SD 24

Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October9, 2020)

Stantec

Memo

To:	James Millard Atlantic Mining NS Inc.	From:	Jonathan Keizer Stantec Consulting Ltd.
File:	121619250	Date:	March 24, 2021

Reference: Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)

INTRODUCTION

The following memo provides a summary of responses to information requests received from Fisheries and Oceans Canada (Reference 20-HMAR-00531, dated October 9, 2020). These information requests are regarding modelling of potential reductions in flow rate to Moose River as a result of pit development at the Atlantic Mining Nova Scotia Touquoy Mine. The information requests have been numbered 20-HMAR-00531-01 through 20-HMAR-00531-06 and are outlined in Table 1 below. Responses have been provided in the following sections.

Table 1 Progress Update Regarding Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)

Request ID	Requested Information	Status & Completion Date
20-HMAR-00531-01	A description of the current dimensions (surface area and depth) of the open pit at the Touquoy mine, the final dimensions planned for the open pit (excluding the proposed expansion), and the expected timeline for completion of the work.	Provided in this update.
20-HMAR-00531-02	An analysis that examines whether there will be further reductions to baseflow in Moose River from further development of the open pit from its current dimensions to the final dimensions (excluding the proposed expansion). The analysis should consider relevant factors that were not considered in the groundwater model, including: 1. seasonal effects on baseflow (particularly during low flow periods); 2. local variations in hydraulic conductivity in the vicinity of Moose River; and 3. the best available information about the annual and monthly discharge, channel width, and depth of Moose River in the vicinity of the Touquoy mine.	
20-HMAR-00531-03	The estimated change in flow in Moose River in relation to the two guidelines/criteria outlined by DFO Science in the following document: "Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada" (https://waves-vagues.dfompo.gc.ca/Library/348881.pdf).	
20-HMAR-00531-04	For any hydrological/groundwater model used to support the above analysis, provide: 1. the complete dataset(s) used for the modelling; 2. a description of any assumptions and limitations associated with the model; and 3. an estimate of the margin of error associated with the model predictions.	

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

20-HMAR-00531-05	A figure showing the observed flow rate at SW-2 and the estimated flow rate at SW-2 based on upstream observations for 2020, and a description of any observed differences in the observed and estimated flow rates.	
20-HMAR-00531-06	The lowest daily flow rate observed at SW-2 in 2020.	

20-HMAR-00531-01

Information Request

A description of the current dimensions (surface area and depth) of the open pit at the Touquoy mine, the final dimensions planned for the open pit (excluding the proposed expansion), and the expected timeline for completion of the work.

Response

The mine footprint in August 2019, August 2020, and at the designed ultimate extent of the pit are shown on Table 2. The open pit is expected to be fully developed in November 2022.

Table 2 Information on Development of Touquoy Open Pit

Pit Shell ID	Bottom Elevation (m CGVD2013)	Maximum Depth (m)	Surface Area (m^2)
August 1, 2019	70.7	42.3	227,251
August 1, 2020	45.8	67.2	230,657
Planned Ultimate Extent (2017)	-25	138	275,752

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

20-HMAR-00531-02

Information Request

An analysis that examines whether there will be further reductions to baseflow in Moose River from further development of the open pit from its current dimensions to the final dimensions (excluding the proposed expansion). The analysis should consider relevant factors that were not considered in the groundwater model, including:

a. seasonal effects on baseflow (particularly during low flow periods);
b. local variations in hydraulic conductivity in the vicinity of Moose River; and
c. the best available information about the annual and monthly discharge, channel width, and depth of Moose River in the vicinity of the Touquoy mine.

Response

The groundwater flow model developed for the Beaver Dam and Fifteen Mile Stream projects was recalibrated to include additional groundwater flow information, as described below. The groundwater flow model was used to assess the changes to baseflows to Moose River based on the August 2019 pit shell, and the planned ultimate extent of the pit shell (see Table 2). The updated groundwater flow modelling is presented in Stantec (2021). Responses to parts a, b, and c, of Information Request 20-HMAR-00531-02 are provided below.

The simulated baseflow rates at SW-2 (Drawing 1; attached) from the groundwater modelling are presented on Table 3, for pre-development (i.e., no pit) conditions, the calibrated conditions based on the extent of the August 2019 pit shell, and the predicted conditions upon development of the ultimate extent of the open pit.

Table 3 Simulated Baseflow Rates in Moose River (m³/s)

Baseflow Period	Pre-development	August 2019 Pit Shell		Ultimate Extent Pit Shell	
		Baseflow	Decrease from Pre-development	Baseflow	Decrease from Pre-development
Mean Annual	0.3454	0.3397	0.0057	0.3391	0.0063
Average Summer	0.1121	0.1086	0.0035	0.1083	0.0038

Based on the extent of the August 2019 pit shell, mean annual baseflow in Moose River is predicted to have been decreased by 0.0057 m³/s, and mean summer baseflow decreased by 0.0035 m³/s from pre-development conditions. The ultimate extent of the open pit is predicted to decrease the mean annual flow by an additional 0.0006 m³/s (or 0.0063 m³/s from pre-development), and summer low flow by an additional 0.0003 m³/s (or 0.0038 m³/s compared to pre-development conditions).

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

a. Seasonal Effects on Baseflow

Seasonal effects on baseflow were assessed based by evaluating the monthly baseflow indices (i.e., ratio of baseflow to total flow) on streamflow records from SW-2, using a recursive filter (Arnold et al. 1995). These indices were used to determine baseflow targets for the groundwater modelling (Stantec 2021), provided under separate cover. The results are shown on Table 4.

Table 4 Monthly Baseflow Indices Calculated at SW-2 for 2017 to 2020

Month	Baseflow Index
April	0.145
May	0.292
June	0.490
July	0.504
August	0.741
September	0.330
October	0.310
November	0.195
December	0.353
Annual	0.290

b. Local Variations in Hydraulic Conductivity

Hydraulic conductivity estimates in wells located in the vicinity of Moose River are summarized on Table 5.

Table 5 Hydraulic Conductivity in Monitoring Wells in Vicinity of Moose River

Well ID	Easting	Northing	Screened Interval (m CGVD2013)	Geological Unit	Hydraulic Conductivity (m/s)
OPM-1A	504335.791	4980786.631	109.99 - 105.39	Silty sand and bedrock	9.0×10^{-6}
OPM-1B	504336.715	4980786.622	99.16 - 98.16	Bedrock	1.7×10^{-5}
OPM-2A	504188.089	4981053.977	109.20 - 104.60	Silty sand and bedrock	1.8×10^{-5}
OPM-2B	504187.283	4981053.492	98.41 - 95.31	Bedrock	6.9×10^{-6}
OPM-3A	504262.963	4981218.454	115.08 - 110.48	Bedrock	9.3×10^{-7}
OPM-3B	504262.657	4981219.65	104.35 - 101.25	Bedrock	1.8×10^{-6}
OPM-4A	504143.763	4981577.527	112.65 - 108.05	Silty sand and bedrock	9.5×10^{-6}
OPM-4B	504144.225	4981576.21	102.02 - 98.92	Bedrock	2.0×10^{-5}

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

c. Streamflow Rates and Moose River Channel Geometry

Streamflow rates were previously derived for the pre-development conditions based on regional regression. The calculated monthly pre-development flow statistics are presented on Table 6. Hydrometric station locations are shown on Drawing 1 (attached).

Table 6 Estimated Pre-development Mean Monthly and Mean Annual Flow Statistics for Moose River Hydrometric stations (m^3/s)

Month	SW-11	HM-1	SW-2
Drainage Area (km^2)	*25.78*	*12.01*	*39.03*
January	0.77	0.33	1.22
February	0.70	0.31	1.10
March	1.07	0.49	1.65
April	1.42	0.62	2.23
May	0.82	0.36	1.29
June	0.43	0.19	0.67
July	0.26	0.12	0.40
August	0.25	0.11	0.39
September	0.30	0.14	0.45
October	0.61	0.28	0.94
November	1.09	0.49	1.70
December	1.09	0.48	1.70
Annual	0.74	0.33	1.15

Surveys of the channel width and depth in Moose River were conducted in 2020, and the results are summarized on Table 7.

Table 7 Moose River Channel Width and Depth

Reach ID	Latitude	Longitude	Wet Width (m)	Channel Width (m)	Wet Depth			Bankfull Max Depth (m)
					25% from LB (m)	50% from LB (m)	75% from LB (m)	
1	44.9878	-62.9458	11.5	12	0.15	0.34	0.2	0.66
2	44.9865	-62.94699	7.5	7.5	0.3	0.5	0.4	0.5
3	44.9866	-62.94706	12.6	12.6	0.3	0.7	0.6	0.7
4	44.9873	-62.94645	4	4	0.42	0.36	0.41	0.52
5	44.9856	-62.94703	12.2	12.2	0.5	0.66	0.67	0.7
6	44.9861	-62.94675	13.7	13.7	0.45	0.3	0.4	0.45
7	44.9863	-62.94682	9	9	0.48	0.4	0.3	0.48

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

Table 7 Moose River Channel Width and Depth

Reach ID	Latitude	Longitude	Wet Width (m)	Channel Width (m)	Wet Depth			Bankfull Max Depth (m)
					25% from LB (m)	50% from LB (m)	75% from LB (m)	
8	44.9869	-62.94688	12.5	12.7	0.42	0.34	0.44	0.42
9	44.9857	-62.94696	-	30.7	-	-	-	-
10	44.9876	-62.94658	5	5	0.35	0.36	0.35	0.35
11	44.9876	-62.94653	8	8.2	0.21	0.2	0.16	0.4
12	44.9875	-62.94633	2.65	2.65	0.25	0.25	0.25	0.25
13	44.9873	-62.94664	10.1	10.1	0.17	0.3	0.48	0.48
14	44.9875	-62.94656	3.6	3.6	0.19	0.17	0.3	0.49
15	44.9877	-62.94617	1.7	1.7	0.17	0.15	0.19	0.27
16	44.9879	-62.94535	4	4.8	0.41	0.45	0.32	0.45
17	44.9878	-62.94557	7	7.5	0.8	1.5	0.5	1.5
18	44.9802	-62.94478	8	8.2	-	-	-	-
19	44.9813	-62.94632	13	13.05	0.35	0.4	0.5	0.5
20	44.9848	-62.94896	13.1	13.3	0.35	0.3	0.3	0.3
21	44.9843	-62.94895	11.6	11.8	0.4	0.4	0.6	ND
22	44.9851	-62.94828	19.4	19.4	0.8	0.3	0.5	0.8
23	44.9804	-62.94547	2	3	0.05	0.06	0.07	0.07
24	44.9836	-62.94821	19.3	19.3	1	-	-	-
25	44.9822	-62.94686	13.8	13.9	0.58	0.62	0.4	0.62
26	44.9825	-62.9471	13.5	13.6	0.58	0.6	0.58	0.58
27	44.9806	-62.94574	12.5	12.8	0.3	0.2	0.35	ND
28	44.9804	-62.94553	9.3	9.4	0.3	0.35	0.32	0.35
29	44.981	-62.94629	11.8	11.8	0.3	0.1	0.28	-
30	44.9806	-62.94577	16.7	16.9	0.39	-	-	-
31	44.9785	-62.94371	-	10.7	0.41	0.58	0.51	1.03
32	44.9787	-62.94387	-	9.7	-	-	-	-
33	44.9769	-62.94317	9.95	10.65	0.215	0.19	0.18	0.565
34	44.9774	-62.94362	-	7.48	-	-	-	-
35	44.9771	-62.94336	-	10.1	-	-	-	-
36	44.9778	-62.94374	-	9.46	-	-	-	-
37	44.979	-62.94404	14.44	14.69	0.17	0.12	0.145	0.37
38	44.9777	-62.94376	-	11.1	-	-	-	-
39	44.9767	-62.94345	11.34	16.14	0.17	0.2	0.2	0.55

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

Table 7 Moose River Channel Width and Depth

Reach ID	Latitude	Longitude	Wet Width (m)	Channel Width (m)	Wet Depth			Bankfull Max Depth (m)
					25% from LB (m)	50% from LB (m)	75% from LB (m)	
40	44.9797	-62.9443	-	8.96	-	-	-	-
41	44.9799	-62.94452	8.75	10.25	0.41	0.58	0.51	1.03
42	44.9782	-62.94364	6.8	10.2	0.07	0.2	0.115	0.5
43	44.9758	-62.9445	7.85	10.55	0.15	0.23	0.135	0.5
44	44.9742	-62.94534	16.5	16.8	1.1	1.3	1.4	1.4
45	44.9733	-62.94587	14.2	14.3	0.45	0.6	0.5	0.6
46	44.9722	-62.94565	35	35	1	-	-	-
47	44.9713	-62.94462	9.46	9.7	1.6	1.2	-	-
48	44.971	-62.94467	12.2	12.3	1.25	0.6	0.6	1.25
49	44.9705	-62.94438	18.3	18.3	0.8	-	-	-
50	44.9704	-62.94388	9.93	10	0.7	-	-	-
51	44.9703	-62.94356	12.1	12.1	0.6	-	-	-
52	44.969	-62.94269	23.6	24	0.5	0.6	0.7	0.7
53	44.9689	-62.94149	14.2	14.2	0.9	0.9	-	-
54	44.9673	-62.94009	16.8	16.8	0.5	-	-	-
55	44.9689	-62.94149	18.8	18.8	-	-	-	-
56	44.9748	-62.94509	40	40	-	-	-	-
57	44.9703	-62.94356	9.25	9.3	0.3	0.4	0.6	0.6

LB = Left Bank of watercourse
- = no data

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

20-HMAR-00531-03

Information Request

The estimated change in flow in Moose River in relation to the two guidelines/criteria outlined by DFO Science in the following document: "Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada" (*https://waves-vagues.dfompo.gc.ca/library/348881.pdf).*

Response

The two guidelines/criteria outlined in the "Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada" (DFO 2013) are summarized below.

- Cumulative flow alterations <10% in amplitude of the actual (instantaneous) flow in the river relative to a "natural flow regime" have a low probability of detectable impacts to ecosystems that support commercial, recreational or Aboriginal fisheries. Such projects can be assessed with "desktop" methodologies.
- Cumulative flow alterations that result in instantaneous flows < 30% of the mean annual discharge (MAD) have a heightened risk of impacts to fisheries.

As discussed in the responses prepared to DFO Reference 20-HMAR-00251 (Stantec (2020) (provided for reference under separate cover) the observed flows at SW-2 were compared to the estimated reduced flows at SW-2 based on upstream flow measurements. The difference between these measurements were used as a first approximation of the project-related impacts.

Based on the updated groundwater flow modelling results discussed in response to 20-HMAR-00531-02, mean annual reductions in baseflow are expected to be 0.0058 m^3/s, and to summer baseflow of 0.0035 m^3/s. These rates were applied to the streamflows observed at SW-2 in 2019 and 2020, as shown on Figure 1.

These expected baseflow reductions amount no more than a 4.5% of reduction in streamflow estimated at SW-2 based on upstream flow in Moose River in 2019 and 2020 which is less than the first ecological flow criterion referenced above.

Mean annual discharge at SW-2 is estimated to be 1.15 m^3/s. Therefore, the second ecological flow criterion that indicates that alterations to instantaneous flows should not result in flows less than 30% of MAD would require alterations in flows to not fall below 0.345 m^3/s. This threshold is depicted as the maximum of the Y-axis on Figure 1. As shown by comparing the observed and estimated lines, no instantaneous flow rates are reduced below this threshold due to project related effects.

As shown on Figure 1, there are periods when the streamflows observed at SW-2 were lower than the estimated reduced streamflows, particularly for September to October 2019. Based on the observed pit dewatering rates, the additional streamflow reductions in Moose River cannot be attributed to baseflow reductions in Moose River. Generally, the volume of water removed from the pit is less than the corresponding observed streamflow reduction in Moose River.

As indicated in correspondence from NRCan (2020), flow observed in rivers during the warm summer months is subject to heavy evapotranspiration losses (20-50% of the flow). This is particularly evident in late summer 2019, during an extended period of limited precipitation. This can account for a portion of the additional flow reductions observed at SW-2. Uncertainty in the flow measurements, particularly at SW-11, may also contribute to a portion of the additional flow reductions reported at SW-2. For example, aquatic vegetation has been observed at SW-11, and may affect the accuracy of the rating curve at SW-11 which does not account for the presence or absence of vegetation.

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

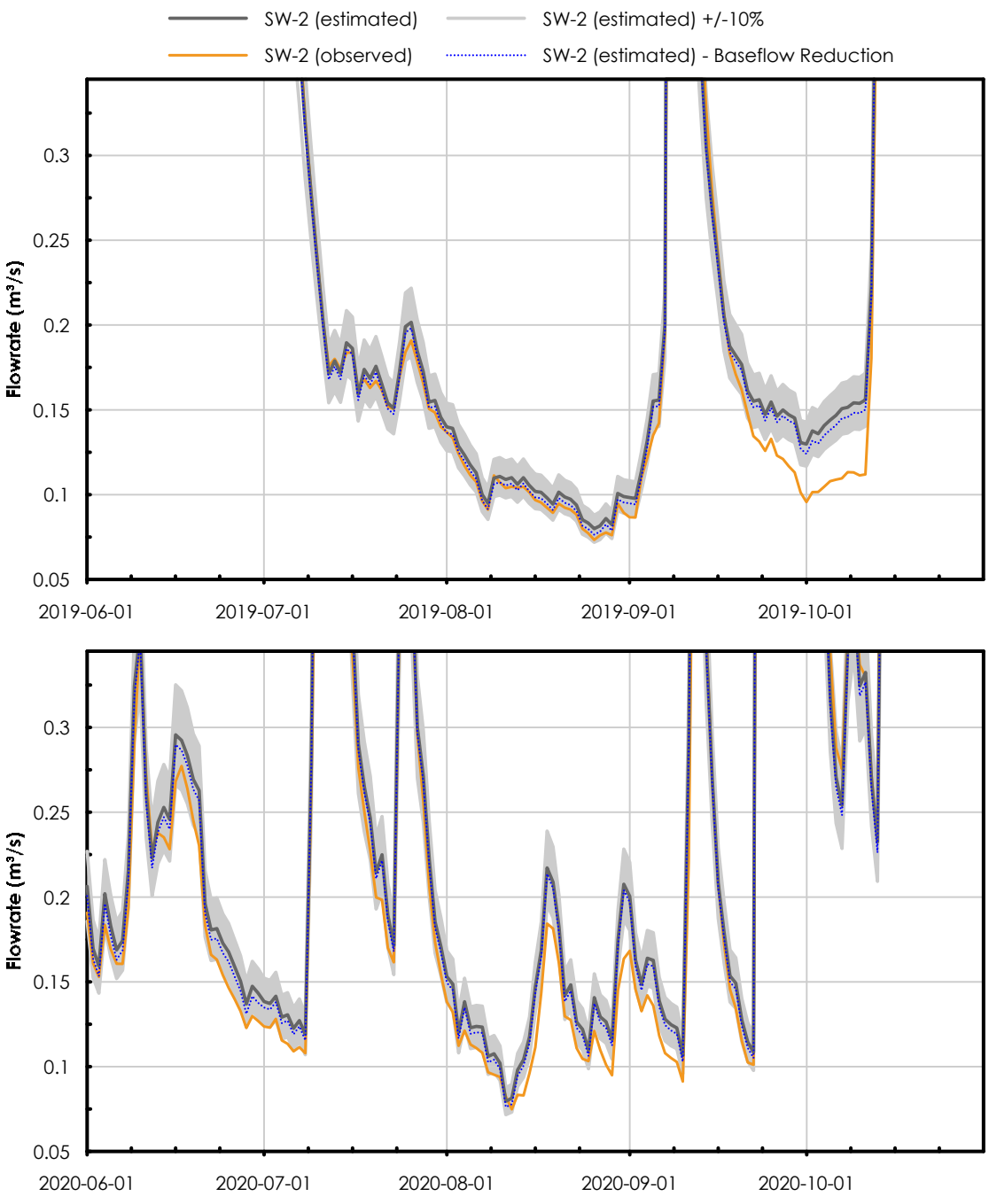

Figure 1 **Comparison of Estimated, Expected, and Observed Streamflows at SW-2**

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

20-HMAR-00531-04

Information Request

For any hydrological/groundwater model used to support the above analysis, provide:

a. the complete dataset(s) used for the modelling;
b. a description of any assumptions and limitations associated with the model; and
c. an estimate of the margin of error associated with the model predictions.

Response

Complete datasets for the groundwater flow modelling are included as attachments to this memorandum, as follows:

- Groundwater level data for monitoring wells – Attachment 1
- Moose River flow data – Attachment 2

The description of the assumptions and limitations (i.e., margin of error) associated with the groundwater flow model included in the groundwater modelling report (Stantec 2021). The groundwater flow model did not match the summer and annual baseflow perfectly, so the relative changes to estimated baseflows were used for these analyses. Sensitivity analyses conducted for the groundwater flow modelling suggest that baseflow estimates were accurate within 10% of the reported values. Increasing the baseflow reductions by 10% does not alter the conclusions that baseflow reductions from pit dewatering are no more than 4.5% of the lowest streamflow rates observed at SW-2.

20-HMAR-00531-05

Information Request

A figure showing the observed flow rate at SW-2 and the estimated flow rate at SW-2 based on upstream observations for 2020, and a description of any observed differences in the observed and estimated flow rates.

Response

Flow hydrographs showing the observed and estimated flow rates at SW-2 are shown on Figure 2 for the full flow record, and on Figure 3 to highlight low flows (i.e., less than 1 m^3/s). It should be noted that the rating curve for SW-2 is based on a maximum streamflow rates of 1.84 m^3/s. Therefore, streamflow rates above 2 m^3/s may not be accurate, as the rating curve has not been validated within this range.

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

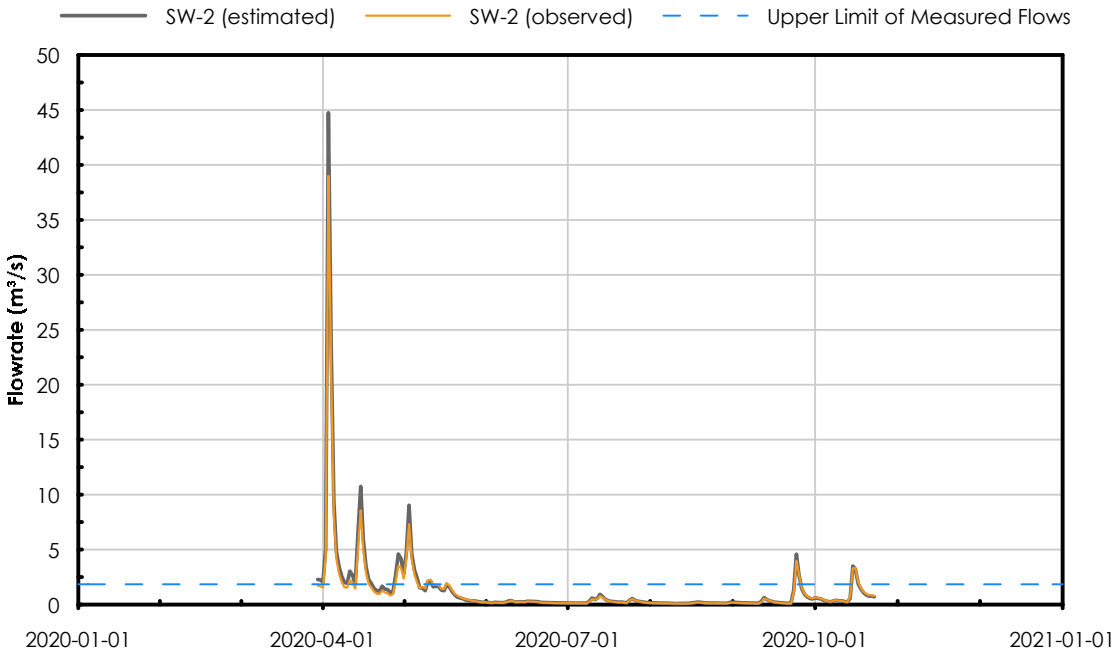

Figure 2 **Comparison of Estimated and Observed Streamflows at SW-2 in 2020**

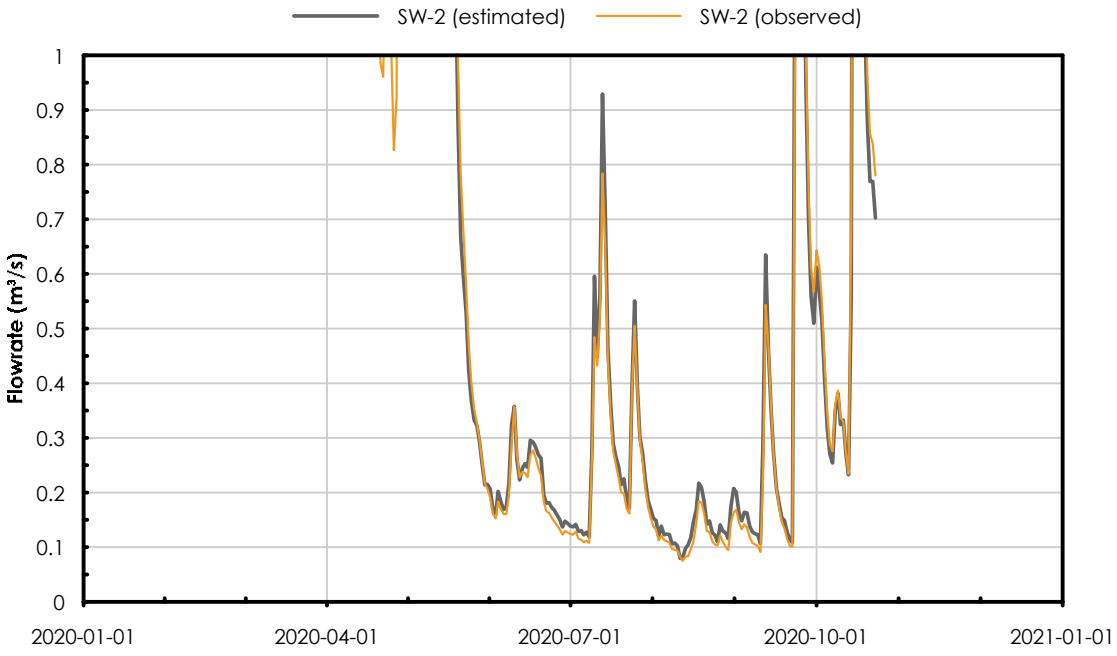

Figure 3 **Comparison of Estimated and Observed Streamflows at SW-2 in 2020 Focussing on Flows < 1.0 m³/s**

Reference: **Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020)**

20-HMAR-00531-06

The lowest daily flow rate observed at SW-2 in 2020.

Response

The lowest daily flow rate observed at SW-2 in 2020, based on the stage-storage curves presented above, and the water level hydrographs recorded at SW-2, was 0.0748 m^3/s, observed on August 12, 2020.

CLOSURE

This document entitled Response to Information Requests from Fisheries and Oceans Canada (Reference 20-HMAR-00531; October 9, 2020) was prepared by Stantec Consulting Ltd. (“Stantec”) for the account of Atlantic Mining NS Inc. (the “Client”). Any reliance on this document by any third party without written consent is strictly prohibited. The material in it reflects Stantec’s professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Stantec Consulting Ltd.

Originally signed by

Jonathan Keizer M.Sc.E., P.Eng.
Senior Hydrogeologist

Phone: 506 452 7588
Jonathan.Keizer@stantec.com

Attachment: 1 – Groundwater level data for OPM Wells

Attachment 2 – Moose River flow data

REFERENCES

Arnold, J.G., P.M. Allen, R. Muttiah, and G. Bernhardt. 1995. Automated Base Flow Separation and Recession Analysis Techniques.” Ground Water 33 (6): 1010–18.

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Stantec Consulting Ltd. 2020. Assessment of Surface Water Flow and Potential for Changes to Fish Habitat in Moose River. Memo prepared for Atlantic Mining NS Inc.

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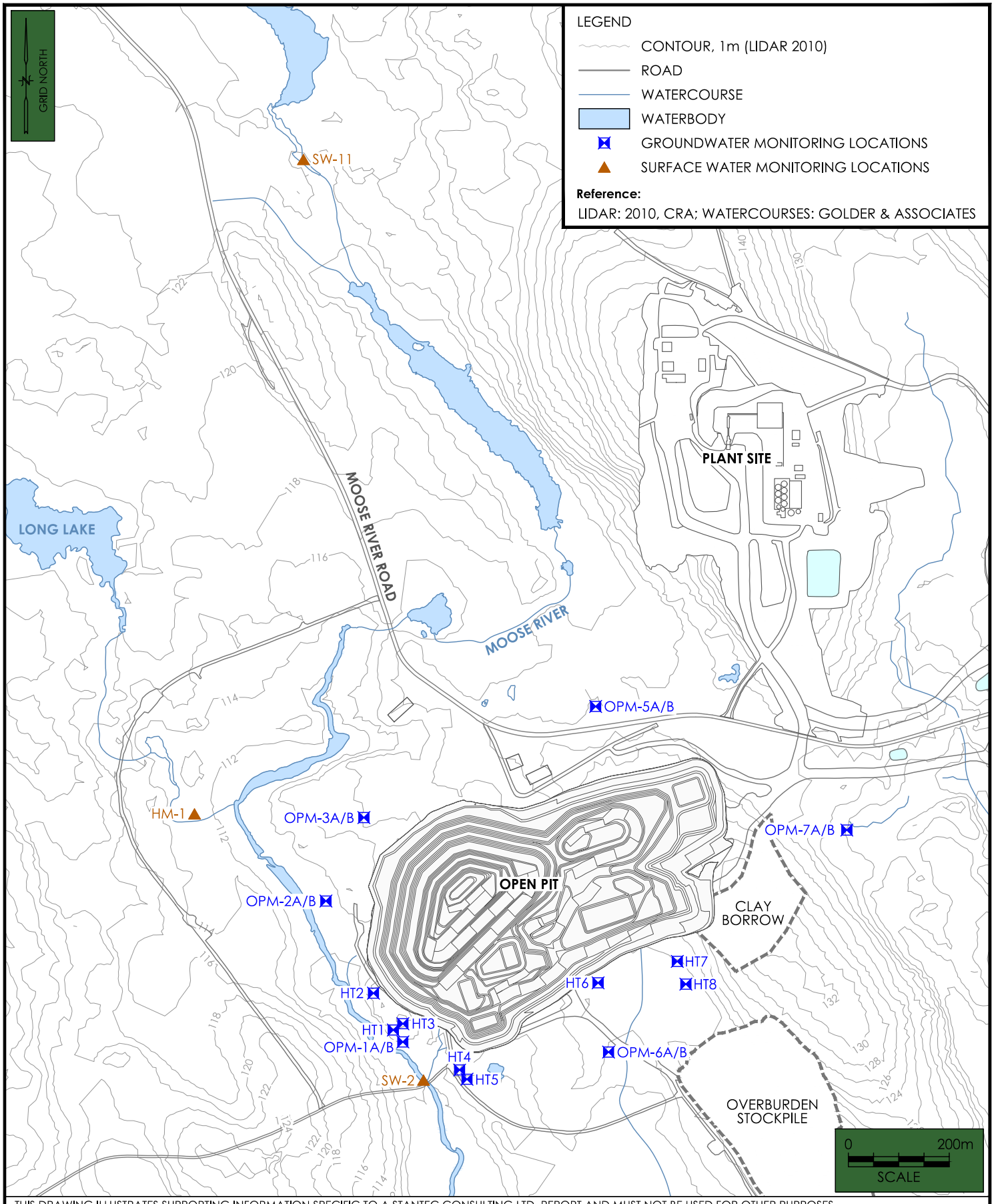

GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS REVIEWED

TOUQUOY GOLD PROJECT

HALIFAX COUNTY, NOVA SCOTIA

Client:	ATLANTIC MINING NS CORP
Job No.:	121619250
Scale:	1 : 10 000
Date:	2019 09 25
Dwn. By:	JL
App'd By:	JK
Dwg. No.:	1

Stantec

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