Atlantic Gold

Appendix G.5b

Water Balance Report Revision 2.0, Atlantic Gold Tailings Management Facility - November 25, 2016

Completed for the Updated 2021 Beaver Dam Mine EIS

Water Balance Report

Revision 2.0

Atlantic Gold Tailings
Management Facility

Prepared for:
Atlantic Gold Corp.
Suite 3083, Three Bentall Centre
595 Burrard Street
Vancouver, BC V7X 1L3

Prepared by:
Stantec Consulting Ltd.
845 Prospect Street
Fredericton, NB
E3B 2T7

Project No. 121619250
November 25, 2016

Sign-off Sheet

This document entitled Water Balance Report was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Atlantic Gold Corporation (the "Client"). Any reliance on this document by any third party 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.

This report was prepared by Rachel Jones, Water Resources Engineer, P.Eng (NB & NS) and reviewed by Sundar Premasiri, Senior Water Resources Specialist, Sheldon Smith, Senior Hydrologist and Jon Keizer, Water Resources Specialist.

<Original signed by>

Prepared by ____

(signature)

Rachel Jones, Water Resources Specialist

Table of Contents

LIST OF TABLES

LIST OF DRAWINGS

LIST OF FIGURES

1.0 INTRODUCTION

The Atlantic Gold mine site is located approximately 60 km northeast of Halifax, in the Moose River Gold Mines district in Halifax County, Nova Scotia (Drawing 1). As shown in Drawing 2, the mine site comprises approximately 176 ha in area, of that area the proposed Tailings Management Facility (TMF) comprises approximately 94 ha. Discharge from the TMF is proposed to drain to a polishing pond, then to a constructed wetland before being discharged to an unnamed tributary to Scraggy Lake, part of Moose River drainage system.

Atlantic Gold is proceeding with design and construction of a new open pit mine, a tailings management facility (TMF) including a tailings pond, and a final polishing pond to the east of the open pit. The tailings pond will act as a sedimentation basin, reclaim water reservoir and cyanide (CN) degradation pond. A process water treatment facility will provide additional CN destruction and arsenic removal. The polishing pond, downstream of the tailings pond and the process water treatment facility, will provide additional treatment prior to discharge to the unnamed tributary to Scraggy Lake. The TMF dam will be constructed in 6 stages (raises) during its anticipated life of 7 years.

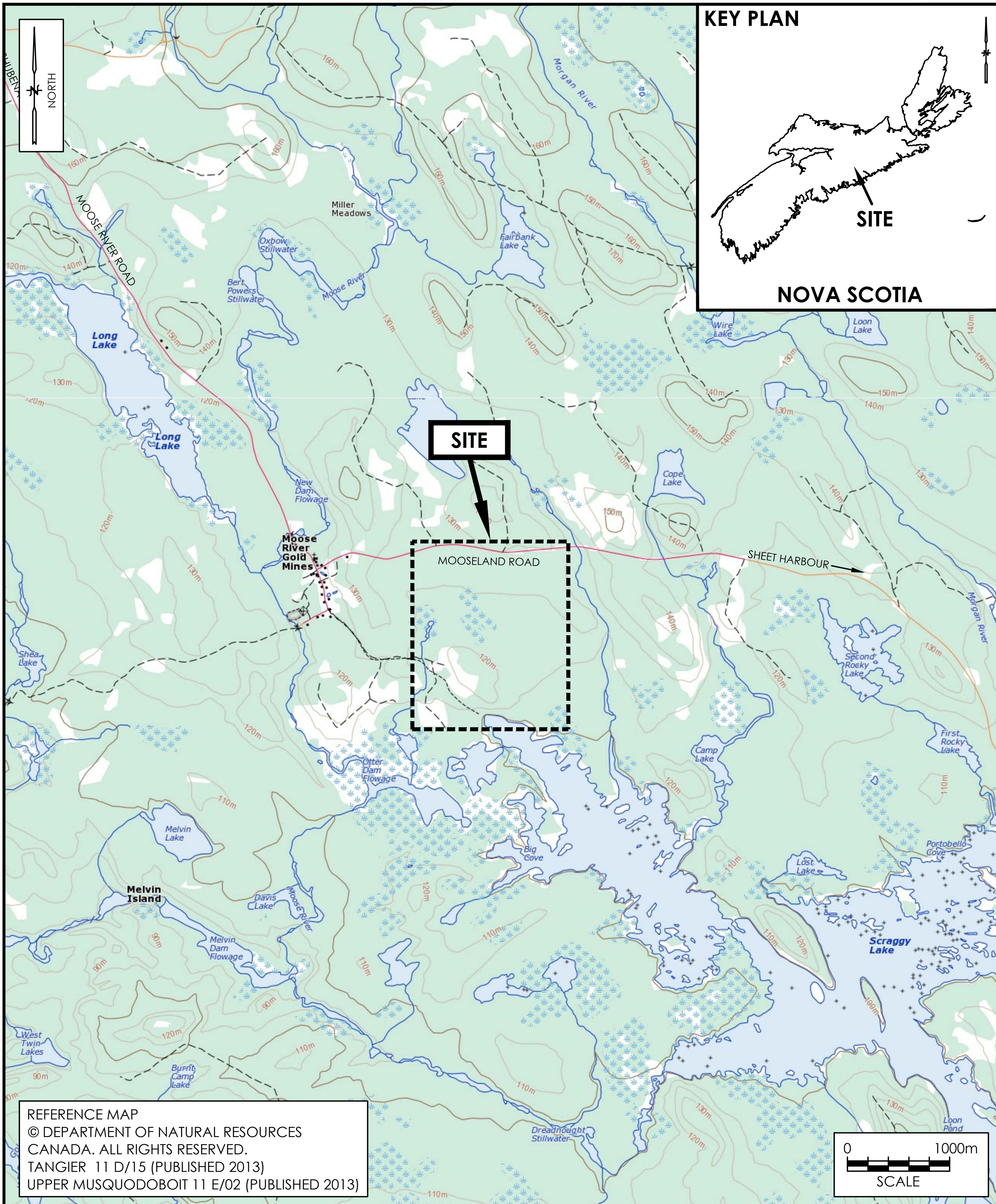
The report describes the proposed water balance for the TMF in an average year of the 7 years of operation. The objective of the water balance is to predict the quantity of water requiring treatment prior to leaving the mine site throughout operation and to understand the overall water management plan at the Atlantic Gold mine. The water balance was prepared as an update to a previous water balance study conducted by Golder (2006), in support of a feasibility study in preparation for detailed design.

1.1 RELEVANT BACKGROUND, GUIDELINES AND LEGISLATION

The following guidelines are used in design and operation of the TMF and polishing pond:

- Environment Canada's Metal Mining Technical Guidance for Environmental Effects Monitoring (2012), and the *Metal Mining Effluent Regulations* (MMER; DFO 2002);
- Canadian Association of Dams (CDA) 2014 Dam Safety Guidelines;
- Health Canada Guideline for Canadian Drinking Water Quality (GCDWQ; Health Canada 2014, as adopted by Nova Scotia government;
- Approval to Operate Open Pit Gold Mine and Mineral Processing Facility (2012-084244) under the Province of Nova Scotia Environment Act, issued by Nova Scotia Environment (NSE 2012); and,
- Operation, Maintenance and Surveillance Manual, prepared by Golder Associates (2007b) in support of TMF approval application to the Nova Scotia Environment.

This report addresses the operational water balance for the TMF. Closure water management plans are not included in the scope of work covered by this report.



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

SITE LOCATION PLAN

TOUQUOY MINE TAILINGS MANAGEMENT FACILITY

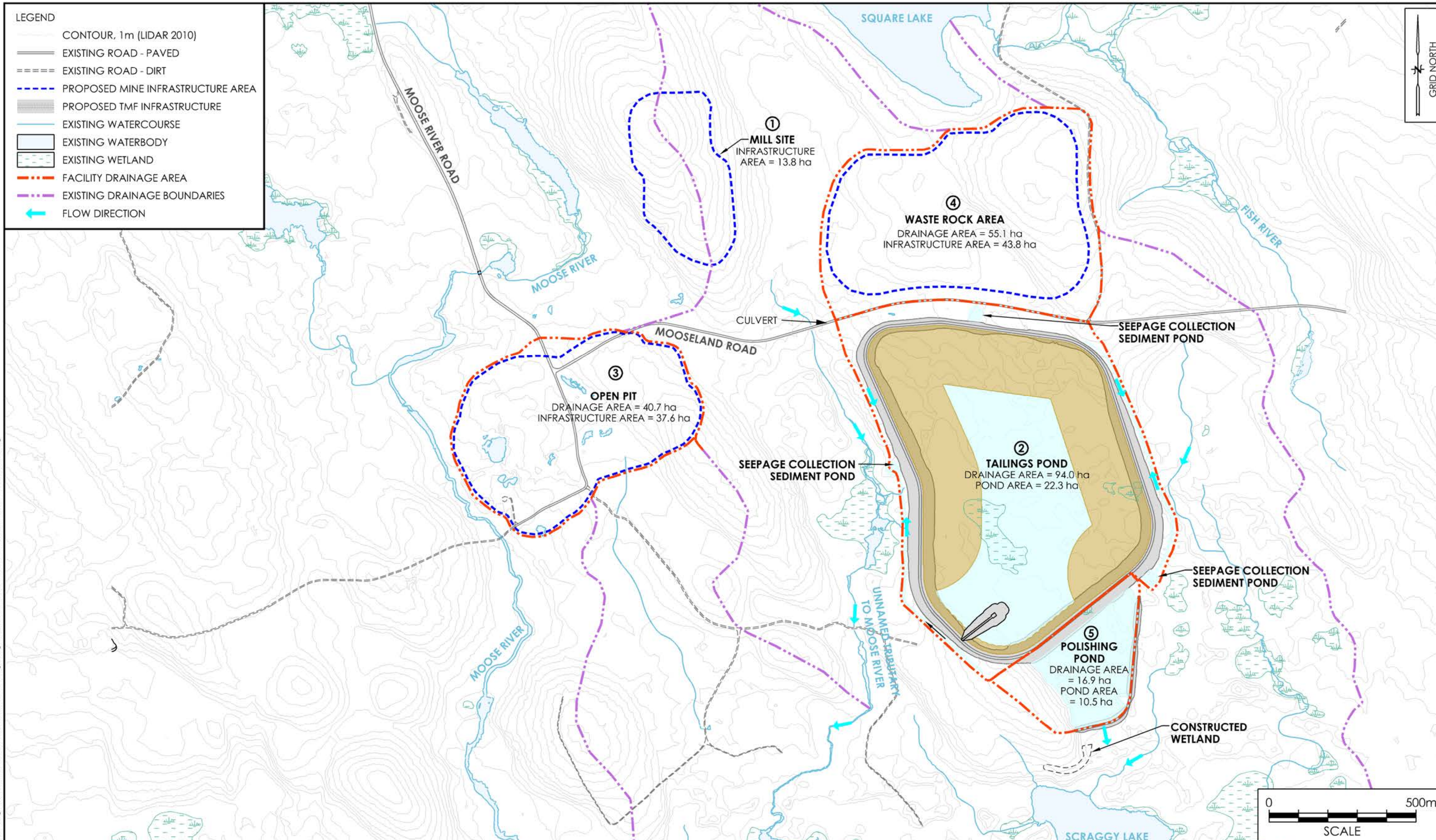
HALIFAX COUNTY, NOVA SCOTIA

Client: DDV GOLD INC.

Job No.:	121619250
Scale:	1 : 50,000
Date:	2016 01 05
Dwn. By:	JL
App'd By:	JG
Dwg. No.:	1

Stantec

V:\1216\active\121619250\1_geotechnical_deliverables\3_drawings_logs\600_TOUQUOY\SHEET FILES\19250C-HYDR-001.dwg



V:\1216\active\121619250\1_geotechnical_deliverables\3_drawings_logs\600_TOUQUOY\SHEET FILES\19250C-HYDR-002.dwg

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

Reference:

1. CONESTOGA-ROVERS & ASSOCIATES; PROJECT No. 820933-E; DRAWING No. 02; DATE: AUGUST 2013.
2. GOLDER & ASSOCIATES: PROJECT No. 06-1118-041C; FIGURE No. 2; DATE: MAY, 2015.

MINE DRAINAGE BOUNDARIES

TOUQUOY MINE TAILINGS MANAGEMENT FACILITY
HALIFAX COUNTY, NOVA SCOTIA

Client: DDV GOLD LTD.

Job No.:	121619250
Scale:	1 : 12,500
Date:	2016 03 10
Dwn. By:	JL
App'd By:	RJ
Dwg. No.:	2

Stantec

2.0 WATER MANAGEMENT PLAN

The primary goal of water management at the site is to reduce operational risks and environmental impacts. The specific objectives of the TMF water management plan include the following:

- Mitigate water quality impacts on receiving waters;
- Reduce the consumptive use of freshwater by reusing mine contact water to avoid additional water takings from natural waterbodies;
- Reduce the water inventory at the site; and,
- Reduce water management costs during construction and operations.

2.1 OVERVIEW OF WATER MANAGEMENT PLAN

The major project components of the TMF water management plan are the mill, tailings pond, process water treatment plant and the polishing pond as shown in Figure 2.1. As required under the approval to operate the open pit gold mine (Nova Scotia Environment 2012), all wastewater and surface runoff associated with the mine site will be directed to the TMF. An overview of key features of the TMF water management plan is as follows:

- Perimeter dams will be constructed to impound the tailings, and will be constructed in downstream raises to provide flexibility in construction and distribute construction costs over the life of the facility.
- The TMF receives water from the mill via tailings slurry water, seepage collection pond discharge (capturing runoff from the waste rock pile and mill site), dewatering of the open pit, runoff from tailings pond un-diverted upstream catchment areas and direct precipitation. Losses from the TMF include reclaim water, discharge to the polishing pond, water retained in the tailings matrix, seepage, and evaporation.
- Seepage collection ditches will collect tailings seepage at the toe of the tailings dam. These ditches will flow into the seepage collection ponds and be pumped and returned to the tailings pond. Perimeter ditches around the waste rock area will flow into three sedimentation ponds with the option to by-pass the TMF, if water quality objectives are achieved. The mill site pond and run-of-mine (ROM) stockpile runoff will be directed to a seepage collection pond. Mine water from dewatering the open pit will be collected in sumps and pumped to the TMF.
- Water collected in the tailings pond will be reclaimed through a decant tower for treatment and/or reuse for various mill processes.
- Surplus tailings water will be retained in the tailings pond to expose water to sunlight and facilitate natural CN degradation before discharge to the polishing pond. The TMF will discharge effluent from the beginning of August until to the end of December and during heavy rainfall events. This discharge period may be extended to as late as February, depending on ice cover, stream flows and climatic conditions. Surplus water in the TMF will be treated at a process water treatment facility to remove residual arsenic present in the

tailings water prior to discharge to the polishing pond. Previous studies concluded that the tailings were non-acid generating (CRA 2007).

- The polishing pond water will be released to a constructed wetland draining into the unnamed tributary of Scraggy Lake or directly to Scraggy Lake. The polishing pond will provide additional passive treatment for approximately 7 days and control the timing and amount of discharge depending on wetland function (CRA 2007). Extreme events exceeding the inflow design flood (IDF) will by-pass the constructed wetland and flow directly to Scraggy Lake. The outlet would be placed as far away from the inlet as possible to increase sedimentation, residence time and length : width ratio.
- Surface runoff upstream of the mine site will be diverted away from the mine site, where possible. As described in the water management plan (Merit Engineers 2006) and required under the approval (NSE 2012), storm runoff from the mill site (formerly described as an approximately 17.6 ha area) will be collected in the stormwater pond for transfer to the tailings pond.
- Water withdrawal from Scraggy Lake is proposed for use in initial ore processing until the tailings pond contains sufficient water for that purpose (Pers. Comm. Thomas 2016). Additionally, the open pit can contain 40,000 m^3 of pit runoff water for use; which can be withdrawn first before withdrawal from Scraggy Lake. Merrit Engineers determined that water withdrawal from Scraggy Lake would provide an adequate water supply to the mill (Merit Engineers 2006). Water will be supplied through a buried pipeline to a raw water/fire water storage tank (Ausenco 2015).
- The Waste Rock Area will contain both overburden and waste rock with an approximate maximum height of 40 m, containing a volume of 10 million cubic metres (Mm^3). A ROM stockpile overflow may be stored within the waste rock area (Merit Engineers 2006).

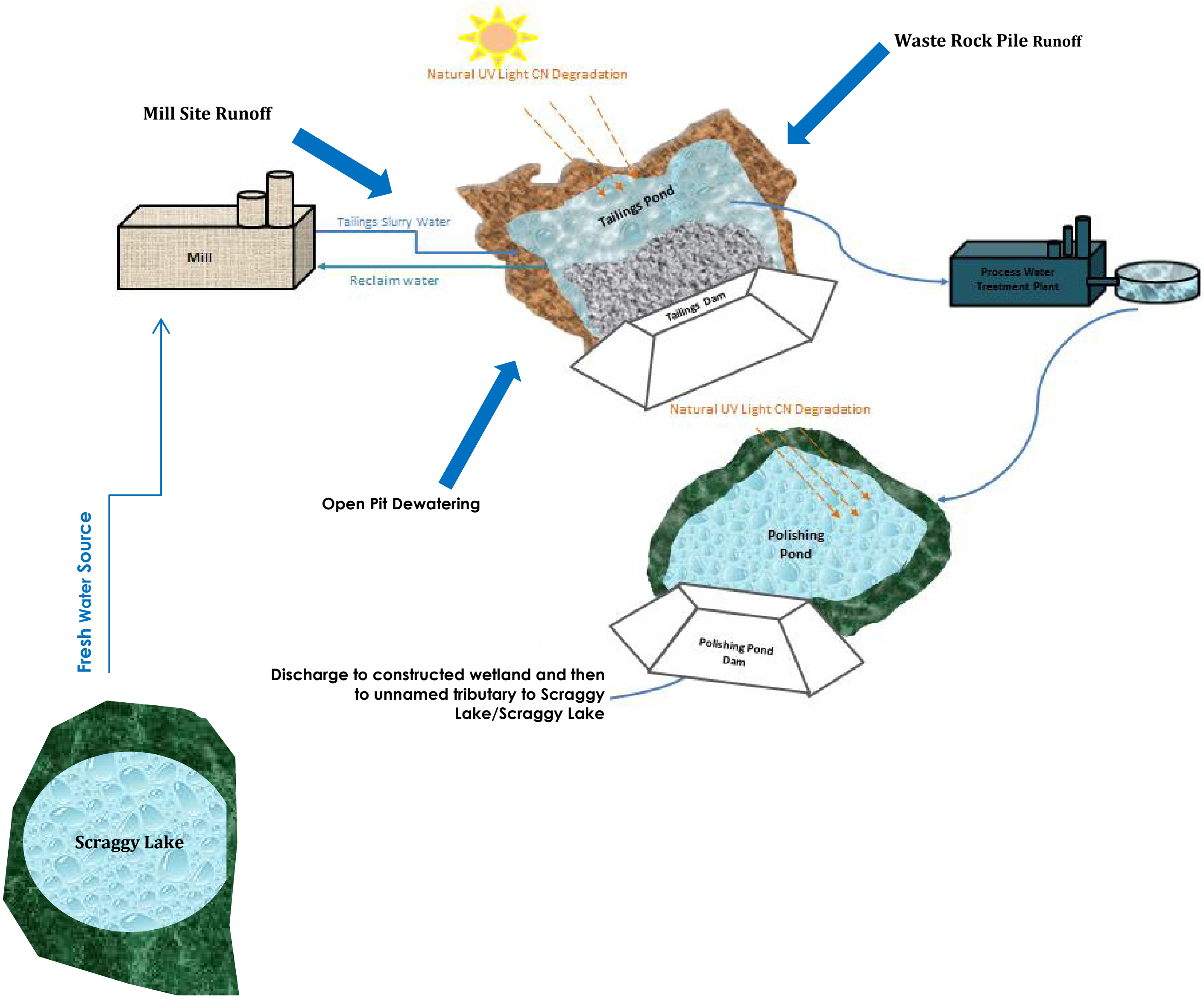


Figure 2.1 TMF Water Management Plan

3.0 WATER QUALITY TREATMENT

Water quality treatment for the tailings process water effluent involves the following:

- Cyanide destruction circuit in the mill circuit using the INCO Air/So^2 process, designed to achieve < 0.6 mg/L weak acid dissociable cyanide levels (pers. comm. Thomas 2016), prior to discharging to the TMF;
- Sedimentation of suspended solids and supplemental natural CN degradation in the TMF, with discharge to a process water treatment facility;
- Arsenic removal and pH adjustment in the process water treatment facility; and
- Effluent equalization and sedimentation in the polishing pond.

The tailings pond will have sufficient storage to facilitate the sedimentation of suspended solids, precipitation of dissolved and suspended arsenic solids and co-precipitation of cyanide-metal complexes. Water will be stored in the tailings pond during open water conditions to promote natural degradation of residual CN, when possible. The CN degradation process in the tailings pond is primarily comprised of volatilization and UV light degradation. The tailings pond is expected to receive CN concentrations in tailings water below MMER specifications (pers. comm. Thomas 2016), and will further reduce CN concentrations prior to discharge to the polishing pond. The tailings pond will generally retain water from approximately January 1 to August 1 to promote the natural degradation of CN. However, discharge may occur during this period to manage extreme runoff events and protect the integrity of the tailings dam. Heavy metal concentrations (copper, lead, zinc and nickel) in the tailings pond are expected to meet *MMER* specifications upon discharge from the TMF, with the exception of arsenic (CBCL 2007).

An effluent treatment plant is planned to be located between the tailings dam and the polishing pond. The treatment process will involve the addition of ferric sulphate to the effluent to precipitate arsenic, hydrated lime to adjust pH, coagulant polymer to facilitate the removal of colloidal sized suspended matter and final pH adjustment. The plant will have a maximum designed capacity of 450 m^3/hr, operating at an average rate of 350 m^3/h (CRA 2012) during discharge periods.

A polishing pond will further reduce the arsenic concentrations via further polishing sedimentation to well below the *MMER* effluent limit (CBCL 2007). Water will be pumped through "TenCate geo bags" which use chemical polymers and flocculants for further settlement and removal of hydroxide sludge and sediments. Water will be retained in the polishing pond for 7 to 28 days (Stantec 2010, Golder 2007b) to facilitate sedimentation of particulate and coagulated material and provide additional pH buffering, if required.

3.1 PREDICTED WATER QUALITY

As reported in the prefeasibility study (Atlantic Gold 2007), mine water and surface runoff from the open pit area will contain suspended solids, explosive residuals (mainly nitrates), and potentially traces of arsenic. Waste rock area runoff water may contain suspended solids and traces of arsenic. Surface runoff from areas immediately up-gradient of the tailings disposal area may contain suspended solids from wind-blown sources (*i.e.,* the waste rock pile, tailings pond, and ROM pad). Process tailings water from the mill will contain suspended solids, be alkaline, and contain free and metal-complexed cyanide. Residual Ammonia and Nitrate in the tailings slurry are typical by-products of cyanide destruction. Key water quality parameters of concern for effluent treatment are listed in Table 3.1. Water quality parameters of concern in the tailings slurry were not available at the time of report preparation.

Table 3.1 Key Water Quality Parameters of Concern

Mine Site Area	Units	Mine Waste Dump	Open Pit	Plant Area Runoff	Tailings Management Facility	MMER Maximum Concentrations (Monthly Average)
Total Suspended Solids	mg/L	0 -1500	0-1500	0-1500	0-1500	15
Arsenic	mg/L	0.6	0.8	0.6	1.5	0.5
Iron	mg/L	0.7	1.8	0.7	2.5	---
Cyanide	mg/L	---	---	---	0.6*	1.0
Nitrate	mg/L-N	---	22.8	---	0.05	---
Ammonia	mg/L - N	---	22.8	---	29.3	---

Note: --- = no value
Source: Atlantic Gold 2007, *= Pers. Comm Thomas 2016, Ausenco 2008.

The water quality treatment chain involving the tailings pond, process water treatment facility and the polishing pond is designed to provide a final effluent that meets the *MMER* effluent water quality criteria. As described in the Environmental Assessment, acid rock drainage will not be a concern with respect to mining, milling, and reclamation stages of the development (CRA 2012).

4.0 BASELINE HYDROLOGY

4.1 CLIMATE

Project site climatic and hydrologic conditions are required for the water balance analysis. Baseline climate and hydrology conditions at the Atlantic Gold mine site and relevant data required for water balance analysis are presented in this section.

The climate for the mine site is continental with temperature extremes moderated by the ocean. The coldest temperature recorded was −41.1 °C on January 31, 1920, at Upper Stewiacke (Environment Canada 2015c). Precipitation is well distributed throughout the year. July and August are the driest months on average.

Environment Canada's Middle Musquodoboit climate station (Station ID 8203535), was used to characterize the climatic conditions at the mine site. This station is located approximately 20 km northwest of the mine site, and reports data collected between 1961 and 2011. As presented in Table 4.1, the climate normal precipitation is approximately 1357.7 mm and the average snowfall of 172.2 cm, based on a period of record 1981-2010 (climate normal period, Environment Canada 2015a). The extreme one day precipitation amount of 173 mm for the period of record of the selected climate station occurred in 1961. Temperatures typically drop below zero between the months of December through March each year.

Average annual lake evaporation is 515 mm for the mine site area based on average lake evaporation at Environmental Canada's Truro climate station (2015b) and corresponding monthly evaporation rates are presented in Table 4.1.

Table 4.1 Representative Climate Values for the Mine Site

Climate Normal for the 30-year period (1981-2010) at Middle Musquodoboit Climate Station													
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Temperature (°C)	-6.2	-5.2	-1.3	4.4	9.9	14.8	18.5	18.4	14.2	8.5	3.5	-2.4	6.4
Rainfall (mm)	80.4	62.1	92.8	99.5	104.9	99.8	103.8	91.9	110.7	116.7	128.6	97.2	1188.3
Snowfall (cm)	49.4	41.3	31.4	9.5	0.5	0.0	0.0	0.0	0.0	0.0	8.2	31.9	172.2
Precipitation (mm)	129.8	100.5	124.2	109.0	105.4	99.8	103.8	91.9	110.7	116.7	136.8	129.1	1357.7
Snow Depth (cm)	40	67	64	22	6	1	0	0	0	0	25	28	21.1
Monthly Lake Evaporation at Truro Climate Station for 30 year period (1981-2010)													
Lake Evaporation (mm/day)	0	0	0	0	89.9	102	117.8	96.1	69	40.3	0	0	515.1

4.1.1 Wet and Dry Years

A frequency analysis was conducted to estimate annual precipitation for various return periods using the Middle Musquodoboit climate station data from 1961 to 2011. Annual precipitation totals for various return periods are presented in Table 4.2, including climate normal, wet and dry year climate conditions. The 100 year return period (1:100) wet and dry annual precipitation amounts are estimated to be 1,831.5 mm and 967.2 mm respectively.

Table 4.2 Annual Precipitation for Range of Return Period Precipitation Events

Return Period	Annual Precipitation (mm)[1]	
	Dry Year	Wet Year
Climate Normal (1981-2010)	1357.7	
5	1179.1	1485.5
10	1111.3	1579.7
25	1043.8	1687.6
50	1002.6	1761.7
100	967.2	1831.5

Note: [1] Based on the average of the period of record of climate station 8203535 Middle Musquodoboit

Maximum annual precipitation of 1,730 mm occurred in 1972 and approximately equal to the 1:40 year wet annual precipitation. Minimum annual precipitation of 1,073 mm occurred in 1992 and approximately equal to the 1:20 dry annual precipitation. Monthly distributions of the 1:100 year annual precipitation used in the water balance modelling were derived using the distribution trends observed in 1972 for wet years, and in 1992 for dry years.

A summary of the derived wet/dry year monthly climate conditions are presented in Table 4.3 for the 1:100 precipitation events. The mean monthly temperatures for the 1:100 wet year climate conditions are derived from monthly data observed during the driest year on record (i.e., in 1972). Similarly, the monthly temperatures for the 1:100 dry year climate conditions are derived from monthly data observed during the wettest year on record (i.e., 1992). The calculated annual precipitation was allocated by month based on the monthly distribution of the representative climate dry (1972) and wet (1992) years for the Middle Musquodoboit climate station.

Table 4.3 Wet and Dry Year Climate Values for the Mine Site

Dry Year													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Temperature (°C)	-6.9	-6.1	-4.1	2.6	9.9	15.7	16.2	18.4	14.5	7.8	1.6	-2.6	**Average** 5.6
1:100 Precipitation (mm)	122.0	134.2	126.3	27.9	54.9	41.1	71.9	56.7	59.4	101.0	96.9	74.9	**Total** 967.2
Wet Year													
Temperature (°C)	-5.3	-7.5	-3.6	3.6	13	15.6	17.1	18	14.2	7.5	2.2	-10.7	**Average** 5.3
1:100 Precipitation (mm)	130.2	136.0	237.9	114.0	152.5	140.8	145.7	103.1	69.8	231.9	217.1	152.5	**Total** 1831.5

4.2 STREAMFLOW

The Environment Canada hydrometric station at Beaverbank River Near Kinsac (Station 01DG003), located approximately 60 km southwest of the mine site, was selected to represent the streamflow characteristics at the mine site. The station has approximately 92 years of record (1922-2012) with a reported drainage area of approximately 96.9 km² (Environment Canada 2013). The station is at a similar elevation to the site and both stations are inland, each located approximately in the middle of the north and south coast.

The mean annual unit flow for the Kinsac station was calculated to be approximately 31 L/s/km². The mean annual unit flow was comparable to published mean annual flows for nearby stations (DFO 2012). The mean annual flow and the monthly minimum and maximum flows for the period of record of the station are presented in the Table 4.4 and in Figure 4.1. The mean monthly stream flows tend to peak twice a year, in spring and fall with low flow occurring in the summer months. The average runoff coefficient of 0.67 was calculated. The coefficient was based on the fraction of the mean annual flow over the total annual precipitation falling on the site for years when data overlapped from 1968 and 2009.

Two hydrological seasons can be identified in the monthly hydrograph and are described below:

- Spring/Summer – period of first peak stream flows corresponding to the spring freshet which can extend from April to as late as September when the freshet falling limb hydrograph fully recedes; and,
- Fall/Winter – period of second peak stream flows start from October followed by the recession period through February of the next year.

Table 4.4 Monthly Mean Flow for Beaverbank River Near Kinsac Hydrometric Station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Year
Mean (m^3/s)	3.82	3.07	4.34	6.01	3.44	1.66	0.91	0.91	1.13	2.35	4.21	4.39	3.02
Min (m^3/s)	0.679	0.151	0.752	1.9	0.524	0.177	0.004	0.004	0.0	0.02	0.311	1.49	0.50
Max (m^3/s)	15.0	9.57	10.2	11.4	11.4	7.95	3.89	6.55	6.58	10.1	10.8	9.76	9.43
Monthly Allocation	11%	8%	12%	17%	9%	5%	3%	3%	3%	6%	12%	12%	100 %

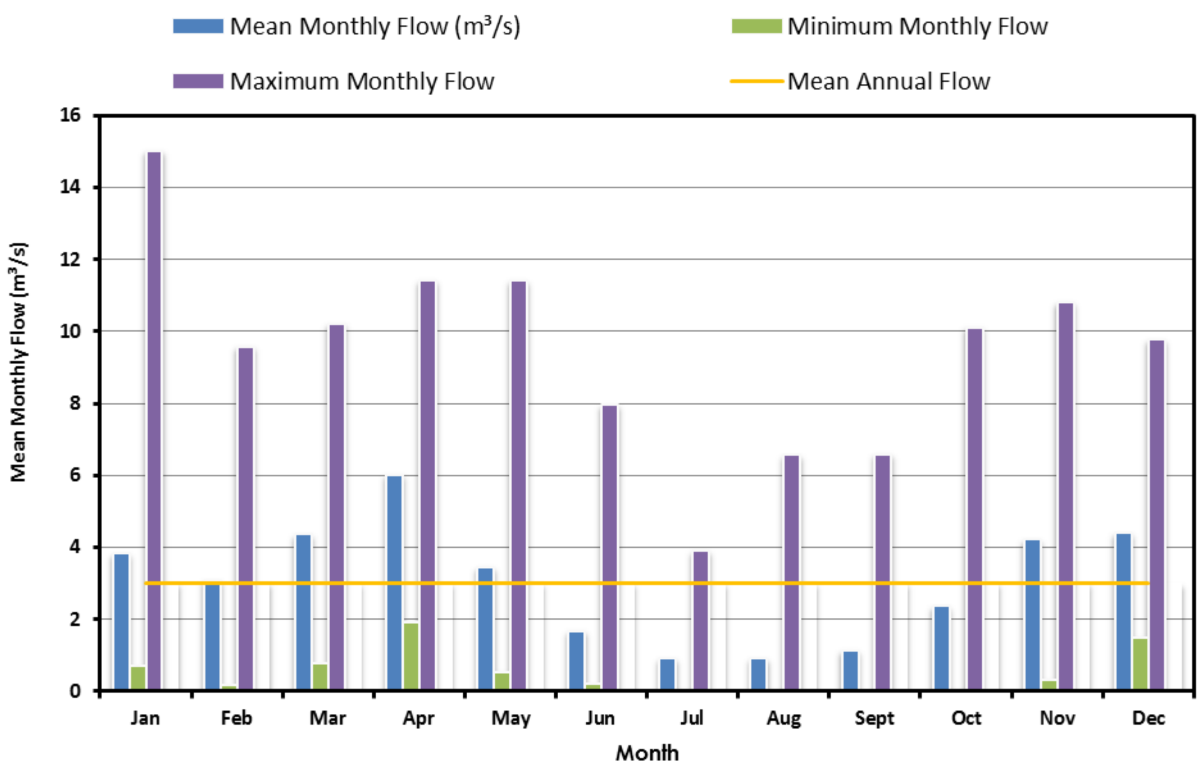


Figure 4.1 Mean Monthly Flows for Beaverbank River Near Kinsac Hydrometric Station (Environment Canada 2013)

Streamflow data from Water Survey of Canada hydrometric stations were used to calculate the streamflow characteristics at the mine site. Three streamflow statistics were used to characterize the mine site hydrology: the mean annual flow, the instantaneous peak flow and the seven-day low flow for various return periods. Streamflow statistics were calculated using the peak instantaneous flow data for the annual populations of maxima (for flood flows) and average daily flow station data for the annual populations of minima (for drought discharge). Populations were fit to nine probability distributions; Log Pearson Type III probability distribution was determined to be the best fit to the data. The computed parameters were used to characterize the mean annual flow, flood and drought flows for the TMF and polishing pond drainage area (1.109 km²) as show in Table 4.5.

Table 4.5 Frequency Analysis for the TMF Drainage Area

	Flood Flow (m^3/h)	7 Day Low Flow (m^3/h)[a]
Proration Factor	**0.0114**[b]	
Return Period		
2	1800	3.6
5	2160	0.45
10	2520	0.18
25	2880	0.06
50	3240	0.03
100	3600	0.01

Note:

[a] Calculated in Aquarius using a weekly average

[b] The hydrometric station drains runoff from an area greater than one order of magnitude larger than the site, as indicated by the proration factor less than 0.1; as a result the frequency analysis may over predict actual runoff conditions.

4.3 ENVIRONMENTAL WATER BALANCE

The environmental water balance can be represented by the following relationship:

$$P = ET + R + I$$

Where:

P = precipitation

ET = evapotranspiration

R = surface runoff

I = infiltration and storage

A spreadsheet-based monthly water balance model was used for the mine site based on the Thornthwaite and Mather method developed to estimate evapotranspiration, surface runoff, infiltration, and streamflow (Mather, 1969, 1978 and 1979; Black, 1996).

The spreadsheet model calculates monthly potential evapotranspiration (PET) using the Malstrom equation (Malstrom, 1969) and is given by:

$$PET = 40.9 \times ea^*$$

$$ea^* = 0.611 \times \exp\left[(17.3T)/(T+237.3)\right]$$

Where:

PET = potential evapotranspiration (mm/month)

ea* = saturation vapour pressure (KPa)

T = mean monthly temperature (°C)

Actual evapotranspiration (AET) is derived from potential evapotranspiration and soil-moisture. When P for a month is less than PET, then AET is equal to P plus the amount of soil moisture that can be withdrawn from storage in the soil. If P for a month is greater than PET, then AET is equal to PET.

Infiltration factors described by the Ontario Ministry of the Environment (OMOE 1995 and 2003) are used to determine the fraction of water surplus (excess of precipitation over evapotranspiration, P-ET) that infiltrates into the ground and the fraction that runs off to the nearby streams. The "infiltration factor" is determined from average landscape topographic slope, hydrologic soil type and vegetation cover type, and is used to determine the proportion of P-ET routed to infiltration. Infiltrated water recharges aquifers and also routes via interflow to waterbodies and watercourses. In the long term all net infiltrated water recharging aquifers is assumed to be discharged as a component of baseflow. Thus an additional line row in the monthly water balance, estimates streamflow which integrates both overland runoff and infiltration routing back to the "stream" as groundwater discharge and interflow components of baseflow.

Although groundwater recharge and groundwater discharge may not balance within the temporal confines of a climate year, in the long-term, all water that recharges groundwater aquifers is assumed to discharge as baseflow to lakes and streams. Therefore, in the Project Study Area case, as all groundwater is assumed to flow in relatively localized groundwater watersheds which are highly correlated to the surface watersheds, all baseflow returns to the local watershed into which its source infiltration occurred. As a result of this convention, the water balance can be further simplified into ET and streamflow which includes all overland flow, interflow and groundwater discharge. It was assumed that runoff, evapotranspiration and infiltration are negligible in months with average monthly temperatures below 0°C.

The water balance model was applied to climate normal, wet and dry year climate conditions to estimate the existing condition environmental water balance over a temporal scale compatible with the Project life cycle.

The environmental water balance was modeled on a monthly basis using a spreadsheet-based monthly water balance model. The water balance model requires input of monthly precipitation, average monthly temperature, soil-moisture storage capacity and infiltration factor. The soil moisture storage capacity for the study area is assumed as 150 mm based on the geology near the open pit which indicated shallow glacial till overburden approximately 4 m in depth consisting of cobbly silt-sand deposits (Stantec 2015a).

The infiltration factor for the TMF area was calculated to be 0.6 based on a topographical factor of 0.5 for an average slope less than 0.6 m/km, a soil factor of 0.12 for clay loam/clay, and a vegetation factor of 0.02-0.05 representing shallow rooted vegetation as recommended by OMOE (2003). This implies that 40% of net infiltrated precipitation will be discharged to surface water via baseflow. It is important to note that all water recharging aquifers eventually cycles back to the surface as groundwater discharge providing baseflow to local streams and lakes. As a result, the water balance can be further simplified into precipitation, ET and streamflow.

Table 4.6, 4.7 and 4.8 show the water balance results under the climate normal, wet year and dry year conditions. Evapotranspiration accounts for approximately 34.7% of total annual precipitation under climate normal conditions at the Middle Musquodoboit Climate Station. Evapotranspiration accounts for approximately 25.6 % under the 1:100 Wet Year conditions and 42.5 % under the 1:100 Dry Year conditions. The mean annual lake evaporation for the Truro climate station is 514 mm (EC 2012); the Truro pan evaporation station is located approximately 50 km northeast of the site.

Table 4.6 Water Balance Results under Climate Normal Conditions (1981-2010)

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	129.8	100.5	124.2	109	105.4	99.8	103.8	91.9	110.7	116.7	136.8	129.1	1357.7
Evapo-transpiration (mm)	0	0	0	34.2	50.0	69.0	87.3	86.78	66.4	45.4	32.13	0.00	471.3
Surface Runoff (mm)	0.0	0.0	0.0	271.4	26.9	15.0	8.0	2.5	21.5	34.6	50.9	0.0	430.8
Infiltration (mm)	0.0	0.0	0.0	287.0	28.5	15.8	8.5	2.6	22.8	36.6	53.8	0.0	455.6
Streamflow (mm)	96.6	70.0	105.5	150.7	79.8	43.4	25.7	25.7	25.7	52.3	105.5	105.5	886.4

Table 4.7 Water Balance Results under 1:100 Wet Year Conditions

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	130.2	136.0	237.9	114.0	152.5	140.8	145.7	103.1	69.8	231.9	217.1	152.5	1831.5
Evapo-transpiration (mm)	0.00	0.0	0.0	32.4	61.4	72.6	79.9	84.6	66.4	42.5	29.3	0.0	469.1
Surface Runoff (mm)	0.0	0.0	0.0	358.8	44.3	33.1	31.9	9.0	1.6	92.1	91.3	0.0	662.1
Infiltration (mm)	0.0	0.0	0.0	379.4	46.8	35.0	33.8	9.5	1.7	97.4	96.6	0.0	700.3
Streamflow (mm)	148.5	107.6	162.1	231.6	122.6	66.8	39.5	39.5	39.5	80.4	162.1	162.1	1362.4

Table 4.8 Water Balance Results under 1:100 Dry Year Conditions

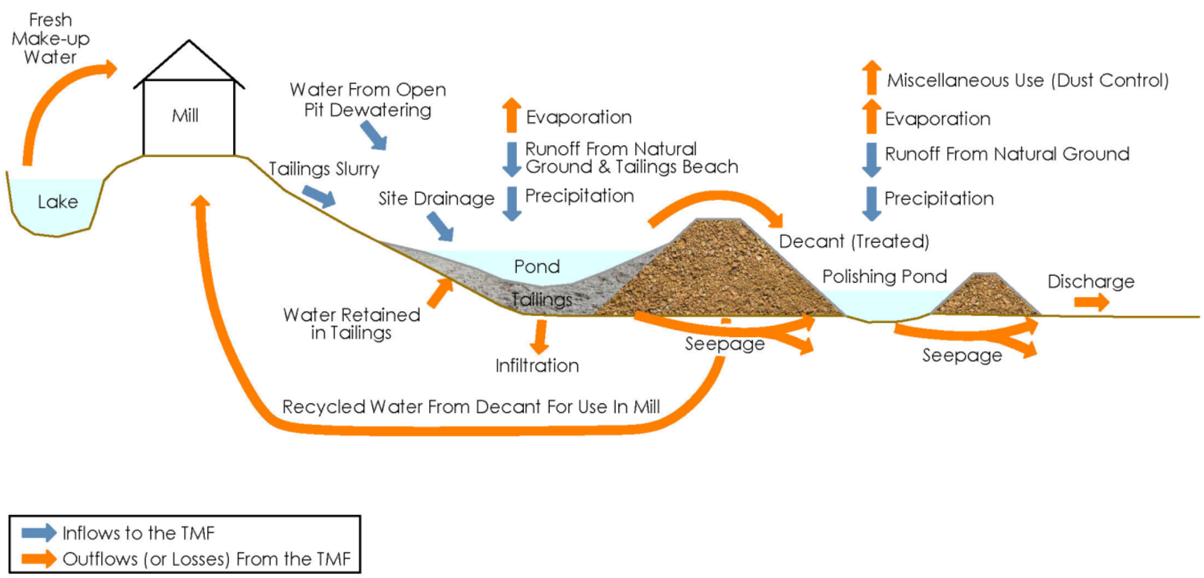
Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Precipitation (mm)	122.0	134.2	126.3	27.9	54.9	41.1	71.9	56.7	59.4	101.0	96.9	74.9	967.2
Evapo-transpiration (mm)	0.0	0.0	0.0	30.1	50.0	71.1	71.9	56.7	59.4	43.3	28.1	0.0	410.6
Surface Runoff (mm)	0.0	0.0	0.0	222.3	2.4	0.0	0.0	0.0	0.0	13.4	33.5	0.0	271.6
Infiltration (mm)	0.0	0.0	0.0	235.1	2.5	0.0	0.0	0.0	0.0	14.2	35.4	0.0	287.2
Streamflow (mm)	60.9	44.1	66.5	95.0	50.3	27.4	16.2	16.2	16.2	33.0	66.5	66.5	558.8

5.0 OPERATIONAL WATER BALANCE

A deterministic water balance model was developed using spreadsheets to provide a functional understanding of mine water flows over a given range of mine operating and climatic conditions. The project site hydrologic and climatic conditions along with mine operational conditions were integrated to develop the TMF water balance model. The following inputs were used in the water balance model:

- Mine process inputs (e.g., process water requirements, slurry water discharge, fresh water requirements);
- Watershed inputs (e.g., drainage plans, drainage area, topography, land uses, etc.);
- Climatic inputs (e.g., temperature, precipitation, evaporation, snow on the ground); and
- Hydrologic inputs (e.g., runoff coefficients, precipitation - runoff factors).

The water balance model has been developed for monthly time steps for average and wet/dry year climatic conditions over the anticipated life-of-mine (LOM). Water balance components of the TMF are illustrated in Figure 5.1.



Note: "Site Drainage" will include direct runoff from precipitation, mill site runoff, and waste rock runoff. A portion of the tailings pond seepage will be collected in seepage collection ditches and pumped back to the tailings pond.

Figure 5.1 Water Balance Components of TMF

5.1 DRAINAGE AREAS

The mine site was delineated into five watersheds using the available Light Detection and Ranging (LiDAR) topography data (CRA 2010) and future mine site operational drainage conditions, as shown in Drawing 2 and identified by area number and facility name. Each watershed was divided into land cover types comprising natural ground, prepared ground, ponds or other drainage features as listed in Table 5.1. Prepared ground is defined as paved ground, roads, industrial areas, or ground of low permeability. Drainage and sub-drainage areas may change as the mine develops.

Table 5.1 Drainage Areas

Drainage Areas		Sub Drainage Areas		
Facility	**Area (ha)**	**Collecting area**	**% of total**	**(m^2)**
① Mill Site	13.8	Natural ground	0	0
		Prepared ground	85.0	117,330
		Collection pond	0.07	90
		ROM pad	12.9	17,820
		Drainage Ditch	2.00	2,760
		TOTAL	**100**	**138,800**
② Tailings Management Facility (Tailings Pond & Water Reclaim Pond)	94.0	Natural ground	0.00	0
		Prepared ground	25.8	242,150
		Pond & wet tailings	36.9	347,200
		Dry tailings beach	36.2	340,130
		Seepage Collection	1.1	10,520
		TOTAL	**100**	**940,000**
③ Open Pit	40.7	Natural ground	0.92	3,760
		Prepared ground	99.08	403,240
		Collection pond	0.00	0
		TOTAL	**100**	**407,000**
④ Waste Rock Area	55.1	Natural ground	17.87	98,440
		Waste Rock and Overburden piles	79.49	438,000
		Collection pond	0.00	0
		Drainage Ditch	2.64	14,560
		TOTAL	**100**	**551,000**

Table 5.1 Drainage Areas

Drainage Areas		Sub Drainage Areas		
Facility	**Area (ha)**	**Collecting area**	**% of total**	**(m²)**
⑤ Polishing Pond	16.9	Natural ground	0.00	0
		Reclaimed ground	37.87	64,000
		Pond	62.13	105,000
		TOTAL	**100**	**169,000**
Total	**221.22**	**-**	**-**	**2,205,000**

Note: ① = denotes site drainage area number.

5.2 RUNOFF

Runoff coefficients were used to allocate precipitation into surface runoff from site areas considering evaporation and infiltration losses. The estimated streamflow coefficient is 0.67 based on an analysis of hydrometric data from the Beaverbank River near Kinsac. Streamflow represents all surface water flows originating from overland flow, direct precipitation runoff from waterbody surfaces, interflow and groundwater discharge. Table 5.2 presents the runoff coefficients used for various land use conditions.

The characteristics of the waste rock pile, such as height, length, compaction, and size and porosity of waste material, will change throughout operation as more ore is processed at the mine site. The initial abstraction of precipitation on the pile or the volume of water required to fill voids in the pile is dependent on the waste rock pile geometry. Higher initial abstraction will result in a loss of runoff, resulting in a lower runoff coefficient. Since the design of the waste rock piles has not yet been completed, a high runoff coefficient was selected for the purposes of the water balance, assuming runoff occurs beneath the shallow depth of waste rock.

Table 5.2 Runoff Coefficients by Land Cover Types

Land Use Type (Runoff Coefficient)						
Natural Ground	**Prepared Ground**	**Ponds and Wet Tailings**	**Dry Tailings Beach**	**Waste Rock Area**	**Run of Mill Stockpile**	**Open Pit**
(0.67)	(0.85)	(1.0)	(0.50)	(0.95)	(0.95)	(1.0)

Climate in the project area is continental with long cold winters and a short warm summer. During the cold months, there is very little surface runoff as precipitation (snow) accumulates on the ground. The accumulated precipitation (snow) is released during the freshet. This process is modeled by applying a monthly precipitation-runoff factor to precipitation to account for how much precipitation becomes surface runoff for a particular month. The remainder of the precipitation will be added to the next non-frozen month. The monthly precipitation-runoff factors are selected based on the project area and are provided in Table 5.3. Note that the starting month in the water balance model is selected as a month that generates 100% of runoff to properly model snowmelt and accumulation processes during cold months.

Table 5.3 Precipitation-Runoff Factor Used in Water Balance Model

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Runoff Factor	0.25	0.25	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5

5.3 SEEPAGE ESTIMATES

Seepage modelling of the tailings pond estimated total seepage volumes to be 1,802 m^3/d or 657,730 m^3/year (Stantec 2015b). This estimate is based on the ultimate dam height, assuming the tailings pond is full of water. It is assumed that 28.6% of the total tailings pond seepage or 100% of the shallow “drain” seepage is expected to be pumped back into the tailings pond via the shallow seepage collection system. The remainder of tailings seepage , approximately 418 m^3/d, will contribute to groundwater flow and discharge into the polishing pond. Seepage from the polishing pond is estimated to be 24 m^3/d or 8,760 m^3/yr that will contribute to groundwater flow and another 575 m^3/d or 209,875 m^3/yr of shallow drain flow that will reach the environment. Dewatering of the open pit is estimated from groundwater modelling to be 517 m^3/d or 188,705 m^3/yr (Stantec 2015a).

5.4 TAILINGS POND OPERATION

A key part of the tailings pond operation is to manage water in the facility such that the tailings facility has adequate capacity at all times to store, route, or otherwise handle runoff from extreme precipitation events. Water enters the tailings pond as process water in the tailings slurry, direct precipitation, and runoff from surrounding un-diverted catchments. Some of the water is lost in the tailings deposit as pore water in the tailings voids, and to evaporation and seepage. Water is recycled to the plant for reclaim use in the mill process. Process and tailings parameters assumed for the tailings pond water balance are presented in Table 5.4.

The drainage area for the tailings pond is approximately 96 ha, the pond and wet tailings area is approximately 42 ha, and the prepared area is approximately 28 ha.

Table 5.4 Process and Tailings Parameters (Stantec 2015b)

Item	Value	Unit
Process		
Milling rate	5,479	t/d
Resources mass (ore to mill)	9,300,000	t
Ore/tailings ratio [1]	1	-
Tailings mass	9,300,000	t
Deposition method	Sub-aerial spigot/end spill	-
Slurry discharge rate (water volume)	7,263	m^3/d
Tailings water reclaim rate	6,845	m^3/d
Mill freshwater make-up	399	m^3/d
Tailings[2]		
Slurry solids fraction of tailings discharged	0.43	-
Specific gravity (ore) (density of water/density of ore)	2.83	-
Void ratio (Volume of voids/volume of solids)	0.90-0.96	-
Deposited dry density (historical results)	1.49	T/m^3

Note:

1 Concentration of gold ore is negligible in comparison to the resultant tailings volume.

2 Tailings values may change by stage and the values presented reflect a conservative estimate.

5.5 OPERATIONAL WATER BALANCE RESULTS

5.5.1 Tailings Pond

5.5.1.1 Tailings Pond Release Rates

The tailings pond release rates to the treatment plant and the timing and period of release were determined considering the following:

- Available active water storage in the tailings pond, to increase storage capacity prior to spring melt conditions;
- Residence time in the tailings pond, to optimize natural cyanide degradation by volatilization and UV light;
- The ice-free period of the tailings water to identify direct exposure to sunlight required for CN degradation. Based on the review of climate records from Middle Musquodoboit climate station, ponded water is expected to be ice-free from the beginning of May to the beginning of November;
- Treatment capacity of the process water treatment facility is between 350 and 450 m^3/hr (Atlantic Gold 2007, Ausenco 2015); and,
- The release rate from the polishing pond to the constructed wetland and from the constructed wetland to the unnamed tributary to Scraggy lake. Because the polishing pond

has limited storage capacity, release to the constructed wetland will generally be equal to the inflow, providing limited retention.

Estimated average release rates from the tailings pond to the polishing pond for climate normal and wet/dry year conditions are presented in Table 5.5. The effluent discharge period would commence around the beginning of August and will last to the end of December or may be extended into February depending on ice cover and stream flows.

Table 5.5 Release Rates from the Tailings Pond to the Polishing Pond

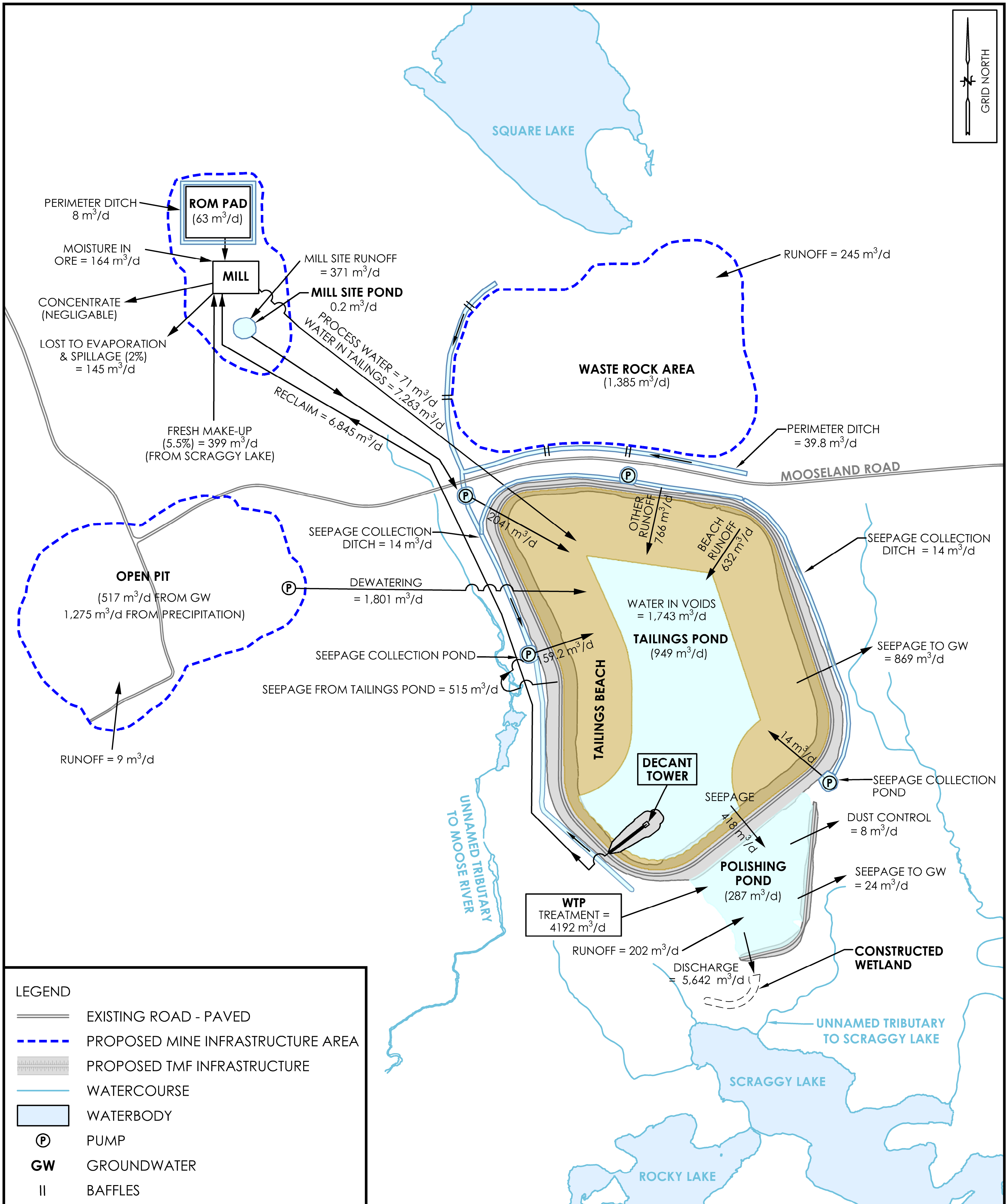
Scenario	Release Period	Average Release Rate (m^3/d)	Assumed Process Water Treatment Facility Capacity (m^3/d)
Climate Normal	7 months (No release in Jan, July, Aug, Nov or Dec)	10,002	8,400 - 10,800
Wet Year	8 months (No releae in Jan, July, August, Decl)	10,863	
Dry Year	3 months (Release in Aug – Oct)	8400	

5.5.1.2 Tailings Pond Water Balance Results

The tailings pond water balance results for climate normal, wet and dry year conditions are presented in Tables 5.6 to 5.8, respectively. Drawing 3 presents the mine process flow diagram for the climate normal scenario. Annual tailings pond surplus for climate normal, wet and dry year conditions are 1,511,251 m^3, 2,293,270 m^3 and 866,620 m^3, respectively. The calculation of cumulative surplus presents the storage in the system beginning in January and balanced at the end of the year.

Surplus water from the tailings pond will be pumped into the polishing pond via the treatment plant at release rates and periods of release specified in Table 5.5. Water is held in the tailings pond over the winter and spring for CN degradation and released from the tailings pond through the water treatment plant. It will take about 5 months to discharge the tailings pond surplus during climate normal conditions; 3 months to discharge the dry year conditions and about 7 months under wet year conditions.

The tailings pond receives direct runoff from precipitation events, runoff from the mill site, waste rock area, and open pit dewatering. A portion of the seepage loss from the tailings pond is collected in seepage collection ditches and pumped back into the tailings pond. Water is discharged to the tailings pond in the tailings slurry and some water is tied up in the tailings. Water is recycled from the tailings pond to the Mill for process use. Water is lost in the tailings pond through evaporation.



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

MINE PROCESS FLOW DIAGRAM

TOUQUOY MINE TAILINGS MANAGEMENT FACILITY
HALIFAX COUNTY, NOVA SCOTIA

Client:	DDV GOLD LTD.
Job No.:	121619250
Scale:	N.T.S.
Date:	2016 11 18
Dwn. By:	JL
App'd By:	RJ
Dwg. No.:	3
Rev. No.:	2.0

Stantec

V:\1216\active\121619250\1_geotechnical\3_drawings_logs\600_TOUQUOY\SHEET FILES\19250C-HYDR-003-REV2.dwg

Table 5.6 Tailings Pond Water Balance Summary - Climate Normal Conditions

Month	Flows (m³/month)										Surplus (Deficit) (m³)
	[1]Total Runoff directly to TMF	Water Discharge with Tailings Slurry	Water Tied up in Tailings	TMF Collected Seepage Water	Discharge from Open Pit	Discharge from Mill Site & Waste Rock Area	Evaporation	TMF Dam Seepage	Reclaim Water to Mill	Release to Polishing Pond	
January	35,644	225,165	-54,019	15,965	32,803	27,808	0	-39,897	-212,188	0	31,280
February	45,165	203,375	-48,792	14,420	35,733	35,236	0	-36,036	-191,654	-132,214	(74,767)
March	113,306	225,165	-54,019	15,965	69,354	88,395	0	-39,897	-212,188	-256,164	(50,085)
April	193,269	217,902	-52,277	15,450	106,472	150,778	0	-38,610	-205,344	-247,901	139,740
May	77,323	225,165	-54,019	15,965	52,419	59,227	-22,511	-39,897	-212,188	-256,164	(154,681)
June	73,215	217,902	-52,277	15,450	49,968	55,875	-25,541	-38,610	-205,344	-199,867	(109,230)
July	76,149	225,165	-54,019	15,965	51,866	57,972	-29,498	-39,897	-212,188	0	91,514
August	67,419	225,165	-54,019	15,965	47,758	51,425	-24,064	-39,897	-212,188	0	77,563
September	81,211	217,902	-52,277	15,450	53,732	62,515	-17,278	-38,610	-205,344	-256,164	(138,863)
October	85,613	225,165	-54,019	15,965	56,320	66,299	-10,091	-39,897	-212,188	-181,794	(48,628)
November	100,358	217,902	-52,277	15,450	62,743	78,294	0	-38,610	-205,344	0	178,517
December	47,355	225,165	-54,019	15,965	38,314	36,944	0	-39,897	-212,188	0	57,638
Annual	**996,028**	**2,651,136**	**-636,036**	187,975	**657,482**	**770,767**	**-128,984**	**-469,755**	**-2,498,347**	**-1,530,267**	**0**

Note: [1] Direct runoff from precipitation falling in TMF drainage area.

Table 5.7 Tailings Pond Water Balance Summary – Wet Year Conditions

Month	Flows (m^3/month)										Surplus (Deficit) (m^3)
	[1]Total Runoff directly to TMF	Water Discharge with Tailings Slurry	Water Tied up in Tailings	TMF Collected Seepage Water	Discharge from Open Pit	Discharge from Mill Site & Waste Rock Area	Evaporation	TMF Dam Seepage	Reclaim Water to Mill	Release to Polishing Pond	
January	48,079	225,165	-54,019	15,965	38,655	37,509	0	-39,897	-212,188	0	59,269
February	60,929	203,375	-48,792	14,420	43,152	47,534	0	-36,036	-191,654	-302,400	(209,472)
March	152,834	225,165	-54,019	15,965	87,958	119,233	0	-39,897	-212,188	-334,800	(39,751)
April	260,675	217,902	-52,277	15,450	138,196	203,365	0	-38,610	-205,344	-324,000	215,357
May	104,320	225,165	-54,019	15,965	65,125	80,289	-22,511	-39,897	-212,188	-334,800	(172,552)
June	98,744	217,902	-52,277	15,450	61,984	75,792	-25,541	-38,610	-205,344	-324,000	(175,900)
July	102,706	225,165	-54,019	15,965	64,365	78,690	-29,498	-39,897	-212,188	0	151,289
August	90,968	225,165	-54,019	15,965	58,841	69,797	-24,064	-39,897	-212,188	0	130,568
September	109,529	217,902	-52,277	15,450	67,059	84,608	-17,278	-38,610	-205,344	-324,000	(142,961)
October	115,471	225,165	-54,019	15,965	70,373	89,593	-10,091	-39,897	-212,188	-334,800	(134,429)
November	135,352	217,902	-52,277	15,450	79,213	105,595	0	-38,610	-205,344	-33,486	223,794
December	63,861	225,165	-54,019	15,965	46,083	49,821	0	-39,897	-212,188	0	94,790
Annual	**1,343,467**	**2,651,136**	**-636,036**	**187,975**	**821,004**	**1,041,826**	**-128,984**	**-469,755**	**-2,498,347**	**-2,312,286**	**0**

Table 5.8 Tailings Pond Water Balance Summary – Dry Year Conditions

Month	Flows (m³/month)										Surplus (Deficit) (m³)
	[1]Total Runoff directly to TMF	Water Discharge with Tailings Slurry	Water Tied up in Tailings	TMF Collected Seepage Water	Discharge from Open Pit	Discharge from Mill Site & Waste Rock Area	Evaporation	TMF Dam Seepage	Reclaim Water to Mill	Release to Polishing Pond	
January	25,401	225,165	-54,019	15,965	27,982	19,817	0	-39,897	-212,188	0	8,225
February	32,183	203,375	-48,792	14,420	29,623	25,107	0	-36,036	-191,654	-76,518	(48,292)
March	80,736	225,165	-54,019	15,965	54,025	62,987	0	-39,897	-212,188	-148,254	(15,480)
April	137,665	217,902	-52,277	15,450	80,302	107,399	0	-38,610	-205,344	-143,472	119,015
May	55,094	225,165	-54,019	15,965	41,957	41,886	-22,511	-39,897	-212,188	-148,254	(96,803)
June	52,160	217,902	-52,277	15,450	40,059	39,449	-25,541	-38,610	-205,344	-115,673	(72,425)
July	54,214	225,165	-54,019	15,965	41,543	40,859	-29,498	-39,897	-212,188	0	42,143
August	48,052	225,165	-54,019	15,965	38,642	36,316	-24,064	-39,897	-212,188	0	33,971
September	57,882	217,902	-52,277	15,450	42,752	44,316	-17,278	-38,610	-205,344	-148,254	(83,461)
October	60,963	225,165	-54,019	15,965	44,719	47,069	-10,091	-39,897	-212,188	-105,212	(27,527)
November	71,527	217,902	-52,277	15,450	49,174	55,802	0	-38,610	-205,344	0	113,625
December	33,746	225,165	-54,019	15,965	31,910	26,327	0	-39,897	-212,188	0	27,008
Annual	**709,625**	**2,651,136**	**-636,036**	**187,975**	**522,688**	**547,335**	**-128,984**	**-469,755**	**-2,498,347**	**-885,637**	**0**

5.5.2 Polishing Pond

5.5.2.1 Polishing Pond Release Rates

Monthly release rates from the polishing pond to the constructed wetland are presented in Tables 5.9 for climate normal, wet and dry year conditions, respectively. A manually operated outlet control structure will be used to discharge the water to the constructed wetland.

No assimilative capacity study has been conducted to assess the effects of the polishing pond water on the downstream receiving water (unnamed tributary to Scraggy Lake and Scraggy Lake). The polishing pond release rates were determined to provide a continuous release year round mimicking inflows, and allowing the minimum retention time of 7 days, assuming complete mixing in the polishing pond. The release rates are compared to the stream flow rates from the environmental water balance for the approximately 110 ha pre-development watershed area, allocated monthly based on the Beaverbank River Near Kinsac hydrometric station. The polishing pond has limited storage capacity to attenuate flows over a long period of time. The release rates represent a total of the inflows received from the tailings pond plus the direct precipitation in the polishing pond watershed area less evapotranspiration losses.

Table 5.9 Polishing Pond Maximum Monthly Release Rates to Unnamed Tributary to Scraggy Lake

Month	Stream Flow (m^3)			Polishing Pond Release Rates (m^3)		
	Climate Normal	Wet Year	Dry Year	Climate Normal	1:100 Wet Year	1:100 Dry Year
January	107,129	164,687	61,993	-15,020	-24,086	-6,893
February	77,630	119,328	44,915	-160,320	-300,513	-73,574
March	117,000	179,769	67,649	-308,096	-438,052	-141,392
April	167,126	256,844	96,594	-302,694	-443,791	-138,913
May	88,498	135,963	51,125	-269,572	-362,763	-123,713
June	48,131	74,081	27,836	-216,797	-318,470	-99,493
July	28,501	43,806	16,524	-15,020	-24,086	-6,893
August	28,501	43,806	16,524	-15,020	-24,086	-6,893
September	28,501	43,806	16,524	-300,046	-354,125	-137,698
October	58,001	89,164	33,492	-217,553	-361,194	-99,840
November	117,000	179,769	67,649	-20,497	-32,076	-9,407
December	117,000	179,769	67,649	-15,020	-24,086	-6,893
Annual	**983,018**	**1,510,791**	**568,473**	**-1,855,655**	**-2,707,327**	**-851,601**

5.5.2.2 Polishing Pond Water Balance Results

The polishing pond water balance results for climate normal, wet and dry year conditions are presented in Tables 5.10 to 5.12, respectively. Annual polishing pond surplus for climate normal, wet and dry year conditions are 1,680,662 m³, 2,537,971 m³ and 977,335 m³ respectively. The polishing pond water will be released into to an unnamed tributary to Scraggy Lake at release rates specified in Table 5.9 throughout the year depending on climate conditions. As expected with approximately 40% larger runoff area diverted to the discharge point, the polishing pond releases water at a rate higher than the baseline (predevelopment) conditions.

It is anticipated that water discharged from the water treatment plant will meet MMER guideline criteria for all parameters (CRA 2012).

Table 5.10 Polishing Pond Water Balance Summary - Climate Normal Conditions

Month	Flows (m³/month)						Surplus (Deficit) (m³)
	Total Runoff	Discharge from TMF	Water used for Dust Control	Evaporation	Seepage	Release to Constructed Wetland	
January	7,745	0	0	0	-12,214	-15,020	4,939
February	9,814	0	0	0	-11,032	-160,320	(7,261)
March	24,619	0	0	0	-12,214	-308,096	(15,099)
April	41,994	0	0	0	-11,820	-302,694	(980)
May	16,801	0	310	-6,608	-12,214	-269,572	9,309
June	15,908	0	467	-7,497	-11,820	-216,797	3,769
July	16,546	0	620	-8,658	-12,214	-15,020	5,701
August	14,649	298,872	713	-7,063	-12,214	-15,020	5,493
September	17,646	289,231	600	-5,072	-11,820	-300,046	(18,888)
October	18,602	298,872	310	-2,962	-12,214	-217,553	(7,595)
November	21,806	289,231	0	0	-11,820	-20,497	13,129
December	10,289	298,872	0	0	-12,214	-15,020	7,483
Annual	**216,417**	**1,475,079**	**3,020**	**-37,860**	**-143,810**	**-1,855,655**	**0**

Table 5.11 Polishing Pond Water Balance Summary – Wet Year Conditions

Month	Flows (m³/month)						Surplus (Deficit) (m³)
	Total Runoff	Discharge from TMF	Water used for Dust Control	Evaporation	Seepage	Release to Constructed Wetland	
January	10,447	330,047	0	0	-12,214	-24,086	(1,425)
February	13,239	0	0	0	-11,032	-300,513	26,157
March	33,208	0	0	0	-12,214	-438,052	(57,830)
April	56,640	298,107	0	0	-11,820	-443,791	(51,332)
May	22,667	0	310	-6,608	-12,214	-362,763	0
June	21,455	0	420	-7,497	-11,820	-318,470	30,888
July	22,316	0	465	-8,658	-12,214	-24,086	1,321
August	19,766	330,047	713	-7,063	-12,214	-24,086	118
September	23,798	319,401	600	-5,072	-11,820	-354,125	(178)
October	25,090	330,047	310	-2,962	-12,214	-361,194	7,637
November	29,409	319,401	0	0	-11,820	-32,076	42,639
December	13,876	330,047	0	0	-12,214	-24,086	2,004
Annual	**291,909**	**2,257,098**	**2,818**	**-37,860**	**-143,810**	**-2,707,327**	**1**

Table 5.12 Polishing Pond Water Balance Summary – Dry Year Conditions

Month	Flows (m³/month)						Surplus (Deficit) (m³)
	Total Runoff	Discharge from TMF	Water used for Dust Control	Evaporation	Seepage	Release to Constructed Wetland	
January	5,519	0	0	0	-12,214	-6,893	(13,588)
February	6,993	0	0	0	-11,032	-73,574	(1,096)
March	17,542	0	0	0	-12,214	-141,392	12,190
April	29,912	0	0	0	-11,820	-138,913	22,650
May	11,971	0	558	-6,608	-12,214	-123,713	17,133
June	11,333	0	750	-7,497	-11,820	-99,493	7,446
July	11,780	0	930	-8,658	-12,214	-6,893	(16,916)
August	10,441	279,825	3,100	-7,063	-12,214	-6,893	(18,830)
September	12,577	270,798	750	-5,072	-11,820	-137,698	5,491
October	13,246	279,825	465	-2,962	-12,214	-99,840	2,978
November	15,542	0	0	0	-11,820	-9,407	(5,685)
December	7,332	0	0	0	-12,214	-6,893	(11,775)
Annual	**154,188**	**830,449**	**6,553**	**-37,860**	**-143,810**	**-851,601**	**0**

6.0 OPERATIONAL DESIGN CONSIDERATIONS

6.1 TAILINGS POND DESIGN CONSIDERATIONS

The TMF is proposed to be constructed in six annual stages: commissioning and Stage 1 through 5. The ultimate pond and wet tailings area will be approximately 240,500 m², based on pond dimensions of roughly 370 x 650 m. The minimum operational water volume to satisfy storage requirements (i.e., the inactive storage volume) was calculated by summing the following:

- a minimum 1 m water depth (approximately 80,000 m³, based on pond dimensions of roughly 400 m x 200 m) at the bottom to prevent the re-suspension of sediments into the water column by process reclaim pumps;
- a minimum of 653,500 m³ of storage for process water to account for a 4 month water deficit scenario in the tailings pond (as requested by Atlantic Gold Corporation); and
- a minimum of 1 m for ice-cover depth (approximately 240,500 m³) during the winter period.

Table 6.1 and Figure 6.1 present the total storage (i.e., active storage plus inactive storage) representing the minimum operational water storage volume for an average year of operation in the tailings pond. The stage-storage curve for each year of operation has not been finalized and therefore storage in the tailings pond has not been related to water level. An operating curve for the tailings pond will be developed and reported as part of a detailed hydraulic design.

Table 6.1 Summary of Water Storage Volumes for the Tailings Pond (m³/yr)

Watershed Parameter	1:100 Dry Climate Condition	Climate Normal Condition	1:100 Wet Climate Condition
Active Storage	568,554	59269	804,725
Inactive Storage	975,000	975,000	975,000
Total Storage	1,121,169	1,021,169	1,181,093

Note: [a] Assuming initial water storage in the pond in January to maintain inactive storage volumes throughout the year. Required inactive storage is reported in table for winter (frozen)_months, required storage of 734,500 in no frozen months.

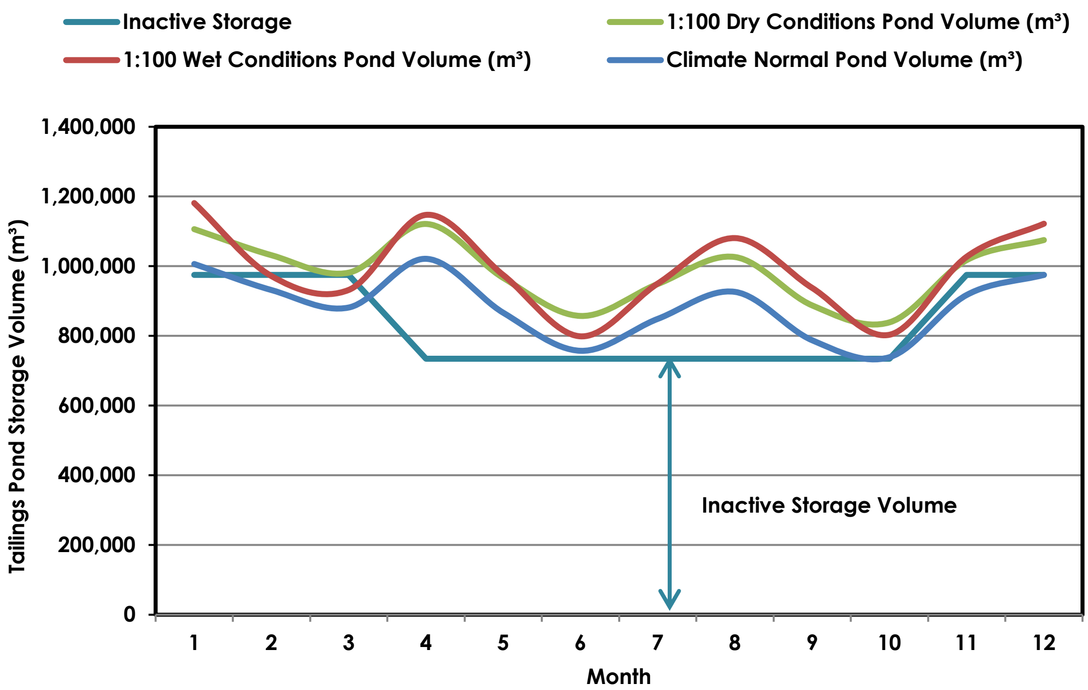


Figure 6.1 Storage Volumes for the Tailings Pond (m^3)

6.2 POLISHING POND DESIGN CONSIDERATIONS

The polishing pond will have an outlet control structure, emergency spillway and downstream flood conveyance channel. The area of the polishing pond is roughly 150,000 m^2. The minimum operational water volume to satisfy storage requirements (*i.e.*, the inactive storage volume) was calculated by summing the following:

- a minimum 1 m water depth (approximately 8,208 m^3) at the bottom to prevent the re-suspension of sediments into the water column during release from the pond; and
- a minimum of 1 m for ice-cover depth (approximately 166,540 m^3) during the winter period.

Table 6.2 and Figure 6.2 presents the total storage (active storage + inactive storage, representing the minimum operational water storage volume for an average year of operation in the polishing pond. The stage-storage curve for each year of operation has not been finalized and therefore storage in the polishing pond has not been related to water level. An operating curve for the tailings pond will be developed and reported in detailed hydraulic design.

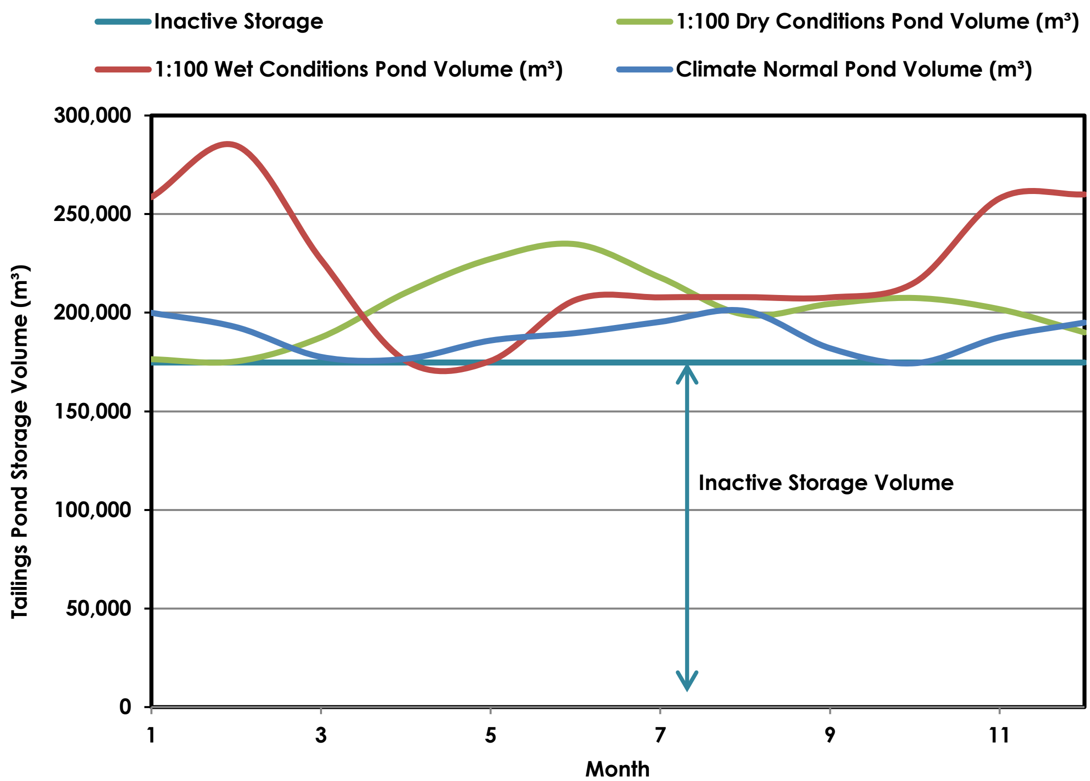


Figure 6.2 Storage Volumes for the Polishing Pond (m³)

Table 6.2 Summary of Storage Volumes for the Polishing Pond (m3/yr)

Watershed Parameter	1:100 Dry Climate Condition	Climate Normal Condition	1:100 Wet Climate Condition
Active Storage	47,736	5,871	24,732
Inactive Storage	175,000	175,000	175,000
Total Storage	234,736	200,871	284,732

6.3 FUTURE DESIGN CONSIDERATIONS

The water balance will be used to inform TMF water management and design of associated facilities. Major considerations in future design are highlighted below.

The proposed TMF will include a tailings dam that must incorporate current regulatory requirements into the design, including the CDA (2014) design standards. The preliminary hazard potential classification for the TMF was assessed as "significant to high hazard" by Golder (2007a). The classification was selected based on the short term loss of fish and fish habitat and the potential cost of clean-up of downstream receivers (Golder 2007a). As part of the feasibility level tailings management facility design, Stantec reviewed the dam classification report and have used the classification of "High" (Stantec 2015b). Design of the tailings dam crest and invert elevation of associated spillways are determined by considering the Inflow Design Flood (IDF), the Environmental Design Flood (EDF), the Normal Operating Water Level, (NOWL) the Low Operating Water Level (LOWL) and freeboard.

The design criteria for the TMF water management are listed in Table 6.3 and introduced in the subsequent sections below. The development of the design criteria will be covered in a future hydraulic design report.

Table 6.3 Designed Criteria for TMF Water Management

CDA Hazard Classification	IDF	Selected EDF	Selected NOWL	Selected LOWL
High	1/3 between the 1:1000 and PMF [1]	Climate Normal + 1:100 year storm conditions or 1:100 Wet Year condition[2]	Operating Storage of 750,000 m^3 for process water reuse	Inactive Storage Condition

Source:
[1] CDA (2014)
[2] Golder (2007a)

6.3.1 Inflow Design Flood

The IDF is the most severe inflow flood (peak, volume, shape, duration, timing) for which a dam and its associated facilities are designed (CDA 2014). As per the CDA requirement for a High hazard classification, the IDF should be 1/3 between the 1:1000 year event and the probable maximum flood (PMF). The PMF is a flood that results from a precipitation event known as the probable maximum precipitation (PMP). The PMP is defined as the most extreme precipitation event physically possible in the area. The PMP was selected in a supporting Dam Break Flooding Study and a preliminary design of the tailings management area both completed by Golder (2007c). Golder reported that the PMF event was approximately 493 mm in 24 hours.

6.3.2 Environmental Design Flood

The EDF is the most severe flood that is to be managed without release of untreated water to the environment (CDA 2014). Retention of water during the EDF requires storage capacity above the NOWL (CDA 2014). An emergency spillway will enhance the safe operation of the TMF by increasing the range of inflows that can be managed in extreme circumstances. The EDF must take into account the water quality that is being stored and could be released, regulatory requirements, frequency of overflow events, the rate and duration of overflows, the environmental sensitivity of the receiving environment, downstream flow in the receiver, downstream mixing characteristics.

As previously defined in the Operation Maintenance and Surveillance Manual (Golder 2007b), the EDF is set as the 1:100 year climate wet conditions or the climate normal conditions plus a 1:100 year precipitation storm, whichever scenario requires the greatest amount of storage volume. Now that more water quality predictions are available, the EDF flow event can be set based on water quality opposed to water quantity. The EDF can be defined by the required dilution of water quality parameters of concern predicted to be in the tailings pond water. The dilution should be sufficient to meet MMER effluent criteria in the release of untreated water above the EDF, as recommended by CDA (2014).

6.3.3 Operating Water Levels

Water levels will be determined when the stage:storage curves for the TMF are determined. The surplus/deficit volume from the water balance analysis can be compared to the respective stage-storage curves of the ponds to determine operating water levels and required height of spillway invert. Based on the hydraulic assessment the normal operating water levels will range within the inactive storage volume surplus, the equalization volume of water required to manage the water in the pond with the given operating conditions.

7.0 SUMMARY

Operational water management for the Atlantic Gold tailings management facility was developed considering the reclaim water requirements, *MMER* effluent water quality criteria, reducing to the extent possible, the water intake from freshwater sources, the water inventory at the site and the environmental impacts to receiving waterbodies.

The tailings pond will receive runoff from the mill site and waste rock piles, and the open pit dewatering during rainfall events at or below 1:25 year. Higher precipitation events falling on these contributing areas, such as the IDF storm will be diverted away from the TMF. The tailings pond will withhold the runoff from the TMF catchment, tailings discharge slurry and the water retained in the tailings mass. The tailings pond will simultaneously act as a sedimentation and cyanide (CN) degradation pond where the tailings effluent will be retained in the pond when active storage is available during the ice free season to promote the natural degradation of CN.

Tailings water will be reclaimed through a decant structure and supplied by pipeline to the mill for process water use. The remainder of the tailings water will be decanted to a water treatment plant or discharged through an emergency spillway during heavy rainfall events. The effluent discharge period would commence around the beginning of August and will last to the end of December or may be extended into February depending on antecedent seasonal precipitation, ice cover and stream flows. Water is held in the tailings pond over the winter and spring for CN degradation and released from the tailings pond through the water treatment plant.

The polishing pond will receive discharge from the treatment plant, under climate normal conditions, between the months of August and December, inclusive. Additional settling of sediments will occur in the polishing pond, with a target retention time between 7 and 30 days. The polishing pond will have a constant base flow release of water, representing 25% of the mean annual flow for the Beaverbank River Near Kinsac hydrometric station; with the remainder mimicking inflows maintaining a minimum of 7 day retention time. This polishing pond will discharge to a constructed wetland and final release to the receiving environment, the unnamed tributary to Scraggy Lake and directly to Scraggy Lake.

7.1 LIMITATIONS

The water balance is based on design components that are currently in development, the available data and assumptions presented in this report. The water balance does not reflect changes in the operation of the mine from commissioning to Stage 1 through 5, and the final stage-storage curves of the TMF and polishing ponds.

Uncertainty in a water balance commonly arises in the selection of runoff coefficients. These coefficients are dependent on the climatic and operational conditions, the degree of saturation and characteristics of the soil, and the vegetation cover, if any. Runoff coefficients should be reviewed as revised to calibrate the runoff model to flow rates observed at the site.

8.0 REFERENCES

Atlantic Gold. 2007. Prefeasibility Study Process Design Criteria – Effluent Treatment. Rev B. May 17, 2007.

Ausenco. 2008. Touquoy Gold Project Cyanide Destruction Process Overview. 1822RPT0001 Revision Number 0. June 13, 2015. Vancouver, BS.

Ausenco. 2015. NI 43-101 Technical Report. Feasibility Study for Moose River Consolidated Project, Nova Scotia. Prepared for Atlantic Gold Corporation. August 13, 2015. Vancouver, BS.

Black, P.E. 1996. Thornthwaite Water Budget, Software Manual, Professional Version.

Canadian Dam Association (CDA), 2014. Canadian Dam Safety Guidelines and Technical Bulletins.

CBCL Limited Consulting Engineers (CBCL). 2007. Touquoy Gold Effluent Treatment Facilities. Preliminary Engineering Study. CBCL Final Report 070836.

Conestoga-Rovers & Associates (CRA). 2007. Environmental Assessment Registration Document for the Touquoy Gold Project, Moose River Gold Mines, Nova Scotia. Prepared for DDV Gold Limited. March 2007. Dartmouth, NS.

Conestoga-Rovers & Associates (CRA). 2010. Light Detection and Ranging Data for the Mine Site.

Conestoga-Rovers & Associates (CRA). 2012. Industrial Approval Application and Supporting Documentation. Touquoy Gold Project Moose River Gold Mines, NS.

Conservation Ontario. 2005. Establishing Environmental Flow Requirements (Synthesis Report)

Department of Fisheries and Oceans Canada (DFO). 2002. Metal Mining Effluent Regulations. P.C. 2002-987. June 6, 2002. Canada Gazette Part II, Vol. 136, No. 13. SOR/202 202 to 226 and SI/2002-90 to 96. Pages 1246 to 1543. Ottawa.

Environment Canada. 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring (EEM) Technical Guidance Document. Available online at: https://ec.gc.ca/Publications/D175537B-24E3-46E8-9BB4-C3B0D0DA806D%5CCOM-1434---Tec-Guide-for-Metal-Mining-Env-Effects-Monitoring_En_02.pdf.

Environment Canada. 2013. Environment Canada HYDAT Database. Water Survey of Canada hydrometric data for Beaverbrook River Near Kinsac. Available at: http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm.

Environment Canada. 2015a. Climate, Canadian Climate Normals, 1981-2010 Canadian Climate Normals & Averages. Middle Musquodoboit, Nova Scotia. Website: http://climate.weather.gc.ca/climate_normals/index_e.html. Reviewed on January 6, 2016.

Environment Canada. 2015b. Climate, Canadian Climate Normals, 1981-2010 Canadian Climate Normals & Averages. Truro, Nova Scotia. Website: http://climate.weather.gc.ca/climate_normals/index_e.html. Reviewed on December 5, 2015.

Environment Canada. 2015c. Climate. Website: http://climate.weatheroffice.gc.ca. Reviewed on January 20, 2016. Updated: August 18, 2010.

Fisheries and Oceans Canada (DFO). 2009. Towards a better understanding of the natural flow regimes and streamflow characteristics of rivers of the Maritime Provinces. Canadian Technical Report of Fisheries and Aquatic Sciences 2843. Prepared by Caissie, C. & Robichaud, S. Gulf Region, Diadromous Fish Section, Moncton, NB.

Golder Associates Ltd (Golder). 2006. Operating Data, Hydrology & Deterministic Site Wide Flow (Water Balance) Model, Feasibility Study. July 5, 2006. Prepared for Atlantic Gold.

Golder Associates Ltd (Golder). 2007a. Touquoy Gold Project Feasibility Study. Tailings Disposal Facility, Nova Scotia. Ontario. May 2007. Prepared for Atlantic Gold.

Golder Associates Ltd (Golder). 2007b. Report on Operation Maintenance and Surveillance Manual Touquoy Mine, Tailings Management Facility, NS. December 2007. Prepared for Atlantic Gold. Mississauga, Ontario.

Golder Associates Ltd (Golder). 2007c. Dam Break Flooding Study. Atlantic Gold Tailings Management Area Touquoy, Nova Scotia. Ontario. September 2007. Prepared for Atlantic Gold.

Health Canada (2014). Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. Website: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/pubs/water-eau/sum_guide-res_recom/sum_guide-res_recom_2014-10_eng.pdf.

Malstrom, V.H, 1969. A New Approach to the Classification of Climate. J. Geogr. 68:351-357.

Mather, J.R. 1969. "The Average Annual Water Balance of the World". Proceedings: Symposium on Water Balance in North America, American Water Resources Association, Banff, Alberta, Canada, Series No. 7:29-40.

Mather, J.R. 1978. The Climatic Water Balance in Environmental Analysis. D.C. Heath and Company, Lexington, Massachusetts, U.S.A.

Mather, J.R.1979. Use of the Climatic Water Budget to Estimate Streamflow. National Technical Information Service (NTIS), Report #: Pb80-180896.

Merit Engineers. 2006. Section 10 Water Management Touquoy Gold Project Definitive Feasibility Study. Commissioned by Atlantic Gold.

Nova Scotia Environment. 2012. Approval – Province of Nova Scotia Environment Act, S.N.S. 1994-95, c.1. For approval holder D.D.V. Gold Ltd. Approval No: 2012-084244. Bedford, NS.

Ontario Ministry of the Environment (OMOE). 1995. Hydrogeological Technical Information Requirement for Land Development Applications.

Ontario Ministry of the Environment (OMOE). 2003. Stormwater Management Planning and Design Manual, Queen's Printer for Ontario. Ontario.

Stantec Consulting Limited. 2010. Final Report Constructed Wetland Design Basis Report for Industrial Approval. Dartmouth, NS. April 2010. Prepared for DDV Gold Limited, Moose River, NS.

Stantec Consulting Limited. 2015a. Groundwater Modelling to Support Evaluation of Disposal of Beaver Dam Tailings in the Touqouy Pit. August 2015. Fredericton, NB. Prepared for Atlantic Gold Corp.

Stantec Consulting Limited. 2015b. Feasibility Level Tailings Management Facility Design – Touquoy Mine. July 2015. Fredericton, NB. Prepared for Atlantic Gold Corp.

Thomas, John. 2016. Atlantic Gold Corporation. Personal Communication. Email Correspondence on February 3, 2016.