Appendix 2

Screening of Keewatinoow Construction Camp Waste Water Effluent Discharge to Creek Fourteen

Prepared by: North/South Consultants Inc. **July 19, 2011**

Introduction

The following provides a screening of the potential effects of sewage effluent discharge on water quality in Creek Fourteen. As the design of the sewage treatment and subsequent effluent discharge has not been finalized, the following was prepared to evaluate several scenarios to assist with a screening. This undertaking was based on various assumptions and available information, and it should not be considered to represent a final analysis.

Methods and Data Sources

The following screening was prepared using the following available information:

- Creek Fourteen Water Quality: As there are no water quality data for Creek Fourteen, water quality data measured during the Conawapa environmental baseline studies in Creek Fifteen (open-water season 2004; Table A2-1) were used for estimating background water quality in Creek Fourteen;

- Creek Fourteen Discharge: Monthly 5^{th}, 50^{th}, and 95^{th} percentile discharge, as provided by Manitoba Hydro (Table A2-2, June 15, 2011 Memorandum);

- Effluent Discharge Rate and Discharge Regime: a seasonal batch release (10 days in spring and 5 days in fall);

- Effluent Quality: Range of measured effluent quality at the Wuskwatim GS camp (2010, Table A2-3, Savard and Schneider-Vieira 2011) and the proposed Wastewater Systems Effluent Standards (Table A2-4, Canada Gazette 2010) and Manitoba Municipal Wastewater Effluent Standards (Table A2-5, Manitoba Water Stewardship 2011).

A mass-balance model was used to estimate fully-mixed water quality conditions in Creek Fourteen, based on the aforementioned information. The scenarios assessed are identified in Table A2-6.

Comparison to Water Quality Objectives and Guidelines

Mass-balance model results (i.e., fully mixed water quality conditions) were then compared to Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOGs) for the protection of aquatic life (PAL) for TSS, pH, and ammonia, the MWQSOG narrative guideline for total phosphorus (TP) for rivers and streams (0.050 mg/L), the MWQSOG recreational guideline for faecal coliform bacteria, and the Canadian Council of Ministers of the Environment (CCME 1999; updated to 2011) interim guideline for nitrate (there is no PAL guideline for nitrate in Manitoba). These objectives and guidelines are summarized in Table A2-7. Note that as the Manitoba Municipal Effluent Discharge Standard for faecal coliform bacteria is equivalent to the Manitoba recreational guideline (200 CFU/100 mL), the guideline would by necessity be met end-of-pipe; this parameter is therefore not assessed further.

Creek Fourteen is intermittent and 5th percentile flows are < 0.003 m^3/s in all months, 50th percentile flows are less than <0.003 m^3/s in December-April, and 95th percentiles are < 0.003 m^3/s in January-March. The MWQSOGs specify that Manitoba Water Quality Objectives are not applicable in intermittent streams when discharge is <0.003 m^3/s; however, Manitoba Water Quality Guidelines apply at all times.

Mass-Balance Modeling Results

The results of mass-balance modeling for scenarios 1-4, which represent ranges of flow conditions, effluent quality, and background water quality, for Creek Fourteen are presented in Table A2-8.

Mass-balance modeling indicates that fully mixed conditions in the creek would not meet MWQSOGs for TSS, TP, and ammonia under the lowest median flow for the spring/fall periods (i.e., 0.01 m^3/s). Under the highest spring/fall 95th percentile flows, MWQSOGs would be exceeded for TP and potentially ammonia (depending upon ambient pH and temperature). Should BOD at the end-of-pipe equal the proposed WSER and Manitoba Municipal Wastewater Effluent Standard (25 mg/L), discharge of biochemical oxygen demand (BOD) could potentially cause decreases in dissolved oxygen (DO) in the creek under some flow conditions in spring and fall; these decreases may potentially result in DO concentrations below the MWQSOGs for the protection of aquatic life.

The 5th percentile flow for Creek 14 in all months is 0.00 m^3/s. Therefore under low flows, the effluent would comprise all or the majority of the creek flow. In these

instances, the Manitoba Water Quality Objectives, which include ammonia and TSS, would not apply. However, the Manitoba Water Quality Guidelines, which include pH and TP, would apply; the narrative guideline for TP would be exceeded and the MWQSOG for pH may not be met depending on the end-of-pipe pH under these conditions.

Fish Habitat

Creek Fourteen originates in a low-lying saturated area, located approximately 100 m upstream of the Conawapa road crossing, and flows southeast to the Nelson River. The channel receives additional flows from roadside ditches, located on either side of the Conawapa road. The stream channel is narrow and shallow (approx. 0.10 m). Riparian vegetation consists predominately of willow and grasses and there is a high level of instream vegetation (grasses) and significant stream cover from overhanging vegetation. The channel connection to the Nelson River is undefined. A lack of hydrological information exists for Creek Fourteen. Water accumulation is likely dependent on precipitation events.

This tributary is rated as Marginal Fish Habitat and does not support fish directly. It provides indirect fish habitat in the form of water, nutrients and food (lower trophic levels) to the Nelson River.

Effects Assessment

The potential effects of the construction and operation of a sewage effluent outlet structure in Creeks Fourteen will depend largely on the type of structure and specific location. Following the *Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff* (DFO 2010), several scenarios are presented in Table A2-9 with corresponding Scale of Negative Effects rating and the Sensitivity of Fish and Fish Habitat rating is presented in Table A2-10.

There are two assumed basic types of effluent outlets; excavated channel that joins a receiving water and an outlet pipe at a receiving water. The outlet pipe configuration is assumed to be either a pipe terminating at the stream bank with no infill of the stream channel proper or a pipe that extends into the stream channel with a resulting infill of stream channel by the pipe or by infill material. Both the excavated channel and outlet pipe in the bank area rated as Low for the scale of negative effect and the outlet pipe located in the stream channel is rated as Moderate due to the expected infilling of streambed.

The fish and fish habitat sensitivity was rated as Low for the Creek Fourteen. Overall there is a Low Risk of a HADD for construction of an effluent outlet structure at the Creek Fourteen.

References

CANADA GAZETTE. 2010. Wastewater Systems Effluent Regulations. Volume 144, No. 12. March 20, 2010, Part I.

CANADIAN COUNCIL OF MINISTERS OF THE ENVIRONMENT. (CCME). 1999. Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg, MB. Updated to 2011.

FISHERIES AND OCEANS CANADA. (DFO) 2010. Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff Version 1.0. August 2010.

MANITOBA WATER STEWARDSHIP. 2011. Manitoba Water Quality Standards, Objectives, and Guidelines. Water Science and Management Branch, Manitoba Water Stewardship Report 2011-01, July 4, 2011. 68 pp.

SAVARD, T.G. and F. SCHNEIDER-VIEIRA. 2011. Treated Sewage Effluent Monitoring Program, Open-Water Season, 2010. A technical memorandum prepared for Manitoba Hydro by North/South Consultants Inc. 7 pp.

Tables

Table A2-1. Statistical summary of water quality measured in Creek Fifteen in the open-water season of 2004.

Sample Location	Ammonia (mg/L N)	Nitrate/ nitrite (mg/L N)	TKN (mg/L)	TN (mg/L)	TP (mg/L)	TSS (mg/L)	pH
Mean	0.004	0.010	0.5	0.510	0.007	<2	7.73
Minimum	0.003	<0.005	0.4	0.408	0.003	<2	7.61
Maximum	0.005	0.021	0.6	0.603	0.011	2	7.93
SD	0.001	0.008	0.1	0.08	0.004	-	0.15
n	4	4	4	4	4	4	4

Table A2-2. Creek Fourteen monthly 5th, 50th, and 95th percentile discharge (data provided by Manitoba Hydro).[1]

Month		Percentile (m^3/s)		
		5th	50th	95th
January		0.00	0.00	0.00
February		0.00	0.00	0.00
March		0.00	0.00	0.00
April		0.00	0.00	0.07
May		0.00	0.03	0.17
June		0.00	0.03	0.09
July		0.00	0.01	0.06
August		0.00	0.01	0.06
September		0.00	0.01	0.07
October		0.00	0.01	0.05
November		0.00	0.01	0.02
December		0.00	0.00	0.01
Minimum		0.00	0.00	0.00
Maximum		0.00	0.03	0.17
May-October	Minimum	0.00	0.01	0.05
	Maximum	0.00	0.03	0.17
Spring (May-June)	Minimum	0.00	0.03	0.09
	Maximum	0.00	0.03	0.17
Fall (September-October)	Minimum	0.00	0.01	0.05
	Maximum	0.00	0.01	0.07

Table A2-3. Statistical summary of effluent quality measured at the Wuskwatim construction camp during environmental monitoring studies, 2010 (Savard and Schneider-Vieira 2011). Monitoring occurred three times during the open-water season.

	Ammonia (mg N/L)	Nitrate/nitrite (mg N/L)	TKN (mg/L)	TN [1] (mg/L)	TP (mg/L)	pH	Faecal coliform bacteria (MPN/100 mL)
Minimum	4.90	0.075	10.7	11.0	2.33	8.21	<3
Maximum	9.42	0.884	13.1	14.0	3.35	9.35	14
Mean	6.73	0.416	12.0	12.4	2.80	8.67	7

[1] calculated as the sum of TKN and nitrate/nitrite.

Table A2-4. Proposed Wastewater Systems Effluent Standards (Canada Gazette 2010).

Unionized ammonia (mg N/L)[1]	CBOD (mg/L)	TSS (mg/L)	Total residual chlorine (mg/L)
1.25	25	25	0.02

[1]at 15 ^{o}C±1 ^{o}C

Table A2-5. Proposed Manitoba Municipal Wastewater Effluent Standards (Manitoba Water Stewardship 2011).

TP (mg/L)	BOD (mg/L)	TSS (mg/L)	Faecal Coliform Bacteria (organisms/100 mL)
1	25	25	200

Table A2-6. Mass-balance model scenarios and information sources: Spring and Fall Batch Release (June-October) discharge scenarios.

Scenario	Creek Fourteen Discharge	Effluent Discharge	Effluent Quality	Creek Fourteen Water Quality
1	Lowest 50th Percentile in spring/fall	Wuskwatim EIS discharge: 2,850 m^3/day (total volume = 42,750 m^3/year discharged over 15 days)	TP, nitrate, TN, ammonia, pH: Minimum concentrations measured in Wuskwatim construction camp effluent, 2010. TSS and BOD: Proposed WSERs and MWQSOG. TP: Proposed MWQSOG.	Minimum concentrations measured in Creek Fifteen in 2004
2	Lowest 50th Percentile in spring/fall	Wuskwatim EIS discharge: 2,850 m^3/day (total volume = 42,750 m^3/year discharged over 15 days)	TP, nitrate, TN, ammonia, pH: Maximum concentrations measured in Wuskwatim construction camp effluent, 2010. TSS and BOD: Proposed WSERs and MWQSOG. TP: Proposed MWQSOG.	Maximum concentrations measured in Creek Fifteen in 2004
3	Highest 95th percentile in spring/fall	Wuskwatim EIS discharge: 2,850 m^3/day (total volume = 42,750 m^3/year discharged over 15 days)	TP, nitrate, TN, ammonia, pH: Minimum concentrations measured in Wuskwatim construction camp effluent, 2010. TSS and BOD: Proposed WSERs and MWQSOG. TP: Proposed MWQSOG.	Minimum concentrations measured in Creek Fifteen in 2004

Scenario	Creek Fourteen Discharge	Effluent Discharge	Effluent Quality	Creek Fourteen Water Quality
4	Highest 95th percentile in spring/fall	Wuskwatim EIS discharge: 2,850 m^3/day (total volume = 42,750 m^3/year discharged over 15 days)	TP, nitrate, TN, ammonia, pH: Maximum concentrations measured in Wuskwatim construction camp effluent, 2010. TSS and BOD: Proposed WSERs and MWQSOG. TP: Proposed MWQSOG.	Maximum concentrations measured in Creek Fifteen in 2004

Table A2-7. MWQSOGs for the protection of aquatic life and recreation and the CCME interim PAL guideline for nitrate.

Water Useage	pH	TSS (mg/L)	Ammonia (mg N/L)	Nitrate (mg N/L)	Faecal Coliform Bacteria (CFU/100/mL)
Protection of aquatic life	6.5-9.0	5 mg/L increase above background (where background TSS is ≤25 mg/L) for a 30-day averaging duration	Objectives are dependent upon water temperature, pH, cool-water vs. cold-water species, and presence/absence of early life stages	2.93	-
		25 mg/L increase above background (where background TSS is≤250 mg/L) for a 1-day averaging duration. [1]			
Recreation	5.0-9.0	-	-	-	200

[1]Or 10% increase above background where background TSS > 250 mg/L.

Table A2-8. Results of mass-balance modeling for Creek Fourteen for Scenarios 1-4.

Scenario	Creek Discharge			Ammonia (mg/L N)	Nitrate/ nitrite (mg/L N)	TN (mg/L)	TP (mg/L)	pH	TSS (mg/L)	BOD[1] (mg/L)
1	Lowest 50th Percentile in spring/fall	Minimum Background WQ; Minimum Effluent Quality/WSERs/MWQSOGs	Best-Case	3.76	0.06	8.53	0.768	7.98	19.42	19.30
2	Lowest 50th Percentile in spring/fall	Maximum Background WQ; Maximum Effluent Quality/WSERs/MWQSOGs	Worst-Case	7.23	0.68	10.87	0.770	8.51	19.65	19.30
3	Highest 95th percentile in spring/fall	Minimum Background WQ; Minimum Effluent Quality/WSERs/MWQSOGs	Best-Case	0.80	0.01	2.13	0.165	7.67	4.90	4.48
4	Highest 95th percentile in spring/fall	Maximum Background WQ; Maximum Effluent Quality/WSERs/MWQSOGs	Worst-Case	1.53	0.16	2.78	0.172	8.00	5.74	4.48

[1] Background BOD in Creek Fourteen estimated as below analytical detection limits (< 1 mg/L).

Table A2-9. Scale of negative effect rating for three effluent outlet structure options.

Attribute	Description	Scale		
		Channel	Bank Pipe Outlet	Channel Infill Pipe Outlet
Extent	The direct footprint of the development as well as indirectly affected areas, such as downstream areas.	Low	Low	Low
Duration	The amount of time that a residual effect will persist.	High	High	High
Intensity	The expected amount of change from baseline condition.	Low	Low	Moderate
Overall		Low	Low	Moderate

Table A2-10. Sensitivity of fish and fish habitat at the assumed outlet structure location in Creek Fourteen.

Attribute	Description	Creek Fourteen
Species Sensitivity	Sensitivity of fish species/community to changes in environmental conditions (e.g., suspended sediments, water temperature, oxygen).	Low
Species Dependence on Habitat	Use of habitat by fish species. Some species may have very specific habitat requirements.	Low
Rarity	The relative strength of a fish population or prevalence of a specific habitat type.	Low
Habitat Resiliency	The relative strength of a fish population or prevalence of a specific habitat type.	Low
Overall		Low

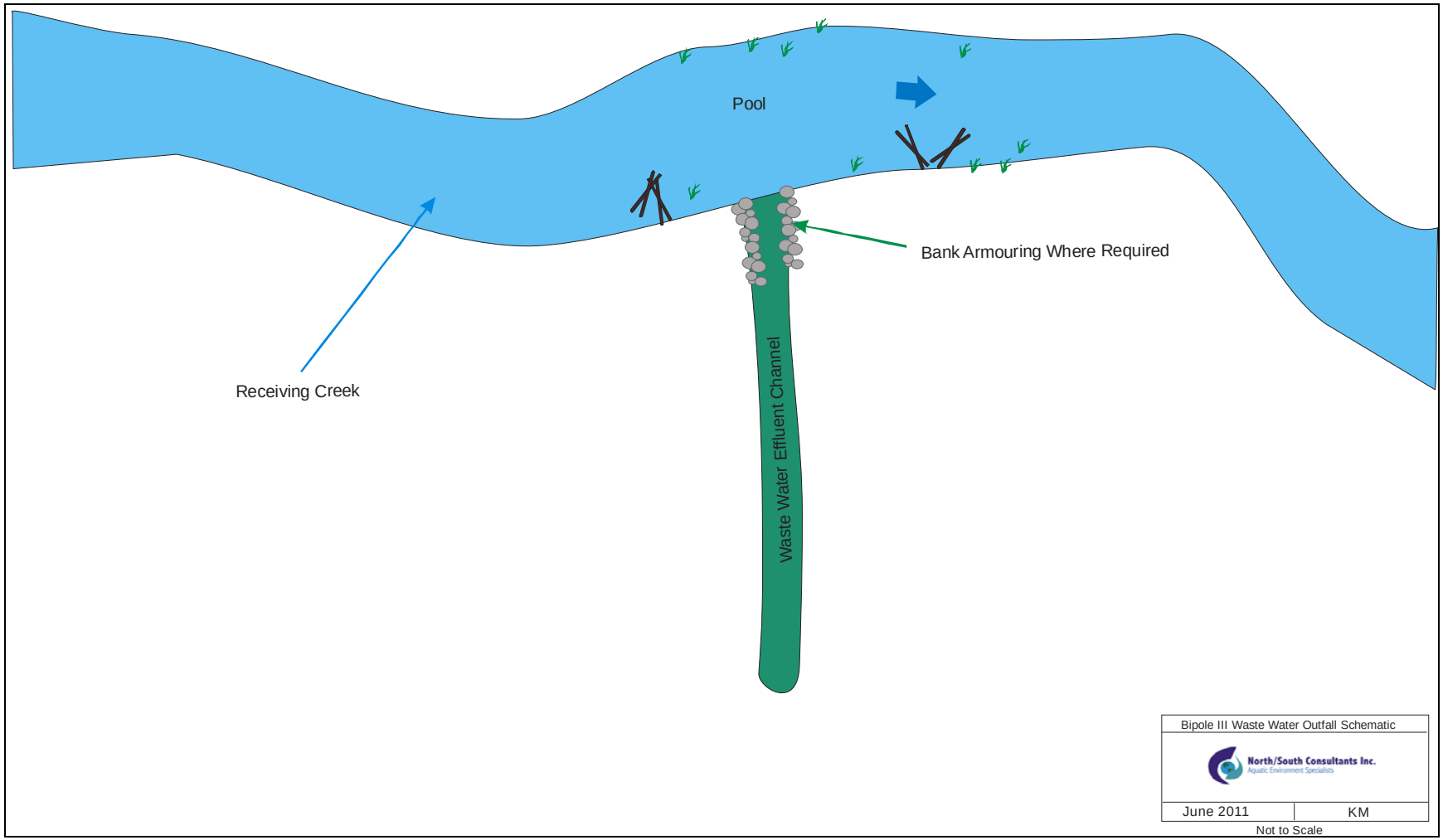

Figure A2-1. Schematic of a constructed waste water effluent channel to the receiving watercourse.

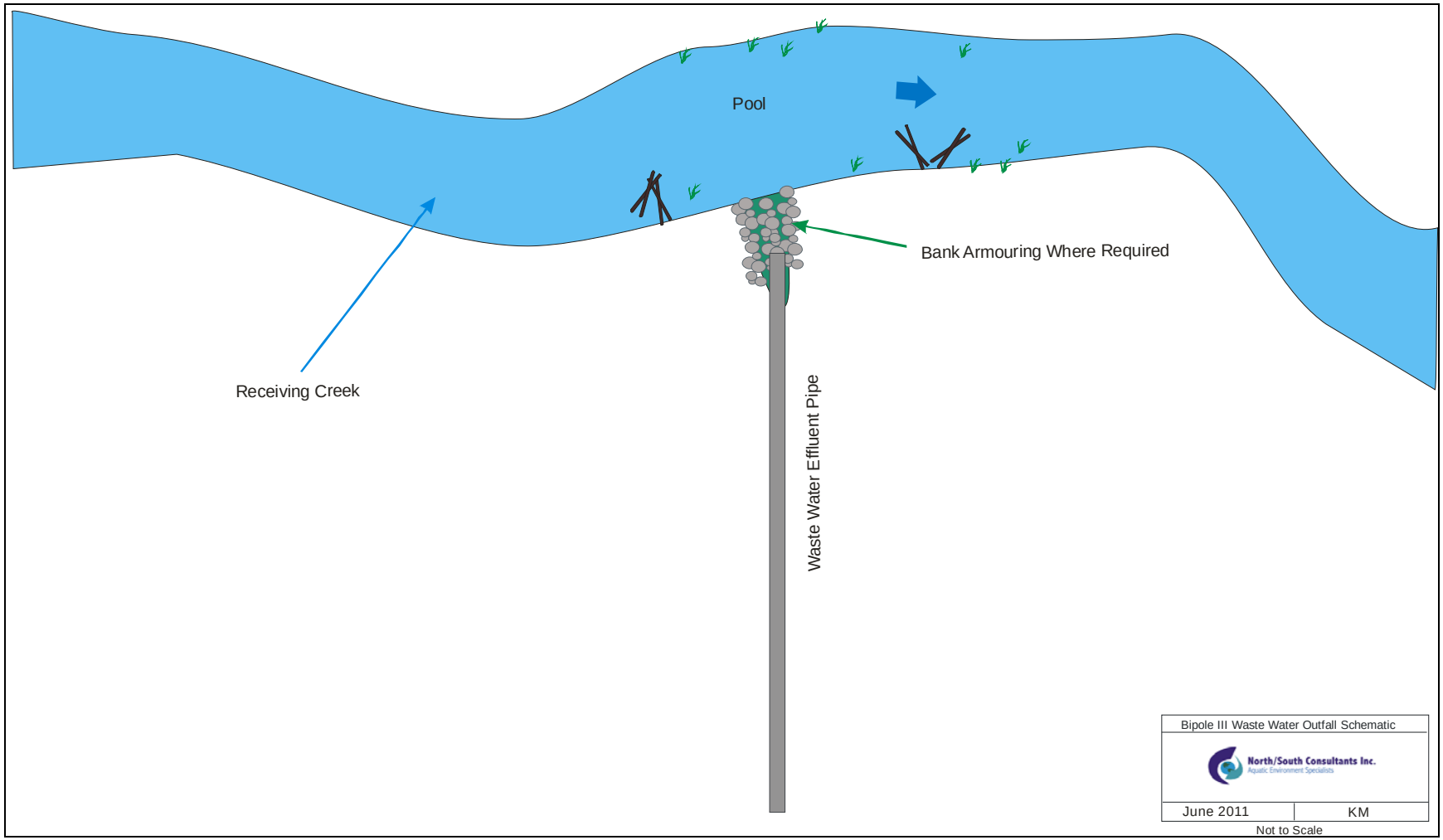

Figure A2-2. Schematic of a constructed waste water effluent pipe terminating at the receiving watercourse bank.