APPENDIX B: HYDRAULIC REPORT

Bruce Harding Consulting Ltd

To	Scott Minty, P.Eng. Manager – Transportation Group	**Date**	November 30, 2010
From	Bruce Harding, P.Eng.	**File**	GR2
Subject	Navin Drain Pedestrian Trail Crossing Hydraulic Assessment for Proposed Crossing Rev 2	**cc**	

This memorandum summarizes the results of our hydrologic analysis and hydraulic assessment for a proposed pedestrian trail crossing of Navin Drain immediately east of Lagimodiere Boulevard. The location of the site is indicated on Figure 1. Photos of the crossing and drain are appended for reference. The total contributing drainage area to the crossing has been estimated to be 18.4 km^2 with a corresponding 10% and 3% discharge of 4.7 m^3/s and 7.1 m^3/s respectively.

Other pertinent features of the site are as follows:

- Municipality - City of Winnipeg
- Watercourse - Navin Drain
- Stream Order - 3rd order drain
- Flow Direction - west
- Designation of Drain Map - No. 9
- Total Drainage Area - 18.4 km^2
- UTM Coordinates - 640310E, 5522830N (Zone 14)

This reach of the Navin Drain has been classified by Fisheries and Oceans Canada[1] as Type E – ephemeral with indirect simple habitat. The typical fish passage requirements, as per the Manitoba Stream Crossing Guidelines[2] including maximum permissible velocity and embedment, will not be required for the proposed crossing.

An assessment on whether the Navin Drain is considered navigable has not been undertaken by Transport Canada; however it is unlikely that the waterway would be deemed navigable. On that basis it has been assumed that no provisions under the Navigable Waters Act are required for this proposed crossing.

1 "Fish Habitat Classification for Manitoba Agricultural Watersheds", Map 062H14, March 2008, Fisheries and Oceans Canada.

2 "Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat", Manitoba Natural Resources - Fisheries Department and the Canadian Department of Fisheries and Oceans, May 1996.

The proposed replacement crossing would consist of a single 1.8m high by 2.4m wide by 5 m long reinforced concrete box culvert complete with headwalls. Additional details with respect to the hydrologic assessment, the hydraulic sizing and layout of the crossing are summarized in the following sections.

1 Flood Hydrology

The total contributing drainage area to the crossing has been estimated to be 18.4 km^2 as delineated on Figure 1. The hydrology for Navin Drain at the proposed crossing site was developed using transitional techniques, utilizing rational and regional discharge coefficients. The transitional approach utilizes direct interpolation on the basis of drainage area between the rational method estimate for a 13 km^2 drainage area and the regional method estimate for a 39 km^2 drainage area.

Rational Estimates

Runoff events, and not snowmelt typically govern flood hydrology for watersheds with small drainage areas. Manitoba Stewardship, Water Branch has developed standards[3], based on the application of rational analysis techniques, for estimating discharge for small rural watersheds. Unit area runoff values applicable to a specific frequency of occurrence are given, with correction factors to account for land use, soil type, slope and rainfall intensity. The drainage area is predominantly cropped, flat with tight clay. The following table summarizes the rational estimates for this site.

Table 1
Navin Drain Flood Hydrology
Rational Discharge Coefficients

Event	Mean Daily Discharge Coefficient ($m^3/s/km^2$)	Correction Factor for Land Use, Slope and Soil Type *	Correction Factor for Rainfall Intensity	Kelln Runoff Adjustment Factor	Adjusted Mean Daily Discharge Coefficient ($m^3/s/km^2$)
50% Flood	0.29	0.75	1.0	0.57	0.12
20% Flood	0.42	0.90	1.0	0.61	0.23
10% Flood	0.51	1.0	1.0	0.64	0.33
3% Flood	0.66	1.0	1.0	0.71	0.47

* - flat, cropped with tight clay soils

3 "Runoff from Small Rural Watersheds", Province of Manitoba, Water Stewardship

Regional Estimates

A streamflow gauge had been operated by Water Survey of Canada on Omand's Creek (Omand's Creek near Metro Route 90 – WSC 05MJ007) for the period from 1978 to 1993. The flood hydrology derived for the Omand's Creek streamflow gauge was selected as the index gauge for Navin Drain. The flood hydrology for the Omand's Creek gauge 05MJ007 was developed by Manitoba Water Stewardship (MWS) utilizing recorded and correlated data for Omand's Creek. The flood hydrology and computed regional discharge coefficients for the Omand's Creek gauge are summarized in Table 2.

Table 2
Omand's Creek at Metro Route 90 – WSC Gauge 05MJ007
Flood Hydrology – Regional Coefficients and Flood Estimates

Flood Event	Flood Estimate Omand's Creek near Metro Route 90 Gauge 05MJ007 Drainage Area = 72.3 km^2 (m^3/s)	Regional Discharge Coefficient
50% Flood	2.7	0.102
20% Flood	6.8	0.257
10% Flood	10.4	0.393
3% Flood	17.8	0.673
Q3D10	7.2	0.273

* - from Regional Flood Formulae Tables, Zone 3, Manitoba Water Stewardship, August 21, 2009, n=0.765

Flood Estimates

Table 3 summarizes the transitional estimates for Navin Drain at the proposed pedestrian trail crossing.

Table 3
Navin Drain Pedestrian Trail Crossing
Flood Hydrology Estimates

Flood Event	Flood Estimate Navin Drain - Drainage Area = 18.4 km^2 (m^3/s)
50% Flood	**1.6**
20% Flood	**3.3**
10% Flood	**4.7**
3% Flood	**7.1**
Q3D10	**3.3**

A 3% discharge will be selected as the proposed design discharge for the pedestrian trail crossing. It was noted that the downstream Lakewood Boulevard box culvert crossing of Navin Drain was designed for a discharge of 7.1 m^3/s, which is equivalent to the design discharge proposed for the pedestrian trail crossing.

3 Hydraulic Sizing of Replacement Crossing

A steady-state backwater model of the Navin Drain 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 assembled from cross-sections, channel profiles and details of the crossings surveyed by Genivar, the City of Winnipeg and the R.M. of Springfield.

The backwater model has been developed to the level of detail required to estimate the relative effect of the proposed crossing. The model has not been calibrated to observed water levels during periods of high flow, and hydraulic parameters such as channel roughness have been selected based on observations, judgement and experience gained from similar projects.

The hydraulic design criterion selected for the replacement crossing is as follows:

- Design discharge – 3% Flood
- Maximum headloss of 0.3 m during the passage of the design discharge
- Culvert soffit to remain free of water surface by a minimum of 0.2 m during passage of design discharge.

The crossing would not be subject to the specific velocity requirements due to the habitat classification; but the assessment will be presented. The culvert length as proposed is less than 25 m; therefore a maximum permissible fish passage velocity of 1.0 m/s during the passage of the 3 day delay –10% fish passage discharge (Q3D10) would typically be required.

The details of the proposed crossing are summarized as follows:

- Single 1.8m high by 2.4m wide by 5 m long reinforced concrete box culvert complete with headwalls.

- Culvert set level with no embedment and not backfilled with rock. Upstream and downstream culvert inverts set at elevation 231.10.
- Culvert set with no skew.
- Refer to appended sketches of the proposed crossing for additional details.

The upstream and downstream aprons should be armoured to minimize erosion and to ensure long term function. The crossing aprons would have the following geometry:

- Base width = 3.0 m
- Armoured apron length at proposed base width = 3.0 m upstream and downstream of culvert ends
- Channel invert at upstream and downstream ends of culverts = 231.10
- Rock armouring to be Class 450 rock 0.65 m thick. Rock armouring to extend to elevation 233.0
- Channel side slopes at 3H:1V
- A transition from the upstream apron to the existing channel is required due to the discontinuity in the channel grade. The transition should be over a 4 m length using Class 450 rock.
- The base of the drainage channel should be excavated to elevation 231.10 between the proposed pedestrian crossing and the Lagimodiere box culvert crossing.

The estimated water surface profiles with the proposed crossing are shown on Figure 2. Table 4 summarizes the hydraulic assessment for the proposed crossing.

Table 4
Navin Drain Pedestrian Trail Crossing
Hydraulic Summary for Proposed Crossing
Proposed 1.8 m high by 2.4 m wide by 5 m long Reinforced Concrete Box Culvert

Flood Event	Discharge (m^3/s)	Water Level Downstream of Crossing (m)	Headloss (m)	Soffit Clearance (m)	Average Culvert Velocity (m/s)
50% Flood	1.6	231.82	<0.05	1.1 clear	0.95
20% Flood	3.3	232.12	0.07	0.8 clear	1.4
10% Flood	4.7	232.32	0.10	0.6 clear	1.7
3% Flood	7.1	232.62	0.14	0.35 clear	2.1
Q3D10	3.3	232.12	0.07	0.8 clear	1.4

It was noted that the upstream Navin Drain culvert crossings located at Plessis, Dawson and

Symington Roads are two 1500mm diameter corrugated steel culverts, which would be consistent with what is proposed at the pedestrian crossing when the additional drainage area is taken into consideration.

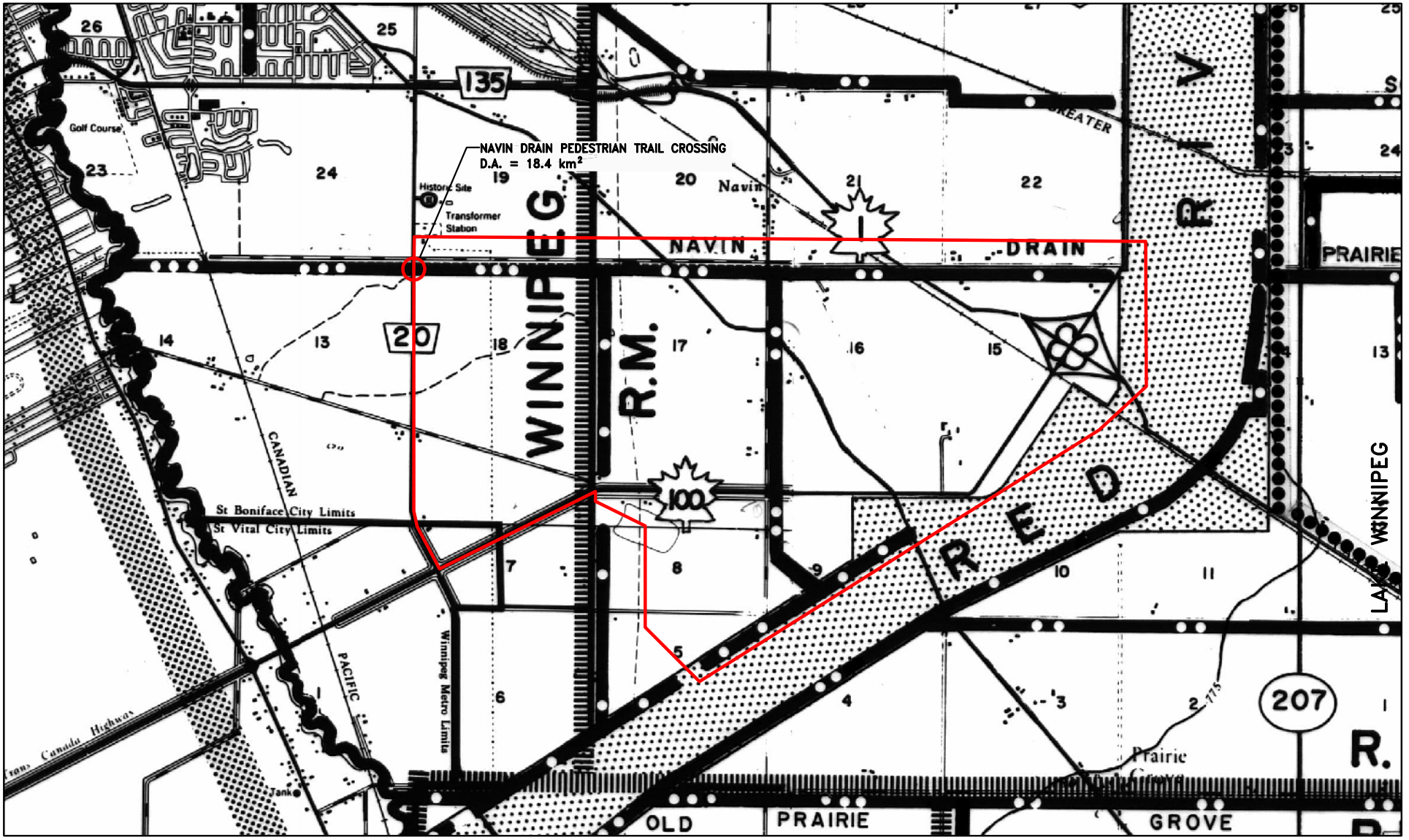
5 Other Considerations

Best Management Practices for working near waterways including the appropriate implementation of sediment and erosion control measures should be followed. Exposed slopes not covered with riprap should be seeded with native flood resistant species and covered with erosion control blanket. Construction activities within the drain shall not take place between April 1 and June 15 of any given year.

Water management during construction can be an important aspect of any project and may influence the cost and scheduling for crossing replacement. The largest flows within the drain are expected to occur during the spring runoff period and following a heavy summer rainfall event. Construction should take place in the fall and winter period when the potential for runoff is reduced thereby minimizing water management requirements. It is anticipated that the drain would not be flowing throughout the fall and winter.

Habitat compensation shouldn't be required to offset the loss of aquatic habitat due to the proposed crossing, as this reach is classified as Type E habitat.

Bruce Harding, P.Eng.
Senior Hydraulic Engineer

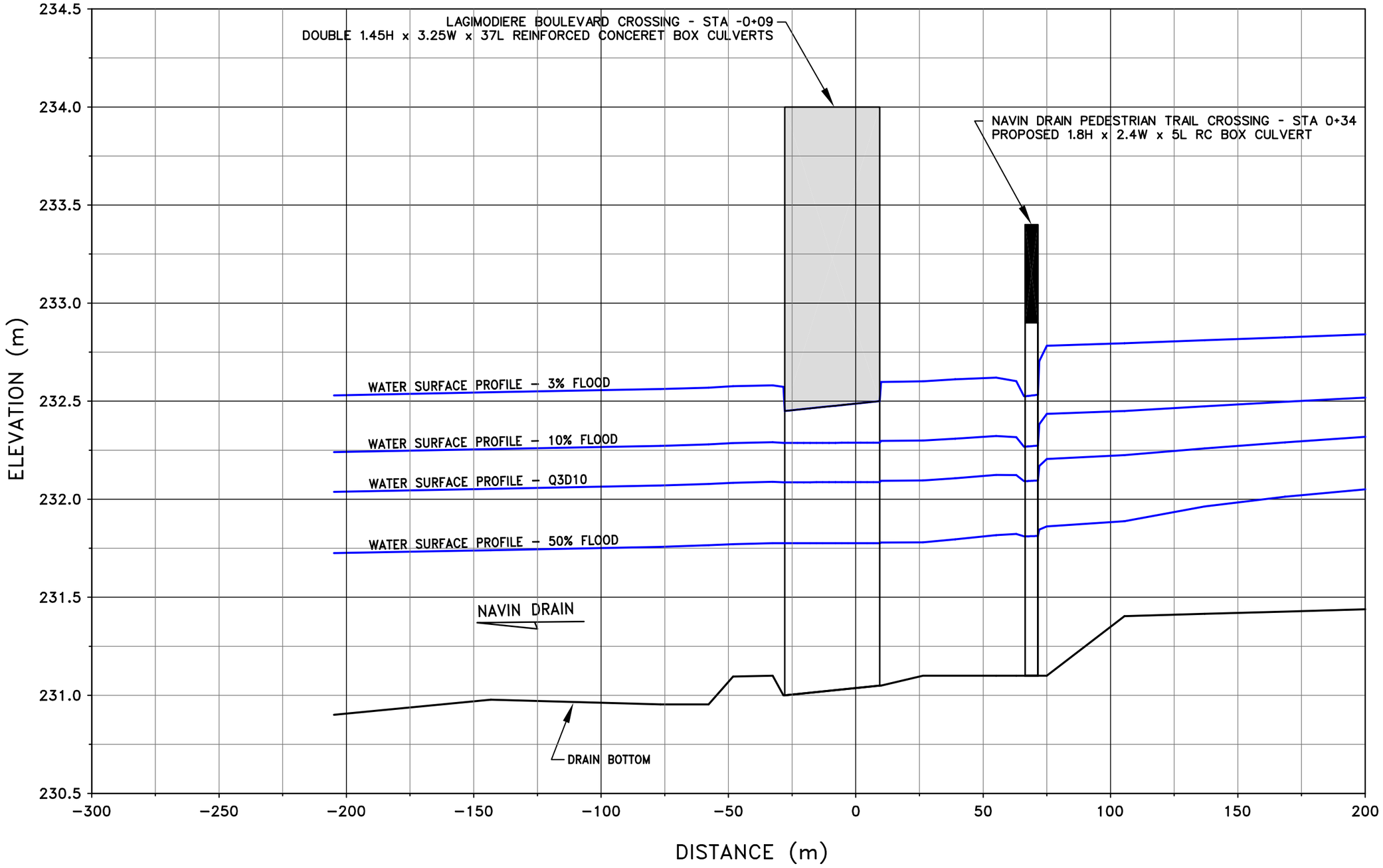


WATERSHED MAP 9

SCALE 1:50000 (METRES)

1250 0 1250 2500

NAVIN DRAIN PEDESTRIAN TRAIL CROSSING
LOCATION PLAN
FIGURE 1



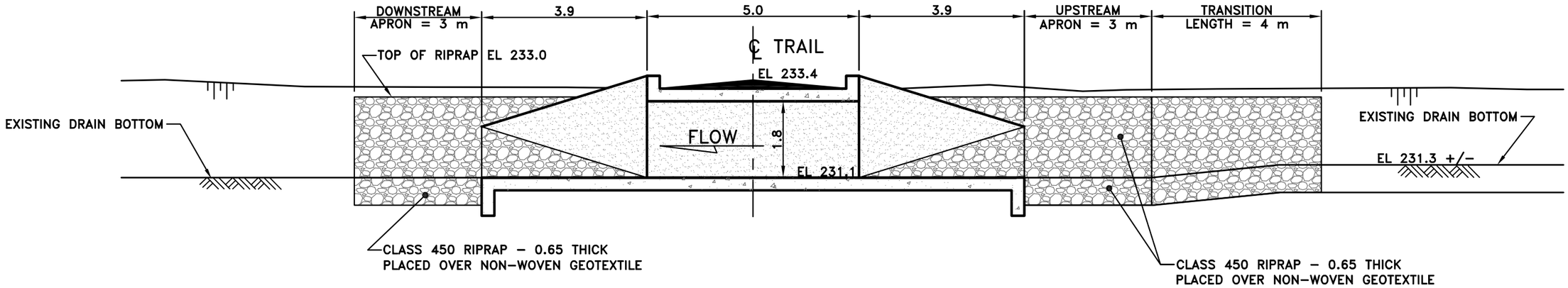
NOTES:

1) WATER SURFACE PROFILES REFLECT HYDRAULIC CONDITIONS WITH PROPOSED 1.8 W x 2.4 H x 5 L RC BOX CULVERT CROSSING AT THE PEDESTRIAN TRAIL
2) DOWNSTREAM BOUNDARY CONDITION FOR HEC–RAS MODEL ASSUMES NORMAL DEPTH AT 0.026% SLOPE

NAVIN DRAIN PEDESTRIAN TRAIL CROSSING
WATER SURFACE PROFILES WITH PROPOSED CULVERT CROSSING
FIGURE 2

WEST

EAST



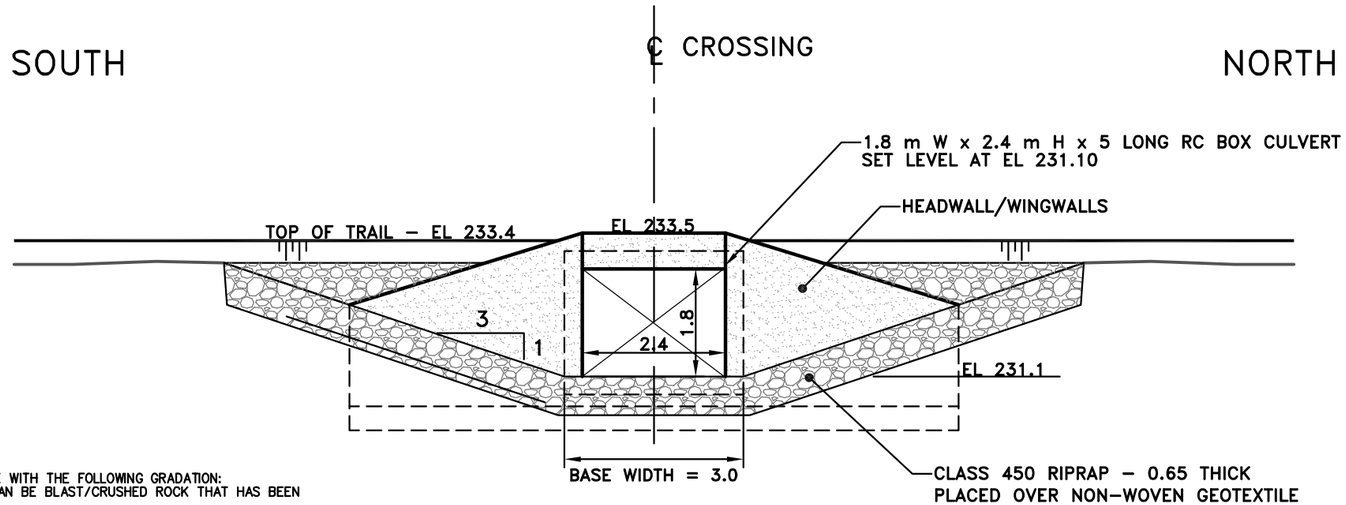
PROFILE THROUGH CULVERT CROSSING

SCALE 1:100

SOUTH

℄ CROSSING

NORTH



NOTES

1) CLASS 450 RIPRAP TO BE WELL GRADED, ROUNDED, CLEAN, SOUND ROCK WITH THE FOLLOWING GRADATION: 100%< 450 mm, 15–50% < 350 mm AND 0–15% < 100 mm. THE ROCK CAN BE BLAST/CRUSHED ROCK THAT HAS BEEN PROCESSED TO THE SPECIFIED GRADATION.
2) ALL EXPOSED EARTH SLOPES NOT COVERED WITH RIPRAP WILL BE SEEDED AND COVERED WITH EROSION CONTROL BLANKET.
3) CULVERT INSTALLATION TO FOLLOW STANDARD PRACTICES FOR BEDDING AND BACKFILL

UPSTREAM ELEVATION

SCALE 1:100

SCALE 1:100 (METRES)

2.5 0 2.5 5

NAVIN DRAIN PEDESTRIAN TRAIL CROSSING
PROPOSED CROSSING DETAILS

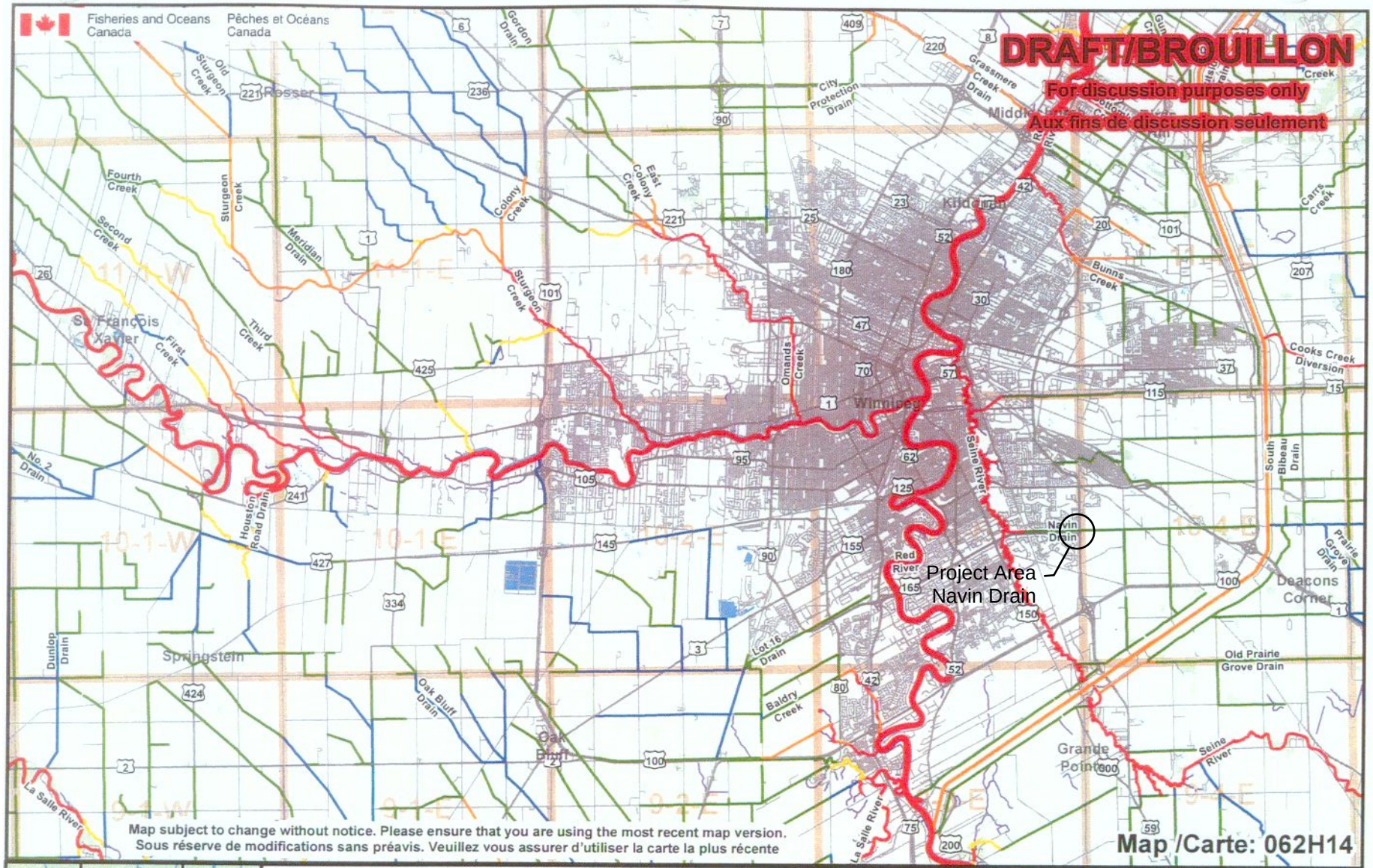
Navin Drain Pedestrian Trail Crossing

Photo No. 1 Navin Drain west of Lagimodiere Boulevard (May 2005)

Photo No. 2 West side of Lagimodiere Boulevard Crossing (May 2005)

Photo No. 3 East side of Lagimodiere Boulevard Crossing (May 2005)

Photo No. 4 Navin Drain east of Lagimodiere Boulevard near proposed crossing (May 2005)



062I04	062I03	062I02
062H13	062H14	062H15
062H12	062H11	062H10

Kilometers 0 1 2 4 6 8 10 Kilomètres

Miles 0 1 2 4 6 Milles

Map not to be used for navigation/
Ne pas utiliser pour la navigation

Habitat Type/ Type d'habitat	Color/ Couleur
A	
B	
C	
D	
E	
Unclassified/ Non classifié	

Fish Habitat Classification for Manitoba Agricultural Watersheds/ Classification de l'habitat du poisson par rapport aux bassins hydrographiques agricoles au Manitoba

Version 1.0

Valid until March 31, 2008
Valide jusqu'au 31 mars 2008

Canada