GR-05-039

GEOTECHNICAL INVESTIGATION

PROPOSED RIVER CROSSING STRUCTURE

UPPER NORTH KLONDIKE RIVER

MILE ~~47.8~~ 48.8, DEMPSTER HIGHWAY Km 78.5

E-3098 August 26, 1975

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

R.M.HARDY & ASSOCIATES LTD.

GEOTECHNICAL INVESTIGATION

PROPOSED RIVER CROSSING STRUCTURE

UPPER NORTH KLONDIKE RIVER

MILE ~~47.8~~ 48.8, DEMPSTER HIGHWAY Km 78.5

E-3098 August 26, 1975

REC'D
DEC. 24/76

3950
3960
3950
STREAM
3970
52
54
56
58
3960
3970
3980
3990
94
KLONDIKE HWY.
E.C. 2522+83
SOILS LOG?
3960
T.H. 69-485
℄ NEW ALIGNMENT
INUVIK
2527
64
66
68
3970
72
T.H. 1-74
T.H. 2-74
66
3980
℄ EXISTING ROAD
3980
3980
68
3970

Department of Public Works
Ministere des Travaux publics

WHITEHORSE, YUKON

LEGEND

(bench mark symbol) . . . . BENCH MARK
(test hole symbol) . . . . TEST HOLE
(shaded area) . . . . EDGE OF WATER
T.D. . . . . .TOP OF DYKE

A detail no.	detail no.
B location drawing no.	sur dessin no.
C drawing no.	dessin no.

A
B C

revisions date

CULVERT SPECIFICATIONS

CULVERT		
LENGTH		
DIAMETER		
GAUGE		
℄ LOCATION		
SKEW ANGLE		
INVERT ELEV.		
INLET		
OUTLET		
SLOPE		

COMPILED FROM UPPER NORTH KLONDIKE RIVER
SURVEY BOOK (1975)
SURVEYOR - B. McKAMEY
B.M. #43 ELEV. 4014.49
2' X 3' BOULDER
242' RT. STA. 2522 + 18.41

NOTE:
B.M. #43 RESURVEYED AUG. 1975. ELEVATION CHANGED TO 4014.49 FROM 4012.82 (SURVEYED 1968). THEREFORE ELEVATIONS IN McNALLY BOOK, 1968, WERE RAISED BY 1.67 FEET.

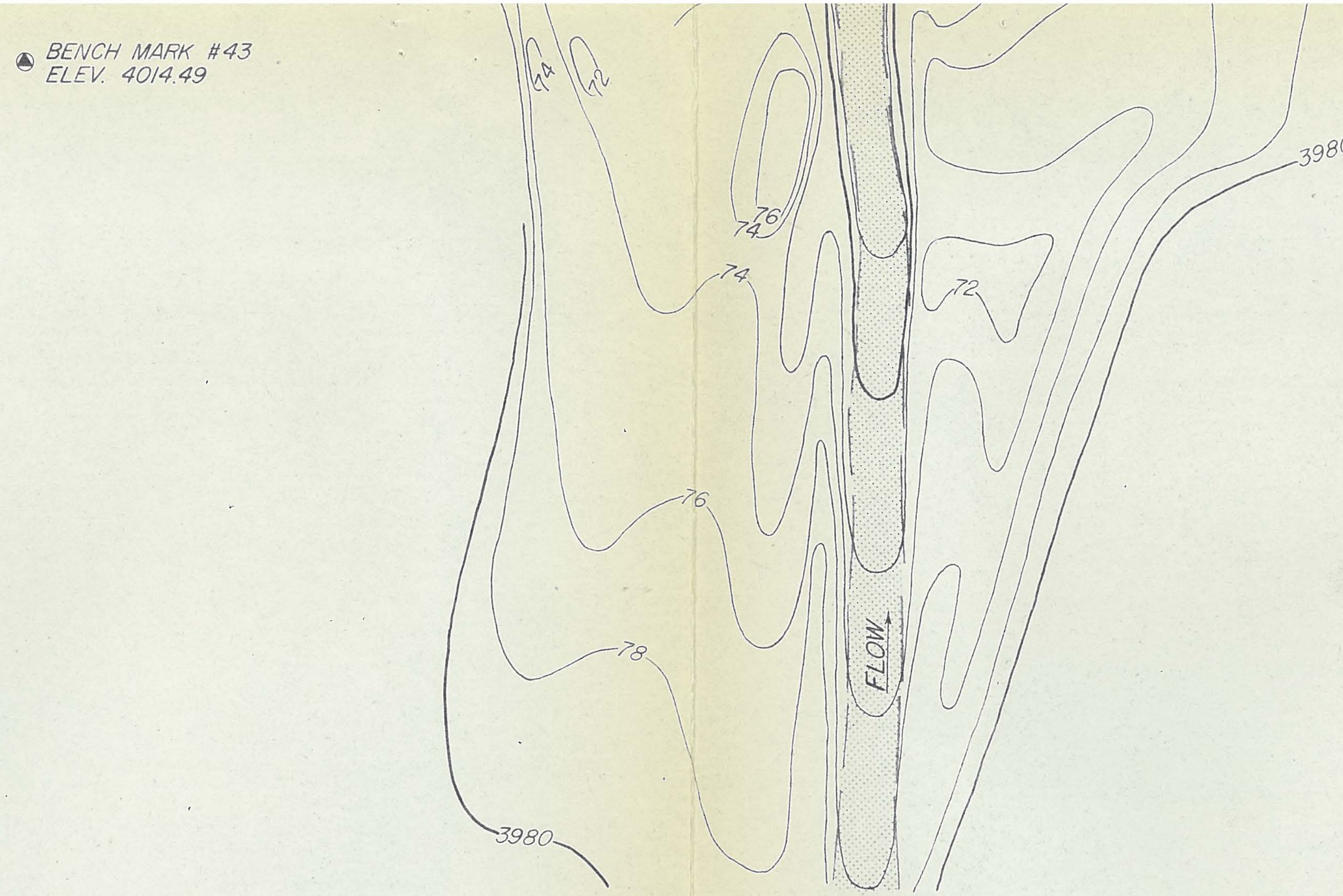
REC'D. DEC. 24/76

project title / titre du projet
RECONSTRUCTION
DEMPSTER HIGHWAY
MILE 25.0 - 53.0

drawing title / titre du dessin
SITE PLAN
UPPER NORTH
KLONDIKE RIVER
MILE 48.8

designed by		conçu par
date		
drawn by	S. GRIFFIN	dessiné par
date	OCT. 1976	
reviewed by	W. BROWN	examiné par
date	OCT. 1976	
approved by	J. QUONG	approuvé par
date	OCT. 1976	
Tender		Soumission
D.P.W. Project Manager		Administrateur de projets M.T.P.
project number		no. du projet
drawing no.		dessin no.

UPPER N KLONDIKE



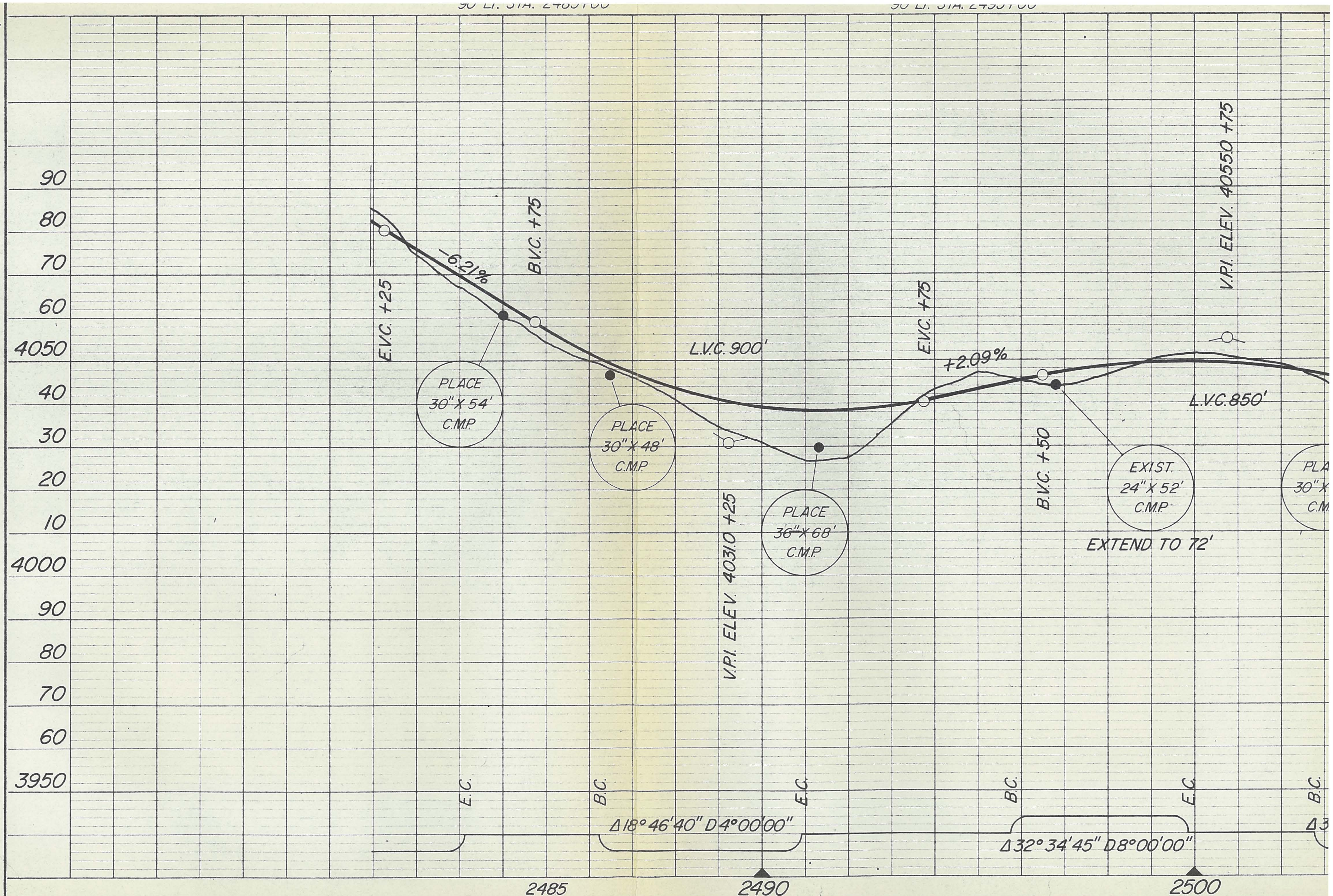
SITE PLAN

SCALE: 1"=50'

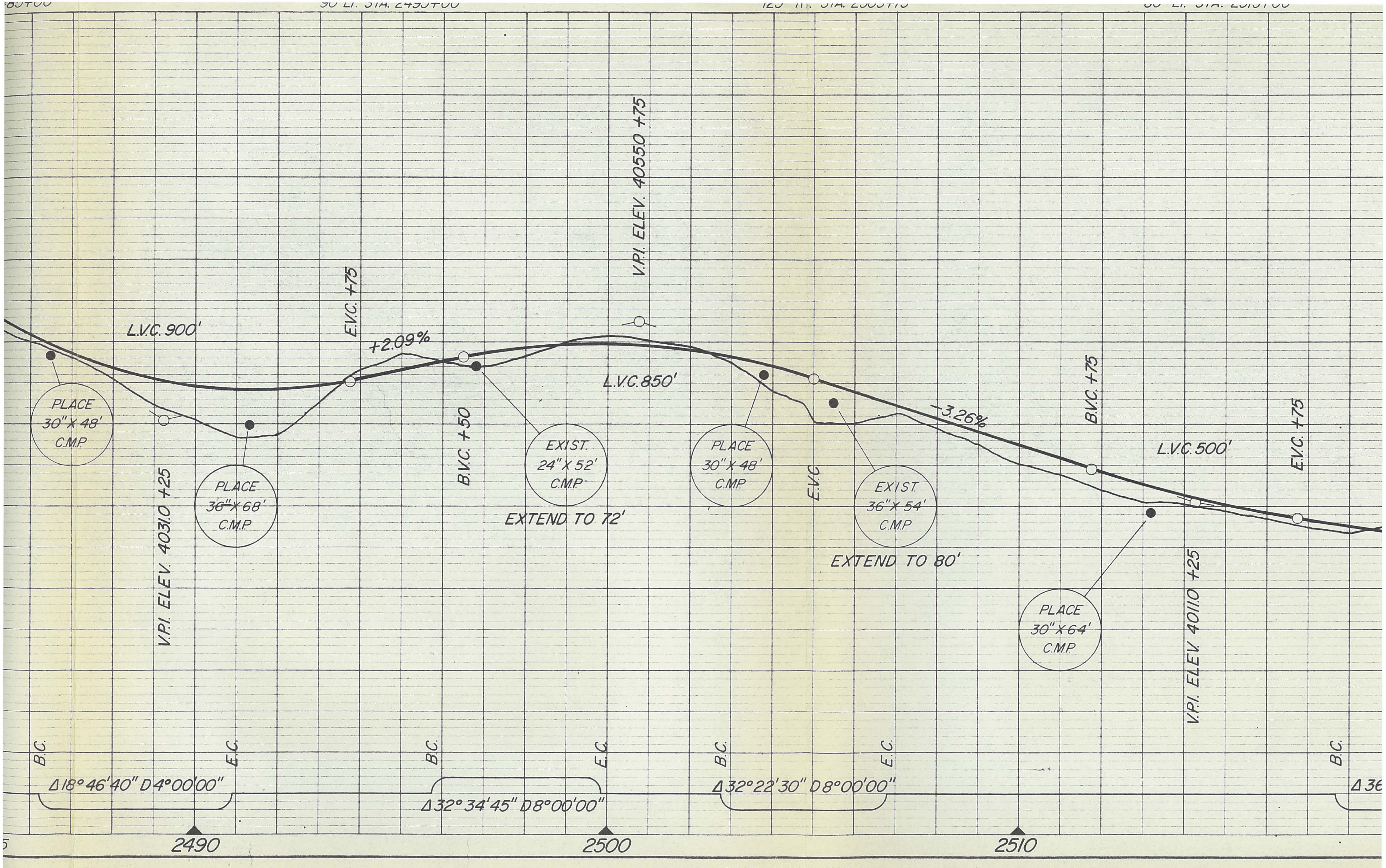
CONTOUR INTERVAL: 2'-0"

PROFILE	BY	DATE
SURVEYED	R. CURIAL & B. McKAMEY	1975
PLOTTED	TECH. SERVICES	1975/76
GRADES CHECKED	P. KNYSH	1976
B. M.'s NOTED	TECH. SERVICES	1975/76
STRUCTURE NOTATIONS CHECKED	P. KNYSH	1976

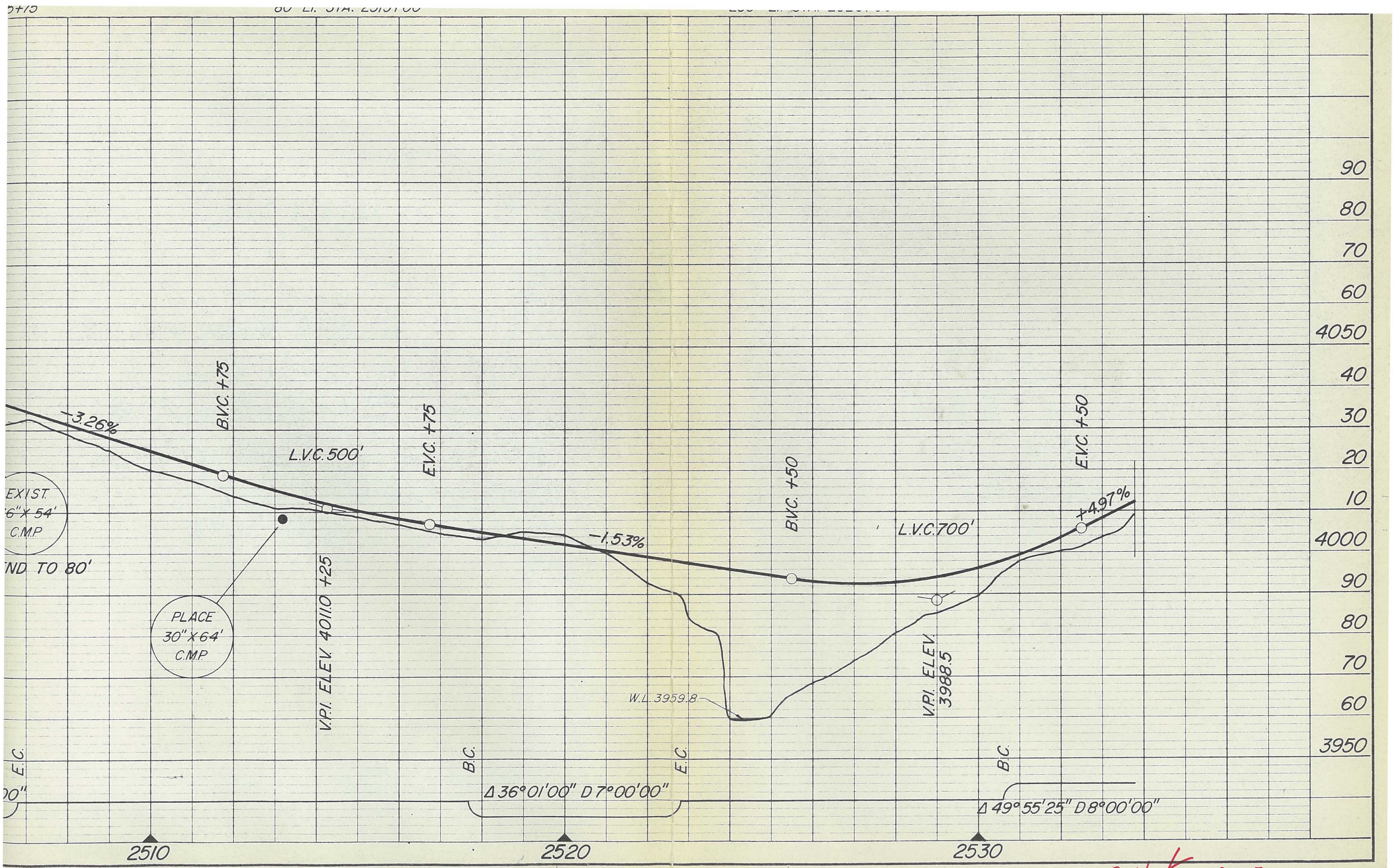
NOTE BOOK No.



K+E



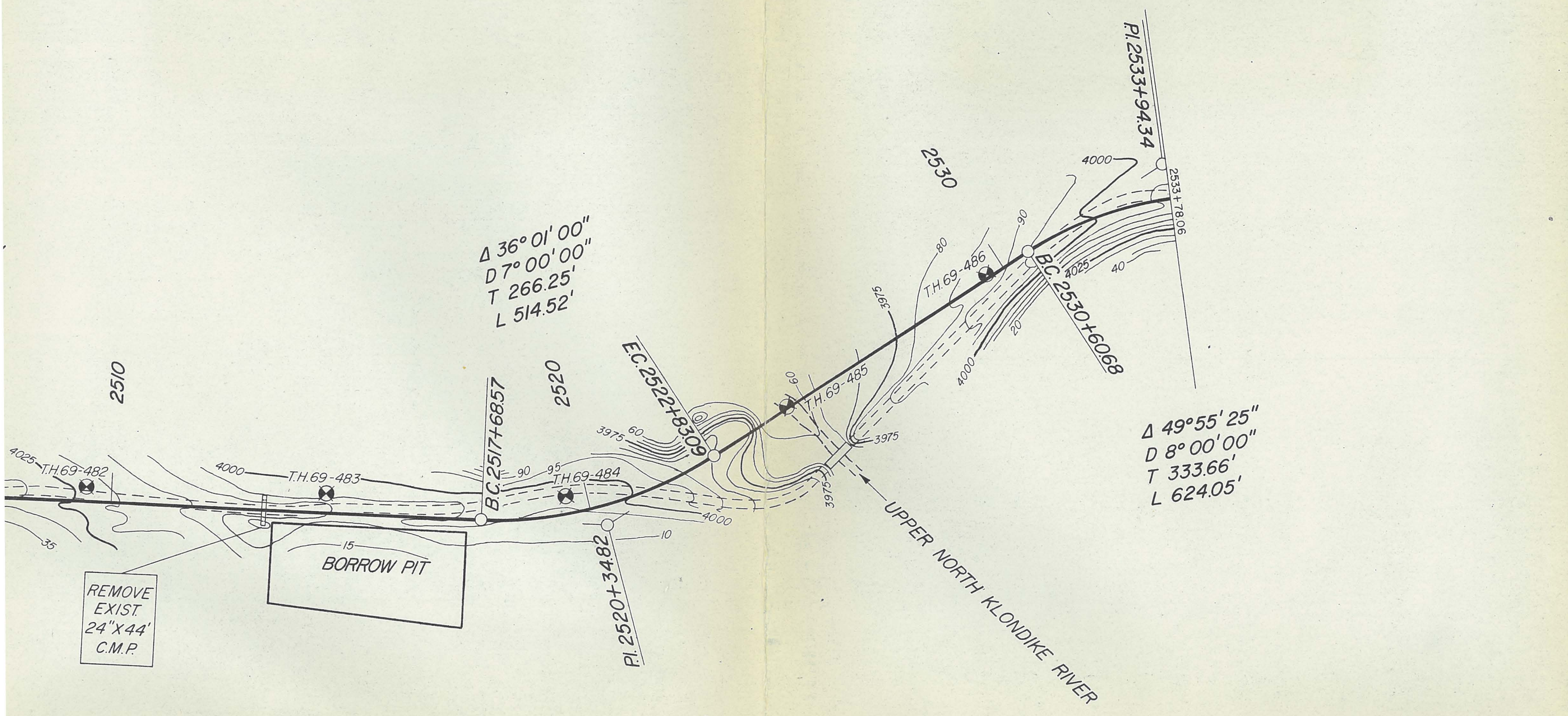
L.V.C. 900'
E.V.C. +75
+2.09%
V.P.I. ELEV. 4055.0 +75
L.V.C. 850'
-3.26%
B.V.C. +75
L.V.C. 500'
E.V.C. +75
PLACE 30" X 48' C.M.P.
V.P.I. ELEV. 4031.0 +25
PLACE 36" X 68' C.M.P.
B.V.C. +50
EXIST. 24" X 52' C.M.P.
EXTEND TO 72'
PLACE 30" X 48' C.M.P.
E.V.C.
EXIST. 36" X 54' C.M.P.
EXTEND TO 80'
PLACE 30" X 64' C.M.P.
V.P.I. ELEV. 4011.0 +25
B.C.
E.C.
B.C.
E.C.
B.C.
E.C.
B.C.
Δ18° 46' 40" D4°00'00"
Δ32° 34' 45" D8°00'00"
Δ32° 22' 30" D8°00'00"
Δ36
2490
2500
2510



UPPER N. KLONDIKE

DRAWING NO.	VERT. SCALE	HORIZ. SCALE	SHEET NO.	TOTAL SHEETS
7102-3	1" = 20'	1" = 200'	24	

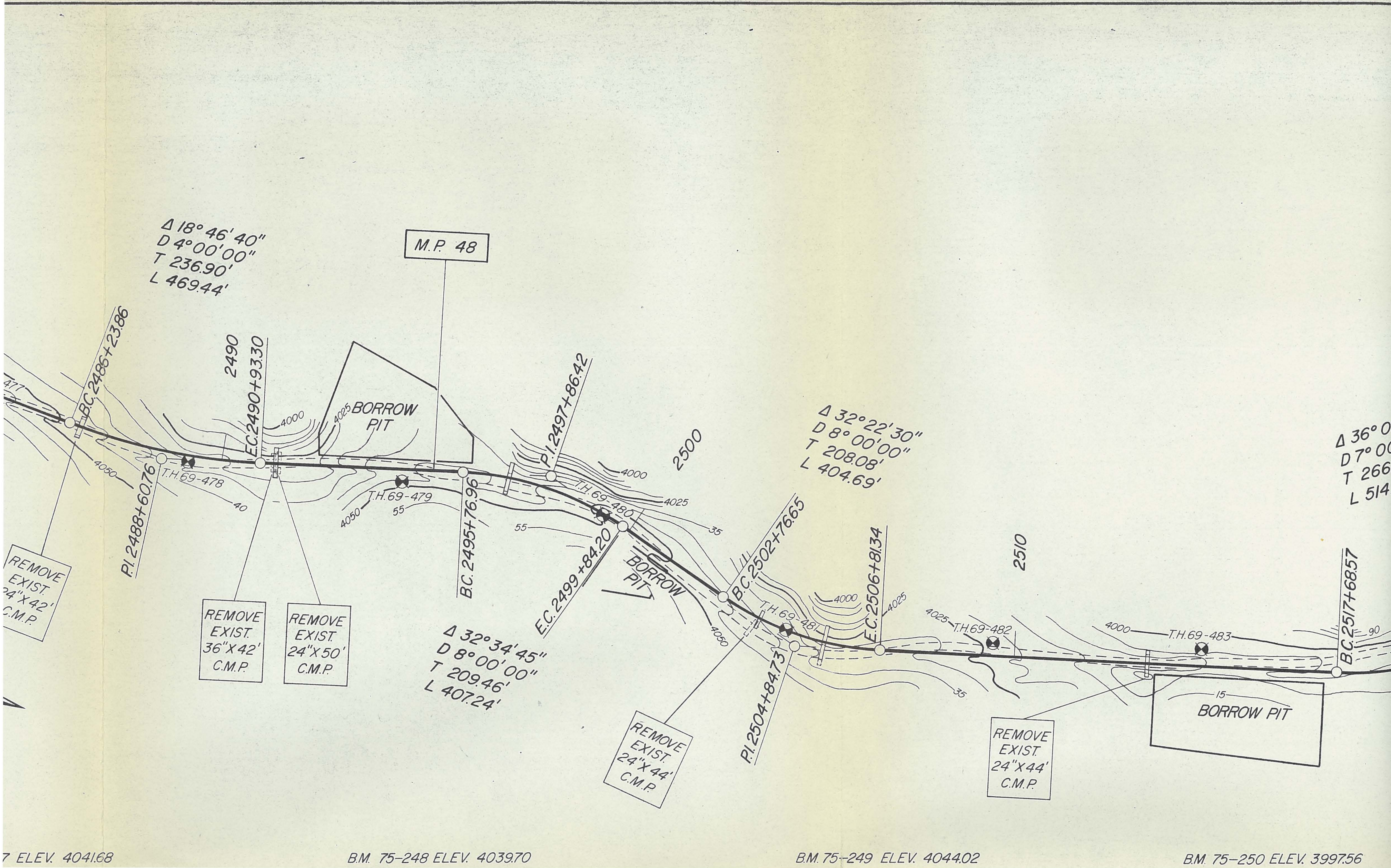
Rec'd. Dec. 24/76



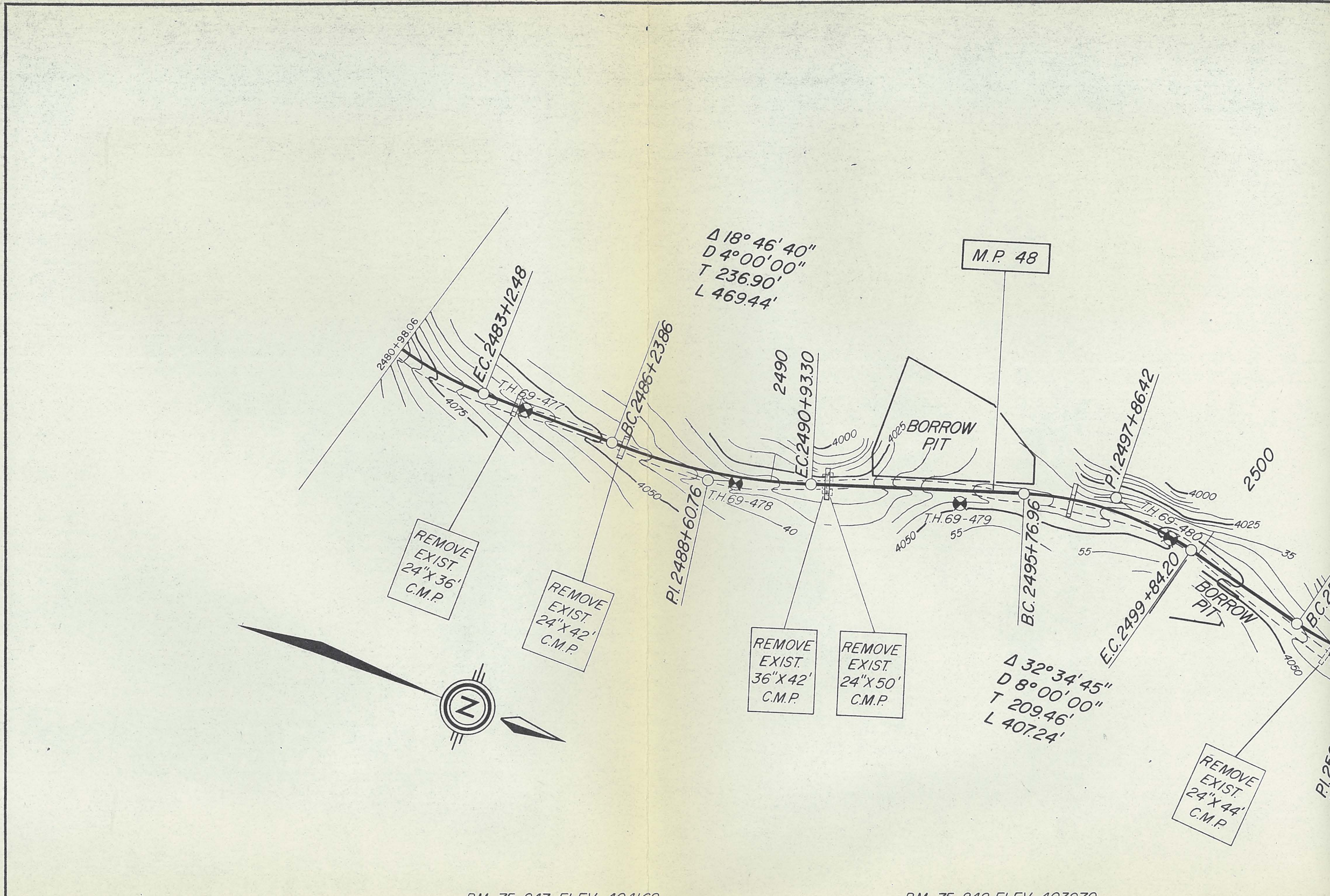
4044.02

B.M. 75-250 ELEV. 3997.56

B.M. 75-251 ELEV. 3974.88


Δ 18° 46' 40"
D 4°00'00"
T 236.90'
L 469.44'
M.P. 48
B.C. 2486+23.86
2490
E.C. 2490+93.30
BORROW PIT
P.I. 2497+86.42
2500
Δ 32°22'30"
D 8°00'00"
T 208.08'
L 404.69'
Δ 36° 01'
D 7° 00'
T 266.2
L 514.5
T.H. 69-478
T.H. 69-479
T.H. 69-480
T.H. 69-481
T.H. 69-482
T.H. 69-483
P.I. 2488+60.76
B.C. 2495+76.96
E.C. 2499+84.20
BORROW PIT
B.C. 2502+76.65
E.C. 2506+81.34
2510
B.C. 2517+68.57
P.I. 2504+84.73
REMOVE EXIST. 24"X42' C.M.P.
REMOVE EXIST. 36"X42' C.M.P.
REMOVE EXIST. 24"X50' C.M.P.
Δ 32°34'45"
D 8°00'00"
T 209.46'
L 407.24'
REMOVE EXIST. 24"X44' C.M.P.
REMOVE EXIST. 24"X44' C.M.P.
BORROW PIT
4000
4025
4050
B.M. 75-248 ELEV. 4039.70
B.M. 75-249 ELEV. 4044.02
B.M. 75-250 ELEV. 3997.56

PLAN	BY	DATE
SURVEYED	B. ANDERSON	1975
PLOTTED	TECH. SERVICES	1975/76
ALIGNMENT CHECKED	P. KNYSH	1976
RT. OF WAY CHECKED		
NOTE BOOK No.		



B.M. 75-247 ELEV. 4041.68

B.M. 75-248 ELEV. 4039.70

INTRODUCTION

At the request of Mr. J. Y. C. Quong, P.Eng., Manager of Technical Services, Department of Public Works of Canada, Whitehorse, Yukon Territory, R. M. Hardy & Associates Ltd. undertood a geotechnical investigation along part of the existing Dempster Highway between Mile 0 and Mile 78. This report deals only with the site at the proposed river crossing structure over the Upper North Klondike River.

The location of the crossing is shown on Plan-Profile Sheet No. 7005-3 "Bridge Site, Plan and Profile, Upper North Klondike River, Mile 48.8, Dempster Highway" dated May, 1969. The site is also shown on Mile Sheet No. 48 of Drawing No. 1132 and is covered by aerial Photographs No. A18137-37 and -38.

A report entitled "geotechnical Investigation, Dempster Highway, Mile 0-78" has been previously submitted to the Department. The geotechnical conditions are discussed in Volume I while Volume II contains information on permafrost in the area of a more general nature. We recommend that these volumes be read in conjunction with the text of this report.

There is an existing bridge at the site which is shown on Photograph No. 11, Appendix A, Volume I of the report mentioned above. This existing structure consists of a 60 foot long Bailey Bridge.

The proposed structure is to be placed approximately 140 feet downstream from the existing Bailey Bridge. A decision has yet to be made on whether to use a 60 foot span steel beam bridge or a culvert of similar cross sectional area.

DRILLING AND TESTING

Two test holes were drilled at the site during the fall of 1974. The locations of these test holes are shown on the above mentioned Drawing No. 7005-3. The logs of these test holes are shown in Appendix A of this report. The drill rig was a Mobile B-40L modified for rotary drilling using diamond bits and a mixture of water and drilling mud for the fluid. Samples were obtained by coring and by straining the drilling fluid. In addition to these two test holes, a shallow exploratory hole, of two feet in depth, was drilled in the river bed during the original geotechnical investigation in 1969.

All samples were shipped to the Department's laboratory in Whitehorse for laboratory testing.

TOPOGRAPHY

The Upper North Klondike River is confined within a narrow valley with steep gradient until it reaches a point immediately upstream from the existing Bailey Bridge. At this point the valley widens. The Upper North Klondike River joins the North Klondike River approximately 150 feet downstream from the proposed crossing.

The width of the water surface was 65 feet at the time of the survey. The vertical distance from the proposed highway grade to the bed of the river is 36 feet. No information is available on the width or depth of the water course during the height of spring runoff or during heavy rain.

SUB-SURFACE CONDITIONS

The surface soils in the valley of the Upper North Klondike River consist of a layer of gravelley sand containing cobbles and some boulders. The thickness of this layer ranges from 4 to 8 feet at the locations of the two test holes. Beneath the gravelley sand there is a deposit of clayey silt and coarse gravel with cobbles also reported.

Bedrock was encountered in both test holes at depths of 13 and 14 feet respectively. The bedrock consists of interbedded layers of quartzite and shale with quartzite predominating. The upper surface of the bedrock would therefore have an elevation of approximately 3950 which is approximately 40 feet below the proposed highway grade.

Permafrost was not reported from either of the test holes drilled at the site nor from any of the test holes drilling along the proposed highway center line within approximately one mile of the location. We are of the opinion that permafrost conditions almost certainly existed at this site prior to construction of the existing road. However, due to the influence of the heat from the river, we believe that any permafrost below the water course would have thawed at sometime in the past. Owing to the sub-surface conditions at this site, it is doubtful if the presence of permafrost would have any appreciable effect on a structure. On the other hand, the silt which lies on top of the bedrock is almost certainly frost susceptible so that some frost heaving action during the winter should be expected.

DISCUSSION AND RECOMMENDATIONS

If a bridge structure were to be selected for this site, it is extremely unlikely that driven piles would be an economical form of foundation due to the relatively shallow depth to the surface of the bedrock. With the length of embedment of only 14 feet, and with the soils on top of the bedrock being, to some extent, frost susceptible, it is probable that jacking of the piles would take place during the winter due to frost action. Similarly, frost action could also be expected under spread footings supporting conventional abutments and piers unless such footings were resting directly on the bedrock. For footings to be taken down to bedrock elevation would require a considerable amount of excavation. Furthermore, the vertical distance from the surface of the bedrock to the highway grade is more than 40 feet which would entail the construction of abutments of considerable height which would be subjected to substantial lateral loads.

An alternative would be to place the abutments, or more simple bridge seats, within the embankment material.

If broken rock and coarse gravel were used for the embankment, the slopes on this material could be placed as steep as 1.7 horizontal to 1.0 vertical. The horizontal distance from the toe of the slope to the top would therefore be approximately 60 feet. If the width of the creek could be constricted to 40 feet, which is approximately the width shown on the above mentioned site plan, the total horizontal distance between the abutments could be as much as 160 feet. This span could be broken into two or three sections by constructing one or two piers in the river bed or immediately adjacent thereto. Some vertical movement of the abutments or bridge seats should be expected and provision would have to be made for adjusting the elevations of the bridge ends as necessary.

The following design parameters can be used for the two alternative approaches described above. Spread footings founded on the bedrock can be designed on the basis of an allowable bearing pressure of 25 ksf. In the case of abutments which will be acting as retaining walls, it should be noted that the allowable bearing pressures beneath footings are the maximum and not the average pressure.

For spread footings founded in any of the surficial material, the allowable soil bearing pressure can be taken to be 5 ksf. In the case of footings placed within the embankment, the allowable soil bearing pressure can be taken to be

5 ksf provided that the embankment material is mainly composed of coarse granular material with material passing the No. 200 sieve limited to 5 percent.

Spread footings placed in the river bed should be placed at least 5 feet below the lowest depth of expected scour unless the footings are placed within bedrock.

As mentioned above, if any abutments or bridge seats are placed so that they rest in or on the embankment fill material, some vertical movements should be expected particularly during the first one or two years of operation. Therefore, we suggest that some provision be made for adjusting the height of the bridge deck at either end of the bridge.

An alternative type of structure, which we recommend considering for this site, would be a large span culvert. Such large culverts are designed on the basis that the actual fill material above the culvert will provide the support and the metal of the culvert pipe will actually carry a negligible part of the load. In placing such culverts, very careful selection of the backfill material is essential. In more temperate climatic zones, clay fill can be used provided that it is compacted. However, at this particular location it is extremely unlikely that clay, even it were available, could be compacted to the required standard of density due to difficulties with weather. Therefore, we recommend that the backfill used around and over large culverts be selected granular material, consisting of natural gravel or crushed rock of a maximum size of two inches and with no more than 10 percent of the material passing the No. 4 sieve.

It would be necessary to compact the granular material using vibratory equipment and placing the material in lifts of a maximum thickness of 8 inches. Each lift should be compacted to at least 80 percent of relative density. (As carrying out the Relative Density Test in the field is usually difficult, an alternative specification could call for compaction to the equivalent of 105 percent of maximum standard Proctor density as defined in ASTM Method D-698). If a large span culvert is to be considered for this site, we recommend that the supplier of the culvert be required to furnish a design and specifications and also provide site supervision. In addition, the design should be reviewed by an independent consultant who would probably require a program of laboratory testing on the granular material.

An examination of the aerial photographs of the area shows that there is little likelihood of any trees, of any significant size, being washed down the river and causing damage to 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 or culvert. However, we suggest that the height of trees growing adjacent to the Upper North Klondike River be checked and, should it be observed that there is a possibility of large trees being washed downstream, such a fact should be considered by the bridge designer.

Embankments constructed below the highest expected flood level should be protected with riprap.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA
PERMIT NUMBER P226
R. M. HARDY & ASSOCIATES LTD.

Respectfully submitted,

R. M. HARDY & ASSOCIATES LTD.

PROFESSIONAL ENGINEER G. McCORMICK ALBERTA

Per:

G. McCormick, P. Eng.

GM:cmg

APPENDIX A

TEST HOLE LOGS

PUBLIC WORKS, CANADA

PACIFIC REGION
DESIGN / CONSTRUCTION
CIVIL ENGINEERING – YUKON

Diamond Drill Mobile Drill B-40

DRILLING RECORD

PROJECT: Dempster Hwy. Mile 48.8 Upper North Klondike River

HOLE NO. 1-74 DATE Oct. 4 1974

LOCATION See Plan

ELEVATION ______ DEPTH 61'

DRILLING NOTES			SAMPLE RECORD					
DEPTH FROM	DEPTH TO	SOIL DESCRIPTION	DEPTH FROM	DEPTH TO	NO.	TYPE	% RECOV.	N VALUE
0	8'	Gravelly sand, some cobbles & boulders						
8'	$10\frac{1}{2}$'	Sand & some clayey silt Sand-dark brown	8'	11'		C		
		Casing was driven from 0 - 8', from 8' - 11' the cobbles were cored						
$10\frac{1}{2}$'	11'	Clayey silt in coarse gravel Clayey silt- light brown & fairly plastic.						
11'	13'	Medium to fine grain sand.						
13'	52'	Bedrock, quartzite Fractured, jointed, weathered along the joints. Some fine sand between the joints. Quartz inclusions Fine texture Some quartz layers and some calcite layers.	$13\frac{1}{2}$'	16'		C		
			16'	20'		C		
			20'	25'		C		
			25'	30'		C		
			30'	35'		C		
			35'	40'		C		
			40'	44'		C		
			44'	47'		C		
			47'	49'		C		
			49'	51'		C		
52'	$52\frac{1}{2}$	Shale layer	51'	53'		C		
$52\frac{1}{2}$'	61'	Quartzite From $52\frac{1}{2}$' quartzite with quartz stringers and the odd calcite layer	53'	54'		C		
			54'	56'		C		
			56'	58'		C		
			58'	60'		C		
			60'	61'		C		

PUBLIC WORKS, CANADA

PACIFIC REGION
DESIGN / CONSTRUCTION
CIVIL ENGINEERING - YUKON

Diamond Drill., Mobile Drill B-40

DRILLING RECORD

PROJECT Dempster Hwy. Mile 48.8 Upper North Klondike River

HOLE NO. 2-74 DATE Oct. 7 1974

LOCATION See Plan

ELEVATION ______ DEPTH 31'

DRILLING NOTES			SAMPLE RECORD					
DEPTH FROM	DEPTH TO	SOIL DESCRIPTION	DEPTH FROM	DEPTH TO	NO.	TYPE	% RECOV.	N VALUE
0	4½'	Gravelly sand. Granite cobbles, Some jade with quartzite.						
4½'	14'	Sandy clayey silt , few cobbles in the silt also some coarse sand. Silt- grey, slightly plastic From 12' the silt is black.						
14'	17'	Bedrock, quartzite with some slate layers. Slate- slightly soft.	15'	17'		C		
17'	20'	Shale	17'	20'		C		
20'	23'	Quartzite	20'	23'		C		
23'	25'	Shale	23'	25'		C		
25'	31'	Quartzite with slate layers, quartz stringers with some calcite layers	25'	27½'		C		
			27½'	31'		C		