

Appendix B

Proposed Water Quality Monitoring Schedule

Excerpted from *Nanisivik Mine Reclamation and Closure Monitoring Plan*, Gartner Lee Limited, February 2004



Nanisivik Mine Reclamation and Closure Monitoring Plan

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3. Water Quality Monitoring

3.1 Approach to Water Quality Monitoring

3.1.1 General Approach

The general approach taken to the design of the water quality monitoring plan is to:

1. fulfill the requirements of the Water Licence;
2. fulfill the general objectives of the Reclamation Performance Monitoring Plan by:
 - (a) collecting location-specific information to monitor the success of location-specific reclamation measures; and
 - (b) collecting general information to assess the quality of water entering Strathcona Sound;
3. work in concert, as appropriate, with the monitoring provisions of the MMER as enforced by Environment Canada; and
4. carry forward existing monitoring locations such that trends spanning the mine-closure milestone can be assessed.

3.1.2 Water Licence Monitoring Requirements

The Water Licence contains specific water monitoring requirements as laid out in Parts D and H as well as Table 1 of that document. These requirements are attached here as Appendix B. The locations and parameters included in the Licence are largely the same as those which required monitoring during the operating period of the mine.

To achieve CanZinco's objectives of measuring the success of the reclamation measures and gathering sufficient information to determine long term site behavior, monitoring above and beyond the stations included in the Licence will occur. It is not the intention of the CanZinco at this time to propose the elimination of any of the existing Licence requirements. All monitoring reflected in the Licence will continue for the immediate future.

3.1.3 Final Discharge Points

Part A, Item 2 of the Water Licence defines "Final Discharge Point" as follows:

"... in respect of an effluent, means an identifiable discharge point of a mine beyond which the operator of the mine no longer exercises control over the quality of the effluent."

Part D, Items 6 and 7 of the Water Licence provide maximum allowable discharge criteria that are to be applied at all Final Discharge Points.

In the context of this Reclamation Performance Monitoring Plan, the following locations are proposed as being considered Final Discharge Points:

1. Outflow from the West Twin Reservoir, analogous to current location 159-4;
2. Outflow from the East Adit Treatment Facility when operating, analogous to current location ; and

The outflow from the West Twin Reservoir is anticipated to flow continuously through the summer season (anticipated mid-May to mid-September). This outflow will include runoff from the reclaimed Surface Cell, Test Cell and Reservoir areas. The flow immediately mixes with outflow from East Twin Lake and passes into Twin Lakes Creek, which reports to Strathcona Sound.

The East Adit Treatment Facility is scheduled to remain in place until runoff from the disturbed areas has returned to pre-mining conditions, which are known to have contained elevated metal concentrations. At that time, and subject to the NWB's approval, the treatment facility will be dismantled and the two ponds removed. The proposed monitoring stations will not be altered except that location 159-12 will be representative of runoff from the reclaimed East Open Pit area, rather than a "Final Discharge Point".

3.1.4 Sampling Locations

The proposed water quality sampling locations are listed in Table 2, and illustrated on Figure 2. Table 2 provides the station name, location description, sampling purpose (Final Discharge Point, location-specific monitoring, general monitoring) and whether the sample is a requirement of the current Water Licence. The stations listed in Table 2 are grouped according to the watershed areas they pertain to and are sorted in order from upstream to downstream locations. All of the stations are located in discreet flowpaths where water collects and can be sampled at a consistent location. In addition to those samples listed in Table 2, each sampling event will also include sampling of ephemeral surface seeps that may be observed and that appear to relate directly to any of the reclaimed areas of the mine site. It is anticipated that such seeps will only be present during freshet or immediately following a substantial rainfall event.

UTM coordinates for each proposed sample location will be gathered in the field in 2004 by GPS survey. A robust placard will be placed in the field at each sample location in 2004 such that the sampling location is readily identifiable in the field.

Table 2. Water Quality Sample Locations

Station	Distance downstream of headwaters (m)	Description	Purpose	Licence Requirement
Twin Lakes Creek Watershed				
NML-23	0	Outflow from East Twin Lake	Upstream control station	No
159-4	750	Outflow from West Twin Disposal Area	Final Discharge Point	Yes
159-9	1750	Twin Lakes Creek stream crossing	Mixing of ETL and WTDA complete	Yes
200-7	2400	Twin Lakes Creek upstream of waste rock piles	Waste rock recovery monitoring	No
159-11	3300	Twin Lakes Creek downstream of waste rock piles	Waste rock recovery monitoring	No
200-3	3400	Twin Lakes Creek downstream of natural sulphide outcrop	Metal loading station	No
159-10	3500	Twin Lakes Creek upstream of west townsite tributary	General Monitoring	Yes
159-6	7250	Outlet of Twin Lakes Creek into Strathcona Sound	General Monitoring	Yes
Chris Creek Watershed				
159-15	100	Chris Creek upstream of Area 14	Upstream control station	Yes
159-16	1000	Chris Creek downstream Area 14	Area 14 monitoring	Yes
159-14	2600	Chris Creek downstream of K-Baseline	K-Baseline monitoring	No
159-13	3100	Chris Creek downstream of East Adit	East Adit Monitoring	No
159-17	4200	Chris Creek outlet into Strathcona Sound	Final Discharge Point	No
East Adit Treatment Facility				
159-12B	N/A	Upstream flow into East Adit Retention Pond	Upstream East Adit Area Monitoring	No
159-12	N/A	Discharge from East Adit Retention Pond	Effluent Discharge	Yes
159-12A	N/A	East Portal Creek flow into East Adit Catchment Pond	East Adit Area Monitoring	Yes
Oceanview Watershed				
159-18	N/A	Run off from Oceanview Open Pit area	Oceanview Monitoring	Yes
159-19	N/A	Discharge from Oceanview sump	Oceanview Monitoring	Yes
Landfill Watershed				
NML-26	0	Surface flow at toe of Landfill	Landfill monitoring	No
NML-30	75	Downstream of Landfill – west drainage system	Landfill monitoring	No
NML-29	125	Downgradient of Landfill – east drainage system	Landfill monitoring	No

Station	Distance downstream of headwaters (m)	Description	Purpose	Licence Requirement
TP02-95	-	Groundwater well downgradient of the Landfill	Landfill monitoring	No
TP02-97	-	Groundwater well downgradient of the Landfill	Landfill monitoring	No
TP02-102	-	Groundwater well downgradient of the Landfill	Landfill monitoring	No
TP03-387	-	Groundwater well downgradient of the Landfill	Landfill monitoring	No

3.2 Reclamation Period

Monitoring during the Reclamation Period will focus on the environmental effects of the reclamation activities, which include covering tailings, relocating tailings, reclamation of rock piles and open pits, covering of the landfill facility, remediation of contaminated soils and possible operation of the east adit water treatment plant, if necessary.

The on-site laboratory is no longer equipped to perform metal analyses and, therefore, these parameters will be determined at an off-site laboratory. The laboratory that is used will be accredited by the Canadian Association of Environmental Analytical Laboratories ("CAEAL"). Analyses for total suspended solids will continue to be conducted on-site.

Table 3 lists the proposed frequencies of sampling and parameters to be determined during the Reclamation Period. In addition to the schedule presented in Table 3, ephemeral surface seeps that may be observed and that appear to relate directly to any of the reclaimed areas of the mine site will also be sampled. It is anticipated that such seeps will only be present during freshet or immediately following a substantial rainfall event.

Table 3. Water Quality Monitoring Schedule – Reclamation Period

Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ^{3,4}
Twin Lakes Creek Watershed				
NML-23	Outflow from East Twin Lake	W	2W	2W – T, S, TSS
159-4	Outflow from West Twin Disposal Area	D	D	W – T, S, TSS
159-9	Twin Lakes Creek stream crossing	W	-	2W – T, S, TSS
200-7	Twin Lakes Creek upstream of	W	-	2W – T, S, TSS

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Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ^{3,4}
	waste rock piles			
159-11	Twin Lakes Creek downstream of waste rock piles	W	-	2W – T, S, TSS
200-3	Twin Lakes Creek downstream of natural sulphide outcrop	W	-	2W – T, S, TSS
159-10	Twin Lakes Creek upstream of west townsite tributary	W	-	2W – T, S, TSS
159-6	Outlet of Twin Lakes Creek into Strathcona Sound	W	2W	2W – T, S, TSS
Chris Creek Watershed				
159-15	Chris Creek upstream of Area 14	W	-	2W – T, S, TSS
159-16	Chris Creek downstream Area 14	W	-	2W – T, S, TSS
159-14	Chris Creek downstream of K-Baseline	W	-	2W – T, S, TSS
159-13	Chris Creek downstream of East Adit	W	-	2W – T, S, TSS
159-17	Chris Creek outlet into Strathcona Sound	W	-	2W – T, S, TSS
East Adit Treatment Facility (prior to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	W	-	2W – T, S, TSS
159-12	Discharge from East Adit Retention Pond	D	D	W – T, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	W	-	2W – T, S, TSS
East Adit Treatment Facility (subsequent to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	W	-	2W – T, S, TSS
159-12	Discharge from East Adit Retention Pond	W	W	2W – T, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	W	-	2W – T, S, TSS
Oceanview Watershed				
159-18	Run off from Oceanview Open Pit area	W	-	2W – T, S, TSS
159-19	Discharge from Oceanview sump	W	-	2W – T, S, TSS
Landfill Watershed				
NML-26	Surface flow at toe of Landfill	W	2W	2W – T, S, TSS
NML-30	Downstream of Landfill – west drainage system	W	2W	2W – T, S, TSS
NML-29	Downgradient of Landfill – east drainage system (intermittent surface flow)	W	2W	2W – T, S, TSS
TP02-95	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS

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Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ^{3,4}
TP02-97	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS
TP02-102	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS
TP03-387	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS

Notes: D=daily; W-weekly; 2W=every 2 weeks; M=monthly; 2A=twice per year (early/late summer).

1. Field Parameters include: pH, conductivity, temperature.
2. Flow measurement may be by velocity measurement, staff gauge or other direct measurement.
3. All metals analyses to include hardness.
T=total metals, D=dissolved metals; S=sulphate; TSS=total suspended solids; TDS=total dissolved solids.
4. TSS determinations may be conducted at the on-site laboratory; other determinations to be made at an accredited off-site laboratory.

3.3 Closure Period

Water quality monitoring through the Closure Period will focus on collecting information necessary to evaluate the effectiveness of the reclamation measures. The monitoring schedule is reduced through the Closure Period in anticipation of monitoring results that confirm the effectiveness of the reclamation measures. If this is not the case, then the monitoring schedule would be amended to collect the appropriate information.

There will not be a continuous manpower presence on the mine site during this period and sampling will be conducted during discreet site visits. The on-site laboratory is no longer equipped to perform metal analyses and, therefore, these parameters will be determined at an off-site laboratory. The laboratory that is used will be accredited by the Canadian Association of Environmental Analytical Laboratories (“CAEAL”). Analyses for total suspended solids will continue to be conducted on-site or in Arctic Bay.

Tables 4 and 5 list the proposed frequencies of sampling and parameters to be determined during the Closure Period for Years 1-2 and Years 3-5, respectively. In addition to the schedules presented in Tables 4 and 5, ephemeral surface seeps that may be observed and that appear to relate directly to any of the reclaimed areas of the mine site will also be sampled. It is anticipated that such seeps will only be present during freshet or immediately following a substantial rainfall event.

Table 4. Water Quality Monitoring Schedule – Closure Period Years 1-2

Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ^{3,4}
Twin Lakes Creek Watershed				
NML-23	Outflow from East Twin Lake	W	2W	2W – T, S, TSS
159-4	Outflow from West Twin Disposal Area	W	W	2W – T, S, TSS
159-9	Twin Lakes Creek stream crossing	W	-	2W – T, S, TSS
200-7	Twin Lakes Creek upstream of waste rock piles	W	-	2W – T, S, TSS
159-11	Twin Lakes Creek downstream of waste rock piles	W	-	2W – T, S, TSS
200-3	Twin Lakes Creek downstream of natural sulphide outcrop	W	-	2W – T, S, TSS
159-10	Twin Lakes Creek upstream of west townsite tributary	W	-	2W – T, S, TSS
159-6	Outlet of Twin Lakes Creek into Strathcona Sound	W	2W	2W – T, S, TSS
Chris Creek Watershed				
159-15	Chris Creek upstream of Area 14	W	-	2W – T, S, TSS
159-16	Chris Creek downstream Area 14	W	-	2W – T, S, TSS
159-14	Chris Creek downstream of K-Baseline	W	-	2W – T, S, TSS
159-13	Chris Creek downstream of East Adit	W	-	2W – T, S, TSS
159-17	Chris Creek outlet into Strathcona Sound	W	-	2W – T, S, TSS
East Adit Treatment Facility (prior to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	W	-	2W – T, S, TSS
159-12	Discharge from East Adit Retention Pond	W	W	2W – T, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	W	-	2W – T, S, TSS
East Adit Treatment Facility (subsequent to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	W	-	2W – T, S, TSS
159-12	Discharge from East Adit Retention Pond	W	-	2W – T, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	W	-	2W – T, S, TSS
Oceanview Watershed				
159-18	Run off from Oceanview Open Pit area	W	-	2W – T, S, TSS
159-19	Discharge from Oceanview sump	W	-	2W – T, S, TSS
Landfill Watershed				

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Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ^{3,4}
NML-26	Surface flow at toe of Landfill	W	2W	2W – T, S, TSS
NML-30	Downstream of Landfill – west drainage system	W	2W	2W – T, S, TSS
NML-29	Downgradient of Landfill – east drainage system (intermittent surface flow)	W	2W	2W – T, S, TSS
TP02-95	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS
TP02-97	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS
TP02-102	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS
TP03-387	Groundwater well downgradient of the Landfill	2A	-	2A – D, S, TDS

Notes: D=daily; W=weekly; 2W=every 2 weeks; M=monthly; 2A=twice per year (early/late summer).

- Field Parameters include: pH, conductivity, temperature.
- Flow measurement may be by velocity measurement, staff gauge or other direct measurement.
- All metals analyses to include hardness.
T=total metals, D=dissolved metals; S=sulphate; TSS=total suspended solids; TDS=total dissolved solids.
- TSS determinations may be conducted at the on-site laboratory; other determinations to be made an accredited off-site laboratory.

Table 5. Water Quality Monitoring Schedule – Closure Period Years 3 to 5

Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ³
Twin Lakes Creek Watershed				
NML-23	Outflow from East Twin Lake	2W	2W	2W – M, S, TSS
159-4	Outflow from West Twin Disposal Area	2W	2W	2W – M, S, TSS
159-9	Twin Lakes Creek stream crossing	2W	-	2W – M, S, TSS
200-7	Twin Lakes Creek upstream of waste rock piles	2W	-	2W – M, S, TSS
159-11	Twin Lakes Creek downstream of waste rock piles	2W	-	2W – M, S, TSS
200-3	Twin Lakes Creek downstream of natural sulphide outcrop	2W	-	2W – M, S, TSS
159-10	Twin Lakes Creek upstream of west townsite tributary	2W	-	2W – M, S, TSS
159-6	Outlet of Twin Lakes Creek into	2W	2W	2W – M, S, TSS

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Station	Description	Field Parameters ¹	Flow ²	Laboratory Parameters ³
	Strathcona Sound			
Chris Creek Watershed				
159-15	Chris Creek upstream of Area 14	2W	-	M – M, S, TSS
159-16	Chris Creek downstream Area 14	2W	-	M – M, S, TSS
159-14	Chris Creek downstream of K-Baseline	2W	-	M – M, S, TSS
159-13	Chris Creek downstream of East Adit	2W	-	M – M, S, TSS
159-17	Chris Creek outlet into Strathcona Sound	2W	-	M – M, S, TSS
East Adit Treatment Facility (prior to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	2W	-	M – M, S, TSS
159-12	Discharge from East Adit Retention Pond	2W	2W	2W – M, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	2W	-	M – M, S, TSS
East Adit Treatment Facility (subsequent to reclamation of the facility)				
159-12B	Upstream flow into East Adit Retention Pond	2W	-	M – M, S, TSS
159-12	Discharge from East Adit Retention Pond	2W	-	2W – M, S, TSS
159-12A	East Portal Creek flow into East Adit Catchment Pond	2W	-	M – M, S, TSS
Oceanview Watershed				
159-18	Run off from Oceanview Open Pit area	2W	-	M – M, S, TSS
159-19	Discharge from Oceanview sump	2W	-	M – M, S, TSS
Landfill Watershed				
NML-26	Surface flow at toe of Landfill	2W	2W	M – M, S, TSS
NML-30	Downstream of Landfill – west drainage system	2W	2W	M – M, S, TSS
NML-29	Downgradient of Landfill – east drainage system (intermittent surface flow)	2W	2W	M – M, S, TSS
TP02-95	Groundwater well downgradient of the Landfill	A	-	A – D, S, TDS
TP02-97	Groundwater well downgradient of the Landfill	A	-	A – D, S, TDS
TP02-102	Groundwater well downgradient of the Landfill	A	-	A – D, S, TDS
TP03-387	Groundwater well downgradient of the Landfill	A	-	A – D, S, TDS

Notes: D=daily; W-weekly; 2W=every 2 weeks; M=monthly; 2A=twice per year (early/late summer).

1. Field Parameters include: pH, conductivity, temperature.

2. Flow measurement may be by velocity measurement, staff gauge or other direct measurement.
3. All metals analyses to include hardness.
T=total metals, D=dissolved metals; S=sulphate; TSS=total suspended solids; TDS=total dissolved solids.
4. TSS determinations may be conducted at the on-site laboratory; other determinations to be made at an accredited off-site laboratory.

3.4 Twin Lakes Creek Metal Loading Studies

The metal loading studies that were conducted and reported during mine operations will be continued through the Reclamation Period and Closure Periods. These continued studies will use the information collected through the water quality monitoring program to estimate the loading of metals in Twin Lakes Creek from various sources and to characterize temporal and spatial trends. The metal loading studies will be reported as a part of the Annual Environmental Reports filed with the NWB.

3.5 Quality Control and Quality Assurance

Water samples will be collected according to appropriate sampling protocols. Samples for dissolved parameters will be filtered in the field using 4 µm. Filters will be sterile disposable filters or new filters will be used for each sample with the filter apparatus rinsed with distilled water between each sample. Samples will be stored in coolers with ice packs to maintain sample temperature at approximately 4°C and shipped to the analytical laboratory as quickly as possible. Preservatives will be added in the field for metal determinations. Field instruments for recording pH and conductivity will be calibrated for each sampling event.

A minimum of 10% of water samples for each sample event and at least one sample will be collected in replicate for each sampling event. The Annual Environmental reports will include an assessment of the quality control analyses.

