Keeyask Infrastructure Project

Terrestrial and Aquatic Monitoring Plan

Water Quality Monitoring

Annual Report 2014-2015

Hydropower Limited Partnership

December 2015

KEEYASK INFRASTRUCTURE PROJECT

TERRESTRIAL AND AQUATIC MONITORING PLAN

Water Quality: Annual Report 2014 - 2015

Report for

MANITOBA CONSERVATION AND WATER STEWARDSHIP

Prepared on Behalf of the
Keeyask Hydropower Limited Partnership

By

North/South Consultants Inc.
&
Environmental Licensing & Protection Department
Manitoba Hydro

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1.0 INTRODUCTION

The Keeyask Hydropower Limited Partnership constructed the Keeyask Infrastructure Project (the Project or KIP) between 2012 to July 2014, after which construction of the Keeyask Generation Project began.

The KIP is located approximately 40 km southwest of Gillam, extending between Provincial Road (PR) 280 and Gull Rapids on the Nelson River. The Project includes a start-up camp and associated infrastructure, a 25 km all-weather access road and the first phase of a main camp. The start-up camp is located near the intersection of PR 280 and the access road, while the first phase of the main camp is located at the end of the access road on the north side of Gull Rapids.

The predicted environmental effects of the KIP are described in the *KIP Environmental Assessment Report* (KHLP 2009). The following describes sampling methods and results from the water quality monitoring program conducted in the vicinity of two stream crossings along the KIP access road from April 1, 2014 to March 31, 2015. This work was conducted in accordance with Section 2.0 of the *Keeyask Infrastructure Project Terrestrial and Aquatic Monitoring Plan*.

Water quality monitoring was conducted at two stream crossings: Looking Back Creek and an unnamed tributary to the South Moswakot River ("Unnamed Tributary") (Figure 1). Sampling occurred on June 22, July 19, September 26, and October 26, 2014.

A permanent clear-span bridge was constructed over Looking Back Creek during 2012/early 2013 (Figure 2) and a culvert was installed in the Unnamed Tributary in early 2012 (Figure 3). Monitoring conducted in 2014 represents the second and final year of post-construction water quality monitoring; the program is designed to determine if there are any differences in water quality upstream versus downstream of each of the road crossings. The water quality monitoring program is focussed on measurement of turbidity and total suspended solids (TSS) but also includes monitoring for nutrients during one sampling event.

Looking Back Creek supports upstream movements of Walleye (*Sander vitreus*) and Northern Pike (*Esox lucius*) at the crossing location.

The Department of Fisheries and Oceans Canada deemed the installation of a culvert at the Unnamed Tributary to be of low risk to fish and fish habitat and no fish were observed in surveys conducted prior to 2013. During one sampling period in 2013 and 2014 (June), Brook Stickleback (*Culaea inconstans*; Figure 4) and small Northern Pike were observed at the crossing.

2.0 METHODS

Monitoring was conducted five times in 2014 (June, July, August, September and October) by North/South Consultants Inc.

2.1 SAMPLING LOCATIONS

Water quality monitoring was conducted at transects located upstream and downstream of the two crossings (Figure 1; Table 1).

At Looking Back Creek, four transects were located as follows:

- approximately 45 m upstream of the stream crossing (SC1-T1);
- immediately downstream of the stream crossing (SC1-T2);
- approximately 50 m downstream of the stream crossing (SC1-T3); and,
- approximately 90 m downstream of the stream crossing (SC1-T4).

Up to three sites were sampled along each transect at Looking Back Creek. The right-hand bank site was not sampled during September due to equipment and site accessibility issues. Sampling sites were located at mid-channel and approximately half way between mid-channel and each bank. Each transect was sampled and named starting from the left-hand bank (when facing upstream) to the right-hand bank (i.e., -1, -2, -3 corresponds left, mid, and right, respectively).

At the Unnamed Tributary, sampling was conducted at a single site within the main flow of the creek at the following locations:

- approximately 100 m upstream of the road crossing and the road footprint within the natural channel of the creek (SC2-T1);
- immediately upstream of the road crossing, located alongside the roadway (SC2-T2);
- immediately downstream of the road crossing (SC2-T3); and,
- approximately 30 m downstream of the road crossing (SC2-T4).

2.2 SAMPLING METHODS AND PARAMETERS

Both stream crossings were accessed by truck. Sites located on Looking Back Creek were sampled by one of three methods, while sites located on the Unnamed Tributary were sampled from shore.

Because of the presence of a log dam along the watercourse, sampling at Looking Back Creek in June and July was completed by wading into the water and waiting until the turbidity levels returned to background levels. Higher water levels in August allowed for site access using a canoe. Sampling in September and October was conducted from shore using a sampling pole. Sampling was conducted moving from downstream to upstream to reduce the potential for sample contamination (e.g., sediment disturbance during sampling). One exception occurred in August, when the laboratory samples were collected in a downstream to upstream order but *in situ* readings at SC1-T4 were measured after sampling at SC1-T3 because of a meter malfunction. Laboratory samples and *in situ* readings collected in October were first collected along the right-hand bank in a downstream to upstream direction, then the left-hand bank and middle locations were accessed from the left bank in a downstream to upstream direction.

During June, July, and August, water depth at each site was measured using a meter stick. For logistical reasons, the water depth could not be determined during the shore-based sampling conducted in September or October. Universal Transverse Mercator (UTM) coordinates were recorded using a hand-held Garmin eTrex.

At each sampling site, *in situ* measurements of turbidity were collected using an Analite NEP 160 turbidity meter in June, July, September, and October. In August, during the more detailed sampling including laboratory measurement of nutrients, *in situ* measurements of turbidity, temperature, pH, dissolved oxygen (DO), and specific conductance were collected at both stream crossings using a YSI EXO2 multimeter. At Looking Back Creek, *in situ* measurements were collected near the surface, at mid-depth and near the bottom when sites were deeper than 1 m. Where water depths were < 1 m, near surface measurements were taken. At the Unnamed Tributary, all measurements were taken from just below the water surface due to limited depth (i.e., < 0.5 m).

At all sites and sampling times, water samples were collected for laboratory analysis of TSS. Additionally, water samples collected from both crossings in August were analysed for nutrients, including: nitrate, nitrite, nitrate/nitrite, total Kjeldahl nitrogen (TKN; calculated by the analytical laboratory), total nitrogen (TN), total phosphorus (TP), and dissolved phosphorus (DP). All TSS and nutrient samples were collected as grab samples from just below the water surface (i.e., 0.1-0.3 m). After collection, samples were kept cool and in the dark until submission to a Canadian Association for Laboratory Accreditations, Inc. (CALA) accredited analytical laboratory (Maxxam Analytics, Winnipeg, MB) for analysis.

2.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Standard QA/QC measures were followed during sample collection (e.g., use of arm length gloves, standard labelling practices, meter verifications, sampling from downstream to upstream, etc.). As part of the monitoring program, a field blank and a trip blank were also collected during each sampling event. Field blanks are test samples of analyte-free media that are taken from the laboratory, carried to the sampling site and exposed to the air there so that any contamination from the air can be measured and accounted for. Trip blanks or transport blanks are test samples of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. They are used to measure cross-contamination from the container and preservative during transport, field handling, and storage.

Details on the intent and methods used to assess these QA/QC samples can be found in British Columbia Ministry of the Environment, Lands, and Parks (BCMELP 1998). All water quality data were evaluated qualitatively for potential outliers and/or transcription or analytical errors. Where one sample differed notably from the others collected along a transect, the measurement was flagged as “suspect”.

3.0 RESULTS

3.1 LOOKING BACK CREEK

Water quality monitoring results for Looking Back Creek are presented in Tables 2 to 5.

Compared across seasons, TSS concentrations and turbidity levels in Looking Back Creek were higher in June than any other period. During the June, August, and September sampling events, TSS and turbidity were similar upstream and downstream of the crossing. In July, TSS and turbidity were both notably lower along transects furthest downstream (i.e., SC1-T3 and SC1-T4) than those further upstream, with the highest TSS concentrations reported at SC1-T2 (mean of 6 mg/L). In contrast, TSS and turbidity were marginally higher downstream than upstream of the stream crossing in October. Overall, however, average TSS concentrations at each downstream transect were less than 5 mg/L higher or lower than the average concentrations at the upstream transect (SC1-T1) during each monitoring period, including October 2014. The Manitoba water quality objectives (MWS 2011) for TSS for the protection of aquatic life stipulate that for long-term durations (i.e., 30 day averaging duration), TSS should not be increased by more than 5 mg/L where background concentrations are $\leq$ 25 mg/L.

During all seasons, turbidity and TSS were generally similar across depth and between the sites within a given transect. A single measurement of TSS from a sample collected at the upstream transect (i.e., SC1-T1) in June was notably elevated (24.3 mg/L) relative to the other two samples collected at the same transect and approximate time. The *in situ* turbidity value for this site (21.6 NTU) was consistent with the other measurements made at the same time along the SC1 transect (24.7 and 23.20 NTU) and similar to values measured at the other transects. This suggests the TSS measurement is suspect and likely reflects a sampling and/or analysis issue (e.g., sediment may have been disturbed during sample collection).

Temperature, pH, DO, and specific conductance measured in August were generally consistent upstream and downstream of the crossing, as well as across each transect and across depth. Water in Looking Back Creek was circumneutral and well-oxygenated with low specific conductance. All measurements of pH and DO were within the Manitoba water quality objectives and guidelines for the protection of aquatic life (6.5 and 9.0, the upper and lower limits for pH; 6.0 and 6.5 mg/L for DO; MWS 2011).

Similar to the *in situ* results and TSS, nutrient concentrations measured in Looking Back Creek in August showed no indication of increasing concentrations downstream of the crossing. Rather, results were similar between upstream and downstream areas. Nitrate and nitrate/nitrite were not detected at any site. All concentrations of nitrate were below the Manitoba water quality guideline for the protection of aquatic life (2.93 mg N/L; Armstrong, *pers. comm*. 2012, MWS 2011). Nitrite measured was slightly above the detection limit in all samples collected, but was well below the Manitoba water quality guideline for the protection of aquatic life (0.06 mg N/L; MWS 2011). TP concentrations were well below the Manitoba narrative nutrient guideline (MWS 2011) of 0.05 mg/L for streams. TKN and TN were generally similar downstream of the stream crossing compared to those upstream.

3.2 UNNAMED TRIBUTARY

Water quality monitoring results for the Unnamed Tributary are presented in Tables 6 to 9.

Turbidity and TSS measured in the Unnamed Tributary were consistently low and generally similar upstream and downstream of the crossing. The single measurement of TSS collected at the upstream transect (i.e., SC2-T1) in October was notably elevated (67.8 mg/L) relative to other sampling times and sites sampled on the same day. The *in situ* turbidity value for this site was low (4.12 NTU) and similar to values measured at the other transects on this date, which suggests the TSS measurement is suspect and likely reflects a sampling and/or analysis issue (e.g., sediment may have been disturbed during sample collection). All TSS concentrations measured at the downstream sites were consistently below the Manitoba water quality objective for the protection of aquatic life (MWS 2011).

In August, measurement of additional *in situ* parameters indicated that the Unnamed Tributary was characterized by circumneutral water with moderate DO and low specific conductance. Temperature, pH, DO, and specific conductance all increased downstream of the crossing, with the highest values recorded at SC2-T4. As in Looking Back Creek, all measurements of pH were within the Manitoba water quality guideline for the protection of aquatic life (range of 6.5 to 9.0, MWS 2011). However, DO measured at three transects (i.e., SC2-T1, -T2, and -T3) was below the objective for the protection of cold-water species (6.5 mg/L) and DO at the upstream transect (i.e., SC2-T1) was also below the objective for the protection of cool-water species (6.0 mg/L).

Flow along the Unnamed Tributary is low, particularly at the upstream transect (SC2-T1), and this likely contributed to the low DO observed.

Nitrate, nitrite, and nitrate/nitrite concentrations measured in August were at or below the detection limit at all sites along the Unnamed Tributary. All concentrations of nitrate and nitrite were below the Manitoba water quality guideline for the protection of aquatic life (2.93 mg N/L & 0.06 mg N/L; Armstrong, *pers. comm*. 2012, MWS 2011). TP concentrations were also below the Manitoba narrative nutrient guideline of 0.05 mg/L for streams. TKN and TN were generally similar downstream of the road crossing compared to those in the upstream reach but concentrations measured in the Unnamed Tributary were higher than those measured in Looking Back Creek.

3.3 QA/QC RESULTS

TSS, nitrate, nitrite, nitrate/nitrite, DP, and TP were not detected in the field or trip blanks (Table 10). Similar to what was observed in 2013, TN nitrogen was detected in both the field and trip blank in August. These results suggest that TN may have been introduced to samples from the sample bottles and/or at the analytical laboratory. In addition, introduction of nitrogen to samples in the field may have also occurred since concentrations were higher, and greater than five times the analytical detection limit, in the field blank than the trip blank. Coefficients of variability (COVs), calculated as the standard deviation/mean x 100, were very low (3.7% and 4.7% for Looking Back Creek and the Unnamed Tributary, respectively) and concentrations of TN varied by less than the concentration measured in the field blank.

3.4 OVERALL EFFECT OF THE KEEYASK INFRASTRUCTURE PROJECT ON WATER QUALITY

Water quality monitoring related to the KIP is now complete. Construction of the two stream crossings followed mitigation prescribed in the *Keeyask Infrastructure Project: Environmental Assessment Report* (KHLP 2009) in order to minimize the environmental effects. During the assessment, it was predicted that after mitigation was applied, there would be no residual effects on Looking Back Creek, but some residual effects were predicted as a result of small, episodic inputs of sediment during culvert installation at the Unnamed Tributary.

Monitoring carried out between 2012 and 2014 confirmed there was a short-term increase in sediment entering the stream during construction around the culvert crossing at the Unnamed Tributary (2012). Though not directly associated with constructing the clear-span bridge itself, there was also a sediment plume observed in 2013 at one location where the road intersects with Looking Back Creek. Both of these events were caused by erosion of exposed soil along the road during construction, prior to permanent erosion protection being installed. Permanent erosion protection (rip rap) was installed on the road slopes at both crossings after the sediment was observed and no other increases in TSS were observed at the crossings after that time.

Other than the above events, monitoring showed no measureable impact on water quality as a result of constructing the two stream crossings.

4.0 REFERENCES

Armstrong, N. 2012. Manitoba Conservation and Water Stewardship, Water Stewardship Division, Water Quality Management Branch. Suite 160, 123 Main Street. Winnipeg, MB. R3C 1A5.

British Columbia Ministry of Environment, Lands, And Parks (BCMELP). 1998. Guidelines for interpreting water quality data. Version 1, May 1998. Prepared for the Land Use Task Force Resource Inventory Committee.

Keeyask Hydropower Limited Partnership. 2009. Keeyask Infrastructure Project: Environmental assessment report. Keeyask Hydropower Limited Partnership, Winnipeg MB.

Manitoba Water Stewardship. 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Manitoba Water Stewardship Report 2011-01. Final Draft: November 28, 2011. 67 pp.

Table 1: GPS locations (NAD 83) and sampling dates for the water quality monitoring program conducted at the two stream crossings along the Keeyask North Access Road, 2014.

Transect ID	Date	Zone	Easting	Northing	Location Description[1]
Looking Back Creek					
SC1-T1	22-Jun-14	15V	360558	6250036	15 m U/S of bridge
	19-Jul-14	15V	360585	6250053	
	25-Aug-14	15V	360554	6250036	
	26-Sep-14	15V	360565	6250034	
	26-Oct-14	15V	360557	6250042	
SC1-T2	22-Jun-14	15V	360618	6250063	Immediately D/S of bridge
	19-Jul-14	15V	360625	6250064	
	25-Aug-14	15V	360629	6250061	
	26-Sep-14	15V	360622	6250055	
	26-Oct-14	15V	360623	6250065	
SC1-T3	22-Jun-14	15V	360671	6250079	50 m D/S of the road crossing
	19-Jul-14	15V	360651	6250112	
	25-Aug-14	15V	360672	6250076	
	26-Sep-14	15V	360675	6250068	
	26-Oct-14	15V	360650	6250068	
SC1-T4	22-Jun-14	15V	360708	6250064	100 m D/S of the road crossing
	19-Jul-14	15V	360712	6250105	
	25-Aug-14	15V	360711	6250066	
	26-Sep-14	15V	360705	6250059	
	26-Oct-14	15V	360640	6250106	
Unnamed Tributary					
SC2-T1	22-Jun-14	15V	345592	6254915	U/S of road crossing
	19-Jul-14	15V	345599	6254923	
	25-Aug-14	15V	345586	6254913	
	26-Sep-14	15V	345591	6254913	
	26-Oct-14	15V	345596	6254928	
SC2-T2	22-Jun-14	15V	345703	6254898	Immediately U/S of crossing,
	19-Jul-14	15V	345682	6254903	located alongside the road
	25-Aug-14	15V	345704	6254896	
	26-Sep-14	15V	345702	6254898	
	26-Oct-14	15V	345685	6254900	
SC2-T3	22-Jun-14	15V	345710	6254922	Immediately D/S of crossing
	19-Jul-14	15V	345712	6254923	
	25-Aug-14	15V	345712	6254922	
	26-Sep-14	15V	345711	6254921	
	26-Oct-14	15V	345709	6254923	
SC2-T4	22-Jun-14	15V	345717	6254945	Approximately 30 m D/S of road crossing
	19-Jul-14	15V	345720	6254948	
	25-Aug-14	15V	345719	6254942	
	26-Sep-14	15V	345717	6254946	
	26-Oct-14	15V	345719	6254934	

[1] U/S = upstream; D/S = downstream

Table 2: *In situ* data collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Looking Back Creek, 2014

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Turbidity (NTU)
15 m U/S	SC1-T1	SC1-T1-1	22-Jun-14	15:22	0.91	0.1	24.70
		SC1-T1-2	22-Jun-14	15:25	0.46	0.1	23.20
		SC1-T1-3	22-Jun-14	15:27	0.30	0.1	21.60
Immediately D/S	SC1-T2	SC1-T2-1	22-Jun-14	15:15	0.46	0.1	22.00
		SC1-T2-2	22-Jun-14	15:14	1.07	0.1	22.60
		SC1-T2-3	22-Jun-14	15:12	0.46	0.1	22.20
50 m D/S	SC1-T3	SC1-T3-1	22-Jun-14	15:06	0.61	0.1	22.10
		SC1-T3-2	22-Jun-14	15:04	0.76	0.1	21.60
		SC1-T3-3	22-Jun-14	15:02	0.50	0.1	23.60
100 m D/S	SC1-T4	SC1-T4-1	22-Jun-14	14:54	0.60	0.1	22.00
		SC1-T4-2	22-Jun-14	~14:52	1.00	0.1	22.10
		SC1-T4-3	22-Jun-14	14:50	0.90	0.1	26.00
15 m U/S	SC1-T1	SC1-T1-1	19-Jul-14	12:45	0.6	0.1	7.59
		SC1-T1-2	19-Jul-14	12:50	0.6	0.1	7.22
		SC1-T1-3	19-Jul-14	13:06	1.2	0.1	7.76
		SC1-T1-3	19-Jul-14	13:06	1.2	0.6	8.06
		SC1-T1-3	19-Jul-14	13:06	1.2	1.2	9.81
Immediately D/S	SC1-T2	SC1-T2-1	19-Jul-14	12:33	0.80	0.1	7.19
		SC1-T2-2	19-Jul-14	12:36	-	0.1	7.21
		SC1-T2-3	19-Jul-14	-	0.70	0.1	8.65
50 m D/S	SC1-T3	SC1-T3-1	19-Jul-14	12:22	0.60	0.1	3.56
		SC1-T3-2	19-Jul-14	12:25	0.60	0.1	3.63
		SC1-T3-3	19-Jul-14	12:30	0.70	0.1	3.23
100 m D/S	SC1-T4	SC1-T4-1	19-Jul-14	12:07	0.90	0.1	4.98
		SC1-T4-2	19-Jul-14	12:15	1.00	0.1	3.85
		SC1-T4-3	19-Jul-14	12:18	0.50	0.1	5.98
15 m U/S	SC1-T1	SC1-T1-1	25-Aug-14	14:40	0.85	0.3	1.49
		SC1-T1-2	25-Aug-14	-	1.4	0.3	1.27
		SC1-T1-2	25-Aug-14	-	1.4	1.0	1.40
		SC1-T1-3	25-Aug-14	14:30	1.5	0.3	1.38
		SC1-T1-3	25-Aug-14	14:30	1.5	1.2	1.47
Immediately D/S	SC1-T2	SC1-T2-1	25-Aug-14	14:20	0.95	0.3	1.23
		SC1-T2-1	25-Aug-14	14:20	0.95	0.8	1.37
		SC1-T2-2	25-Aug-14	-	1.40	0.3	1.23
		SC1-T2-2	25-Aug-14	-	1.40	1.1	1.70
		SC1-T2-3	25-Aug-14	14:10	1.40	0.3	1.54
		SC1-T2-3	25-Aug-14	14:10	1.40	1.0	1.91
50 m D/S	SC1-T3	SC1-T3-1	25-Aug-14	13:40	.-	-	-
		SC1-T3-2	25-Aug-14	13:30	1.00	0.3	1.59
		SC1-T3-3	25-Aug-14	13:25	0.70	0.3	1.90
100 m D/S	SC1-T4	SC1-T4-1	25-Aug-14	14:00	0.60	0.3	1.68
		SC1-T4-2	25-Aug-14	-	1.05	0.3	1.61
		SC1-T4-3	25-Aug-14	14:03	0.85	0.3	1.55

Table 2: Continued.

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Turbidity (NTU)
15 m U/S	SC1-T1	SC1-T1-1	26-Sep-14	15:25	-	0.2	12.3
		SC1-T1-2	26-Sep-14	15:30	-	0.2	11.0
		SC1-T1-3	26-Sep-14	-	-	-	-
Immediately D/S	SC1-T2	SC1-T2-1	26-Sep-14	15:12	-	0.2	11.5
		SC1-T2-2	26-Sep-14	-	-	0.2	11.5
		SC1-T2-3	26-Sep-14	-	-	-	-
50 m D/S	SC1-T3	SC1-T3-1	26-Sep-14	14:50	-	0.2	10.0
		SC1-T3-2	26-Sep-14	-	-	0.2	10.5
		SC1-T3-3	26-Sep-14	-	-	-	-
100 m D/S	SC1-T4	SC1-T4-1	26-Sep-14	14:25	-	0.2	11.00
		SC1-T4-2	26-Sep-14	14:32	-	0.2	11.00
		SC1-T4-3	26-Sep-14	-	-	-	-
15 m U/S	SC1-T1	SC1-T1-1	26-Oct-14	16:18	-	0.2	9.06
		SC1-T1-2	26-Oct-14	16:14	-	0.2	9.12
		SC1-T1-3	26-Oct-14	15:37	-	0.2	11.32
Immediately D/S	SC1-T2	SC1-T2-1	26-Oct-14	16:06	-	0.2	12.11
		SC1-T2-2	26-Oct-14	16:04	-	0.2	12.81
		SC1-T2-3	26-Oct-14	15:31	-	0.2	11.45
50 m D/S	SC1-T3	SC1-T3-1	26-Oct-14	16:00	-	0.2	11.16
		SC1-T3-2	26-Oct-14	15:59	-	0.2	11.21
		SC1-T3-3	26-Oct-14	15:27	-	0.2	11.83
100 m D/S	SC1-T4	SC1-T4-1	26-Oct-14	15:56	-	0.2	11.36
		SC1-T4-2	26-Oct-14	15:54	-	0.2	12.28
		SC1-T4-3	26-Oct-14	15:16	-	0.2	12.25

[1] U/S = upstream; D/S = downstream

Table 3: TSS results for water samples collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Looking Back Creek, 2014. Values in blue italics are considered suspect.

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Laboratory ID	Total Suspended Solids (mg/L)
Analytical Detection Limit						4.0
15 m U/S	SC1-T1	SC1-T1-1	22-Jun-14	15:22	JX4112	12.3
		SC1-T1-2	22-Jun-14	15:25	JX4113	13.0
		SC1-T1-3	22-Jun-14	15:27	JX4114	*24.3*
Immediately D/S	SC1-T2	SC1-T2-1	22-Jun-14	15:15	JX4115	12.0
		SC1-T2-2	22-Jun-14	15:14	JX4116	13.8
		SC1-T2-3	22-Jun-14	15:12	JX4117	13.5
50 m D/S	SC1-T3	SC1-T3-1	22-Jun-14	15:06	JX4118	11.3
		SC1-T3-2	22-Jun-14	15:04	JX4119	12.5
		SC1-T3-3	22-Jun-14	15:02	JX4120	11.3
100 m D/S	SC1-T4	SC1-T4-1	22-Jun-14	14:54	JX4120	11.3
		SC1-T4-2	22-Jun-14	14:52	JX4103	12.8
		SC1-T4-3	22-Jun-14	14:50	JX4104	17.0
15 m U/S	SC1-T1	SC1-T1-1	22-Jul-14	12:45	KE3790	5.8
		SC1-T1-2	22-Jul-14	12:50	KE3791	4.0
		SC1-T1-3	22-Jul-14	13:06	KE3792	5.3
Immediately D/S	SC1-T2	SC1-T2-1	22-Jul-14	12:33	KE3787	7.0
		SC1-T2-2	22-Jul-14	12:36	KE3788	6.3
		SC1-T2-3	22-Jul-14	13:00	KE3789	4.8
50 m D/S	SC1-T3	SC1-T3-1	22-Jul-14	12:22	KE3793	<4.0
		SC1-T3-2	22-Jul-14	12:25	KE3794	<4.0
		SC1-T3-3	22-Jul-14	12:30	KE3795	<4.0
100 m D/S	SC1-T4	SC1-T4-1	22-Jul-14	12:07	KE3796	4.3
		SC1-T4-2	22-Jul-14	12:15	KE3797	5.0
		SC1-T4-3	22-Jul-14	12:18	KE3798	<4.0
15 m U/S	SC1-T1	SC1-T1-1	25-Aug-14	14:40	KL0423	<4.0
		SC1-T1-2	25-Aug-14	-	KL0424	<4.0
		SC1-T1-3	25-Aug-14	14:30	KL0425	<4.0
Immediately D/S	SC1-T2	SC1-T2-1	25-Aug-14	14:20	KL0426	<4.0
		SC1-T2-2	25-Aug-14	-	KL0427	<4.0
		SC1-T2-3	25-Aug-14	14:10	KL0428	<4.0
50 m D/S	SC1-T3	SC1-T3-1	25-Aug-14	13:40	KL0429	<4.0
		SC1-T3-2	25-Aug-14	13:30	KL0430	<4.0
		SC1-T3-3	25-Aug-14	13:25	KL0431	<4.0
100 m D/S	SC1-T4	SC1-T4-1	25-Aug-14	13:00	KL0432	4.0
		SC1-T4-2	25-Aug-14	12:45	KL0433	<4.0
		SC1-T4-3	25-Aug-14	12:40	KL0434	<4.0

Table 3: Continued.

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Laboratory ID	Total Suspended Solids (mg/L)
Analytical Detection Limit						4.0
15 m U/S	SC1-T1	SC1-T1-1	26-Sep-14	15:25	KS4497	<4.0
		SC1-T1-2	26-Sep-14	15:30	KS4498	<4.0
Immediately D/S	SC1-T2	SC1-T2-1	26-Sep-14	15:12	KS4495	<4.0
		SC1-T2-2	26-Sep-14	-	KS4496	<4.0
50 m D/S	SC1-T3	SC1-T3-1	26-Sep-14	14:50	KS4493	<4.0
		SC1-T3-2	26-Sep-14	-	KS4494	<4.0
100 m D/S	SC1-T4	SC1-T4-1	26-Sep-14	14:25	KS4491	<4.0
		SC1-T4-2	26-Sep-14	14:32	KS4492	<4.0
15 m U/S	SC1-T1	SC1-T1-1	26-Oct-14	16:18	KZ7288	6.5
		SC1-T1-2	26-Oct-14	16:14	KZ7289	7.3
		SC1-T1-3	26-Oct-14	15:37	KZ7290	<4.0
Immediately D/S	SC1-T2	SC1-T2-1	26-Oct-14	16:06	KZ7291	12.5
		SC1-T2-2	26-Oct-14	16:04	KZ7292	8.0
		SC1-T2-3	26-Oct-14	15:31	KZ7293	7.8
50 m D/S	SC1-T3	SC1-T3-1	26-Oct-14	16:00	KZ7294	7.0
		SC1-T3-2	26-Oct-14	15:59	KZ7295	8.0
		SC1-T3-3	26-Oct-14	15:27	KZ7296	7.8
100 m D/S	SC1-T4	SC1-T4-1	26-Oct-14	15:56	KZ7297	4.5
		SC1-T4-2	26-Oct-14	15:54	KZ7298	7.8
		SC1-T4-3	26-Oct-14	15:16	KZ7299	13.3

[1] U/S = upstream; D/S = downstream

Table 4: Additional *in situ* data collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Looking Back Creek, August 2014.

Transect Location [1]	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	pH (pH units)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Specific Conductance (µS/cm)
Manitoba Water Quality Objectives and Guidelines								*6.5-9.0*	*6.0[2]/6.5[3]*		
15 m U/S	SC1-T1	SC1-T1-1	25-Aug-14	14:40	0.85	0.3	11.05	7.64	9.49	86.2	156.3
		SC1-T1-2	25-Aug-14	-	1.4	0.3	11.06	7.63	9.49	86.2	155.4
		SC1-T1-2	25-Aug-14	-	1.4	1.0	11.06	7.65	9.48	86.2	155.5
		SC1-T1-3	25-Aug-14	14:30	1.5	0.3	11.06	7.67	9.51	86.4	155.5
		SC1-T1-3	25-Aug-14	14:30	1.5	1.2	11.06	7.64	9.49	86.2	155.4
Immediately D/S	SC1-T2	SC1-T2-1	25-Aug-14	14:20	0.95	0.3	11.04	7.63	9.44	85.7	156.5
		SC1-T2-1	25-Aug-14	14:20	0.95	0.8	11.04	7.64	9.44	85.7	156.1
		SC1-T2-2	25-Aug-14	-	1.40	0.3	11.04	7.64	9.44	85.7	156.1
		SC1-T2-2	25-Aug-14	-	1.40	1.1	11.04	7.65	9.44	85.7	156.0
		SC1-T2-3	25-Aug-14	14:10	1.40	0.3	11.03	7.66	9.48	86.1	156.1
		SC1-T2-3	25-Aug-14	14:10	1.40	1.0	11.04	7.63	9.44	85.7	156.1
50 m D/S	SC1-T3	SC1-T3-1	25-Aug-14	13:40	-	-	-	-	-	-	-
		SC1-T3-2	25-Aug-14	13:30	1.00	0.3	11.02	7.60	9.40	85.3	156.6
		SC1-T3-3	25-Aug-14	13:25	0.70	0.3	11.02	7.60	9.39	85.2	156.6
100 m D/S	SC1-T4	SC1-T4-1	25-Aug-14	14:00	0.60	0.3	11.02	7.66	9.48	86.0	156.6
		SC1-T4-2	25-Aug-14	-	1.05	0.3	11.02	7.64	9.44	85.7	156.5
		SC1-T4-3	25-Aug-14	14:03	0.85	0.3	11.02	7.64	9.44	85.7	156.5

[1] U/S = upstream; D/S = downstream
[2] Manitoba water quality objective for the protection of cool-water species
[3] Manitoba water quality objective for the protection of cold-water species

Table 5: Additional *in situ* data collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Looking Back Creek, August 2014.

Transect Location [1]	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	pH (pH units)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Specific Conductance (µS/cm)
Manitoba Water Quality Objectives and Guidelines								*6.5-9.0*	*6.0[2]/6.5[3]*		
15 m U/S	SC1-T1	SC1-T1-1	25-Aug-14	14:40	0.85	0.3	11.05	7.64	9.49	86.2	156.3
		SC1-T1-2	25-Aug-14	-	1.4	0.3	11.06	7.63	9.49	86.2	155.4
		SC1-T1-2	25-Aug-14	-	1.4	1.0	11.06	7.65	9.48	86.2	155.5
		SC1-T1-3	25-Aug-14	14:30	1.5	0.3	11.06	7.67	9.51	86.4	155.5
		SC1-T1-3	25-Aug-14	14:30	1.5	1.2	11.06	7.64	9.49	86.2	155.4
Immediately D/S	SC1-T2	SC1-T2-1	25-Aug-14	14:20	0.95	0.3	11.04	7.63	9.44	85.7	156.5
		SC1-T2-1	25-Aug-14	14:20	0.95	0.8	11.04	7.64	9.44	85.7	156.1
		SC1-T2-2	25-Aug-14	-	1.40	0.3	11.04	7.64	9.44	85.7	156.1
		SC1-T2-2	25-Aug-14	-	1.40	1.1	11.04	7.65	9.44	85.7	156.0
		SC1-T2-3	25-Aug-14	14:10	1.40	0.3	11.03	7.66	9.48	86.1	156.1
		SC1-T2-3	25-Aug-14	14:10	1.40	1.0	11.04	7.63	9.44	85.7	156.1
50 m D/S	SC1-T3	SC1-T3-1	25-Aug-14	13:40	-	-	-	-	-	-	-
		SC1-T3-2	25-Aug-14	13:30	1.00	0.3	11.02	7.60	9.40	85.3	156.6
		SC1-T3-3	25-Aug-14	13:25	0.70	0.3	11.02	7.60	9.39	85.2	156.6
100 m D/S	SC1-T4	SC1-T4-1	25-Aug-14	14:00	0.60	0.3	11.02	7.66	9.48	86.0	156.6
		SC1-T4-2	25-Aug-14	-	1.05	0.3	11.02	7.64	9.44	85.7	156.5
		SC1-T4-3	25-Aug-14	14:03	0.85	0.3	11.02	7.64	9.44	85.7	156.5

[1] U/S = upstream; D/S = downstream
[2] Manitoba water quality objective for the protection of cool-water species
[3] Manitoba water quality objective for the protection of cold-water species

Table 6: Nutrient concentrations measured in water samples collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Looking Back Creek, August 2014.

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Lab ID	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ Nitrite (mg N/L)	Total Kjeldahl Nitrogen (mg N/L)	Total Nitrogen (mg/L)	Total Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)
Analytical Detection Limit						0.020	0.002	0.020	0.020	0.020	0.0050	0.0050
Manitoba Water Quality Objectives and Guidelines						*2.93*[2]	*0.06*	-	-	-	-	*0.050*
15 m U/S	SC1-T1	SC1-T1-1	25-Aug-14	14:40	KL0423	<0.020	0.003	<0.020	0.586	0.586	0.0230	0.0216
		SC1-T1-2	25-Aug-14	14:35	KL0424	<0.020	0.003	<0.020	0.584	0.584	0.0214	0.0218
		SC1-T1-3	25-Aug-14	14:30	KL0425	<0.020	0.003	<0.020	0.575	0.575	0.0224	0.0222
Immediately D/S	SC1-T2	SC1-T2-1	25-Aug-14	14:20	KL0426	<0.020	0.003	<0.020	0.565	0.565	0.0217	0.0231
		SC1-T2-2	25-Aug-14	14:15	KL0427	<0.020	0.003	<0.020	0.554	0.554	0.0220	0.0222
		SC1-T2-3	25-Aug-14	14:10	KL0428	<0.020	0.003	<0.020	0.599	0.599	0.0223	0.0218
50 m D/S	SC1-T3	SC1-T3-1	25-Aug-14	13:40	KL0429	<0.020	0.003	<0.020	0.594	0.594	0.0227	0.0224
		SC1-T3-2	25-Aug-14	13:30	KL0430	<0.020	0.003	<0.020	0.570	0.570	0.0219	0.0233
		SC1-T3-3	25-Aug-14	13:25	KL0431	<0.020	0.003	<0.020	0.525	0.525	0.0218	0.0249
100 m D/S	SC1-T4	SC1-T4-1	25-Aug-14	12:45	KL0432	<0.020	0.003	<0.020	0.569	0.569	0.0225	0.0227
		SC1-T4-2	25-Aug-14	12:43	KL0433	<0.020	0.003	<0.020	0.596	0.596	0.0219	0.0225
		SC1-T4-3	25-Aug-14	12:40	KL0434	<0.020	0.003	<0.020	0.594	0.594	0.0228	0.0230

[1] U/S = upstream; D/S = downstream

[2] 13 mg $NO_3^- \cdot L^{-1}$ (Armstrong. pers. comm. 2012, MWS 2011)

Table 7: *In situ* data collected at water quality monitoring transects located near the Keeyask North Access Road crossing at the Unnamed Tributary, 2014.

Transect Location	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Turbidity (NTU)
U/S of road crossing	SC2-T1	SC2-T1	22-Jun-14	12:58	0.30	0.1	0.54
Immediately U/S	SC2-T2	SC2-T2	22-Jun-14	13:15	0.30	0.1	2.10
Immediately D/S	SC2-T3-1	SC2-T3-1	22-Jun-14	13:22	0.30	0.1	2.25
Immediately D/S (backwater)	SC2-T3-2	SC2-T3-2	22-Jun-14	13:32	0.30	0.1	2.50
30 m D/S	SC2-T4	SC2-T4	22-Jun-14	13:38	0.15	0.1	4.50
U/S of road crossing	SC2-T1	SC2-T1	19-Jul-14	14:13	0.30	0.1	0.10
Immediately U/S	SC2-T2	SC2-T2	19-Jul-14	14:06	0.40	0.1	0.22
Immediately D/S	SC2-T3-1	SC2-T3-1	19-Jul-14	14:00	0.30	0.1	0.10
30 m D/S	SC2-T4	SC2-T4	19-Jul-14	13:56	0.30	0.1	0.10
U/S of road crossing	SC2-T1	SC2-T1	25-Aug-14	-	0.40	0.2	<0.1
Immediately U/S	SC2-T2	SC2-T2	25-Aug-14	16:09	0.40	0.2	<0.1
Immediately D/S	SC2-T3-1	SC2-T3-1	25-Aug-14	16:00	0.30	0.2	<0.1
30 m D/S	SC2-T4	SC2-T4	25-Aug-14	15:50	0.20	0.1	<0.1
U/S of road crossing	SC2-T1	SC2-T1	26-Sep-14	16:35	-	0.1	1.6
Immediately U/S	SC2-T2	SC2-T2	26-Sep-14	16:30	-	0.1	1.1
Immediately D/S	SC2-T3-1	SC2-T3-1	26-Sep-14	16:15	-	0.1	1.6
30 m D/S	SC2-T4	SC2-T4	26-Sep-14	16:35	-	0.1	1.2
U/S of road crossing	SC2-T1	SC2-T1	26-Oct-14	14:45	-	0.1	4.12
Immediately U/S	SC2-T2	SC2-T2	26-Oct-14	14:39	-	0.1	4.61
Immediately D/S	SC2-T3-1	SC2-T3-1	26-Oct-14	14:33	-	0.1	4.63
30 m D/S	SC2-T4	SC2-T4	26-Oct-14	14:25	-	0.1	4.72

[1] U/S = upstream; D/S = downstream

Table 8: TSS results for water samples collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Unnamed Tributary, 2014. Values in blue italics are considered suspect.

Transect Location[1]	Transect ID	Site ID	Sample Date	Sample Time	Laboratory ID	Total Suspended Solids (mg/L)
Analytical Detection Limit						4.0
U/S of road crossing	SC2-T1	SC2-T1	22-Jun-14	12:58	JX4105	<4.0
Immediately U/S	SC2-T2	SC2-T2	22-Jun-14	13:15	JX4106	<4.0
Immediately D/S	SC2-T3	SC2-T3-1	22-Jun-14	13:22	JX4107	<4.0
Immediately D/S (backwater)	SC2-T3	SC2-T3-2	22-Jun-14	13:32	JX4108	<4.0
30 m D/S	SC2-T4	SC2-T4	22-Jun-14	13:38	JX4109	5.5
U/S of road crossing	SC2-T1	SC2-T1	19-Jul-14	14:13	KE3799	6.8
Immediately U/S	SC2-T2	SC2-T2	19-Jul-14	14:06	KE3800	5.3
Immediately D/S	SC2-T3	SC2-T3-1	19-Jul-14	14:00	KE3802	5.0
30 m D/S	SC2-T4	SC2-T4	19-Jul-14	13:56	KE3802	5.8
U/S of road crossing	SC2-T1	SC2-T1	25-Aug-14		KL0435	<4.0
Immediately U/S	SC2-T2	SC2-T2	25-Aug-14		KL0436	<4.0
Immediately D/S	SC2-T3	SC2-T3-1	25-Aug-14		KL0437	<4.0
30 m D/S	SC2-T4	SC2-T4	25-Aug-14		KL0438	<4.0
U/S of road crossing	SC2-T1	SC2-T1	26-Sep-14		KS4504	7.0
Immediately U/S	SC2-T2	SC2-T2	26-Sep-14		KS4503	<4.0
Immediately D/S	SC2-T3	SC2-T3-1	26-Sep-14		KS4500	<4.0
30 m D/S	SC2-T4	SC2-T4	26-Sep-14		KS4499	<4.0
U/S of road crossing	SC2-T1	SC2-T1	26-Oct-14	14:45	KZ7300	*67.8*
Immediately U/S	SC2-T2	SC2-T2	26-Oct-14	14:39	KZ7301	<4.0
Immediately D/S	SC2-T3	SC2-T3-1	26-Oct-14	14:33	KZ7302	<4.0
30 m D/S	SC2-T4	SC2-T4	26-Oct-14	14:25	KZ7303	<4.0

[1] U/S = upstream; D/S = downstream

Table 9: Additional *in situ* data collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Unnamed Tributary, August 2014.

Transect Location	Transect ID	Site ID	Sample Date	Sample Time	Total Water Depth (m)	Sample Depth (m)	Temperature (°C)	pH (pH units)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	Specific Conductance (µS/cm)
Manitoba Water Quality Objectives and Guidelines								*6.5-9.0*	*6.0[2]/6.5[3]*		
U/S of road crossing	SC2-T1	SC2-T1	25-Aug-14	-	0.40	0.2	10.45	6.99	*5.60*	50.2	123.3
Immediately U/S	SC2-T2	SC2-T2	25-Aug-14	16:09	0.40	0.2	9.98	7.01	*6.13*	54.6	127.7
Immediately D/S	SC2-T3-1	SC2-T3-1	25-Aug-14	16:00	0.30	0.2	9.96	7.09	*6.41*	56.8	128.2
30 m D/S	SC2-T4	SC2-T4	25-Aug-14	15:50	0.20	0.1	10.17	7.43	7.31	65.1	133.3

[1] U/S = upstream; D/S = downstream
[2] Manitoba water quality objective for the protection of cool-water species
[3] Manitoba water quality objective for the protection of cold-water species

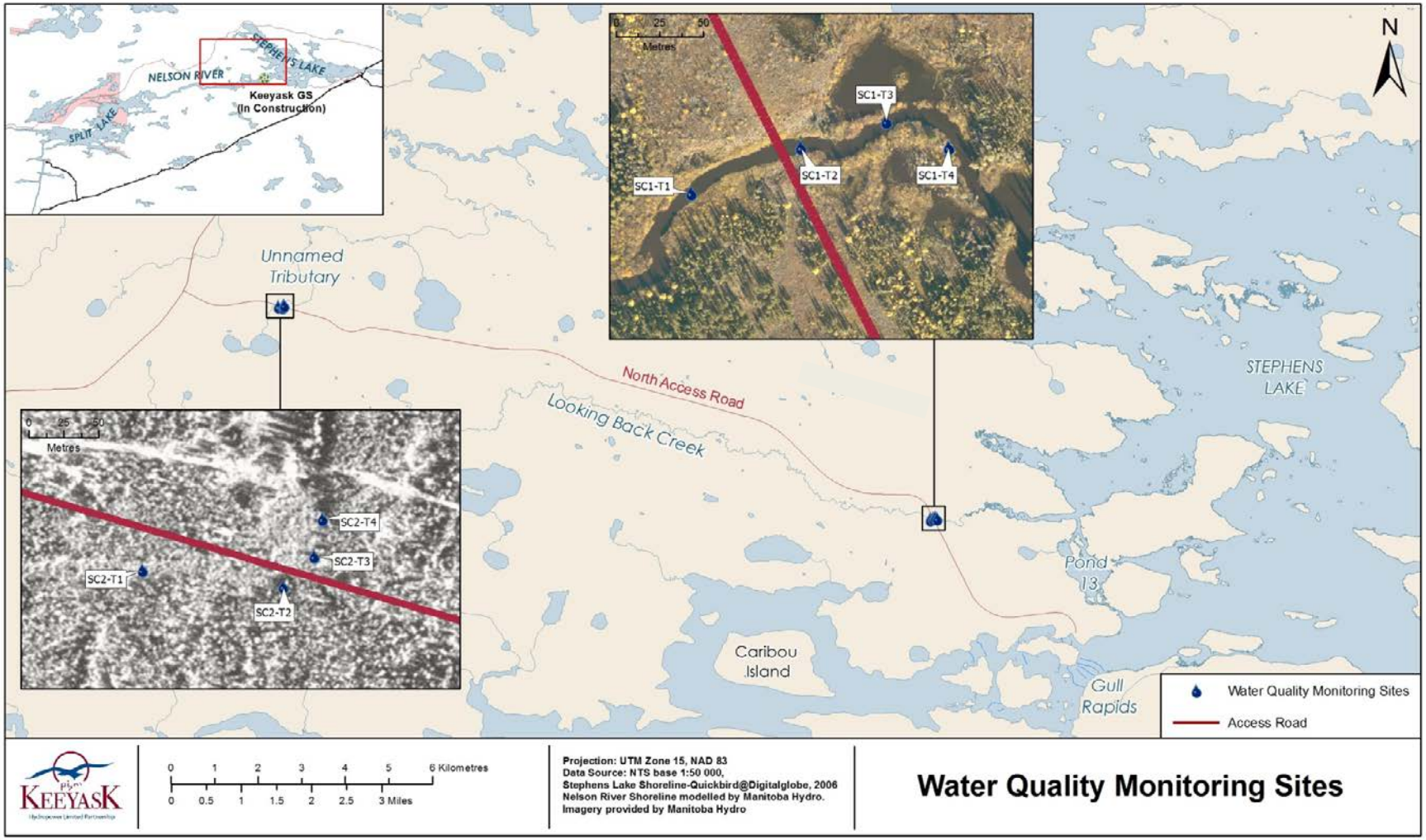
Table 10: Nutrient concentrations measured in water samples collected at water quality monitoring transects located near the Keeyask North Access Road crossing at Unnamed Tributary, August 2014.

Transect Location	Transect ID	Site ID	Sample Date	Sample Time	Laboratory ID	Nitrate (mg N/L)	Nitrite (mg N/L)	Nitrate/ Nitrite (mg N/L)	Total Kjeldahl Nitrogen (mg N/L)	Total Nitrogen (mg/L)	Total Dissolved Phosphorus (mg/L)	Total Phosphorus (mg/L)
Analytical Detection Limit						0.020	0.002	0.020	0.020	0.020	0.0050	0.0050
Manitoba Water Quality Objectives and Guidelines						*2.93[2]*	*0.06*	-	-	-	-	*0.050*
U/S of road crossing	SC2-T1	SC2-T1	25-Aug-14	16:20	KL0435	<0.020	0.002	<0.020	0.763	0.763	0.0219	0.0247
Immediately U/S	SC2-T2	SC2-T2	25-Aug-14	16:12	KL0436	<0.020	<0.002	<0.020	0.738	0.738	0.0188	0.0263
Immediately D/S	SC2-T3	SC2-T3	25-Aug-14	16:00	KL0437	<0.020	<0.002	<0.020	0.767	0.767	0.0180	0.0180
30 m D/S	SC2-T4	SC2-T4	25-Aug-14	15:50	KL0438	<0.020	0.002	<0.020	0.692	0.692	0.0225	0.0190

[1] U/S = upstream; D/S = downstream
[2] 13 mg $NO_3^- \cdot L^{-1}$ (Armstrong. pers. comm. 2012, MWS 2011)

Table 11: Results for QA/QC samples submitted to Maxxam Laboratories in 2014. Results exceeding five times the analytical detection limit are indicated in bold red.

Sample Type	Sample ID	Date Sampled	Lab ID	Total Suspended Solids	Nitrate	Nitrite	Nitrate/ Nitrite	Total Kjeldahl Nitrogen	Total Nitrogen	Total Dissolved Phosphorus	Total Phosphorus
				(mg/L)	(mg N/L)	(mg N/L)	(mg N/L)	(mg N/L)	(mg/L)	(mg/L)	(mg/L)
Analytical Detection Limit				4.0	0.020	0.002	0.020	0.020	0.020	0.0050	0.0050
Field Blank	MJ-1	22-Jun-14	JX4111	<4.0							
Trip Blank	SJ-1	22-Jun-14	JX4110	<4.0							
Field Blank	MJ-1	19-Jul-14	KE3803	<4.0							
Trip Blank	SJ-1	19-Jul-14	KE3804	<4.0							
Field Blank	MJ-1	25-Aug-14	KL0440	<4.0	<0.020	<0.002	<0.020	**0.106**	**0.106**	<0.0050	<0.0050
Trip Blank	SJ-1	25-Aug-14	KL0439	<4.0	<0.020	<0.002	<0.020	0.054	0.054	<0.0050	<0.0050
Field Blank	MJ-1	26-Sep-14	KS4501	<4.0							
Trip Blank	SJ-1	26-Sep-14	KS4502	<4.0							
Field Blank	MJ-1	26-Oct-14	KZ7304	<4.0							
Trip Blank	SJ-1	26-Oct-14	KZ7305	<4.0							



Map 1: Location of water quality monitoring transects near stream crossings along the KIP access road, 2014

Figure 1: Clear-span bridge over Looking Back Creek.

Figure 2: Road crossing for the Unnamed Tributary.

Figure 3: Brook Stickleback in the culvert at the Unnamed Tributary on August 20, 2013.