Appendix 1

Screening of Keewatinoow Converter Station Waste Water Effluent Discharge to Goose Creek

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

Introduction

The following provides a screening of the potential effects of sewage effluent discharge from the Keewatinoow Converter Station on water quality and fish habitat in Goose Creek. 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:

- Goose Creek Water Quality: Water quality data measured during the Conawapa environmental baseline studies in Goose Creek (open-water season 2004; Table A1-1);
- Goose Creek Discharge: Monthly 5th, 50th, and 95th percentile discharge, as provided by Manitoba Hydro (Table A1-2, 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 Generating Station (GS) camp (2010, Table A1-3, Savard and Schneider-Vieira 2011) and the proposed waste water systems effluent standards (Table A1-4, Canada Gazette 2010) and Manitoba municipal wastewater effluent standards (Table A1-5, Manitoba Water Stewardship 2011).

A mass-balance model was used to estimate fully-mixed water quality conditions in Goose Creek, based on the aforementioned information. Six scenarios were examined as summarized in Table A1-6.

Mass-balance model results (i.e., fully mixed water quality conditions) were then compared to Manitoba Water Quality Standards, Objectives, and

Guidelines (MWQSOGs; Manitoba Water Stewardship 2011) for the protection of aquatic life (PAL) for total suspended solids (TSS), pH, and ammonia, the MWQSOG narrative guideline for total phosphorus (TP; 0.050 mg/L) for streams and rivers, the MWQSOG recreational guideline for faecal coliform bacteria, and the Canadian Council of Ministers of the Environment (CCME 1999; updated to 2010) interim guideline for nitrate (there is no PAL guideline for nitrate in Manitoba). These objectives and guidelines are summarized in Table A1-7. 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.

Mass-Balance Modeling Results

Results of the mass-balance modeling for scenarios 1-6, which represent ranges of flow conditions, effluent quality, and background water quality, are presented in Table A1-8. The mass-balance modeling indicates that discharge of sewage effluent would not result in exceedences of Manitoba PAL objectives or guidelines for ammonia, pH, or TSS or exceedences of the CCME interim PAL guideline for nitrate in a fully mixed condition under 5^{th}, 50^{th}, or 95^{th} percentile flows (spring and fall). The narrative guideline for TP would be exceeded slightly however under low flows (the lowest monthly 5^{th} percentile flow over the spring and fall period). Some exceedences of water quality objectives and guidelines may also occur within the mixing zone.

Fish Habitat

<u>Goose Creek</u>

Goose Creek is a tributary of the lower Nelson River approximately 31 km in length. Over the majority of its length (the upper 27 km) the creek consists of a low gradient bog/wetland stream with abundant instream vegetation and a poorly defined channel. In contrast, the lower 4 km, including the reach adjacent to the Keewatinoow Converter Station site consist of riffle-scour pool habitat with coarse substrate and elevated water velocities (Swanson and Kansas 1987). Groundwater seepage locations have been recorded in the lower 4 km including locations adjacent to the Keewatinoow Converter Station site (Swanson et al. 1990, Lavergne and MacDonell 2010). Goose Creek is considered a brook trout nursery stream but recently brook trout were not captured in the stream (Kroeker and MacDonell 2006). Sculpins, pearl dace, and longnose sucker were captured in the area of the Keewatinoow Converter Station site (Kroeker and MacDonell 2006). However, suitable habitat for brook trout is present near the Keewatinoow Converter Station site and as this species is present in the stream it will be assumed that it may be found near the converter station site.

Effects Assessment

The potential effects of the construction and operation of a sewage effluent outlet structure in Goose Creek will depend largely on the type of structure and specific location. Construction of an outlet that does not reduce the amount of fish habitat would be expected to represent a low risk of a HADD. In contrast a structure that results in the loss or degradation of fish habitat are more likely to be ruled a HADD. Following the “Practitioners Guide to the Risk Management Framework for DFO Habitat Management Staff” (DFO 2010), several scenarios are presented in Table A1-9 with corresponding Scale of Negative Effects rating and the Sensitivity of Fish and Fish Habitat rating is presented in Table A1-10.

There are two assumed basic types of effluent outlets; excavated channel that joins a receiving water (Figure A1-1) and an outlet pipe at a receiving water (Figure A1-2). 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 High for Goose Creek. The High rating was largely a result of the use of Goose Creek by brook trout and the associated habitat.

Overall there is a Low to Medium Risk of a HADD for an outlet at Goose Creek. Considering the assumptions and uncertainty about the type of outlet and location, this assessment should be revisited once further details are available.

References

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Tables

Table A1-1. Statistical summary of water quality measured in Goose Creek 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	0.002	-	0.5	0.5	0.005	<2	7.98
Minimum	<0.003	<0.005	0.4	0.4	0.002	<2	7.85
Maximum	0.003	<0.005	0.5	0.5	0.008	2	8.15
SD	0.0009	-	0.1	0.1	0.003	0.5	0.13
n	3	3	3	3	3	3	3

Table A1-2. Goose Creek monthly 5th, 50th, and 95th percentile discharge (data provided by Manitoba Hydro).

Month		Percentile (m^3/s)		
		5th	50th	95th
January		0.06	0.12	0.26
February		0.04	0.08	0.15
March		0.03	0.06	0.10
April		0.03	0.06	4.38
May		0.05	2.26	9.23
June		0.68	2.38	6.03
July		0.30	1.08	3.94
August		0.12	0.72	3.84
September		0.08	0.84	3.81
October		0.15	0.83	3.08
November		0.11	0.45	1.38
December		0.06	0.20	0.50
Minimum		0.03	0.06	0.10
Maximum		0.68	2.38	9.23
May-October	Minimum	0.05	0.72	3.08
	Maximum	0.68	2.38	9.23
Spring (May-June)	Minimum	0.05	2.26	6.03
	Maximum	0.68	2.38	9.23
Fall (September-October)	Minimum	0.08	0.83	3.08
	Maximum	0.15	0.84	3.81

Table A1-3. 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)	pH	Faecal coliform bacteria (MPN/100 mL)
Minimum	4.90	0.075	10.7	11.0	8.21	<3
Maximum	9.42	0.884	13.1	14.0	9.35	14
Mean	6.73	0.416	12.0	12.4	8.67	7

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

Table A7-4. Proposed waste water systems effluent standards (Canada Gazette 2010) and Manitoba industrial and municipal waste water effluent standards (Manitoba Water Stewardship 2011).

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 $^oC \pm 1$ ^oC

Table A7-5. 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 A1-6. Mass-balance model scenarios and information sources: Spring and Fall Batch Release.

Scenario	Goose Creek Discharge	Effluent Discharge	Effluent Quality	Goose Creek Water Quality
1	Lowest 5th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004
2	Lowest 5th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004
3	Lowest 50th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004

Scenario	Goose Creek Discharge	Effluent Discharge	Effluent Quality	Goose Creek Water Quality
4	Lowest 50th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004
5	Highest 95th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004
6	Highest 95th percentile: Spring and fall	10,000 L/day = 243 m^3/day (total volume = 3,650 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 Goose Creek in 2004

Table A1-7. 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 A1-8. Results of mass-balance modeling for Goose Creek for Scenarios 1-6. Summary statistics of water quality measured in Goose Creek (2004) are included for comparison.

Scenario	Creek Discharge			Ammonia (mg N/L)	Nitrate/ nitrite (mg N/L)	TN (mg/L)	TP (mg/L)	pH	TSS (mg/L)	BOD[1] (mg/L)
Goose Creek Water Quality			Mean	0.002	-	0.5	0.005	7.98	<2	-
			Minimum	<0.003	<0.005	0.4	0.002	7.85	<2	-
			Maximum	0.003	<0.005	0.5	0.008	8.15	2	-
1	Lowest 5th percentile: Spring and fall	Minimum Background WQ; Minimum Effluent Quality/WSERs/MWQSOGs	Best-Case	0.263	0.006	0.96	0.06	7.86	2.3	1.8
2	Lowest 5th percentile: Spring and fall	Maximum Background WQ; Maximum Effluent Quality/WSERs/MWQSOGs	Worst-Case	0.505	0.050	1.22	0.06	8.17	3.2	1.8
3	Lowest 50th percentile: Spring and fall	Minimum Background WQ; Minimum Effluent Quality/WSERs/MWQSOGs	Best-Case	0.018	0.003	0.44	0.005	7.85	1.1	<1
4	Lowest 50th percentile: Spring and fall	Maximum Background WQ; Maximum Effluent Quality/WSERs/MWQSOGs	Worst-Case	0.035	0.005	0.55	0.011	8.15	2.1	<1
5	Highest 95th percentile: Spring and fall	Minimum Background WQ; Minimum Effluent Quality/WSERs/MWQSOGs	Best-Case	0.003	0.003	0.40	0.002	7.85	1.0	<1
6	Highest 95th percentile: Spring and fall	Maximum Background WQ; Maximum Effluent Quality/WSERs/MWQSOGs	Worst-Case	0.006	0.003	0.50	0.008	8.15	2.0	<1

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

Table A1-9. 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 A1-10. Sensitivity of fish and fish habitat at the assumed outlet structure location in Goose Creek.

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

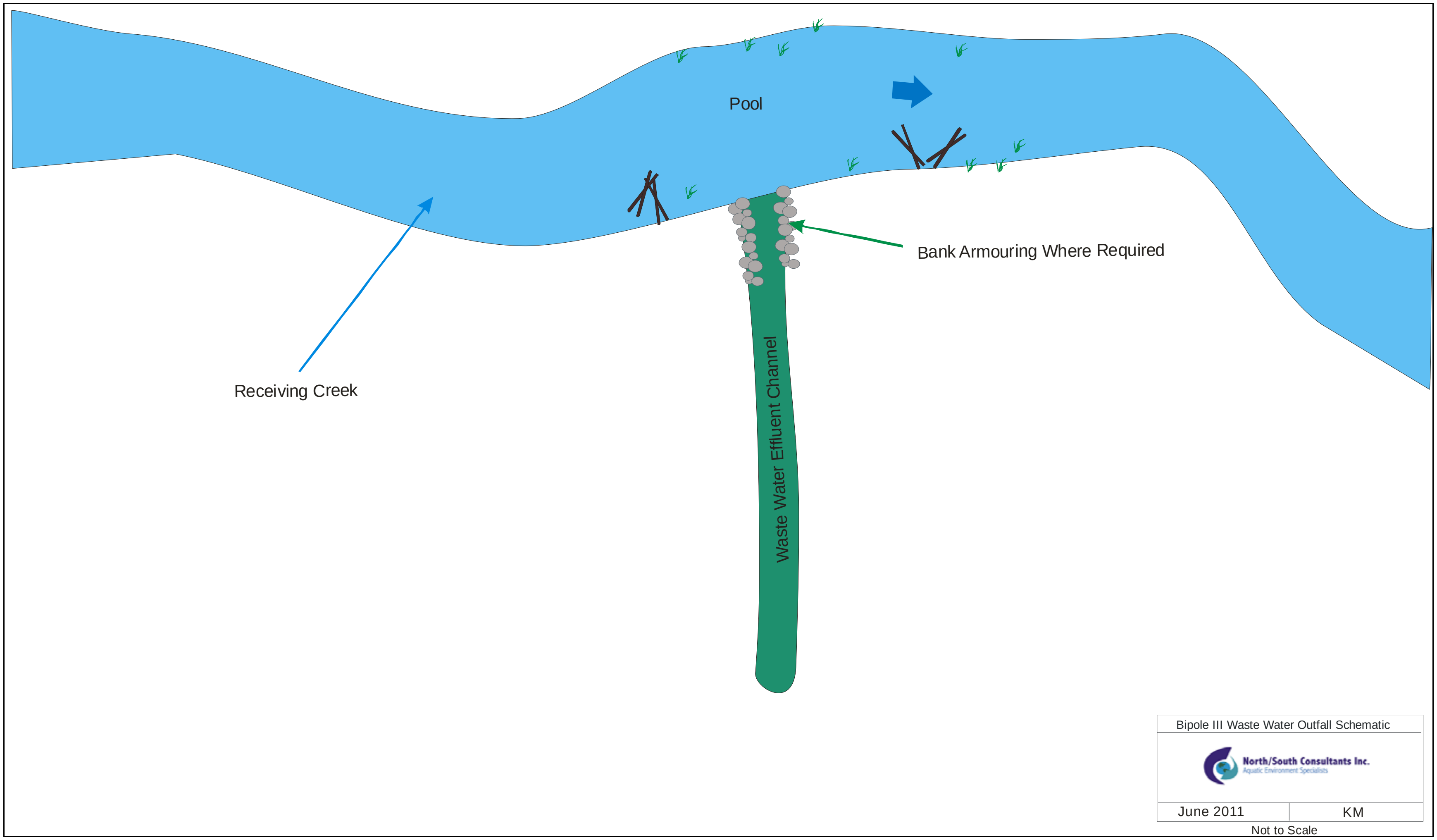

Figure A1-1.Schematic of a constructed waste water effluent channel to the receiving watercourse.

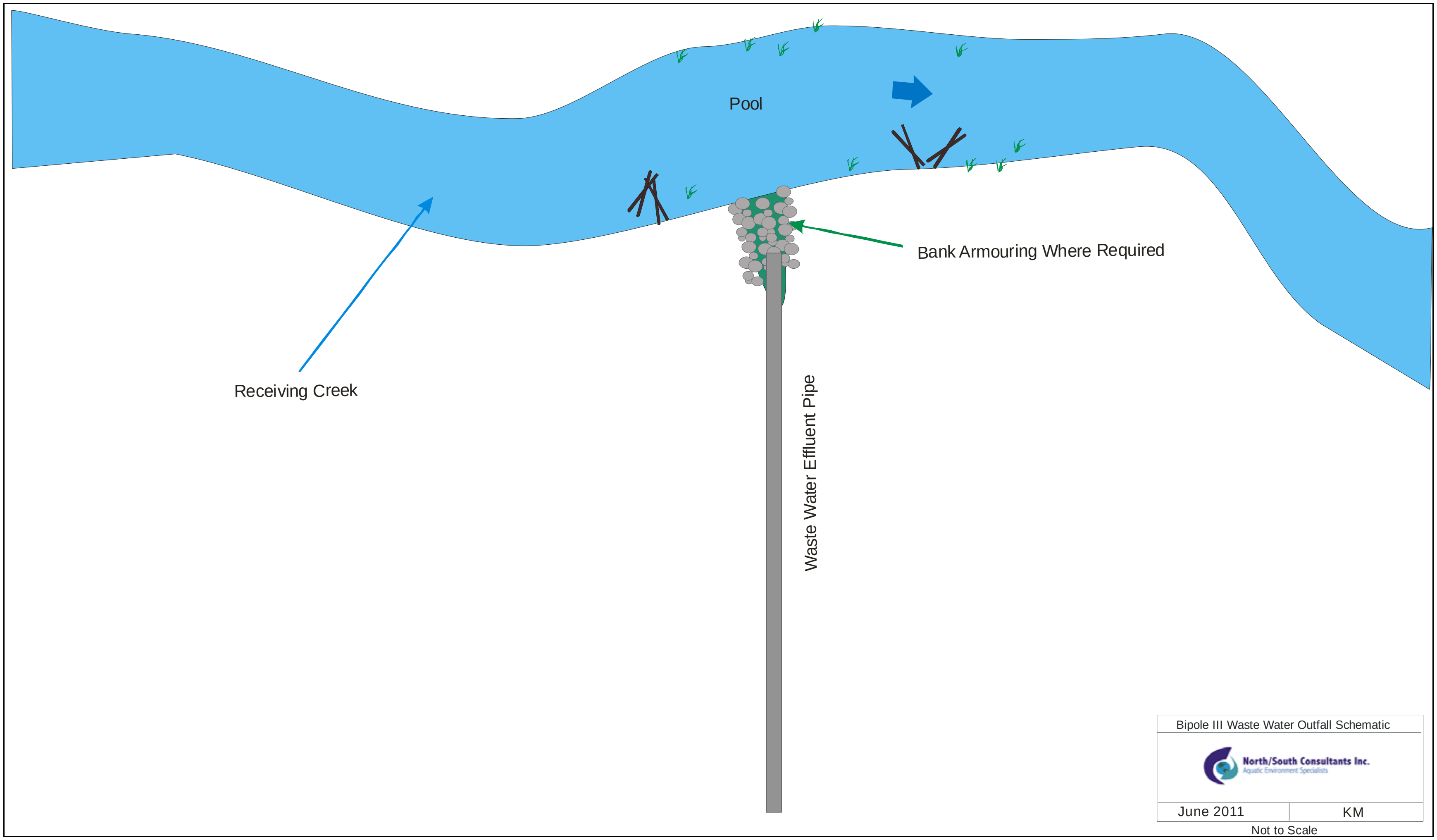

Figure A1-2. Schematic of a constructed waste water effluent pipe terminating at the receiving watercourse bank.