

Appendix B: Hydraulic Report



September 23, 2022

Our File No. 0035-099-00

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**RE: St. Vital Bridge Rehabilitation - Red River
Hydrologic and Hydraulic Assessment**

This letter report summarizes the results of our hydraulic assessment of the Red River at the St. Vital Bridge in Winnipeg, MB. The existing multi-span St. Vital Bridge consists of twinned structures crossing the Red River connecting Osborne Street and Dunkirk Drive (Figure 1). The structures, founded on shared river piers, were constructed in 1964 and rehabilitated in 1988. The bridges are approximately 280 m long, with each structure conveying two lanes of traffic in the north and southbound direction. The hydraulic analysis was conducted for the existing bridge and channel conditions (circa August 2021).

Pertinent features of the site are as follows:

- Jurisdiction - City of Winnipeg
- Watercourse - Red River
- UTM Coordinates - 634650E, 5524263N (Zone 14)
- City of Winnipeg River Stationing - 38+241

Additional details with respect to the hydraulic assessment of the existing bridge conditions are summarized in the following sections.

Red River Hydrology

The hydrology for the Red River is complicated by the operation of the Floodway, which diverts flow around the City of Winnipeg during times of a flood within the Red River Valley. Additionally, the Saint Andrews Lock and Dam, located downstream of Winnipeg, controls river levels through the City of Winnipeg including the St. Vital Bridge reach during the open water period. The project site is also influenced by inflows from the Assiniboine River, which is located approximately 5.5 km downstream of the site.

Manitoba Water Stewardship has developed flood hydrology for the Red River within the City of Winnipeg taking into account the upgraded Floodway and current Floodway operations. The hydrology derived by Manitoba Water Stewardship is based on a detailed and comprehensive assessment of recorded flows in addition to the incorporation of estimates of extreme historical events. The table from Manitoba Water Stewardship summarizing their assessment is appended for reference. The assessment from Manitoba Water Stewardship has flood hydrology derived for the Red River downstream of the Floodway Inlet and at James Avenue which would be indicative of flood conditions within the Red River throughout the City of Winnipeg. Table 1 summarizes the flood hydrology for the Red River taking into account the flows diverted to the Floodway.

The backwater analyses of the Red River for the project area requires a discharge for the downstream boundary condition. The discharge required reflects conditions downstream of the Saint Andrews Lock and Dam at the Floodway outlet. The discharge would be approximately equal to the discharge at the project site when the Floodway is not operating, however this cannot be assumed under flood conditions when total Red River flows are greater than approximately 1100 m³/s. The discharge has been estimated from the Manitoba Water Stewardship updated hydrology table by summing the Red River at James Avenue discharge and the Floodway discharge. Table 1 summarizes the estimated discharge downstream of the Saint Andrews Lock and Dam.

Table 1 – Red River Flood Hydrology

Discharge Event	Red River at St. Vital Bridge* (m³/s)	Red River at James Avenue** (m³/s)	Red River Downstream of St. Andrews Lock and Dam*** (m³/s)
0.625% (160 Year)	2195	2331	4775
1%	2168	2292	4225
2%	1688	1810	3452
5%	1334	1453	2597
10%	1283	1401	2033
20%	1179	1361	1597
50%	824	1005	1005

* Red River downstream of Flood Inlet plus LaSalle River contribution, Manitoba Water Stewardship, Updated Red River Hydrology - February 2010

** Red River at James Ave, Manitoba Water Stewardship, Updated Red River Hydrology - February 2010

*** Sum of Red River at James Ave discharge and Floodway discharge, Manitoba Water Stewardship, Updated Red River Hydrology - February 2010

The Red River is controlled by the Saint Andrews Lock and Dam through the City of Winnipeg during the open water period typically between May and October. The target control level is approximately 223.7 m at James Avenue and the water levels are maintained at this level independent of flows in the Red River except under flood conditions. Normal flows during this period are approximately 140 m³/s at the St. Vital bridge site and 200 m³/s downstream of the confluence with the Assiniboine River.

Hydraulic Assessment – Existing Conditions

The hydraulic conditions within the Red River were assessed to establish the baseline hydraulic regime. A steady-state backwater model of the Red River within the study reach was developed using the US Army Corps of Engineers River Analysis System HEC-RAS model. The HEC-RAS model is a one-dimensional backwater model, which is considered to be the universal standard for computing steady-state water surface profiles. The backwater model was developed from cross sectional information available from an existing comprehensive calibrated hydraulic model developed for the City of Winnipeg.

The framework for the backwater model, to allow for the assessment within the project area, was the hydraulic model developed for the January 2015 Red River Hydraulic Assessment for the City of Winnipeg¹. Additional cross sections were incorporated into the January 2015 backwater model to provide additional detail upstream and downstream of the St Vital Bridge from Sta 38+356 to Sta 38+169. The sections were assembled from topographic and bathymetric surveys undertaken in August 2021 by GDS Surveys and in September 2019 by Darren Wanless Surveys. Table 2 summarizes the hydraulic assessment under existing conditions. A sketch of the existing bridge is shown on Figure 2.

The estimated water surface profiles for the Red River for the existing conditions are shown on Figure 1. A sketch of the upstream elevation of the modelled St Vital Bridge is shown on Figure 3. A hydraulic summary of the existing conditions for a range of flood events is provided in Table 2.

Table 2 – Red River Hydraulic Summary for the St. Vital Bridge (Sta 38+241) – Existing Conditions

Probability	Discharge (m ³ /s)	Water Level Upstream of Crossing (m)	Water Level Downstream of Crossing (m)	Headloss (m)	Clearance to Underside of Girder * (m)	Bridge Opening Velocities (m/s)
0.625% (160 Year)	2195	230.28	230.27	0.007	0.84	1.26 – 1.28
1%	2168	230.08	230.06	0.008	1.04	1.28 – 1.30
2%	1688	228.89	228.88	0.007	2.23	1.23 – 1.26
5%	1334	227.87	227.86	0.006	3.25	1.19 – 1.21
10%	1283	227.68	227.67	0.006	3.44	1.18 – 1.20
20%	1179	227.52	227.51	0.006	3.60	1.12 – 1.13
50%	824	226.41	226.40	0.004	4.71	0.94 – 0.95
50% Summer Flow **	140	223.75	223.75	0.004	7.37	0.26 – 0.27

* - Lowest underside of Girder Elevation (existing) at approximately el. 231.12 m.

** - assumes that the Red River levels through Winnipeg are regulated by St Andrews Lock and Dam

Provincial hydraulic and regulatory design criteria/standards generally require that the energy loss (head loss) across a bridge structure should not exceed 0.2 m and that bridge opening velocities should be less than 1.5 m/s for discharges up to the design discharge. In addition, the underside of girder elevation should remain a minimum of 0.3 m above water surface during passage of design discharge.

¹ "Red River Hydraulic Assessment, Hydraulic Model Update", January 2015, prepared for the City of Winnipeg, Water and Waste Department by Bruce Harding Consulting Ltd.

It is imperative that bridge structures over the Red River within the City of Winnipeg have minimal restriction and headloss to limit the increase in upstream water levels which may aggravate flooding concerns. A 1985 guideline provided a policy on the maximum headloss that a bridge structure over waterways with a delineated floodway could incur. The guideline limited headloss to 0.12 m for rivers where the design discharge was confined within the river channel and 0.03 m where overbank flow occurs under the design discharge. It is understood that these policies no longer are applied; however, they serve as a guideline for design and assessment purposes. A copy of the policies is appended for reference.

Due to the proximity of the two bridge structures to each other, it is important to assess the structures as a whole in terms of headloss to ensure that the structures are not restrictive. Assuming a design discharge equivalent to the 0.625% (160yr) flood, the total combined headloss across the structures is estimated as 0.007 m which would satisfy the previous policy requirements.

For this assessment it has been assumed that the Red River is considered navigable. Under the Navigable Waters Act (Transport Canada), sufficient clearances are required to permit navigation by watercraft through a crossing located on a navigable waterway. The following minimum vertical and horizontal clearances for small powered watercraft were assumed:

- Provide a minimum vertical clearance of 2.5 m from the underside of girder to the water surface corresponding to the $Q_{50\%}$ summer flow.
- Provide a minimum clear horizontal width of 4 m within the bridge opening at the water surface corresponding to the $Q_{50\%}$ summer flow.

The existing St. Vital bridge crossing was assessed to determine if the structures would meet Provincial hydraulic requirements for a range of discharges from the $Q_{50\%}$ Summer navigation discharge up to the $Q_{0.625\%}$ discharge (160-Year Event). The St. Vital bridge crossing meets all hydraulic design criteria, up to and including the $Q_{0.625\%}$ discharge (160-Year Event).

The navigation clearances for small powered watercraft would be achieved at this location. The clear horizontal width is approximately 40m between the centre piers, with a vertical clearance of approximately 7.37 m to the underside of girder at the regulated Red River level (223.75) combined with the 50% summer flow.

Closure

The hydrotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice).

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

If you have any questions regarding the findings or recommendations presented, please contact the undersigned at your earliest convenience.

TREK Geotechnical Inc.
Per:

Reviewed By:



Micha Roemer, M.Sc., P.Eng.
Water Resources Engineer

Bruce Harding, P.Eng.
Senior Water Resources Engineer



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0 25 50 75 m
SCALE = 1 : 1 500 (279 mm x 432 mm)

NOTES: 1. AERIAL IMAGE FROM CITY OF WINNIPEG 2016

Figure 01
SITE PLAN

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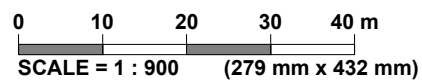
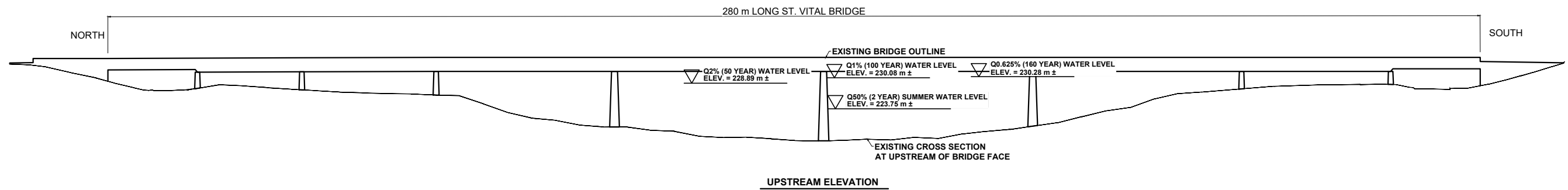
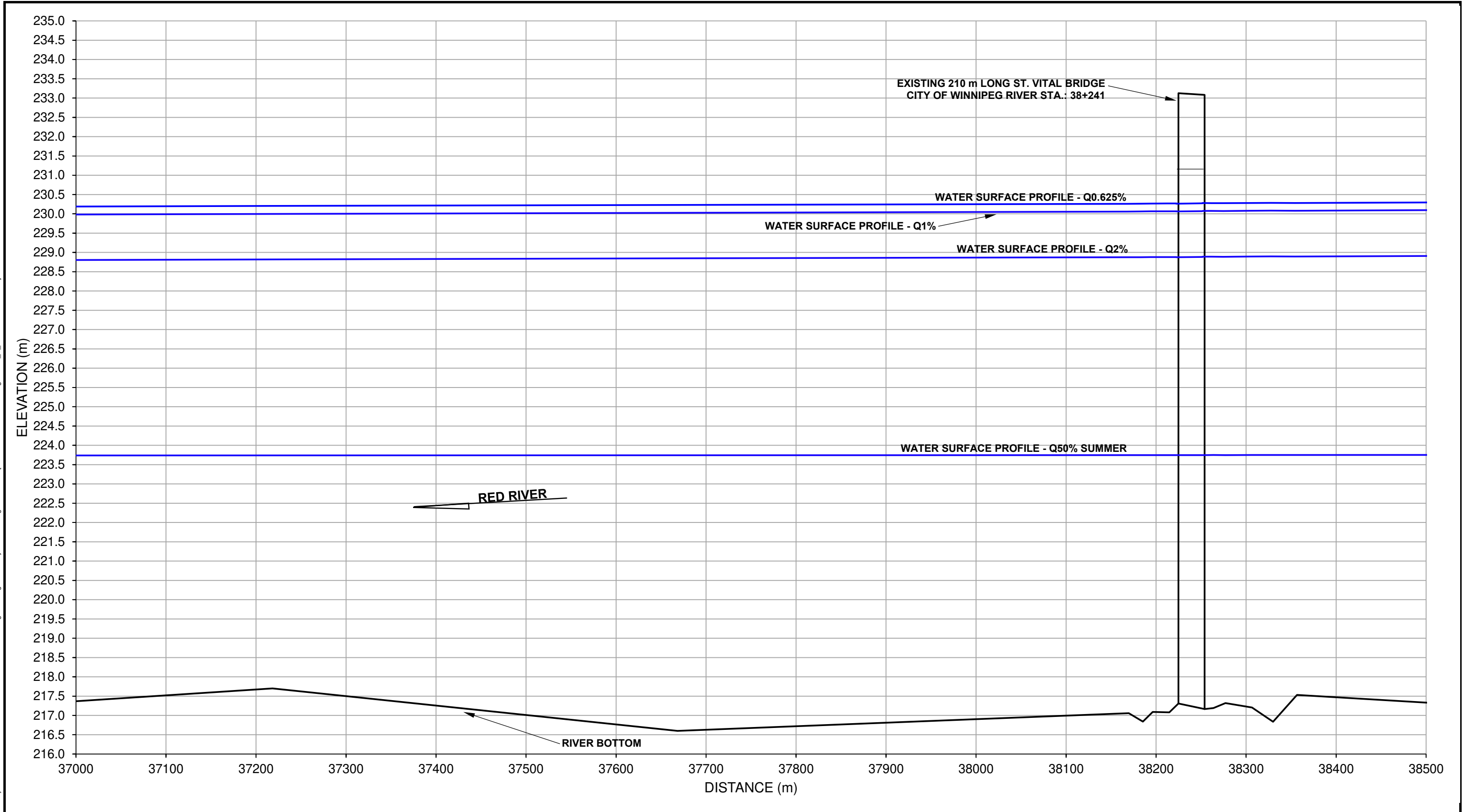


Figure 02
Existing Conditions - St. Vital Bridge
Upstream Elevation



Z:\Projects\0035 Morrison Hershfield\0035_099_00 St. Vital Bridge\2 Design\2.9 Analysis and Design Notes\WR\2022-11-23 St. Vital Existing WSP 0_A_MF_0035_099_00.xlsx\Profile Data

NOTES:

1. HEC-RAS MODEL DEVELOPED FROM AUGUST 2021 (GDS SURVEYS), SEPTEMBER 2019 (WANLESS SURVEYS) AND SEPTEMBER 2013 (GDS SURVEYS/BHC).
2. WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH THE EXISTING 210 LONG ST. VITAL BRIDGE.

Figure 03
ST. VITAL BRIDGE OVER RED RIVER
EXISTING CONDITIONS - WATER SURFACE PROFILES

June 7, 1985

File: 1.4.2B

Mr. D. Kingerski, P. Eng.
Rivers and Streams Authority Engineer
Department of Environmental Planning
The City of Winnipeg
395 Main Street
Winnipeg, Manitoba
R3B 3E1

Dear Mr. Kingerski:

RE: RESTRICTION OR IMPEDANCE OF FLOW, THE
RIVERS AND STREAMS ACT

This is in response to your letter of May 3, 1985 requesting information with respect to Provincial guidelines or policies on flow impedance or restriction on rivers and streams. The following are the policies which the Water Resources Branch applies:

1. Streams on which the floodway has not been delineated:
 - (a) Where the water surface corresponding to a given flow is below the normal channel of the stream, the backwater from obstructions, excluding bridges, should not exceed 21 cm. (0.7 feet).
 - (b) Where water surface corresponding to a given flow is above the normal channel of the stream, the backwater from obstructions, excluding bridges should not exceed 30 cm. (1.0 foot) under design flood conditions.
2. Backwater from bridges should not exceed 12 cm. (0.4 feet) in either of the above two cases.
3. In areas where a floodway has been delineated on maps the following would apply:
 - (a) For flows that are confined to the channel, the backwater from obstructions, excluding bridges, should not exceed 21 cm. (0.7 feet). In the case of bridges the backwater should not exceed 12 cm. (0.4 feet).

Mr. D. Kingerski, P. Eng.

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(b) For flows that are above the channel capacity, the increase in water levels from any obstructions including bridges, should not exceed the design flood levels as shown on the flood risk maps by more than 3 cm. (0.1 foot).

If you have any questions regarding these policies, please contact Mr. John Toye at 945-6694.

Yours truly

ORIGINAL SIGNED BY
N. MUDRY

N. Mudry, P. Eng.
Chief of Water Management

NM:JT:jph
b/c. C. Crust