2014 Hope Bay Seepage Monitoring Program

Prepared for

TMAC Resources

Prepared by

SRK Consulting (Canada) Inc.
1CT022.001
March 2015

2014 Hope Bay Seepage Monitoring Program

March 2015

Prepared for

TMAC Resources
372 Bay Street, Suite 901
Toronto, ON M5H 2W9

Tel: +1 867-873-4767
Web: www.tmacresources.com

Prepared by

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2
Canada

Tel: +1 604 681 4196
Web: www.srk.com

Project No: 1CT022.001

File Name: 1CT022.001_HopeBay_Seepage2014_Report_AML_LNB_KSS_20150313

Executive Summary

Annual geochemical reporting requirements for the Doris North mine, Hope Bay project include results from the quarry rock, Doris North underground waste rock and seepage monitoring programs. In 2014, the monitoring program was limited to the seepage survey as there was no development of the underground mine or at any of the quarries. This report presents results of the 2014 freshet seep survey. The objective of the seepage monitoring program is to confirm that the water quality associated with these materials is within expected ranges. The seepage program was completed in accordance with conditions outlined in Part D "Conditions applying to Construction and Operations" Item 20 of Water License 2AM-DOH1323 (Nunavut Water Board 2013) and the Quarry A, B & D Management and Monitoring Plan, Revision 01 (SRK 2010).

Seep survey locations were established opportunistically by walking the toes of all roadways, building pads and quarry sites along the Doris North and Doris-Windy roads (Appendix A). A total of 26 seepage sites and 3 reference sites were established and measured for field parameters. As per the water license, a minimum of 10% of the total sample set, including any sites with elevated conductivity, were submitted to a laboratory for an extended analytical suite. A total of 11 samples were collected and analyzed at a commercial laboratory.

The results of the 2014 sampling program indicated that there are no issues with respect to metal leaching or acid rock drainage (ML/ARD) in seepage associated with the infrastructure at Hope Bay. Results were comparable to previous seepage surveys with an improvement in seepage quality from waste rock influenced areas. All parameters were compared to the Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life to screen for elevated parameters. Comparisons to these criteria were used solely for screening purposes and are not directly applicable because the seep locations do not support aquatic life. Seepage from waste rock influenced areas had elevated levels of ammonia, chloride and nitrate compared to CCME water quality guidelines though levels have decreased gradually since 2012, suggesting that active flushing of drilling brines and blasting residues from the waste rock pile is ongoing. Seepage is managed in accordance with the Doris North Interim Water Management Plan, Revision 5 (SRK 2012).

Table of Contents

List of Tables

Appendices

1 Introduction

As part of the verification, monitoring and management plans for Hope Bay Project, TMAC Resources (TMAC) is required to monitor seepage from the Doris North infrastructure pads and roads, waste rock and quarries. SRK was asked to complete the seepage surveys and annual reports from 2009 to 2014. Results of the last reported seep survey are in the 2013 Hope Bay Seepage Monitoring Program (SRK 2014). Annual geochemical reporting requirements for the Doris North mine, Hope Bay project include results from the quarry rock, Doris North underground waste rock and seepage monitoring programs. In 2014 there was no development of the underground mine or any of the quarries; therefore the only monitoring requirement was related to existing infrastructure which is addressed herein.

This report presents results of the 2014 freshet seepage survey. The seepage program was completed in accordance with the conditions outlined in Part D "Conditions applying to Construction and Operations" Item 20 of Water Licence No: 2AM-DOH1323 (Nunavut Water Board 2013):

> *The Licensee shall conduct a Quarry Rock Seepage Monitoring and Management program in accordance with the Hope Bay Project Doris North Waste Rock and Ore Management Plan (SRK 2010) and Hope Bay Project Quarry A, B & D Management and Monitoring Plan - Revision 01 (SRK 2010a), and in accordance with the following:*
>
> a) *The seep survey shall measure pH and Electrical Conductivity (EC) levels in the precipitation runoff and snowmelt that comes into contact with rock along the roadways, building pads and quarry sites;*
>
> b) *The seep survey shall measure pH and EC levels at several reference points on the tundra not subject to mine influences;*
>
> c) *The quarry rock seepage program shall be conducted on any ephemeral seepage present at the time of the quarry rock seepage monitoring program and not at pre-determined seepage stations;*
>
> d) *A minimum of at least 10% of the total sample set shall be submitted for secondary analysis, regardless of the values of measured field pH and EC; and*
>
> e) *The Quarry Rock Seepage Monitoring Program shall be expanded beyond the 100 samples to include monitoring of all rock drains.*
>
> *The Licensee shall provide a report that presents the data collected from the Quarry Rock Seepage Monitoring and Management Program conducted under PART D, Item 20. The report shall include a discussion of the interpretation of geochemical data and shall be presented to the Board for review, no later than six (6) months after the collection of samples.*

As indicated in the above referenced management plans, seep surveys are completed annually during freshet during and for at least 2 years following the period of quarry or waste rock deposition. Therefore the seep survey was reduced this year in comparison to previous years due to the lack of recent construction. The 2014 seep survey included all areas that were constructed in 2011 or later, which consisted of:

- Expansion of the east side of the airstrip;
- Frozen core dam, vent raise pad and Tail Lake access road;
- Southern section of Doris-Windy road leading into Windy Camp;
- Roberts Bay jetty; and
- Doris overburden sedimentation control berm and upper diversion berm north of Doris Camp.

2 Methods

2.1 Seep Survey and Sample Collection

The seep survey was carried out between June 14th and June 19th, 2014. Seep survey locations were established opportunistically by walking the toes of the applicable roadways, building pads, and berms along the Doris North and Doris-Windy roads (Appendix A). The samples used as reference points (not subject to mine influences) were collected at approximately the same points as the 2010-2013 seep surveys (in the vicinity of the Doris-Windy Road, Appendix A).

Field measurements were taken at all locations where water was observed flowing into and out of construction rock material including true seeps where precipitation runoff and snowmelt came into contact with rock along the roadways, building pads and berms. Electrical conductivity (EC), pH, temperature, oxidation-reduction potential (ORP) and flow rates (where possible) were measured at each of these locations at the time of monitoring.

A total of 26 seepage sites and 3 reference sites were established. Seepage sites at Roberts Bay, the frozen core dam and the Tail Lake access road were not established due to lack of flow. The dam area was still under snow and the spillway area was dry. As per the water license, a minimum of 10% of the total sample set, including any sites with elevated conductivity, were submitted to a laboratory for an extended analytical suite. A total of 11 samples were collected and analyzed. In addition, two duplicates and two field blanks were collected and submitted for laboratory analysis, and two travel blanks were included in sample shipments as part of SRK's quality assurance/quality control (QA/QC) program.

2.2 Laboratory Analysis

Eleven samples were collected by SRK and submitted to ALS Environmental Labs in Vancouver, BC where they were analyzed for pH, conductivity, sulphate, acidity, alkalinity, chloride, fluoride, nitrate, nitrite, phosphorus, ammonia, total dissolved solids (TDS), total suspended solids (TSS) and low level dissolved metals including mercury and selenium. All samples were filtered and preserved in the field, as required.

2.3 Quality Assurance and Quality Control

QA/QC review of all data was conducted by SRK and deemed acceptable. Two duplicates, two field blanks and two travel blanks were collected as part of SRK's QA/QC program. For the field blanks parameters were below detection limits indicating appropriate field filtration and sampling methods were employed. The field duplicate results were within ±10% relative percent difference (RPD) for all parameters except zinc. The RPD% for zinc was slightly outside of the range for both duplicate samples, however levels of zinc were within the range of analytical uncertainty (within 10 times the detection limit of <0.001) and therefore could not be assessed.

For all samples, TDS demonstrated a strong positive correlation with lab conductivity, with values of conductivity slightly exceeding TDS. Laboratory and field values of pH and conductivity were compared. Values were near parity for conductivity for all samples. Values of pH were slightly higher in the field than the lab samples for most samples.

3 Results and Discussion

3.1 Field Data

Appendix A presents maps of the seepage sample locations. A complete set of field observations and measurements is provided in Appendix B.

3.1.1 Field Measurements

Table 1 outlines the median calculations for pH and EC from the 26 sample sites. The data were grouped according to area, specifically Waste Rock Influenced Area, Doris North Areas (Roberts Bay, Airstrip, Tail Lake Frozen Core Dam, Vent Raise and access road), Doris Windy Road (southern section leading to Windy Camp) and reference sites. The field data are summarized as follows.

- The pH at all sites was neutral to alkaline.
- The samples from the area influenced by the Doris North mine waste rock pile (n= 7) overall had the highest levels of field conductivity, with median levels of 846 µS/cm. Sample 14-WR-003 collected at the toe of the waste rock pile had a conductivity of 2990 µS/cm, the highest value in 2014. Samples 14-DC-07 and 14-DC-08, at the toe of the road across and downstream from the pollution control pond had elevated conductivity measurements of 2860 µS/cm and 2020 µS/cm respectively.
- The conductivity measurements in the Doris North areas (n =14) had a median of 224 µS/cm.
- Doris-Windy Road samples (n= 5) had a median conductivity of 607 µS/cm.
- The three reference points that were sampled to represent conditions outside the influence of mining operations, had the lowest conductivity values, with a median of 108 µS/cm.

Table 1: Median Field EC and Field pH of Seepage Sites (Grouped by Area)

Site Area	No. of Samples	Conductivity (µS/cm)	pH
		Median	Median
Waste Rock Influenced Area	7	846	8.2
Doris North Areas	14	244	8.2
Doris-Windy Road	5	607	7.9
Reference Points	3	108	7.3

P:\01_SITES\Hope.Bay\1CH008.023_Geochem_Monitoring\C_Seep_Surveys\June2014 Seepage Survey\Working File\[Hope Bay_WorkingFile_2014_AML_Rev00.xlsx]

3.2 Laboratory Data

A summary of water quality analyses for the 11 samples is presented in Table 2. Complete results are presented in Appendix B. All parameters were compared to the CCME water quality guidelines for the protection of aquatic life to screen for elevated parameters. Comparisons to these criteria were used solely for screening purposes and are not directly applicable because the seep locations do not support aquatic life.

3.2.1 Waste Rock Influenced Area

Three samples from the Waste Rock Influenced Area were submitted for laboratory analysis (Table 2). Laboratory pH levels of these samples ranged from 7.9 to 8.0. Three samples were compared to the CCME guideline for copper which ranges from 0.002 to 0.004 mg/L depending on the hardness of the water. For comparisons, a conservative approach was taken with data compared against the lowest guideline value. All three samples had copper values that were higher than but the same order of magnitude as the CCME guidelines[1]. Copper loading rates ranged from 0.09 to 0.24 kg/year and were lower than the predicted rate (0.69 kg/year) made prior to mining (SRK 2007).

Sample 14-WR-003 collected at the toe of the waste rock pile had ammonia, nitrate and chloride concentrations that exceeded the CCME guidelines by one order of magnitude. The cadmium concentrations for 14-WR-003 was also higher than the guideline but within the same order of magnitude. Sample 14-DC-08 collected across the primary road from the pollution control pond had ammonia, nitrate and chloride concentrations that exceeded the CCME guidelines but were within the same order of magnitude. Nitrate and chloride levels in seep 14-DC-17 (collected east of 14-DC-08 near a sump) were elevated in comparison to the guidelines, but within the same order of magnitude.

[1] Comparisons to CCME guideline are intended for screening purposes and are not directly applicable because the seepage sites do not support aquatic life.

Table 2: Summary of Water Quality Results

Group	Sample ID	Field pH	Lab pH	Field EC	Flow	Alkalinity, Total	SO_4	Ammonia**	Nitrate	Chloride	Al	As	Cd***	Cu	Pb	Ni	Zn
	Units	s.u.	s.u.	uS/cm	L/s	mg $CaCO_3$/L	mg/L	mg N/L	mg N/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	CCME guideline*	6.5-9	6.5 - 9	-	-	-	-	2.3**	2.9	120mgCl/L	0.1	0.005	0.000017	0.002 - 0.004	0.001	0.025	0.03
Waste Rock Influenced Area	14-WR-003	8.1	8.0	2990	1.5	87	88	**21**	**55**	**877**	0.01	0.0018	**0.000046**	**0.0051**	<0.0001	0.0013	<0.002
	14-DC-08	8.2	7.9	2020	0.75	76	43	**2.5**	**5.1**	**493**	0.02	0.0014	**0.000022**	**0.0049**	<0.00005	0.00112	0.0012
	14-DC-17	8.3	7.9	695	0.5	57	24	2.0	**5.2**	**158**	0.01	0.00084	0.000012	**0.0058**	<0.00005	0.00074	0.0011
Doris North Area	14-DC-06	8.2	8.1	277	10	84	15	0.041	0.42	19	0.01	0.00072	<0.00001	**0.0066**	<0.00005	0.00095	<0.001
	14-DC-11	7.9	7.8	183	0.5	68	3.7	0.0093	0.0087	18	0.01	0.00019	<0.00001	**0.0021**	<0.00005	0.00075	0.0013
	14-TLR-20	9.0	8.1	106	--	38	4.3	0.047	0.25	7.8	0.07	0.00079	0.000011	**0.014**	0.0001	0.00083	<0.001
	14-DC-25	8.2	7.2	244	--	74	14	0.008	0.4	25	0.02	0.00086	<0.00001	**0.008**	<0.00005	0.00062	0.0033
Doris Windy	14-DW-05	8.0	7.6	177	5	34	2.7	0.039	0.24	26	0.03	0.00026	<0.00001	**0.0023**	<0.00005	0.0020	0.0025
Reference Points	14-REF-001	7.1	8.1	57	--	19	<0.5	<0.005	<0.005	4.0	0.05	0.00014	<0.00001	0.0014	<0.00005	0.0022	0.0046
	14-REF-002	7.3	7.9	114	--	21	2.9	<0.005	0.0053	17	0.02	<0.0001	<0.00001	0.0009	<0.00005	0.0010	0.0027
	14-REF-003	7.5	8.0	108	--	24	2.1	<0.005	<0.005	5.9	0.01	<0.0001	**0.00002**	0.0012	<0.00005	<0.0005	0.0014

Notes:

*Comparisons to CCME water quality guidelines for the protection of aquatic life are intended for screening purposes and are not directly applicable because the seepage sites do not support aquatic life.

Values in **bold** indicates value exceeds respective water quality guideline for the parameter.

**Guideline for ammonia is pH and temperature dependent. Seepage waters had an average temperature of 3.5ºC at time of sampling. This guideline value is approximate.

***Cadmium guideline for a hardness of 25 mg $CaCO_3$ mg/L

3.2.2 Doris North Areas

Four samples from the Doris North Areas were submitted for laboratory analysis (Table 2). The pH values of the samples were neutral to alkaline (between 7.2 and 8.1). All four samples had copper levels higher than the lowest CCME guideline. Copper levels were generally the same order of magnitude as the CCME guideline, though one sample was ten times higher. The samples were less than CCME guidelines for all other parameters.

3.2.3 Doris Windy Road

One sample was collected at the southernmost point of the Doris Windy road. The pH was 7.6 and slightly exceeded the CCME guideline for copper, but was within the same order of magnitude.

3.2.4 Reference Point Samples

All three reference samples were submitted for laboratory analysis. The pH of these samples was neutral to alkaline, ranging from 7.9 to 8.1. Dissolved metal concentrations were generally equivalent or slightly lower than those measured at other seepage locations. One sample exceeded the CCME guideline for cadmium though the value was the same order of magnitude

3.3 Comparison to Previous Seep Surveys

3.3.1 Waste Rock Influenced Area

A comparison of the sample 14-WR-003 collected at the toe of the Doris North mine waste rock pile in 2014 to samples collected at the same location in previous years is presented in Table 3. Similar comparisons were not possible for the other waste rock seeps discussed previously because seeps have not been consistently observed in those other locations. Underground mining occurred from late 2010 to the end of 2011. The first seepage survey of the waste rock piles occurred in summer 2011 while the mine was operating. The seepage samples collected in 2014 are most comparable to samples from 2012 and 2013 as both represent closure conditions and the configuration of the waste rock pile was consistent between sampling events. By comparison, in 2011 the waste rock pile was smaller.

In 2011 and 2012 three seeps were sampled whereas there was only one present in 2013 and 2014 (Table 3). A comparison of the 2014 with previous years is as follows:

- Levels of conductivity, ammonia, chloride and nitrate have continuously decreased since 2012.
- Levels of conductivity (2990 µS/cm) in 2014 were 30% and 75% lower as compared to 2013 and 2012 respectively.
- Levels of ammonia (21 mg/L), chloride (877 mg/L) and nitrate (55 mg/L) in 2014 were 20% and 60% lower as compared to 2013 and 2012 respectively. This suggests that residual blasting residues (ammonia and nitrate) and drilling salts (chloride) are being flushed from the waste rock pile.

- Sulphate levels (88 mg/L), which were attributable to sulphide oxidation, are slightly higher (~20%) than values observed in 2012 and 2013.
- Trace metal levels were comparable to previous years. The analytical detection limits are lower than earlier data sets.

3.3.2 All Other Areas (Excludes Waste Rock Influenced Area)

Historical summary statistics of field EC and field pH for all sites except those in the waste rock influenced area are provided in Table 4. The median conductivity of seepage waters across the site was slightly higher in 2014 as compared to 2013, but comparable to levels in 2012 and 2009. Levels of pH were consistent since 2009.

One seep from under the helicopter pad has remained consistently high flow (~10 L/s) since 2011. This seep was sampled in the same location in 2014 as in 2011- 2013. A comparison of the data is discussed in Table 5.

3.3.3 Reference Points

Results from 2014 reference point samples were compared to results from 2013. These results were consistent with the 2013 reference point samples, taken from the approximately the same locations.

Table 3: Comparison of water quality results from 14-WR-003 to samples at the same location in 2011 to 2014

Parameters	Units	2011		2012			2013	2014
		DC09	DC08	12-WR-SEEP-01	12-WR-SEEP-02	12-WR-SEEP-03	13-WR-03	14-WR-003
Temperature °C	-	0.1	0.1	<5.5	5.1	6.9	<0.1	4.5
EC	uS/cm	5776	4410	10,405	14,600	12,227	4078	2990
pH		7.4	7.5	7.6	6.7	8.0	7.9	8.1
Alkalinity	mg $CaCO_3$/L	50	70	75	80	84	91.8	87
Ammonia	mg/L as N	35	27	68	67	62	27	21
Chloride	mg/L	1660	1220	2280	2550	2530	1100	877
Nitrate	mg/L as N	63	50	134	137	136	65	55
Sulfate	mg/L	28	39	59	76	75	71	88
Al	mg/L	<0.03	<0.03	0.0074	0.0078	0.0083	0.011	0.011
Sb	mg/L	<0.001	<0.001	<0.0005	<0.0005	<0.0005	0.00026	0.00031
As	mg/L	<0.004	<0.002	0.0013	0.0013	0.0013	0.0015	0.0018
Cd	mg/L	0.00018	<0.00017	0.00029	0.00032	0.00034	0.000095	0.000046
Cu	mg/L	0.0097	0.014	0.0065	0.0059	0.0063	0.0092	0.0051
Fe	mg/L	0.064	<0.03	0.046	0.036	0.038	0.011	<0.01
Pb	mg/L	<0.0005	<0.0005	<0.00025	<0.00025	<0.00025	<0.0001	<0.0001
Mg	mg/L	34	36	67	80	79	31	33
Mn	mg/L	0.72	0.25	0.46	0.79	0.82	0.187	0.1
Mo	mg/L	0.0017	0.0021	0.0029	0.0037	0.0037	0.0061	0.0034
Ni	mg/L	0.0067	<0.005	0.0036	0.0038	0.0045	0.0019	0.0013
Se	mg/L	<0.01	<0.01	0.0012	0.0014	0.0014	0.0012	0.0015
Zn	mg/L	<0.015	<0.03	<0.005	<0.005	<0.005	<0.002	<0.002

P:\01_SITES\Hope.Bay\1CH008.023_Geochem_Monitoring\C_Seep_Surveys\June2014 Seepage Survey\Working File\[Hope Bay_WorkingFile_2014_AML_Rev00.xlsx]

Table 4: Historical Summary Statistics of Field Conductivity and Field pH for All Other Areas (Excludes Waste Rock Influenced Area)

Statistic	Field Conductivity (µS/cm)						Field pH					
	2009	2010	2011	2012	2013	2014	2009	2010	2011	2012	2013	2014
P25	195	162	107	178	144	166	7.5	7.3	7.6	7.6	7.7	7.8
Median	269	197	190	248	222	256	7.8	7.5	7.8	8.0	7.9	8.0
P95	896	671	554	577	420	657	8.3	8.1	8.2	8.9	8.6	9.0
n	75	60	79	72	66	29	75	60	79	72	66	29

P:\01_SITES\Hope.Bay\1CH008.023_Geochem_Monitoring\C_Seep_Surveys\June2014 Seepage Survey\Working File\[Hope Bay_WorkingFile_2014_AML_Rev00.xlsx]

Table 5: Comparison Between Stations Sampled at the Same Location in 2011 to 2014.

Figure	Sample ID		Summary of comparison
	2014	**Previous Years**	
4	14-DC-06	13-DC-58	Sulphate levels in 2014 (15 mg/L) were lower than 2013 and comparable to 2011 and 2012. The conductivity in 2012 and 2013 was the same and has decreased by 30% in 2014 (277 µS/cm)
		12-DC-03	In 2014, ammonia concentrations remained consistent (0.04 mg/L) with values from 2013 and an order of magnitude lower than previous years. Nitrate (0.42 mg/L) levels decreased by an order of magnitude compared to previous years (including 2013) and chloride (18 mg/L) levels decreased by half since 2013.
		11-DC04	All other water quality results were consistent between years.

P:\01_SITES\Hope.Bay\1CH008.023_Geochem_Monitoring\C_Seep_Surveys\June2014 Seepage Survey\Working File\[Hope Bay_WorkingFile_2014_AML_Rev00.xlsx]

4 Conclusions and Recommendations

The results of the 2014 sampling program indicated that there are no issues with respect to ML/ARD in seepage associated with the infrastructure at Hope Bay. All parameters were compared to the CCME water quality guidelines for the protection of aquatic life to screen for elevated parameters. Comparisons to these criteria were used solely for screening purposes and are not directly applicable because the seep locations do not support aquatic life. The 2014 results were comparable to previous seepage surveys with an improvement in seepage quality from waste rock influenced areas. Seepage from waste rock influenced areas had elevated levels of ammonia, chloride and nitrate compared to the CCME water quality guidelines though levels have decreased gradually since 2012, suggesting that active flushing of drilling brines and blasting residues from the waste rock pile is ongoing. The majority of this seepage is captured in the water management system implemented at Hope Bay. Continued management of seepage from the waste rock pile is recommended.

There was no mining after 2011, and no construction or quarry development after 2012. Therefore, the 2014 seepage survey has satisfied the water license requirements for monitoring seepage associated with the quarry rock. In 2015, a seepage survey of site infrastructure is not required. However it is recommended that a 2015 seepage survey be conducted to monitor seepage from the waste rock pile and the areas downstream of the pollution control pond.

This report,"*2014 Hope Bay Seepage Monitoring Program"* was prepared by

Original signed by

Ashley Landriault, B.Sc.
Staff Consultant (Geochemistry)

and reviewed by

Original signed by

Lisa Barazzuol, P.Geo. (BC)
Senior Consultant (Geochemistry)

Kelly Sexsmith, P.Geo. (BC)
Practice Leader (Environmental Geochemist)

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

5 References

CCME, 1999, updated 2007. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of Environment.

Nunavut Water Board, 2013. Water Licence No: 2AM-DOH1323. August 16, 2013.

SRK Consulting (Canada) Inc, 2007. Water Quality Model, Doris North Project, Hope Bay, Nunavut, Canada. Prepared for Miramar Hope Bay Limited. March 2007.

SRK Consulting (Canada) Inc, 2010. Quarry A, B & D Management and Monitoring Plan Report 1CH008.038.002. Prepared for Hope Bay Mining Limited. October 2010.

SRK Consulting (Canada) Inc, 2012. Doris North Project Interim Water Management Plan, revision 05 Report 1CH008.069. Prepared for Hope Bay Mining Limited. December 2012.

SRK Consulting (Canada) Inc, 2014. 2013 Hope Bay Seepage Monitoring Program 1CT022.000. Prepared for TMAC Resources Inc. March 2014.