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Design and Construction Resources (Civil)

Structures (Bridges) Section

Mackenzie Highway Northwest Territories

Lynn Creek Bridge

Mile 713.4

Phase 1 Report

March 1975

B-2896

MACKENZIE HIGHWAY
NORTHWEST TERRITORIES

LYNN CREEK BRIDGE
MILE 713.4

PHASE 1 REPORT
MARCH, 1975

STRUCTURES (BRIDGES) SECTION
CIVIL ENGINEERING DIVISION
RESOURCES BRANCH
DESIGN AND CONSTRUCTION
PUBLIC WORKS CANADA
OTTAWA

CONTENTS

INTRODUCTION

At the request of the Western Region, Public Works of Canada, The Structures (Bridges) Section, Civil Engineering Division, Resources Branch, Headquarters, Public Works of Canada, undertook the Phase 1 (Preliminary Engineering) Design of Lynn Creek Bridge based on the information and data given by the following consultants:

1. Hydrologist: Bolter Parish Trimble Ltd.,
   11805 - 149 St.,
   Edmonton, Alberta

2. Geotechnical: EBA Engineering Consultants Ltd.,
   11738 Kingsway Ave.,
   Edmonton, Alberta

3. Environment Impact: Lombard North Planning Ltd.,
   PT. 1135 - 17 Ave. S.W.
   Calgary, Alberta

The Phase 1 Design includes preliminary investigations and recommended type of structures, estimated quantity and cost, environmental concerns, aesthetics, construction schedule, and temporary crossing.

SUMMARY

1. Lynn Creek Bridge crossing is located in Section C, at Mackenzie Highway mile 713.4, and about 12 miles south of Fort Good Hope.

2. The recommended superstructure is a 90 foot long single span of composite (steel and concrete) construction, and substructures are two identical concrete abutments supported by steel piles.

3. The estimated cost is about $580,000 as of January, 1975. The cost of the temporary crossing is not included.

4. The estimated construction time is about two years including shop fabrication and excluding moving out of heavy equipment after completion of construction.

5. A 40 foot long single span Bailey bridge on timber cribs is recommended for temporary crossing. The temporary crossing may be removed during spring run-offs.

6. Specific geotechnical and environmental information on the bridge site will be required as a prerequisite to detailed design of the bridge. The hydrological data are sufficient.

HYDROLOGICAL DATA

The data was provided by Bolter Parish Trimble Ltd. in July, 1974. They are sufficient for Phase 2 Design.

1. Drainage area: 31.0 sq. miles.
2. Design discharge: 1,500 cfs.
3. Stream velocity at design discharge at site:
   - A. Natural mean main channel: 6.4 fps.
   - B. Constricted mean main channel: 7.0 fps.
4. Design ice: 3.5 ft. thick at El. 464.0
5. Design high water level: El. 465.7
6. Evident high water level: El. 462.2
7. High water level for maximum velocity and scour: El. 463.2
8. Estimated general bed scour at site: to El. 454.0
9. Rip-rap: Class 1 (12" diameter) stones weighing 80 lbs. average.

GEOTECHNICAL DATA

Specific data for foundation design is not available.

Listed below is some general information obtained from EBA Engineering Consultants' Reports, "Center Line Subgrade Conditions and Borrow Resources, Mile 632 to Mile 725", and "Airphoto Mosaics, Borrow Borehole Profiles and Center Line Terrain Summary, Mile 725 to Mile 674":

1. Borrow resources:

Borrow Area No.	Access Mile	Access Distance	Borrow Material	Overall Evaluation
1	721.5	4.5 miles	Sand & Gravel	Excellent
2A	718.7	660 feet	Limestone bedrock	Good
2B	718.7	2,000 feet	Limestone bedrock	Good
11	714.4	550 feet	Limestone or Dolomite	Good
15	713.5	550 feet	Shale	Good
17	712.7	550 feet	Shale	Fair to good

2. Incidence of permafrost: approximately 30%.
3. Average borehole depth: about 16 feet.
4. Terrain summary:
    A. Terrain type: Ridge-and-Knoll Moraine.
    B. Physiographic feature: Drumlinized till plain, Rolling large linear features.
    C. Material description: Molded basal till, low plastic silty-clay till.

ENVIRONMENTAL IMPACT DATA

Particular information, such as fish migration, stream siltation, wetland habitats, vegetation, and archaeological potential, on the bridge site is not available.

Listed below is some useful information obtained from Lombard North Planning's Report, "Environmental Impact Study, Mackenzie Highway Mile 550-725", of October 16, 1972:

1. Mean temperature:

January	-15 degrees to 25 degrees Fahrenheit.
July	25 degress to 95 degrees Fahrenheit.

2. Summer season:

    Lower elevation - early May to late September.

    Higher elevation - late May to early September.

3. Visual resources:

    Mile 707-725 - This area is relatively flat and uninteresting with extensive burned over areas.

A copy of this report will be sent to Lombard North Planning Limited for their review and comment.

SELECTION OF BRIDGE STRUCTURE

1. Recommended structure:

   A. Substructure: two identical cast-in-place concrete abutments supported by steel piles.

   B. Superstructure: a 90 foot long single span of composite construction consisting of two steel girders and precast concrete deck panels.

2. The major reasons for the above selections are as follows:

   A. The single span bridge is feasible due to the relatively short crossing, and is desirable since it eliminates pier and subsequently avoids ice forces on the bridge, local scour, and effect on fish migration.

   B. The adequate clearance above high water permits the use of the twin girder system, which has a relatively deeper section, but requires less steel than the multi girder system. The clearance is about 8 feet.

   C. The precast concrete deck system was considered feasible for Lynn Creek as well as many other bridge crossings along the Mackenzie Highway where local sources of aggregates are uncertain.

3. Other alternative schemes of bridge deck:

   A. Cast-in-place concrete deck on the two steel girders.

   B. Cast-in place concrete deck on multi steel girders.

Since there is an excellent source of aggregates near the bridge site as indicated in the geotechnical consultants report (see p.4), the above two schemes will be also feasible, and will not substantially affect the cost estimate and the construction schedule which are based on the precast concrete deck alternative.

4. Precast concrete deck vs. cast-in-place concrete deck:
   Our final design submission will give further consideration to the following various comparative factors relating to advantages and disadvantages of the two possible alternative bridge deck systems.

Item	Precast Concrete deck	Cast-in-place Concrete deck
Quality control of concrete	good (in shop)	more difficult (in field)
Precision required in steel girder fabrication	higher than normal	normal
Economy in mass production	high potential	not applicable
Shop labour content	high	low
Field labour content	low	high
Transportation to site	partially finished product	raw materials
Field formwork required	minimum	substantial
Concrete casting and site construction	two separate operations	single operation
Concrete casting	in all seasons	preferably in summer
Erection of panels	in all seasons	not applicable
Installation of panel joints	preferably in summer	not applicable
Construction of concrete overlay	in summer	not applicable
Adaptability to two girder system	feasible	costly due to long span formwork
Adaptability to multi girder system	not feasible due to uneven girder camber	feasible
Local concrete aggregates available	feasible	feasible
Local concrete aggregates not available	feasible	uneconomical

STRUCTURAL DATA

1. Specifications: CSA Standard S6-1974.

2. Loading:

   A. HS25 or one HS40 along centreline of roadway with 125% allowable stress.

   B. 30 psf. on roadway for future surfacing.

3. Bridge length:

   A. Overall bridge length: 123'-6.

   B. Back wall to back wall of abutments: 91'-6.

   C. Overall superstructure length: 91'-0.

   D. Bearing to bearing: 90'-0 single span.

4. Bridge width:

   A. Overall width: 35'-0.

   B. Roadway width: 32'-0.

5. Abutment piles: use steel HP or pipe piles.

   A. In permafrost: drill hole, place pile and inject slurry of sand and water mixture.

   B. In unfrozen soil: drive piles until design capacity is reached.

6. Abutments: Two identical cast-in-place concrete (fc' = 4,000 psi.) abutments with wing walls and approach deck. Use of pre-cast concrete elements combined with cast-in-place concrete will be investigated in final design.

7. Embankment: 2 to 1 slope.

8. Rip-rap: 20" diameter (Class II) stones weighing 400 lbs. average.

9. Bearings: Any type, such as rocker, Lubritef, which functions well in cold weather.

10. Girders: Two 6 foot deep steel (CSA G40.21, 50A) girders spaced at 21'-0.

11. Precast concrete (fc' = 4,000 psi.) deck:
    A. Dimension: 35'-0 x 3'-4 x 1'-0 thick average.
       Volume: 4.32 cu. yd.
       Weight: 8.75 tons.
    B. May be fabricated in Fort Good Hope.
    C. Less formwork required in field.
    D. Can be erected in all weather conditions.
    E. Fill shear keys (panel joints) and shear connector pockets with high strength, non-shrinking mortar or Epoxy concrete in warm weather.

12. Deck expansion joint: sliding steel plates with gutter or water-tight, non-tension joint.

13. Concrete overlay: 2½" thick concrete (fc' = 4,000 psi.) reinforced with welded wire fabric.

14. Curbs: Two 1'-6 x 1'-0 high cast-in-place concrete (fc' = 4,000 psi.) curbs.

15. Railing: Galvanized HSS (CSA G40.21, 50W) posts and rails at 2'-6 above roadway.

16. Elevations:

    A. Centreline roadway at El. 480.9 ±.

    B. Bottom of girder at El. 473.7 ± .

    C. Clearance above design high water level: 8.0 feet ±.

QUANTITY AND COST ESTIMATES (JAN. 1975)

1. Assumptions:

   A. Total 30 steel piles, each 40 foot long.

   B. Unit cost is all inclusive of work in place.

   C. Embankment by bridge contractor.

2. Estimated quantities and costs:

Item	Unit of Measurement	Estimated Quantity	Unit Cost $	Cost $
Abutments				
Steel piles	ft.	1,200	140	168,000
Concrete	cu. yd.	200	450	90,000
Reinforcing steel	lb.	17,600	0.65	11,440
Embankment	cu. yd.	7,500	6	45,000
Rip-rap	cu. yd.	600	40	24,000
			Subtotal	338,440
Superstructure				
Structural steel	ton	28	2,400	67,200
Concrete	cu. yd.	130	400	52,000
Reinforcing steel	lb.	27,200	0.60	16,320
Railings	ft.	247	60	14,820
Deck joints	ft.	70	100	7,000
Deck drains	Each	4	200	800
Concrete overlay	cu. yd.	30	300	9,000
			Subtotal	167,140
				505,580
Plus approx. 15% contingency				74,420
			Total	$580,000

3. Average cost:

   A. $6,374 per foot of superstructure length.

   B. $4,696 per foot of overall bridge length.

   C. $ 134 per square foot of overall bridge dimension.

CONSTRUCTION SCHEDULE

Year	Month	Activity			
1	10	Materials-fabrication (9 months)		Tender call and contract award. Fabricate steel piles, reinforcing steel, steel girders, bearings, precast concrete deck panels, deck joints, drains, and railings.	
	11				
	12				
2	1				
	2				
	3				
	4				
	5				
	6		Logistics (11 months)		Ship by barge to Fort Good Hope, heavy construction equipment, concrete aggregates, cement and all fabricated items.
	7			Advance party and survey crew to site by helicopter.	
	8				
	9				
	10				
	11				
	12				
3	1			Haul by winter roads, concrete aggregates, fill and rip-rap materials from local source, and all construction equipment and materials from Fort Good Hope to bridge site.	
	2	Field construction (8 months)			Construct abutments, embankment and rip-rap.
	3				
	4				
	5			Erect steel girders and precast concrete deck panels.	
	6				
	7			Grout deck panel joints and shear connector pockets, construct end decks and curbs, place concrete overlay, and install railings.	
	8				
	9				

TEMPORARY CROSSING

A 40 foot long single span Bailey bridge is recommended. Details are listed below:

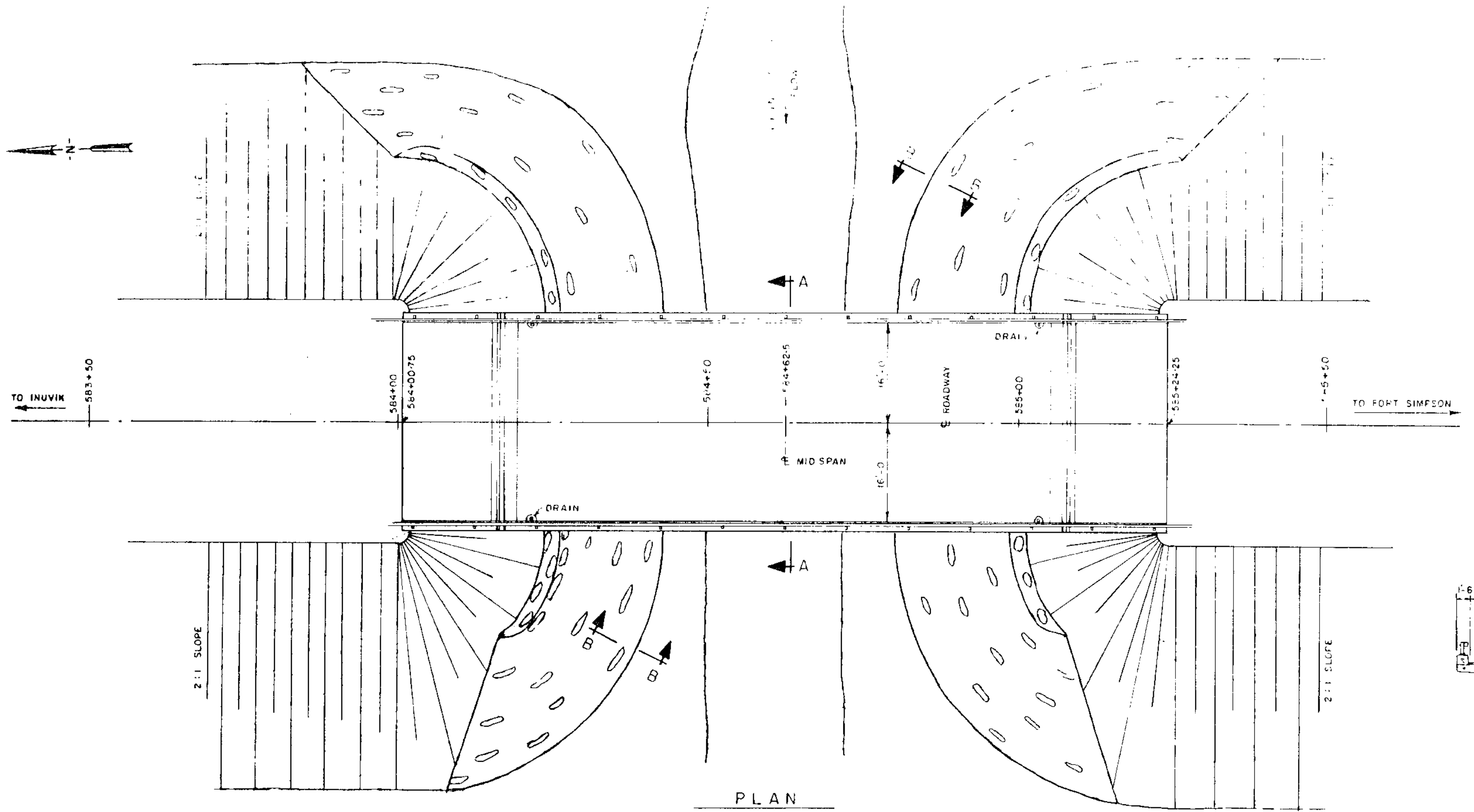
1. Location: About 80 feet downstream from the proposed permanent bridge.
2. Bridge type: 40 foot long Extra Wide Double Single Bailey with timber deck.
3. Bridge capacity including 30% impact:
   - A. Moment: 1,646 ft.-Kips. equivalent to HS56.3 or H73.2.
   - B. Shear: 114.2 Kips. equivalent to HS31.8 or H45.3 (governs).
4. Abutments: Rock filled timber cribs.
5. Clearance: Bottom chords at El. 465.2, three feet above evident high water level at El. 462.2.
6. Spring run-off: The Bailey bridge may be removed before and re-erected after spring run-off. See Note 2.

Note: 1. The temporary bridge at this site is not essentially required for the construction of the permanent bridge.

2. The removal of the temporary bridge during spring run-offs is based on the design discharge of 1,500 cfs. at El. 465.7 of a return period of 50 years and, therefore, is a very precautionary measure. The risk of not removing the bridge is small, since the desired service life of the bridge is short and the bridge is designed for the evident high water level at El.462.2. A longer Bailey bridge erected at a higher elevation could be used, however, very high costly temporary embankments would be required.

LIST OF DRAWINGS

inches 0 1 2 3 4 5 6 7 8 pouces



PLAN
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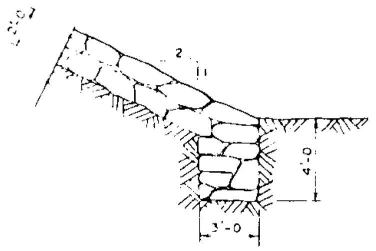

SECTION B-B
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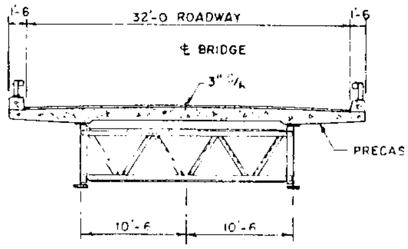

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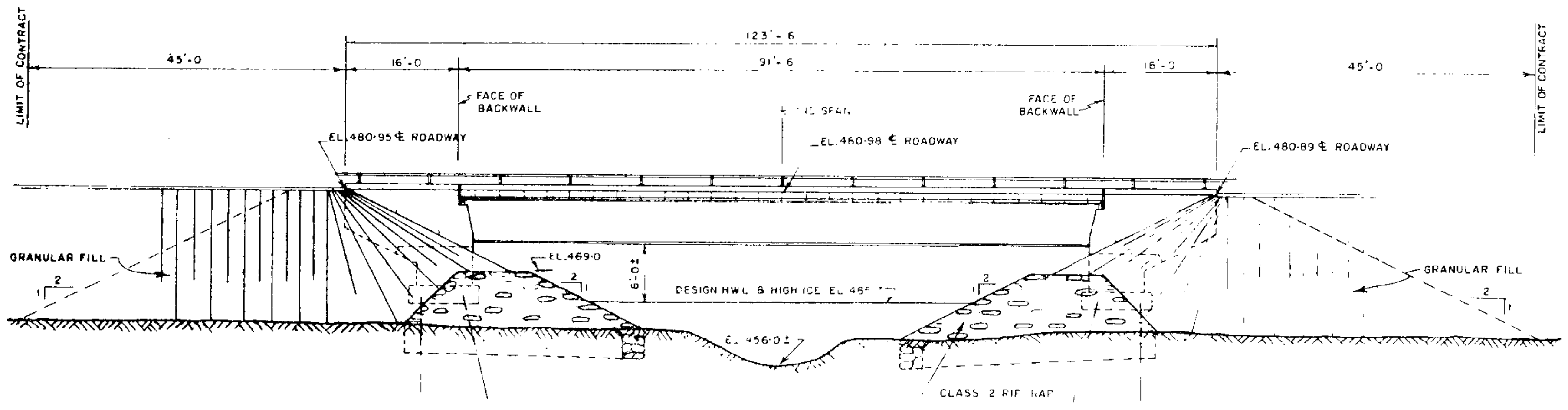


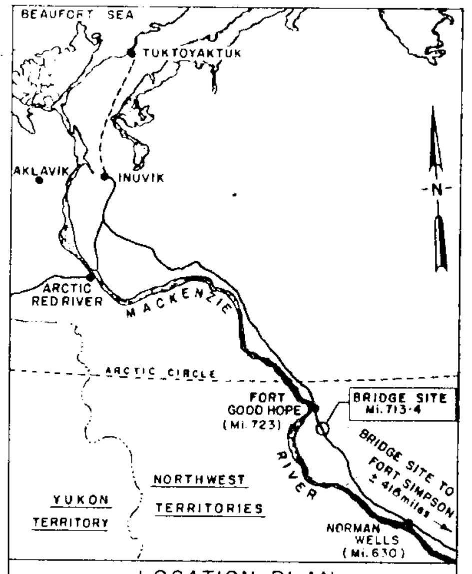
ELEVATION

HYDROLOGICAL DATA

1. DRAINAGE AREA = 31.0 SQ. MILES.
2. DESIGN DISCHARGE = 1,500 CFS.
3. STREAM VELOCITY AT DESIGN DISCHARGE AT SITE:
   (a) NATURAL MEAN MAIN CHANNEL = 6.4 FPS.
   (b) CONSTRICTED MEAN MAIN CHANNEL = 7.0 FPS.
4. DESIGN ICE = 3.5 FT. THICK AT EL. 464.0.
5. DESIGN HIGH WATER LEVEL = EL. 465.7.
6. EVIDENT HIGH WATER LEVEL = EL. 462.2.
7. HIGH WATER LEVEL FOR MAXIMUM VELOCITY AND SCOUR = EL. 463.2.
8. ESTIMATED GENERAL BED SCOUR AT SITE = TO EL. 454.0.

GENERAL NOTES

1. DESIGN SPECIFICATIONS = CSA STANDARD S6-1974.
2. LOADING:
   (a) HS 25 OR ONE HS 40 ALONG CENTRELINE OF ROADWAY WITH 125% ALLOWABLE STRESS.
   (b) 30 PSF. ON ROADWAY FOR FUTURE SURFACING.
3. STRUCTURAL STEEL SHALL CONFORM TO CSA G.40.21-1973, 50A.
4. CONCRETE SHALL HAVE COMPRESSIVE STRENGTH OF 4,000 psi AT 28 DAYS.
5. REINFORCING STEEL SHALL CONFORM TO CSA G.30.12-1972.



LOCATION PLAN
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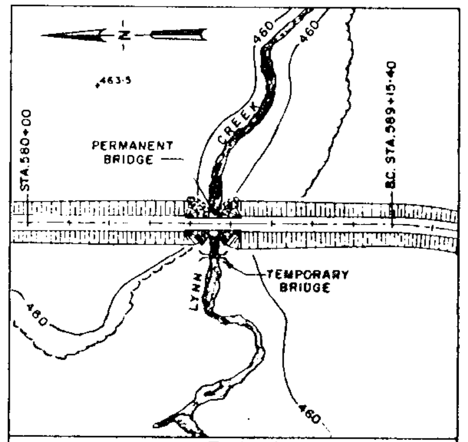

SITE PLAN
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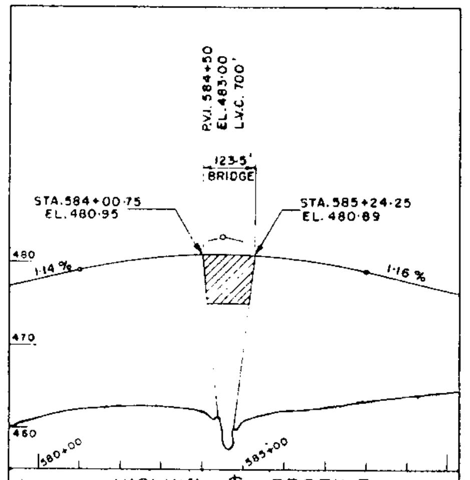

HIGHWAY ℄ PROFILE
SCALE HORIZ 1" = 200', VERT 1" = 10'

Public Works Canada Travaux public Canada

Design and Construction
Études et Construction

Resources (civil)
Direction des resources
(génie civil)

Structures (Bridges) Section
Section des ouvrages d'art
(ponts)

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

revisions
revisions

designed by / conçu par S. C. PENG date
checked by / examiné date
drawn by / dessiné par D. A. SYMON
checked by / examiné date
recommended by / recommandé par date
J. C. BEAUCHAMP
chief bridge engineer / ingénieur en chef (ponts)
approved by / approuvé par date
assistant director resources (civil) / directeur adjoint ressources (génie civil)

project title / titre du projet

LYNN CREEK BRIDGE

MACKENZIE HIGHWAY Mi. 713·4

N. W. T.

drawing title / titre du dessin

GENERAL LAYOUT

PHASE I

project no. / no. du projet

drawing no. / dessin no. 1 of / de 4

PRELIMINARY

Date
31-1-75

D.P.W. 700 B (revised april 1,1974)

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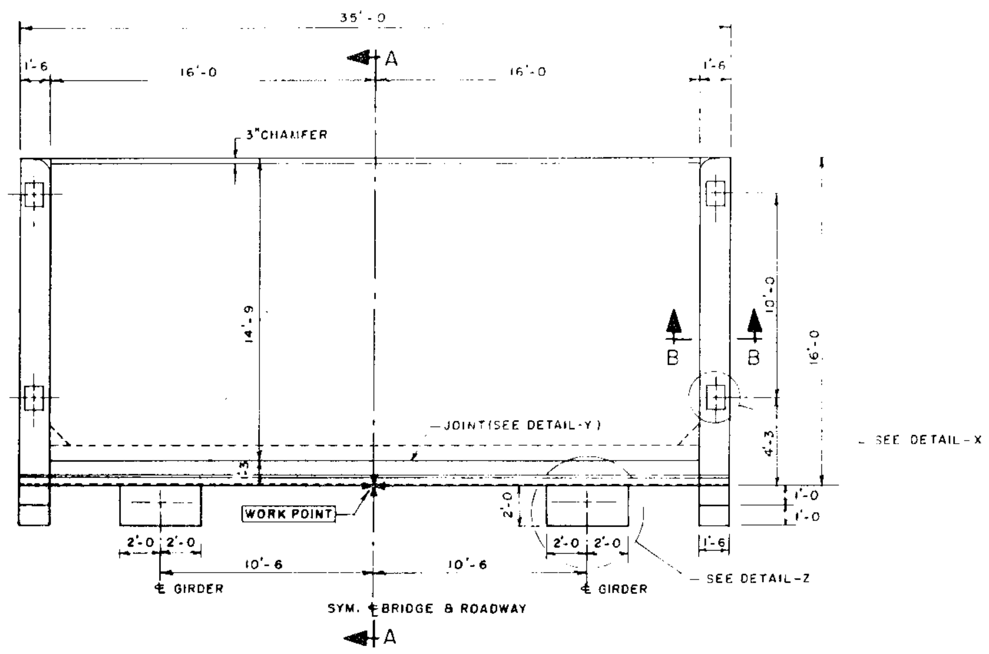

PLAN
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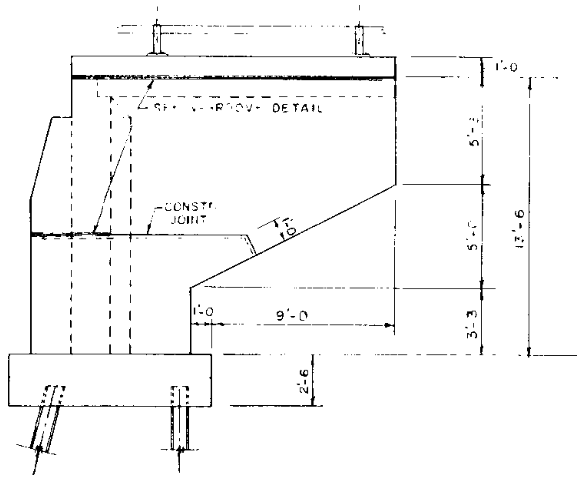

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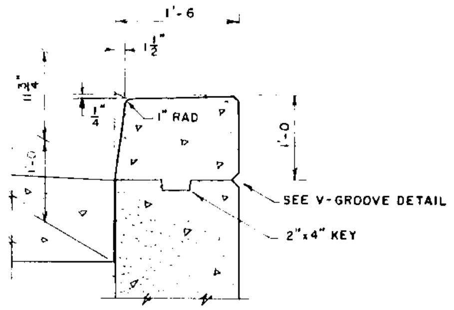

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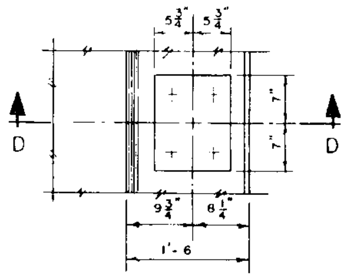

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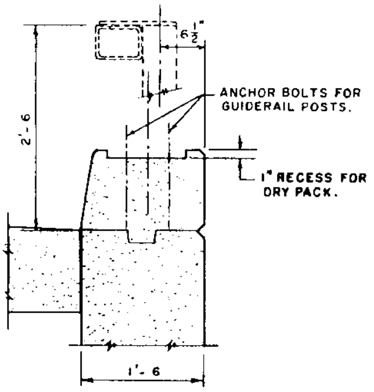

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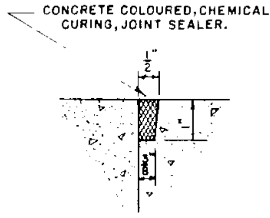

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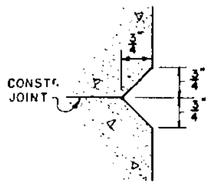
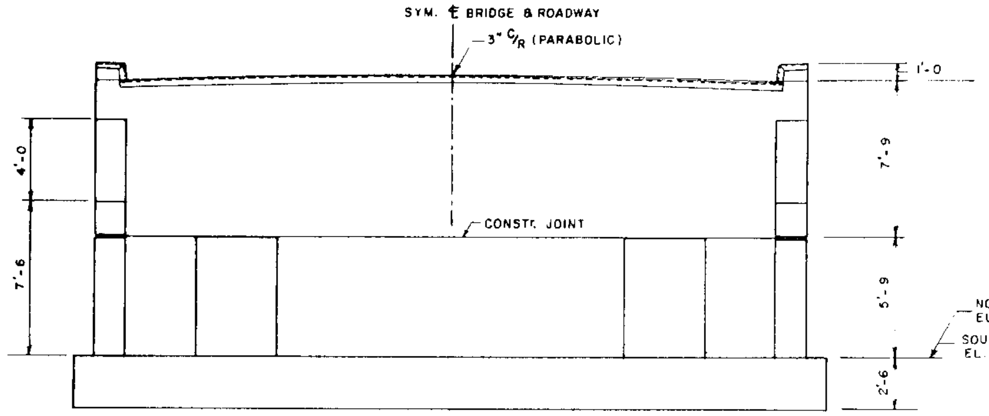


V-GROOVE DETAIL



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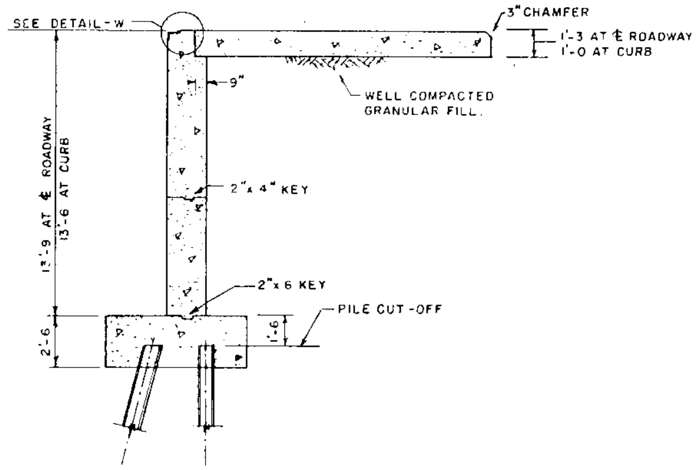

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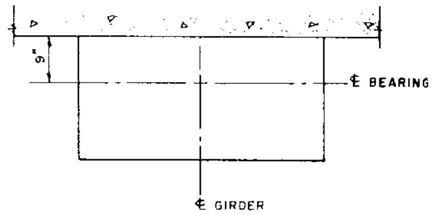

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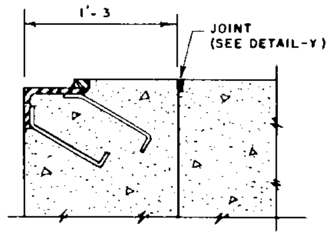

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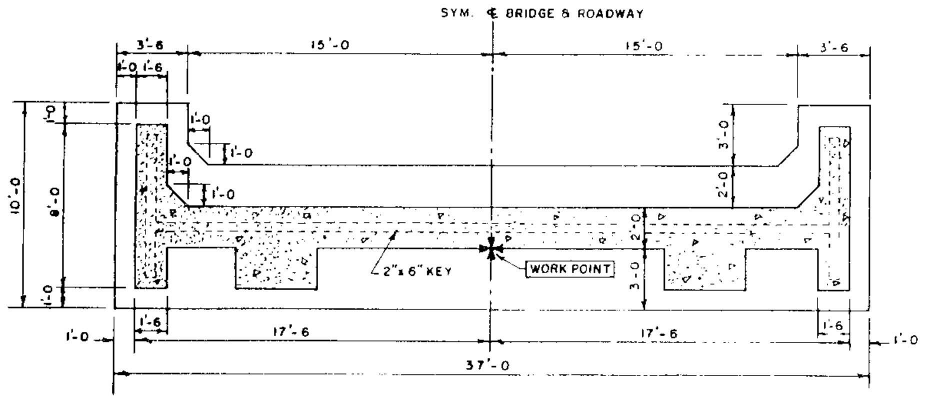

FOUNDATION PLAN
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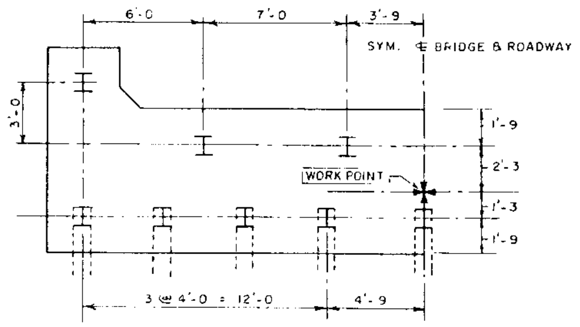

PILE LAYOUT
SCALE $\frac{1}{4}$" = 1'-0

0

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Date
31-1-75

Public Works Canada
Travaux public Canada

Design and Construction
Études et Construction

Resources (civil)
Direction des resources (génie civil)

Structures (Bridges) Section
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détail no.
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revisions
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designed by
conçu par S.C. PENG
date

checked by
examiné
date

drawn by
dessiné par D. A. SYMON

checked by
examiné
date

recommended by
recommandé par
J. C. BEAUCHAMP
chief bridge engineer
ingénieur en chef (ponts)
date

approved by
approuvé par
date

assistant director resources (civil)
directeur adjoint ressources (génie civil)

project title
titre du projet

LYNN CREEK BRIDGE
MACKENZIE HIGHWAY MI. 713.4
N. W. T.

drawing title
titre du dessin

ABUTMENTS
PHASE I

project no.
no. du projet

PRELIMINARY

drawing no.
dessin no. 2 of/de 4

D.P.W. 700 B (revised april 1, 1974)

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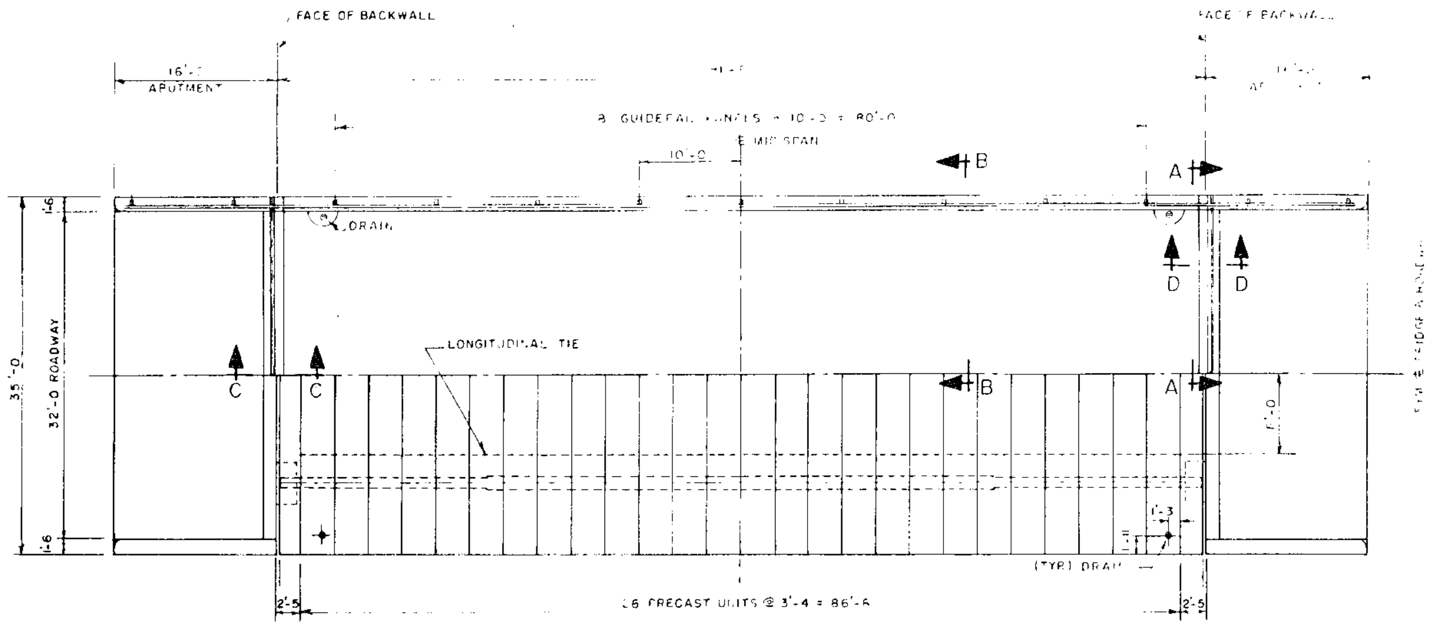

PLAN

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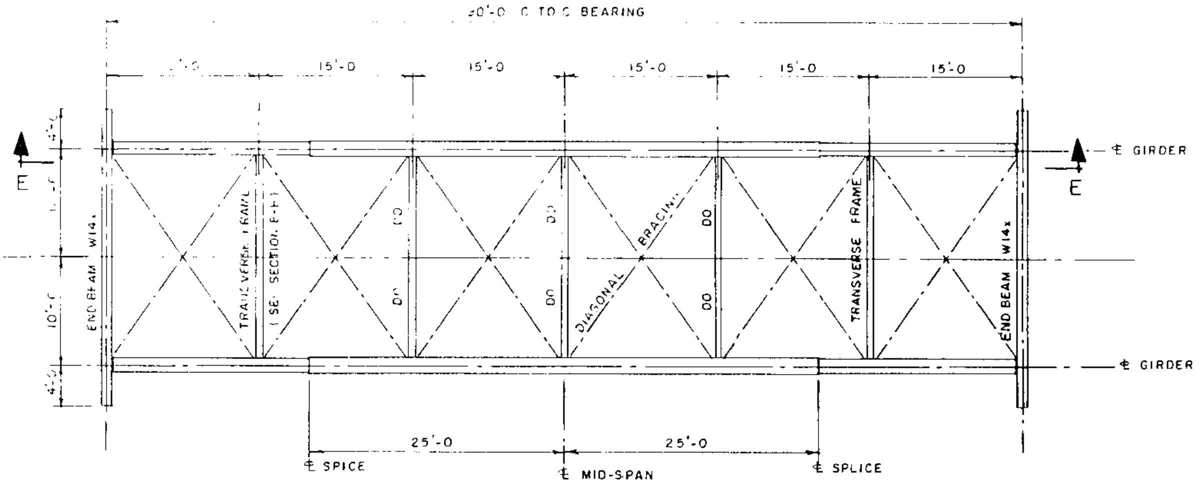

PLAN (STRUCTURAL STEEL)

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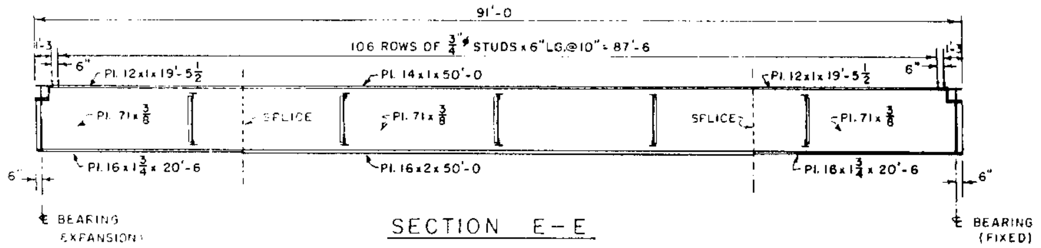
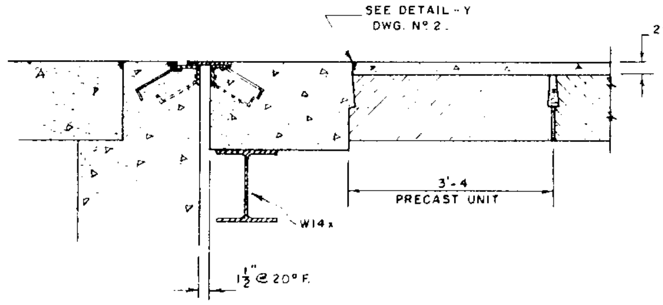


SECTION E-E



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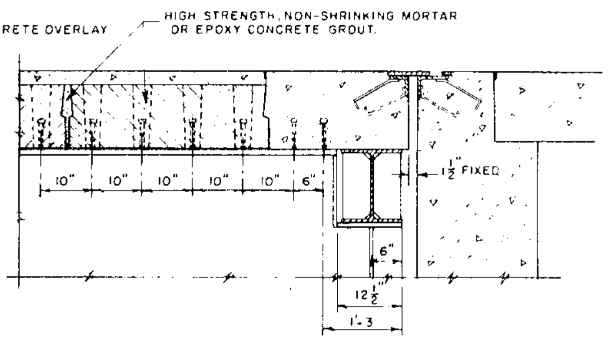

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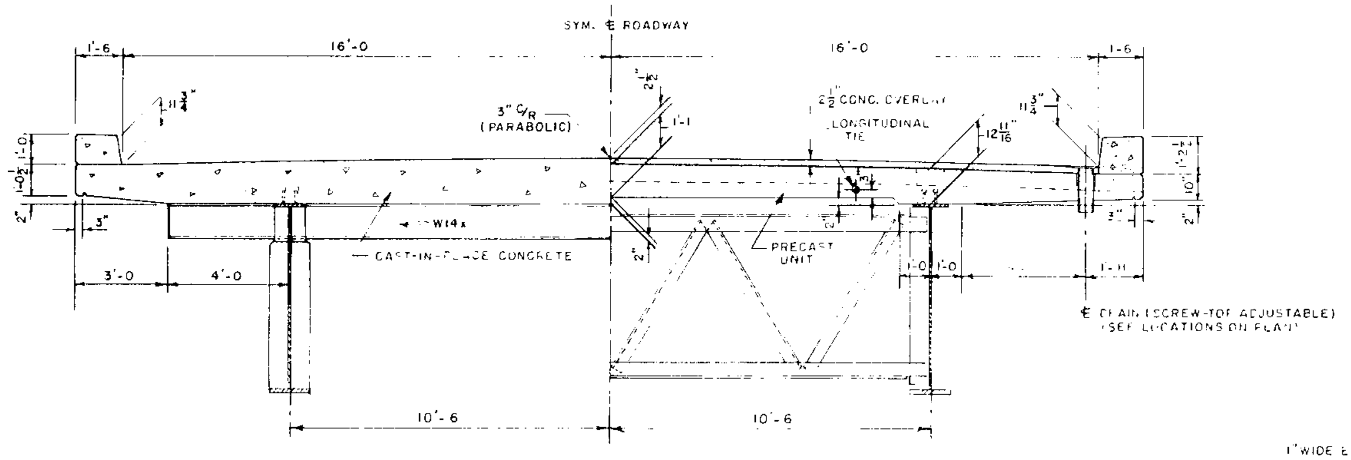
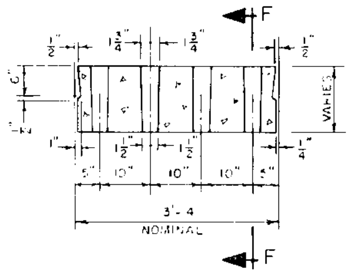


SECTION A-A

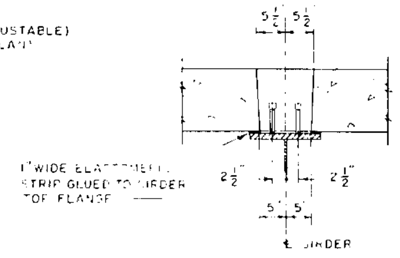
SECTION B-B

SCALE $\frac{3}{4}"$ = 1'-0



PRECAST UNIT SECTION

SCALE $\frac{3}{4}"$ = 1'-0



SECTION F-F

PRELIMINARY

Public Works Canada
Travaux public Canada

Design and Construction
Études et Construction

Resources (civil)
Direction des resources
(génie civil)

Structures (Bridges) Section
Section des ouvrages d'art
(ponts)

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

revisions
revisions

designed by / conçu par S.C. PENG — date

checked by / examiné — date

drawn by / dessiné par D. A. SYMON

checked by / examiné — date

recommended by / recommandé par — date
J.C. BEAUCHAMP
chief bridge engineer
ingénieur en chef (ponts)

approved by / approuvé par — date

assistant director resources (civil)
directeur adjoint ressources (génie civil)

project title
titre du projet

LYNN CREEK BRIDGE

MACKENZIE HIGHWAY MI. 713·4

N.W.T.

drawing title
titre du dessin

SUPERSTRUCTURE

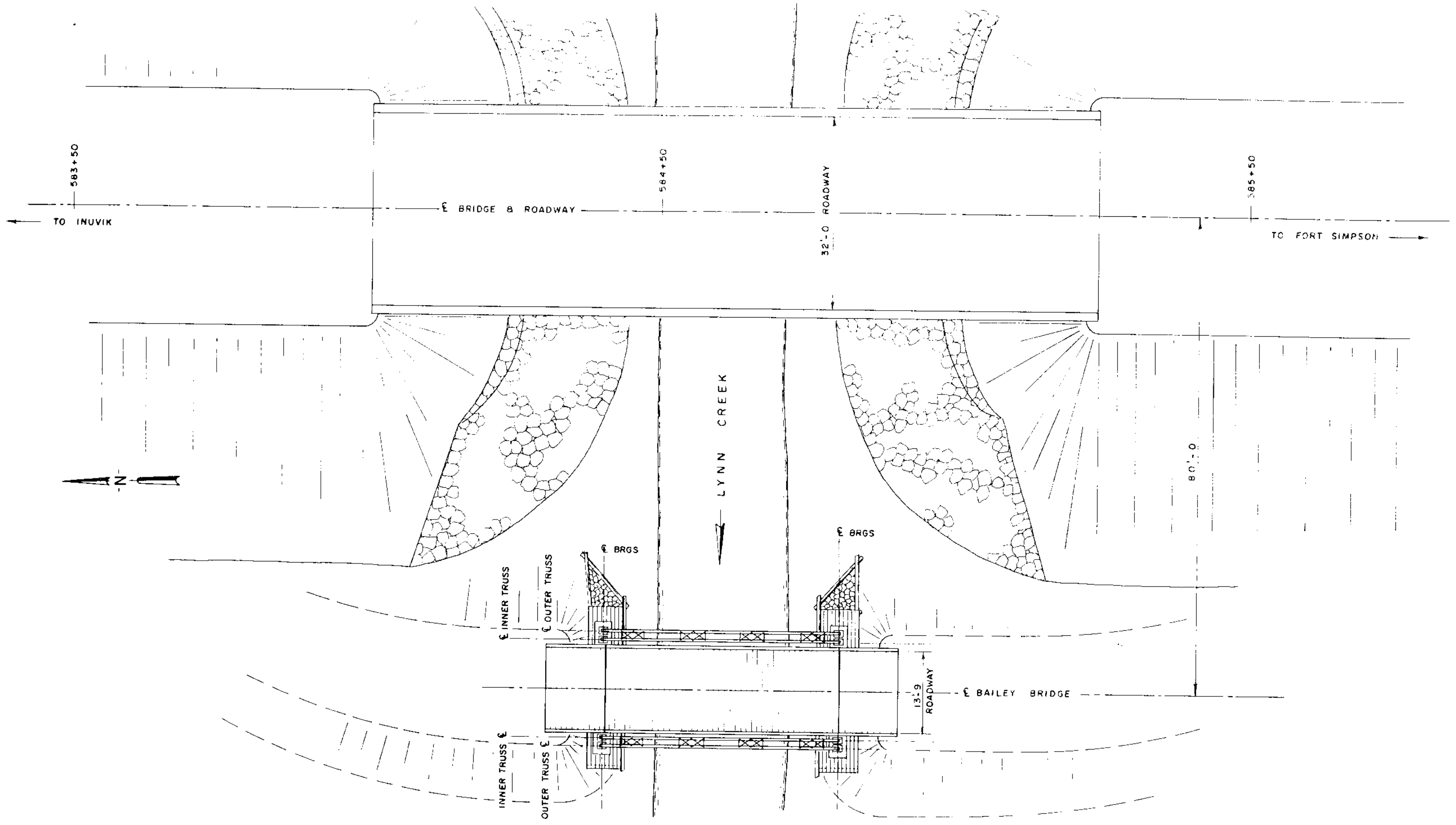
PHASE I

project no.
no. du projet

drawing no. / dessin no. 3 of / de 4

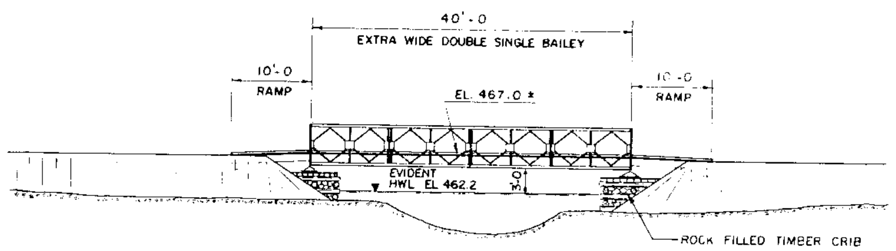
Date
31-1-75

inches 0 1 2 3 4 5 6 7 8 pouces



P L A N

SCALE 1" = 10'



E L E V A T I O N

SCALE 1" = 10'

NOTES:

1. FOR DETAILS OF BAILEY BRIDGE SEE "THE BAILEY AND UNIFLOTE HANDBOOK", FOURTH EDITION, 1971.

Public Works Canada
Travaux public Canada

Design and Construction
Études et Construction

Resources (civil)
Direction des resources
(génie civil)

Structures (Bridges) Section
Section des ouvrages d'art
(ponts)

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

revisions
revisions

designed by
conçu par [illegible]
date

checked by
examiné
date

drawn by
dessiné par [illegible]

checked by
examiné
date

recommended by
recommandé par
[illegible]
date
chief bridge engineer
ingénieur en chef (ponts)

approved by
approuvé par
date
assistant director resources (civil)
directeur adjoint ressources (génie civil)

project title
titre du projet

LYNN CREEK BRIDGE

MACKENZIE HIGHWAY MI. 713·4

N.W.T.

drawing title
titre du dessin

TEMPORARY CROSSING

PHASE I

project no.
no. du projet

PRELIMINARY

drawing no.
dessin no. 4 of de 4

0

0

Date
3.3.1975

D.P.W. 700 B (revised april 1,1974)

centimetres 0 2 4 6 8 10 12 14 16 18 20 centimetres