2016 Annual Water Quality Monitoring Report

Former Nanisivik Mine Site, Nunavut

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Executive Summary

This report provides a summary of the 2016 water quality monitoring results for the Nanisivik Mine located on the Borden Peninsula of northern Baffin Island in Nunavut, Canada. The water quality monitoring program has been conducted as required under Nunavut Water Licence 1AR–NAN1419 and is intended to assess the overall performance of reclamation and closure activities at the former mine site. The effectiveness and adequacy of mine reclamation is to be demonstrated through monitoring key parameters at key sampling stations. Results for the Final Discharge Point (Station 159–4) are compared to the authorized criteria stated in the Water Licence, while parameters at the remaining sampling stations are compared to their non–regulatory station–specific 95th percentile action levels (calculated from historical data) as indicated in the Contingency Plan for Water Quality Exceedances, Former Nanisivik Mine Site, submitted to Canzinco Mines Ltd. in March, 2015.

Water quality monitoring of the decommissioned Nanisivik Mine in 2016 was successful in July and August, but sampling was not possible in September due to early snow and freezing rain which caused the closure of the road leading to the Mine. Water quality monitoring of the decommissioned Nanisivik Mine in 2016 indicate that the mine decommissioning is meeting its objectives, and that conditions in the freshwater environment at the site are returning to a state similar to those that existed prior to the mine development.

The available results indicated compliance with maximum authorized concentrations at Station 159-4, the final discharge point of the West Twin Disposal Area, with the exception of an apparent exceedance of the upper limit for pH, based on a suspect field measurement. The corresponding laboratory measured pH value was within the authorized range. Further, the presence of a contractor's laydown area near Station 159-6 had no effect on water quality, as determined by comparison of results from 159-6 to results from a temporary upstream sampling station (159-6 Temp).

Minor non-conformances of the site-specific action levels for cadmium, lead and zinc were reported in July and August at Chris Creek (Station 159-14). Maximum measured values during the 2016 monitoring program were 0.0013 mg/L cadmium, 0.009 mg/L lead, and 0.54 mg/L zinc. Although concentrations were above the 95th percentile site-specific action level for these parameters, they are within the historical levels recorded for Nanisivik prior to mining activities and within the concentration range reported for the post-decommissioning period (2007-2016). Communication with Canzinco's geotechnical consultant (G. Claypool, M.Eng., P.Eng., personal communication 2016), who was on site in early August 2016, confirmed there were no signs of landslides, erosion or natural thermokarsting within Chris Creek. Mr. Claypool also indicated that climate conditions at Nanisivik were warmer and likely wetter than in previous years; an observation supported by weather data collected by Environment Canada for July and August 2016. Therefore, the elevated concentrations of cadmium, lead and zinc are likely reflective of weather conditions, and deeper than usual melting of the surface permafrost, during 2016.

Water quality at Station NML-30 near the Landfill showed no indication of impairment, with the exception of apparently spurious field measured pH values in a field duplicate sample in July, and in the August sample. The field measured pH values for 2016 are suspect, and therefore no concern is attached to these observations.

The missed sampling event in September 2016, is regrettable. The 2017 field plan has been prepared to begin approximately 2 weeks earlier than the 2016 field season, and for the September sampling to take place at the earliest opportunity, to limit the potential for a weather event to prevent the third sample collection in September 2017. Steps will be taken to ensure that reliable field measurements of pH are obtained during the 2017 sampling program. A sampling plan has been prepared for the 2017 field season, and is attached to this report as Appendix D.

1.0 INTRODUCTION

1.1 GENERAL INTRODUCTION

Stantec Consulting Ltd. (Stantec) is pleased to provide Canzinco Mines Ltd. with a review of the 2016 water quality monitoring data for the former Nanisivik Mine (the Mine) in the territory of Nunavut, Canada. The monitoring program is required under Water Licence 1AR-NAN1419 (the Water Licence, Nunavut Water Board, 2015) and is intended to assess the overall performance of reclamation and closure activities at the former Nanisivik Mine.

1.2 SITE DESCRIPTION

The Mine is located on the Borden Peninsula, part of northern Baffin Island (Drawing A-1, Appendix A). Specifically, the Mine is located on the southern shore of Strathcona Sound, approximately 33 kilometres by road from the hamlet of Arctic Bay. The Mine is located 750 kilometres north of the Arctic Circle at an approximate latitude of 73 degrees north. In 1998, Canzinco Ltd., a wholly owned subsidiary of Breakwater Resources Ltd., took possession of the Mine, and operated it until 2002. Breakwater Resources Ltd., was acquired by Nyrstar Sales & Marketing AG in 2011.

The Mine facilities, which are now decommissioned, consisted of an underground mine and a 2,200 tonnes per day concentrator that used conventional crushing, rod and ball mill grinding, differential lead and zinc flotation, and concentrate drying. Between 1976 and 2002, the underground facility extracted and shipped zinc and lead concentrates. Ore concentrates were shipped from a concentrate storage shed located adjacent to Strathcona Sound, where a deepwater wharf allowed ocean-going vessels to moor. Concentrates were transferred to ships using a ship-loader. Process tailings were transported to and deposited at the West Twin Disposal Area (WTDA), where resulting effluent was discharged into Twin Lakes Creek. The Mine was in full operation from its opening in 1976 until closure in September, 2002.

Reclamation activities began at Nanisivik in 2002. On July 30, 2006, Environment Canada approved Nanisivik as having achieved "recognized closed mine" status under the *Metal Mining Effluent Regulations* and therefore, mine effluent and environmental effects monitoring requirements under those regulations were no longer required. On October 1, 2008, reclamation of the site was completed and a post-closure monitoring period began. Water quality monitoring continued during 2016 under Nunavut Water Licence 1AR–NAN1419, issued by the Nunavut Water Board (2015).

1.3 SAMPLING LOCATIONS

The main sampling locations used for water quality monitoring near the Mine are described in Table 1.1 and are shown in Drawing A-2 (Appendix A). During the 2016 Water Quality Monitoring Program, monitoring stations included those listed in Schedule I, Table 2 of Water Licence 1AR-NAN1419, with the voluntary addition of sampling at Station ELO and 159-6 Temp (Table 1.1).

Station ELO is located upstream of NML-23 and was added during the 2012 program to confirm that elevated sulphate concentrations that were sporadically being detected originate from the watershed of East Twin Lake, and not from seepage proximal to NML–23 that could indicate a release from the WTDA. Station 159-6 Temp was added in 2016 when an independent contractor's laydown and storage area was identified within 30 m of Twin Lakes Creek, and within 10 m of the usual sampling station 159-6 (see Photos A1 through A6, Appendix A). Station 159-6 Temp was established approximately 120 m upstream of the Nanisivik wharf, and 30 m upstream of the laydown area, to confirm that water monitoring results at the station 159-6 were not influenced by activities or events at the laydown area.

Table 1.1 Surface Water Quality Sampling Locations Tested in 2016

Group	Station	Distance Downstream of Headwaters (m)	Description
Twin Lakes Creek Watershed	ELO	100	Outflow of East Twin Lake upstream of NML–23
	NML–23	400	Outflow of East Twin Lake
	159–4	750	Outflow from West Twin Disposal Area
	159–6	7,250	Outlet of Twin Lakes Creek into Strathcona Sound
	159-6 Temp	7,200	Outlet of Twin Lakes Creek into Strathcona Sound, upstream of the wharf construction laydown area*
Chris Creek Watershed	159–14	2,600	Chris Creek downstream of K–Baseline
Landfill Watershed	NML–29	75	Downstream of landfill – east drainage system
	NML-30	75	Downstream of landfill – west drainage system

Note:
Sampling locations as detailed by Gartner Lee Ltd. (2004), except as otherwise noted in the text.
* Contractors for the Department of National Defence/Defence Construction Canada at the Nanisivik wharf.

1.4 PREVIOUS WATER QUALITY MONITORING PROGRAMS

1.4.1 Water Licences

Since 1976, the Mine has operated under five different Water Licences issued by the Northwest Territories Water Board and the Nunavut Water Board:

- Northwest Territories Water Licence N5L3–0159 – Northwest Territories Water Board (July, 1976; renewed in 1978, 1983, 1988 and 1991);
- Nunavut Water Licence NWB1NAN9702 – Nunavut Water Board (July, 1997; the original term of five years was extended until closure in September, 2002);

- Nunavut Water Licence NWB1NAN0208 – Nunavut Water Board (October, 2002 to May, 2008);
- Nunavut Water Licence NWB1AR–NAN0914 – Nunavut Water Board (April, 2009 to December, 2014); and
- Nunavut Water Licence 1AR-NAN1419 – Nunavut Water Board (renewal for the period December 23, 2014 through December 22, 2019).

In comparison with previous Water Licences, and consistent with the progression of the decommissioning and post-closure monitoring, the conditions of the current Water Licence (Schedule I, Table 2) implement a reduction in sampling locations, frequency and parameters required for analysis. The Water Licence (Part F, Sections 1 and 2) contains maximum authorized concentrations of certain water quality parameters at Station 159-4, the final discharge point for the decommissioned West Twin Disposal Area (Table 1.2).

Table 1.2 Effluent Quality Requirements for the West Twin Disposal Area, Station 159-4

Parameter	Maximum Authorized Concentration (mg/L)
Total Arsenic (mg/L)	0.25
Total Copper (mg/L)	0.10
Total Lead (mg/L)	0.10
Total Nickel (mg/L)	0.50
Total Zinc (mg/L)	0.25
Total Suspended Solids (mg/L)	15.0
Total Cadmium (mg/L)	0.005
pH (units)	6.0 – 9.5 (pH units)
Note: Where a visible sheen has been observed in effluent the maximum authorized concentration of oil and grease shall not exceed 15.0 mg/L.	

Data for the remaining stations are compared to station-specific 95th percentile values (Table 1.3) that were presented to the Nunavut Water Board in the Contingency Plan for Water Quality Exceedances (Stantec, 2015). These are non-regulatory values calculated from historical data for each key parameter. If the 95th percentile value is exceeded for any key parameter at the same monitoring station on two consecutive occasions, an investigation will be initiated to determine the cause of the exceedance. Action levels have not been identified for other parameters because they are of less concern from a toxicological perspective (*e.g.,* major ion concentrations such as calcium and chloride), or because there is insufficient data to develop an estimate of the 95th percentile value. For pH, values are compared to the acceptable range listed in the Water Licence limits for Station 159–4 (*i.e.,* 6.0 to 9.5).

The Water Licence (Schedule I, Table 2) provides details of the expected Stations, Monitoring Parameters, and Frequency for the monitoring period of 2015 to 2019. Details of the monitoring requirements are provided in Table 1.4.

Table 1.3 Non-Regulatory Station-Specific Action Levels for the 2016 Water Quality Monitoring Program

Parameter	Station				
	Twin Lakes Creek Watershed		Chris Creek Watershed	Landfill Watershed	
	159–6	NML–23	159–14	NML–30	NML–29
Total Cadmium (mg/L)	0.014	0.0044	0.0005	0.00025	0.00025
Total Lead (mg/L)	0.044	0.016	0.0022	0.0050	0.0050
Total Zinc (mg/L)	4.6	0.12	0.13	0.03	0.03
Total Sulphate (mg/L)	463	25	408	240	240
Total Suspended Solids (mg/L)	53	10	32	22	22
pH (units)	6.0 – 9.5 (pH units)				
Notes: NML-29 flow is intermittent; action levels in case of flow are the same as at NML-30.					

Table 1.4 Water Quality Monitoring Schedule for Post Closure Period, 2015 to 2019

Water Quality Monitoring Stations 2015 to 2019				
Station Number	**Station Description**	**Purpose**	**Parameters to be Measured**	**Monitoring Frequency**
Twin Lakes Creek Watershed				
ELO^	Outflow of East Twin Lake upstream of NML–23	Water Quality at the Outlet to East Twin Lake (Control)	NAN-1	Monthly
NML–23	Outflow from East Twin Lake	Upstream Control Station	NAN-1	Monthly
159–4	Outflow from West Twin Disposal Area	Final Discharge Point	NAN-1	Monthly
			NAN-4	Annually
159–6	Outlet of Twin Lakes Creek into Strathcona Sound	General Monitoring	NAN-1 NAN-2	Monthly
			NAN-4	Annually
159–6 Temp*	Outlet of Twin Lakes Creek into Strathcona Sound upstream of the wharf construction laydown area and upstream of 159-6	General Monitoring	NAN-1 NAN-2	Monthly
			NAN-4	Annually
Chris Creek Watershed				
159–14	Chris Creek downstream of K–Baseline	K–Baseline Monitoring	NAN-1	Monthly
Landfill Watershed				
NML–29	Downstream of landfill – East Drainage System	Landfill Monitoring	NAN-1 NAN-2	Monthly
NML–30	Downstream of landfill – West Drainage	Landfill Monitoring	NAN-1 NAN-2	Monthly

Notes:
Monthly monitoring to be carried out during periods of flow or July 1 to September 1, annually.
NAN-1 includes: Metals analysis (total cadmium, lead and zinc), major cations (calcium, magnesium, sodium, potassium, ammonia, and hardness), major anions (chloride, sulphate, bicarbonate, carbonate, nitrate+nitrite, and alkalinity), TSS, and field-measured parameters (specific conductivity, temperature, pH and visual observation for hydrocarbon sheen).
NAN-2 includes: Petroleum hydrocarbon analysis of F2 to F4 hydrocarbons.
NAN-4 includes: ICP (trace metal) scan.
^ voluntary station added in 2012; analysis is the same as at NML-23.
* voluntary station added in 2016; analysis is the same as at 159-6.

1.4.2 Summary of Water Quality Monitoring Prior to 2016

In the seven years of monitoring following the decommissioning of the Mine, two main themes have emerged.

Of greatest significance, the decommissioning appears to have achieved its objectives with respect to overall water quality. Key areas that were decommissioned, such as the West Twin Disposal Area and Landfill show consistently good water quality results over the period 2008 to 2015. Water quality trends over time are illustrated graphically in Appendix C.

Sampling stations lower in the Twin Lakes Creek drainage system show substantial improvement and have stabilized since decommissioning activities ceased in 2008. The area remains subject to upset conditions due to the unpredictable nature of weathering and erosion in the zone where the creek valley cuts through the natural mineral outcrop. Stations located within the Chris Creek drainage, where natural mineralization exists at or close to the ground surface, are similarly subject to occasional upsets, but have likewise produced results that are consistent with conditions that prevailed before mining occurred.

The decommissioned facilities overall behaved as expected throughout the post-decommissioning period (2008-2015). Results obtained between 2008 and 2015 have exhibited a range of results that reflect natural processes and regional weather trends over the period, and can be considered indicative of likely future performance.

2.0 REVIEW OF 2016 WATER QUALITY DATA

Water samples were collected from the Twin Lakes Creek, Chris Creek and Landfill watersheds during the 2016 open flow sampling season (i.e., July and August). A summary of the 2016 water quality monitoring results is presented in tabular format in Appendix B. Water samples could not be collected in September, 2016, (the third sampling event required by the Water Licence) due to early snowfall followed by a period of freezing rain, which prevented access to the Mine (L. Kigutaq, personal communication 2016). Therefore, no results are available for September 2016.

2.1 STATION 159-4 (FINAL DISCHARGE POINT)

Only the data for Station 159-4 are compared to the effluent quality requirements for the final discharge point (from the Water Licence, Part F, Item 1). The water quality data for the parameters specified in the Water Licence at Station 159-4 are presented in Table 2.1. Full data are provided in Table B1 (Appendix B). Temporal trends are shown graphically in Figure C1 (Appendix C). Concentrations of the regulated parameters (*i.e.*, arsenic, cadmium, copper, lead, nickel, zinc and total suspended solids) remained below the maximum authorized concentrations. Field measured pH values slightly exceeded the authorized range in August 2016, however, there appears to have been a problem with the instrument or calibration, such that the field measured pH values were consistently high during 2016. The laboratory measurements for pH were lower than field measured pH, and within the required range, at 7.64 and 7.98 for July and August, respectively. See Section 2.5 (Quality Assurance) for additional information regarding field measured pH values.

For the additional, non-regulated parameters, the sulphate concentrations at Station 159-4 ranged between 149 and 628 mg/L (Table B1 and Figure C1), below the action level of 1,471 mg/L based on the station–specific 95th percentile value. Hydrocarbon fractions F2 through F4 were not reported in either the July or August sample, and no visible sheen was observed in July or August 2016 at Station 159-4.

Table 2.1 Concentrations of Water Licence Parameters at Station 159–4 in 2016

Parameter	Maximum Authorized Concentration (mg/L)	159–4		
		July 14, 2016	August 02, 2016	September 2016
Total Arsenic (mg/L)	0.25	<0.001	---	n/a
Total Copper (mg/L)	0.10	<0.001	---	n/a
Total Lead (mg/L)	0.10	0.001	0.001	n/a
Total Nickel (mg/L)	0.50	<0.005	---	n/a
Total Zinc (mg/L)	0.25	0.02	0.08	n/a
Total Suspended Solids (mg/L)	15.0	<2	<1	n/a
Total Cadmium (mg/L)	0.005	<0.0001	0.0002	n/a
pH (units) Field Measured	6.0-9.5 (pH units)	9.4	**9.9**	n/a
pH (units) Laboratory Measured	6.0-9.5 (pH units)	7.64	7.98	n/a
Petroleum Hydrocarbons	visible sheen[1]	nvs	n/a	n/a

Notes:
Required sampling includes monthly testing for NAN-1 (total cadmium, lead and zinc) with major cations, major anions, TSS, and the field parameters of specific conductivity, temperature, pH and visual observation for hydrocarbon sheens, and annual testing by ICP scan for trace metals generally.
n/a = data not available.
Bold = exceeds a regulatory limit in the Water Licence
--- = data not required; annual testing per Schedule I, Table 2 of the Water Licence.
nvs = no visual sheen observed.

2.2 TWIN LAKES CREEK WATERSHED (EXCLUDING STATION 159–4)

Two additional stations (NML-23, located in the upper reach of the Twin Lakes Creek watershed near the outlet of East Twin Lake; and Station 159-6, located in Twin Lakes Creek, immediately before it discharges into Strathcona Sound) are identified in the Water Licence for post-closure monitoring within the Twin Lakes Creek watershed. In addition, Canzinco samples station ELO at the outlet to East Twin Lake on a voluntary basis. An additional temporary station (159-6 Temp) was implemented in 2016 when a contractor's laydown/storage area was identified immediately upstream of Station 159-6. Selected water quality data for Stations 159-6 and NML-23 are presented in Tables 2.2 and 2.3, with the full data provided in Tables B2-1 and B2-2, in Appendix B.

Table 2.2 Maximum Concentrations of Selected Parameters at Station 159–6

Parameter	Action Level for Station 159-6	July 14, 2016	August 02, 2016	September 2016
Total Cadmium (mg/L)	0.014	0.0003	0.0004	n/a
Total Lead (mg/L)	0.044	<0.001	0.003	n/a
Total Zinc (mg/L)	4.6	0.09	0.13	n/a
Total Sulphate (mg/L)	463	49	42	n/a
Total Suspended Solids (mg/L)	53	<2	8	n/a
pH (units) Field Measured	6.0-9.5 (pH units)	9.1	**10.2**	n/a
pH (units) Laboratory Measured	6.0-9.5 (pH units)	7.51	7.27	n/a
Petroleum Hydrocarbons (mg/L)	visible sheen[1]	nvs/n.d.	n.d.	n/a

Notes:
n/a = data not available.
Bold = exceedance of 95th percentile site-specific action level.
n.d. = results for F2, F3 and F4 below analytical detection limits of 0.02, 0.05 and 0.05 mg/L, respectively.
nvs = no visual sheen observed.

Table 2.3 Maximum Concentrations of Selected Parameters at Stations NML–23

Parameter	Action Level for Station NML-23	July 13, 2016	August 02, 2016	September 2016
Total Cadmium (mg/L)	0.0044	<0.0001	<0.0001	n/a
Total Lead (mg/L)	0.016	<0.001	<0.001	n/a
Total Zinc (mg/L)	0.12	<0.01	<0.01	n/a
Total Sulphate (mg/L)	25	3	8	n/a
Total Suspended Solids (mg/L)	10.0	<2	<1	n/a
pH (units) Field Measured	6.0-9.5 (pH units)	8.7	9.4	n/a
pH (units) Laboratory Measured	6.0-9.5 (pH units)	7.26	6.75	n/a
Petroleum Hydrocarbons (mg/L)	visible sheen[1]	nvs	n.d.	n/a

Notes:
n/a = data not available.
n.d. = results for F2, F3 and F4 below analytical detection limits of 0.02, 0.05 and 0.05 mg/L, respectively.
nvs = no visual sheen observed.

Overall, the water quality results for Stations 159-6 and NML-23 were within the expected ranges in 2016, with no indications of water quality impairment that would indicate any concerns with respect to the environmental performance of the decommissioned Mine. A slight exceedance of pH (based on the field measured value) occurred at Station 159-6 in August, but the laboratory measured pH value was within the expected range. Results from Stations ELO and 159-6 Temp (see Tables B2-1 and B2-2 in Appendix B) were generally consistent with the results from the nearby stations NML-23 and 159-6, respectively, and did not indicate any need for further investigation. One discrepancy was observed in the field-measured

conductivity value at NML-23 in August, where a value of 1,229 µS was reported. The corresponding laboratory measured value was in the expected range at 44 µS. The reason for this discrepancy is not known.

2.3 CHRIS CREEK WATERSHED

The Water Licence requires continued sampling at Station 159-14 during the period 2015 to 2019. Station 159-14 is located on Chris Creek approximately 1.6 km upstream of its discharge to Strathcona Sound. Selected water quality data for Station 159-14 are presented in Table 2.4, with the full data provided in Table B3, in Appendix B.

Table 2.4 Concentrations of Selected Parameters at Station 159-14 in 2016

Parameter	Action Level for Station 159-14	July 13, 2016	August 02, 2016	September 2016
Total Cadmium (mg/L)	0.0005	**0.0007**	**0.0013**	n/a
Total Lead (mg/L)	0.0022	0.001	**0.009**	n/a
Total Zinc (mg/L)	0.13	**0.34**	**0.54**	n/a
Total Sulphate (mg/L)	408	319	241	n/a
Total Suspended Solids (mg/L)	32	<1	6	n/a
pH (units) Field Measured	6.0-9.5 (pH units)	9.1	9.3	n/a
pH (units) Laboratory Measured	6.0-9.5 (pH units)	7.99	7.98	n/a
Petroleum Hydrocarbons (mg/L)	visible sheen[1]	nvs	nvs	n/a

Notes:
Bold = exceedance of 95th percentile site-specific action level.
n/a = data not available.
nvs = no visual sheen observed.

The site-specific action levels at Station 159-14 were exceeded in two consecutive sampling periods for cadmium and zinc, and was exceeded in one sample for lead (Table 2.4). Communication with Canzinco's geotechnical consultant (G. Claypool, M.Eng., P.Eng., personal communication 2016), who was on site in early August 2016, confirmed there were no signs of landslides, erosion or natural thermokarsting within Chris Creek. Mr. Claypool also indicated that climate conditions at Nanisivik were warmer and likely wetter than in previous years. This observation is substantiated by Environment Canada monthly weather data for the closest weather station at Arctic Bay, where monthly temperature range from 16.9°C to 1.3°C for July, and 13°C to 1.3°C for August (Environment Canada 2016 a,b). Therefore, the elevated concentrations of cadmium, lead and zinc may simply reflect weather conditions, and deeper than usual melting of the surface permafrost, during 2016.

The measured concentrations of cadmium, lead and zinc at Station 159-14 are within with historical range for Chris Creek for the period 2007 through 2015. The maximum recorded values since 2007 are 0.0009 mg/L for cadmium; 0.003 mg/L for lead; and 0.72 mg/L for zinc. Prior to the development of the Mine, BC Research (1975) measured substantially higher concentrations of cadmium (0.028 mg/L), lead (0.02 mg/L) and zinc (15 mg/L). Taking these historical trace metal levels into consideration, the measurements recorded in 2016 do not appear to be grounds for concern.

2.4 LANDFILL WATERSHED

The Landfill is located west of the Mine, with primary drainage systems that flow intermittently to the east and west, monitored at Stations NML-29 and NML-30, respectively. No sampling was conducted at Station NML-29 during the 2016 monitoring period, as no flow was observed. Flow at this site has been intermittent throughout the post-closure period. Samples were collected in both July and August, 2016, from Station NML-30. A summary of the water quality data for Stations NML-30 is presented in Table 2.5. Full data are provided in Table B4-1, in Appendix B.

Water quality results for Station NML-30 were generally below the 95th percentile action levels in 2016, with no indication of water quality impairment. The exception is an elevated field measured pH (9.7) in the August sample. In addition, a pH of 10.2 was recorded for a field duplicate measurement during the July sampling event (see Table B4 in Appendix B). These elevated pH values were not replicated by the laboratory measured pH values (Tables 2.5 and B4). The field measured pH values are suspect, and therefore no concern is attached to these observations.

Table 2.5 Concentrations of Selected Parameters at Station NML-30 in 2016

Parameter	Action Level for Stations NML-29 and NML-30	July 14, 2016	August 2, 2016	September 2016
Total Cadmium (mg/L)	0.00025	<0.0001	<0.0001	n/a
Total Lead (mg/L)	0.0050	<0.001	<0.001	n/a
Total Zinc (mg/L)	0.03	<0.01	<0.01	n/a
Total Sulphate (mg/L)	240	51	76	n/a
Total Suspended Solids (mg/L)	22	<2	<1	n/a
pH (units) Field Measured	6.0-9.5 (pH units)	9.5	**9.7**	n/a
pH (units) Laboratory Measured	6.0-9.5 (pH units)	8.15	8.14	n/a
Petroleum hydrocarbons (mg/L)	visible sheen[1]	n.d.	n.d.	n/a

Notes:
Bold = exceedance of 95th percentile site-specific action level.
n/a = data not available. September samples were not collected as a result of early snowfall and poor access conditions.
n.d. = results for F2, F3 and F4 below analytical detection limits of 0.02, 0.05 and 0.05 mg/L, respectively.

2.5 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) DISCUSSION

The Quality Assurance/Quality Control (QA/QC) sampling program consisted of the collection and analysis of "blank" and "field duplicate" samples for quality assurance purposes. The QA/QC program permits the evaluation of the efficiency of quality control measures implemented during sampling to limit potential contamination and produce reliable results. Four field duplicate samples (two at each Station 159–6 and NML-30) and two blank samples were submitted for analysis during the 2016 Water Quality Monitoring Program. Relative Percent Difference (RPD) of each duplicate parameter measured is provided in Table 2.6. Higher RPDs are typically observed when analyte concentrations are very low (*i.e.*, close to their respective laboratory detection limit). There are no firm guidelines for the degree of correlation expected between duplicates due to the potential for natural heterogeneity within and between samples, as well as potential contaminant distribution.

In general, the duplicate results agree closely with their corresponding samples and confirm the representativeness of sampling procedures. For most of the samples the relative percent difference (RPD) from the mean for individual parameters ranged between 0% and 10% for field duplicates. One of the three outliers with a RPD greater than 40% was observed for total suspended solids. Measurements of TSS are inherently variable, and collection of water samples can result in disturbance of sediments leading to changes in water quality that are detected in duplicate samples collected after the primary sample.

The remaining two outliers with RPD greater than 40% were observed for ammonia (reported as N-NH3). Of the two field blank samples, the July sample reported a trace of ammonia. Although not analysed in the August sample, results for the July field blank were generally lower than those reported in the four field duplicates analyzed and lower than the concentrations reported in the field samples. The ammonia result is therefore considered to be a minor problem with the laboratory-supplied distilled water, and not indicative of elevated background or contamination in the field samples. The overall data quality is considered acceptable.

A concern arising during the 2016 sampling program, however, relates to the field measured pH values. These were consistently higher (by 1 to 2 pH units) during 2016 than in previous years, and higher than the corresponding laboratory measured pH values. It seems likely that there was a problem with the instrument, or with the calibration of the instrument, during 2016. This should be addressed in 2017 by procuring a new pH meter and calibration buffers, and be reviewing the instrument calibration and operation procedures with the field technician prior to field sampling.

Table 2.6 Results of QA/QC Samples and Associated Relative Percent Differences

Parameter	Parent 14-Jul-2016 159-6	Field Dup 14-Jul-2016 159-6	RPD (%)	Parent 2-Aug-2016 159-6	Field Dup 2-Aug-2016 159-6	RPD (%)	Parent 14-Jul-2016 NML-30	Field Dup 14-Jul-2016 NML-30	RPD (%)	Parent 2-Aug-2016 NML-30	Field Dup 2-Aug-2016 NML-30	RPD (%)	Greater Than 40% RPD
pH	9.1	9.1	0.00%	10.2	7.24	33.94%	9.5	10.2	7.11%	8.14	9.7	17.49%	0
Conductivity	0.187	0.187	0.00%	0.149	0.146	2.03%	0.329	0.271	19.33%	0.398	0.407	2.24%	0
TSS	<1	<2	NC	8	3	90.91%	<2	<1	NC	<1	<1	NC	1
Sulphate	49	48	2.06%	42	41	2.41%	50	51	1.98%	76	76	0.00%	0
Cadmium	0.0003	0.0003	0.00%	0.0004	0.0004	0.00%	<0.0001	<0.0001	NC	<0.0001	<0.0001	NC	0
Lead	<0.001	<0.001	NC	0.003	0.003	0.00%	<0.001	<0.001	NC	<0.001	<0.001	NC	0
Zinc	0.09	0.09	0.00%	0.13	0.13	0.00%	<0.01	<0.01	NC	<0.01	<0.01	NC	0
Alkalinity (as $CaCO_3$)	35	34	2.90%	26	25	3.92%	122	123	0.82%	143	154	7.41%	0
Chloride	2	2	0.00%	3	3	0.00%	2	2	0.00%	3	3	0.00%	0
Ammonia (as nitrogen)	0.133	0.069	63.37%	0.026	<0.025	3.92%	<0.025	0.341	172.68%	<0.025	<0.025	NC	2
NO_2+NO_3 as N	0.1	0.11	9.52%	<0.10	<0.10	NC	0.17	0.15	12.50%	0.12	0.1	18.18%	0
Hardness (as $CaCO_3$)	86	86	0.00%	68	68	0.00%	180	182	1.10%	219	219	0.00%	0
HCO_3 as $CaCO_3$	35	34	2.90%	26	25	3.92%	122	123	0.82%	143	154	7.41%	0
Calcium	18	18	0.00%	14	14	0.00%	39	40	2.53%	48	48	0.00%	0
Magnesium	10	10	0.00%	8	8	0.00%	20	20	0.00%	24	24	0.00%	0
Potassium	<1	<1	NC	<1	<1	NC	1	1	0.00%	1	1	0.00%	0
Sodium	<2	<2	NC	<2	<2	NC	<2	<2	NC	<2	<2	NC	0
F2	<0.02	<0.020	NC	<0.020	<0.020	NC	<0.020	<0.020	NC	<0.020	<0.020	NC	0
F3	<0.05	<0.050	NC	<0.050	<0.050	NC	<0.050	<0.050	NC	<0.050	<0.050	NC	0
F4	<0.05	<0.050	NC	<0.050	<0.050	NC	<0.050	<0.050	NC	<0.050	<0.050	NC	0

Notes:

1. F2, F3, F4 represent petroleum hydrocarbon fractions by increasing molecular weight.
2. Dup = Field Duplicate
3. RPD = Relative Percent Difference
4. NC = RPD not calculated as both measurements were reported as being below the limit of quantification.
4. Concentrations of parameters are reported in mg/L unless otherwise specified.
5. Shaded orange cells represent RPD higher than 40%.

3.0 DISCUSSION

Water quality monitoring of the decommissioned Nanisivik Mine in 2016 was successful in July and August, but sampling was not possible in September due to early snow and freezing rain which caused the closure of the road leading to the Mine. Sampling in 2017 should be initiated as early as possible, and sampling in September should be scheduled for the first week of the month, in order to ensure that three monthly sampling periods are achieved.

The available results indicated compliance with maximum authorized concentrations at Station 159-4, the final discharge point of the West Twin Disposal Area, with the exception of an apparent exceedance of the upper limit for pH, based on a suspect field measurement. The corresponding laboratory measured pH value was within the authorized range. Results were similar at Station 159-6, near the mouth of Twin Lakes Creek. Further, the presence of a contractor's laydown area associated with construction near the dock, had no effect on water quality as determined by comparison of results from 159-6 to results from a temporary upstream sampling station (159-6 Temp).

Minor non-conformances of the site-specific action levels for cadmium, lead and zinc were reported in July and August at Chris Creek (Station 159-14). Maximum parameter exceedances during the 2016 monitoring program were reported at 0.0013 mg/L cadmium, 0.009 mg/L lead, and 0.54 mg/L zinc. Although concentrations were above the 95th percentile site-specific action level for these parameters, they are within the historical levels recorded for Nanisivik prior to mining activities and within the concentration range reported for the post-decommissioning period (2007-2016). Maximum concentrations reported for 2016 of cadmium, lead and zinc are similar to previously reported exceedances observed between 1996 and 2012 during other seasons with warmer temperatures and periods of precipitation, and lower than concentrations that were reported by BC Research (1975) prior to construction of the Mine. Communication with Canzinco's geotechnical consultant (G. Claypool, M.Eng., P.Eng., personal communication 2016), who was on site in early August 2016, confirmed there were no signs of landslides, erosion or natural thermokarsting within Chris Creek. Mr. Claypool also indicated that climate conditions at Nanisivik were warmer and likely wetter than in previous years. This observation is substantiated by Environment Canada monthly weather data for the closest weather station at Arctic Bay, where monthly temperature range from 16.9°C to 1.3°C for July, and 13°C to 1.3°C for August (Environment Canada 2016 a,b). Therefore, the elevated concentrations of cadmium, lead and zinc may simply reflect weather conditions, and deeper than usual melting of the surface permafrost, during 2016.

Sampling near the Landfill (Stations NML-29 and NML-30) showed no flow at NML-29. Water quality at Station NML-30 showed no indication of water quality impairment, with the exception is an apparently spurious field measured pH values in a field duplicate sample in July, and in the August sample. The field measured pH values for 2016 are suspect, and therefore no concern is attached to these observations.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the 2016 water quality monitoring program at the former Nanisivik Mine site in Nunavut indicate that the mine decommissioning is meeting its objectives, and that conditions in the freshwater environment at the site are returning to a state similar to those that existed prior to the mine development.

The missed sampling event in September 2016, is regrettable. The 2017 field plan has been prepared to begin approximately 2 weeks earlier than the 2016 field season, and for the September sampling to take place at the earliest opportunity, to limit the potential for a weather event to prevent the third sample collection in September 2017. A sampling plan has been prepared for the 2017 field season, and is attached to this report as Appendix D. In addition, steps will be taken to ensure that field instruments (e.g., pH meter) are in good working condition and properly calibrated prior to sampling in 2017.

5.0 CLOSING

This report has been prepared for the sole benefit of Canzinco Mines Ltd., as a subsidiary of Nyrstar Sales & Marketing AG. The report may not be used by any other person or entity, other than for its intended purposes, without the consent of Nyrstar Sales & Marketing AG and Stantec Consulting Ltd.

The information and conclusions contained in this report are based upon work undertaken in accordance with generally accepted engineering and scientific practices current at the time the work was performed. The information provided in this report was compiled from existing documents, information provided by Canzinco Mines Ltd., data provided by analytical laboratories, and others. Information obtained from these sources has been assumed to be correct. Stantec Consulting Ltd. accepts no responsibility for damages or liability that may arise from use of this data.

The conclusions presented in this report represent the best technical judgment of Stantec based on the data obtained from the work. The conclusions are based on samples collected by field personnel contracted by Canzinco Mines Ltd. at the time the work was performed at the specific testing and/or sampling locations, and can only be extrapolated to an undefined limited area around these locations. Samples were obtained by others and submitted directly to Exova Accutest for laboratory analysis. Stantec cannot comment on whether the samples adequately represent site conditions. Due to the nature of the investigation and the limited data available, Stantec cannot warrant against undiscovered environmental liabilities.

If any conditions become apparent that deviate from our understanding of conditions as presented in this report, Stantec Consulting Ltd. requests to be notified immediately, and permitted to reassess the conclusions provided herein.

This report was prepared by Jodie Lowe and Annick St-Amand, Ph.D. and reviewed by Malcolm Stephenson, Ph.D. Should you have any questions or comments on the contents of this report, please contact the undersigned.

We trust that the above information fulfills your needs at this time. Should you require additional information, please do not hesitate to contact us.

Sincerely,

STANTEC CONSULTING LTD.

Annick St-Amand, Ph.D. Environmental Scientist, Organic Chemist	Malcolm Stephenson, Ph.D. Senior Principal, Project Manager

6.0 REFERENCES

BC Research. 1975. Terrestrial Environmental Studies at Strathcona Sound, N.W.T. Project 1552, Progress Report No. 2. March, 1975.

Environment Canada. 2016a. Hourly Data Report for Station Arctic Bay CS for July 2016 and August 2016. Available online at http://climate.weather.gc.ca/historical_data/search_historic_data_e.html. Accessed on October 13, 2016.

Environment Canada. 2016b. Canadian Climate Normals 1981-2010 Station Data for Nanisivik, Nunavut. Available online at http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnProv&lstProvince=NU&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=1769&dispBack=0. Accessed on October 13, 2016.

Gartner Lee Limited. 2004. Nanisivik Mine Reclamation and Closure Monitoring Plan. February, 2004.

Nunavut Water Board. 2015. Water Licence No: 1AR-NAN1419. Approved by the Minister of Aboriginal Affairs and Northern Development Canada on January 29, 2015.

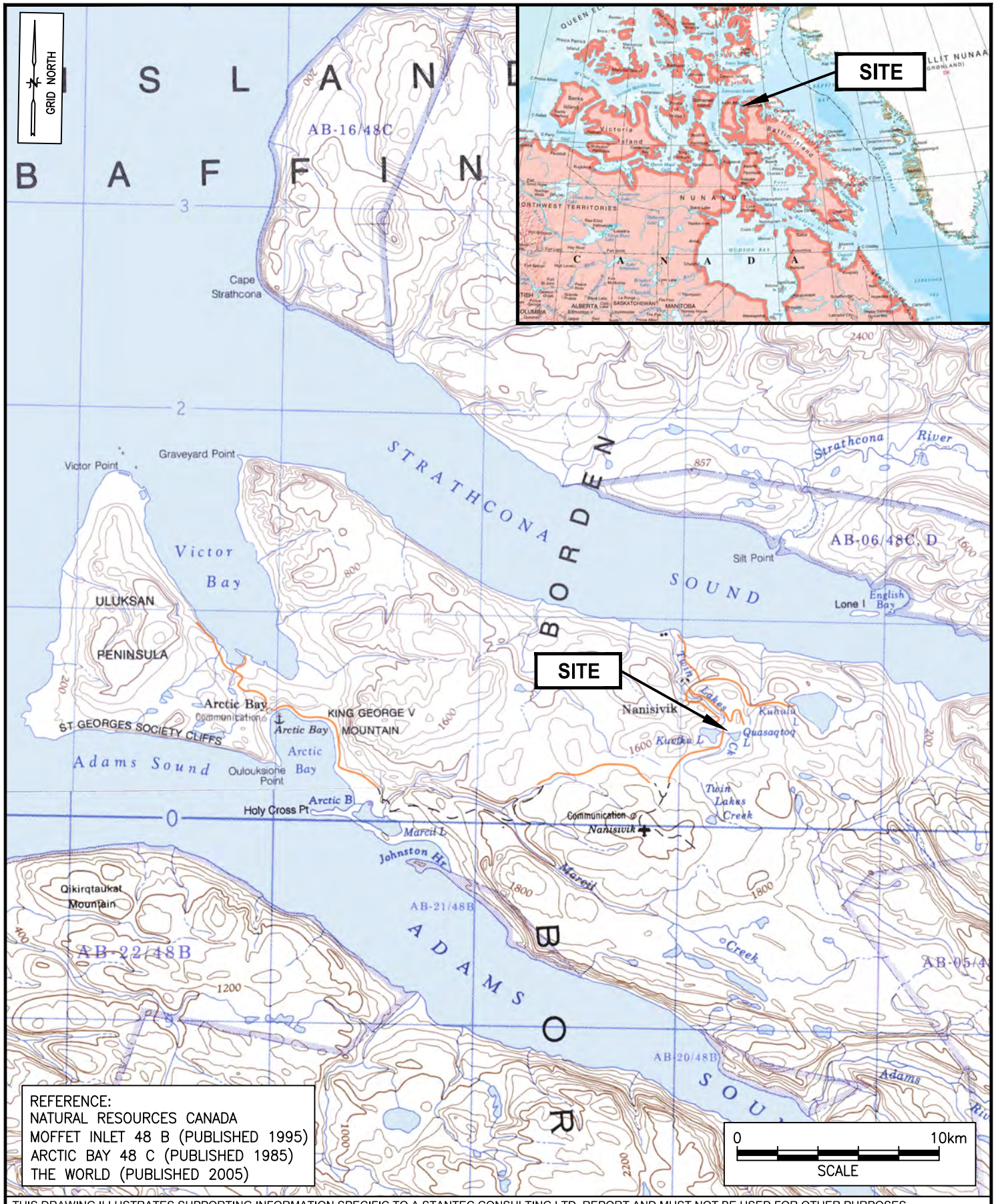
Stantec. 2015. Contingency Plan for Water Quality Exceedances, Former Nanisivik Mine Site. Prepared by Stantec Consulting Ltd. (Stantec) on behalf of Nyrstar, dated March 24, 2015.

Personal Communications

Geoff Claypool, M.Eng., P.Eng. August 23, 2016. BCG Engineering Inc. Vice President, Senior Geotechnical Engineer, Calgary, AB. Email to J. Lowe, Stantec Consulting Ltd. RE: Nanisivik – Station 159-14 Chris Creek (downstream from k-Baseline).

Lily Kigutaq. September 30, 2016. Canzinco Mines Ltd. onsite field technician at Arctic Bay, NU. Email to J. Lowe, Stantec Consulting Ltd. Re: Nanisivik - Water Quality Sampling - September 2016.

Appendix A DRAWINGS AND PHOTOS



THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

SITE LOCATION

WATER QUALITY MONITORING

NANISIVIK MINE, NUNAVUT

Client: CANZINCO LTD. c/o NYRSTAR CANADA (HOLDINGS) LTD.

Job No.:	121811901
Scale:	1 : 250,000
Date:	09-FEB-2017
Dwn. By:	JL
App'd By:	MS

Dwg. No.: A-1

Stantec

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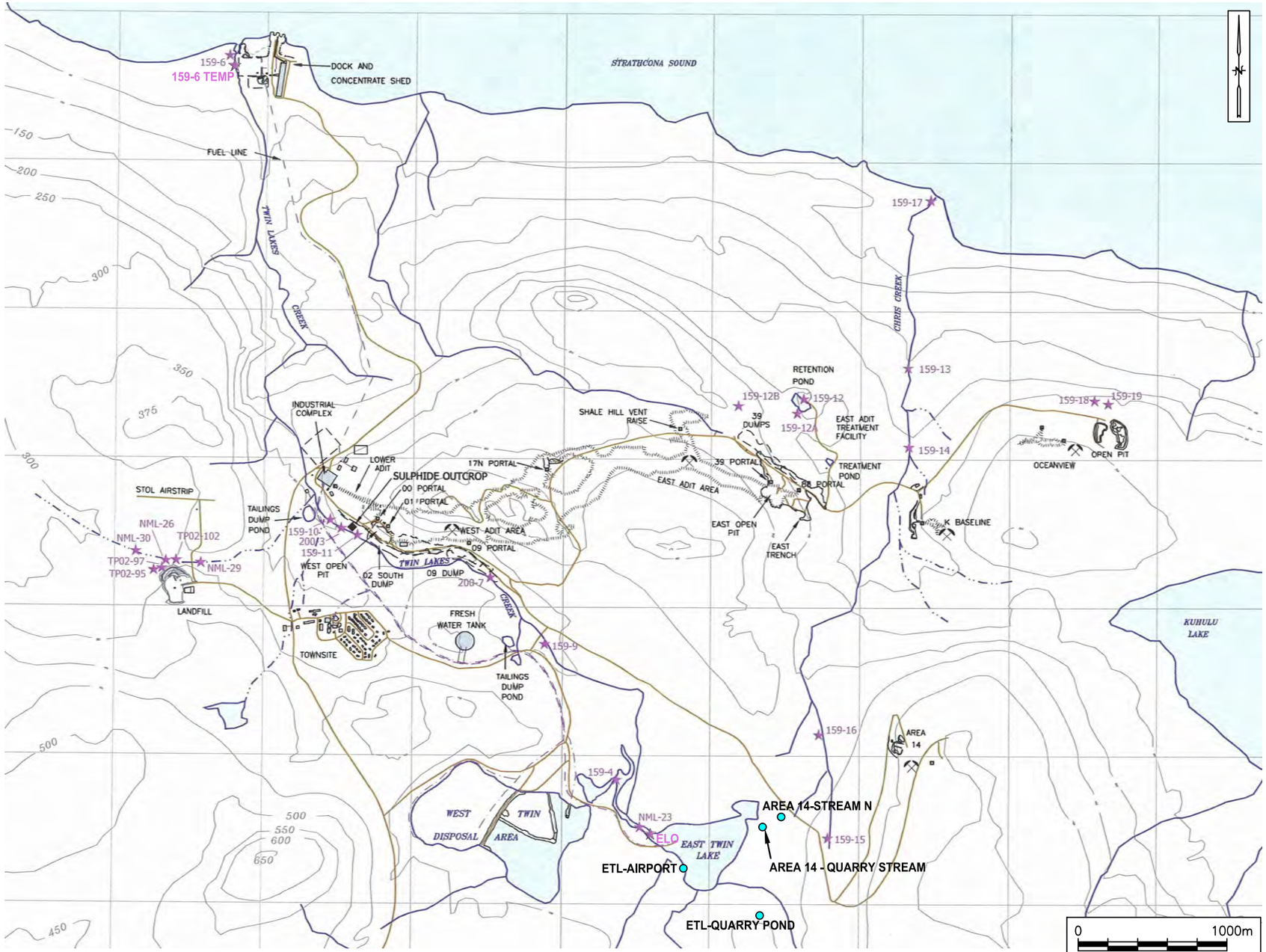


LEGEND:

- ROAD
- GROUND CONTOUR (50 m INTERVAL)
- SHORELINE, DRAINAGE, STREAMS
- INTERMITTENT DRAINAGE
- HIGH TIDE LINE – SURVEYED
- TOP OF BANK
- PIPELINE
- EXTENT OF UNDERGROUND WORKINGS
- MINING AREA
- ADIT, RAISE
- ★ NML-16 WATER SAMPLING LOCATION

WATER QUALITY MONITORING STATIONS 2014-2019		
STATION	LATITUDE	LONGITUDE
ELO	73.022543 N	−84.470025 W
NML−23	73.022970 N	−84.472946 W
159−4	73.025644 N	−84.477130 W
NML−29	73.038523 N	−84.555158 W
NML−30	73.038580 N	−84.574106 W
159−6	73.069603 N	−84.557824 W
159−14	73.047278 N	−84.418062 W
159−6 TEMP	73.069141 N	−84.556367 W

THIS DRAWING ILLUSTRATES SUPPORTING INFORMATION SPECIFIC TO A STANTEC CONSULTING LTD. REPORT AND MUST NOT BE USED FOR OTHER PURPOSES.

Reference:
ORIGINAL FIGURES PROVIDED BY NANISIVIK MINE

WATER SAMPLING LOCATIONS - MINE AREA

WATER QUALITY MONITORING
NANISIVIK MINE, NUNAVUT

Client: CANZINCO LTD. c/o NYRSTAR CANADA (HOLDINGS) LTD.

Job No.:	121811901
Scale:	1 : 30,000
Date:	09-FEB-2017
Dwn. By:	JL
App'd By:	MS

Dwg. No.: A-2

Stantec

V:\1218\active\121811901\03_data\1_CAD\SHEET FILES\121811901_WQM_A-2.dwg

Photo A1 **Final discharge location, Station 159-6 Twin Lakes Creek**

Photo A2 **Watercourse with substrate showing no visible hydrocarbon sheen at Station 159-6**

Photo A3 **Department of National Defence contractor's laydown and storage area from upstream at Station 159-6**

Photo A4 **Department of National Defence contractor's laydown and storage area from downstream at Station 159-6**

Photo A5 **New station marker at Station 159-6 Temp**

Photo A6 **View of the Department of National Defence contractor's laydown and storage area looking downstream from Station 159-6 Temp**

Appendix B 2016 SUMMARY DATA TABLES

Table B1: Final Discharge Point (Station 159-4)

Parameter	Authorized Licence Limit (mg/L; unless otherwise specified)	Concentration (mg/L; unless otherwise specified)	
		14-Jul-16	02-Aug-16
		159-4	159-4
Laboratory pH (units)	6 - 9.5	7.64	7.98
Field pH (units)	6 - 9.5	9.4	**9.9**
Field Conductivity (mS)	N/A	0.391	0.046
Field Temperature (°C)	N/A	11.5	11.6
Total Suspended Solids	15	<2	<1
Sulphate	1,471	149	628
Aluminum	N/A	0.03	---
Antimony	N/A	<0.0005	---
Arsenic	0.25	<0.001	---
Beryllium	N/A	<0.0005	---
Boron	N/A	0.25	---
Cadmium	0.005	<0.0001	0.0002
Chromium	N/A	<0.001	---
Cobalt	N/A	<0.0002	---
Copper	0.1	<0.001	---
Iron	N/A	0.04	---
Lead	0.1	0.001	0.001
Manganese	N/A	<0.01	---
Molybdenum	N/A	0.005	---
Nickel	0.5	<0.005	---
Selenium	N/A	<0.001	---
Silicon	N/A	0.3	---
Silver	N/A	<0.0001	---
Strontium	N/A	0.234	---
Thallium	N/A	<0.0001	---
Titanium	N/A	<0.01	---
Uranium	N/A	<0.001	---
Vanadium	N/A	<0.001	---
Zinc	0.25	0.02	0.08
Alkalinity (as $CaCO_3$)	N/A	38	98
Chloride	N/A	3	14
Ammonia (as N)	N/A	0.038	<0.025
Nitrate + Nitrite (as NO_2+NO_3)	N/A	<0.10	0.14
Hardness (as $CaCO_3$)	N/A	200	741
Bicarbonate (as $CaCO_3$)	N/A	38	98
Calcium	N/A	44	160
Magnesium	N/A	22	83
Potassium	N/A	3	8
Sodium	N/A	<2	5
F2 ($C_{>10}$-C_{16})	N/A	---	---
F3 ($C_{>16}$-C_{34})	N/A	---	---
F4 ($C_{>34}$-C_{50})	N/A	---	---

Notes:

Authorized Licence Limit – Monthly Measurement (most conservative)

A station specific action level of 1,471 mg/L is also available for sulphate based on 95th percentile calculated from Station

--- = Analysis not required NR = Not Reported

N/A = Not applicable, station specific action level not defined.

Bold = Value exceeds Authorized Licence Limit, as listed within the Water Licence requirements.

Table B2-1: Twin Lakes Creek Water Quality Data (Station 159-6)

Parameter	Action Level (mg/L; unless otherwise specified)	Concentration (mg/L; unless otherwise specified)				
		14-Jul-16	14-Jul-16	02-Aug-16	02-Aug-16	02-Aug-16
		159-6	159-6 Dup	159-6	159-6 Dup	159-6 TEMP
Laboratory pH (units)	6 - 9.5	7.51	7.51	7.27	7.24	7.27
Field pH (units)	6 - 9.5	9.1	9.1	10.2	7.2	7.27
Field Conductivity (mS)	N/A	0.187	0.187	0.149	0.146	0.147
Field Temperature (°C)	N/A	7.7	7.7	11.5	NR	NR
Total Suspended Solids	53	<1	<2	8	3	8
Sulphate	463	49	48	42	41	41
Aluminum	N/A	0.02	---	---	---	---
Antimony	N/A	<0.0005	---	---	---	---
Arsenic	N/A	<0.001	---	---	---	---
Beryllium	N/A	<0.0005	---	---	---	---
Boron	N/A	0.05	---	---	---	---
Cadmium	0.014	0.0003	0.0003	0.0004	0.0004	0.0004
Chromium	N/A	<0.001	---	---	---	---
Cobalt	N/A	<0.0002	---	---	---	---
Copper	N/A	<0.001	---	---	---	---
Iron	N/A	<0.03	---	---	---	---
Lead	0.044	<0.001	<0.001	0.003	0.003	0.002
Manganese	N/A	<0.01	---	---	---	---
Molybdenum	N/A	<0.005	---	---	---	---
Nickel	N/A	<0.005	---	---	---	---
Selenium	N/A	<0.001	---	---	---	---
Silicon	N/A	0.4	---	---	---	---
Silver	N/A	<0.0001	---	---	---	---
Strontium	N/A	0.054	---	---	---	---
Thallium	N/A	<0.0001	---	---	---	---
Titanium	N/A	<0.01	---	---	---	---
Uranium	N/A	<0.001	---	---	---	---
Vanadium	N/A	<0.001	---	---	---	---
Zinc	4.6	0.09	0.09	0.13	0.13	0.13
Alkalinity (as $CaCO_3$)	N/A	35	34	26	25	25
Chloride	N/A	2	2	3	3	3
Ammonia (as N)	N/A	0.133	0.069	0.026	<0.025	<0.025
Nitrate + Nitrite (as NO_2+NO_3)	N/A	0.1	0.11	<0.10	<0.10	<0.10
Hardness (as $CaCO_3$)	N/A	86	86	68	68	68
Bicarbonate (as $CaCO_3$)	N/A	35	34	26	25	25
Calcium	N/A	18	18	14	14	14
Magnesium	N/A	10	10	8	8	8
Potassium	N/A	<1	<1	<1	<1	<1
Sodium	N/A	<2	<2	<2	<2	<2
F2 ($C_{>10}$-C_{16})	N/A	<0.02	<0.020	<0.020	<0.020	---
F3 ($C_{>16}$-C_{34})	N/A	<0.05	<0.050	<0.050	<0.050	---
F4 ($C_{>34}$-C_{50})	N/A	<0.05	<0.050	<0.050	<0.050	---

Notes:

Station specific action levels based on 95th percentile calculated from Station specific historical data.

--- = Analysis not required NR = Not Reported

N/A = Not applicable, station specific action level not defined.

Bold = Value exceeds Authorized Licence Limit, as listed within the Water Licence requirements.

Table B2-2: Twin Lakes Creek Water Quality Data (Station NML-23/ELO)

Parameter	Action Level (mg/L; unless otherwise specified)	Concentration (mg/L; unless otherwise specified)		
		13-Jul-16	02-Aug-16	02-Aug-16
		NML-23	NML-23	ELO
Laboratory pH (units)	6 - 9.5	7.26	6.75	6.80
Field pH (units)	6 - 9.5	8.7	9.4	6.8
Field Conductivity (mS)	N/A	0.027	1.229	0.044
Field Temperature (°C)	N/A	7.1	12.600	NR
Total Suspended Solids	10	<2	<1	<1
Sulphate	25	3	8	8
Arsenic	N/A	---	---	---
Cadmium	0.0044	<0.0001	<0.0001	<0.0001
Copper	N/A	---	---	---
Lead	0.016	<0.001	<0.001	<0.001
Nickel	N/A	---	---	---
Zinc	0.12	<0.01	<0.01	<0.01
Alkalinity (as $CaCO_3$)	N/A	9	9	10
Chloride	N/A	2	2	2
Ammonia (as N)	N/A	<0.025	<0.025	<0.025
Nitrate + Nitrite (as NO_2+NO_3)	N/A	<0.10	<0.10	<0.10
Hardness (as $CaCO_3$)	N/A	9	18	18
Bicarbonate (as $CaCO_3$)	N/A	9	9	10
Calcium	N/A	2	4	4
Magnesium	N/A	1	2	2
Potassium	N/A	<1	<1	<1
Sodium	N/A	<2	<2	<2
F2 ($C_{>10}$-C_{16})	N/A	---	---	<0.020
F3 ($C_{>16}$-C_{34})	N/A	---	---	<0.050
F4 ($C_{>34}$-C_{50})	N/A	---	---	<0.050

Notes:

Station specific action levels based on 95th percentile calculated from Station specific historical data.

--- = Analysis not required NR = Not Reported

N/A = Not applicable, station specific action level not defined.

Bold = Value exceeds Authorized Licence Limit, as listed within the Water Licence requirements.

Table B3: Chris Creek Water Quality Data (Station 159-14)

Parameter	Action Level (mg/L; unless otherwise specified)	Concentration (mg/L; unless otherwise specified)	
		13-Jul-16	02-Aug-16
		159-14	159-14
Laboratory pH (units)	6 - 9.5	7.99	7.98
Field pH (units)	6 - 9.5	9.1	9.3
Field Conductivity (mS)	N/A	0.758	0.701
Field Temperature (°C)	N/A	12.8	10.000
Total Suspended Solids	32	<1	6
Sulphate	408	319	241
Arsenic	N/A	---	---
Cadmium	0.0005	**0.0007**	**0.0013**
Copper	N/A	---	---
Lead	0.0022	0.001	**0.009**
Nickel	N/A	---	---
Zinc	0.13	**0.34**	**0.54**
Alkalinity (as $CaCO_3$)	N/A	100	108
Chloride	N/A	5	7
Ammonia (as N)	N/A	<0.025	<0.025
Nitrate + Nitrite (as NO_2+NO_3)	N/A	0.89	0.74
Hardness (as $CaCO_3$)	N/A	434	364
Bicarbonate (as $CaCO_3$)	N/A	100	108
Calcium	N/A	83	75
Magnesium	N/A	55	43
Potassium	N/A	4	4
Sodium	N/A	4	4
F2 ($C_{>10}$-C_{16})	N/A	---	
F3 ($C_{>16}$-C_{34})	N/A	---	
F4 ($C_{>34}$-C_{50})	N/A	---	

Notes:

Station specific action levels based on 95th percentile calculated from Station specific histo

--- = Analysis not required NR = Not Reported

'N/A = Not applicable, station specific action level not defined.

Bold = Value exceeds Authorized Licence Limit, as listed within the Water Licence requireme

Table B4: Landfill Water Quality Data (Station NML-30)

Parameter	Action Level (mg/L; unless otherwise specified)	Concentration (mg/L; unless otherwise specified)			
		14-Jul-16	14-Jul-16	02-Aug-16	02-Aug-16
		NML-30	NML-30 DUP	NML-30	NML-30 DUP
Laboratory pH (units)	6 - 9.5	8.15	8.15	8.14	8.13
Field pH (units)	6 - 9.5	9.5	10.2	8.1	9.7
Field Conductivity (mS)	N/A	0.329	0.271	0.398	0.407
Field Temperature (°C)	N/A	NR	NR	NR	NR
Total Suspended Solids	22	<2	<1	<1	<1
Sulphate	240	50	51	76	76
Arsenic	N/A	---	<0.001	---	---
Cadmium	0.00025	<0.0001	<0.0001	<0.0001	<0.0001
Copper	N/A	---	0.001	---	---
Lead	0.005	<0.001	<0.001	<0.001	<0.001
Nickel	N/A	---	<0.005	---	---
Zinc	0.03	<0.01	<0.01	<0.01	<0.01
Alkalinity (as $CaCO_3$)	N/A	122	123	143	154
Chloride	N/A	2	2	3	3
Ammonia (as N)	N/A	<0.025	0.341	<0.025	<0.025
Nitrate + Nitrite (as NO_2+NO_3)	N/A	0.17	0.15	0.12	0.1
Hardness (as $CaCO_3$)	N/A	180	182	219	219
Bicarbonate (as $CaCO_3$)	N/A	122	123	143	154
Calcium	N/A	39	40	48	48
Magnesium	N/A	20	20	24	24
Potassium	N/A	1	1	1	1
Sodium	N/A	<2	<2	<2	<2
F2 ($C_{>10}$-C_{16})	N/A	<0.020	<0.020	<0.020	<0.020
F3 ($C_{>16}$-C_{34})	N/A	<0.050	<0.050	<0.050	<0.050
F4 ($C_{>34}$-C_{50})	N/A	<0.050	<0.050	<0.050	<0.050

Notes:

Station specific action levels based on 95th percentile calculated from Station specific historical data.

--- = Analysis not required NR = Not Reported

N/A = Not applicable, station specific action level not defined.

Bold = Value exceeds Authorized Licence Limit, as listed within the Water Licence requirements.

Appendix C 2016 TEMPORAL TREND FIGURES

Figure C1: Temporal trends at Station 159-4

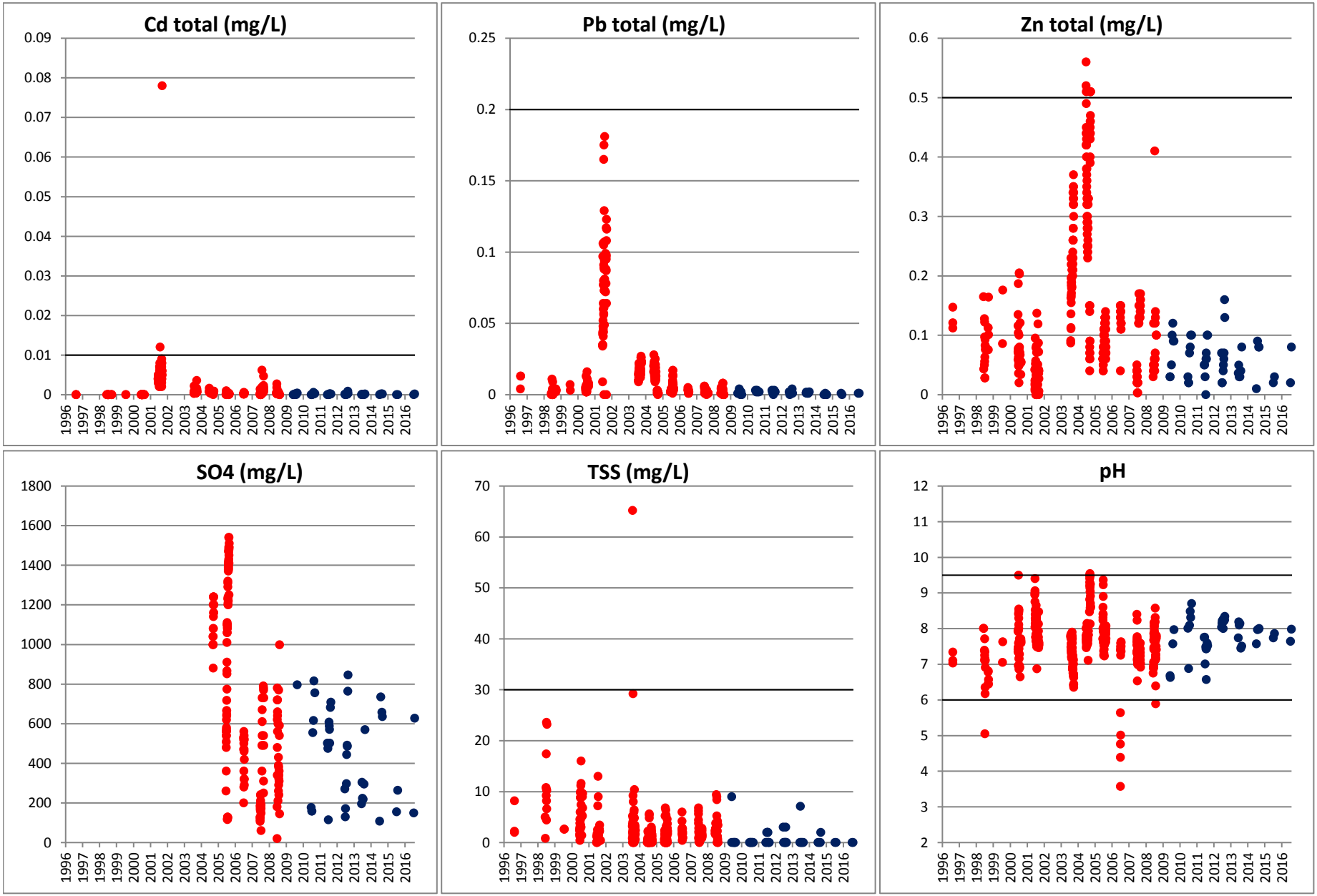


Figure C2: Temporal trends at Station 159-6

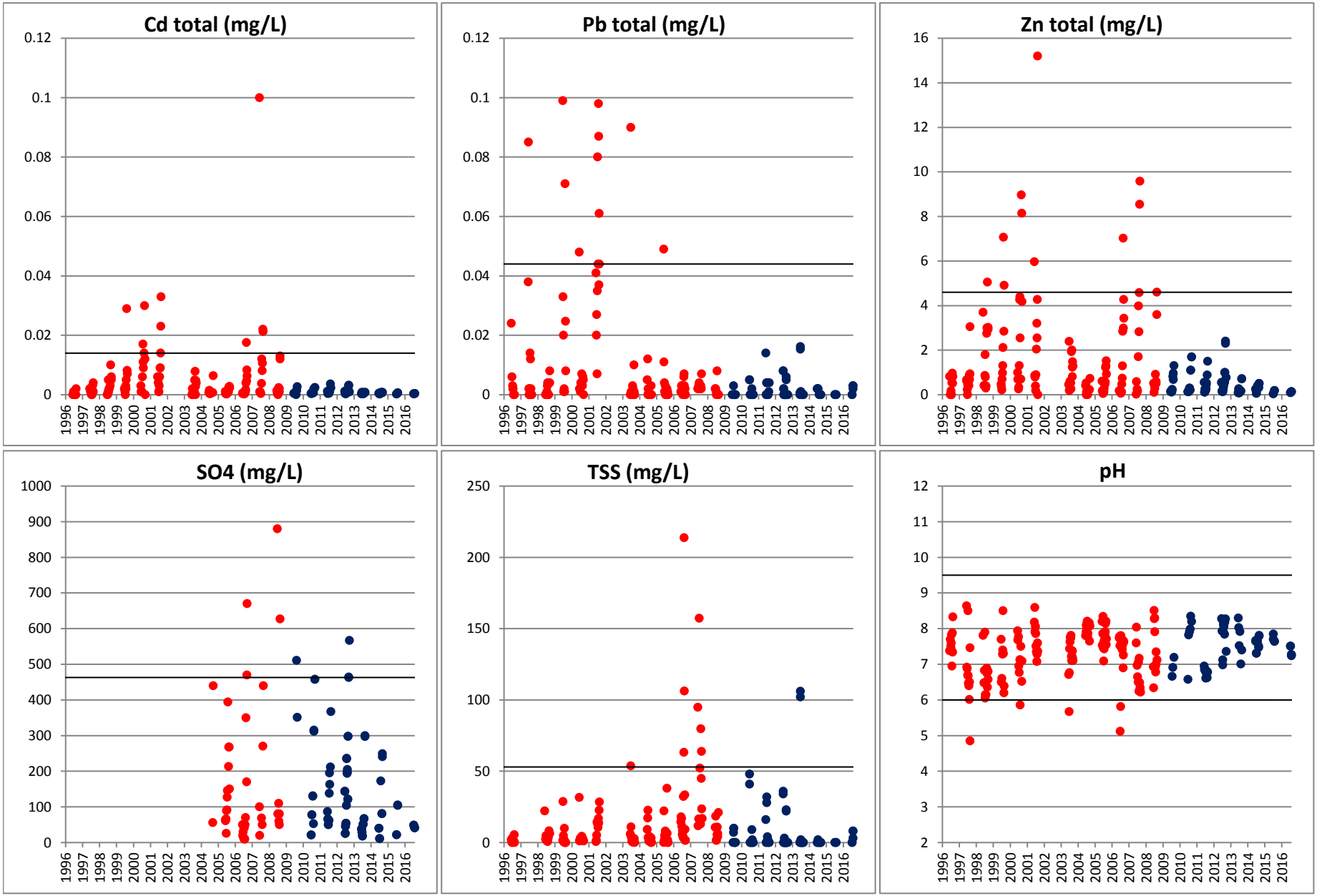


Figure C3: Temporal trends at Station NML-23

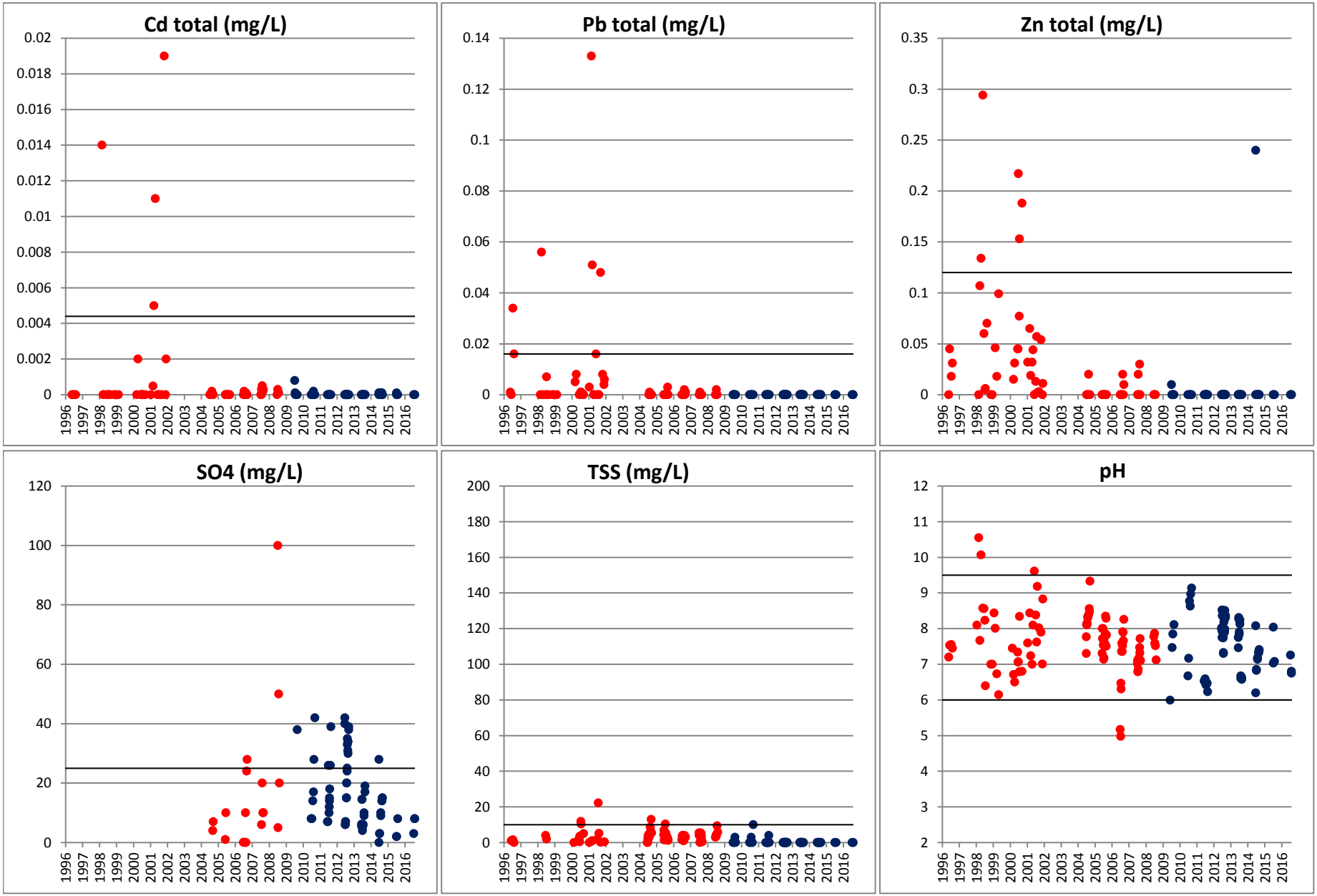


Figure C4: Temporal trends at Station 159-14

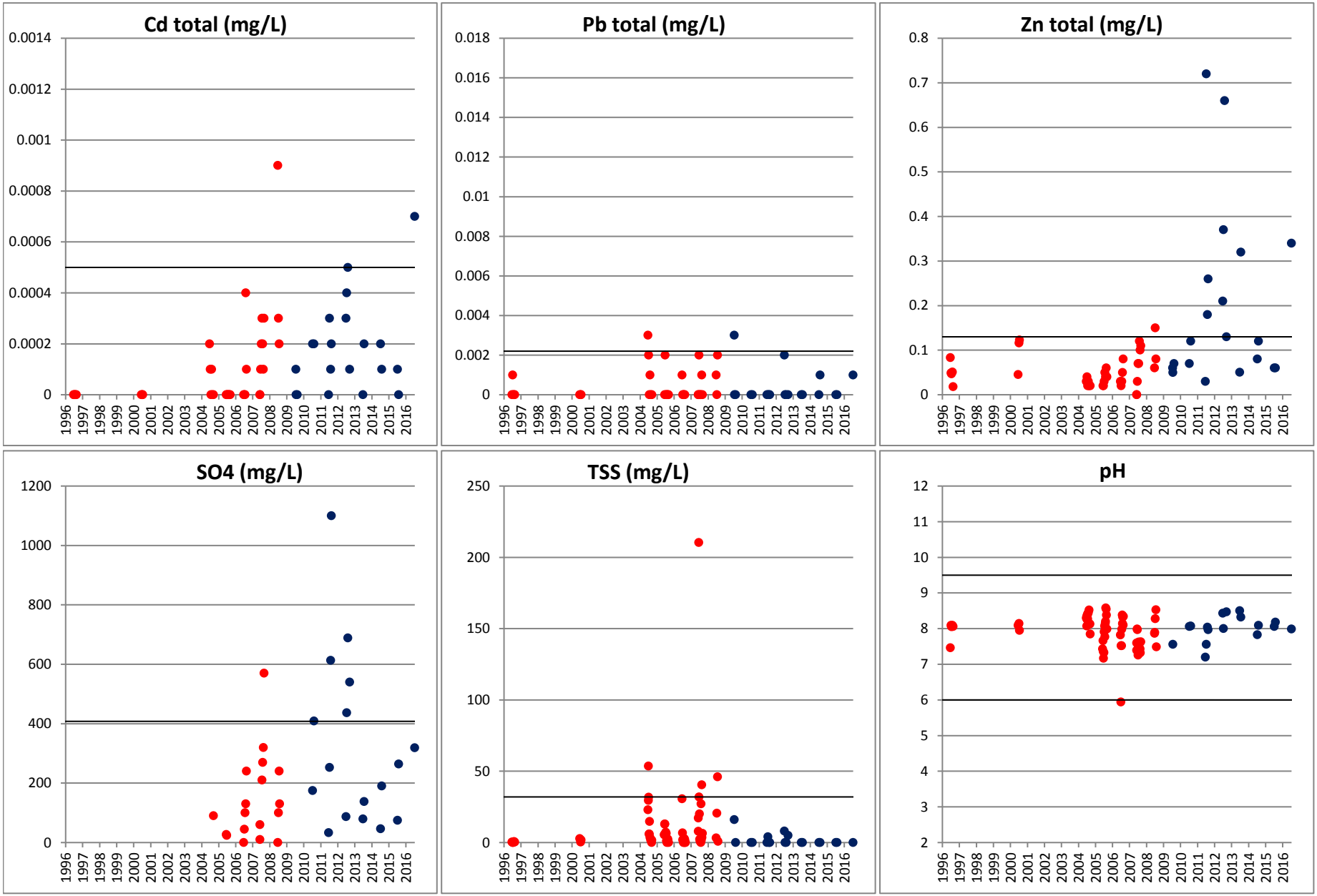
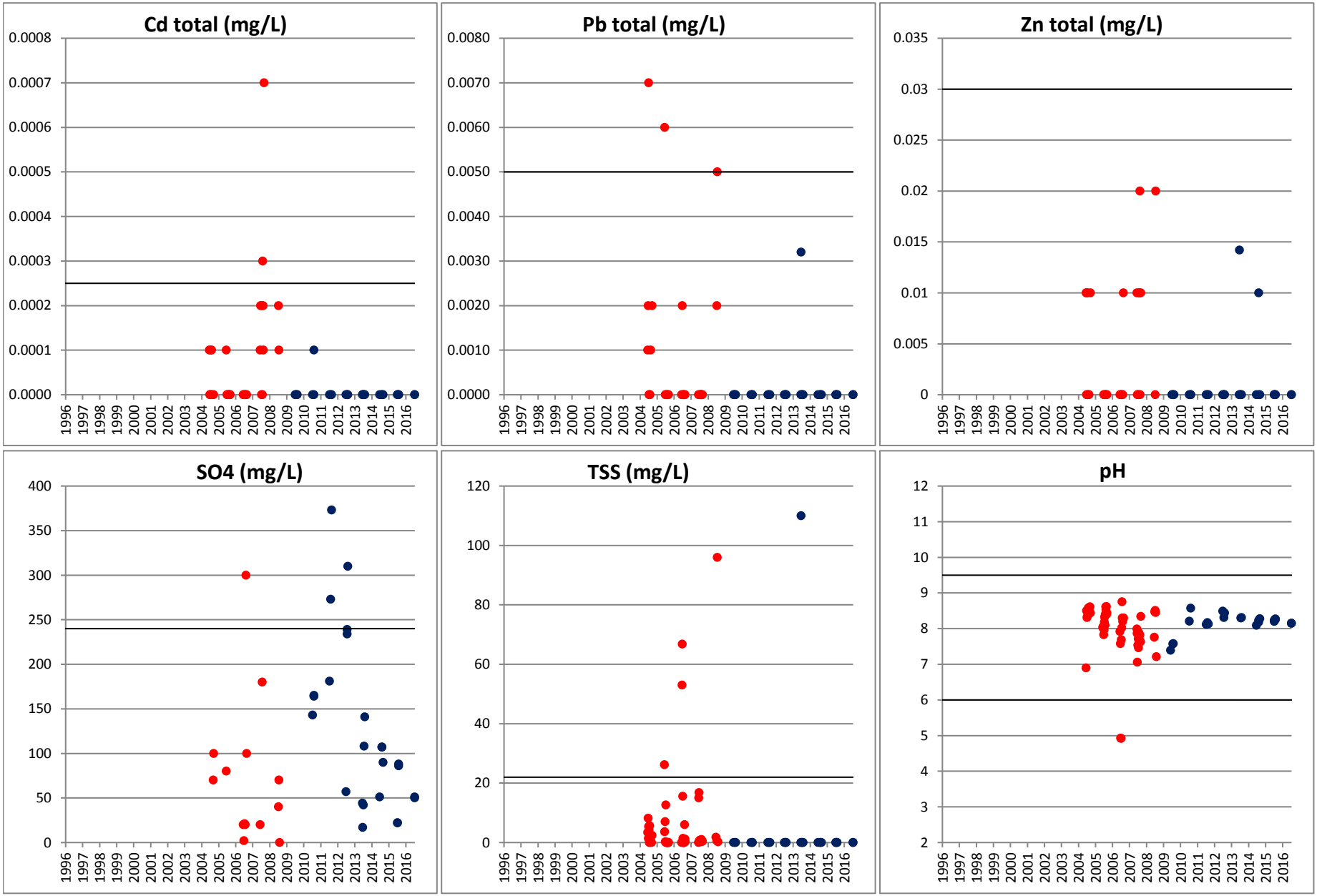


Figure C5: Temporal trends at Station NML-30



Appendix D 2017 FIELD PLANS

MONTH 1 Week of Monday, June 26-Sunday, July 3, 2017		Sampling Date pH-meter Calibration Date					Field Data and Observations			
Field collected data must be documented using this bound field notebook.	Date / Time	Bottles Required per sample	rinse?	collected ✓	Chain of Custody Analytical Group and Requirement		Temp (°C)	pH	Conductivity	Visual Observations *example: hydrocarbon sheen is visible, photo taken, left bank of the creek is showing signs of erosion*
TWIN LAKES CREEK WATERSHED										
NML-23 (159-20) *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
ELO *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
159-4 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter plastic	YES		NAN-4	Annual				
159-6 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
		1 liter plastic	YES		NAN-4	Annual				
TEMPORARY 159-6 *Samples required if laydown area identified in 2016 remains on the shore of Twin Lakes Creek* *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
		1 liter plastic	YES		NAN-4	Annual				
DUP-1 *Field Duplicate - Twin Lakes Creek*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
		1 liter plastic	YES		NAN-4	Monthly				
CHRIS CREEK WATERSHED										
159-14 *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
LANDFILL										
NML-29 (159-21) *East side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
NML-30 *West side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
DUP-2 *Field Duplicate - Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
Quality Control										
BLANK *Field Blank*		1 liter plastic	NO		NAN-1	Monthly				
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	NO		NAN-2	Monthly				
		1 liter plastic	NO		NAN-4	Monthly				

IF NO FLOW : INDICATE USING N/F.

FIRST AIR TRACKING NUMBER _____

DATE SHIPPED: _____

Have you provided field notes to Jodie Lowe at Stantec?

Date: _____

MONTH 2 Week of Monday, July 24 -Sunday, July 30, 2017		Sampling Date pH-meter Calibration Date					Field Data and Observations			
Field collected data must be documented using this bound field notebook.	**Date / Time**	**Bottles Required**			**Chain of Custody Analytical Group and Requirement**		**Temp (°C)**	**pH**	**Conductivity**	**Visual Observations**
		per sample	**rinse?**	**collected ✓**						*example: hydrocarbon sheen is visible, photo taken, left bank of the creek is showing signs of erosion*
TWIN LAKES CREEK WATERSHED										
NML-23 (159-20) *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
ELO *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
159-4 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
159-6 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
TEMPORARY 159-6 *Samples required if laydown area identified in 2016 remains on the shore of Twin Lakes Creek* *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
DUP-1 *Field Duplicate - Twin Lakes Creek*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
		1 liter plastic	YES		NAN-4	Monthly				
CHRIS CREEK WATERSHED										
159-14 *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
LANDFILL										
NML-29 (159-21) *East side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
NML-30 *West side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
DUP-2 *Field Duplicate - Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
Quality Control										
BLANK *Field Blank*		1 liter plastic	NO		NAN-1	Monthly				
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	NO		NAN-2	Monthly				
		1 liter plastic	NO		NAN-4	Monthly				

IF NO FLOW : INDICATE USING N/F.

FIRST AIR TRACKING NUMBER _____

DATE SHIPPED: _____

Have you provided field notes to Jodie Lowe at Stantec?

Date: _____

MONTH 3 Week of Monday, August 28 -Sunday, September 3, 2017		Sampling Date pH-meter Calibration Date					Field Data and Observations			
Field collected data must be documented using this bound field notebook.	Date / Time	Bottles Required per sample	rinse?	collected ✓	Chain of Custody Analytical Group and Requirement		Temp (°C)	pH	Conductivity	Visual Observations *example: hydrocarbon sheen is visible, photo taken, left bank of the creek is showing signs of erosion*
TWIN LAKES CREEK WATERSHED										
NML-23 (159-20) *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
ELO *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
159-4 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
159-6 *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
TEMPORARY 159-6 *Samples required if laydown area identified in 2016 remains on the shore of Twin Lakes Creek* *Outflow from West Twin Lake Disposal Area*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
DUP-1 *Field Duplicate - Twin Lakes Creek*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
		1 liter plastic	YES		NAN-4	Monthly				
CHRIS CREEK WATERSHED										
159-14 *Outflow from East Twin Lake*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
LANDFILL										
NML-29 (159-21) *East side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
NML-30 *West side of Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
DUP-2 *Field Duplicate - Landfill*		1 liter plastic	YES		NAN-1	Monthly			□ mS □ µS	
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	YES		NAN-2	Monthly				
Quality Control										
BLANK *Field Blank*		1 liter plastic	NO		NAN-1	Monthly				
		125 mL plastic with H_2SO_4 preservative	NO							
		125 mL plastic with HNO_3 preservative	NO							
		1 liter amber glass - **fill to top**	NO		NAN-2	Monthly				
		1 liter plastic	NO		NAN-4	Monthly				

IF NO FLOW : INDICATE USING N/F.

FIRST AIR TRACKING NUMBER _____

DATE SHIPPED: _____

Have you provided field notes to Jodie Lowe at Stantec?

Date: _____