Public Works Canada
Travaux publics Canada

Western Region
Région de l'Ouest

PROPOSED TEMPORARY BRIDGE
RIVER BETWEEN TWO MOUNTAINS
MILE 411.6
MACKENZIE HIGHWAY, N.W.T.

Government of Canada / Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

000003

TO / A
G. D. REID
Ass't. Director Resources (Civil)
Public Works Canada
OTTAWA, Ontario

FROM / DE
F. E. KIMBALL
Project Manager
N.W.T. Roads
EDMONTON, Alberta

SECURITY - CLASSIFICATION — DE SÉCURITÉ	
OUR FILE — N/RÉFÉRENCE	9305-52-309
YOUR FILE — V/RÉFÉRENCE	
DATE	April 17th, 1975

SUBJECT / OBJET

MACKENZIE HIGHWAY, PROPOSED TEMPORARY BRIDGE, RIVER BETWEEN TWO MOUNTAINS

This submission consists of:

1) Bolter Parish Trimble's response to Item 6(m) of the M.H.E.W.G. "Review of Phase 1B Bridge Design Submission, Mackenzie Highway Miles 297 - 550".

2) A letter dated March 3, 1975 from G. D. Reid to F. E. Kimball and a letter dated February 25, 1975 from M. Girgrah to J. Beauchamp.

3) Two letters dated February 11 and April 4, 1975 from Reid Crowther & Partners responding to several points raised during discussion involving this structure.

4) Two plan sheets of the proposed structure.

Enclosed are 24 copies of this submission. Five copies of this submission have been forwarded to Mr. C. Amos of D.I.N.A. in Yellowknife. A single copy has been forwarded to D.O.E. in Edmonton and Winnipeg and E.M.R. in Calgary and Mr. F. Janz of D.I.N.A. in Edmonton.

Every attempt has been made to provide all additional information requested for this temporary structure. Please forward this submission to D.I.N.A. as soon as possible as there is some urgency in resolving this matter so that materials for the temporary crossing can be ordered.

F. E. KIMBALL
Project Manager, N.W.T. Roads
Western Region

RIVER BETWEEN TWO MOUNTAINS

HYDROLOGIC ASSESSMENT AT SITE OF PROPOSED TEMPORARY CROSSING

TEMPORARY CROSSING

The proposed location of the temporary crossing is approximately 4000 feet upstream from the Mackenzie River and 300 feet upstream from the permanent bridge, at the existing winter road crossing.

The Bailey Bridge type structure will be set to allow 3 feet clearance to the underside from the estimated high water level of elevation 281 of the River Between Two Mountains at design flood. The approach grades are lower than the bridge deck and would be over-topped during flood stage although the bridge itself would not be affected.

The effect of an ice-jam on the Mackenzie River would possibly cause back up water to an elevation of 292 at the bridge site.

Figure 1 shows the relevant locations and water levels.

FLOW CHARACTERISTICS OF RIVER BETWEEN TWO MOUNTAINS

The calculated design flood of 23,400 c.f.s. is based on a 50 year frequency and the water elevation at the permanent bridge site at this design flow has been determined to be 280. The elevation

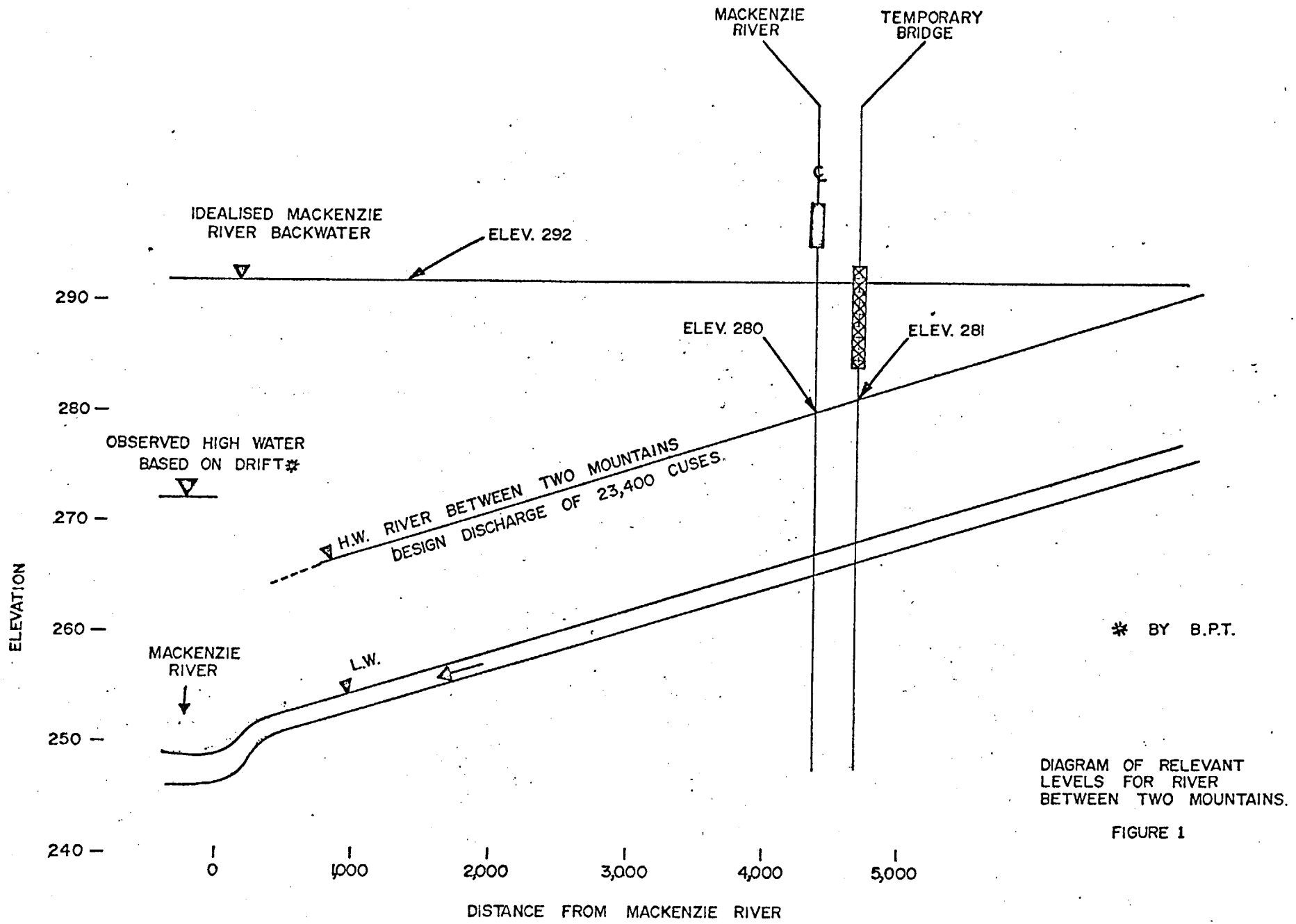


DIAGRAM OF RELEVANT LEVELS FOR RIVER BETWEEN TWO MOUNTAINS.

FIGURE 1

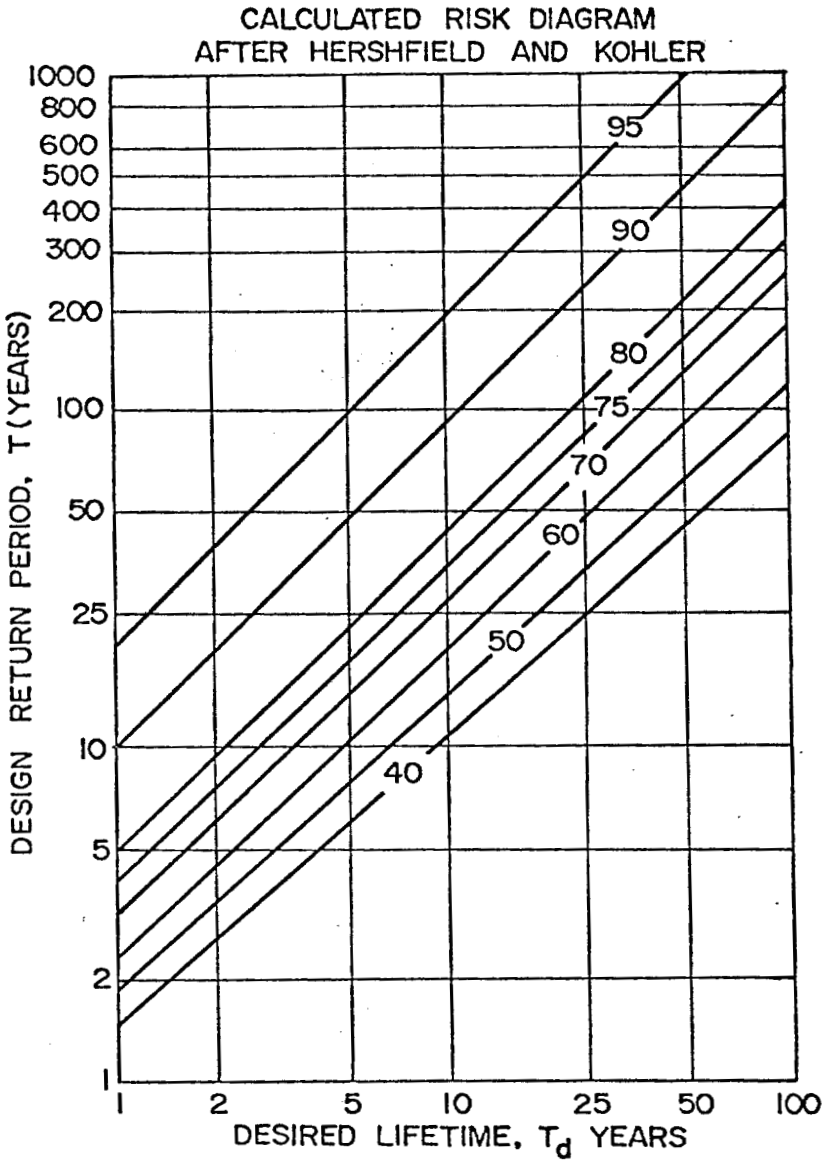
at this flow at the temporary bridge site upstream, of 281, appears conservative and reasonable.

It is possible, if a combination of deep snow accumulation, rapid snowmelt and heavy precipitation occurred simultaneously, to have the design flood take place during ice break-up and to have the River Between Two Mountains' ice run at a design high water elevation of 281. Since the probability of a 50 year design flood occurring in any one year is 2% (4% in the next 2 years), and this order of flood can occur anytime in May and June independent of break-up, the probability of a 50 year design flood occurring during an ice break-up is remote, certainly not more than 1% in any one year.

The risk factors involved for various return periods are shown in Figure 2 and by inspection, the theoretical probability of a structure not failing with a desired lifetime of 2 years and a design return period of 50 years is greater than 95%. This applies to design flood only and does not take into account the probability of ice run not occurring simultaneously with design high water.

It would appear reasonable to conclude that the risk of design flood and ice run occurring together would be in the order of 1%.

Characteristically, the right bank tributaries of the north-flowing Mackenzie River break-up before the Mackenzie itself. In 1973, the following break-up dates were observed:



——— THEORETICAL PROBABILITY OF NOT FAILING IN T_d YEARS

River Between Two Mountains ..... May 7
Ocher River ..... May 3
Blackwater River ..... May 3
Little Smith Creek ..... May 3
Cinnamon Bear Creek (Mile 569) ..... May 12
Oscar Creek ..... May 13
Hanna River ..... May 13
Donnelly River ..... May 15

The dates of the break-up of the Mackenzie River at these locations were not recorded but in all cases, the tributaries were flowing and depositing their ice load into the still frozen Mackenzie River.

In 1974, the River Between Two Mountains ice run began on May 16 and the Mackenzie River was still ice-bound.

MACKENZIE RIVER ICE JAMS

Historically, the Mackenzie River is renowned for the dramatic ice break-up and ice jams that occur almost annually. In the last 15 years, data has been gathered to locate the principal locations where ice-jams occur, the dates and duration of break-up and ice run, the extent of ice shove and water rise at selected sites and other general ice jam information.

The Mackenzie River breaks up generally from Fort Simpson to Fort Good Hope first with the mean date being May 16 at Fort Simpson, May 17.5 at Fort Norman and May 18 at Fort Good Hope. The major control is the Liard River water entering at Fort Simpson.

Break-up is typically associated with a rapid rise in water level, the formation of ice jams, the impoundment of the river upstream from ice jams, the stranding of driftwood on the banks and the formation of large ice shove boulder pads in rythmic sequence along many constricted sections.

In the approach to the River Between Two Mountains steep boulder shores and ice-formed boulder ridges confirm that severe and high ice-shove has occurred, although the nearest downstream probable ice jam location is listed as about 7 miles distant. The combined ice shove and driftwood limits at River Between Two Mountains are listed as about 33 feet above June 30, 1970 Mackenzie River water level.

The elevation of 292 specified at the River Between Two Mountains bridge site as the possible high water due to backwater effects of the Mackenzie River ice jam was derived from the recorded rise at Wrigley and appears reasonable and valid.

Recurrence of ice jams at any one location is subject to the run-off stage, the thickness of ice, the contribution of ice by tributaries, and other fluvial processes. No ice jam has been reported near the mouth of River Between Two Mountains since records have been kept although this does not rule out the possibility that jams can occur there and the drift and ice shove evidence (33 feet) observed above the river mouth indicates that ice jams have occurred in the area.

Ice jams generally form within a two week period following first movement of ice cover. In the vicinity of River Between Two Mountains, this brackets the mean ice jam period from May 17 to May 31.

Predicting the probability of the backwater of the Mackenzie River affecting the temporary bridge site on River Between Two Mountains is not possible although the absence of any visible driftwood or other debris on the flood plain in the vicinity of the bridge indicates very infrequent recurrence.

POSSIBLE EFFECT OF MACKENZIE RIVER BACKWATER ON TEMPORARY BRIDGE.

The location of the site of the temporary bridge is about 4000 feet upstream from the mouth of the River Between Two Mountains.

This distance from the Mackenzie River precludes any possibility of Mackenzie River ice reaching the bridge site. The only effect an ice jam on the Mackenzie would have would be to back water to elevation 292 up to the bridge site.

If the backwater from the Mackenzie River reaches the temporary bridge and no ice is present in the River Between Two Mountains, the Bailey Bridge will be slowly inundated about 8 feet. As long as the timber deck is secured, there should not be any damage to the heavy steel bridge.

The maximum recorded rate of stage drop of the Mackenzie River from Wrigley records is 28.77 feet in approximately 18 hours between the instantaneous gauge height on May 13, 1963 at 5:30 p.m. and the mean daily on May 14. This rate of drop is only 1.6 feet/hour and the resulting velocity at the bridge would be in the order of 2.5 feet/second with a significant over bank flow being accommodated over the flood plain and the approach roads.

The probability of the maximum backwater effect of the Mackenzie River due to Mackenzie River ice jam reaching the temporary bridge in the 2 years life of the bridge and at the same time as the design flood run-off of the River Between Two Mountains is occurring and the ice break-up of River Between Two Mountains is underway, is most remote. Considering that the River Between Two Mountains ice run has taken place before the Mackenzie River first ice movement in both 1973 and 1974, the only years recorded, that traditionally the west-flowing River Between Two Mountains does break-up before the Mackenzie River, that on neither occasion was the design discharge reached during ice run and there is about a 1% probability that design discharge and ice run would occur together, that there is no evidence of the back-water effect of the Mackenzie River ice jams ever having reached the site of the temporary bridge, that the elevation of the possible effect of the Mackenzie River ice jam at the site was based on the maximum recorded near Wrigley which is higher than the maximum observed in

the vicinity of River Between Two Mountains and that the only damage that could possibly happen to the steel temporary bridge would be by ice run on the River Between Two Mountains taking place simultaneously with the other relevant happenings, it can be concluded that the probability of the bridge sustaining any damage is almost negligible.

SUMMARY

The temporary crossing proposed for the River Between Two Mountains appears to be adequate to remain in service for 2 years.

MacKay, D.K. and Mackay, J.R., 1972. Break-up and Ice Jamming on the Mackenzie River, N.W.T. In: Mackenzie Delta Area Monograph, Brock University. p.p. 87-93.

MacKay, D.K. and Mackay, J.R., 1973. Locations of Spring Ice Jamming on the Mackenzie River, N.W.T. In: Hydrologic Aspects of Northern Pipeline Development, Information Canada Cat. No. R27-72, p.p. 233-257.

Typed Copy

OTTAWA, Ontario K1A 0M4

G. D. Reid,
Assistant Director,
Resources (Civil)
Department of Public Works,
Sir Charles Tupper Bldg.,
Ottawa, Ontario K1A 0M2

3/106-971/75

Dear Sir:

Mackenzie Highway
Review of Phase 1B Bridge Designs
Sections A and B

The Review of the Phase 1B Bridge Designs submitted for eleven stream crossings on Section A and B of the Mackenzie Highway has been completed. Directions on items general to all of these bridges is listed below followed by specific direction and comment on each of the eleven submissions.

You are authorized to proceed with the preparation of the final design and contract documents for the Shale Creek, Willowlake River and River Between Two Mountain bridges. Therefore response to the items of specific direction for these bridges should be provided as soon as possible.

Attached is one copy of the E.W.G. report entitled "Review of Phase 1B Bridge Design Submissions, Mackenzie Highway, Miles 297-550". Reference to a number of items in this report will be required in responding to the specific direction. In some cases, it will be necessary to refer to the E.W.G. response to the Phase 1A bridge submissions previously forwarded to your Department.

GENERAL

(a) As a general rule, aggregate and rip rap for the bridge construction should be obtained from streambeds.

(b) All approach fills to temporary bridges should be constructed of suitable granular material and adequately rip rapped. The apprach fills are to be removed and the area restored after the temporary bridges are no longer required.

(c) Any changes in the location of temporary bridges from that shown in the bridge submissions are to be forwarded to this Department for approval.

(d) Identified archaeological sites in the immediate area of the crossing sites are to be adequately fenced and signed.

....2

(e) For future bridge designs, field work at the sites should contain sufficient sampling of bed material so that a reasonable estimate can be made of scour conditions at the crossing site.

SPECIFIC

1. Shale Creek, Mile 331.0

   (a) In river construction at this site should not scheduled during the May-July period.

   (b) A response to items 4(f), (m) and (h) of the attached report is requested and a value for item 4(c) is to be provided.

   (c) Additional geotechnical information on the foundation conditions at the crossing site is to be provided.

2. Willowlake River, Mile 394.7

   (a) A response to items 3(a), (g) and (k) of the attached report is requested.

   (b) Please submit cost estimates of the ways of protecting the north bridge abutment and bank, and indicate what degree of protection could be expected from

      (i) setting back the bridge 1.5 feet per expected year of design life;

      (ii) rip rapping above and below water level for necessary back distances;

      (iii) rip rapping as conditions require in the future;

      (iv) channel training.

3. River Between Two Mountains, Mile 411.6

   (a) A response to items 6(c) and (m) of the attached report is requested. The value reported for item 6(b) is to be checked.

   (b) It has been noted that the design flow is now considered to overtop the existing banks, whereas it was previously stated that it would be confined. Please provide an explanation accounting for this difference.

   (c) Confusion has arisen concerning the affects of backwater and ice conditions on the temporary bridge crossing as referred to under the description of the temporary crossing conditions. Clarification of this discussion is requested when responding to item 6(m) as directed above.

.....3

(d) Environmental concerns as indicated in the Phase 1B report relate primarily to year-round fish activities. Riverbed disturbance should be minimized as much as possible and pier construction scheduled with this in mind. Care should be taken in construction of the temporary bridge, particularly the mid-channel pier. Measures to prevent siltation from approach fills and cuts should also be taken.

4. Unnamed Creek, Mile 419.2

(a) A response to items 7(d), (f) and (i) of the attached report is requested and a value for item 7 (b) is to be provided.

(b) A geotechnical report and an environmental report on this crossing are to be provided.

5. Ochre River, Mile 454.6

(a) A response to items 8(f), (g) and (m) of the attached report is requested and a value for item 8(e) is to be provided.

(b) Precautions should be taken during late summer construction of piers to prevent siltation of potential downstream spawning habitat for whitefish. Stabilization and rip-rapping of cut-banks and fills should be undertaken to prevent siltation of the river.

6. Whitesand Creek, Mile 459.7

(a) A response to items 9(f), (g) and (m) of the attached report is requested.

(b) Precautions should be taken to prevent excessive siltation from the proposed cuts on both banks. The consultant's recommended procedures should be followed with regard to construction activities in order to reduce environmental impact.

(c) Archaeological sites in the vicinity are to be kept under surveillance during the construction period and adequately protected prior to testing and possible excavation.

7. Rainbow Creek, Mile 471.4

(a) A response to item 10(m) of the attached report is requested.

(b) Surveillance of the archaeological sites in the vicinity is to be maintained and excavation carried out if necessary.

(c) Runoff from the approach fills should be diverted directly into the Mackenzie River.

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8. Steep Creek, Mile 511.8

(a) A response to items 11(f), (h), (l) and (m) of the attached report is to be provided.

(b) Consideration should be given to utilizing a longer temporary bridge due to possible scour and siltation which could occur at flood stage velocities with the present crossing.

(c) Please consult with EWG to obtain their recommendations concerning this crossing site and forward these to this Department accompanied by your estimates of the costs which would be incurred by implementation of the recommendations.

9. Salina River, Mile 521.0

(a) It is requested that a response be provided to item 12(f) of the attached report and a value for item 12(e) be provided.

(b) Controls to prevent siltation occurring from the approach cuts are to be provided.

(c) The temporary bridge should be constructed as scheduled in Attachment 1, Chapter VIII and not as suggested on page 19 of the Phase 1B report.

(d) Additional geotechnical information as noted by the bridge consultant is to be obtained for this crossing.

(e) Please consult with EWG to obtain their recommendations concerning this crossing site and forward these to this Department accompanied by your estimates of the costs which would be incurred by implementation of the recommendations.

10. Little Smith Creek, Mile 533.0

(a) A response to items 13(b) and (f) is requested and a value for item 13(c) is to be provided.

(b) This stream contains both spring and fall spawning fish. Construction is to be scheduled to avoid stream disturbance from May 1 to June 30 and September 1 to November 15.

(c) Please investigate and report on the feasibility of moving the temporary bridge to a location approximately 200 feet further from the permanent structure.

(d) Surveillance for archaeological sites should be maintained during construction.

(e) Please ensure that the rip rap required to control the possible erosion on both sides of the channel is installed at the earliest possible opportunity.

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11. Big Smith Creek, Mile 544.0

(a) Geotechnical investigation of the new site is required.

(b) A response to item 14(f) of the attached report is requested.

(c) The archaeological site at the southern approach is to be evaluated and surveillance maintained on the other pre-historic sites during construction.

Yours sincerely,

W. McKim, P. Eng., C. Eng.,
Director,
Engineering & Architecture
Branch.

Encl.

R. Berton:ijr

cc: W. R. Binks
W. G. Cleghorn
Dr. J. Riddick
R. C. Armstrong
F. Janz

11882

Mr. F.E. Kimball
Project Manager
N.W.T., Roads

1240-4

G.D. Reid
Assistant Director
Resources (Civil)

9305-50-309

March 3, 1975

MacKenzie Highway Bridges
Temporary Bridges for
1. Little Smith Creek and
2. River Between Two Mountains

At your request we have reviewed the following temporary bridges:

1. Little Smith Creek

Referring to pages 22 and 23, Section11, Division 1 of the Draft Tender Package, MacKenzie Highway M521.49 to 546.30, February 1975, our suggestions are as follows:

a. Considering possible differential settlements of the supports, the use of two 90' spans of broken span construction would be better than the 180' continuous girder construction.

b. Instead of a Double Double Reinforced Extra Wide Bailey, a Double Double Extra Wide (DDEW) Bailey is considered adequate. The capacity of the 90' single span DDEW Bailey is equivalent to M532.5 for moment and MS42.2 for shear including impact.

c. Please revise Clause 1.1.27.3 to read "The substructure shall be designed by the contractor and certified by a professional engineer, and shall ....."

Mr. S.C. Peng has discussed the above with Mr. J. Twack by telephone on February 21, 1975.

2. River Between Two Mountains

Referring to Mr. R.C. Aitken's letter of February 11, 1975, addressed to Mr. N.A. Huculak, Reid Crowther's drawings 20316-P1 and P2, and a telephone discussion between Mr. R.M. Brook and Mr. S.C. Peng on February 24, 1975, our comments are as follows:

a. Considering possible differential settlements of the supports, the broken span construction is preferable.

b. With the alternate pier locations given, the possible span arrangements are 90' - 130', 100' - 120' and 110' - 110'.

.../

c. The selected superstructures are adequate. The capacity of a 130' single span Double Double Reinforced Extra Wide Bailey is equivalent to HS 39.8 for moment and HS 32.7 for shear including impact.

d. The substructure has been revieved by the Waterways and Harbours Section and ourselves. We concur with the comments given in Mr. M. Girgrah's memorandum of February 25, 1975, addressed to Mr. J.C. Beauchamp. Attached herewith is a copy of the memorandum. We are not prepared to recommend approval of Reid Crowther's design at this time. We suggest that the comments be forwarded to the consultant for their further consideration and any changes they may wish to submit for a final review.

Original Signed by
G. D. REID

G. D. Reid,
Assistant Director,
Resources (Civil).

c.c. Mr. N.A. Buculak, DPW, Edmonton
Mr. J.C. Beauchamp

S.C. Peng/tas/8-4327

Government of Canada / Gouvernement du Canada

MEMORANDUM NOTE DE SERVICE

SECURITY - CLASSIFICATION — *DE SÉCURITÉ*	
OUR FILE — *N/RÉFÉRENCE*	
YOUR FILE — *V/RÉFÉRENCE*	
DATE	February 25, 1975

TO / Mr. J.C. Beauchamp,
Chief Bridge Engineer.

FROM / DE Head,
Waterways & Harbours.

SUBJECT / OBJET Mackenzie Highway - Temporary Bridge Supports.

With reference to your request to review the crib supports for the temporary bridge, we have the following comments:

1. In accordance with our design practice, the centre crib should be 16 feet wide. Alternatively, rip-rap should be placed around the crib to reduce the exposed height to 10 feet, i.e. equal to the proposed width.

2. The longitudinal and cross members should be bolted to the vertical timber posts.

3. Drift pins, at least 5/8 inch diameter, should be used instead of common nails.

The plans and engineering reports are returned herewith.

M. Girgrah,
Resources (Marine).

Encls.

→ C.R.

9305-52-309

Twach –

Huculak –

CONSULTING ENGINEERS AND PLANNERS

Reid, Crowther & Partners Limited

7410 Blackfoot Trail S.E., P.O. Box 5600, Postal Station "A", Calgary, Alberta, Canada T2H 1X9 Telex 038-22780, Telephone (403) 253-3301

PLEASE REFER TO FILE No. 20,316-4(a)

February 11, 1975

Department of Public Works
10th Floor, One Thornton Court
P.O. Box 488
Edmonton, Alberta
T5J 2K1

Attention N. A. Huculak
Regional Highways Engineer

Gentlemen:

Mackenzie Highway - Proposed Temporary Bridge
River Between Two Mountains

Enclosed please find sepias of our Drawings 20,316-P1 and P2 showing layout and substructure details of the proposed temporary bridge at the above site.

You will note that we have shown two alternate superstructure systems which are suitable for the spans and loadings required at this site - a double-double, chord reinforced, extra wide Bailey bridge and a triple-single, chord reinforced, extra wide Acrow bridge. We have also indicated a range of center pier locations which give some flexibility in locating the center pier to suit the actual riverbed conditions.

At our recent meeting it was agreed that, because of the apparent depth of water at the proposed temporary crossing, we would look into a piled bent alternate. Since then, Mr. Twach visited the site and has advised that the water depth was in the order of 2-1/2 ft. where the center pier is to be located. This being the case we are of the opinion that timber cribs are still the most practical substructure design for this crossing.

Before Mr. Twach called we had given considerable thought to the pile bent solution and we had discussed it with several contractors and suppliers of H-piles. We had reached the conclusion that this solution should only be considered if the water was in fact much deeper than anticipated. Our reasons for not favouring this scheme are that the riverbed is armored with large boulders which will be difficult to drive through, heavy H-piles will be required to resist driving forces and there is a shortage of heavy H-piles at this time; also, the success of the steel pile bent is dependent on close driving tolerances so that cap beams, bracing, etc. can be welded to the piles without excessive fill plates and we doubt that these tolerances can be obtained with piles driven through heavy gravel and boulders.

Department of Punlic Works
Edmonton, Alberta

February 11, 1975

Drawing P2 shows details of the timber cribs, scour protection and suggested construction procedure. We have shown two timber crib designs - one using horizontal tie bolts to resist pressure exerted by the rock fill and the other using split-ring connectors and one additional row of transverse timbers to resist these forces. If the split-rings are readily available, this alternate may prove to be more economical and more easily constructed.

We trust that all the information required is shown on these Drawings, however should you have any questions please contact the writer or Mr. R. M. Brook in Calgary at 253-3301.

Yours truly,

R. C. Aitken, P. Eng.

RCA/mm
Enclosures

CONSULTING ENGINEERS AND PLANNERS

Reid, Crowther & Partners Limited

7410 Blackfoot Trail S.E., P.O. Box 5600, Postal Station "A", Calgary, Alberta, Canada T2H 1X9 Telex 038-22780, Telephone (403) 253-3301

PLEASE REFER TO FILE No. 20,316-4(a)

April 4, 1975

10595

Public Works Canada
10th Floor, One Thornton Court
P.O. Box 488
Edmonton, Alberta
T5J 2K1

Attention N. A. Huculak
Regional Highways Engineer
Western Region

Mr. Huculak

Gentlemen:

Temporary Bridge at River Between Two Mountains
Mile 411.6 Mackenzie Highway

With reference to your letter of March 19, 1975 and memorandums from G. D. Reid and M. Girgrah attached, we offer the following comments.

Timber Crib Stability

The permanent bridge substructure will be designed to resist an ice force based on an assumed ice thickness of 3 ft. and an ice pressure of 100 psi parallel to the flow. If the same criteria are used in the design of the temporary crib, the ice force parallel to stream flow will be 430 kips (based on a 10 ft. wide crib). With a force of this magnitude we would expect crushing of the upstream nosing which will reduce the effective ice force acting on the pier. We have therefore arbitrarily reduced the force used for stability calculations to 300 kips or 70% of the permanent design load. Even with this reduced force we suspect that damage to the upstream nosing will occur.

In calculating the factor of safety against overturning we have assumed that the scour apron will govern the bed level at the pier and overturning moments have therefore been computed at this level. The factor of safety under deadload plus ice is 1.5 in the direction of stream flow. For an abnormal condition where bed scour has occurred down to the underside of the crib, the factor of safety reduces to 1.17. However, we consider this situation to be an "ultimate" condition for the two to three year design life of the structure.

Public Works Canada
Edmonton, Alberta

April 4, 1975

Normal bridge design practice is that bridge substructures are designed for a force perpendicular to the stream flow equal to 15% of the force acting parallel to the stream flow, that is 45 kips. The factor of safety against overturning at the scour apron level is 2.85 and for the "ultimate" condition the factor of safety is 2.27.

By increasing the pier width to 16 ft. the stream area will be reduced and there will be a greater possibility of ice jams. Also, the greater width will increase ice forces and in fact the factor of safety against overturning in the long direction will actually be reduced to 1.15 for the "ultimate" case.

Construction Details

There is a reference to vertical members and we wonder if this relates to our design or the design proposed at the other crossing referred to in the memorandums. We have not included vertical timber members because we feel that the crib structure is adequately held together by the vertical and horizontal tie bolts passing through the header and stretcher timbers.

The 12 x 3/8 diameter common standard spikes can be changed to 5/8 diameter drift pins. We had selected the spikes because we are working with 8" timbers and in our opinion the spikes were more appropriate.

We realize that the design of timber cribs is quite imprecise and we offer this background information on our design approach for the consideration of Mr. Beauchamp and Mr. Girgrah. We have no objections to modifying the cribs as suggested but we would appreciate your further comments on the points discussed before making changes to our drawings.

With reference to points raised by Mr. J. Twach at our recent meeting, we have investigated the possibility of reducing the number of horizontal tie rods. Using the construction method as shown we feel that no reduction is possible unless we accept a higher steel stress in the rods. However the number of rods could be reduced by using larger diameters and fastening them to vertical steel channels on the outside of the stretcher timbers. This approach has the advantage of reducing the number of tie rods to be placed but it also has the disadvantage that the channels can be damaged by ice.

As discussed it had been our intention to show a vertical lagging on the inside of the crib to retain gravel. This modification will be included in our revised drawings.

We will hold off modifying our drawings until we receive your further comments.

Yours truly,

R. C. Aitken, P. Eng.

RCA/RMB/mm