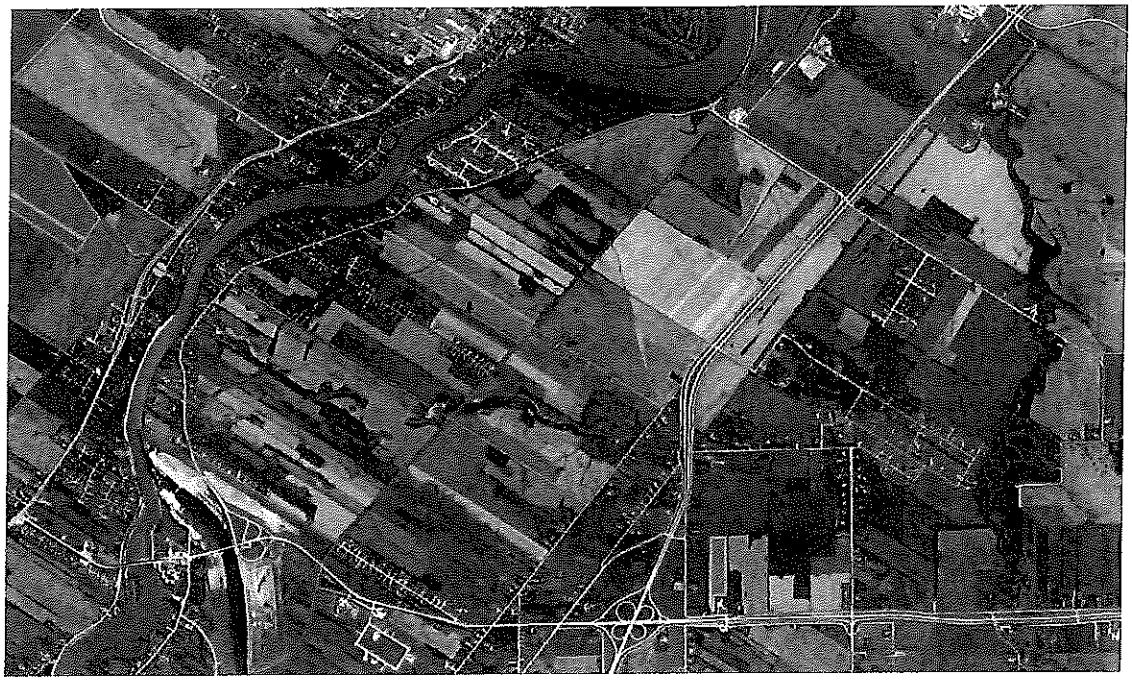
RM of St Clements

Bunns Creek and Tributary Drains
Drain and Crossing Upgrades
Hydrologic and Hydraulic Assessment



September 2016

Bruce Harding Consulting Ltd

RM of St Clements

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APEGM

Certificate of Authorization

Bruce Harding Consulting Ltd.

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Prepared by: Bruce Harding, P.Eng.

September 2016

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1 Introduction

This report summarizes the hydraulic and hydrologic assessment of Bunns Creek and tributary drains. Concerns with respect to localized flooding and ineffective drainage have been identified warranting the assessment of the existing drainage. The project area is shown on Figure 1.

Options for drainage upgrades for Bunns Creek have been developed, which include drain cleanout or drain reconstruction from Henderson Highway to Floodway Drive north, in addition to several culvert crossing replacements. These proposed improvements to the creek will provide a lower water surface profile within the creek itself in addition to improving runoff from tributary drains. Additionally, the proposed upgrades will ensure the long term function and integrity of the drain itself. Options for the upgrade of the east and west ditches of Floodway Drive North and the east drains along the railway grade are also presented.

Pertinent features of project area are as follows:

- Municipality - St Clements
- Stream Order - 1st and 2nd order drain
- Flow Direction - northwest
- Designation of Drain Map - No. 12
- Total Drainage Area - 17.5 km^2
- UTM Coordinates of Study reach - Downstream 651115E, 5554640N
  - Upstream end 6509000E, 5549435N

The following sections summarize: 1) the hydrological assessment, 2) the hydraulic assessment of the existing drain, 3) the proposed drainage upgrades and 4) the estimated costs for implementation.

2 Flood Hydrology

As shown on Figure 1, the runoff to Bunns Creek started near the intersection of PTH 44 and PTH 59 and trends north. The creek receives additional runoff from a large drain south of the Henderson Highway culvert crossing combining for a total contributing drainage area at the downstream end near the Red River of approximately 17.5 km^2. The incremental contributing drainage areas have been identified and delineated at key locations. The local drainage is ungauged; therefore the flood hydrology was derived using standard hydrological techniques. Table 1 summarizes the area hydrology.

Table 1
Hydrology – Bunns Creek

Location	Drainage Area (km^2)	50% Discharge (m^3/s)	10% Discharge (m^3/s)	5% Discharge (m^3/s)	3% Discharge (m^3/s)
At Mowatt Road	4.0	0.9	2.0	2.3	2.6
At Railway Crossing	8.3	1.8	4.2	4.8	5.5
At Henderson Highway (PR 204)	16.0	2.9	6.8	8.0	9.1
At Bunns Road	16.3	2.9	6.9	8.1	9.2
At Red River	17.5	3.0	7.0	8.2	9.4

3 Hydraulic Assessment - Existing Conditions

The existing drainage for Bunns Creek, including the tributary drains along the railway embankment and adjacent to North Floodway Drive were assessed to determine efficacy. The existing drainage patterns are as shown on Figure 1.

3.1 Assessment Standards and Requirements

Drains

The following hydraulic criteria were applied for creeks/drains:

- Assessment discharge – 5% (1:20 year)
- Water surface profile to remain at or below prairie level
- Maximum channel velocity of 0.9 m/s at assessment discharge

Culvert Crossings

The following hydraulic criteria were applied for culvert crossings:

- Design discharge – 5% (Municipal Roads & Crossings) or 3% (Henderson Highway)
- Maximum headloss of 0.3 m during the passage of the assessment discharge

3.2 Bunns Creek

A detailed steady-state hydraulic backwater model of Bunns Creek was developed to assess the hydraulic conditions of the existing drain and culvert crossings. Approximately 3700 m of the creek was modeled starting 370m downstream of Bunns Road extending upstream to North Floodway Drive. The lower 1900 m reach of drain along the bank of the Red River was not modelled. The hydraulic analysis for the creek was undertaken 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 for the drain was developed using cross-sections, channel profiles and details of the crossingssurveyed by GDS Surveys in September 2016.

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

Figure 2 presents the computed water surface profiles for the existing creek for discharges equivalent to a 5% flood event. Table 2 summarizes the hydraulic assessment of the existing culvert crossings. In general the creek is capable of conveying flood runoff within prairie level particularly in the lower reach near Henderson Highway. There is however a significant length of the creek near the railway where the water surface profile exceeds prairie level. Drainage efficiency would be enhanced through drain reconstruction/cleanout to improve the geometric template of the creek in addition to the upgrade of several culvert crossings. The observations noted from the hydraulic assessment of the drain are as follows:

- The drain would benefit from regrading particularly in the reach from Henderson Highway upstream to the railway, where the drain is shallow, with a narrow base and steep side slopes..
- The headloss and culvert velocity at the Mowatt Road crossing exceeds standards and warrants upgrade.
- The headlosses and culvert velocities at Bunns Road, at Henderson Highway (PR 204) and at the driveway crossing immediately downstream of Henderson Highway exceed standards. The increased headlosses, particularly when the combined headloss for both culvert crossings are considered, results in surcharged water levels upstream of Henderson Highway, however the water level is contained within prairie Level.

3.3 North Floodway Drive - East and West Drains

The drains on the west and east side of North Floodway Drive are not providing effective drainage for several reasons:

- the overall grade is relatively flat (0.04%) which is adequate to provide drainage, however the drains must be constructed and maintained properly to ensure long term function. A cleanout to grade would be beneficial.
- There are a larger number of access crossings with individual culverts which appear undersized and poorly set which is hindering the drainage. Upsizing and resetting of the culverts is required.
- The flat grade and the larger number of culverts are resulting in ponding which is aggravating drainage problems because of vegetation growth which is difficult to control and maintain.

Table 2
Bunns Creek
Hydraulic Summary - Existing Crossings

Location	Station	Existing Crossing	Assessment (Design) Discharge		Headloss at Assessment Discharge (m)	Culvert Velocities at Assessment Discharge (m)
			Probability	(m^3/s)		
Bunns Road	2334	2 - 1600 dia x 15.2 long CSP	5%	8.1	0.81	2.55 to 3.0
Driveway	2685	2 - 1500 dia x 10.1 long PCC	5%	8.0	0.69	3.0 to 4.6
Henderson Highway (PR 204)	2728	2 - 1500 dia x 23.2 long CSP	3% *	9.1	0.90	2.6
Railway (Formerly CNR)	3978	3 - 750 dia and 1200 dia CSP - approx 13 long	5%	4.8	0.33	1.4 to 1.65
Field Crossing	4490	900 dia and 1050 dia CSP - approx 12 long	5%	2.3	0.15 **	1.1
Mowatt Road	5581	750 dia x 11.6 long CSP	5%	2.3	0.76 **	2.4

* - MIT Standard

** - road overtopped at design discharge

3.4 Railway Drains

The drains along the east side of the railway north and south of Bunns Creek are heavily overgrown and ineffective. A drain cleanout or possibly the construction of new drains off of the railway right-of-way would be beneficial.

4 Drainage Upgrades

The following sections present the proposed upgrades to the local drainage. The proposed upgrades consist of drain reconstruction or enhanced drain cleanouts and crossing upgrades. The design criteria for the proposed upgrades are also presented. Two options for upgrade are presented for Bunns Creek including full upgrade and partial upgrade. Preliminary plan-profile drawings of the two upgrade options are appended. Upgrade options for the east and west side of Floodway Drive North and for the railway drains are also presented along with preliminary plan-profile drawings,

4.1 Design Standards and Requirements

Drains

The following hydraulic criteria were applied for the drain design:

- Design discharge – 5%.
- Water surface profile to remain at or below prairie level
- Maximum channel velocity of 0.9 m/s at design discharge

Culvert Crossings

The following hydraulic criteria were applied for culvert crossings:

- Design discharge – 5% (Municipal Roads & Crossings) or 3% (Henderson Highway)
- Maximum headloss of 0.3 m during the passage of the applicable design discharge
- Culvert soffit to remain clear at design discharge
- Culvert velocity less than 2.0 m./s at design discharge
- The drain is classified as Type C (complex habitat with non-indicator species) downstream of Henderson Highway and Type E upstream (indirect habitat) of Henderson Highway by Fisheries and Oceans Canada (habitat classification map appended). As such, there are no limiting culvert velocity requirements or embedment requirements.

4.2 Upgrade Options - Bunns Creek

Full Upgrade Option

The full upgrade option for Bunns Creek would be an all encompassing upgrade including full drain cleanout and reconstruction and culvert crossings upgrades. Water surface profiles with the full upgrade are presented in Figure 3.

The drain would have either enhanced drain cleanout or full reconstruction over the length of the drain. The reconstruction would involve reshaping the drain to the proposed geometric template with sufficient berms and spoil berm offsets. The geometric template proposed for the drain is as follows:

- Base width = 3.0 m
- Side Slopes = 3:1
- The proposed channel grades are summarized in Table 3

Table 3
Bunns Creek
Full Upgrade Option - Channel Grades and Upgrades Required

Location	Sta (m)	Elevation (m)	Grade	Drain Upgrade Required
Downstream limit of project	19+05	219.00		
			1.1%	None required
Bunns Road	23+34	223.72		
			0. 285%	None required
Henderson Highway (PR 204)	27+28	224.83		
			0.125%	Drain Reconstruction
Railway	39+78	226.40		
			0.125%	Drain Reconstruction
Field Crossing	44+90	227.04		
			0.135%	Drain Reconstruction
Mowatt Road	55+81	228.51		
			0.135%	Cleanout to Grade
Floodway Drive North	57+50	228.74		

All of the crossings would be upgraded for this option including Henderson Highway (PR 204) and the railway. Both have been assumed to be installed with open cut, however Manitoba Infrastructure and the Railway may require jacking which would significantly increase installation cost. The proposed crossing upgrades for the full upgrade option are summarized in Table 4.

Table 4

Bunns Creek

Hydraulic Summary - Proposed Crossings for Full Upgrade

Location	Station	Proposed Crossing	Assessment (Design) Discharge		Headloss at Assessment Discharge (m)	Culvert Velocities at Assessment Discharge (m)
			Probability	(m^3/s)		
Bunns Road	2334	2 - 2400 dia x 20 long CSP	5%	8.1	0.20	2.0
Driveway	2685	2 - 2400 dia x 18 long CSP	5%	8.0	0.20	1.65
Henderson Highway (PR 204)	2728	2 - 2100 dia x 35 long PCC	3% *	9.1	0.15	1.75
Railway (Formerly CNR)	3978	2 - 1600 dia x 16 long CSP	5%	4.8	0.30	1.8
Field Crossing	4490	2 - 1200 dia x 13 long CSP	5%	2.3	0.20	1.4
Mowatt Road	5581	2 - 1200 dia x 15 long CSP	5%	2.3	0.29	1.7

* - MIT Standard

Partial Upgrade Option

The partial upgrade option shares some upgrades with that of the full upgrade option, however only two crossings (Mowatt and downstream field crossing) are proposed to be upgraded to help reduce the overall cost. Water surface profiles with the partial upgrade are presented in Figure 4. Water surface profiles comparing the proposed partial upgrade option, to the full upgrade option and to existing conditions are presented in Figure 5.

The drain would have either enhanced drain cleanout or full reconstruction over the length of the drain. The reconstruction would involve reshaping the drain to the proposed geometric template with sufficient berms and spoil berm offsets. The geometric template proposed for the drain is as follows:

- Base width = 3.0 m
- Side Slopes = 3:1
- The proposed channel grades are summarized in Table 5

Table 5
Bunns Creek
Partial Upgrade Option - Channel Grades and Upgrades Required

Location	Sta (m)	Elevation (m)	Grade	Drain Upgrade Required
Downstream limit of project	19+05	219.00		
			1.1%	None required
Bunns Road	23+34	223.72		
			0. 285%	None required
Henderson Highway (PR 204)	27+25	224.83		
			0.285%	Cleanout to Grade
Upstream Henderson Highway (east ditch)	27+60	224.93		
			2.5%	Rock transition
At Henderson Highway (east ditch)	27+90	225.69		
			0.06%	Drain Reconstruction
Railway	39+78	226.40		
			0.125%	Drain Reconstruction
Field Crossing	44+90	227.04		
			0.135%	Drain Reconstruction
Mowatt Road	55+81	228.51		
			0.135%	Cleanout to Grade
Floodway Drive North	57+50	228.74		

Only the crossing at Mowatt Road and the downstream field crossing would be upgraded for this option, with the remaining crossings would unchanged. The proposed crossing upgrades for the partial upgrade option are summarized in Table 6.

Table 6

Bunns Creek

Hydraulic Summary - Proposed Crossings for Partial Upgrade

Location	Station	Proposed Crossing	Assessment (Design) Discharge		Headloss at Assessment Discharge (m)	Culvert Velocities at Assessment Discharge (m)
			Probability	(m^3/s)		
Bunns Road	2334	No change to existing (2 - 1600 dia x 15.2 long CSP)	5%	8.1	0.81	2.55 to 3.0
Driveway	2685	No change to existing (2 - 1500 dia x 10.1 long PCC)	5%	8.0	0.69	3.0 to 4.6
Henderson Highway (PR 204)	2728	No change to existing (2 - 1500 dia x 23.2 long CSP)	3% *	9.1	0.90	2.6
Railway (Formerly CNR)	3978	No change to existing (3 - 750 dia and 1200 dia CSP - approx 13 long)	5%	4.8	0.36	1.5 to 1.75
Field Crossing	4490	2 - 1200 dia x 13 long CSP	5%	2.3	0.13	1.0
Mowatt Road	5581	2 - 1200 dia x 15 long CSP	5%	2.3	0.29	1.5

* - MIT Standard

4.3 Proposed Upgrade - Floodway Drive North

The east and west drains along Floodway Driver North will require upgrade from PTH 44 north to Mowatt Road. Both drains require cleanout to grade, with a proposed grade of 0.04%, a 1 m wide base and 3:1 side slopes. The culvert crossings will require upgrade along the entire length of each drain with culverts replaced as follows:

- East Drain - 750 diameter corrugated steel culverts (CSP) south of Clarke Road and 1000 diameter CSP north of Clarke Road.
- West Drain - 900 diameter CSP south of Clarke Road and 1050 diameter CSP north of Clarke Road.

Additionally the Floodway Drive North through-grade culvert at Mowatt Road would also require upgrade to a 1050 diameter CSP to convey runoff from the east side of Floodway Drive North to Bunns Creek.

Plan-profile drawings are appended.

4.4 Proposed Upgrade - Railway Drains

The east drain along the railway embankment from Bunns Creek to Mowatt Road can be reconstructed to grade the drain north to Bunns Creek. Sufficient grade exists to ensure proper drainage. The drain can be reconstructed entirely within the existing drain alignment however the drain could be completely offset to the east outside of the railway right-of-way if there are concerns working adjacent to the railway.

The east drain along the railway embankment for approximately 800 m north of Bunns Creek can have a cleanout to grade. The grades further north however would not permit directing the runoff to Bunns Creek and would continue to flow north to PR 509.

Plan-profile drawings are appended.

4.5 Cost Estimates

Feasibility level capital costs estimates for the proposed drainage improvements have been prepared for each option. The capital cost estimates, are summarized in Table 7 and include the following where applicable:

- Material costs – culverts, riprap, etc.
- Installation – cost for riprap placement, drain excavation and reshaping, culvert installation, gradient control structure reconstruction, etc.
- Land purchase and Utilities
- Mobilization and Demobilization – costs incurred by contractor to bring equipment to site
- Erosion and Sediment Control
- Site Supervision
- Contingency – 25%

Table 7
Drainage Upgrades
Summary of Capital Cost Estimates

Drainage Improvements	Estimated Cost ($)
Bunns Creek	
• Full Upgrade Option	$875,000
• Partial Upgrade Option	$385,000
Floodway Drive North	$395,000
Railway Drains	$110,000

Note: The cost estimates are exclusive of applicable taxes.

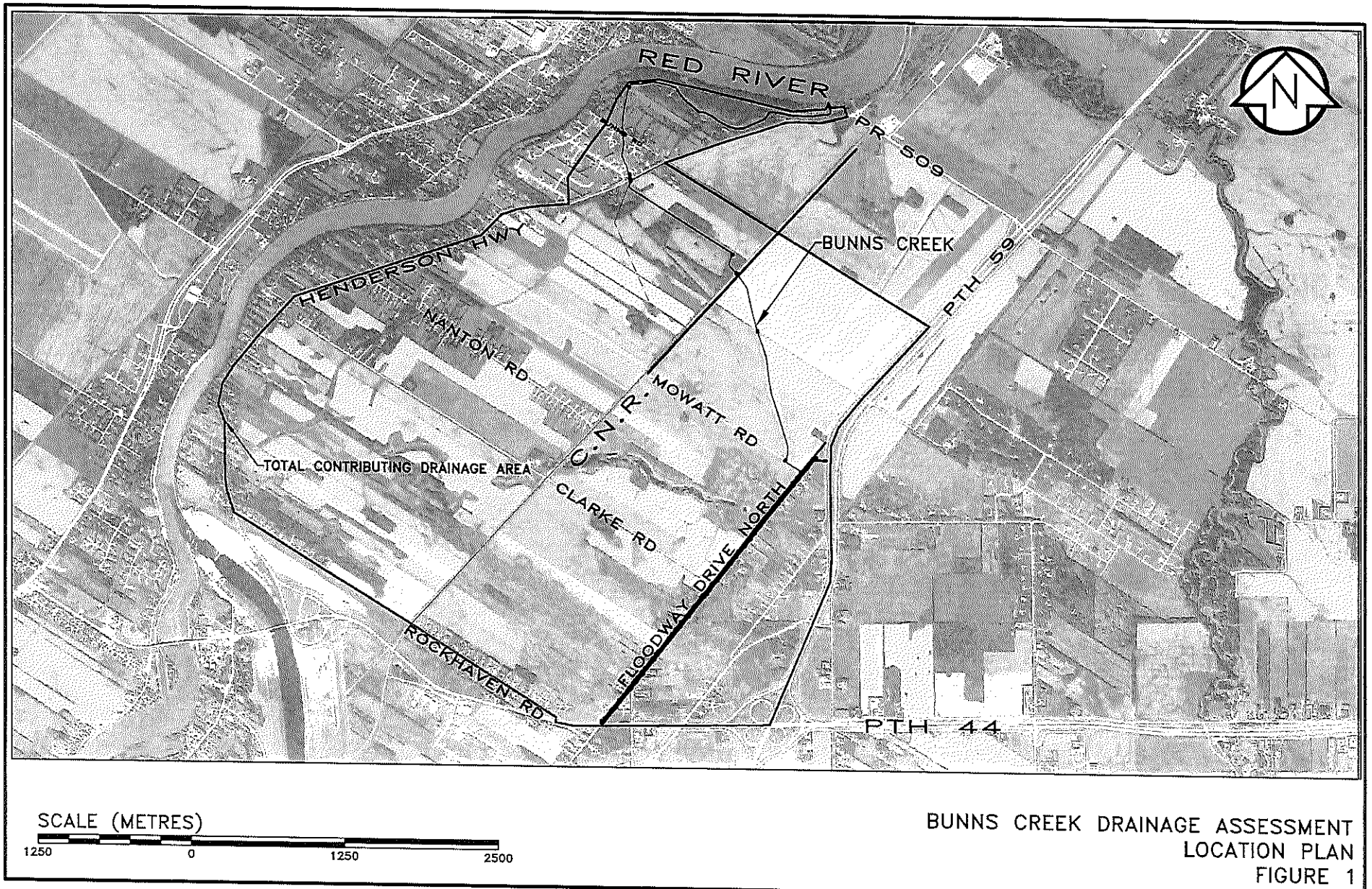
5 Conclusions and Recommendations

The existing drainage within Bunns Creek, although reasonably effective, could be improved through drain reconstruction, drain cleanouts and crossing upgrades. Two options for upgrade have been proposed for Bunns Creek, however it is recommended that the partial upgrade option be considered as it provides the necessary improvements, while minimizing cost. .Detailed plan-profile drawings for the partial upgrade option, complete with the proposed drain design and crossing upgrades, are appended for reference.

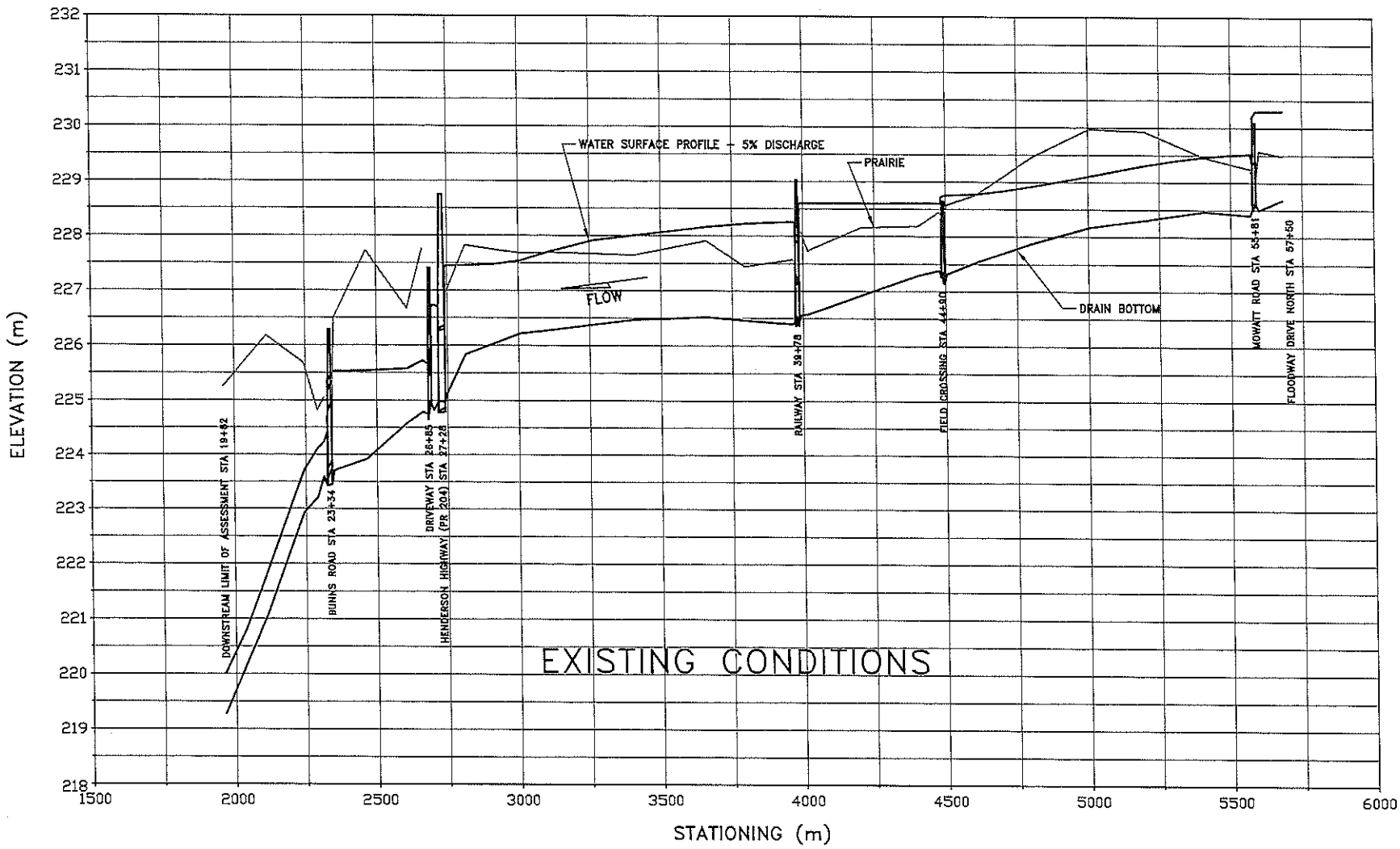
Additional options for upgrading the drainage along Floodway Drive North and the railway are also presented including plan-profile drawings. The poor drainage noted along Floodway Drive North can be attributed to low slope, but more notably the larger number of culvert crossings. It is recommended that consideration be given for service roads for future developments of this nature within the RM to limit the number of drain crossings. This reduction in the number of crossings will improve drainage and reduce maintenance efforts.

Efforts for drainage improvement should be focused on upgrades to Bunns Creek first starting at Henderson Highway and working upstream. Upgrades to Floodway Drive North as funding permits can be completed following completion of the upgrades to Bunns Creek. The drainage work adjacent to the railway, although beneficial, should be undertaken after completion of upgrades' to Bunns Creek and Floodway drive North.

Figures

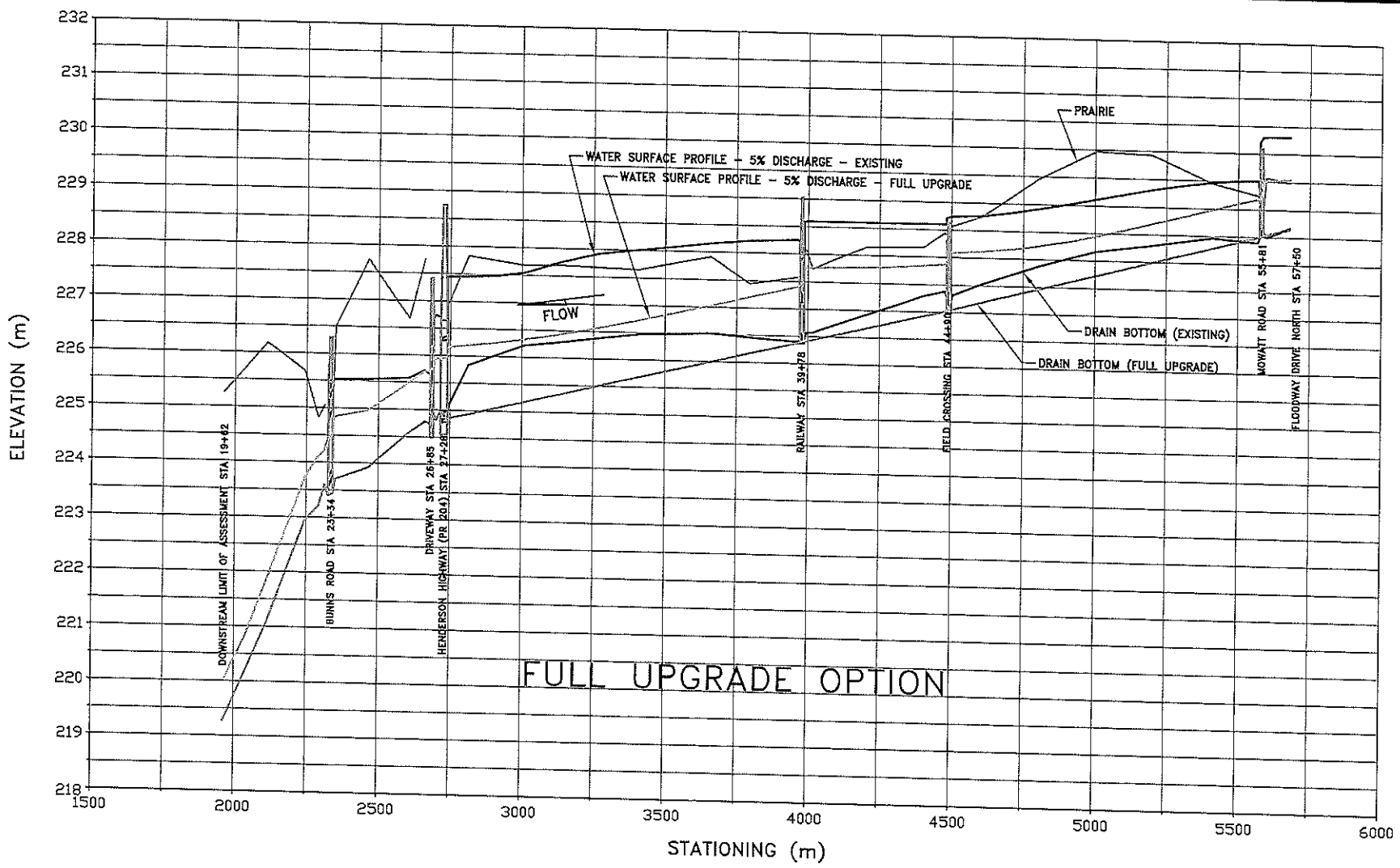


BUNNS CREEK DRAINAGE ASSESSMENT
LOCATION PLAN
FIGURE 1



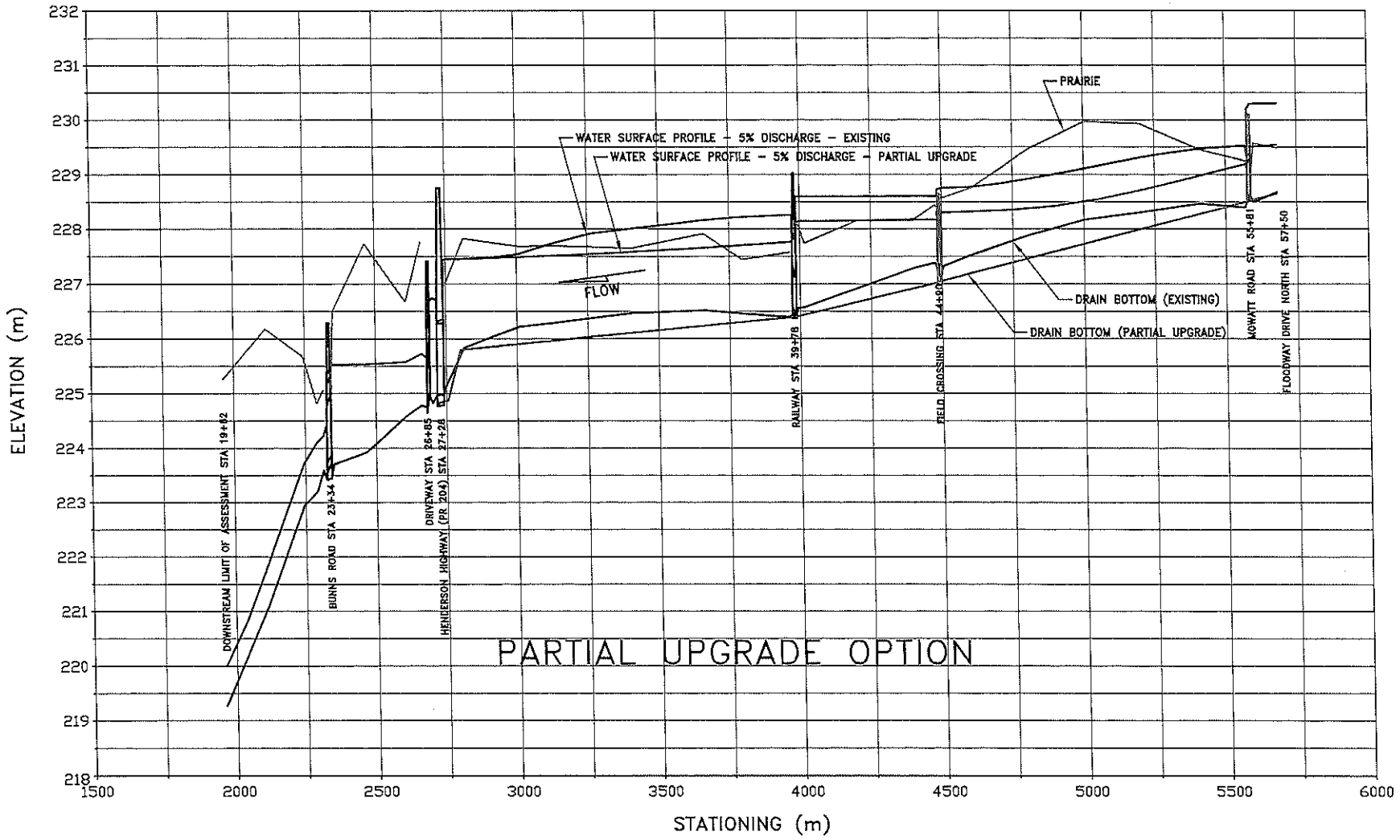
NOTES:
1) SURVEYED SEPTEMBER 2016 BY GDS SURVEYS
2) WATER SURFACE PROFILES REFLECT EXISTING CONDITIONS (DRAIN, CROSSINGS) – SEPTEMBER 2016

BUNNS CREEK
WATER SURFACE PROFILES
EXISTING CONDITIONS
FIGURE 2



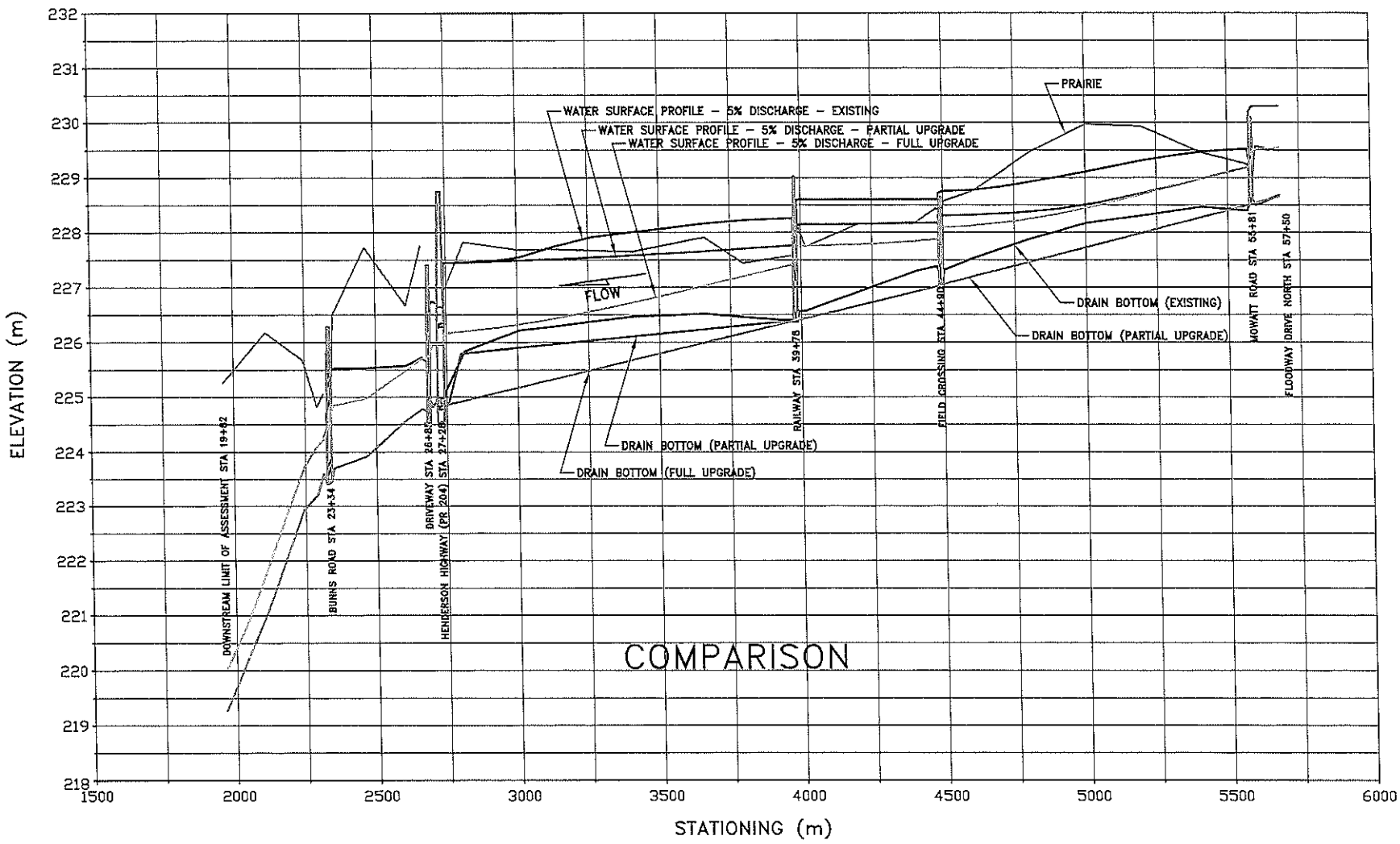
NOTES:
1) SURVEYED SEPTEMBER 2016 BY GDS SURVEYS
2) WATER SURFACE PROFILES REFLECT FULL UPGRADE CONDITIONS (DRAIN, CROSSINGS)

BUNNS CREEK
WATER SURFACE PROFILES
FULL UPGRADE OPTION
FIGURE 3



NOTES:
1) SURVEYED SEPTEMBER 2016 BY GDS SURVEYS
2) WATER SURFACE PROFILES REFLECT PARTIAL UPGRADE CONDITIONS (DRAIN, CROSSINGS) – SEPTEMBER 2016

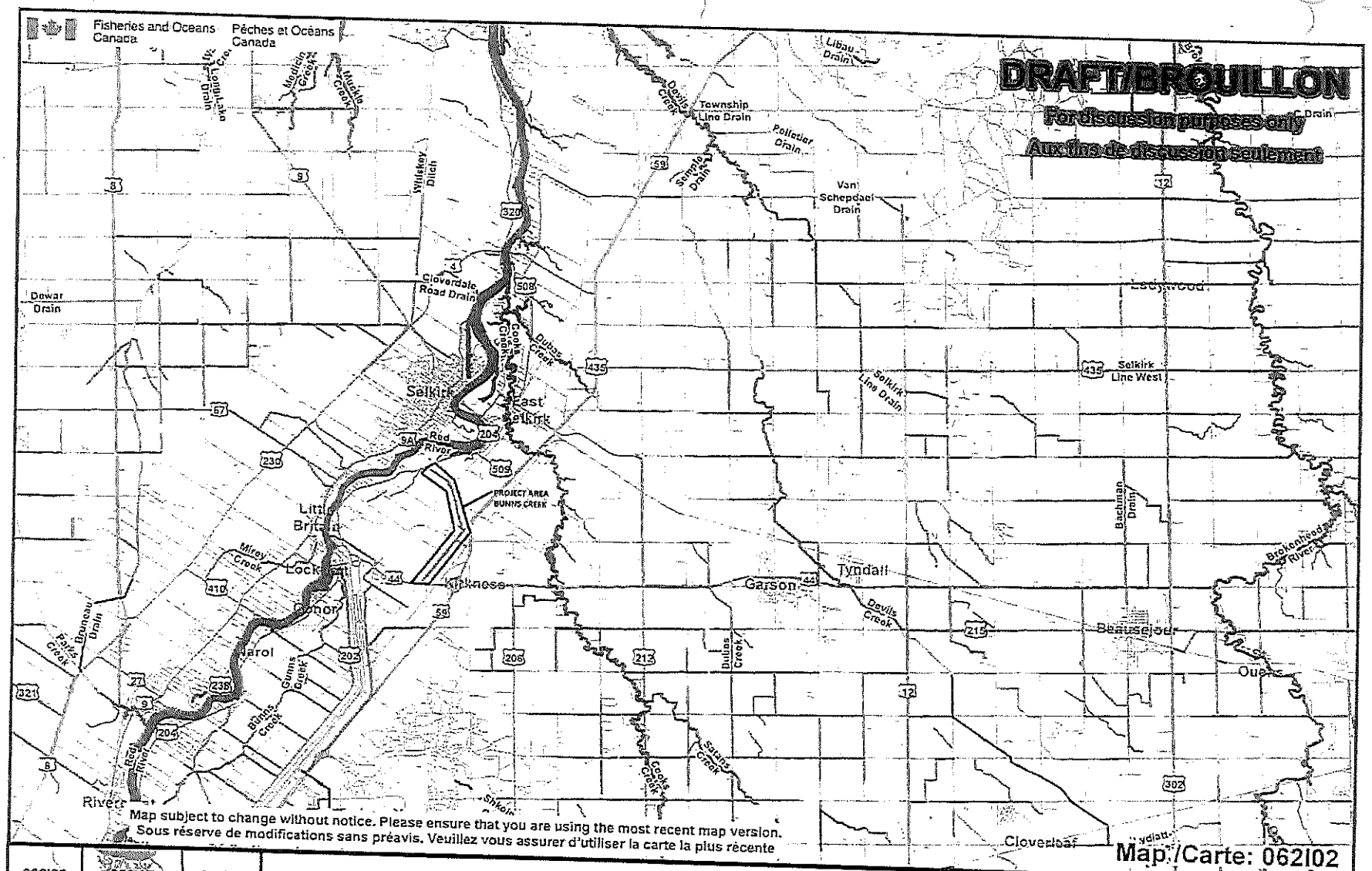
BUNNS CREEK
WATER SURFACE PROFILES
PARTIAL UPGRADE OPTION
FIGURE 4



NOTES:
1) SURVEYED SEPTEMBER 2016 BY GDS SURVEYS
2) WATER SURFACE PROFILES REFLECT EXISTING, PARTIAL UPGRADE AND FULL UPGRADE CONDITIONS (DRAIN, CROSSINGS) – SEPTEMBER 2016

BUNNS CREEK
WATER SURFACE PROFILES
COMPARISON – PROPOSED OPTIONS TO EXISTING
FIGURE 5

Appendix A
Fish Habitat Classification Map



062I06	062I07	062I08
062I03	062I02	062I01
062H14	062H15	062H16

Kilometers 0 1 2 4 6 8 10 Kilomètres

Miles 0 1 2 4 6 Miles

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

Appendix B
Preliminary Plan-Profile Drawings
Bunns Creek