

**APPENDIX 2:**  
**RESULTS OF A PERIPHYTON SURVEY OF THE ASSINIBOINE RIVER,**  
**DOWNSTREAM OF THE MIXING ZONE, AUGUST 2002.**



## TABLE OF CONTENTS

1.0	INTRODUCTION .....	301
2.0	APPROACH AND METHODS .....	303
3.0	RESULTS AND DISCUSSION .....	305
3.1	QUALITATIVE ASSESSMENT OF PERIPHYTON COLONIZATION .....	305
3.2	QUANTITATIVE ASSESSMENT OF PERIPHYTON .....	305
4.0	CONCLUSIONS.....	307
5.0	LITERATURE CITED.....	308

## LIST OF TABLES

- Table 1. Densities of periphyton, expressed as chlorophyll *a*, and percentage composition of pheophytin.

## LIST OF FIGURES

- Figure 1. Locations of river reaches where the periphyton survey was conducted, August 2002. Numbers in blue denote the locations of water quality sampling sites for intensive monitoring studies.
- Figure 2. Locations of periphyton sampling sites for quantitative analysis of chlorophyll *a*, August 2002. Periphyton sampling sites are indicated by red circles. Numbers in blue denote the locations of water quality sampling sites for intensive monitoring studies.
- Figure 3. Periphyton on cobble substrate at site 11, just upstream of the PTH 34 Bridge.
- Figure 4. Small pebbles with filamentous algae in Reach 2, just downstream of periphyton sampling site 9aPer.
- Figure 5. Blankets of periphyton on the river bottom at sampling site 8 (Treesbank).
- Figure 6. Blankets of periphyton on the river bottom in Reach 2, just upstream of site 10 at the PTH 5 Bridge.
- Figure 7. Partially exposed cobble flat in Reach 1, at periphyton sampling site 8aPer.
- Figure 8. Partially exposed cobble flat in Reach 2, at periphyton sampling site 9aPer.
- Figure 9. Partially exposed cobble flat in Reach 3, near periphyton sampling site 11Per.
- Figure 10. Cobble collected near site 8, August 08, 2002.
- Figure 11. Cobble collected from the right bank site 8aPer from a depth of 0.5 to 0.6 m (Reach 1), August 07, 2002. Evidence of recent water level changes can be seen on the background cobble.
- Figure 12. Cobble collected from the left bank site 9aPer from a depth of approximately 0.15 m (Reach 2), August 08, 2002.
- Figure 13. Cobble collected from the centre channel site 10Per from a depth of approximately 0.3 to 0.45 m (Reach 2), August 08, 2002.
- Figure 14. Cobble collected from the right bank site 11Per from a depth of approximately 0.15 to 0.3 m (Reach 3), August 09, 2002.
- Figure 15. Large rock at site 11Per (Reach 3) with patchy periphyton, August 09, 2002. Areas where algae has sloughed off are evident on the surface.



## 1.0

## INTRODUCTION

The Assiniboine River Monitoring Study, conducted by Earth Tech Canada Inc. (formerly Reid Crowther and Partners Ltd.) and North/South Consultants Inc. was initiated in 1998 and is continuing at the present time. The main objective of the study is to assess the effects of effluent release from the industrial wastewater treatment facility (IWWTF) constructed for the Maple Leaf hog processing plant, which became operational in September 1999, on water quality in the Assiniboine River from Brandon downstream to Portage la Prairie.

Through the conduct of this study, it was noted that substantive periphyton colonize the Assiniboine River within the effluent mixing zone. It has also been suggested that periphyton may play a significant role in the removal of nutrients from the water column, owing to the relatively high densities of algae that have been observed in the mixing zone and the observed decline in nutrients (Cooley et al. 2001).

High densities of periphyton may impair water quality in two fashions. Firstly, although the removal of nutrients from the water column by growing periphyton may decrease the available nutrients for growth of phytoplankton, and therefore may reduce the potential for development of nuisance algal blooms, high densities of periphyton may also cause large diurnal declines in dissolved oxygen (DO) due to respiration processes. Decreases in DO due to periphyton may create or exacerbate existing diurnal declines in DO. Additionally, seasonal death and decay of periphyton (typically in the fall) may further contribute to dissolved oxygen depletion in the Assiniboine River, as microbial decay of organic matter is an aerobic process. These declines are important because low levels of dissolved oxygen may be harmful to aquatic life. Periphyton may also impair the aesthetic quality of surface waters and may impinge upon the quality of surface waters used for recreation.

Previous studies of periphyton densities in the Assiniboine River have been conducted in conjunction with water quality monitoring as a component of the Assiniboine River Monitoring Study. These periphyton assessments have been limited to sites within the effluent mixing zone. Densities of periphyton at these sites have been observed to be high, relative to the scientific literature and water quality objectives for other jurisdictions (there are currently no numeric objectives for periphyton densities in Manitoba). The need to determine the presence and abundance of periphyton downstream of the mixing zone was identified in relation to the proposed expansion of the Maple Leaf Meats Hog Processing Plant from a one-shift to a two-shift capacity. The guidelines issued by Manitoba Conservation for the conduct of an

Environmental Impact Statement (EIS) for this proposed expansion, included the following statement:

“no further net increase in total nitrogen and total phosphorus due to the proposed Development will occur to the Assiniboine River unless it can be clearly shown from the river studies and the water quality model that no effect will be observed on algal growth, while bearing in mind that upon the completion of Manitoba’s *Nutrient Management Strategy*, it may be necessary to further reduce concentrations of nitrogen and phosphorus releases to the river.”

To address the implications of this statement, in terms of its relevance to the ML hog processing plant, a reconnaissance survey was conducted of the occurrence of suitable substrate and periphyton colonization in areas downstream of the mixing zone, outside of the areas where previous work had been focussed. The objective of this undertaking was to determine if an increase in nutrient loads to the river could potentially increase the growth of periphyton downstream of the mixing zone. Specifically the objectives of the survey were:

- to determine if suitable substrate for periphyton growth is present downstream of Site 8;
- to evaluate the colonization of any observed suitable substrate by periphyton (qualitative);
- to measure the densities of periphyton at selected locations (quantitative).

This report presents the results of the periphyton survey and a brief discussion pertaining to implications of the results.

## 2.0

## APPROACH AND METHODS

The reconnaissance survey of periphyton growth in representative stretches of the Assiniboine River was conducted from August 07-09, 2002. River reaches that were evaluated during the survey were selected based on the suspected occurrence of suitable substrate for periphyton growth (cobble, rocks, boulders) downstream of Site 8. Final sampling areas were also selected in consideration of accessibility and logistics of sampling.

The focus of the survey was placed downstream of Site 8 (Treesbank) because the river is fully mixed beyond site 8 and because no periphyton sampling has been conducted beyond that point in previous studies. Furthermore, as only limited areas of the river are accessed downstream of Site 8 during the conduct of the river monitoring conducted during the Assiniboine River Monitoring Study, the occurrence of suitable substrate for periphyton growth, and the presence and densities of periphyton, were not known.

Stretches of the Assiniboine River that were surveyed included (Figure 1):

- Reach 1: approximately 7 km stretch between water quality sampling sites 8 and 9, beginning from the Treesbank Ferry site to approximately 0.5 km downstream of the confluence with the Souris River;
- Reach 2: approximately 18.5 km stretch, beginning downstream of site 9 and extending to approximately 2 km downstream of Site 10 (Spruce Sands area); and,
- Reach 3: approximately 2 km stretch, beginning immediately upstream of at Site 11 (PTH 34 bridge).

In addition, because periphyton presence and abundance vary seasonally and can change rapidly with changes in environmental conditions (e.g., temperature), Site 8 was also evaluated at the time of the survey to provide context for the observed presence and densities of periphyton in these downstream reaches at that particular time.

The occurrence of substrate and periphyton was assessed qualitatively throughout the areas that were accessed in the study. The type of bottom substrate was evaluated along all stretches of river accessed at the time of the survey through prodding and visual assessment. Where suitable substrate was observed, a visual assessment was made of the occurrence of periphyton. Representative photographs were taken of the occurrence of periphyton.

Quantitative assessments of periphyton densities were conducted at five locations: Site 8Per; Site 8aPer; Site 10Per; and, Site 11Per (Figure 2). At these sites, five rocks of sufficient size to

accommodate sampling were randomly selected across the river channel (right, centre, and left channel samples were obtained at every site) and periphyton samples were obtained. In total, five replicate samples were collected for each site where quantitative analysis was conducted.

Algae were collected by thoroughly scraping two 2.0" X 2.0" (5.1 cm X 5.1 cm) square areas on the upward faces of representative cobble. One sample from each cobble was used for chlorophyll *a* analysis and the other was collected and archived for measurement of ash-free dry mass (biomass). The algae samples were scraped directly into sealable polyethylene bags. A small amount of water was added to samples to be used for chlorophyll *a* analysis to prevent sample dessication. Samples were immediately placed in coolers where they were kept cold and dark until delivered to EnviroTest Laboratories (chlorophyll *a* samples) or transferred into freezers (biomass samples). A representative sample of the periphyton was scraped from the cobble, placed in glass scintillation vials, the vials were filled with river water, and the samples were preserved with Lugol's solution. These samples were archived should the desire to identify and enumerate algae arise in the future.

All analyses were performed by Enviro-Test Laboratories. Chlorophyll *a* was analysed using the standard spectrophotometric method following sample filtration and total sample extraction in methanol.

### 3.0 RESULTS AND DISCUSSION

The following is a synopsis of results obtained from the periphyton survey conducted in August 2002. Information is presented from the qualitative and quantitative assessments below.

#### 3.1 QUALITATIVE ASSESSMENT OF PERIPHYTON COLONIZATION

In general, periphyton was observed to have colonized all 'suitable' substrate within the areas accessed in the Assiniboine River in August 2002. These substrates included cobble (Figure 3), the typical substrate for periphyton in the Assiniboine River, and all other available substrates such as woody debris and clams. Attached algae was also observed growing on sandy substrates (i.e., epipsammon) in some areas and small pebbles (Figure 4). The presence of attached algae on unstable substrate (i.e., sand) in August 2002 was likely possible owing to the low river discharges and subsequent low river velocities which facilitates such growing conditions for periphyton. Blankets of periphyton were observed in areas where depths were sufficiently low to obtain a clear view of the river bottom (Figures 5 and 6).

Cobble and pebble substrates were abundant in some stretches of each area accessed during the survey. Exposed cobble flats were also observed throughout the reaches accessed during the survey, indicating additional substrate for periphyton growth would be available under higher river discharges (Figures 7, 8 and 9).

Filamentous algae were abundant throughout areas accessed (Figures 10-15) and at some locations, had sloughed off (Figures 12, 14, and 15). On August 08, 2002, clumps of detached *Cladophora* were observed floating down the river in Reach 2, indicating sloughing was recent and/or on-going. Some rocks observed throughout the reaches examined were patchy and exhibited evidence of recent sloughing of filamentous algae (Figure 15).

#### 3.2 QUANTITATIVE ASSESSMENT OF PERIPHYTON

Densities of chlorophyll *a* and percentage composition of pheophytin measured in periphyton sampled from sites 8, 8a, 9a, 10, and 11 are presented in Table 1. The densities of chlorophyll *a* at site 8 (Treesbank) were similar to those measured in June and July 2002 but lower than densities measured in late August, 2002 during the conduct of the intensive monitoring programs

(Toews 2002). The fraction of pheophytin was higher, however, in these samples relative to the data collected during the intensive monitoring. Densities were similar across all sites examined.

High densities of periphyton may be associated with large diurnal fluctuations in oxygen, and the occurrence of critically low oxygen levels at nighttime, which may adversely affect aquatic life. Although no numeric water quality criteria or guidelines for periphytic algae have been proposed for the province of Manitoba, the B.C. Ministry of the Environment has adopted a maximum criterion of 100 mg chlorophyll *a*/m<sup>2</sup> for the protection of aquatic life in streams and a criterion of 50 mg/m<sup>2</sup> for preservation of recreational use of streams (Cooley et al. 2001). In addition, Carr and Chambers (1998) recommended a guideline of 100 mg/m<sup>2</sup> (seasonal mean) for maintenance of ‘intermediate water quality’ and 50 mg/m<sup>2</sup> for high water quality, in Alberta, based on the occurrence of densities measured upstream of major point sources of nutrient input. Similarly, Dodds et al. (1998) reported that periphyton densities between 70 and > 200 mg/m<sup>2</sup> were indicative of eutrophication in streams. Periphyton chlorophyll *a* densities measured during the periphyton survey as far downstream of Brandon as site 11 (approximately 185 km downstream of Brandon) were well above 100 mg/m<sup>2</sup> and therefore above criteria that have been proposed for the protection of water quality.

## 4.0

## CONCLUSIONS

Periphyton were abundant throughout areas accessed downstream of the mixing zone in August 2002 and had colonized all available substrates that were examined. This study determined:

1. Suitable substrate for periphyton is present and may be relatively abundant in some reaches of the river, downstream of the mixing zone. The abundance of cobble substrate is lower under low river discharges.
2. Under the conditions that occurred in August 2002, periphyton were able to colonize all types of substrates in the areas accessed, including cobble, small pebbles, clams, debris, and sand.
3. Densities of periphyton measured at several locations downstream of the mixing zone were comparable and were similar to those observed at site 8 (i.e., the end of the mixing zone) at the time of the survey.

## 5.0

## LITERATURE CITED

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## **TABLES AND FIGURES**



Table 1. Densities of periphyton, expressed as chlorophyll *a*, and percentage composition of pheophytin.

Date	Sample	Chlorophyll <i>a</i> (µg)	Pheophytin (µg)	Chlorophyll <i>a</i> /unit area (mg/m <sup>2</sup> )	Pheophytin/unit area (mg/m <sup>2</sup> )	Total Chlorophyll <i>a</i> /unit area (mg/m <sup>2</sup> )	Pheophytin (%)
7-Aug-02	8Per1L	680	280	263.5	108.5	372.0	29.2
	8Per2L	710	720	275.1	279.0	554.1	50.3
	8Per3C	590	600	228.6	232.5	461.1	50.4
	8Per4C	770	750	298.4	290.6	589.0	49.3
	8Per5R	930	500	360.4	193.8	554.1	35.0
Mean		736	570	285.2	220.9	506.1	42.8
7-Aug-02	8APer1R	1100	990	426.3	383.6	809.9	47.4
	8APer2C	470	260	182.1	100.8	282.9	35.6
	8APer3C	650	330	251.9	127.9	379.8	33.7
	8APer4L	660	400	255.8	155.0	410.8	37.7
	8APer5L	570	230	220.9	89.1	310.0	28.8
Mean		690	442	267.4	171.3	438.7	36.6
8-Aug-02	9Per1L	480	370	186.0	143.4	329.4	43.5
	9Per2L	560	110	217.0	42.6	259.6	16.4
	9Per3R	630	220	244.1	85.3	329.4	25.9
	9Per4C	790	490	306.1	189.9	496.0	38.3
	9Per5C	400	320	155.0	124.0	279.0	44.4
Mean		572	302	221.7	117.0	338.7	33.7
8-Aug-02	10Per1R	820	340	317.8	131.8	449.5	29.3
	10Per2R	1400	380	542.5	147.3	689.8	21.3
	10Per3C	1100	350	426.3	135.6	561.9	24.1
	10Per4C	600	220	232.5	85.3	317.8	26.8
	10Per5L	1000	340	387.5	131.8	519.3	25.4
Mean		984	326	381.3	126.3	507.6	25.4
9-Aug-02	11Per1R	1100	560	426.3	217.0	643.3	33.7
	11Per2R	590	300	228.6	116.3	344.9	33.7
	11Per3C	1300	760	503.8	294.5	798.3	36.9
	11Per4C	340	160	131.8	62.0	193.8	32.0
	11Per5L	190	67	73.6	26.0	99.6	26.1
Mean		704	369	272.8	143.1	415.9	32.5



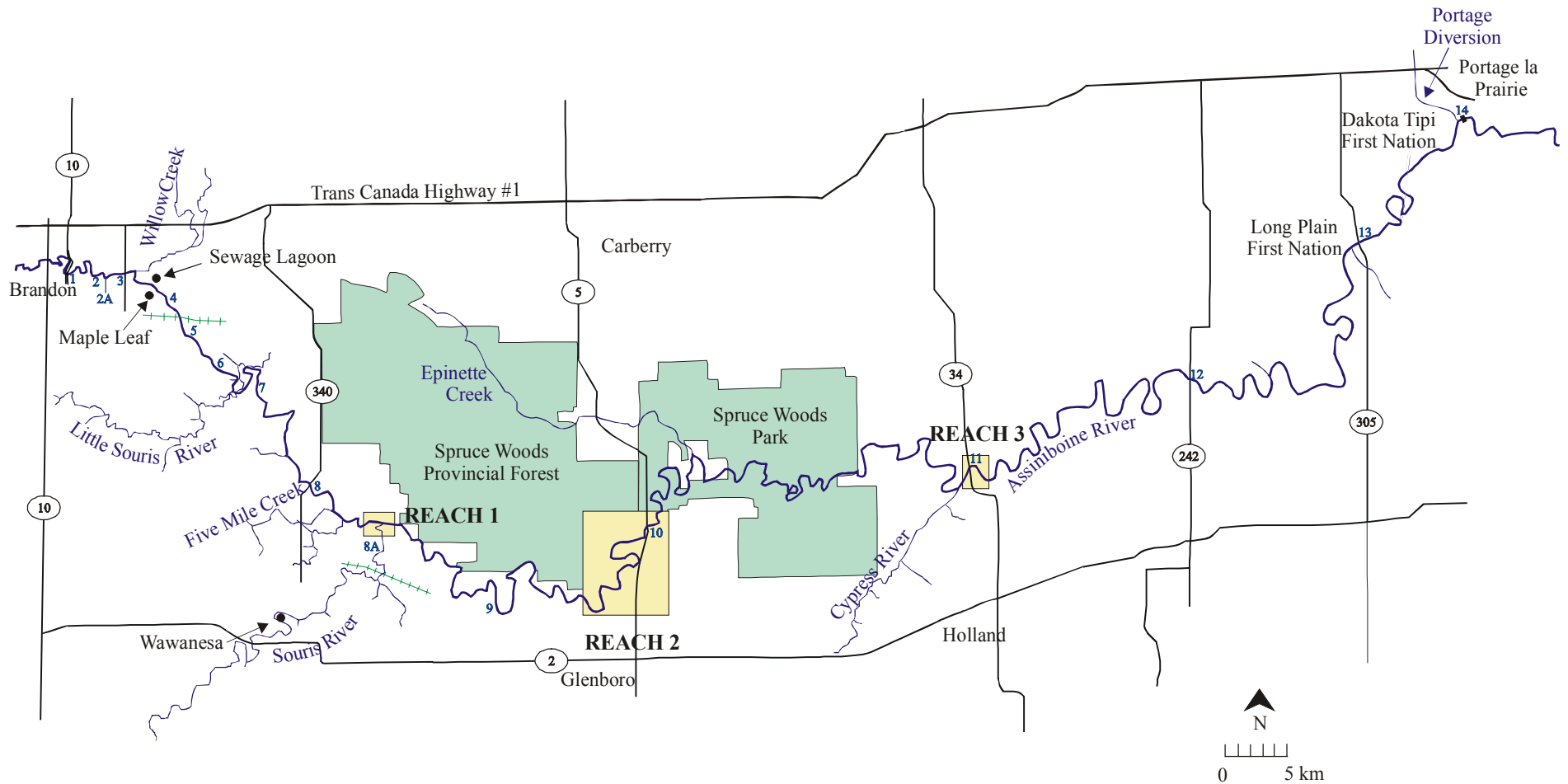


Figure 1. Locations of river reaches where the periphyton survey was conducted, August 2002. Numbers in blue denote the locations of water quality sampling sites for intensive monitoring studies.

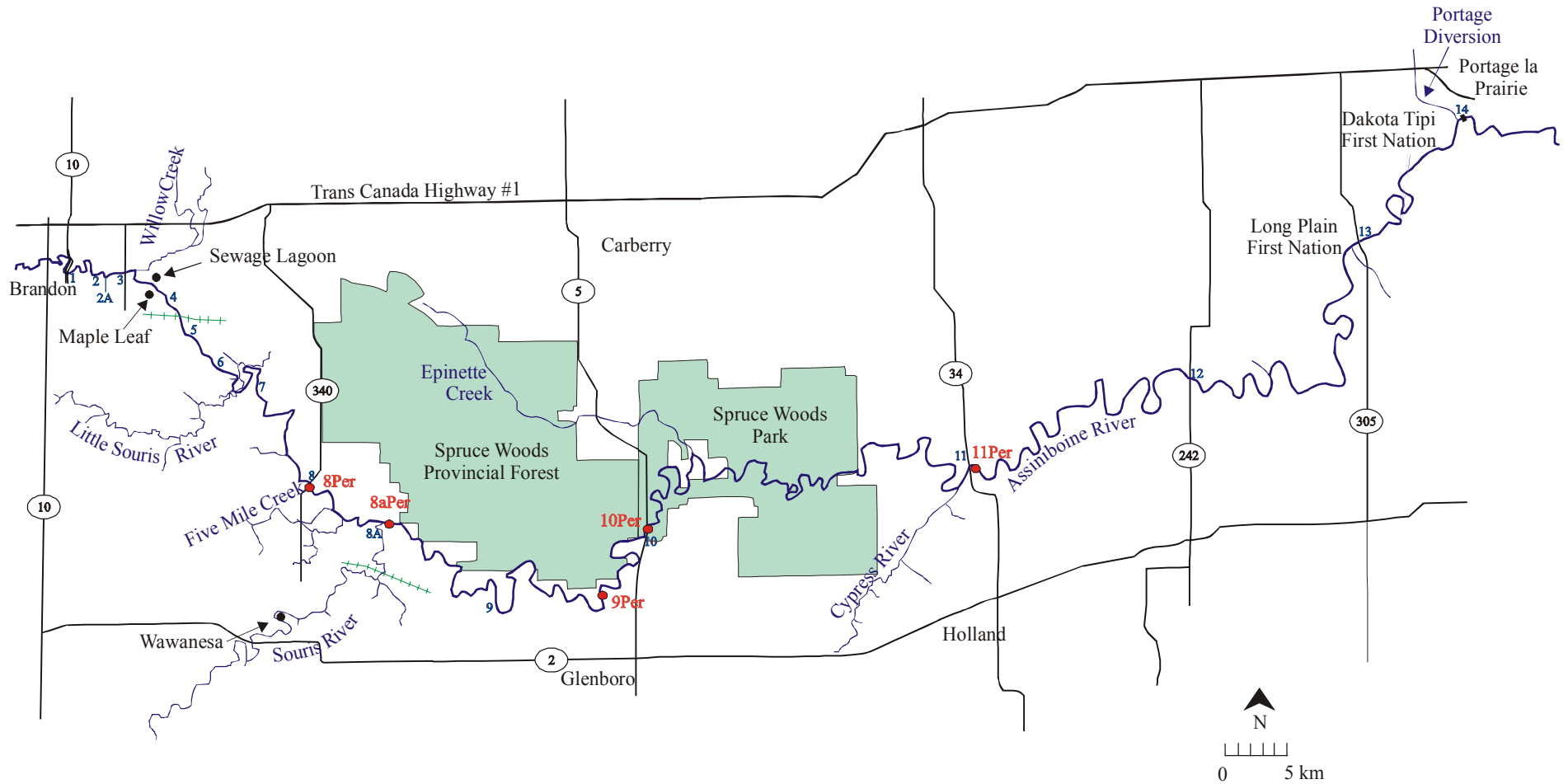


Figure 2. Locations of periphyton sampling sites for quantitative analysis of chlorophyll *a*, August 2002. Periphyton sampling sites are indicated by red circles. Numbers in blue denote the locations of water quality sampling sites for intensive monitoring studies.



Figure 3. Periphyton on cobble substrate at site 11, just upstream of the PTH 34 Bridge.



Figure 4. Small pebbles with filamentous algae in Reach 2, just downstream of periphyton sampling site 9aPer.



Figure 5. Blankets of periphyton on the river bottom at sampling site 8 (Treesbank).



Figure 6. Blankets of periphyton on the river bottom in Reach 2, just upstream of site 10 at the PTH 5 Bridge.



Figure 7. Partially exposed cobble flat in Reach 1, at periphyton sampling site 8aPer.



Figure 8. Partially exposed cobble flat in Reach 2, at periphyton sampling site 9aPer.



Figure 9. Partially exposed cobble flat in Reach 3, near periphyton sampling site 11Per.



Figure 10. Cobble collected near site 8, August 08, 2002.



Figure 11. Cobble collected from the right bank site 8aPer from a depth of 0.5 to 0.6 m (Reach 1), August 07, 2002. Evidence of recent water level changes can be seen on the background cobble.



Figure 12. Cobble collected from the left bank site 9aPer from a depth of approximately 0.15 m (Reach 2), August 08, 2002.



Figure 13. Cobble collected from the centre channel site 10Per from a depth of approximately 0.3 to 0.45 m (Reach 2), August 08, 2002.



Figure 14. Cobble collected from the right bank site 11Per from a depth of approximately 0.15 to 0.3 m (Reach 3), August 09, 2002.



Figure 15. Large rock at site 11Per (Reach 3) with patchy periphyton, August 09, 2002. Areas where algae has sloughed off are evident on the surface.

