GEOTECHNICAL INVESTIGATION

PROPOSED BRIDGE SITE

VERMILION CREEK, MILE 605.6

MACKENZIE HIGHWAY

E-2510

R.M.HARDY & ASSOCIATES LTD.

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OCTOBER 16, 1973

R.M.HARDY & ASSOCIATES LTD.

CONSULTING ENGINEERING & TESTING • GEOTECHNICAL DIVISION

File No. E-2510

October 16, 1973

Mr. F. E. Kimball, P.Eng.
Manager of Northern Roads Program,
Department of Public Works of Canada,
One Thornton Court,
Edmonton, Alberta.

Re: Geotechnical Investigation
Mackenzie Highway
Proposed Bridge Site, Vermilion Creek
Mile 605.6

Dear Mr. Kimball:

We are pleased to submit a report on the proposed bridge site at Vermilion Creek. As you are aware, the site for this bridge has been moved downstream approximately 2000 feet from the original location where our test holes were drilled. We do not believe that this change in the site will lead to radical changes in the soil conditions at creek level. However, the soil conditions in the approaches to the original and present sites are quite different.

Should you wish for any explanation or amplification of any part of this report we will be pleased to be at your service.

Respectfully submitted,

R. M. HARDY & ASSOCIATES LTD.,

Per:

G. McCormick, P.Eng.

GM/jc

INTRODUCTION

At the request of Mr. F. E. Kimball, P.Eng., Manager of Northern Roads Programme, Department of Public Works of Canada, Western Region, R. M. Hardy & Associates Ltd. undertook a geotechnical investigation along part of the proposed location of the Mackenzie Highway. This report deals only with that part of the investigation appertaining to the proposed bridge at Vermilion Creek.

The original location of this bridge site is shown on mosaic sheet No. 47 of a set of mosaics prepared by Department of Public Works for the Mackenzie Highway project. The site is covered by aerial photographs Nos. A22783-211, 212 and 213 (scale 1" = 1000'). This original crossing was located where the Canadian National Telecommunications right-of-way crosses the creek. Subsequent to drilling operations being completed in the field, the location of the bridge site was moved downstream a distance of approximately 2000 feet.

R. M. Hardy & Associates Ltd. have been provided with a sketch plan and profile showing the revised crossing. This drawing is entitled "Proposed Drainage Structure at Vermilion Creek" and is not dated. It was used as the basis for Plate 1, Appendix A.

A report entitled "Geotechnical Investigations, Mackenzie Highway, Mile 544 to Mile 635", has been previously submitted to the Department. The geotechnical conditions are discussed in Volume 1 while Volume II contains information on permafrost of a more general nature. We recommend that these volumes be read in conjunction with this report.

TOPOGRAPHY

The general direction of the drainage in the area is southwesterly towards the Mackenzie River. The valley sides of Vermilion Creek are relatively steep and rise at an average gradient of 8 percent on the northerly side and 5 percent on the southerly side. The vertical distance from high water level to the surrounding terrain is approximately 68 feet. The width of the creek at the water line is approximately 50 feet.

SOIL PROFILE

The soil profile in the area of the approaches consists mainly of glacial lake basin deposits overlying clay till. The valley walls of Vermilion Creek are covered with slopewash of shallow depth. The floor of the valley has been classed as alluvial meander flood plain. At the original crossing site, shale was encountered at shallow depths on the south side of the valley but was not encountered on the northerly side. We believe that, in the floor of the valley at the present site, shale will be encountered within 20 feet of the ground surface.

The glacial lake basin deposits of this area usually contain high water contents and considerable quantities of excess ice. The slopewash deposits are also generally of fine grained material with high ice contents. The underlying till and shale have low water contents with little or no visible ice being present.

Permafrost can be expected to considerable depth on either sides of the creek but is not expected to be present actually beneath the creek within the depths normally penetrated by piles.

DISCUSSION AND RECOMMENDATIONS

The effect of a stream on the permafrost profile is shown on Plate 2, Appendix A. This chart shows that the thaw bulb beneath a small creek can penetrate to considerable depth so that, for bridge building purposes, the presence of permafrost beneath the stream bed can be ignored. However, it should be noted that the permafrost profile beneath the sides of the stream bed plunges at an extremely steep angle.

As is well known, the flow of water in northern streams varies tremondously throughout the year. Very large flows can be experienced during the spring runoff. The bed of the stream is composed of a mixture of gravel silt and clay overlying clay till and shale. The depth of scour should therefore be limited. The amount of scour that should be expected will depend on the flow of water during the height of the spring runoff and the constriction imposed on the stream by the bridge structure.

Because of the nature of the soil in the approach area and the valley sides we do not believe it would be advisable to use concrete abutments or piers. Also, because of difficulties due to logistics, it will be highly desirable that onsite work be kept to a minimum. We therefore recommend the bridge abutments and any piers be supported on driven steel H piles. It is extremely unlikely that timber piles could be driven to the required depths at this site without damaging the timbers. Precast concrete piles should not be used due to difficulties of transportation and also because the length of precast pile would have to be determined in advance. Steel pipe piles are an alternative possibility. However, it is probable that they would not be able to withstand the driving stresses and preboring of holes would be necessary.

Steel H piles which are to be placed on the banks where they will not be affected by scour should be driven a minimum of 30 feet below existing grade and designed on the basis of an allowable skin friction of 400 psf (on the gross perimeter) with the top 10 feet of pile being assumed to carry no load.

Steel H piles driven in the stream bed should be driven a minimum distance of 20 feet below the bottom of anticipated scour and should be designed on the basis of the "Table of Penetration Resistance" following. Design parameters are summarized on Plate 3, Appendix A. If bedrock is encountered within the depths specified, the piles should be driven 10 feet into it.

Driving steel H piles will require considerable energy. The weight of the pile driving hammer should be at least twice the weight of the pile being driven. If a diesel hammer is used the weight of the hammer should be at least equal to the weight of the pile. To prevent damage to the points of the pile they should be reinforced with flange plates for a distance equal to 1.5 times the size of the pile. Alternatively, the point can be reinforced with the driving shoe. Piles should be driven to practical refusal or refusal according to the following table of penetration resistances assuming that the hammer delivers an energy of 15,000 ft. pounds per blow.

TABLE OF PENETRATION RESISTANCE

Description	Inches Per Blow
refusal	.00-.05
practical refusal	.05-.25
high resistance	.25-.50
medium resistance	.50-1.25

In order to ensure that refusal has been reached, driving should be continued for at least 100 blows after refusal is first recorded.

Piles driven in the stream bed to refusal, as defined above, may be designed for the full structural strength of the pile section acting as a column. A design load will depend upon the allowable stresses in the pile, the column length and the arrangement of lateral bracing. Piles driven to practical refusal, as defined above, should be designed for two-thirds of the value permitted for the pile as a structural column. Consideration should be given to using battered piles on the outside of the pile bents in order to provide increased lateral resistance.

If a drop hammer is used in driving the piles, care should be taken that the energy delivered to the piles is not greater than 50,000 ft. pounds per blow unless calculations show that the pile can safely take higher impact stresses.

It is probable that bedrock will be encountered by the piles driven in the stream bed. If possible, the depth of embedment in the bedrock should be 10 feet. The bedrock will shatter to some extent under driving with some consequent deterioration of the material. However, we believe that piles driven into the bedrock would be capable of developing the full structural strength of the steel section.

One of the problems facing the bridge is the possibility of log jams occurring which can cause partial or complete failure of the structure. Log jams are only likely to occur where trees travelling down the river have a greater length than the clear span of the bridge. We suggest that the height of trees growing adjacent to Vermilion Creek upstream of the bridge site should be checked, and should it be observed that there is a possibility of large trees being washed downstream, such facts should be borne in mind by the bridge designer.

If piles are used to support a vertical face of embankment fill, the lateral force against the pile can be computed by assuming the backfill to be a fluid with a density of 60 pounds per cubic foot where the backfill is not compacted.

Embankments constructed below the highest expected flood level should be protected with riprap. As suitable rock may not be available, sandbags filled with concrete may have to be used.

Respectfully submitted,

R. M. HARDY & ASSOCIATES LTD.,

Per:

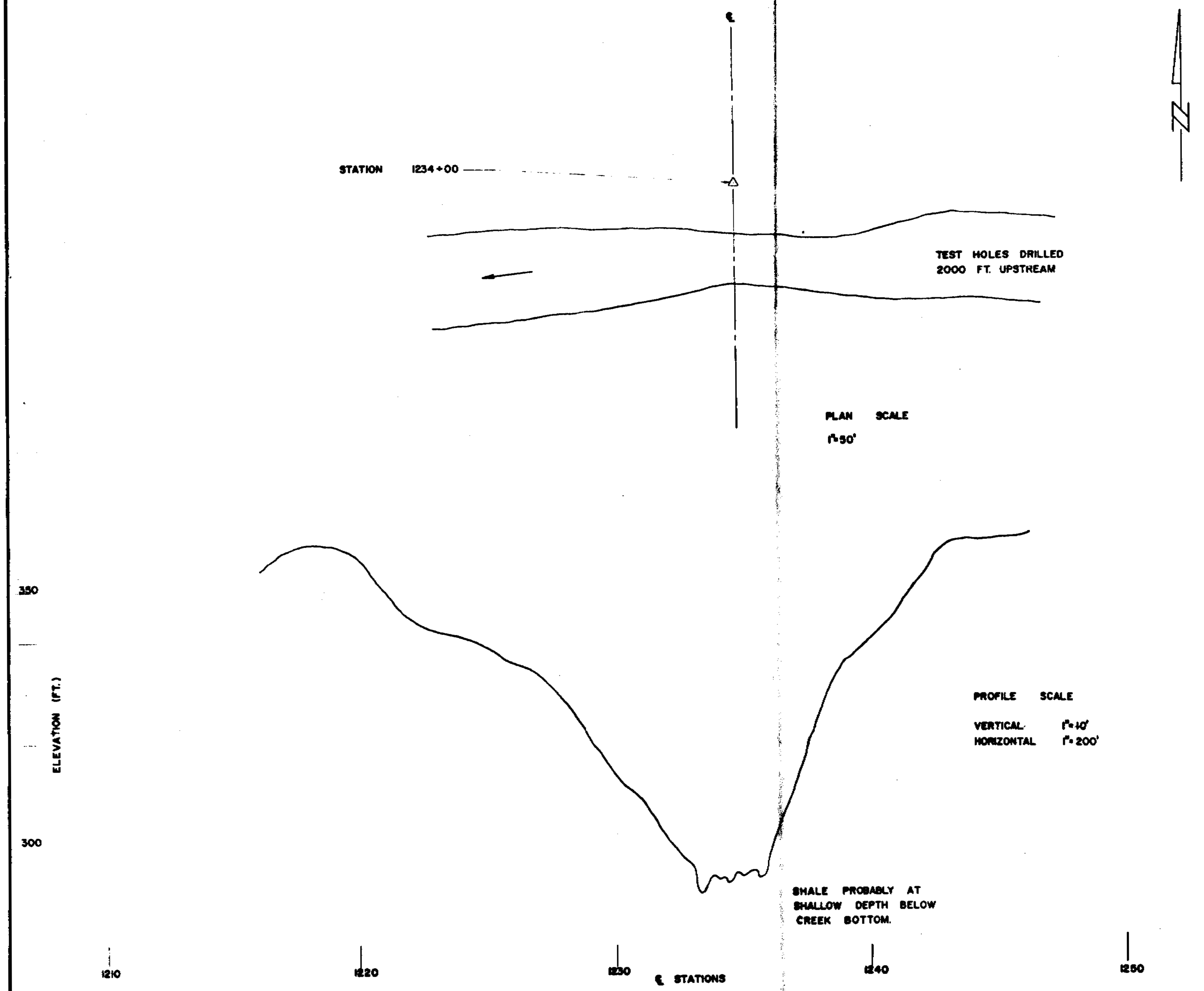
G. McCormick, P.Eng.

GM/jc

THE ASSOC[illegible] OF PROFESS[illegible] OF A[illegible]
PE[illegible]
P [illegible]
R. M. H[illegible] AND ASSOC[illegible] LTD.

APPENDIX A

Section
Chart



NOTE

THIS DRAWING HAS BEEN REDUCED TO 50 % SIZE

No.	REVISION	DATE	BY

D.P.W. DWG "PROPOSED DRAINAGE STRUCTURE AT VERMILION CREEK"

REFERENCES

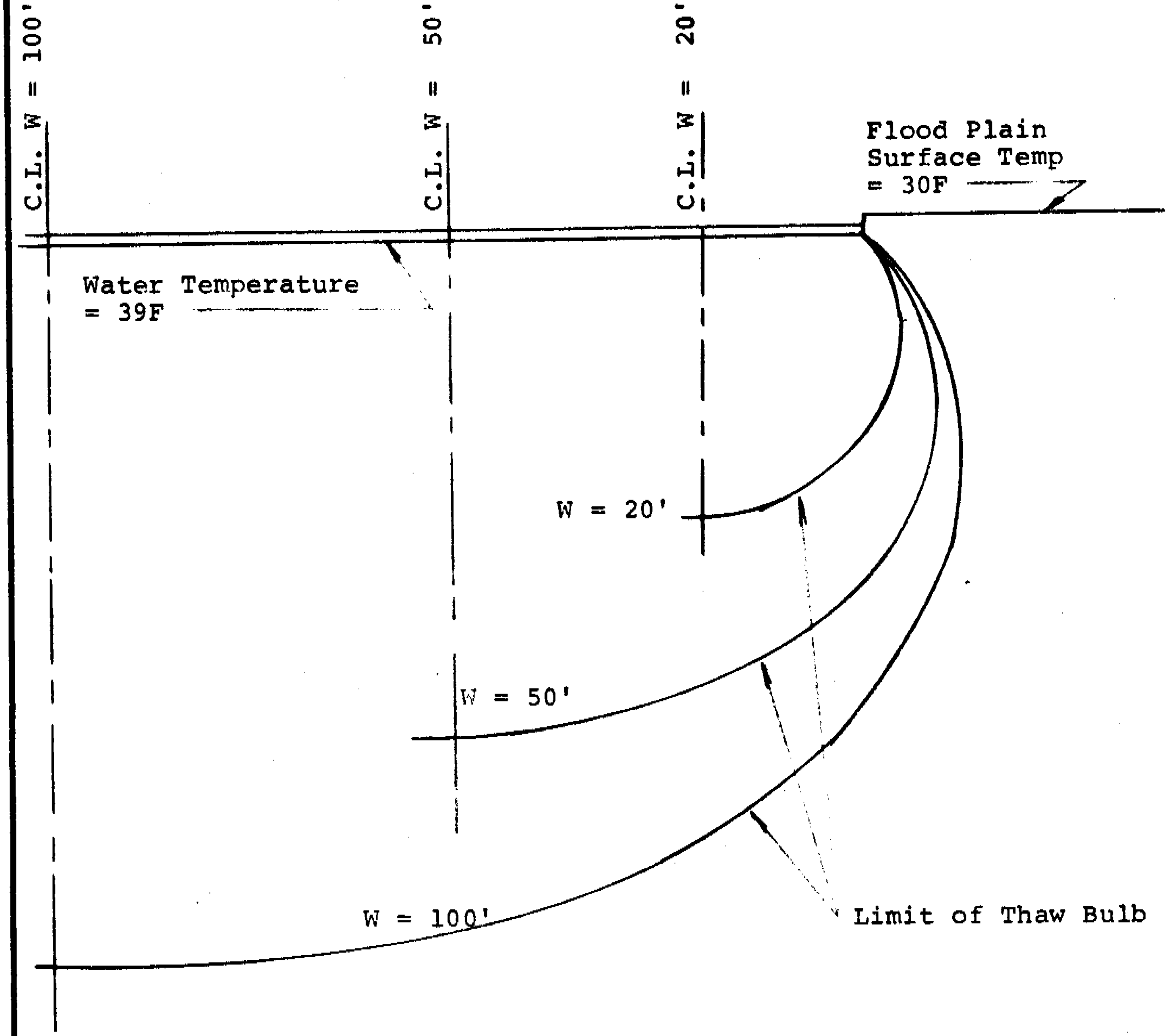
R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

DEPARTMENT OF PUBLIC WORKS
MAKENZIE HIGHWAY
VERMILION CREEK

SCALE SHOWN DATE OCT. 9 '73 MADE R. V. S. CHKD G. Mc. APPD.

No. E 2510 - 103 REV 0

PLATE 1



Scale: 1" = 10'

W = River Width
C.L. = Center Line

G.Mc September 14/73 E-2510

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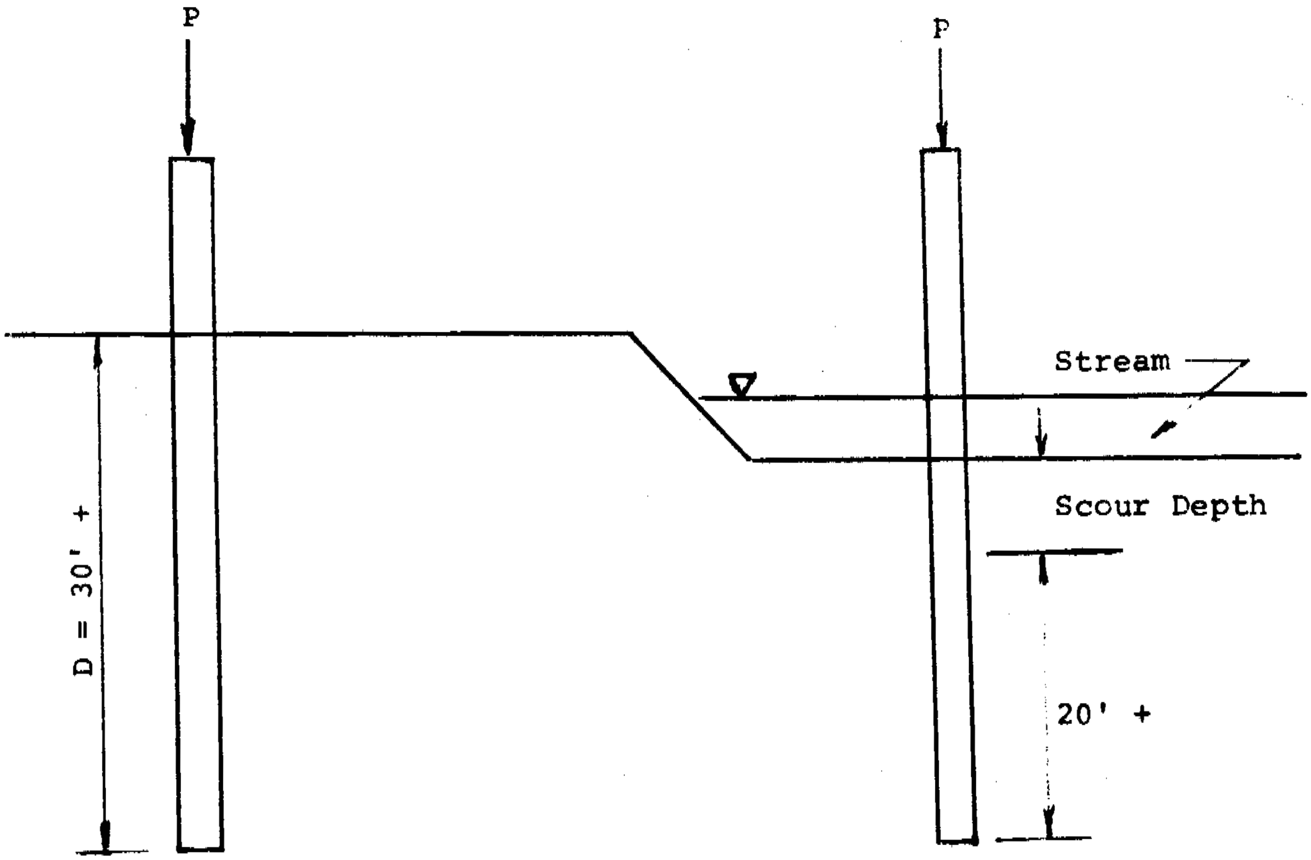
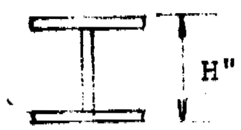
THAW BULBS BENEATH RIVERS
NORMAN WELLS AREA





Gross Perimeter = $\frac{4H}{12} = \frac{H}{3}$ ft.

Piles on dry land to be designed on the basis of an allowable shaft friction over effective length of embedment of D-10 with D minimum = 30 ft.

Piles in stream bed to be driven to 20+ feet below scour depth and designed on the basis of penetration values (see text).

R.M. HARDY & ASSOCIATES LTD.
CONSULTING ENGINEERING & TESTING

MACKENZIE HIGHWAY
BRIDGE PILES
NORMAN WELLS AREA

SCALE	DATE	MADE G.Mc	CHKD.	JOB: E2510	PLATE