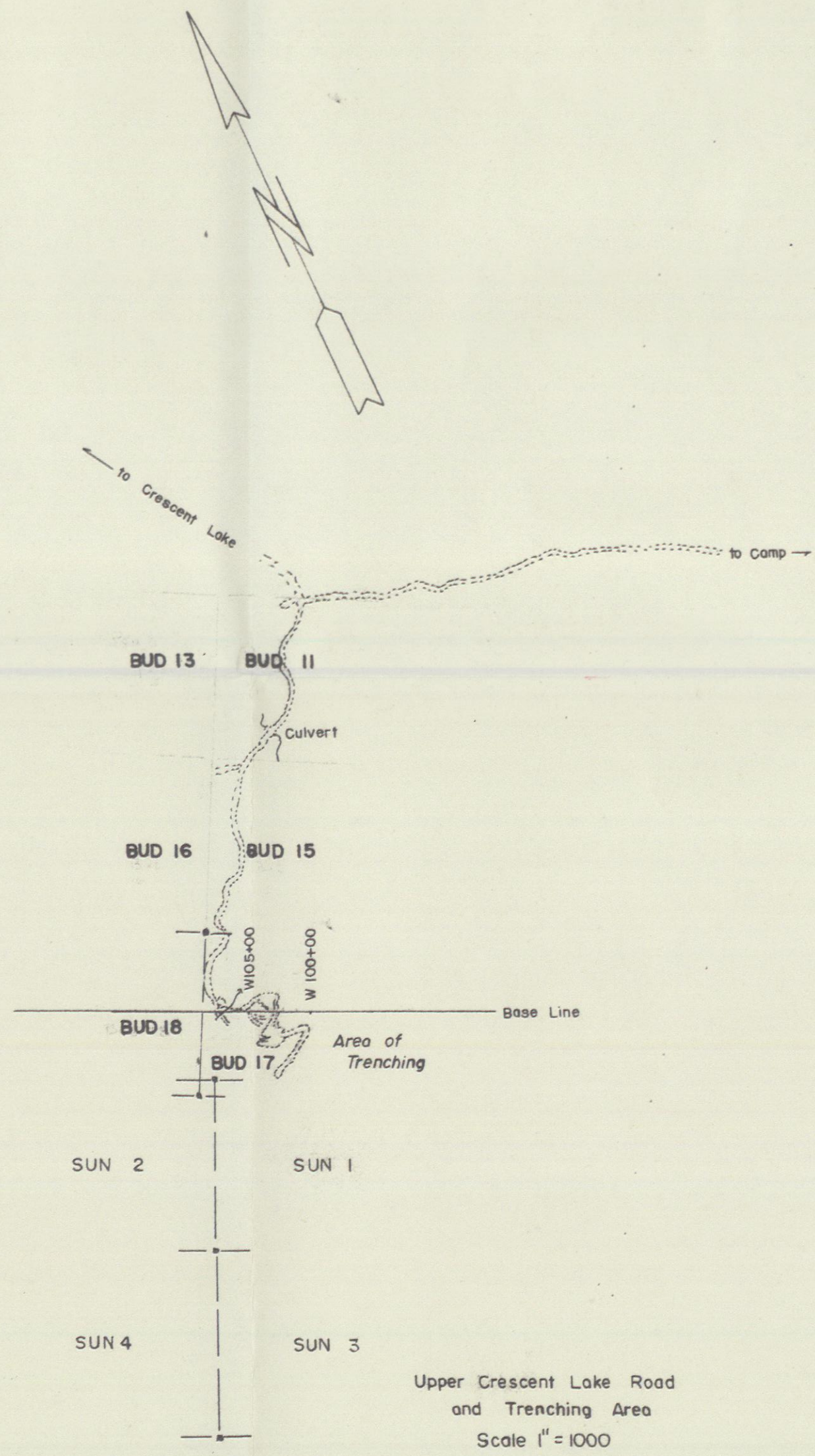
S 3000

S 2000

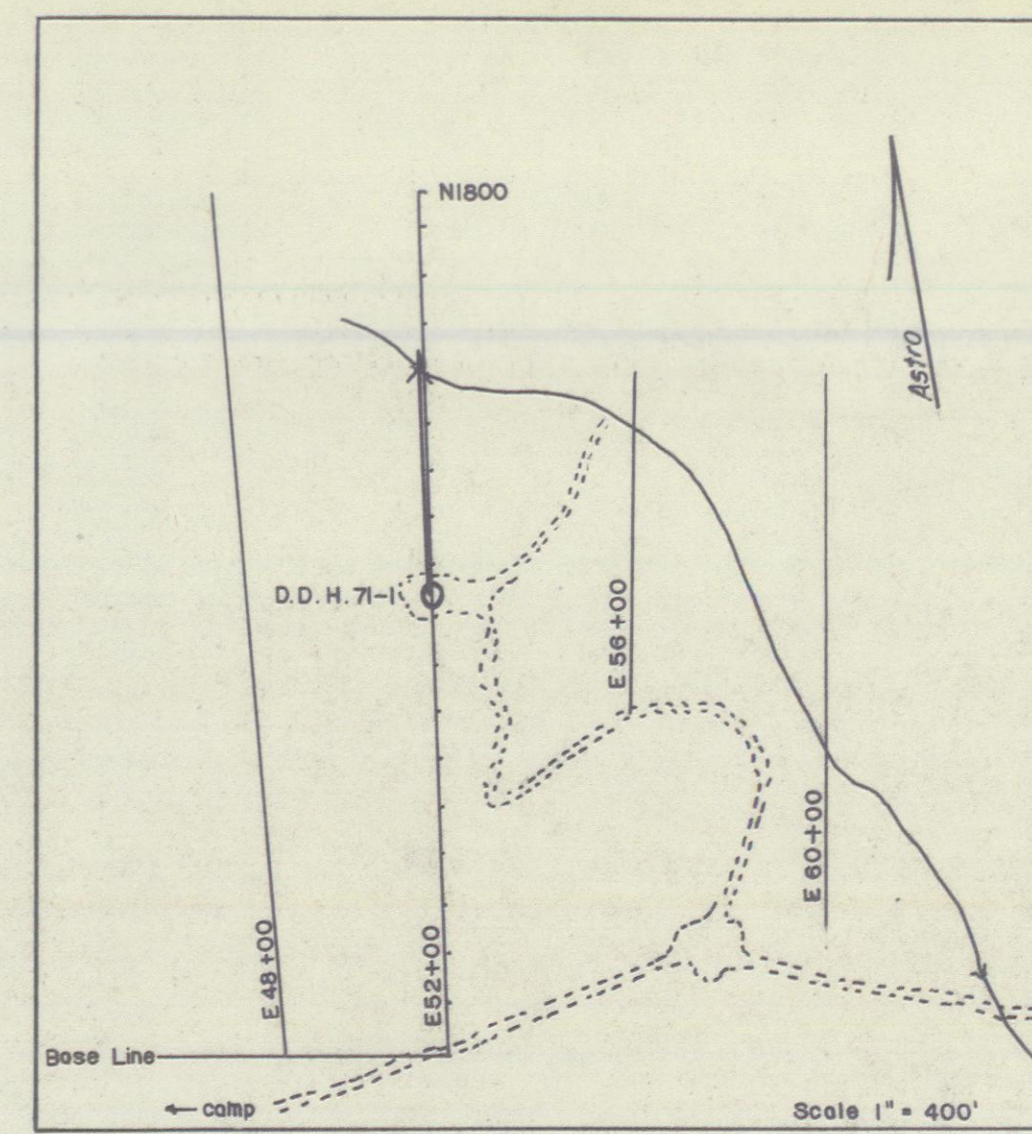
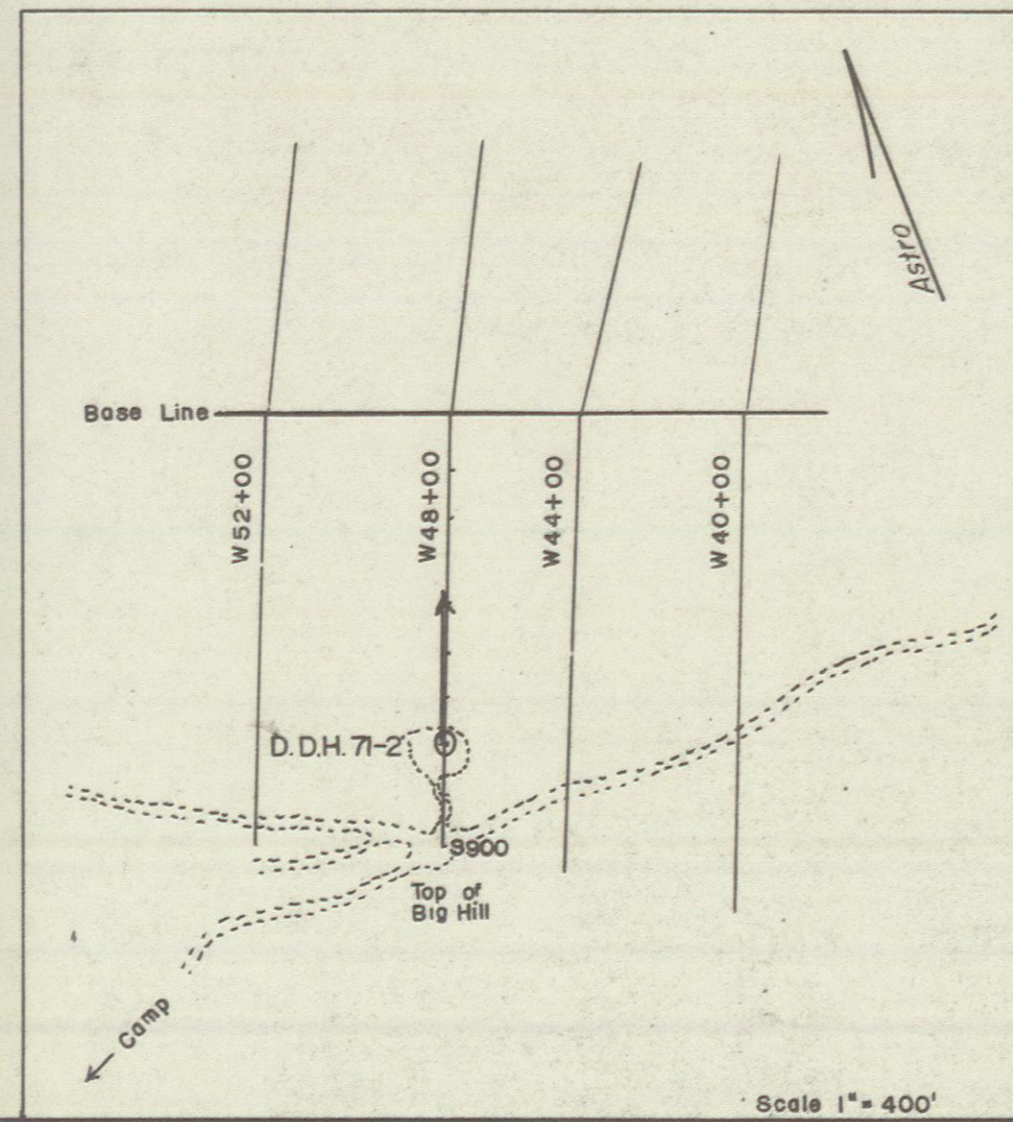
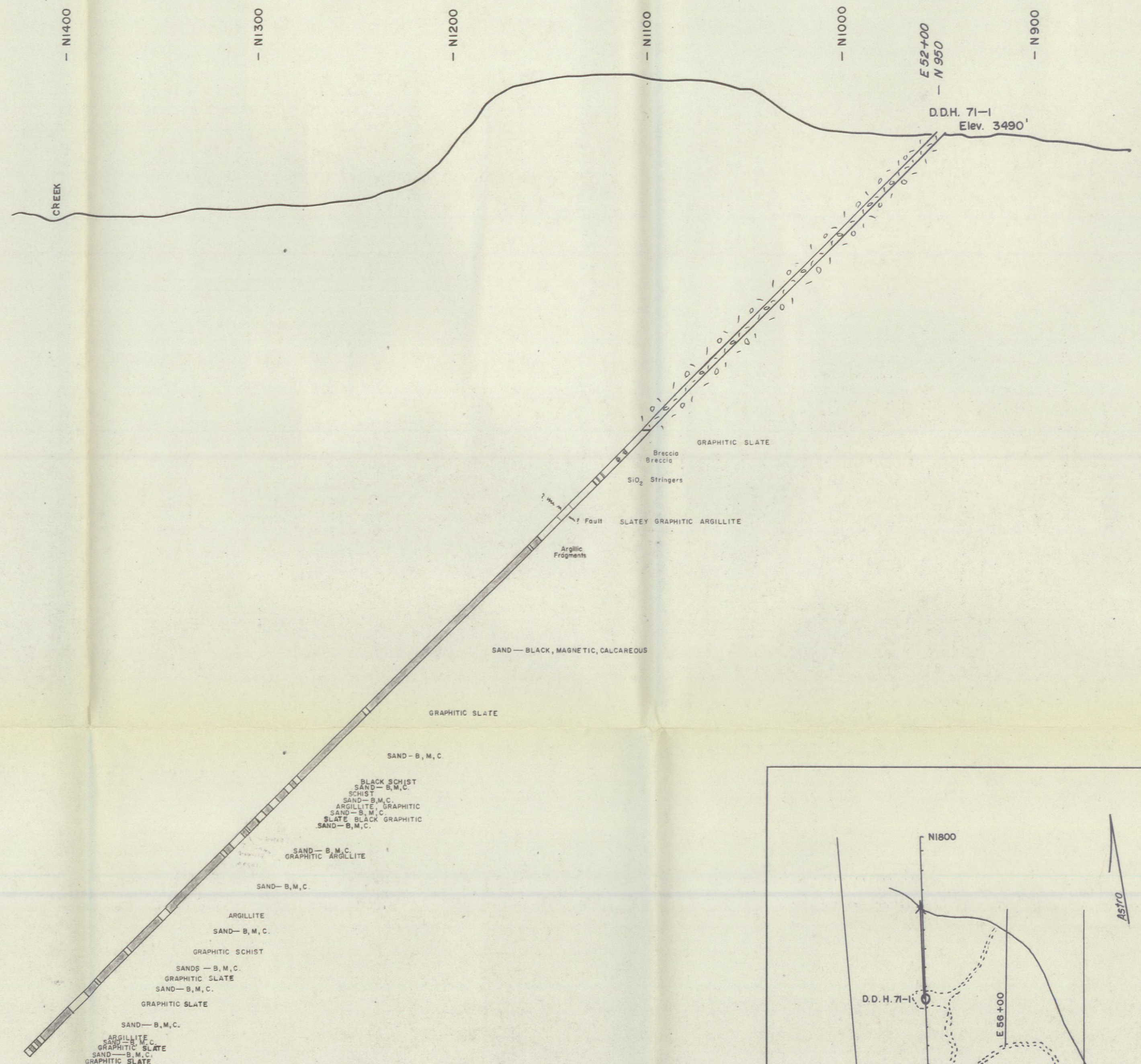
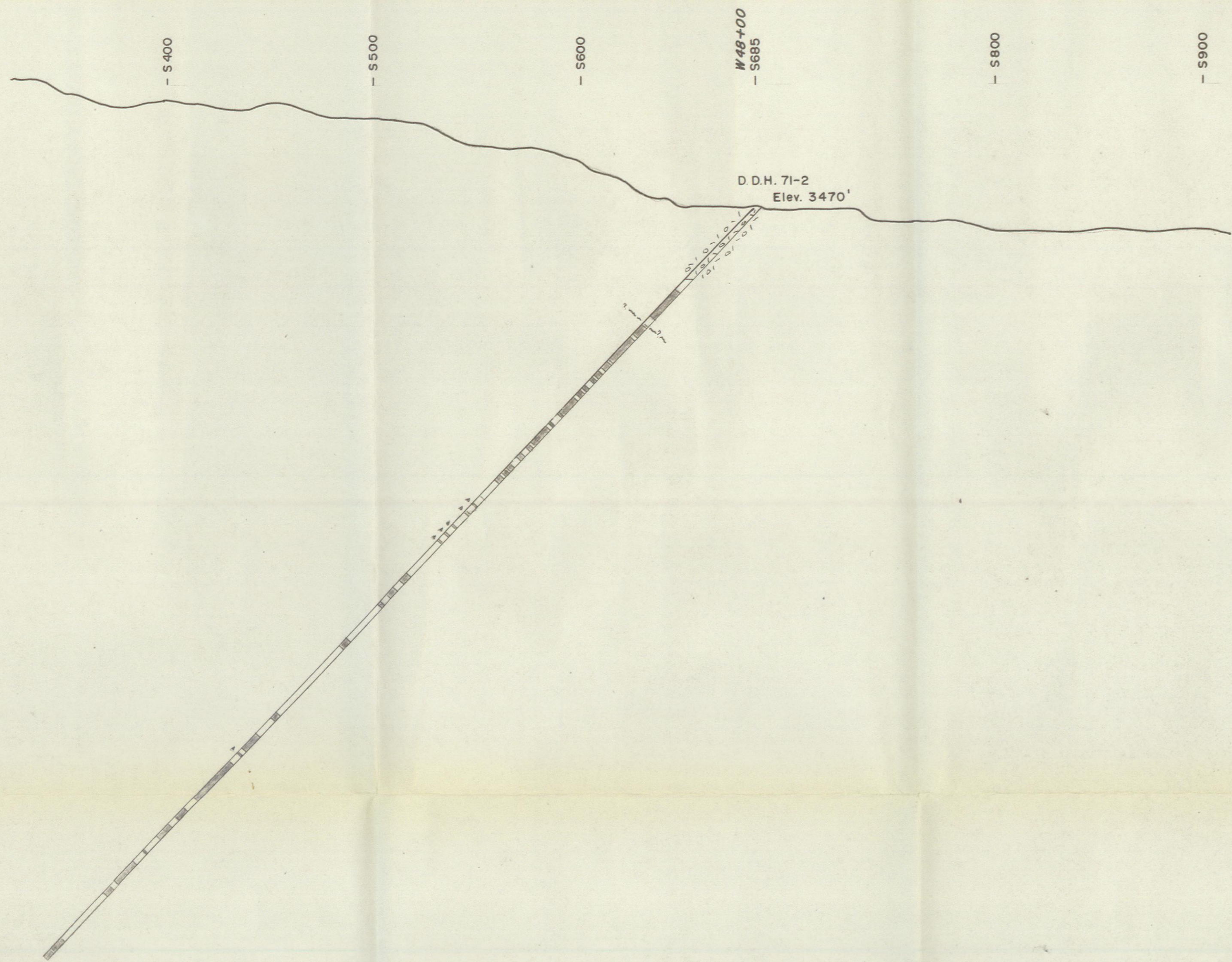
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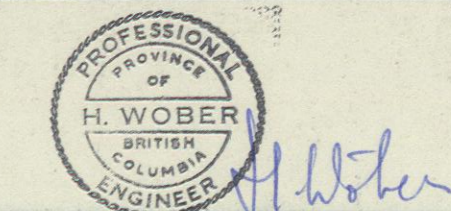
BOSWELL RIVER MINES LTD.	
MacDONALD CONSULTANTS LIMITED	
11 - 425 HOWE ST.	VANCOUVER 1, B.C.
SWIFT RIVER PROPERTY	
SCALE 1" = 200'	MAGNETOMETER SURVEY
DRAWN J.P.H.	
DATE JULY, 1971	
NUMBER 294 - 2 f	



<b>BOSWELL RIVER MINES LTD.</b>	
<b>MacDONALD CONSULTANTS LIMITED</b>	
11 — 425 HOWE ST.	VANCOUVER 1, B.C.
SWIFT RIVER AREA	
Upper Crescent Lake Road	
SCALE	1" = 100'
DRAWN	J. P. H.
DATE	AUG. 1971
NUMBER	294-2G
<b>TRENCHING AREA</b>	



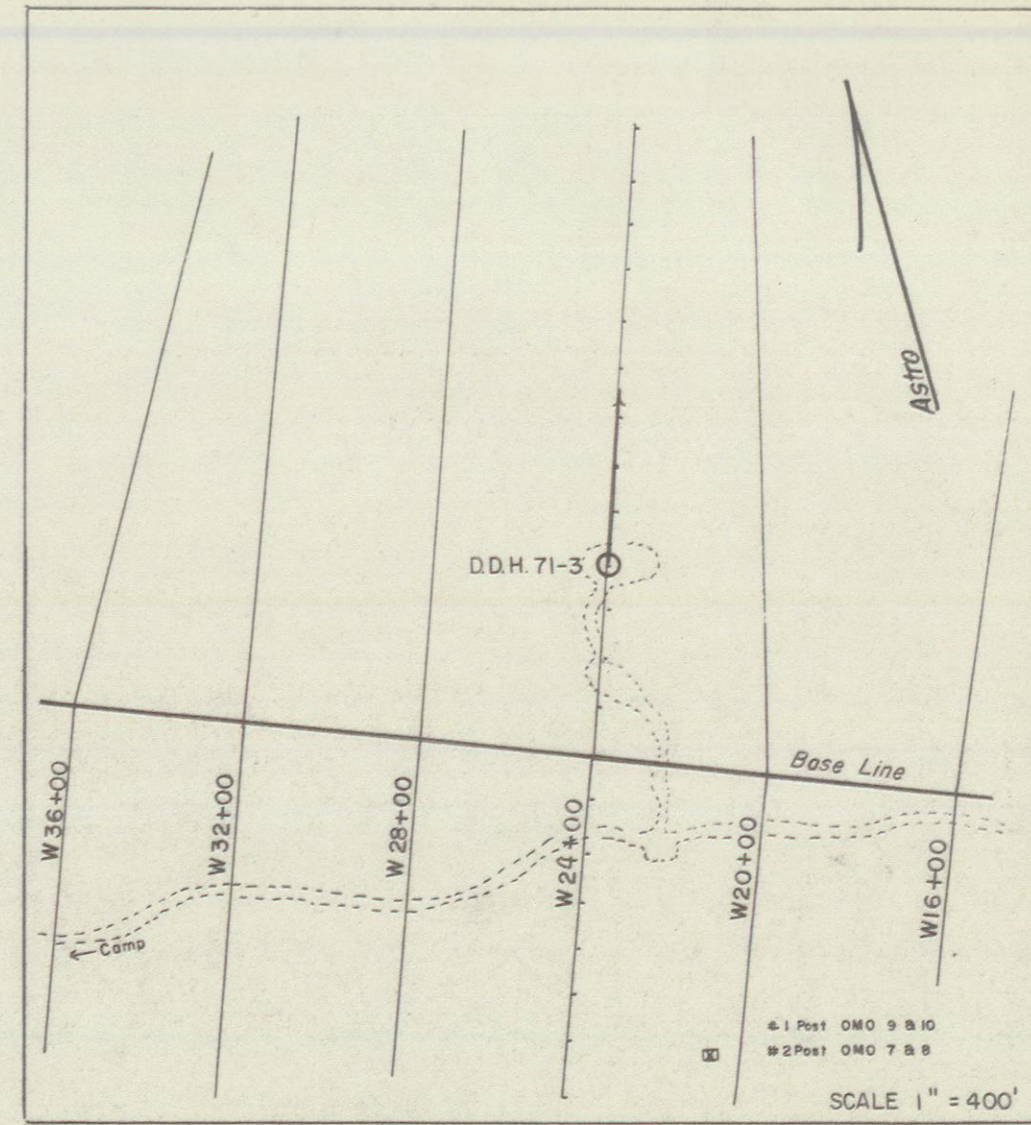
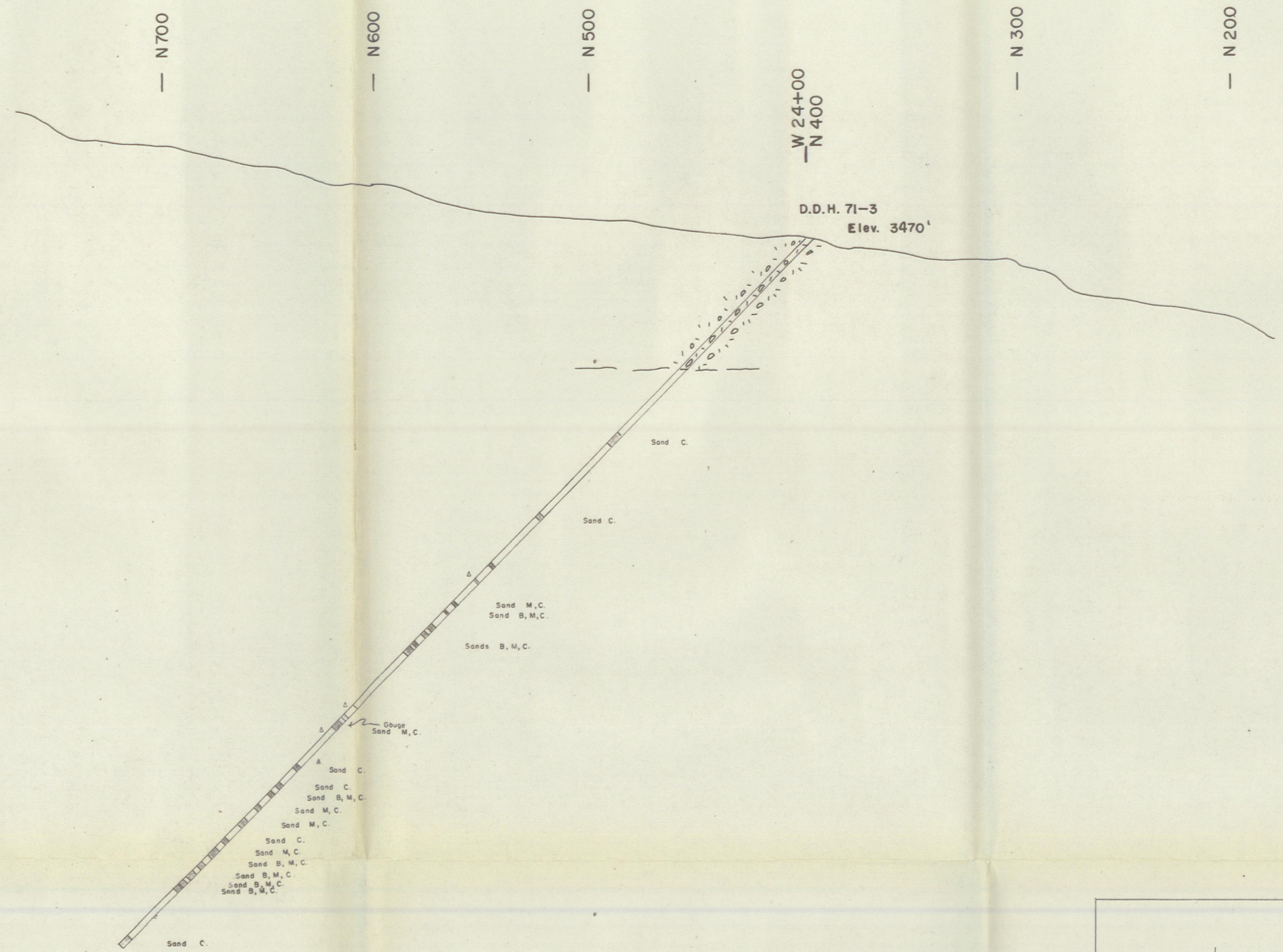
- LEGEND**
- OVERBURDEN
  - SAND-B,M,C. B. black, M. magnetic, C. calcareous
  - GRAPHITIC Schist, Slates, Argillites
  - DOLomite
  - BRECCIA



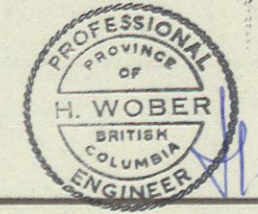
**BOSWELL RIVER MINES LTD. (N.P.L.)**  
**MacDONALD CONSULTANTS LIMITED**  
 11 - 425 HOWE ST. VANCOUVER 1, B.C.

**SWIFT RIVER PROPERTY**

SCALE	1" = 40'	Diamond Drill Holes # 71-1 & # 71-2
DRAWN	J. P. H.	
DATE	MARCH, 1971	
NUMBER	204-3A	

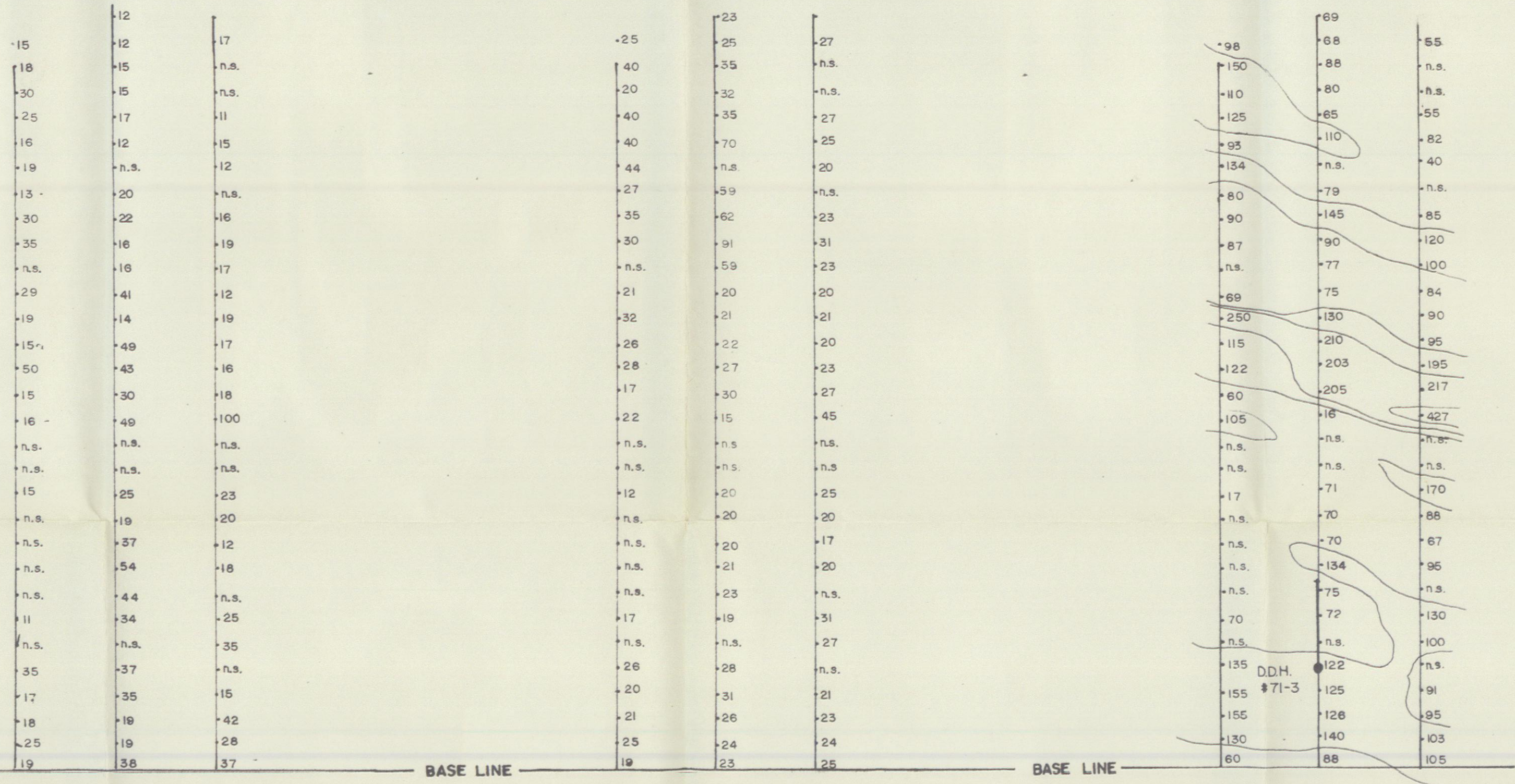


- LEGEND**
- OVERBURDEN
  - SAND B, M, C. B. black, M. magnetic, C. calcareous
  - GRAPHITIC schist, slates, argillites
  - DOLOMITE
  - BRECCIA



*H. Wober*  
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**MacDONALD CONSULTANTS LIMITED**  
 11 - 425 HOWE ST. VANCOUVER 1, B.C.

<b>SWIFT RIVER PROPERTY</b>	
SCALE 1" = 40'	Diamond Drill Hole # 71-3 & # 71-
DRAWN J. p.h.	
DATE May, 1971	
NUMBER 294-3 B	

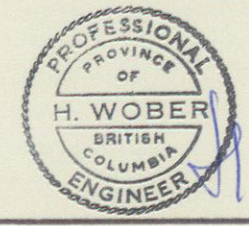


COPPER

LEAD

ZINC

LEGEND  
 0 — 100 PPM  
 101 — 200 PPM  
 201 — PPM



*H. Wober*

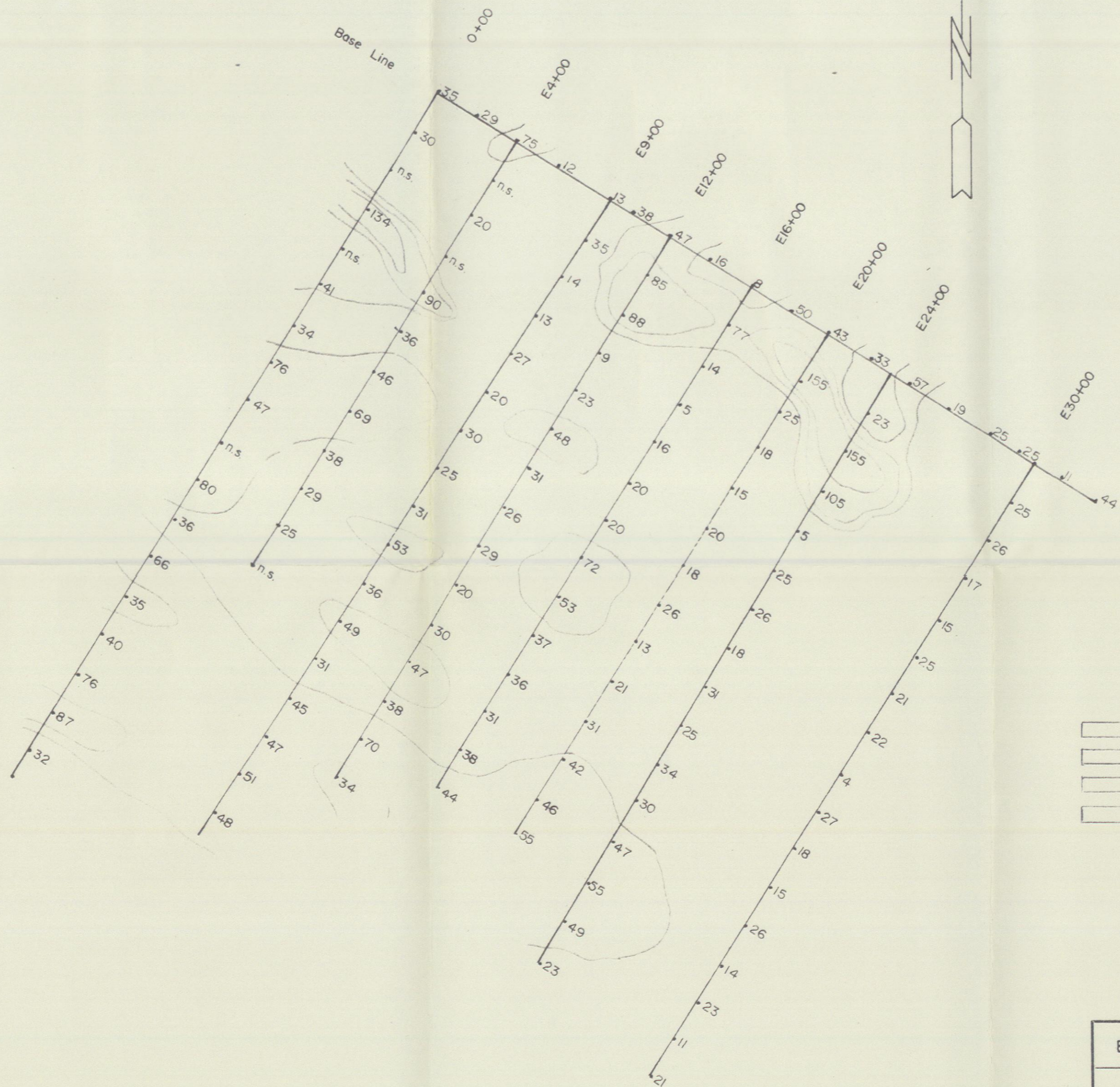
BOSWELL RIVER MINES LTD. (N.P.L.)

MacDONALD CONSULTANTS LIMITED  
 11 — 425 HOWE ST. VANCOUVER 1, B.C.

SWIFT RIVER PROPERTY

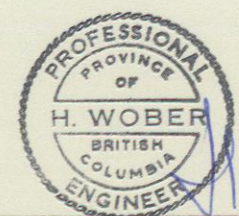
SCALE 1" = 400'  
 DRAWN J.P.H.  
 DATE AUG. 1971  
 NUMBER 294-3C

GEOCHEMICAL SURVEY  
 AREA OF  
 DDH.#71-3



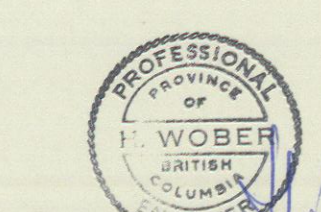
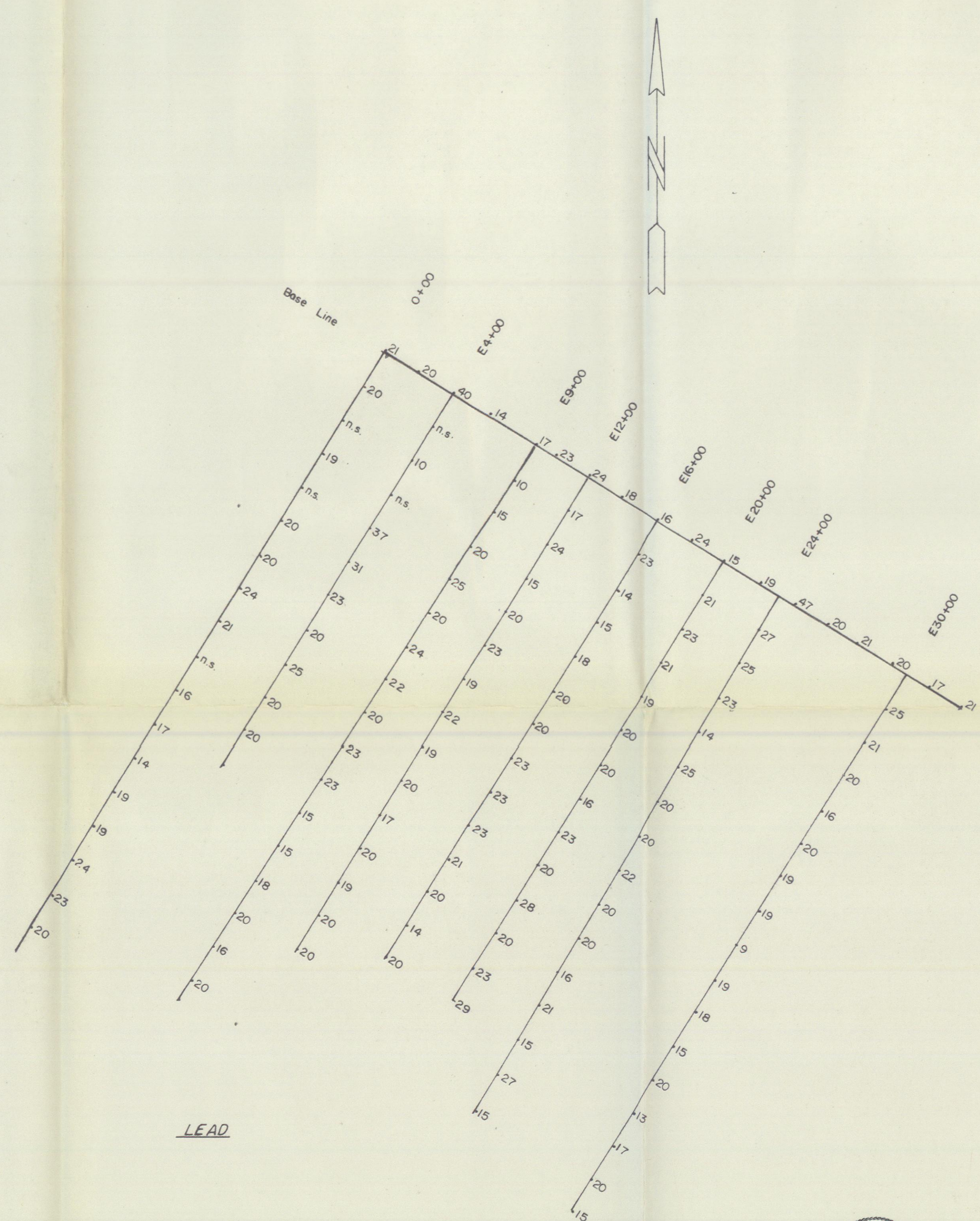
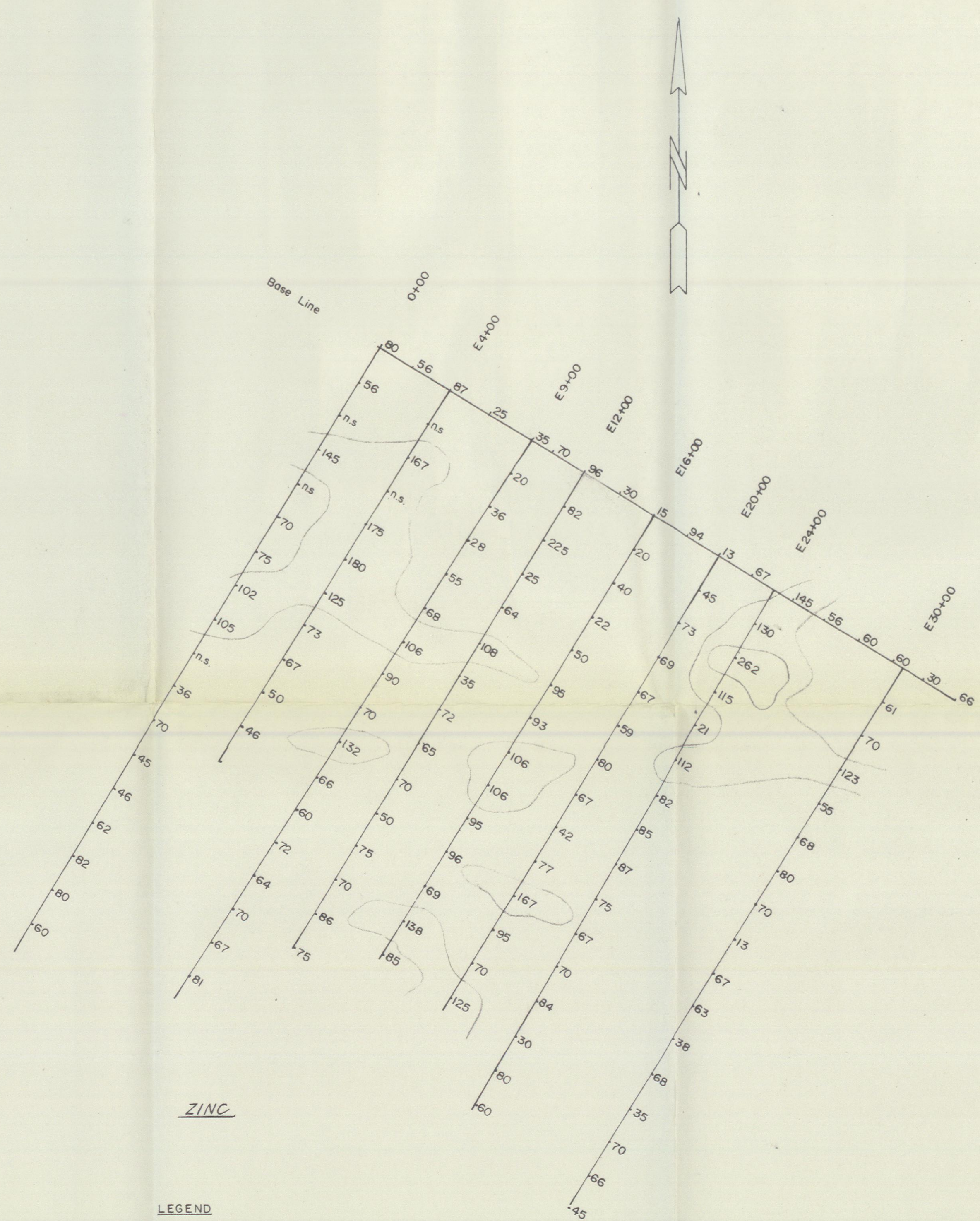
**LEGEND**

[Shaded Box]	0 — 40 P.P.M.
[Shaded Box]	41 — 80 P.P.M.
[Shaded Box]	81 — 120 P.P.M.
[Shaded Box]	121 — P.P.M.



*H. Wober*

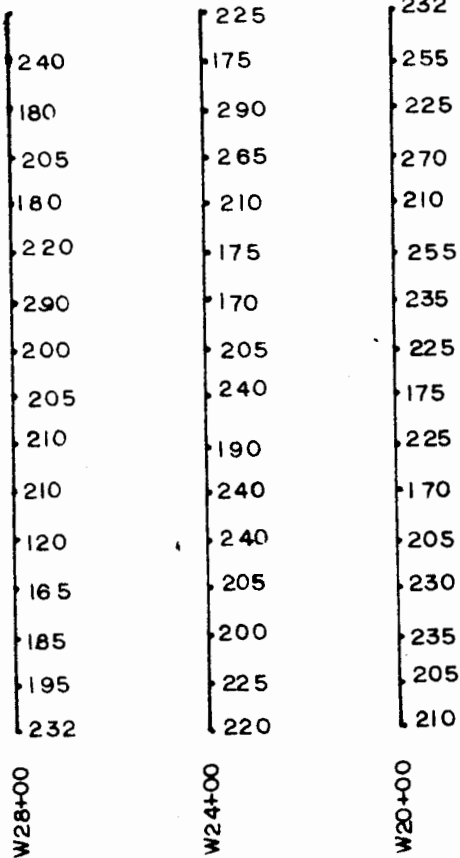
BOSWELL RIVER MINES LTD. (N.P.L.)	
MacDONALD CONSULTANTS LIMITED	
11 — 425 HOWE ST.	VANCOUVER 1, B.C.
SWIFT RIVER PROPERTY	
SCALE 1" = 400'	GEOCHEMICAL SURVEY COPPER SOUTH AREA
DRAWN J. P. H.	
DATE AUG. 1971	
NUMBER 294-3D	



BOSWELL RIVER MINES LTD. (N.P.L.)	
MacDONALD CONSULTANTS LIMITED 11 — 425 HOWE ST. VANCOUVER 1, B.C.	
SWIFT RIVER PROPERTY	
SCALE 1" = 400'	GEOCHEMICAL SURVEY ZINC & LEAD SOUTH AREA
DRAWN J. P. H.	
DATE AUG. 1971	
NUMBER 294-3E	

N3000

N1500



D.D.H. 71-3



*H. Wober*

**MacDonald Consultants Ltd.**

BOSWELL RIVER MINES (N.P.L.)

SCALE	1"=400'
DRAWN	J.P.H.
DATE	AUG. 71
NO.	294-3 <sup>F</sup>

MAGNETOMETER  
SURVEY  
EXTENSION  
AREA D.D.H. 71-3