ARTEMIS GOLD INC

Memo

Date: 16 September 2022

Reference: Blackwater Gold – Follow-up Monitoring Programs

Subject: Federal Decision Statement Condition 3.15

1. INTRODUCTION

The Blackwater Gold Project (Project) received a Decision Statement (DS) on April 15, 2019, under the *Canadian Environmental Assessment Act, 2012* (CEA Agency 2019) and an Environmental Assessment Certificate #M19-01 on June 21, 2019 under the 2002 *Environmental Assessment Act* (EAO 2019).

Condition 3.15 of the DS requires Blackwater Gold (BW Gold) to develop a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to adverse environmental effects of the Project on fish habitat in Davidson Creek, Creek 661, and Chedakuz Creek. The condition is as follows:

> *The Proponent shall develop, in consultation with Indigenous groups and other relevant authorities, a follow-up program to verify the accuracy of the environmental assessment and determine the effectiveness of the mitigation measures as it pertains to adverse environmental effects of the Designated Project on fish habitat in Davidson Creek, Creek 661 and Chedakuz Creek. The Proponent shall develop the follow-up program prior to construction and shall implement the follow-up program during all phases of the Designated Project. The Proponent shall apply conditions 2.9 and 2.10 when implementing the follow-up program. As part of the follow-up program, the Proponent shall:*
>
> - *monitor water flows in Davidson Creek during the open water season from construction until decommissioning, and temperature continuously from construction until decommissioning [3.15.1];*
> - *monitor water quality in Davidson Creek, Creek 661 and Chedakuz Creek for contaminants of potential concern, including those identified in Table 5 of the environmental assessment report, during all phases of the Designated Project [3.15.2]; and*
> - *monitor, during all phases of the Designated Project, groundwater quality and quantity downstream of the tailings storage facility site D, open pit, west waste rock dump and low-grade ore stockpile to confirm that groundwater quantity and quality parameters are at or below the values identified by the Proponent in the modelled predictions in Section 5 of Blackwater Gold Project: Additional Water Quality Model Sensitivity Scenario (July 20, 2017) and Section 3 of Blackwater Gold Project: Water Treatment Responses for Comments 1266, 1270, 1271, 1272, and 1273 (February 15, 2017) for nitrite and contaminants of potential concern, and to verify the effectiveness of water management measures [3.15.3].*

Conditions 2.9 and 2.10 are as follows:

2.9 The Proponent shall, where a follow-up program is a requirement of a condition set out in this Decision Statement:

- *conduct the follow-up program according to the information determined pursuant to condition 2.5 [2.9.1];*
- *undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s) [2.9.2];*
- *determine whether modified or additional mitigation measures are required based on the monitoring and analysis undertaken in accordance with condition 2.9.2 [2.9.3]; and*
- *if modified or additional mitigation measures are required pursuant to condition 2.9.3, develop and implement these mitigation measures in a timely manner and monitor them in accordance with condition 2.9.2 [2.9.4].*

2.10 Where consultation with Indigenous groups is a requirement of a follow-up program, the Proponent shall discuss the follow-up program with Indigenous groups and determine, in consultation with Indigenous groups, opportunities for their participation in the implementation of the follow-up program, including the analysis of the follow-up results and whether modified or additional mitigation measures are required, as set out in condition 2.9.

The Federal DS also requires that each follow-up program required by the DS also includes adaptive management (DS Condition 2.5) where the Proponent is required to *have a Qualified Professional, where such a qualification exists for the subject matter of the follow-up program, determine, as part of the development of each follow-up program and in consultation with the party or parties being consulted during the development, the following information:*

- *the follow-up activities that must be undertaken by a qualified individual [2.5.1];*
- *the methodology, location, frequency, timing and duration of monitoring associated with the follow-up program [2.5.2];*
- *the scope, content, format and frequency of reporting of the results of the follow-up program [2.5.3];*
- *the levels of environmental change relative to baseline conditions that would require the Proponent to implement modified or additional mitigation measure(s), including instances where the Proponent may require Designated Project activities to be stopped [2.5.4]; and*
- *the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the follow-up program shows that the levels of environmental change referred to in condition 2.5.4 have been reached or exceeded [2.5.5].*

An Aquatic Effects Monitoring Program (AEMP) has been developed for the Project to monitor the aquatic receiving environment (Figure 1-1). The purpose of the AEMP is to provide the information on the aquatic receiving environment necessary to achieve the following objectives:

- Detect Project-related effects on the aquatic ecosystem components (including surface water quality);
- Confirm water quality predictions and effects assessments, as presented in the Joint *Mines Act* and *Environmental Management Act* Permit Application (Joint Application; submitted April 2022);
- Meet permit and regulatory requirements for receiving environment quality;
- Assess the performance of mitigation and management measures; and
- Provide the framework to identify how monitoring results will inform adaptive management decision making to prevent or minimize the potential for Project-related effects.

This memorandum describes the monitoring and reporting components of the AEMP Plan that will address the DS conditions 3.15.1, 3.15.2 and the associated follow-up program DS conditions 2.5, 2.6, 2.9, and 2.10. The AEMP Plan is applicable to Construction and Operations; a Closure and Post-Closure follow-up program will be developed towards the end of Operations phase and will be informed by the final Reclamation and Closure Plan and monitoring data collected during Operations. Requirements related to monitoring flows and water temperature in Davidson Creek (as per DS condition 3.15.1) are provided in Section 2, while monitoring related to surface water quality (as per DS condition 3.15.2) are provided in Section 3.

The Mine Site Water and Discharge Monitoring and Management Plan (MSDP) details groundwater quantity and quality monitoring to be completed during Construction and Operations phases (Figures 1-2 to 1-5). As with the AEMP Plan, continued monitoring during Closure and Post-Closure will be further informed by the final Reclamation and Closure Plan and monitoring data collected during Operations. Monitoring requirements related to groundwater quality and quantity are provided in Section 4.

This version of the follow up program for DS Condition 3.15 is being submitted in accordance with the DS Condition 2.15 requirement to submit the document prior to beginning construction. Although limited early works construction activities (e.g., site preparation activities such as site clearing, grubbing) will be initiated at the Project shortly, these activities will be limited in scale, will not be altering water flows or requiring changes in water management, and do not include instream works. This version of the follow up program includes placeholders or templates for information that is not yet available (e.g., *Fisheries Act* Authorization, Trigger Response Plan expected to be required as part of the *Environmental Management Act* effluent discharge authorization, updated water quality modelling, etc.). It is anticipated that this version of the follow up program will be updated prior to construction activities that would have the potential to meaningfully affect water flows, water temperature, water quality, or groundwater quality or quantity and prior to reporting being required under the follow up program.

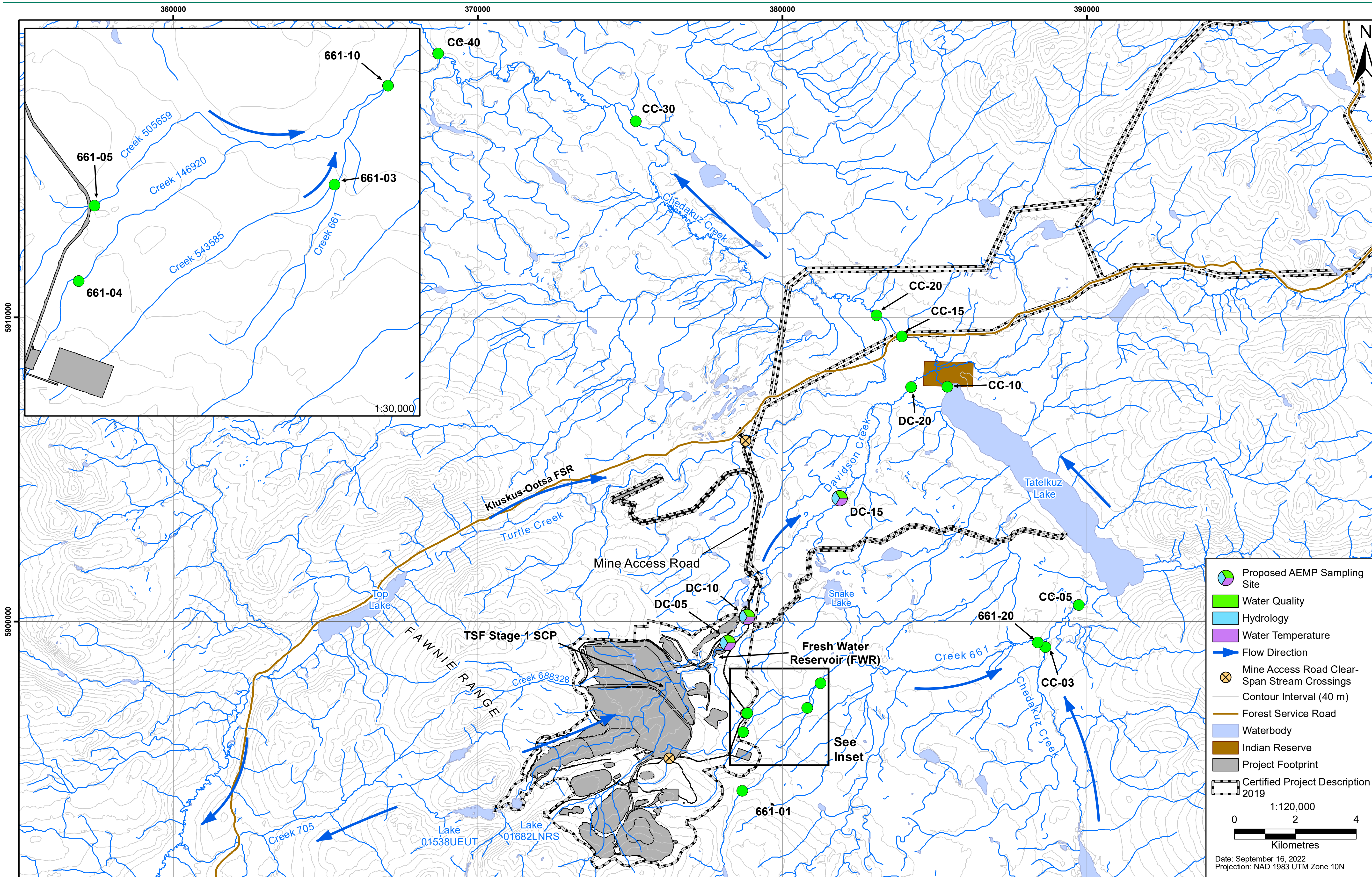

Figure 1-1: Aquatic Effects Monitoring Program Sampling Locations, Federal Decision Statement Condition 3.15.1 and 3.15.2

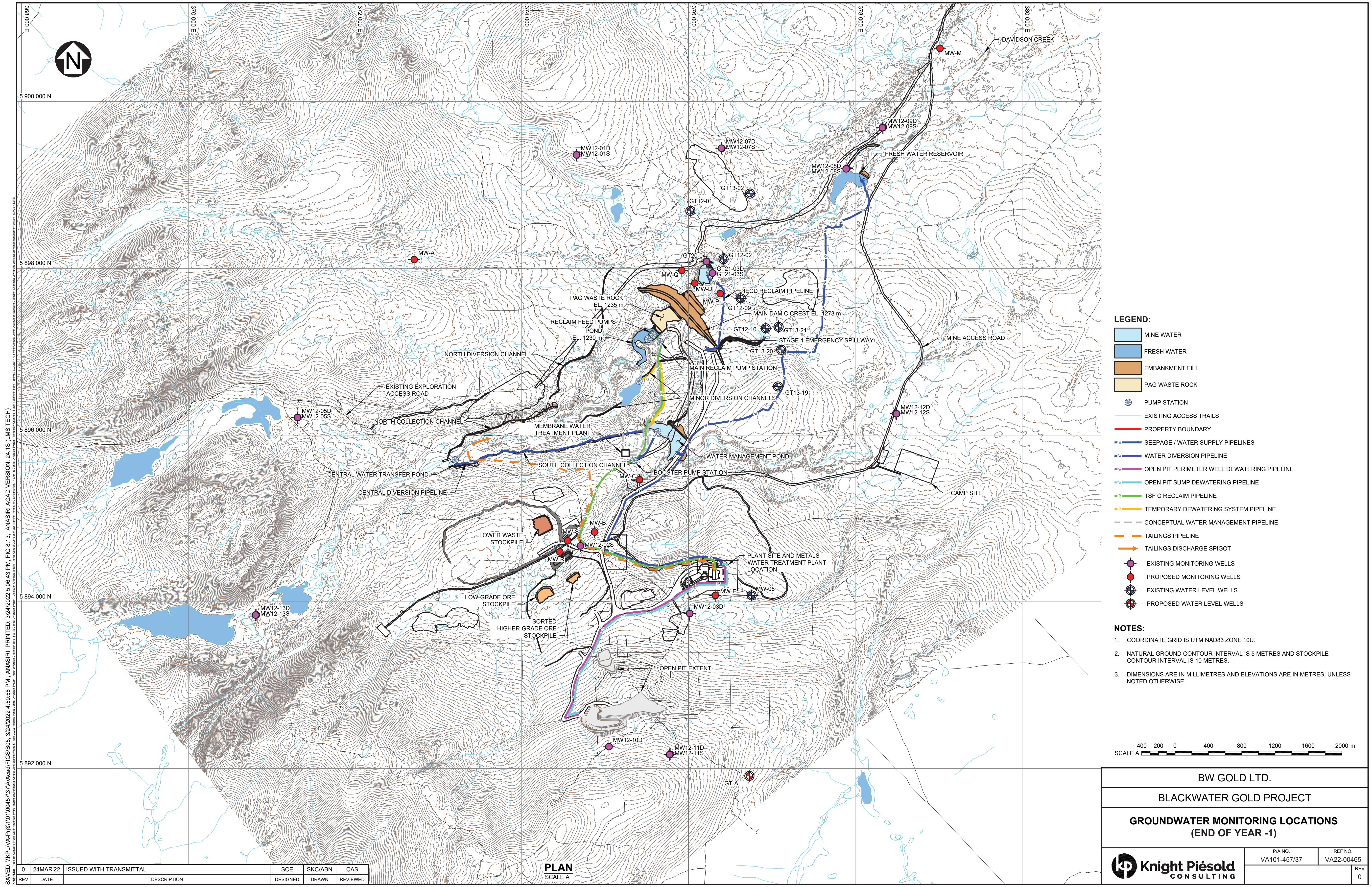

Figure 1-2: Groundwater Monitoring Locations (End of Year -1)

Source: Knight Piésold Consulting (2022).

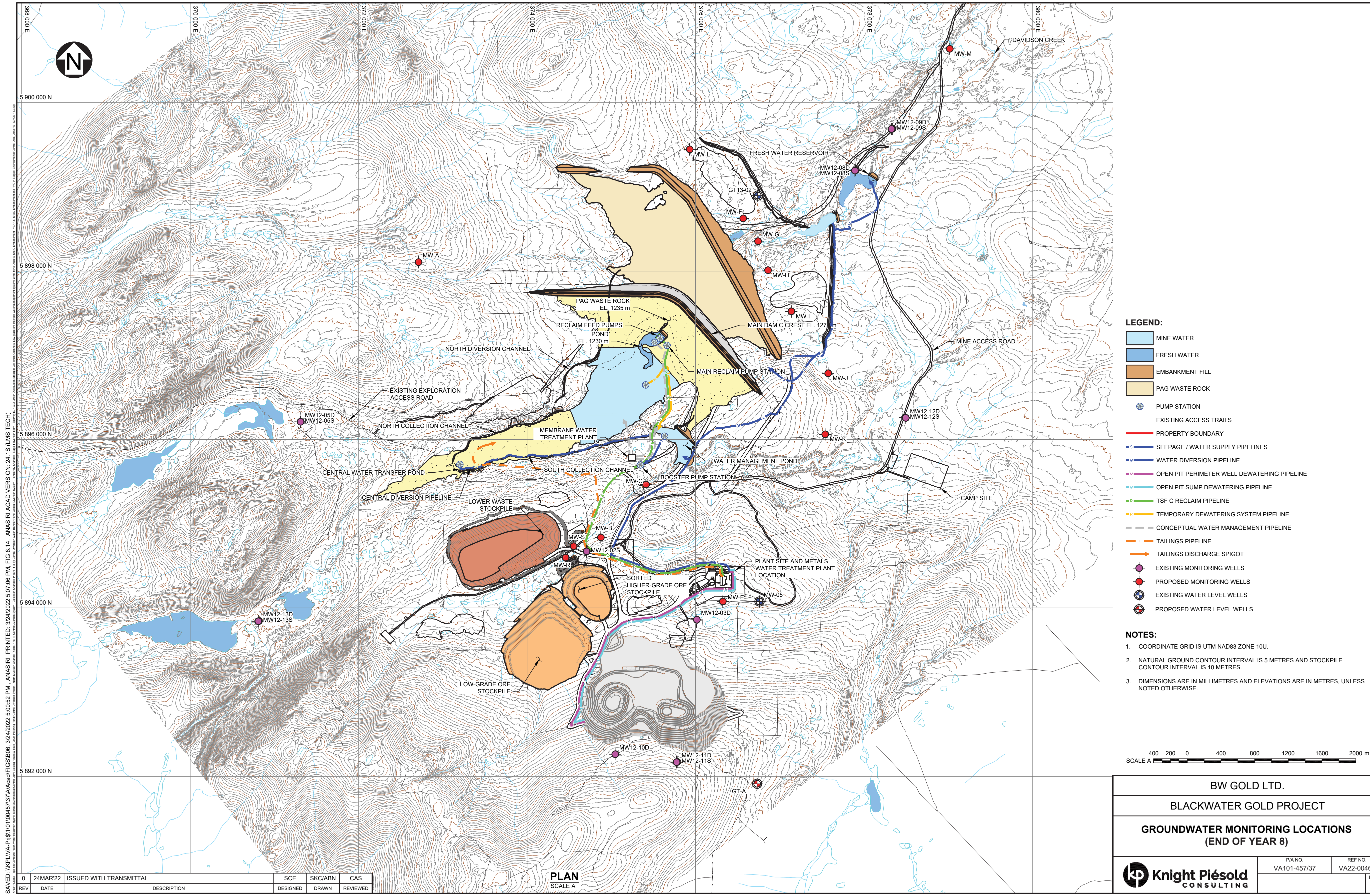

Figure 1-3: Groundwater Monitoring Locations (End of Year +8)

Source: Knight Piésold Consulting (2022).

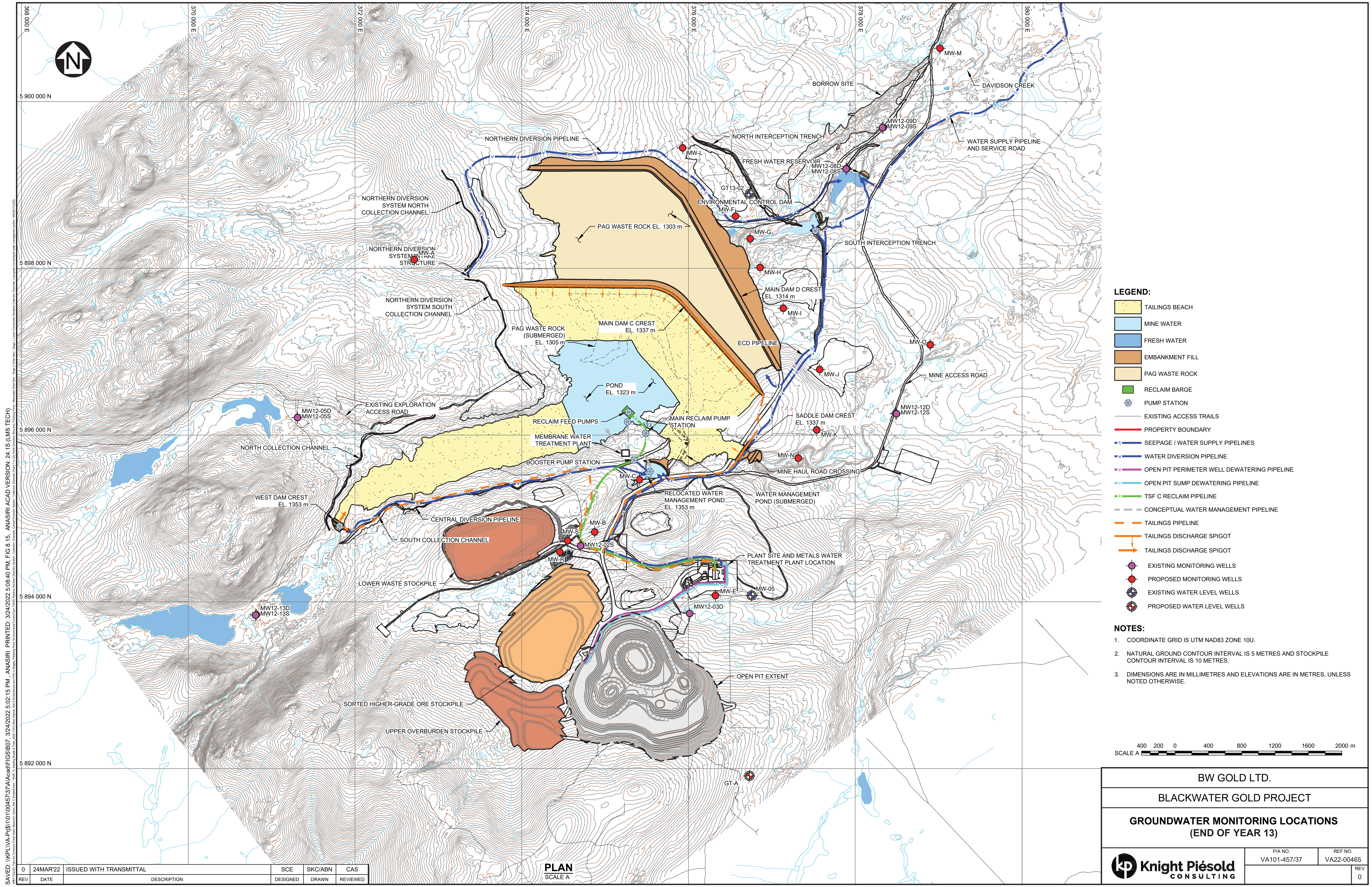

Figure 1-4: Groundwater Monitoring Locations (End of Year +13)

Source: Knight Piésold Consulting (2022).

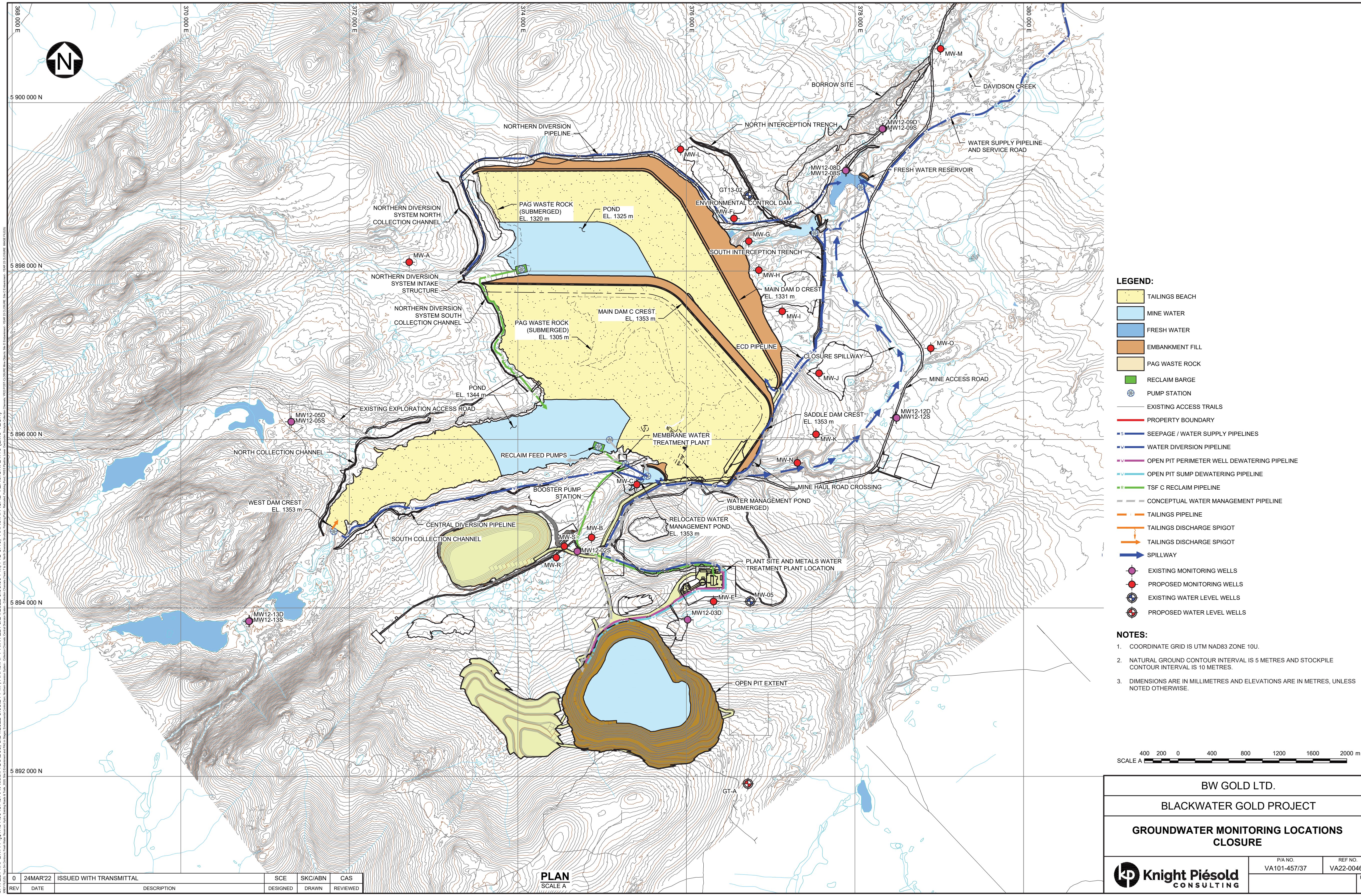

Figure 1-5: Groundwater Monitoring Locations (Closure)

Source: Knight Piésold Consulting (2022).

2. MONITORING FLOWS AND TEMPERATURE IN DAVIDSON CREEK (3.15.1)

2.1 Decision Statement Condition Requirement

The DS Condition 3.15.1 requires the Proponent to monitor water flows in Davidson Creek during the open water season from construction until decommissioning, and temperature continuously from construction until decommissioning.

2.2 Field Methods

Surface water flows and temperature in Davidson Creek will be monitored during the open water season beginning in Construction as indicated in Table 2.2-1 (locations shown in Figure 1-1). Monitoring at each of the sites will be conducted in accordance with the AEMP Plan (Section 4.3 and Section 4.4 of AEMP Plan).

Table 2.2-1: Davidson Creek Surface Water Flow and Temperature Monitoring Locations

Station ID	Surface Water Flow[1]	Surface Water Temperature
DC-05	✓	✓
DC-10	✓ (spot)	-
DC-15	✓	✓

Notes:

Dash indicates sampling component is not completed at that site.

[1] A continuous hydrology monitoring station will be installed at selected locations during open water season unless indicated as spot measure.

2.3 Data Analysis

2.3.1 Annual Monitoring

Water flows in Davidson Creek will be calculated as rating curves, measured discharge records, estimated winter streamflow, and mean monthly discharge (Section 4.3.4 of AEMP Plan). Annual water temperature records will be compiled and graphically presented to examine seasonal trends. Comparison to the nearest hydrology station discharge record will also be completed using graphical analysis to determine if water temperature trends are related to water flows and depth (Section 4.4.1.3 of the AEMP Plan).

2.3.2 Comparison to Environmental Assessment

The DS Condition 2.9 requires the Proponent to “undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s)”.

Potential changes in streamflow were predicted in Davidson Creek, Creek 661, Chedakuz Creek, and Creek 705 as a result of water diversions, alteration of watershed areas (and subsequent runoff volumes), and capture of run-off by various infrastructure components required for the Project (see Appendix 5.1.2.6D in

New Gold 2015). Thus, instream flow needs (IFN) were developed for Davidson Creek to address potential effects on fish and fish habitat. During all phases of the Project, streamflow is expected to be monitored to maintain the IFN in Davidson Creek as defined in Appendix 5.1.2.6D in New Gold (2015), unless otherwise authorized by Fisheries and Oceans Canada (as per DS Condition 3.8). The DS Condition 3.8 is as follows:

The Proponent shall develop, prior to construction, measures to maintain instream flow needs in Davidson Creek. The Proponent shall maintain instream flow needs in Davidson Creek during all phases of the Designated Project at a minimum within flow rates recommended by the Proponent in Appendix 5.1.2.6D of the Environmental Impact Statement, unless otherwise authorized by Fisheries and Oceans Canada.

Additional hydrometric data for Davidson Creek was collected following the calculation of the IFN values in 2015. The data were used to update the baseline hydrology and the amount of fish habitat available under baseline conditions; therefore, the IFN values from New Gold (2015) were updated as part of the submission of the *Fisheries Act* Authorization Application (Appendix C of Palmer 2022a). The IFN values shown in Table 2.3-2 are the flows “otherwise authorized by Fisheries and Oceans Canada” referred to in DS Condition 3.8 and replace the IFN values previously identified in the Assessment Report (CEA Agency 2019). Therefore, the weekly mean streamflow measured at site DC-05 in upper Davidson Creek, immediately downstream of the FWR, will be assessed against the IFN values defined in the *Fisheries Act* Authorization (Table 2.3-1).

Table 2.3-1: Davidson Creek Instream Flow Needs Authorized by Fisheries and Oceans Canada

Period	Instream Flow Needs (m^3/s)[1]	Days
December 1 to April 15	0.08	105-106
April 16 to May 10	0.15	25
May 11 to May 15 (flushing flows)	0.56	5
May 16 to June 30	0.56	46
July 1 to July 15	0.30	15
July 16 to August 31	0.15	47
September 1 to November 30	0.12	91

[1] Instream flow needs provided are pending approval by Fisheries and Oceans Canada and were submitted as Table 3 in Appendix C of the Fisheries Act Authorization Application (Palmer 2022a).

The DS Condition 3.9 is as follows:

> *The Proponent shall maintain water temperature in Davidson Creek, as described by the Proponent in Section 5 of Appendix A (Blackwater Gold Project – Assessment of Flows from the Water Treatment Plant and North and South Diversions on Davidson Creek Temperatures. Knight Piesold. Memorandum VA16-01038) of Appendix C-1 of the Environmental Impact Statement Supplemental Report Assessment of Effects Related to Project Changes (August 2016), unless otherwise authorized by Fisheries and Oceans Canada.*

Surface water temperature modelling was completed during the Environmental Assessment (EA) for two locations in Davidson Creek – at the mine access road crossing and site H4B (now identified as DC-15). The predicted surface water temperature indicated that the augmented flows in Davidson Creek would be within 1°C of simulated baseline water temperature when water is discharged from the FWR except for the months of September and October (Appendix C-1 of ERM 2016a).

The minimum, mean, and maximum monthly temperatures defined in the August 2016 assessment of effects were provided in Appendix C-1 of ERM (2016a) during the EA. Baseline temperature monitoring has continued since the EA, and updated minimum, mean, and maximum monthly temperatures are provided in Table 2.3-2 for Station DC-05, located immediately downstream of the FWR.

Table 2.3-2: Baseline Minimum and Maximum Daily and Mean Monthly Temperatures at Station DC-05 in Davidson Creek

Month	Minimum Daily Temperature (°C)[1]	Mean Monthly Temperature (°C)[1]	Maximum Daily Temperature (°C)[1]
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			

Note: Baseline temperatures will be added to the table once baseline monitoring concludes at the beginning of Project construction.

Temperature modelling has been updated since the EA to reflect optimization of the Project mine plan that occurred during permitting (KP 2022) and an updated effects assessment was completed (Palmer 2022b). Predicted temperatures are expected to remain within 1°C of the mean daily temperature range the majority of the time (93% to 99% of the time, depending on the scenario evaluated), consistent with modelling completed during the environmental assessment.

It is anticipated that a trigger response plan (TRP) will be developed as a condition of the *Environmental Management Act* effluent discharge authorization. The TRP will include water temperature triggers, which will be based on water temperature requirements defined in the FAA as the temperatures “otherwise authorized by Fisheries and Oceans Canada” (consistent with Condition 3.8), and actions or responses in the event that a trigger level is exceeded. The baseline temperature range (minimum and maximum daily temperatures) and mean monthly temperatures are defined in Table 2.3-2.

2.3.3 Effectiveness of Mitigation Measures and Adaptive Management

Provided that IFN and temperature requirements described in the FAA are met, mitigation measures are considered to be effective.

It is anticipated that a TRP will be developed at a later date as a condition of the *Environmental Management Act* effluent discharge authorization, which will include triggers and actions related to water flows (hydrology) and temperature. The actions to be completed reflect the level of risk when the trigger level has been reached with the main objective to meet permit conditions, DS conditions 3.8 and 3.9, and/or prevent irreversible adverse effects.

Station DC-05 in upper Davidson Creek is considered the point of compliance at which water flows are expected to meet instream flow needs (IFN). Thus, trigger levels for fish habitat (as hydrology in Davidson Creek) are defined in relation to the IFN (see Table 2.3-1).

Surface water temperature, downstream of the Project, in Davidson Creek is also expected to change as a result of flow augmentation from the FWR. Thus, trigger levels for surface water temperature are defined in relation to temperature requirements in the FAA (see Table 2.3-4 in this memo). The surface water temperature trigger levels would also apply to station DC-05 (point of compliance) in Davidson Creek.

The TRP and associated actions or responses that will be implemented in the event that triggers are exceeded will identify when mitigation measures may not be performing as expected (i.e., a trigger level is exceeded) and will allow the adjustment of mitigation measures or implementation of additional mitigation measures, if necessary, to ensure that no adverse effects occur in Davidson Creek (i.e., adaptive management or trigger responses).

3. MONITORING WATER QUALITY IN DAVIDSON CREEK, CREEK 661, AND CHEDAKUZ CREEK FOR CONTAMINANTS OF POTENTIAL CONCERN (3.15.2)

3.1 Decision Statement Condition Requirements

Condition 3.15.2 requires the monitoring of water quality in Davidson Creek, Creek 661, and Chedakuz Creek for contaminants of potential concern (COPCs[1]), including those identified in Table 5 of the environmental assessment report, during all phases of the Designated Project.

[1] The federal DS uses the terminology “contaminant of potential concern” or COPC, while provincially the term “parameter of concern” or POC is used. COPC and POC are defined as parameters with concentrations greater than water quality guidelines or parameters that have been identified as “special-case” parameters in the Joint Application. For simplicity, COPC is the terminology used in this memo.

3.2 Field Methods

Surface water quality samples will be collected at sites downstream from the mine site, as indicated in Table 3.2-1. Water quality samples will be collected at each of the sites in accordance with the AEMP Plan (Section 4.4.2.2 of the AEMP Plan).

Table 3.2-1: Surface Water Quality Monitoring Locations and Sampling Frequency in Davidson Creek, Creek 661, and Chedakuz Creek

Watershed	Station ID from EA Water Quality Model[1]	Station ID from Joint Application Water Quality Model[2]	Station ID in AEMP Plan	Monthly	Quarterly	5-in-30[1]
Davidson Creek	n/a	WQ28	DC-05	✓	-	✓
	n/a	WQ27	DC-10	✓	-	-
	WQ26	WQ26	DC-15	✓	-	-
	WQ7	WQ7	DC-20	✓	-	-
Creek 661	n/a	n/a	661-01	✓	-	✓
	n/a	n/a	661-03	✓	-	✓
	n/a	n/a	661-04	✓	-	✓
	n/a	n/a	661-05	✓	-	-
	WQ5-US	WQ5	661-10	✓	-	✓
	WQ5-DS	Creek 661	661-20	-	✓	-
Chedakuz Creek	n/a	n/a	CC-03	✓	-	✓
	n/a	n/a	CC-05	-	✓	✓
	WQ8	WQ8	CC-10	✓	-	✓
	WQ9	WQ9	CC-15	-	✓	✓
	n/a	WQ13	CC-20	✓	-	✓
	n/a	Halfway Chedakuz Creek	CC-30	-	✓	✓
	n/a	Chedakuz Creek Mouth	CC-40	-	✓	✓

Notes:

[1] From Figure 4 in CEA Agency (2019).

[2] From Lorax (2021).

n/a means that the station was not included in the EA or Joint Application water quality modelling and predicted water quality is not available for this location.

Dashes indicate sampling component is not completed at that site.

15-in-30 water sampling refers to the collection of 5 water samples in 30 days during spring freshet, fall rains, and winter low flow periods and replaces the monthly or quarterly sample during the three months when the 5-in-30 samples are collected.

3.3 Data Analysis

3.3.1 Annual Monitoring

Surface water quality concentrations will be analyzed as outlined in Section 4.4.2.3 of the AEMP Plan.

In the EA, the first screening step to identify COPCs was comparison of water quality predictions against water quality guidelines (WQGs). If predicted concentrations of a parameter were below WQGs, it was not identified as a COPC. However, if a parameter had a concentration that was predicted to be higher than WQGs it was identified as a COPC, and the second step was to compare the predicted concentrations against the range of natural variability measured in baseline studies. Using this screening procedure, the COPCs identified in Table 5 of the CEA Agency report (2019) for Davidson Creek and Creek 661 during the Construction and Operations phases are provided in Table 3.3-1.

The CEA Agency report (2019) did not identify any COPCs in Chedakuz Creek during Construction or Operations because the concentrations of all parameters were predicted to remain below WQGs.

Table 3.3-1: Contaminants of Potential Concern identified in Davidson Creek and Creek 661 in Construction and Operations (from CEA Agency [2019])

<table>
<tr><th>Creek</th><th>Contaminant of Potential Concern</th><th>Project Phase</th><th>Natural Variability</th><th>Guideline Exceeded</th></tr>
<tr><td rowspan="3">Davidson Creek</td><td>Nitrate</td><td>Operations</td><td>Exceeds limits of natural variability over one month</td><td rowspan="3">BC Ministry of Environment and Climate Change Strategy's long-term (chronic) Approved Water Quality Guidelines for Freshwater Aquatic Life[1]</td></tr>
<tr><td>Nitrite</td><td>Construction</td><td>Exceeds limits of natural variability over four months</td></tr>
<tr><td>Dissolved aluminum</td><td>Operations</td><td>Within the upper limit of natural variability</td></tr>
<tr><td rowspan="4">Creek 661</td><td>Dissolved aluminum</td><td>Operations</td><td>Within the upper limit of natural variability</td><td rowspan="4">BC Ministry of Environment and Climate Change Strategy's long-term (chronic) Approved Water Quality Guidelines for Freshwater Aquatic Life[1]</td></tr>
<tr><td>Total chromium</td><td>Operations</td><td>Exceeds limits of natural variability (at upstream sampling node only over three months)</td></tr>
<tr><td>Total copper</td><td>Operations</td><td>Exceeds limits of natural variability (at upstream sampling node only over one month)</td></tr>
<tr><td>Total zinc</td><td>Operations</td><td>Exceeds limits of natural variability over six months during operations</td></tr>
</table>

Source: Table 5 from CEA Agency (2019)

[1] BC Ministry of Environment and Climate Change Strategy. (No date). Approved water quality guidelines. Retrieved November 2018 from www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-qualityguidelines/approved-water-quality-guidelines.

Since the EA, additional work has been completed to support provincial Joint *Mines Act/Environmental Management Act* (MA/EMA) permitting and a Joint Application was submitted in March 2022. Baseline datasets for the Joint Application were expanded to include data up to 2020 and updated water quality modelling was completed to reflect optimization of the Project mine plan.

Based on work completed for the Joint Application, nitrogen forms (nitrate, nitrite, ammonia), total phosphorus, and total dissolved solids (TDS) were water quality parameters identified as the Project-related special-case COPCs for aquatic life in the conceptual site model (CSM; Entia 2022). Dissolved aluminum was also identified as a COPC for aquatic life as both baseline and predicted concentrations were higher than WQGs (Entia 2022). The CSM also recommended the inclusion of total mercury in monitoring due to uncertainties in the geochemical source terms used in water quality predictions. Other than dissolved aluminum, the COPCs identified in the CEA Agency (2019) Assessment Report (as shown in Table 3.3-1) from the EA were no longer identified as COPCs in the Joint Application as their predicted concentrations did not exceed water quality guidelines.

In addition to the COPCs identified in CEA Agency (2019) and Entia (2022), analysis of water chemistry will include constituents with BC WQG (ENV 2019a, 2021), federal WQG (CCME 2021a), approved Science-Based Environmental Benchmark (SBEBs), or Yinka Dene Water Law (YDWL) water quality standards (Table 3.3-2). A dissolved aluminum SBEB has been proposed for Davidson Creek and Creek 661 that is based on the background method (i.e., the SBEB is based on the seasonal 95th percentile plus 20% of concentrations measured in Davidson Creek and Creek 661 prior to development of the Project; Lorax 2022). No Project-related effects to aquatic biota would be expected if the future concentrations of dissolved aluminum remain below the SBEB. Once approved, the dissolved aluminum SBEB would be used as the applicable benchmark in place of the BC WQG.

Table 3.3-2: Water Quality Benchmarks Based on Water Quality Guidelines for the Protection of Aquatic Life, Wildlife, and Agriculture (Livestock)

Parameter	Water Quality Guideline1				Yinka Dene Water Law Standard	
	BC WQG	Type of Guideline	CCME WQG	Type of Guideline	DC-05	CC-15
Physical Parameters and Dissolved Anions						
pH (pH units)	6.5 to 9	Aquatic life	6.5 to 9	Aquatic life	6.5 to 9	6.8 to 8.1
Total suspended solids	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	BCWQG	BCWQG
Turbidity (in NTU)	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	BCWQG	BCWQG
Total dissolved solids	ng[3]	ng	3000	Livestock	ng[3]	ng
Chloride	150	Aquatic life	120	Aquatic life	120	60
Fluoride	sample specific[2]	Aquatic life	0.12	Aquatic life	1	0.53

Parameter	Water Quality Guideline1				Yinka Dene Water Law Standard	
	BC WQG	Type of Guideline	CCME WQG	Type of Guideline	DC-05	CC-15
Sulphate	sample specific[2]	Aquatic life	1000	Livestock	218	111
Nutrients						
Ammonia (as N)	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	1.83 (BCWQG)	0.84
Nitrate (as N)	3	Aquatic life	3	Aquatic life	3	1.5
Nitrite (as N)	sample specific[2]	Aquatic life	0.06	Aquatic life	0.02 (BCWQG)	0.011
Total Phosphorous	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	ng	ng
Cyanides						
Total Cyanide	ng	ng	0.005	Aquatic life	0.2	0.1
Cyanide, Weak Acid Dissociable	0.005	Aquatic life	ng	ng	0.005	0.005
Total Metals						
Aluminum	ng	ng	sample specific[2]	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Antimony	0.009	Aquatic life	ng	ng	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Arsenic	0.005	Aquatic life	0.005	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Barium	1	Aquatic life	ng	ng	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Beryllium	0.00013	Aquatic life	0.1	Livestock	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Boron	1.2	Aquatic life	1.5	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Cadmium	ng	ng	sample specific[2]	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Chromium[4]	0.001	Aquatic life	0.001	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Cobalt	0.004	Aquatic life	1	Livestock	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Copper	300	Wildlife	sample specific[2]	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Iron	1	Aquatic life	0.3	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only

Parameter	Water Quality Guideline1				Yinka Dene Water Law Standard	
	BC WQG	Type of Guideline	CCME WQG	Type of Guideline	DC-05	CC-15
Lead	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Manganese	sample specific[2]	Aquatic life	ng	ng	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Mercury	0.00002	Aquatic life	0.000026	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Molybdenum	0.016	Livestock	0.073	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Nickel	sample specific[2]	Aquatic life	sample specific[2]	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Selenium	0.002	Aquatic life	0.001	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Silver	sample specific[2]	Aquatic life	0.00025	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Thallium	0.0008	Aquatic life	0.0008	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Uranium	0.0085	Aquatic life	0.015	Aquatic life	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Vanadium	0.1	Livestock	0.1	Livestock	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Zinc	sample specific[2]	Aquatic life	5	Livestock	YDWL Standard for dissolved only	YDWL Standard for dissolved only
Dissolved Metals						
Aluminum[5]	sample specific[2]	Aquatic life	ng	ng	0.14 mg/L (April to July) / 0.05 mg/L (August to March)	0.041 mg/L (April to July) / 0.029 mg/L (August to March)
Cadmium	sample specific[2]	Aquatic life	ng	ng	0.00014 mg/L	0.00009 mg/L
Copper	sample specific[2]	Aquatic life	ng	ng	0.00290 mg/L	0.0026 mg/L
Iron	0.35	Aquatic life	ng	ng	0.3 mg/L	0.19 mg/L
Manganese	ng	ng	sample specific[2]	Aquatic life	0.02 mg/L	0.019 mg/L
Zinc	ng	ng	sample specific[2]	Aquatic life	0.04 mg/L	0.017 mg/L

See tables notes on next page.

Notes:
WQG = water quality guideline; ng = no guideline
Unless otherwise specified, units are in mg/L.
[1] Only the most conservative WQG is shown in the table. Sources of water quality guidelines include:

- *Approved or working BC Water quality guidelines for the protection of aquatic life, wildlife, and agriculture-livestock (BC ENV 2021a, 2021b).*
- *Canadian Council of Ministers of the Environment water quality guidelines for the protection of aquatic life or agriculture-livestock (CCME 2022).*

[2] This parameter has a water quality guideline based on toxicity modifying factors (e.g., hardness, pH). The guideline will be calculated on a sample-by-sample basis, consistent with guidance in BC ENV (2016).

[3] No aquatic life guideline is available for this parameter. A benchmark of 500 mg/L, used in effects assessment for the Joint Application, will be used to confirm the results of the effects assessment.

[4] Based on the guideline for hexavalent chromium, as there is no guideline for total chromium.

[5] When approved, the science-based environmental benchmark for dissolved aluminum will replace the BC WQG for dissolved aluminum.

Thus, assessment of water quality parameters, described in Section 3.3.2, at each of the monitoring locations on an annual basis will be for the following parameters: total suspended solids, TDS, pH, alkalinity, total phosphorus, ammonia-N, nitrate-N, nitrite-N, chloride, fluoride, sulphate, cyanide (total and weak acid dissociable), total metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc); and dissolved metals (aluminum, cadmium, copper, iron, manganese, and zinc).

3.3.2 Comparison to Environmental Assessment

The DS Condition 2.9 requires the Proponent to *undertake monitoring and analysis to verify the accuracy of the environmental assessment as it pertains to the particular condition and/or to determine the effectiveness of any mitigation measure(s).*

The Project's potential effects on surface water quality were described in Section 6.1 of the federal Assessment Report (CEA Agency 2019). Several water quality parameters were predicted to exceed WQGs in Davidson Creek and Creek 661 during the Construction and Operations phases. However, the magnitude of the exceedances was predicted to be low to moderate, with concentrations generally within the limits of natural variability.

Since the CEA Agency (2019) assessment report was issued, an updated water quality model (Lorax 2021) has been completed to reflect Project optimizations, an updated water balance model (KP 2021a), and an updated baseline dataset. Generally, parameter concentrations are predicted to be below WQGs during Construction and Operations phases. The exception is dissolved aluminum, where guideline exceedances are driven by background concentrations and not by the Project; an SBEB based on background concentrations has been proposed for this parameter to be used in place of the WQG.

Table 3.3-3 provides the assessment nodes at which water quality was predicted in the EA and the Joint Application, along with the associated baseline and AEMP sampling locations. The monthly predicted concentrations from the CEA Agency report (2019; for the EA) and Lorax (2021; for the Joint Application) at each of the assessment nodes and the AEMP baseline sampling locations in Davidson Creek and Creek 661 were compiled and the concentrations are provided in Tables 3.3-4 to 3.3-9.

To verify the accuracy of the environmental assessment, station-by-station comparisons of the water quality measured under the AEMP Plan with be made with the following:

- BC and CCME WQGs (Table 3.3-2); and

if water concentrations are higher than BC or CCME WQGs then:

- predicted concentrations from the environmental assessment, where available (Tables 3.3-4 to 3.3-9); and
- predicted concentrations from the Joint Application, where available (Tables 3.3-4 to 3.3-9).

Comparisons of measured data to YDWL Standards will be completed for informational purposes only and will not be used to verify the results of the environmental assessment because YDWL water quality standards were not considered in the environmental assessment.

As long as the concentrations measured in monitoring under the AEMP Plan remain below WQGs (Table 3.3-2) or within the range predicted in the EA or Joint MA/EMA Application (Tables 3.3-4 to 3.3-9), then potential for effects to the environment would be consistent with what was identified in the effects assessment in the environmental assessment.

Table 3.3-3: Water Quality Model Nodes, Baseline Sampling Locations, and Aquatic Effects Monitoring Program Sampling Location

Criteria	Joint MA/EMA Application Assessment Nodes: Water Quality Model (Lorax 2021)	Assessment Nodes: CEA Agency (2019)	Baseline Sampling Station up until 2021	AEMP Sampling Station (2022 onwards)
Davidson Creek	WQ28	-	WQ28	DC-05
	WQ27	-	WQ27	DC-10
	WQ26	WQ26	WQ26	DC-15
	WQ7	WQ7	WQ7	DC-20
Creek 661	-	-	WQ3	661-05
	WQ5	WQ5_US	WQ5	661-10
	WQCk661	WQ5_DS	661-20	661-20

Dashes indicate not modelled or assessed.

Table 3.3-4: Water Quality Benchmarks for DC-05 In Davidson Creek Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

Table 3.3-5: Water Quality Benchmarks for DC-10 In Davidson Creek Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

Table 3.3-6: Water Quality Benchmarks for DC-15 In Davidson Creek Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

Table 3.3-7: Water Quality Benchmarks for DC-20 In Davidson Creek Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

Table 3.3-8: Water Quality Benchmarks for 661-10 In Creek 661 Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

Table 3.3-9: Water Quality Benchmarks for 661-20 In Creek 661 Based on Predicted Concentrations

[The table containing predicted parameter concentrations by month will be provided upon completion of final Joint Application water quality model predictions]

3.3.3 Effectiveness of Mitigation Measures and Adaptive Management

To evaluate the effectiveness of mitigation measures, monthly concentrations of water quality parameters measured in Davidson Creek (DC-05, DC-10, DC-15, DC-20) and Creek 661 (661-05, 661-10, 661-20) will be assessed against the WQGs provided in Table 3.3-2 and predicted water quality benchmarks defined in Tables 3.3-4 to 3.3-9. Mitigations measures are considered to be effective and performing as expected as long as concentrations remain lower than WQGs and the predicted water quality benchmarks.

To address DS Condition 2.5, Section 6 (Adaptive Management) of the AEMP Plan provides the quantitative triggers to assess the levels of environmental change relative to baseline conditions that would require implementation, modification, or additional mitigation measure(s). In addition, the AEMP Plan provides the mechanism for identifying the technically and economically feasible mitigation measures to be implemented by the Proponent if monitoring conducted as part of the AEMP Plan (follow-up program) shows that the levels of environmental change referred to in DS Condition 2.5.4 have been reached or exceeded (DS Condition 2.5.5).

In addition, Section 10 (Nonconformity and Corrective Actions) and Section 11 (Adaptive Management) of the MSDP identify specific responses and mitigation measures to be implemented by the Proponent if monitoring shows that concentrations in effluent or water from individual mine site facilities exceed trigger levels. Since water chemistry is predicted to meet water quality guidelines at the end of pipe at the discharge point from the FWR, ensuring that trigger levels are not exceeded at the discharge point from the FWR will also ensure that water chemistry in the downstream receiving environment in Davidson Creek will meet BC

WQG. It is anticipated that a more detailed TRP will be developed under the *Environmental Management Act* effluent discharge permit that will further define triggers and action or responses related to water chemistry at discharge points.

Water quality triggers and management responses to prevent an irreversible adverse effect from occurring at near-field monitoring locations in Davidson Creek (DC-05, DC-10, and DC-15) and Creek 661 (661-05 and 661-10) are provided in Table 6.2-2 of the AEMP Plan. This includes comparison of measured data to WQGs (Table 3.3-2), predicted concentrations (Tables 3.3-4 to 3.3-9), and baseline concentrations (Tables 3.3-10 to 3.3-14). The action level in the adaptive management framework is defined based on whether concentrations are higher than baseline levels, higher than predicted concentrations, statistically significant, and/or higher than guidelines, with management actions corresponding to the level of risk (see Section 6 of the AEMP Plan for additional details).

Table 3.3-10: Water Quality Benchmarks for DC-05 In Davidson Creek Based on Baseline Concentrations

[The table containing parameter concentrations by month will be provided upon completion of baseline monitoring]

Table 3.3-11: Water Quality Benchmarks for DC-10 In Davidson Creek Based on Baseline Concentrations

[The table containing parameter concentrations by month will be provided upon completion of baseline monitoring]

Table 3.3-12: Water Quality Benchmarks for DC-15 In Davidson Creek Based on Baseline Concentrations

[The table containing parameter concentrations by month will be provided upon completion of baseline monitoring]

Table 3.3-13: Water Quality Benchmarks for 661-05 In Creek 661 Based on Baseline Concentrations

[The table containing parameter concentrations by month will be provided upon completion of baseline monitoring]

Table 3.3-14: Water Quality Benchmarks for 661-10 In Creek 661 Based on Baseline Concentrations

[The table containing parameter concentrations by month will be provided upon completion of baseline monitoring]

4. Monitoring Groundwater Quality and Quantity

4.1 Decision Statement Condition Requirements

The DS Condition 3.15.3 requires the monitoring of groundwater quality and quantity downstream of Tailings Storage Facility D (TSF D), Open Pit, west waste rock dump, and Low Grade Ore (LGO) Stockpile. Monitoring results should be compared to "*values identified by the Proponent in the modelled predictions in Section 5 of Blackwater Gold Project: Additional Water Quality Model Sensitivity Scenario (July 20, 2017)* *and Section 3 of Blackwater Gold Project: Water Treatment Responses for Comments 1266, 1270, 1271, 1272, and 1273 (February 15, 2017) for nitrite and contaminants of potential concern, and to verify the effectiveness of water management measures*".

Note that the west waste rock dump is no longer a mine facility in the optimized mine plan and is instead replaced by the Upper and Lower Waste Stockpiles.

4.2 Field Methods

Groundwater quality and quantity monitoring is described in Section 7.3.4 of the MSDP. Groundwater quality and quantity monitoring locations are summarized in Tables 4.2-1 and 4.2-2.

Sampling of groundwater quality is described in Section 7.3.4.1 of the MSDP. Groundwater quality samples will be collected using methods that are in accordance with the well purging and sampling procedures from the following documents:

- British Columbia Field Sampling Manual. Part E Groundwater (Draft). Edition. Province of British Columbia. 2021; and
- Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures. 1996. United States Environmental Protection Agency. Puls, R.W., and M.J. Barcelona. EPA/540/S-95/504 (EPA 1996).

Analysis of groundwater quality samples will include in situ parameters, physical parameters, anions, nutrient, cyanide, cyanate, and thiocyanate, dissolved metals, total metals, total organic carbon and dissolved organic carbon.

Monitoring of groundwater quantity (flow) is described in Section 7.3.4.2 of the MSDP and consists of monitoring groundwater levels adjacent to and downgradient of mine facilities. Groundwater levels will be monitored using pressure transducers installed in monitoring wells and vibrating wire piezometers (VWPs) grouted into drillholes. The pressure transducers will be downloaded quarterly when the monitoring wells are sampled and water levels will be measured at the same time and compared against pressure transducer readings to ensure equipment is functioning correctly. If non-vented pressure transducers are used, a separate pressure transducer will be deployed to record barometric pressure. In order to capture impacts to both the shallow and deeper groundwater systems, a range of depths and geologic units will be monitored.

In addition to monitoring groundwater at wells, groundwater discharging to surface will be monitored as part of seep surveys conducted downgradient of specific mine facilities, as described in Section 7.3.4.3 of the MSDP. Seep surveys will be completed to identify and characterize groundwater discharging to ground surface, with seep mapping and sampling for water quality where flows are sufficient.

Table 4.2-1: Groundwater Quality Monitoring Locations and Sampling Frequency

Facility	ID	Coordinates	Screen Zone (mbgs)	Frequency	Screen Zone Depth Rationale	Description
Background Well	MW12-01D/S	01D: 5899360N.374655E	36.6 – 39.6	Quarterly (MW12-01D only)	Shallow: Shallowest permeable horizon (weathered bedrock).	Existing wells north of TSF. Decommissioned prior to construction of Main Dam D.
		01S: 5899360N.374658E	9.1 – 12.2		Deep: Competent bedrock well.	
Background Well	MW12-05D/S	05D: 5896210N.371310E	23.2 – 26.2	Annual	MW12-05S: Overburden well.	Existing upgradient reference sites located in Davidson Creek headwater.
		05S: 5896210N.371309E	7.6 – 10.7		MW12-05D: Shallow bedrock well.	
	MW12-13S	13S: 5893830N.370808E	10 – 13.1		MW12-13S: Shallowest permeable horizon (glaciofluvial deposits).	
Background Well	MW-A (S/D)	TBD	TBD	Quarterly	Shallowest and deeper water bearing zone.	Proposed upgradient reference site. Install in Construction.
LGO and Ore Stockpiles	MW12-02S	5894670N.374704E	8.2 – 9.8	Quarterly	Shallowest water bearing zone (glacial till).	Existing wells down-gradient of ore stockpiles and LGO Stockpile Collection Pond.
LGO, Ore and Waste Stockpiles	MW-B (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed wells down-gradient of ore and waste stockpiles. Install in Construction.
	MW-C (S/D)					
	MW-R (S/D)					
	MW-S (S/D)					
Open Pit	MW12-03D	5893860N.376013E	33.5 – 36.6	Quarterly	Shallowest water bearing zone (glacial till).	Existing wells down-gradient of deposit.
Plant Site	MW-E (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed wells down-gradient of Plant Site. Install in Construction phase.
IECD	GT20-04	5898081N.376215E	22.17 – 27.94	Quarterly	Water bearing zone above bedrock (glacial till).	Existing wells downs-gradient of IECD. Decommissioned in Year +5.

Facility	ID	Coordinates	Screen Zone (mbgs)	Frequency	Screen Zone Depth Rationale	Description
TSF C / Main Dam C	MW-D (S/D) MW-P (S/D) MW-Q (S/D)	TBD	TBD	Quarterly	MW-D: screens target the inferred buried glaciofluvial unit and an underlying permeable horizon. MW-P and MW-Q: screens target horizons that could be potential seepage pathways from the facilities (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed wells down-gradient of Main Dam C South Abutment. Install in Construction and Decommission in Year +5.
TSF C / Main Dam C	MW-K (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till and/or weathered bedrock).	Proposed wells down-gradient of Main Dam C. Install prior to Year +10.
TSF D / Main Dam D	MW-F (S/D) MW-G (S/D) MW-H (S/D) MW-I (S/D) MW-J (S/D) MW-L (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed wells down-gradient of Main Dam D. Install in Year +5.
TSF D / Main Dam D	MW12-07D/S	07D: 5899440N.376395E 07S: 5899440N.376399E	35.4 – 38.6 19.8 – 22.9	Quarterly	Shallowest and deeper water bearing zones (glaciofluvial deposits).	Existing well north of TSF. Decommission prior to construction of the North Interception Trench.
Downgradient of Aggregate Source	MW-M (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed site. Install in Construction.

Facility	ID	Coordinates	Screen Zone (mbgs)	Frequency	Screen Zone Depth Rationale	Description
FWR	MW12-08D/S	08D: 5899260N.377911E	32.6 – 35.6	Quarterly	Shallowest (glaciofluvial deposits) and deeper (glacial till) water bearing zones.	Existing wells down-gradient of ECD/North of FWR.
		08S: 5899260N.377911E	16.2 – 19.3			
FWR	MW12-09D	5899688N.378334E	30.5 – 33.6	Quarterly	Water bearing zone (glacial till).	Existing wells down-gradient of FWR.
TSF Closure Spillway	MW-O (S/D)	TBD	TBD	Quarterly	Shallowest and deeper water bearing zones (glaciofluvial deposits).	Proposed wells down-gradient of Saddle Dam. Install prior to Year +10.
Camp Site	MW12-12D/S	12D: 5896250N.378490E	31.2 – 34.2	Quarterly	Shallowest (glaciofluvial deposits) and deeper (glacial till) water bearing zones.	Existing wells down-gradient of Camp Site and TSF Spillway in Closure.
		12S: 5896250N.378490E	11.2 – 14.2			
Saddle Dam	MW-N (S/D)	TBD	TBD	Quarterly	Well screens to be installed in horizons that could be potential seepage pathways (i.e., glacial till, glaciofluvial, and/or weathered bedrock).	Proposed wells down-gradient of Saddle Dam. Install prior to Year +10.

Notes:

Coordinates presented in UTM Zone 10U NAD 83.

Screen zone is metres below ground surface.

TBD – to be determined.

Table 4.2-2: Groundwater Quantity (Flow) Monitoring Locations

Facility	ID	Description
Background Well	MW12-01D/S	Existing wells north of TSF. Decommissioned prior to construction of Main Dam D.
	MW12-05D/S MW12-13S	Existing upgradient reference sites located in Davidson Creek headwater.
	MW-A (S/D)	Proposed upgradient reference site. Install in Construction.
Ore Stockpiles	MW12-02S	Existing wells down-gradient of ore stockpiles and LGO Collection Pond.
Ore and Waste Stockpiles	MW-B (S/D) MW-C (S/D) MW-R (S/D) MW-S (S/D)	Proposed wells down-gradient of ore and waste stockpiles. Install in Construction.
Open Pit	MW12-10D MW12-11D/S	Existing wells within Open Pit extent. Decommissioned/lost in Year +13.
	MW12-03D	Existing wells down-gradient of deposit.
Plant Site	MW-E (S/D)	Proposed wells down-gradient of Plant Site. Install in Construction phase.
IECD	GT20-04 GT21-03D/S	Existing wells downs-gradient of IECD. Decommissioned in Year +5.
TSF C / Main Dam C	GT12-01 GT12-02 GT12-09 GT12-10 GT12-11 GT13-19 GT13-20 GT13-21	Existing wells down-gradient of Main Dam C. Decommissioned prior to construction of Main Dam D.
	MW-D (S/D) MW-P (S/D) MW-Q (S/D)	Proposed wells down-gradient of Main Dam C. Install in Construction and Decommission in Year +5.
	MW-K (S/D)	Proposed wells down-gradient of Main Dam C. Install prior to Year +10.

Facility	ID	Description
TSF D / Main Dam D	MW-F (S/D) MW-G (S/D) MW-H (S/D) MW-I (S/D) MW-J (S/D) MW-L (S/D)	Proposed wells down-gradient of Main Dam D. Install in Year +5.
	MW12-07D/S	Existing well north of TSF. Decommission prior to construction of the North Interception Trench.
Downgradient of Aggregate Source	MW-M (S/D)	Proposed site. Install in Construction.
FWR	MW12-08D/S	Existing wells down-gradient of ECD/North of FWR.
	MW12-09D/S	Existing wells down-gradient of FWR.
TSF Closure Spillway	MW-O (S/D)	Proposed wells down-gradient of closure spillway. Install prior Year +10.
Camp Site	MW12-12D/S	Existing wells down-gradient of Camp Site and TSF Spillway in Closure.
Saddle Dam	MW-N (S/D)	Proposed wells down-gradient of Saddle Dam. Install prior to Year +10.

4.3 Data Analysis

4.3.1 Annual Monitoring

Monitoring (sampling) for groundwater quality will be conducted quarterly at the majority of the 29 groundwater quality locations, with monitoring at a few background sites conducted annually. Monitoring for groundwater quantity (flow) will consist of continuously monitoring water levels at 40 locations using pressure transducers and VWPs, with data downloads and manual water level measurements in standpipe piezometers and monitoring wells conducted quarterly. The groundwater quality and quantity monitoring locations are shown on Figures 1-2 to 1-5.

Monitoring well locations were selected for groundwater quality monitoring based on the following criteria:

- They are screened within potential groundwater flow pathways;
- They are reasonably spaced around the down-gradient area; and
- The screen depths are reasonably distributed to capture impacts to both the shallow and deeper groundwater systems.

The MSDP groundwater monitoring program includes monitoring background conditions. Monitoring background conditions is an important component of impact assessment and effective quality assurance. Six monitoring wells at four locations (MW12-05S/D, MW-A, MW12-01D/S, and MW12-13S) are proposed for monitoring background conditions during Construction and Operations. Background data will be used to distinguish between impacts due to Project activities and variation due to natural conditions such as climate change. As baseline data are still being collected, summary statistics for baseline groundwater quality are not yet available and will be added to a subsequent version of this follow up plan, once available.

Groundwater quality results will be reviewed in a timely manner and evaluated with QA/QC procedures such as the anion-cation balance and by comparing original and duplicate sample concentrations and dissolved and total metals concentrations. Analyses of potential impacts to groundwater quality will be conducted by comparing data against the background baseline dataset. Interpretations for potential impacts to groundwater quality will be made in conjunction with surface water studies.

Groundwater flow analyses will consider impacts to groundwater levels as well as changes to groundwater flow paths. Groundwater levels during construction and operations will be compared against reference groundwater levels established prior to breaking ground to assess the potential for impacts to surface water or changes in groundwater flow pathways. Groundwater levels are expected to decrease surrounding the Open Pit; analyses will include comparison against predicted water level drawdowns. Groundwater levels downstream of the TSF could increase associated with potential seepage from the facility; water levels downstream of the TSF will be compared against background water levels. Interpretations for potential impacts will be made in conjunction with any surface water studies.

For the Open Pit, the measured volumes of mine water pumped from the dewatering wells will be compared to the predicted values, and the models will be updated if required, to reflect these differences and improve understanding of the groundwater regime. The predicted propagation of the zone of water level depression surrounding the open pit as it is advanced will be compared against measured groundwater levels at monitoring sites.

Seepage collected by the TSF C and TSF D embankment drains and inflows to the Interim Environmental Control Dam (IECD) and ECD will be monitored and compared to predicted values. Monitoring wells located down-gradient of TSF C and TSF D will be used to monitor for potential unrecoverable seepage by monitoring water levels and water quality. Buried glaciofluvial sand and gravel channels and the weathered bedrock horizons are potential preferential groundwater flow pathways that may convey seepage down-gradient of the TSF. An increase in groundwater level downgradient of the TSF in these deeper subsurface horizons could indicate a hydraulic connection and potential for subsurface seepage flow.

Water quality of seepage collected by TSF C and TSF D embankment drains and inflows to the IECD and ECD will be monitored and compared to predicted values. Seepage from the TSF will report rapidly to the embankment drains and its quality can be assessed to predict the quality of potentially unrecoverable foundation seepage that would have a much longer travel time. Monitoring wells down-gradient of Main Dam C, Main Dam D, TSF C Saddle Dam, IECD, and the ECD will be used to monitor for indications of unrecoverable seepage.

Monitoring wells will be located down-gradient of the LGO stockpile and Upper and Lower Waste Stockpiles to provide early warning of possible seepage quantity or quality concerns. One existing monitoring well (MW12-02S) and four new monitoring sites (MW-B and MW-C) will monitor groundwater quality downgradient of all stockpiles. Proposed monitoring well MW-R will monitor groundwater down gradient of the LGO stockpile and associated collection pond and proposed monitoring well MW-S will monitor groundwater down-gradient of the Lower Waste Stockpile.

Monitoring wells will be located down-gradient of the Plant Site to provide early warning of possible seepage quantity or quality concerns. One new monitoring site (MW-E) is proposed to monitor groundwater quality downgradient (south) of the Plant Site.

Monitoring of water levels and water quality at groundwater discharge points will assist in characterizing potential for impacts to surface water from groundwater. Groundwater discharge quality monitoring will consist of a seep mapping and sampling program. Seep surveys are aimed at enhancing the understanding of groundwater flow in the project area and specifically down-gradient of the TSF, stockpiles, and Pit Lake, and to identify potential pathways for seepage from these facilities. Seep monitoring will include descriptions of seeps and waterbodies encountered during mapping, their frequency and location, elevation, and water quality. Where sufficient flow exists, water quality samples of the seep will be collected following the same QA/QC procedures established for surface water sampling.

Seep surveys will be conducted during construction and operations. Results of each seep survey will be compared against results of earlier surveys to assess potential groundwater flow pathways from the mine to the receiving environment and potential for impacts to surface water from groundwater.

4.3.2 *Comparison to Environmental Assessment*

DS Condition 3.15.3 requires that results from groundwater quality and quantity monitoring will be compared to predictions made in the environmental assessment, as follows:

- Section 5 of Blackwater Gold Project: Additional Water Quality Model Sensitivity Scenario (July 20, 2017).
- Section 3 of Blackwater Gold Project: Water Treatment Responses for Comments 1266, 1270, 1271, 1272, and 1273 (February 15, 2017) for nitrite and contaminants of potential concern.

The two documents referenced by DS 3.15.3 specifically focus on Closure and Post-Closure water quality. Section 5 of the July 20, 2017 document provides summary statistics of predicted surface water quality in TSF D supernatant and Davidson Creek (WQ26) in Post-closure. Section 3 of the February 15, 2017 document provides predicted surface water quality in the TSF D Pond, TSF D spillway, plunge pool, and Davidson Creek (WQ26) in Closure and Post-closure. Predicted water quality predictions made in the environmental assessment for mine facilities during Construction and Operations is presented in Section 5 of the Updated Surface Water Quality Model Report (ERM, 2016b), and appears to be more relevant than the references provided in DS Condition 3.15.3. The predicted geochemical source term for tailings seepage from the environmental assessment is presented in Table 4.3 1 reproduced from Table E 3 of ERM (2016b).

Table 4.3-1: Geochemical Source Terms for Tailings Seepage

Parameter	Average Concentration from Saturated Columns (mg/L)
Alkalinity (as CaCO3)	129
Sulphate ($SO4^-$)	2300
Nitrate ($NO3^-$)	0.005
Nitrite ($NO2^-$)	0.01
Total Cyanide	0.1
Weak-acid Dissociable Cyanide	0.015
Aluminum	0.002
Antimony	0.00595
Arsenic	0.00305
Barium	0.0346
Boron	0.0291
Cadmium	0.000052
Calcium	446
Chromium	0.0001
Cobalt	0.034
Copper	0.0001
Iron	0.09

Parameter	Average Concentration from Saturated Columns (mg/L)
Lead	0.00012
Magnesium	20.7
Manganese	7.2
Molybdenum	0.035
Nickel	0.0073
Phosphorus	0.001
Selenium	0.00035
Silver	0.000005
Uranium	0.00545
Zinc	0.55
Chloride	19
Fluoride	0.02
Ammonia	33.5

[1] *From Table E-3 in ERM (2016b).*

[2] *Average concentration based results of two saturated columns.*

The Project's potential effects on groundwater quality and quantity were described together with surface water quality and quantity in Section 6.1 of the federal Assessment Report (CEA Agency 2019). Due to the relationship between groundwater and surface water their predicted effects were considered together and are discussed in Section 3.2.2. Updated groundwater modelling (KP 2021b) and water quality modelling (Lorax 2021) have been completed for the Joint Application to reflect Project optimizations and an updated baseline dataset since the CEA Agency (2019) assessment report was issued. The assessment nodes at which water quality was predicted in the EA and the Joint Application are presented in Table 3.3-3.

Water quality and water level results will be compared against background parameter concentrations and water levels to identify potential seepage pathways. If potential seepage is identified, the increase in measured parameter concentrations will be used to estimate seepage rates and groundwater flow velocities that will then be compared against predicted rates and velocities from the numerical groundwater modelling (KP 2021b). Measured concentrations of parameters will be compared against concentrations in TSF seepage predicted in the environmental assessment and against updated predictions of seepage concentrations originating from TSF C, TSF D, LGO Stockpile, Upper and Lower Waste Stockpiles, and Plant Site presented in the Joint Application.

4.3.3 Effectiveness of Mitigation Measures and Adaptive Management

If measured groundwater quality and quantity is similar to what was predicted then mitigation measures are considered to be performing as expected.

In the event that there are substantive deviations between what was predicted and what is measured, preliminary triggers for additional mitigation, monitoring, and/or management are included in the MSDP. Table 11-1 of the MSDP provides facility-specific triggers and responses in the event that groundwater levels deviate from those predicted and concentrations of water quality parameters increase above predicted levels. Section 11.1 of the MSDP includes contingency measures specific to groundwater that could be implemented in the event that monitoring suggests the mitigation measures are not performing as expected.

In addition to the triggers and responses provided in Section 10 (Nonconformity and Corrective Actions) and Section 11 (Adaptive Management) of the MSDP, a TRP will be developed as a condition of the *Environmental Management Act* effluent discharge authorization, once issued. The TRP will build on the triggers and actions or responses described in the MSDP to ensure that results of monitoring are within the expected (predicted) range and mitigation measures are performing as expected so that corrective actions, if required, can be implemented before adverse effects can occur in the receiving environment outside of the mine site.

5. REPORTING

A draft annual report of the AEMP report (for reporting of flows, temperature, and water quality) and the MSDP report (for groundwater quality and quantity) in accordance with DS 3.15 will be provided to IAAC and Indigenous groups no later than June 30 following the reporting year to which the annual report applies, in accordance with DS Condition 2.12. The report will provide the information required by DS Conditions 2.11 and 2.13 that set out annual reporting requirements related to the implementation of conditions in DS 3.15.

REFERENCES

CEA Agency. 2019. Blackwater Gold Project Environmental Assessment Report. Government of Canada.

Entia Environmental Consultants Ltd. (Entia). 2022. Blackwater Gold Project: Conceptual Site Model. March 2022. Prepared for BW Gold Ltd. by Entia Environmental Consultants Ltd.

ERM Consultants Canada Ltd. (ERM). 2016a. Blackwater Gold Project: Updated Surface Water Quality Effects Assessment. August 2016. Prepared for New Gold Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

ERM. 2016b. Blackwater Gold Project: Updated Surface Water Quality Model Report. August 2016. Prepared for New Gold Inc. by ERM Consultants Canada Ltd.: Vancouver, BC.

Knight Piésold Ltd. (KP). 2022. Blackwater Gold Project: Updated Water Temperature Modeling. Draft in preparation. Prepared for BW Gold Ltd. by Knight Piésold Ltd. Vancouver, BC.

KP. 2021a. Blackwater Gold Project: Life of Mine Water Balance Model Report. Rev 1. November 2021. Prepared for BW Gold Ltd. by Knight Piésold Ltd. Vancouver, BC.

KP. 2021b. Blackwater Gold Project: Numerical Groundwater Modelling Report. Rev 1. November 2021. Prepared for BW Gold Ltd. by Knight Piésold Ltd. Vancouver, BC.

Lorax Environmental Services Ltd. (Lorax). 2021. Blackwater Gold Project: Water Balance and Water Quality Model Report. November 2021. Prepared for Artemis Gold Inc. by Lorax Environmental Services Ltd. Vancouver, BC.

Lorax. 2022. Blackwater Gold Project Development Plan for Dissolved Aluminum Science-Based Environmental Benchmark. March 2022. Prepared for BW Gold Inc. by Lorax Environmental Services Ltd.

Palmer Environmental Consulting Group (Palmer). 2022a. Blackwater Gold Project Application for Authorization under Paragraph 35(2)(b) of the *Fisheries Act* (Non-Emergency Situations). May 2022. Prepared for BW Gold Ltd. by Palmer Environmental Consulting Group. Vancouver, BC.

Palmer. 2022b. Memorandum – Response to Information Requests #48 and #50: Comparison of Temperature in Davidson Creek with BC WQG. June 2022. Prepared for BW Gold Ltd. by Palmer Environmental Consulting Group. Vancouver, BC.