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5.3.2 Surface Water Flow

5.3.2.1 Introduction

This section of the Environmental Assessment (EA) discusses the potential effects of the proposed Blackwater Gold Project (the Project) on surface water flows and lake levels in watersheds that are either within or adjacent to the Project during the construction, operation, closure, and post-closure phases. The scoping process concluded that surface water flows and lake levels are the key indicators/factors for assessment of the Surface Water Flow Valued Component (VC) for the aquatic subject area under the environmental pillar for this EA. Refer to **Section 5.3.1** for further discussion on VC selection. As this section only pertains to surface water flow and lake levels, other sections in Aquatic Environment contain further information on surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetlands.

The following sections include the following:

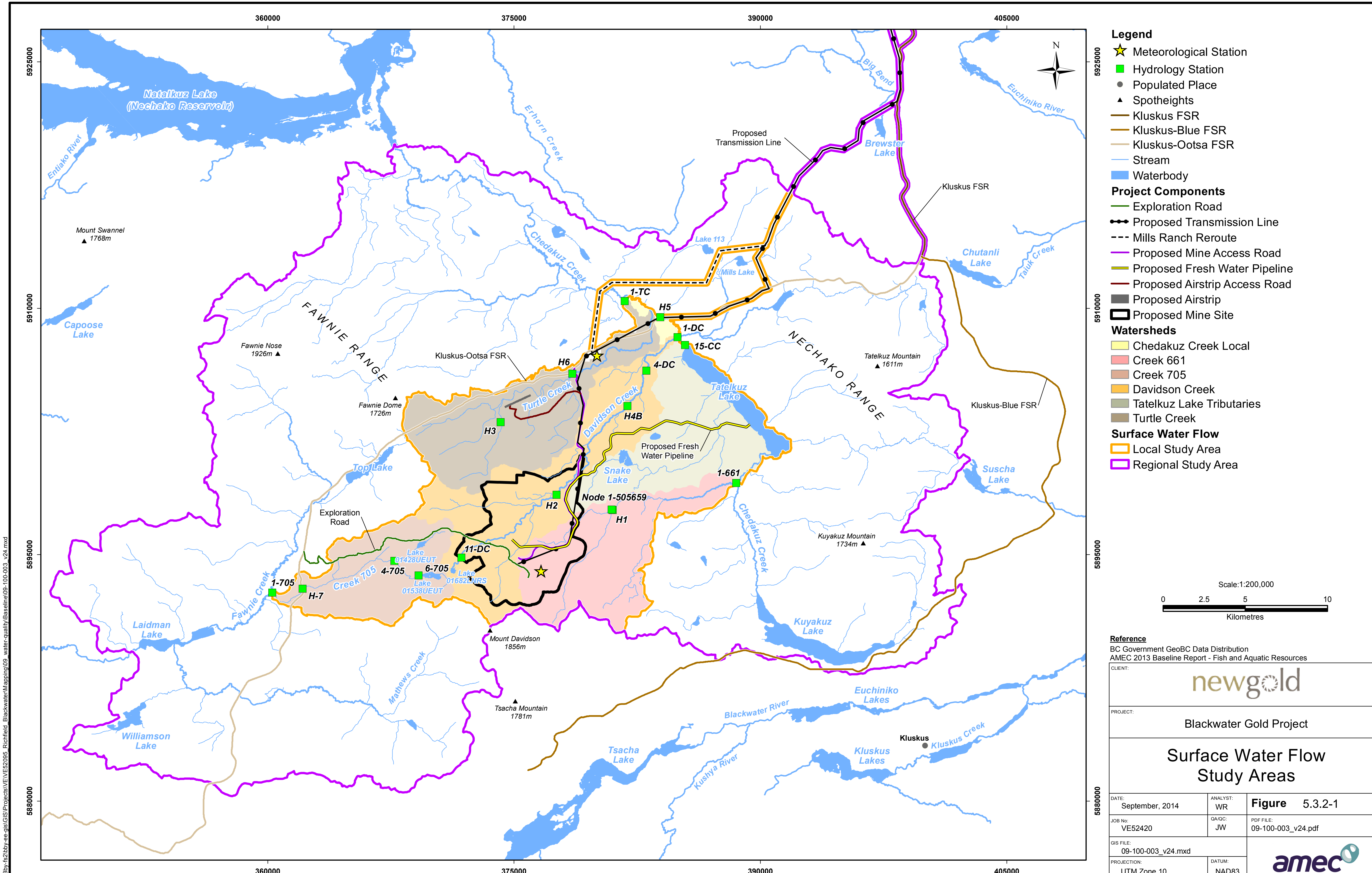
- Summary of the hydrology baseline (includes surface water flow, climate and Tatelkuz Lake levels);
- Potential effects of the Project on the surface water flows and lake levels within potentially affected watersheds (prior to implementing mitigation measures such as meeting Instream Flow Needs (IFN) in Davidson Creek);
- Measures that can be implemented to mitigate the potential effects of the Project (including meeting IFN in Davidson Creek);
- Residual effects (after implementing mitigation measures such as meeting IFN in Davidson Creek), as well as the significance and likelihood of these effects, on the surface water flows and lake levels;
- Climate change;
- Monitoring;
- Cumulative effects resulting from the residual effects of the Project with other past, present (including water licenses), or reasonably foreseeable future projects. Historical land use in the Project area includes mineral exploration activities, agriculture, recreational activities, forestry activities, and Aboriginal traditional use. Present and future land use in the Project area that could potentially impact surface water flow includes agriculture, forestry and mineral exploration;
- Limitations; and
- Conclusions based on a quantitative and qualitative assessment of predicted surface water flows and lake levels due to the residual effects of the Project (after implementing mitigation measures such as IFN in Davidson Creek) during all project phases (construction, operation, closure, and post-closure).

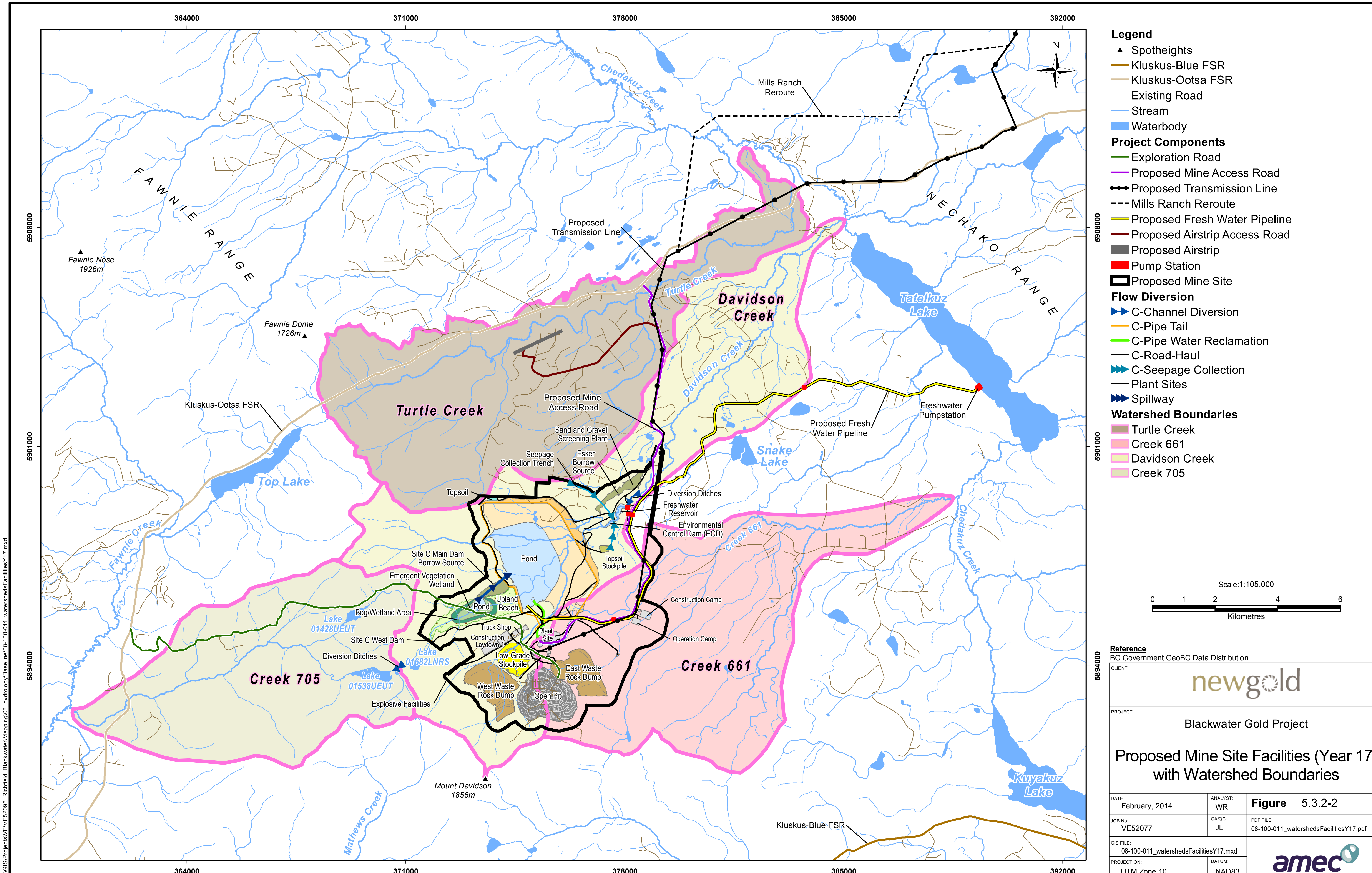
Surface water flow as a VC falls under the jurisdiction, regulations, and guidelines of several federal and provincial governmental agencies, all of which are interested in the effects of the Project on surface water flows and lake levels, as summarized in **Table 4.1-1** in **Section 4**. For instance, the British Columbia (BC) *Water Protection Act* (Government of BC, 1996) and *Fish Protection Act* (Government of BC, 1997) are key regulations governing surface water ownership and the protection of aquatic habitats, respectively. Likewise, the federal *Fisheries Act* (Government of Canada, 2013) governs the protection of fish habitat and surface water within the Project area.

Temporal boundaries and spatial boundaries of the Project are described in **Section 4**. There are no administrative boundaries that would apply to surface water flow and lake levels. Technical boundaries include those imposed by limitations in knowledge, data collection and modelling assumptions which have been discussed in **Section 5.3.2.6**.

The surface water flow Local Study Area (LSA) of the Project includes the following watersheds: Turtle Creek, Davidson Creek, Creek 661, Creek 705, and lower Chedakuz Creek (which contains Tatelkuz Lake) (**Figure 5.3.2-1**). These watersheds are either within or adjacent to the Project mine surface footprint (**Figure 5.3.2-2**). All Project mining components are surface structures, and most of them are located in the Davidson Creek and Creek 661 Watersheds. Drainage from the extreme upper extents of the Davidson Creek Watershed will be directed to the Creek 705 Watershed. Water from Tatelkuz Lake in the Chedakuz Creek Watershed will be used to supplement mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in open pit flooding (during closure). The Project includes other mine components, such as a transmission line, access roads, and an airstrip, that may require clearing and water crossings.

The Project has the potential, with its water diversion, water management, and withdrawal activities, to affect natural streams, drainage areas, and surface water flows (monthly and annual flows, peak flows, and low flows) within these watersheds and to affect Tatelkuz Lake levels during the construction, operations, closure, and post-closure phases (temporal boundaries). In addition, the alteration of surface water flows and Tatelkuz Lake levels has the potential to affect other Project VCs, such as surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetlands.


Legend
Meteorological Station
Hydrology Station
Populated Place
Spotheights
Kluskus FSR
Kluskus-Blue FSR
Kluskus-Ootsa FSR
Stream
Waterbody
Project Components
Exploration Road
Proposed Transmission Line
Mills Ranch Reroute
Proposed Mine Access Road
Proposed Fresh Water Pipeline
Proposed Airstrip Access Road
Proposed Airstrip
Proposed Mine Site
Watersheds
Chedakuz Creek Local
Creek 661
Creek 705
Davidson Creek
Tatelkuz Lake Tributaries
Turtle Creek
Surface Water Flow
Local Study Area
Regional Study Area
Scale:1:200,000
0 2.5 5 10
Kilometres
Reference
BC Government GeoBC Data Distribution
AMEC 2013 Baseline Report - Fish and Aquatic Resources
CLIENT:
newgold
PROJECT:
Blackwater Gold Project
Surface Water Flow
Study Areas
DATE: September, 2014
ANALYST: WR
Figure 5.3.2-1
JOB No: VE52420
QA/QC: JW
PDF FILE: 09-100-003_v24.pdf
GIS FILE: 09-100-003_v24.mxd
PROJECTION: UTM Zone 10
DATUM: NAD83
amec
Natalkuz Lake
(Nechako Reservoir)
Entiako River
Erhorn Creek
Big Bend
Euchiniko River
Brewster Lake
Proposed Transmission Line
Kluskus FSR
Mount Swannel 1768m
Chedakuz Creek
Lake 113
Mills Lake
Chutanli Lake
Taiuk Creek
FAWNIE RANGE
NECHAKO RANGE
Capoose Lake
Fawnie Nose 1926m
Kluskus-Ootsa FSR
1-TC
H5
1-DC
15-CC
H6
4-DC
Tatelkuz Mountain 1611m
Fawnie Dome 1726m
Turtle Creek
Davidson Creek
H4B
Tatelkuz Lake
Kluskus-Blue FSR
H3
Proposed Fresh Water Pipeline
Top Lake
Snake Lake
1-661
Suscha Lake
Node 1-505659
H2
H1
Exploration Road
11-DC
Kuyakuz Mountain 1734m
Lake 01428UEUT
4-705
6-705
Lake 01682LNRS
Lake 01538UEUT
Creek 705
1-705
H-7
Fawnie Creek
Kuyakuz Lake
Laidman Lake
Mount Davidson 1856m
Mathews Creek
Euchiniko Lakes
Blackwater River
Tsacha Mountain 1781m
Williamson Lake
Kluskus
Kluskus Creek
Tsacha Lake
Kluskus Lakes
Kushya River
360000
375000
390000
405000
5925000
5910000
5895000
5880000
\\Bby-fs2\bby-ee-gis\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\09_water-quality\Baseline\09-100-003_v24.mxd



Proposed Mine Site Facilities (Year 17) with Watershed Boundaries

Figure 5.3.2-2

5.3.2.2 Valued Component Baseline

Preservation of existing fish stocks and water quality are important objectives for local residents and Aboriginal groups. Members of these groups have expressed their interest in the Project's effects on surface water flow and Tatelkuz Lake levels. These groups' comments during the engagement and consultation process have provided insights into traditional, ecological, or community knowledge, which is defined as a body of knowledge built up by a group of people through generations of living in close contact with nature. This includes unique knowledge about the local environment, how it functions, and its characteristic ecological relationships.

Water is of great importance to First Nations that reside near the Project. In July 2013, interviews were conducted with residents of Indian Reserve (IR) #28. At the time, it was noted that "water is our life, it is the life for plants, trees and animals." One Elder noted that she used to drink water from Tatelkuz Lake and Chedakuz Creek, but now she drives to Vanderhoof to obtain bottled drinking water. The Elder also described flow variations noting flows in the area are generally high in the spring. During the spring of 2013, flows were so high that it impeded access to IR #28 as the bridge on Davidson Creek was flooded (interviews with Lhoosk'uz Dene Elders, 2013).

Surface water flow is also valued by local residents. For example, lakes, rivers, and streams are used by recreational canoeists, while the major rivers (e.g., Blackwater, Nechako, and Stuart) are used for white water rafting and boating (interviews with BC Ministry of Forests, Lands and Natural Resource Operations, 2013). Boating is flow dependent, meaning changes to the water flow could affect one's ability to engage in these activities. In addition, people engaging in boating activity value surface water flow and volume, streambed features, and channel gradient and restrictions because these features contribute to the enjoyment of boating activities. Late summer and fall are important times for boating, while spring is important for white water rafting (interviews with BC Ministry of Forests, Lands and Natural Resource Operations, 2013). The Project avoids the watersheds containing the Blackwater and Stuart Rivers and therefore will not impact these watercourses. Surface water is also valued as a source of drinking water for human and cattle consumption (interviews with Tatelkuz Lake Ranch Resort, 2012). Additional comments on surface water flows and related issues raised can be found in **Section 3** that contains the public and Aboriginal issues tracking tables for the Project. **Section 14** through **Section 16** provide a summary of the Aboriginal background, rights, and interests for the Project.

In addition to Aboriginal traditional use, past land use in the Project area includes mineral exploration, agricultural, recreational and forestry activities. The effects of these past activities on the existing watersheds are included in the surface water flow baseline conditions and are assessed as potential cumulative effects with the Project (**Section 5.3.2.5**) on surface water flow in the Aquatics RSA. Present and future land use in the Project area that could potentially affect surface water flow includes agriculture, forestry, and mineral exploration are assessed as potential cumulative effects with the Project (**Section 5.3.2.5**) on surface water flow in the Aquatics RSA.

The Project area includes the Turtle Creek, Davidson Creek, Creek 661, Creek 705, and Chedakuz Creek watersheds. In the spring of 2011, a field program was initiated to collect hydrologic data for the Project. The field program covered the period from the spring of 2011 to the winter of 2013. Project climate data were collected from July 2011 to December 2012 (Knight Piésold Ltd. (Knight

Piésold), 2013f). The following sections summarize the surface water flow baseline for the Project, relevant climate baseline information, and baseline Tatelkuz Lake levels for the Project. Unless otherwise noted, all surface water flow, climate, and Tatelkuz Lake level baseline information was determined by Knight Piésold. Refer to **Section 5.1.2.1** for detailed baseline information.

The available hydrological data were used in a quantitative assessment of the potential residual effects of the Project. A combination of quantitative and qualitative assessments (i.e., expertise and professional judgement) was used to determine the significance of the residual effects.

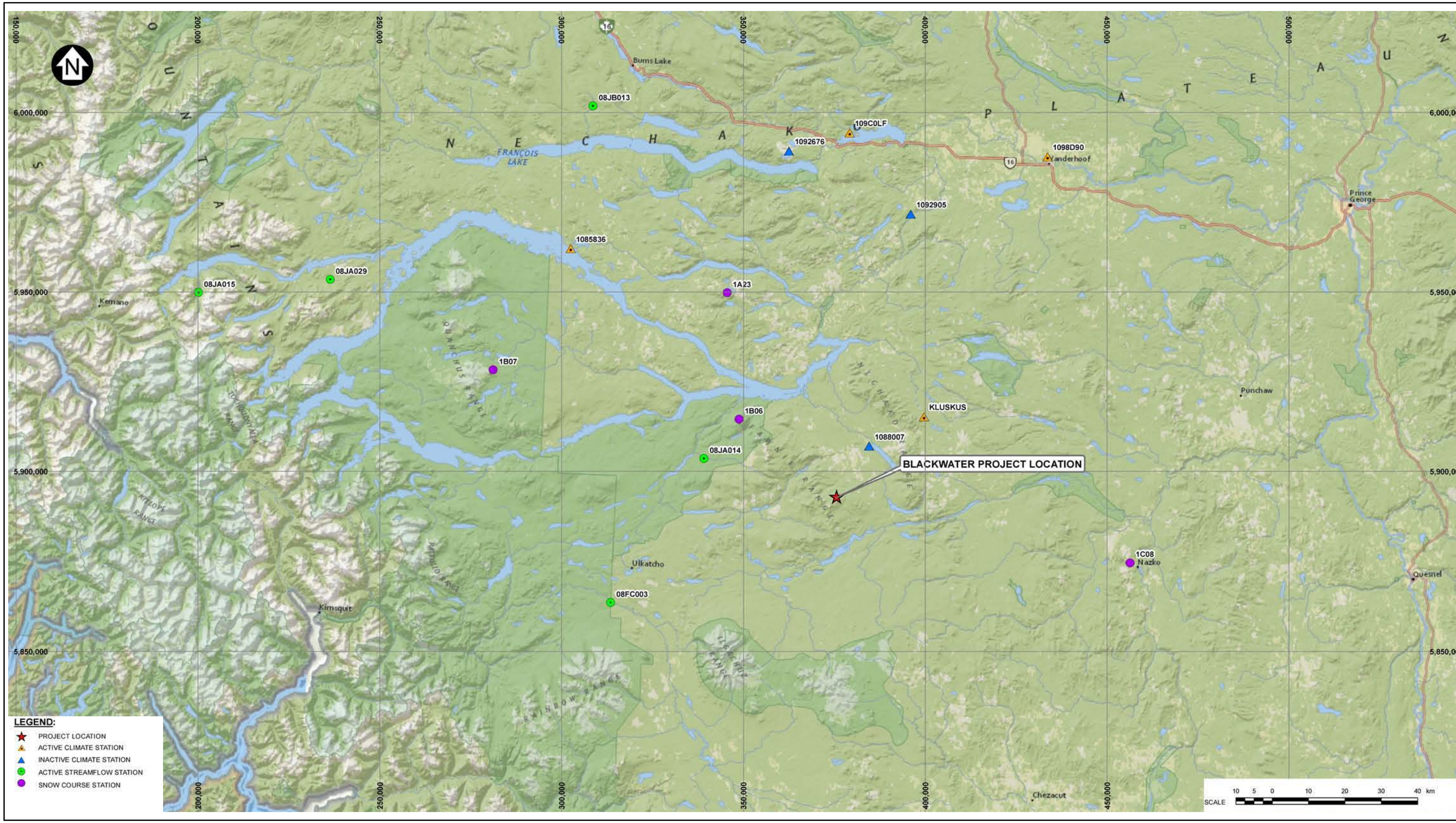
5.3.2.2.1 Surface Water Flow

Hydrological data were collected within the Project area from the spring of 2011 through the winter of 2013. Data collection continued beyond 2013 for future work and permitting. If necessary, hydrometric stations were removed during the winter months to avoid ice damage, although periodic winter flow measurements were obtained manually (Knight Piésold, 2013f). Data collection activities were undertaken according to the guidelines given in the Manual of British Columbia Hydrometric Standards (British Columbia Ministry of the Environment, 2009). Hydrological data were collected at the following seven hydrometric stations within the Project area (**Figure 5.3.2-1**).

- H1 (also Water Quality Node 5): Creek 661, a tributary of Chedakuz Creek, located at approximately the mid-point of the watershed;
- H2 (also Water Quality Node 10): Davidson Creek, a tributary of Chedakuz Creek, located in the upper extents of the Davidson Creek Watershed , immediately downstream of the proposed Project mine site;
- H3 (also Water Quality Node 11): Creek 700, a tributary of Turtle Creek;
- H4B (also Water Quality Node 26): Davidson Creek, a tributary of Chedakuz Creek, located in the lower extents of the Davidson Creek Watershed at a bridge crossing;
- H5 (also Water Quality Node 9): Chedakuz Creek, at a road crossing below its confluence with Davidson Creek and downstream of Tatelkuz Lake;
- H6: Turtle Creek, a tributary of Chedakuz Creek, located at a bridge crossing; and
- H7: Creek 705, a tributary of Fawnie Creek, located in the lower extents of the Creek 705 Watershed at the Kluskus-Ootsa Forest Service Road (FSR) Bridge.

Figure 5.3.2-1 shows three additional hydrometric stations (H8, H9, and H10). These stations are not included in the hydrology section, as no data have been collected for these sites.

Regional hydrometric data are available from Water Survey of Canada (WSC). **Figure 5.3.2-3** shows the location of these hydrometric stations.



Notes:

Figure from Knight Piésold 2013 Engineering Hydrometeorology Report (VA101-457/6-12, Revision 0) dated 04 November 2013 (Appendix 5.1.2.1B).

CLIENT: newgold	DWN BY: MY	PROJECT: Blackwater Gold Project	DATE: January 2014
	CHK'D BY: JK		PROJECT NO: VE52277
AMEC Environment & Infrastructure 4445 Lougheed, Suite 600, Burnaby, B.C., V5C 0E4 Tel. 604-294-3811 Fax 604-294-4664	DATUM: N/A	TITLE: Regional Streamflow and Climate Stations	REV. NO.: A
	PROJECTION: N/A		FIGURE No. 5.3.2-3
	SCALE: N/A		

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Knight Piésold used the site and regional climate and hydrometric data to estimate the following baseline flows for the Project (**Appendix 5.1.2.1B** in **Section 5.1.2.1**):

- Mean monthly and annual flows;
- Wet and dry monthly and annual flows for recurrence intervals of 5, 10, 20, and 50 years;
- Instantaneous peakflows for some hydrometric stations for recurrence intervals of 2, 5, 10, 20, 50, 100, and 200 years (referred to as peak flood events in the AIR); and
- Seven-day duration low flows for recurrence intervals of 10 years (7Q10, referred to as 10-year seven-day low flow in the AIR) and 20 years (7Q20).

Both site and regional data were used to establish baseline hydrological parameters for the Project. The long-term mean annual unit runoff for the Project area was estimated to be 6.1 litres per second per square kilometre (L/s/km^2), which is equivalent to an average runoff of 198 millimetres (mm). The effective annual runoff coefficient for the natural drainage areas in the Project was estimated to be 0.31 (Knight Piésold, 2013f).

A spreadsheet watershed model that had a monthly time step was developed to simulate the Project baseline flows. The watershed model was used to estimate baseline average surface water flows within the Turtle Creek, Davidson Creek, Creek 661, and Creek 705 watersheds. The Chedakuz Creek Watershed was not included in the spreadsheet watershed model. Instead, a long-term synthetic baseline stream flow series was developed for Node H5 that was pro-rated to Node 15-CC on the basis of drainage area. The long-term synthetic streamflow series at Node H5 was used for the analysis of Project effects at this node and these streamflow impacts were pro-rated to Node 15-CC using drainage area (Knight Piésold, 2013d). Hydrologic data were collected at seven hydrometric stations within the Project area, as previously discussed. In addition to the Project hydrometric stations, there were also various water quality monitoring nodes and locations of interest to fisheries that were included in the watershed model (**Figure 5.3.2-4**). The following watershed model nodes (WMN) were deemed essential for identifying the effects of the Project on surface water flows in the Turtle Creek, Davidson Creek, Creek 661, and Creek 705 Watersheds:

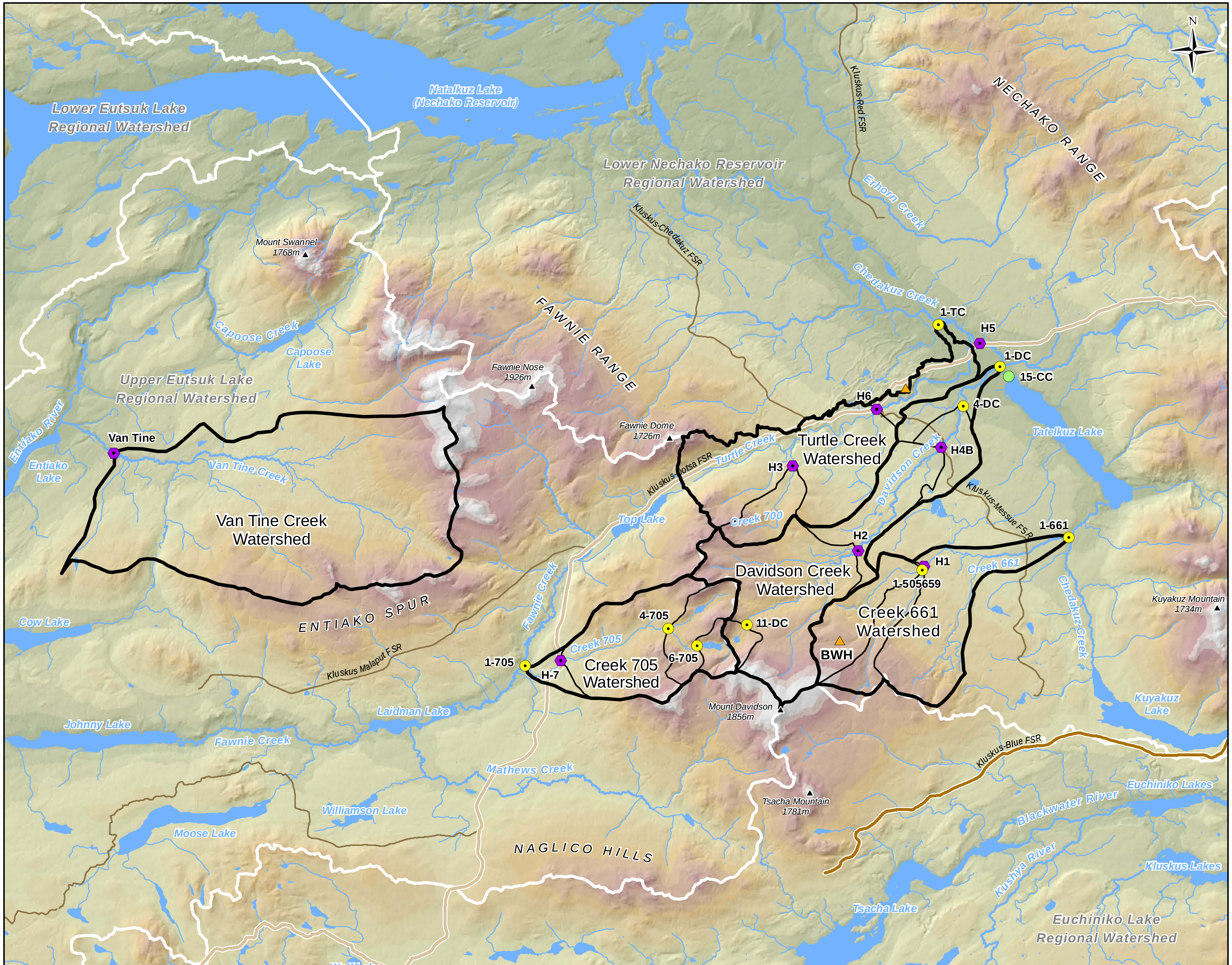
- WMN H3 (also site hydrometric station H3 and Water Quality Node 11): Creek 700, a headwater tributary of Turtle Creek, located in the upper extents of the Turtle Creek Watershed;
- WMN H6 (also site hydrometric station H6): Turtle Creek, a tributary of Chedakuz Creek, located at the approximate mid-point of the Turtle Creek Watershed;
- WMN 1-TC (also Water Quality Node 26): Turtle Creek, upstream of its confluence with Chedakuz Creek;
- WMN 11-DC: headwaters of Davidson Creek, adjacent to the Project TSF saddle dam, and the limit of the Davidson Creek Watershed to be redirected to the Creek 705 Watershed by the Project;
- WMN H2 (also site hydrometric station H2 and Water Quality Node 10): Davidson Creek, a tributary of Chedakuz Creek, located in the upper extents of the Davidson Creek

Watershed, immediately downstream of the Project mine site. This node was used for watershed model calibration (Knight Piésold, 2013d);

- WMN H4B (also site hydrometric station H4B and Water Quality Node 26): Davidson Creek, located in the lower extents of the Davidson Creek Watershed at a bridge crossing;
- WMN 4-DC: Davidson Creek, located at the approximate upper extents of kokanee spawning;
- WMN 1-DC (also Water Quality Node 7): Davidson Creek, upstream of its confluence with Chedakuz Creek;
- WMN H1 (also site hydrometric station H1 and Water Quality Node 5): Creek 661, a tributary of Chedakuz Creek, located at the approximate mid-point of the entire watershed. This node was used for watershed model calibration (Knight Piésold, 2013d);
- WMN 1-505659: a tributary of Creek 661, the drainage area to this node may be affected by drainage from the Project mine site in the headwaters of the Creek 661 Watershed;
- WMN 1-661: Creek 661, upstream of its confluence with Chedakuz Creek;
- WMN 6-705 (also Water Quality Node 16): Creek 705, a tributary of Fawnie Creek, downstream of Lake 01538UEUT;
- WMN 4-705: Creek 705, located downstream of all lakes in the upper extents of the Creek 705 Watershed;
- WMN H7 (also site hydrometric station H7): Creek 705, located in the lower extents of the Creek 705 Watershed at the Kluskus-Ootsa FSR bridge;
- WMN 1-705: Creek 705, upstream of its confluence with Fawnie Creek; and
- Van Tine: Regional WSC hydrometric station (ID# 08JA014), used for watershed model calibration (Knight Piésold, 2013d).

The following watershed nodes (WN) were deemed essential for identifying the effects of the Project on surface water flows in the Chedakuz Creek watershed but were not included in the previously discussed spreadsheet watershed model:

- WN 15-CC (also Water Quality Node 8): Chedakuz Creek, at the outlet of Tatelkuz Lake; and
- WN H5 (also site hydrometric station H5 and Water Quality Node 9): Chedakuz Creek, at a road crossing below its confluence with Davidson Creek and downstream of Tatelkuz Lake.



Legend

Climatology Station

- Climatology Station
- Hydrology Station/Watershed Model Node
- Node Not Included in Watershed Model
- Watershed Model Node
- Stream (>4th Order)
- Stream (2nd & 3rd Order)
- Lake
- Watershed Boundaries
- Sub-Watersheds (Used for Knight Piesold Watershed modeling)

Elevation (m)

1,681 - 1,925	1,251 - 1,315
1,621 - 1,680	1,201 - 1,250
1,561 - 1,620	1,136 - 1,200
1,501 - 1,560	1,076 - 1,135
1,441 - 1,500	1,015 - 1,075
1,376 - 1,440	951 - 1,015
1,316 - 1,375	850 - 950

KEY MAP

Scale:1:200,000

0 2.5 5 10

Kilometres

Reference

Basemap: GeoBase DEM; Streams; Freshwater Atlas GeoBC; Hydrology stations and sub-watershed data from Knight Piésold 2013 Engineering Hydrometeorology Report (VA101-457/6-12, Revision 0) dated 04 November 2013 (Appendix 5.1.2.1B).

CLIENT: newgold

PROJECT: Blackwater Gold Project

Baseline Watershed Model Discretization

DATE: June, 2014	ANALYST: MY	**Figure** 5.3.2-4
JOB No: VE52420	QA/QC: AP	PDF FILE: 08-100-010_hydrometrix_monitoring_stations_v4.pdf
GIS FILE: 08-100-010_hydrometrix_monitoring_stations_v4.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

Y:\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\08_hydrology\Baseline\08-100-010_hydrometrix_monitoring_stations_v4.mxd

Flows for the following hydrological events were determined using statistical methods that were applied to the output from the spreadsheet watershed model: 1:5 dry and wet years; 1:10 dry and wet years; 1:20 dry and wet years; 1:50 dry and wet years; and 7Q10 and 7Q20 low flows. An Excel-based model that used primarily a lognormal distribution was employed to estimate dry and wet flows for each node. The 7Q10 and 7Q20 low flows were estimated by conducting a frequency analysis on annual monthly low flow values and then multiplying the results by 7-day to monthly ratios (Knight Piésold, 2013d). **Table 5.3.2-1** summarizes the estimated baseline mean wet and dry monthly and annual surface water flows at each of the watershed nodes listed earlier. These surface water flows were used as the basis for assessing the key hydrologic parameters of mean monthly and annual, peak, and low flows within Project watersheds for each phase of the Project.

Lake levels were assessed using mean and 1:50 year dry conditions (the worst case evaluated) for monthly and annual flow data. Discharge and stage data for the mean and the 1:10 year dry conditions downstream of Tatelkuz Lake, based on mean daily discharges, were provided by Knight Piésold in Table 2 of **Appendix 5.3.2C**. However, a direct comparison between 1:50 monthly flows and 1:10 daily flows is not possible as daily and monthly flows for varying return periods have no correlation. Lake levels were revised very slightly in a reanalysis by Knight Piésold (January 2014). The letter memorandum is attached as **Appendix 5.2.3D**. The data set out in **Appendix 5.3.2D** is provided for information purposes. It is important to note that the data was produced subsequent to the data set used in the assessment. Although these data are different from those in the assessment they do not alter the outcomes of the assessment.

The recurrence intervals used in the analyses were selected in accordance with provincial recommendations for water quality modelling, e.g., derivation of 7Q10 flows (BC MOE, 2012) and the assessment of aquatic effects of changes to stream flows (Lewis et al., 2004).

Table 5.3.2-1: Estimated Baseline Mean Wet and Dry Monthly and Annual Surface Water Flows for the Project

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
Turtle Creek													
H3 (WQ11:upper watershed on tributary Creek 700)													
1:50 Dry	1.4	1.0	0.8	0.9	124	51	15	5.4	2.8	1.4	1.2	1.4	17
1:20 Dry	1.8	1.3	1.1	1.6	139	64	18	6.8	3.8	2.3	1.9	2.0	20
1:10 Dry	2.3	1.7	1.4	2.8	153	79	22	8.4	5.0	3.5	3.0	2.6	24
1:5 Dry	3.0	2.2	1.9	5.5	173	101	28	11	7.0	5.9	5.0	3.8	29
Mean	6.1	4.3	4.3	52	226	185	49	21	18	31	27	9.8	53
1:5 Wet	8.8	6.2	6.3	70	275	263	68	28	24	42	39	15	70
1:10 Wet	12	8.1	8.6	138	310	338	86	37	34	71	66	21	94
1:20 Wet	15	10	11	240	343	415	104	45	44	109	102	28	122
1:50 Wet	19	13	15	447	384	524	130	57	60	175	167	39	169
H6 (mid-point of watershed)													
1:50 Dry	53	46	40	61	339	166	128	104	85	57	50	54	99
1:20 Dry	61	53	48	82	389	205	142	112	94	69	62	63	115
1:10 Dry	69	61	55	106	439	248	156	121	102	82	75	73	132
1:5 Dry	80	71	66	145	510	312	175	132	114	101	94	86	157
Mean	112	99	102	325	710	550	225	159	143	168	165	126	241
1:5 Wet	142	126	133	481	897	749	272	184	170	221	222	162	313
1:10 Wet	165	146	159	659	1041	943	305	201	189	272	278	192	379
1:20 Wet	187	166	185	853	1,176	1,139	335	216	206	322	336	220	445
1:50 Wet	215	191	219	1,143	1,350	1,410	373	234	227	390	414	257	535
1-TC (WQ 13 upstream of confluence with Chedakuz Creek)													
1:50 Dry	72	65	58	81	377	194	158	132	111	78	69	74	122
1:20 Dry	82	74	67	106	430	237	174	142	122	93	83	85	141

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1:10 Dry	92	82	77	134	483	284	190	152	131	108	99	96	161
1:5 Dry	105	94	90	179	557	352	211	164	144	130	121	112	188
Mean	143	128	130	368	764	596	263	194	176	201	199	158	277
1:5 Wet	177	159	166	534	958	801	313	222	206	260	262	200	355
1:10 Wet	204	182	196	711	1,104	995	347	241	227	313	322	233	423
1:20 Wet	228	204	223	901	1,241	1,189	378	257	245	364	380	264	490
1:50 Wet	259	232	259	1,176	1,416	1,452	416	277	267	431	459	304	579
Davidson Creek													
11-DC (upper extents of watershed upstream of proposed TSF)													
1:50 Dry	0.0	0.0	0.0	0.0	22	12	2.7	0.5	0.1	0.0	0.0	0.0	3.1
1:20 Dry	0.0	0.0	0.0	0.0	25	15	3.5	0.7	0.1	0.0	0.0	0.0	3.7
1:10 Dry	0.0	0.0	0.0	0.0	29	19	4.3	0.9	0.2	0.0	0.0	0.0	4.4
1:5 Dry	0.0	0.0	0.0	0.0	34	24	5.7	1.2	0.3	0.0	0.0	0.0	5.5
Mean	0	0	0	8	49	46	11	3	1	2	2	0	10
1:5 Wet	0.0	0.0	0.0	20	63	66	16	3.7	1.5	0.7	0.2	0.0	14
1:10 Wet	0.0	0.0	0.0	29	74	86	21	5.0	2.3	2.4	0.6	0.1	18
1:20 Wet	0.1	0.0	0.0	35	85	107	27	6.4	3.3	6.7	2.3	0.5	23
1:50 Wet	0.4	0.1	0.0	41	99	136	34	8.4	5.1	21	11	2.2	30
H2 (WQ10 midpoint of watershed immediately downstream of proposed TSF)													
1:50 Dry	58	53	50	34	374	308	184	136	107	88	57	57	125
1:20 Dry	90	84	57	46	432	369	204	145	116	99	91	65	150
1:10 Dry	98	91	84	60	491	434	224	153	124	110	102	99	173
1:5 Dry	108	100	93	83	573	529	250	165	136	125	117	111	199
Mean	133	123	115	204	816	834	318	191	163	166	160	141	281
1:5 Wet	156	145	136	280	1,036	1,116	382	215	190	203	198	169	352

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
1:10 Wet	172	159	150	385	1,210	1,358	427	231	207	231	227	189	412
1:20 Wet	186	172	162	502	1,375	1,596	468	245	222	256	254	207	471
1:50 Wet	203	189	178	675	1,588	1,915	519	262	241	288	288	230	548
H4B (WQ26)													
1:50 Dry	80	73	70	67	461	364	227	169	118	90	78	79	156
1:20 Dry	103	94	79	87	529	434	251	182	148	105	93	91	183
1:10 Dry	114	104	101	109	597	507	275	194	159	119	108	117	209
1:5 Dry	129	117	113	144	692	612	308	210	174	158	145	134	245
Mean	168	152	145	297	964	949	391	246	210	215	210	183	345
1:5 Wet	205	184	176	411	1,214	1,257	470	281	244	266	267	228	433
1:10 Wet	231	208	197	542	1,407	1,519	525	304	267	305	313	262	507
1:20 Wet	256	229	217	680	1,589	1,774	575	324	287	342	358	294	577
1:50 Wet	286	256	241	878	1,822	2,113	637	348	312	388	415	334	669
4-DC													
1:50 Dry	92	84	80	90	503	373	230	171	136	104	90	90	170
1:20 Dry	104	94	91	115	577	446	256	184	148	120	106	104	195
1:10 Dry	115	104	101	143	652	522	281	197	160	136	123	118	221
1:5 Dry	131	118	116	186	756	633	316	214	176	160	148	137	258
Mean	174	156	155	362	1,053	991	406	254	216	229	227	192	369
1:5 Wet	214	191	192	504	1,328	1,316	491	292	254	290	295	243	467
1:10 Wet	243	217	220	656	1,539	1,595	551	316	279	339	353	282	549
1:20 Wet	270	241	245	814	1,739	1869	606	338	302	386	410	319	628
1:50 Wet	304	270	278	1038	1994	2233	675	365	330	446	485	367	732
1-DC (WQ7 upstream of confluence with Chedakuz Creek)													
1:50 Dry	113	105	100	112	540	403	259	198	161	126	110	111	195

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1:20 Dry	127	117	112	141	617	478	286	213	175	144	129	127	222
1:10 Dry	140	128	124	172	694	557	313	226	188	162	148	142	250
1:5 Dry	157	144	141	220	801	671	349	244	205	187	175	163	288
Mean	203	185	184	404	1,104	1,033	441	286	247	260	258	223	403
1:5 Wet	246	223	225	557	1,384	1,361	527	326	287	324	330	277	506
1:10 Wet	277	250	254	712	1,598	1,640	588	351	313	375	391	318	589
1:20 Wet	306	275	281	870	1,798	1,911	643	374	337	422	448	356	668
1:50 Wet	341	305	315	1091	2,053	2,270	711	401	365	482	523	405	772
Creek 661													
H1 (WQ5)													
1:50 Dry	1.3	1.1	0.9	0.6	38	31	14	6.4	3.2	1.9	1.4	1.3	8.4
1:20 Dry	1.7	1.4	1.1	0.8	47	39	17	7.6	4.0	2.5	1.9	1.8	10
1:10 Dry	2.1	1.7	1.3	1.0	56	49	20	8.8	4.9	3.3	2.6	2.3	13
1:5 Dry	2.7	2.2	1.7	1.5	70	64	24	11	6.1	4.6	3.8	3.2	16
Mean	6	4	3	20	117	122	38	16	11	11	11	8	31
1:5 Wet	7.6	5.7	4.6	19	162	175	51	22	15	16	15	11	42
1:10 Wet	10	7.3	5.9	44	202	228	62	26	18	22	22	15	55
1:20 Wet	12	8.9	7.3	88	242	283	72	31	22	28	29	19	70
1:50 Wet	16	11	9.3	179	296	361	87	36	28	39	41	26	94
1-505659 (upper extents of watershed on a tributary potentially impacted by mine footprint)													
1:50 Dry	2.3	1.2	0.5	0.6	149	96	33	15	8.1	3.8	2.8	2.7	26
1:20 Dry	3.1	1.7	0.8	1.2	168	116	40	17	10	5.5	4.2	3.8	31
1:10 Dry	4.0	2.3	1.2	2.3	188	138	47	20	12	7.6	6.0	5.0	36
1:5 Dry	5.5	3.3	1.9	4.8	214	170	56	24	15	11	9.2	7.0	44
Mean	12	9	8	60	289	275	89	36	26	37	34	17	75

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1:5 Wet	18	14	12	81	356	372	117	47	35	51	47	25	98
1:10 Wet	25	21	19	170	407	458	142	56	44	77	73	36	127
1:20 Wet	32	28	29	313	454	543	166	64	52	106	104	47	162
1:50 Wet	43	40	45	622	513	657	199	76	64	154	155	64	219
1-661 (upstream of confluence with Chedakuz Creek upstream of Tatelkuz Lake)													
1:50 Dry	48	44	40	34	439	250	135	97	68	42	37	45	107
1:20 Dry	55	49	46	49	505	312	157	107	77	53	48	53	126
1:10 Dry	62	55	52	67	572	379	180	116	86	66	60	62	146
1:5 Dry	71	63	60	99	665	481	212	129	98	86	79	74	176
Mean	97	85	82	293	934	852	307	162	134	169	164	114	283
1:5 Wet	121	105	103	424	1,184	1,186	393	192	163	230	226	148	373
1:10 Wet	139	120	119	621	1,378	1,504	462	214	187	298	297	177	460
1:20 Wet	156	134	133	851	1,561	1,828	529	233	208	369	373	205	548
1:50 Wet	177	152	152	1,214	1,796	2,278	614	257	236	470	481	243	672
Creek 705													
6-705 (WQ16 in upper extents of watershed downstream of fish compensation)													
1:50 Dry	0.0	0.0	0.0	0.0	60	49	11	3.6	1.4	0.1	0.5	0.0	10
1:20 Dry	0.0	0.0	0.0	0.0	69	53	13	4.4	1.9	0.8	0.6	0.0	12
1:10 Dry	0.0	0.0	0.0	0.0	78	57	15	5.4	2.5	1.3	0.8	0.0	13
1:5 Dry	0.1	0.0	0.0	0.0	91	62	19	6.7	3.4	2.2	1.2	0.2	16
Mean	2	1	1	18	130	75	29	12	9	12	10	4	25
1:5 Wet	4.0	2.2	1.7	37	165	87	38	16	12	17	12	7.1	33
1:10 Wet	4.9	2.5	2.1	58	193	95	46	20	17	28	24	9.5	42
1:20 Wet	5.8	2.7	2.5	74	219	102	54	25	22	44	42	12	50
1:50 Wet	6.9	3.0	2.9	95	253	111	64	30	30	72	74	15	63

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
4-705 (midpoint of watershed)													
1:50 Dry	0.0	0.0	0.0	0.0	186	125	31	7.5	3.2	0.5	0.5	0.0	29
1:20 Dry	0.0	0.0	0.0	0.0	217	141	37	9.7	3.7	0.9	0.7	0.0	34
1:10 Dry	0.0	0.0	0.0	0.0	250	157	43	12	4.3	1.6	0.9	0.0	39
1:5 Dry	0.1	0.0	0.0	0.0	296	179	53	16	5.5	3.3	1.5	0.3	46
Mean	5	2	1	74	437	238	85	33	23	38	33	11	82
1:5 Wet	9.1	3.1	2.3	161	564	294	112	46	30	50	25	24	110
1:10 Wet	12	3.7	3.3	243	668	334	137	61	53	102	66	29	143
1:20 Wet	15	4.2	4.2	314	768	372	161	76	84	184	145	32	180
1:50 Wet	18	4.9	5.2	403	898	420	193	99	136	358	328	37	242
H7 (lower extents of watershed)													
1:50 Dry	1.9	0.1	0.0	9.4	517	290	81	29	14	6.3	4.3	5.2	80
1:20 Dry	2.7	0.1	0.0	12	601	338	97	36	19	10	7.3	6.5	94
1:10 Dry	4.0	0.3	0.2	15	688	388	114	44	24	15	11	8.6	109
1:5 Dry	6.9	1.7	1.5	22	811	459	139	55	33	26	20	13	132
Mean	27	17	16	252	1,181	670	222	100	80	131	116	46	239
1:5 Wet	41	28	28	249	1,512	868	294	134	110	180	166	68	306
1:10 Wet	58	35	33	569	1,781	1,026	358	170	151	301	290	95	405
1:20 Wet	74	41	39	1,100	2,038	1,177	420	205	195	425	410	122	521
1:50 Wet	97	49	45	1,869	2,372	1,374	505	255	261	640	630	158	688
1-705 (upstream of confluence of Fawnie Creek)													
1:50 Dry	11	8.7	7.8	22	542	307	93	39	22	11	9.1	11	90
1:20 Dry	14	11	9.9	26	629	357	110	47	28	17	14	14	106
1:10 Dry	17	13	12	31	718	409	128	56	35	24	21	19	124
1:5 Dry	22	17	16	42	843	481	154	69	46	38	33	26	149

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean	41	30	31	282	1,218	694	239	114	94	146	132	61	258
1:5 Wet	58	42	43	334	1,555	895	313	151	128	204	190	88	333
1:10 Wet	75	53	56	664	1,826	1,053	376	186	167	318	302	122	433
1:20 Wet	92	64	69	1,147	2,084	1,204	438	221	208	457	442	159	549
1:50 Wet	117	80	88	2,011	2,419	1,401	521	268	266	688	678	215	729
Van Tine (WSC Regional Station ID# 08JA014)													
1:50 Dry	35	26	28	146	1,633	848	257	119	72	103	32	35	278
1:20 Dry	45	33	32	209	1,882	1,014	312	147	93	108	50	49	331
1:10 Dry	57	42	39	288	2,135	1,187	371	176	117	114	75	65	389
1:5 Dry	76	55	54	426	2,490	1,440	459	220	155	127	122	93	476
Mean	153	110	165	1,215	3,533	2,244	766	385	330	548	517	237	854
1:5 Wet	222	159	237	1,886	4,463	2,992	1,025	515	452	776	766	354	1,154
1:10 Wet	294	210	328	2,789	5,204	3,627	1,266	644	598	1,230	1,242	503	1,495
1:20 Wet	371	264	419	3,846	5,904	4,248	1,506	774	754	1,794	1,848	672	1,867
1:50 Wet	482	341	539	5,523	6,805	5,076	1,832	952	978	2,747	2,891	930	2,425
Chedakuz Creek													
15-CC (outlet of Tatelkuz Lake)													
1:50 Dry	604	626	705	548	959	973	659	445	334	424	630	598	625
1:20 Dry	659	677	763	685	1,240	1,238	788	522	411	503	723	666	740
1:10 Dry	712	726	819	835	1,558	1,533	923	601	496	587	817	734	862
1:5 Dry	782	789	892	1,062	2,056	1,990	1,120	713	622	706	949	825	1,042
Mean	954	942	1,071	2,027	4,301	3,913	1,811	1,070	1,123	1,106	1,341	1,066	1,727
1:5 Wet	1,117	1,087	1,236	2,654	5,908	5,355	2,335	1,369	1,472	1,433	1,674	1,288	2,244
1:10 Wet	1,227	1,183	1,347	3,377	7,798	6,948	2,833	1,625	1,847	1,726	1,944	1,449	2,775
1:20 Wet	1,325	1,268	1,446	4,115	9,796	8,606	3,320	1,872	2,226	2,011	2,197	1,595	3,315

Mine Phase	Estimated Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
1:50 Wet	1,445	1,370	1,565	5,143	12,665	10,952	3,970	2,194	2,745	2,389	2,523	1,778	4,062
H5 (midway between Davidson Creek and Turtle Creek confluences)													
1:50 Dry	908	941	1,059	824	1,441	1,462	990	669	501	637	946	898	940
1:20 Dry	991	1,018	1,147	1,029	1,864	1,860	1,184	784	618	757	1,086	1,001	1,112
1:10 Dry	1,070	1,090	1,230	1,255	2,341	2,304	1,387	903	745	881	1,228	1,102	1,295
1:5 Dry	1,175	1,186	1,341	1,596	3,090	2,990	1,683	1,072	934	1,062	1,426	1,240	1,566
Mean	1,434	1,416	1,609	3,047	6,464	5,880	2,721	1,607	1,688	1,662	2,015	1,602	2,595
1:5 Wet	1,678	1,634	1,858	3,988	8,878	8,047	3,509	2,057	2,213	2,153	2,516	1,936	3,372
1:10 Wet	1,843	1,778	2,025	5,074	11,719	10,442	4,257	2,443	2,776	2,594	2,921	2,177	4,171
1:20 Wet	1,991	1,905	2,173	6,184	14,721	12,933	4,989	2,813	3,344	3,022	3,302	2,398	4,981
1:50 Wet	2,171	2,059	2,352	7,729	19,033	16,458	5,966	3,297	4,125	3,590	3,791	2,673	6,104

Source: Knight Piésold, 2013d (**Appendix 5.1.2.1B**).

Note: L/s = litre per second.

Table 5.3.2-2 shows a summary of the estimated instantaneous peak flows. Knight Piésold noted that using the baseline data might considerably overestimate the peak instantaneous flows for the Project until more definitive site information is available (Knight Piésold, 2013f). Hence, the estimated instantaneous peak flows are conservatively high from an engineering design standpoint.

Table 5.3.2-2: Estimated Instantaneous Peak Flows for the Project

Station Name	Area (km^2)	Instantaneous Peak Flows (m^3/s)						
		Return Period (Years)						
		2	5	10	20	50	100	200
Index Flood Frequency Factor		***0.47***	***0.76***	***1.00***	***1.26***	***1.65***	***1.99***	***2.40***
H1	8.9	1.2	1.9	2.5	3.1	4.1	4.9	5.9
H2	47.2	4	7	9	11	15	18	22
H3	9.0	1.2	1.9	2.5	3.2	4.2	5.0	6.0
H4B	61.0	5.4	8.8	11.6	14.6	19.1	23.1	27.8
H5	593.0	31	50	66	83	108	131	158
H6	55.0	5.0	8.2	10.7	13.5	17.7	21.3	25.7
H7	41.0	3.9	6.2	8.2	10.3	13.5	16.3	19.7

Source: H1, H2, and H5 data from Knight Piésold (Knight Piésold, 2013f, **Appendix 5.1.1.1A**). AMEC estimated remaining data

Note: km^2 = square kilometre; m^3/s = cubic metre per second

Table 5.3.2-3 shows a summary of the estimated baseline 7Q10 and 7Q20 low flows.

Table 5.3.2-3: Estimated Baseline for 7Q10 and 7Q20 Low Flows

Return Period	7 Day Low Flows (L/s)																	
	Turtle Creek			Davidson Creek					Creek 661			Creek 705				Van Tine	Chedakuz	
	H3	H6	1-TC	11-DC	H2	H4B	4-DC	1-DC	H1	1-505659	1-661	6-705	4-705	H7	1-705	08JA014	15-CC	H5
1:10 Year	0.9	43.1	59.1	0.0	63.7	75.4	75.7	93.6	0.8	0.8	41.0	0.0	0.0	8.5	9.1	26.0	468.9	704.7
1:20 Year	0.7	41.0	56.0	0.0	60.7	71.6	71.8	89.1	0.6	0.4	39.8	0.0	0.0	7.9	8.5	21.8	459.4	690.3

Source: Knight Piésold, 2013d (**Appendix 5.1.2.1B**).

Note: 7Q10 = seven-day, consecutive low flow with a 10-year return period; 7Q20 = seven-day, consecutive low flow with a 20-year return period;
L/s = litre per second.

5.3.2.2.2 Climate

Regional data and site data were used to estimate baseline climate parameters for the Project. Only those climate parameters pertaining to surface water flow, such as precipitation, evapotranspiration, sublimation, snowmelt, and temperature are summarized herein. These climate parameters were used as a basis for water balance, watershed models, and hydrological design criteria for the Project.

A mean annual precipitation of 636 mm was estimated for the Project. Based on regional precipitation distribution patterns, it is expected that the Project area will experience precipitation throughout the year, with April being the driest month and November, December, and January being the wettest months (Knight Piésold, 2013f). **Table 5.3.2-4** summarizes the mean precipitation, rainfall, and snow water equivalent estimated for the Project.

Table 5.3.2-4: Estimated Mean Precipitation, Rainfall, and Snow Water Equivalent for the Project

Parameter	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation	mm	73	45	39	20	50	66	52	51	47	47	74	72	636
Precipitation Distribution	%	12	7	6	3	8	10	8	8	7	7	12	11	100
Rainfall	mm	0	0	0	13	50	66	52	51	47	31	0	0	310
Rainfall Distribution	%	0	0	0	65	100	100	100	100	100	65	0	0	49
Snow Water Equivalent	mm	73	45	39	7	0	0	0	0	0	16	74	72	326
Snow Water Equivalent Distribution	%	100	100	100	35	0	0	0	0	0	35	100	100	51

Source: Knight Piésold, 2013f (**Appendix 5.1.1.1A**).
Note: mm = millimetre; % = percent.

Table 5.3.2-5 summarizes the 24-hour extreme precipitation and **Table 5.3.2-6** summarizes the wet and dry annual precipitation estimated for the Project.

Table 5.3.2-5: Estimated 24-hour Extreme Precipitation for the Project

Return Period (Years)	24-hour Extreme Event (mm)
1:2	37
1:5	44
1:10	50
1:15	53
1:20	55
1:25	56
1:50	61
1:100	66
1:200	71
1:500	78
1:1000	82
PMP	195

Source: Knight Piésold, 2013f (**Appendix 5.1.1.1A**).
Note: mm = millimetre; PMP = Probable Maximum Precipitation.

Table 5.3.2-6: Estimated Wet and Dry Annual Precipitation for the Project

Return Period (Years)	Precipitation (mm)
1:200 year wet	794
1:100 year wet	779
1:50 year wet	762
1:20 year wet	737
1:10 year wet	715
Mean Annual	636
1:10 year dry	557
1:20 year dry	535
1:50 year dry	510
1:100 year dry	493
1:200 year dry	478

Source: Knight Piésold, 2013f (**Appendix 5.1.1.1A**).
Note: mm = millimetre.

Annual potential evapotranspiration of 445 mm was estimated for the Project. Annual actual evapotranspiration estimates for the Project varied across the study area and ranged between 267 mm and 356 mm based on vegetative cover (Knight Piésold, 2013f). **Table 5.3.2-7** summarizes the estimated monthly potential evapotranspiration for the Project. The potential evapotranspiration is defined as the amount of evapotranspiration that would occur given an infinite supply of water from a crop surface, and these values are believed to be reasonably representative of lake evaporation conditions.

Table 5.3.2-7: Estimated Potential Evapotranspiration for the Project

Parameter	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Potential evapotranspiration	mm	0	0	0	20	66	93	104	91	54	13	0	0	445
Potential evapotranspiration distribution	%	0	0	0	4	15	21	23	20	12	3	0	0	100

Source: Knight Piésold, 2013f (**Appendix 5.1.1.1A**).
Note: mm = millimetre; % = percent.

Sublimation was estimated for the Project area to be 100 mm over the winter season. The snowmelt was estimated for the Project to be 21% in April, 53% in May, and 26% in June (Knight Piésold, 2013f).

Mean annual temperature was estimated for the Project to be 2.0°C. The minimum mean monthly temperature was estimated to be -7.7°C and is expected in January. The maximum mean monthly temperature was estimated to be 12.5°C and is expected in July (Knight Piésold, 2013f).

The climate parameters estimated for the Project were used as a basis for developing water balance and watershed models and for hydrological design criteria for the Project.

5.3.2.2.3 Tatelkuz Lake Levels

Baseline outflows for Tatelkuz Lake were estimated by scaling a long-term synthetic discharge series based on drainage area from WN H5, which is located downstream of Tatelkuz Lake. These data, in conjunction with available lake level data, were used to estimate a relationship between discharge and lake levels. To more fully understand the potential for changes in Tatelkuz Lake levels, annual estimated lake level fluctuations were related to the area and volume of the lake using the lake bathymetric survey (Knight Piésold, 2013b).

Measured lake levels and outlet discharges were used to estimate Tatelkuz Lake levels for a 40-year period. The mean lake level was estimated to be approximately 927.60 metres above sea level (masl). Long-term analysis suggests that Tatelkuz Lake levels are the lowest in April and August and highest during freshet, with occasional higher levels following summer or fall rain events. For 80% of the time, lake level changes are expected to be small and within 0.30 m. The maximum fluctuation between historic minimum and maximum lake levels is approximately 2.0 m. At the time of the bathymetric survey, the water level in Tatelkuz Lake was estimated to be 927.60 masl, and the point of zero flow at the lake outlet was estimated to be at 926.48 masl. The difference in lake volume between these two lake levels was determined to be approximately 11 million cubic metres (Mm^3) of water, or approximately 5.6% of the total lake volume. The water depth at the lake outlet at the time of the bathymetric survey was estimated to be 1.12 m, and the outflow to Chedakuz Creek to be about 7.1 m^3/s (Knight Piésold, 2013b). These results were used as the basis for assessing the effects on Tatelkuz Lake levels resulting from each phase of the Project.

5.3.2.3 Potential Effects of the Proposed Project and Proposed Mitigation

This section discusses the potential effects of the Project and proposed mitigation on surface water flow. Interactions between the surface water flow VC and the project components and activities are presented in **Table 4.3-2** (Project Components and Activity Interaction Matrix for Selected VCs) in **Section 4**. A site water balance is presented in **Appendix 2.2A-6** (Knight Piésold Updated Water Balance Letter Report (23 December 2013), which identifies the quantities of runoff, groundwater, and seepage from mine workings that are considered in the effects assessment.

Effects are defined as the interactions between baseline surface water flows and lake levels (i.e., hydrologic parameters for the assessment of the Surface Water Flow VC) and the Project components and activities necessary for the construction, operations, closure, and post-closure phases of the mine. These interactions and activities have the potential to change the monthly and annual flows, peak flows, low flows, and lake levels. Mitigation measures to reduce or eliminate potential Project effects on the Surface Water Flow VC will be discussed in this section. The mitigation measures include those already identified in the Project Description and Mine Water Management Plan (MWAMP) (**Section 12.2.1.18.4.18**), in addition to the mitigation measures identified in this EA.

There are key interactions between the mine site and the Surface Water Flow VC during all phases of the Project. During operation and closure phases, there is also a key interaction between the freshwater supply system and surface water flow and lake levels. There are negligible interactions between the Kluskus-FSR, the transmission line, the airstrip and mine access road and surface water flows.

5.3.2.3.1 Watersheds Potentially Affected by the Project

The surface water flow LSA for the Project includes five watersheds: Turtle Creek, Davidson Creek, Creek 661, Creek 705, and Chedakuz Creek (includes Tatelkuz Lake) (**Figure 5.3.2-4**). These watersheds are either within or adjacent to the Project footprint, and they are described in more detail below. The Project has the potential, with its water diversion, water management, and water withdrawal activities, to change surface water flows within these watersheds and Tatelkuz Lake levels during the construction, operations, closure, and post-closure phases. Refer to **Table 4.3-2** (Project Components and Activity Interaction Matrix for Selected VCs) in **Section 4** for a list of Project components and activities and their interactions with all Project VCs. In general, surface water flows and lake levels affected by the Project's footprint and related mining operations will be managed under the Project's MWAMP (**Section 12.2.1.18.4.18**). In addition to Aboriginal traditional use, past land use in the Project area includes mineral exploration, agricultural, recreational and forestry activities. Mineral exploration uses freshwater in small quantities and forestry has the potential to affect runoff in areas where vegetation is removed. The effects of these activities on the existing watersheds are included in the surface water flow baseline conditions and are assessed as potential cumulative effects with the Project (**Section 5.3.2.5**) on surface water flow in the Aquatics RSA. Present and future land use in the Project area that could potentially affect surface water flow includes agriculture, forestry, and mineral exploration and are assessed as potential cumulative effects with the Project (**Section 5.3.2.5**) on surface water flow in the Aquatics RSA. This EA section only pertains to surface water flow and lake levels; refer to **Section 5.3.5** of this EA for groundwater information.

5.3.2.3.1.1 Turtle Creek Watershed

The Turtle Creek Watershed (approximately 63.9 km^2) is a sub-watershed of the Chedakuz Creek Watershed. Turtle Creek drains into Chedakuz Creek, which then drains into Nechako Reservoir. The Turtle Creek Watershed is located north of the Project, and no mining facilities are located within this watershed. Nevertheless, limited portions of the proposed mine access road and transmission line (including access roads), and the proposed airstrip and related access road will be located within the Turtle Creek Watershed. The mainstem of Turtle Creek has been identified as a key environmental location, given the presence of rainbow trout and Turtle Creek's contribution to Chedakuz Creek flows. The effects assessment of Turtle Creek extends from its headwaters through to its confluence with Chedakuz Creek.

5.3.2.3.1.2 Davidson Creek Watershed

The Davidson Creek Watershed (approximately 76.2 km^2) is a sub-watershed of the Chedakuz Creek Watershed. Davidson Creek drains into Chedakuz Creek, which then drains into Nechako Reservoir. The Davidson Creek Watershed contains most of the Project mining facilities, including: the Tailings Storage Facility (TSF); open pit; waste rock dumps; ore stockpiles; supporting mine infrastructure; and other mine site water management features. The extreme upper extents of the headwaters of the Davidson Creek Watershed will be permanently diverted to the Creek 705 Watershed due to the proposed TSF. Portions of the proposed mine access road and transmission line (including access roads) will be located within the Davidson Creek Watershed. Most of Davidson Creek has been identified as a key environmental location, given the presence of kokanee (downstream of the Project) and rainbow trout, and its contribution to Chedakuz Creek flows. The effects assessment of Davidson Creek extends from its headwaters through to its confluence with Chedakuz Creek.

5.3.2.3.1.3 Creek 661 Watershed

The Creek 661 Watershed (approximately 56.3 km^2) is a sub-watershed of the Chedakuz Creek Watershed. Creek 661 drains into Chedakuz Creek, which then drains into Tatelkuz Lake. The majority of the Creek 661 Watershed is located east of the Project. Nevertheless, one of the Creek 661 tributaries is within the footprint of the mining facilities and is proposed to contain a portion of the open pit, the East Dump, and both the construction and operation camps. Portions of the proposed mine access road and transmission line (including access roads) will be located within the Creek 661 Watershed. The majority of Creek 661 has been identified as a key environmental location, given the presence of kokanee (downstream of the Project) and rainbow trout and its contribution to Chedakuz Creek flows. The effects assessment of Creek 661 extends from its headwaters through to its confluence with Chedakuz Creek.

5.3.2.3.1.4 Creek 705 Watershed

The Creek 705 Watershed (approximately 45.3 km^2) is a sub-watershed of the Fawnie Creek Watershed. Creek 705 drains into Fawnie Creek, which then drains into the Entiako River and eventually Nechako Reservoir. The Creek 705 Watershed is located west of the Project mining facilities, and no mining facilities are located within this watershed. Nevertheless, a portion of the extreme upper extents of the headwaters of the Davidson Creek Watershed will be permanently diverted to the Creek 705 Watershed due to the proposed TSF within the Davidson Creek watershed. The majority of Creek 705 has been identified as a key environmental location, given the presence of rainbow trout and its contribution to Fawnie Creek flows. In addition, two current surface water licenses (one is a drinking water source and the other is a point of water diversion) are located on Matthews Creek, a tributary of Fawnie Creek. The effects assessment of Creek 705 extends from its headwaters through to its confluence with Fawnie Creek.

5.3.2.3.1.5 Chedakuz Creek Watershed

The Chedakuz Creek Watershed (approximately 593 km^2) contains the Turtle Creek, Davidson Creek, and Creek 661 watersheds. Chedakuz Creek drains into Nechako Reservoir. The Chedakuz Creek Watershed contains the Project. Tatelkuz Lake is located within the Chedakuz Creek Watershed and it is proposed as the primary source of supplemental freshwater for mining water requirements (during operations) to meet IFN in Davidson Creek downstream of the TSF (during operations and closure and to aid in the filling of the open pit during closure). The proposed mine access road, transmission line (including access roads), and the airstrip and related access road will be located within the Chedakuz Creek Watershed. The mainstem of Chedakuz Creek, below Tatelkuz Lake, has been identified as a key environmental location given the presence of kokanee (downstream of the Project) and rainbow trout. The effects assessment of Chedakuz Creek extends from its confluence with Tatelkuz Lake to upstream of its confluence with Turtle Creek.

5.3.2.3.2 Surface Water Flow Project Phase Description

Surface water flows (**Appendix 5.1.2.1B**) and Tatelkuz Lake levels (**Appendix 5.3.2C**) resulting from the Project were estimated for the five distinct phases of the Project: baseline, construction, operation, closure, and post-closure. In addition, the operation and closure phases were divided into “unmitigated” and “mitigated” scenarios for the Davidson Creek and Chedakuz Creek watersheds. The unmitigated scenario assumes that freshwater from Tatelkuz Lake would not be used to meet IFN in Davidson Creek (during operations and closure) nor aid in the filling of the open pit (during closure), while the mitigated scenario includes this measure. Refer to **Section 5.3.2.2** for a description of Project baseline conditions. The other phases of the Project are described below, which, unless otherwise noted, are based on information provided by Knight Piésold (2013d).

Tatelkuz Lake is located approximately 20 km northeast of the mine site, and it is proposed as the primary source of supplemental freshwater external to the mine site for the Project. A pipeline from the lake to the mine site will convey water. This freshwater supply system will consist of the following major components: Tatelkuz Lake intake and pump station, freshwater supply pipeline, booster pump stations, freshwater reservoir, and a temperature and flow control system (Knight Piésold, 2013e). This freshwater supply system is designed to provide a continuous flow of freshwater for plant needs (during operations), to mitigate flow reductions in Davidson Creek to meet IFN requirements (during operations and closure), and to aid in the filling of the open pit (during closure). If necessary, this freshwater supply system may also be used to supplement requirements for processing or to saturate potentially acid-generating waste rock within the TSF (Knight Piésold, 2013e). Refer to the Project MWAMP (**Section 12.2.1.18.4.18**), the Project Description, and the Instream Flow Study in **Appendix 5.1.2.6D** for additional information on the Tatelkuz Lake freshwater supply system.

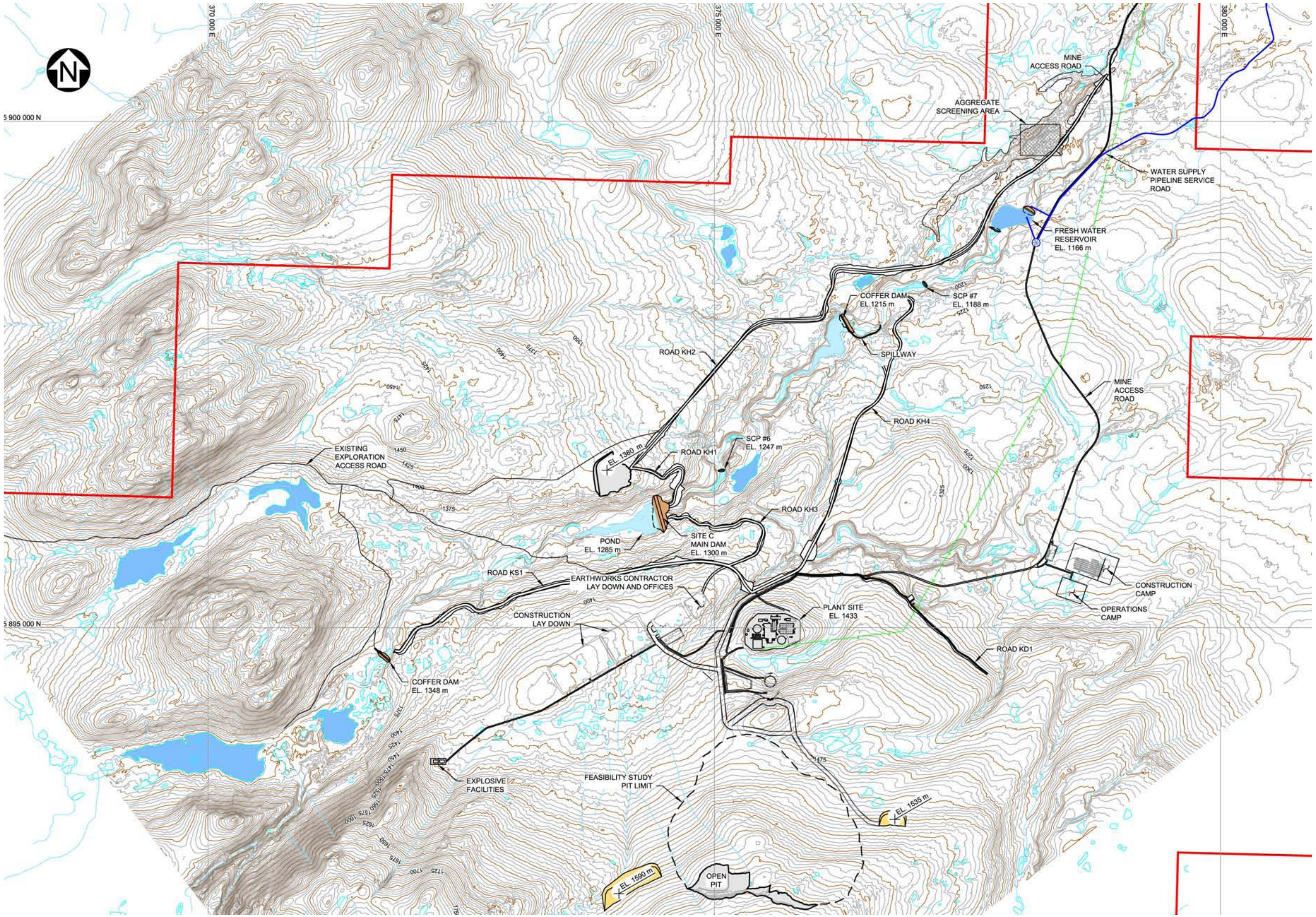
5.3.2.3.2.1 Construction

Figure 5.3.2-5 shows the proposed mine arrangement for Year -2 of the construction phase of the Project (Year 1 is assumed to be the start of mining). **Figure 5.3.2-6** shows the discretization of sub-catchments for the construction phase of the Project used for watershed modelling (Knight Piésold, 2013d). The construction phase of the Project is expected to occur over two years.

Refer to the Project MWAMP (**Section 12.2.1.18.4.18**) for details on water management during construction. The watershed modelling for the construction phase of the Project is based on the following:

- On-site Project facilities exist entirely in the Davidson Creek and Creek 661 watersheds;

- The construction of the coffer dam at WMN 11-DC will permanently redirect the upper extents of the Davidson Creek headwaters to the Creek 705 Watershed. A portion of groundwater from the Davidson Creek headwaters will also be directed to the Creek 705 Watershed;
- During construction of the TSF Site C Main Dam, a sediment control pond will collect seepage and surface water and pump this water back to the TSF. However, groundwater will flow freely;
- Water interception ditches will exist to direct surface water around Project facilities to sediment control ponds; and
- Additional coffer dams, sediment control dams, and a freshwater reservoir will be built on Davidson Creek. Surface water and groundwater will pass these structures at natural rates.



Legend

- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- BORROW AREA (ZONES S, C, AND ROCKFILL)
- NAG WASTE ROCK / OVERBURDEN
- BORROW AREA (ZONES F AND T)
- PUMPSTATION
- WATER SUPPLY PIPELINE SERVICE ROAD
- TRANSMISSION LINE
- NEW GOLD PROPERTY BOUNDARY

NOTES:

1. CONTOUR INTERVAL IS 5 METRES.
2. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
3. SCP STANDS FOR SEDIMENT CONTROL POND.

Source
Knight Piésold Engineering and Environmental Services
http://www.knightpiesold.com/en/

CLIENT: newgold

PROJECT: Blackwater Gold Project

General Arrangement Construction (End of Year -2) Plan

DATE: May, 2014	ANALYST: KP	**Figure** 5.3.2-5	
JOB No: VE52420	QA/QC: WR	PDF FILE: End of Year -2 Plan.pdf	
AI FILE: End of Year -2 Plan.mxd		amec	
PROJECTION: UTM Zone 10	DATUM: NAD83		

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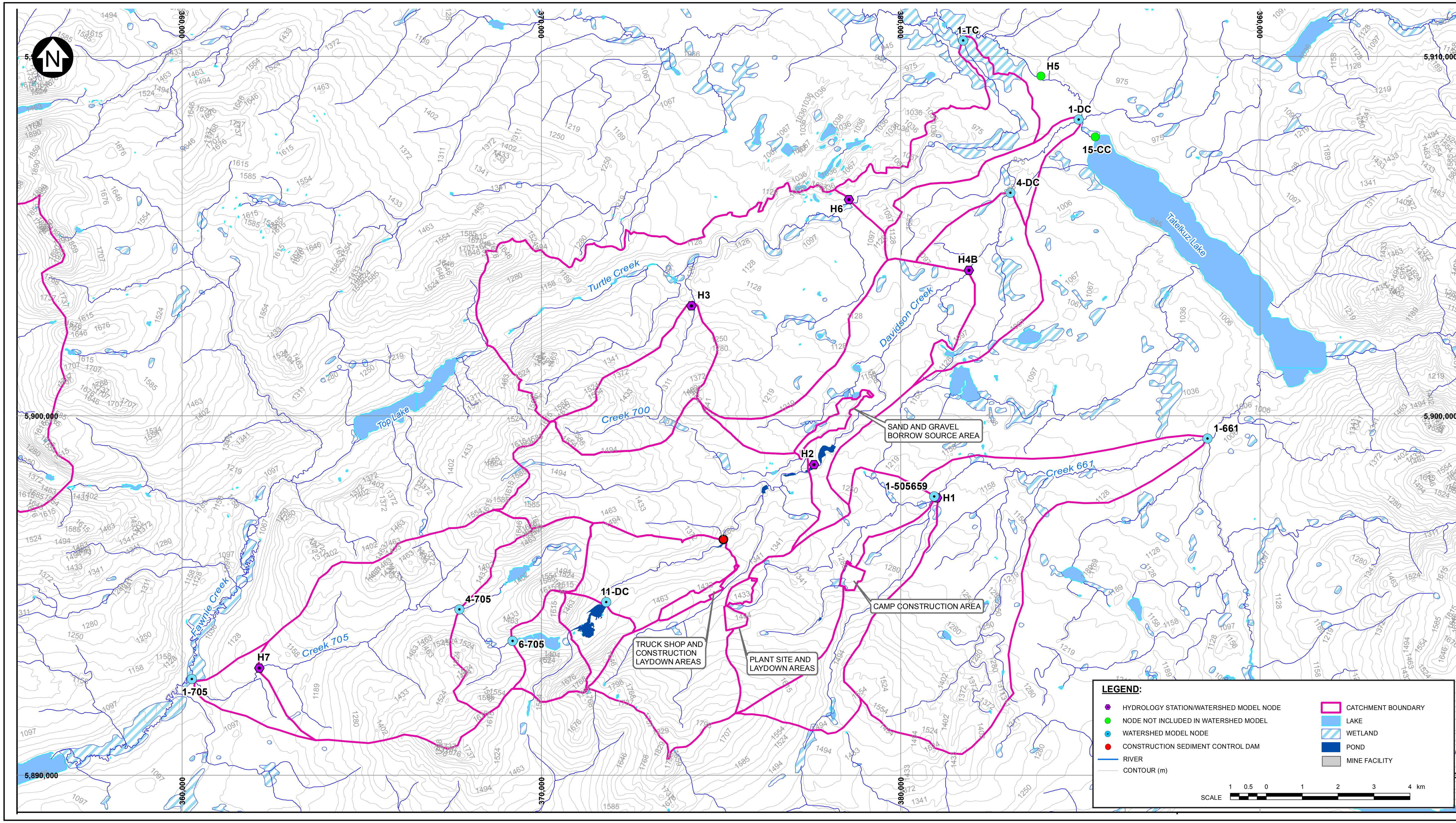

Notes:

Figure from Knight Piésold Watershed Modelling Report (VA101-457/6-6, Revision 1) dated 17 January 2014 (Appendix 5.1.2.1C).

CLIENT: newgold

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amec

DWN BY:	MY
CHK'D BY:	JK
DATUM:	N/A
PROJECTION:	N/A
SCALE:	N/A

PROJECT

Blackwater Gold Project

TITLE

Discretization of Sub-catchments for Construction (End of Year -2) Plan

DATE:	January 2014
PROJECT NO:	VE52277
REV. NO.:	A
FIGURE No.	5.3.2-6

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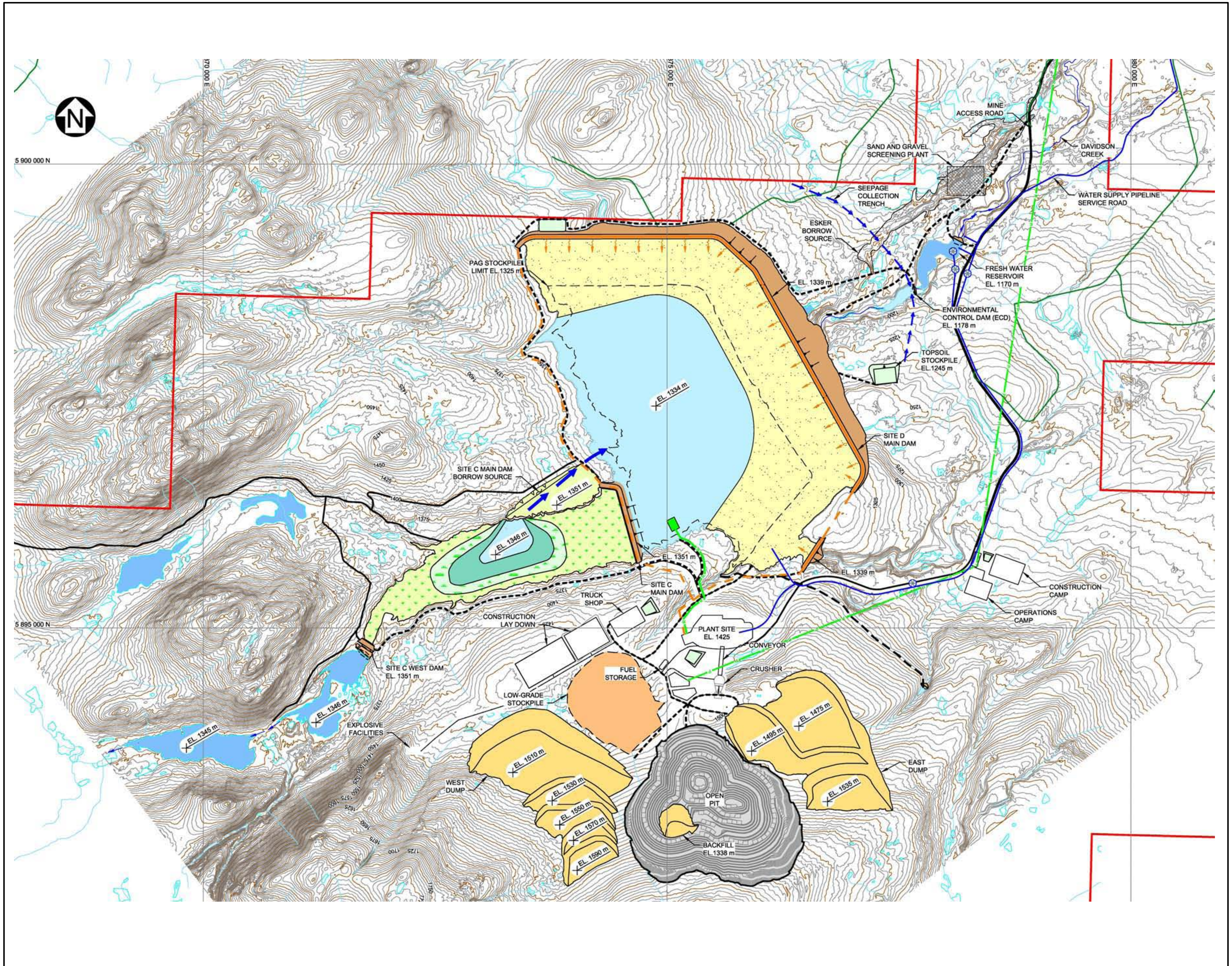
5.3.2.3.2.2 Operations

Figure 5.3.2-7 shows the proposed mine arrangement for Year 17 of the operations. **Figure 5.3.2-8** shows the discretization of sub-catchments for the operations phase of the Project used for watershed modelling (Knight Piésold, 2013d). The mine is expected to be in operation for 17 years, with the last year of operations expected to have the greatest potential for impacts on the Surface Water Flow VC, as all facilities will be at their maximum size. Refer to the Project MWAMP (**Section 12.2.1.18.4.18**) for details on water management during operations. The watershed modelling for the operations phase of the Project is based on the following:

- On-site Project facilities exist entirely in the Davidson Creek and Creek 661 watersheds;
- The open pit will be at its maximum size and will be collecting surface water and groundwater (although active mining will have ceased in Year 14) (Knight Piésold, 2013c);
- The TSF will be filling, and there will be no release of surface water from the TSF to the environment during operations;
- The TSF Site C West Dam will continue to redirect the upper extents of the Davidson Creek headwaters to the Creek 705 Watershed; The interception trench and environmental control dam (ECD) downstream of the TSF on Davidson Creek will collect seepage, groundwater, and local surface water flows, which will then be pumped back to the TSF;
- The waste rock dumps and low-grade ore stockpile footprint will be at their maximum extents but not yet reclaimed. Therefore, infiltration and evapotranspiration rates are assumed to be higher and lower, respectively, than for natural groundcover;
- Runoff and toe discharge from the west waste rock dump and the low-grade ore stockpile will be directed to the TSF;
- Runoff and toe discharge from the east waste rock dump will contribute to surface flows in the upper extents of the Creek 661 Watershed after being directed through a sediment control pond; and
- In the unmitigated scenario, the freshwater supply system from Tatelkuz Lake would not exist, and flows in Davidson Creek would not meet IFN. Mitigation measures are discussed in **Section 5.3.2.3.4**.



Legend

- UPLAND BEACH
- BOG / WETLAND AREA
- EMERGENT VEGETATION WETLAND
- UPLAND SLOPE
- TAILINGS BEACH
- POND
- EMBANKMENT FILL
- PAG WASTE ROCK
- NAG WASTE ROCK / OVERBURDEN
- LOW-GRADE ORE
- TOPSOIL
- RECLAIM SYSTEM
- WATER SUPPLY PUMPSTATION
- CONSTRUCTION HAUL ROAD
- MINE HAUL ROAD
- MINE ACCESS ROAD
- PIPELINE SERVICE ROAD
- FRESH WATER FLOW DIRECTION
- WATER RECLAIM PIPELINE
- NEW GOLD PROPERTY BOUNDARY
- TRANSMISSION LINE
- SPILLWAY
- SEEPAGE COLLECTION TRENCH
- TAILINGS PIPELINE
- TAILINGS DEPOSITION

NOTES:

1. CONTOUR INTERVAL IS 5 METRES.
2. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS AR NOTED OTHERWISE.

SCALE A 400 200 0 400 800 1200

Source
Knight Piésold Engineering and Environmental Services
http://www.knightpiesold.com/en/

CLIENT: newgold™

PROJECT: Blackwater Gold Project

General Arrangement Operations (End of Year 17) Plan

DATE: May, 2014	ANALYST: KP	**Figure** 5.3.2-7	
JOB No: VE52420	QA/QC: WR	PDF FILE: PostClosurePlanNov2012.pdf	
AI FILE: PostClosurePlanNov2012.mxd			
PROJECTION: UTM Zone 10	DATUM: NAD83	amec	

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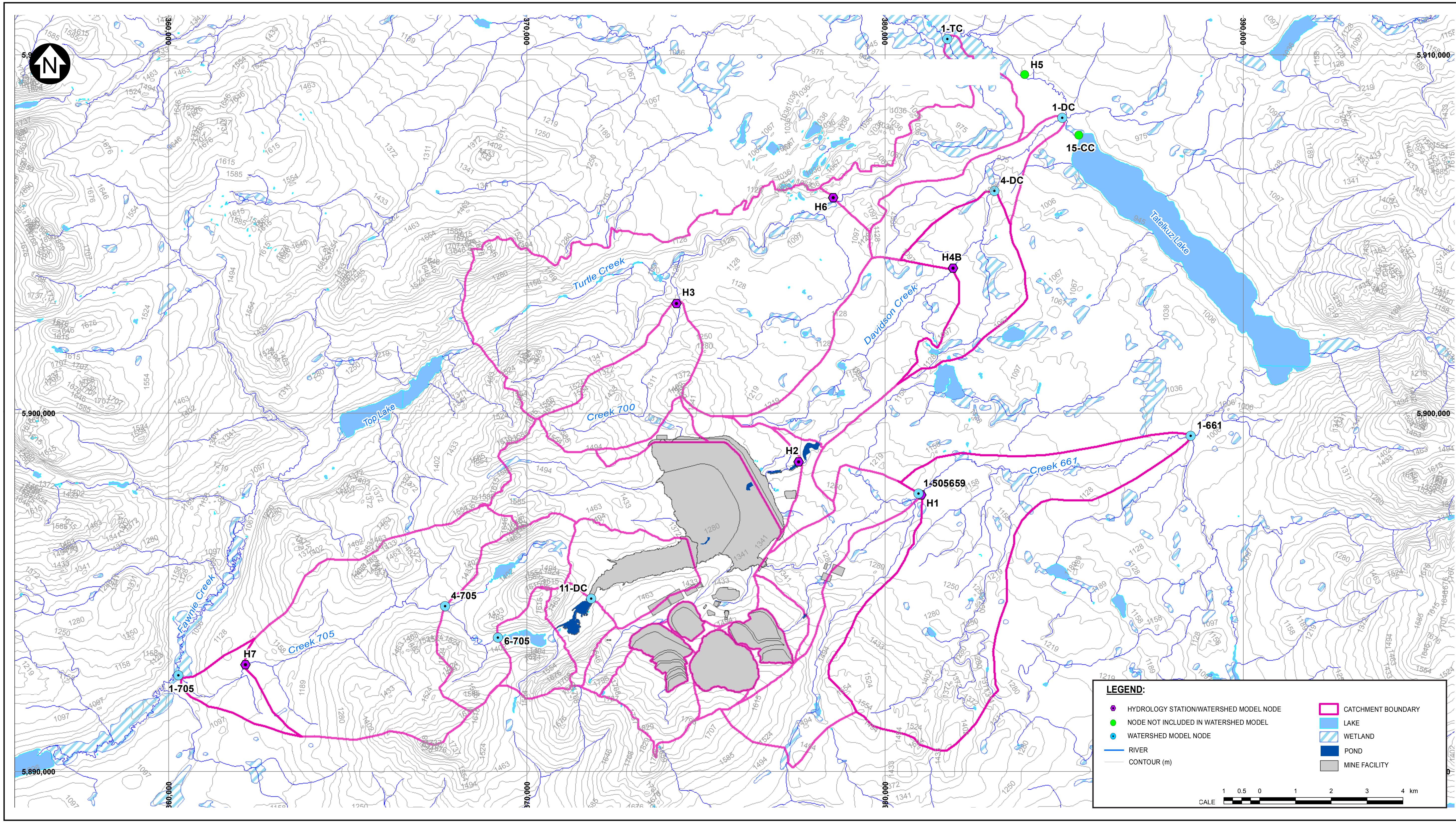

Notes:

Figure from Knight Piésold Watershed Modelling Report (VA101-457/6-6, Revision 1) dated 17 January 2014 (Appendix 5.1.2.1C).

CLIENT: newgold

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amec

DWN BY:	MY
CHK'D BY:	JK
DATUM:	N/A
PROJECTION:	N/A
SCALE:	N/A

PROJECT: Blackwater Gold Project

TITLE: Discretization of Sub-catchments for Operations (End of Year 17) Plan

DATE:	January 2014
PROJECT NO:	VE52277
REV. NO.:	A
FIGURE No.	5.3.2-8

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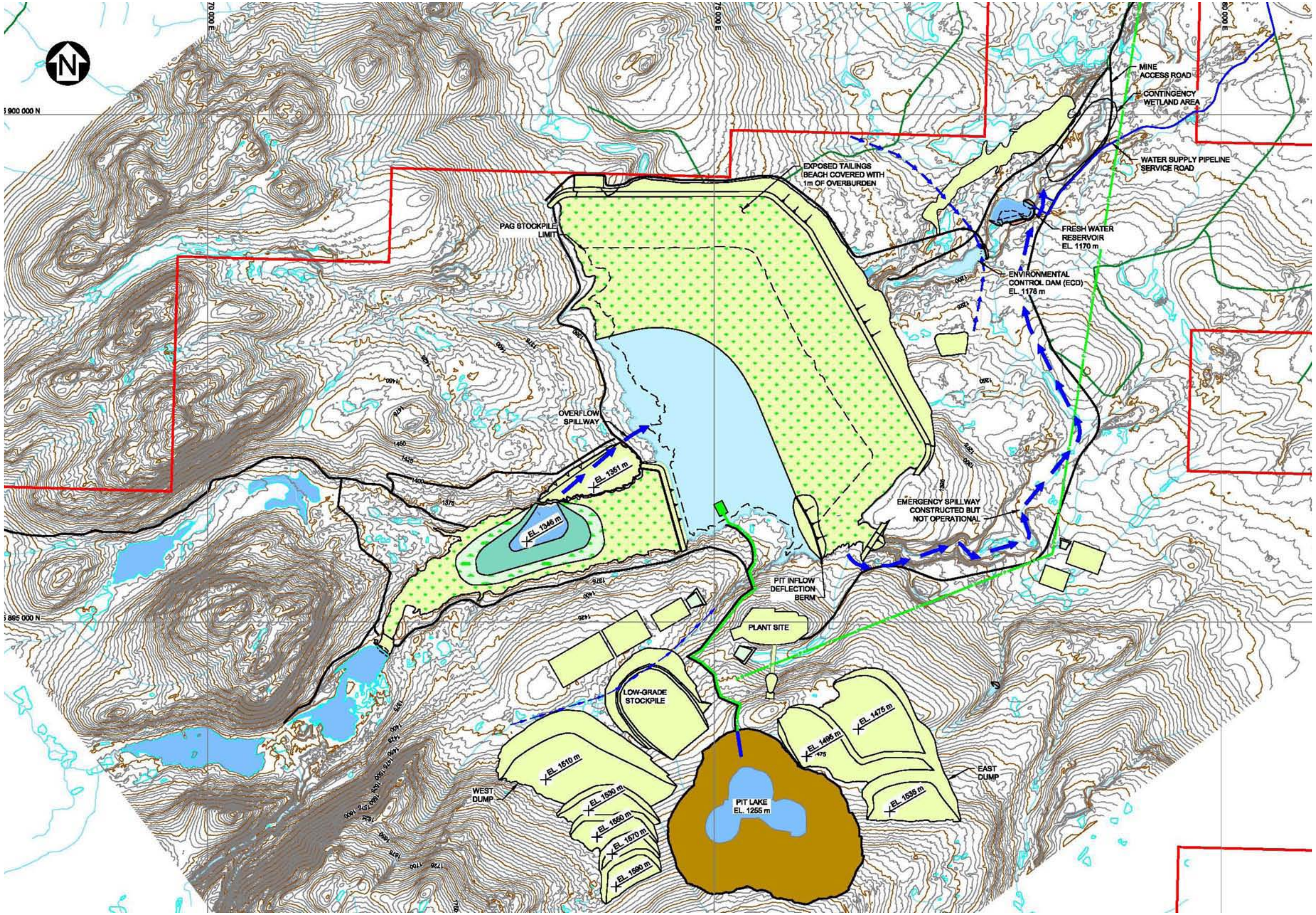
5.3.2.3.2.3 Closure

Figure 5.3.2-9 shows the proposed mine arrangement for Year 20 of the closure phase of the Project (the end of milling is assumed to be Year 17). **Figure 5.3.2-10** shows the discretization of sub-catchments for the closure phase of the Project used for watershed modelling (Knight Piésold, 2013d). The closure phase is expected to occur over approximately 20 years. The initial two years will involve the removal and reclamation of mine facilities that are no longer required. The subsequent 18 years is the amount of time expected for the open pit to fill, with the aid of water supply from Tatelkuz Lake (without this aid the fill time would increase to 21 years) and start discharging towards the TSF. The TSF would start discharging to Davidson Creek. Refer to the Project MWAMP (**Section 12.2.1.18.4.18**) for details on water management during closure. The watershed modelling for the closure phase of the Project is based on the following:

- On-site Project facilities exist entirely in the Davidson Creek and Creek 661 Watersheds, but mine facilities that are no longer required will be decommissioned and removed. Due to reclamation activities, watershed model infiltration and evapotranspiration parameters have been adjusted to reflect soil cover and/or immature vegetation;
- The interception trench and ECD downstream of the TSF on Davidson Creek will collect seepage, groundwater, and local surface water flows, which will then be pumped back to the TSF;
- The open pit dewatering system will have been decommissioned in Year 15 at the conclusion of open pit mining (low grade ore is processed for the last two years of mine operations), and the open pit will be filling (Knight Piésold, 2013c);
- The TSF will be full and water will be pumped to the open pit to assist in pit filling. In addition, water from Tatelkuz Lake will be used to assist in pit filling and it is predicted that the open pit will be full in Year 35 (Knight Piésold, 2013c). The use of water from Tatelkuz Lake to aid in the filling of the open pit is considered a mitigation measure as without this aid it would take longer to fill the open pit;
- The TSF spillway channel will be constructed but not yet operational. However, the construction of the spillway will permanently direct a portion of the drainage area (north of the spillway) from the Creek 661 Watershed to the Davidson Creek Watershed;
- If it meets water quality standards, runoff and toe discharge from the east waste rock dump may be directed from the Creek 661 watershed to the TSF; and
- In the unmitigated scenario, the freshwater supply system from Tatelkuz Lake would not exist, and flows in Davidson Creek would not meet IFN. Mitigation measures are discussed in **Section 5.3.2.3.4**.



Legend

- UPLAND BEACH
- UPLAND SLOPE
- BOG / WETLAND AREA
- EMERGENT VEGETATION WETLAND
- POND
- ROCK SLOPES
- RECLAIM SYSTEM
- MINE ACCESS ROAD
- PIPELINE SERVICE ROAD
- WATER RECLAIM PIPELINE
- TRANSMISSION LINE
- DIVERSION CHANNEL
- SEEPAGE COLLECTION TRENCH
- SPILLWAY

NOTES:

1. CONTOUR INTERVAL IS 5 METRES.
2. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.

SCALE A 400 200 0 400 800 1200 1600 2000 m

Source
Knight Piésold Engineering and Environmental Services
http://www.knightpiesold.com/en/

CLIENT: newgold

PROJECT: Blackwater Gold Project

General Arrangement Closure (End of Year 20) Plan

DATE: May, 2014	ANALYST: KP	**Figure** 5.3.2-9
JOB No: VE52420	QA/QC: WR	PDF FILE: PostClosurePlanNov2012.pdf
AI FILE: PostClosurePlanNov2012.mxd		amec
PROJECTION: UTM Zone 10	DATUM: NAD83	

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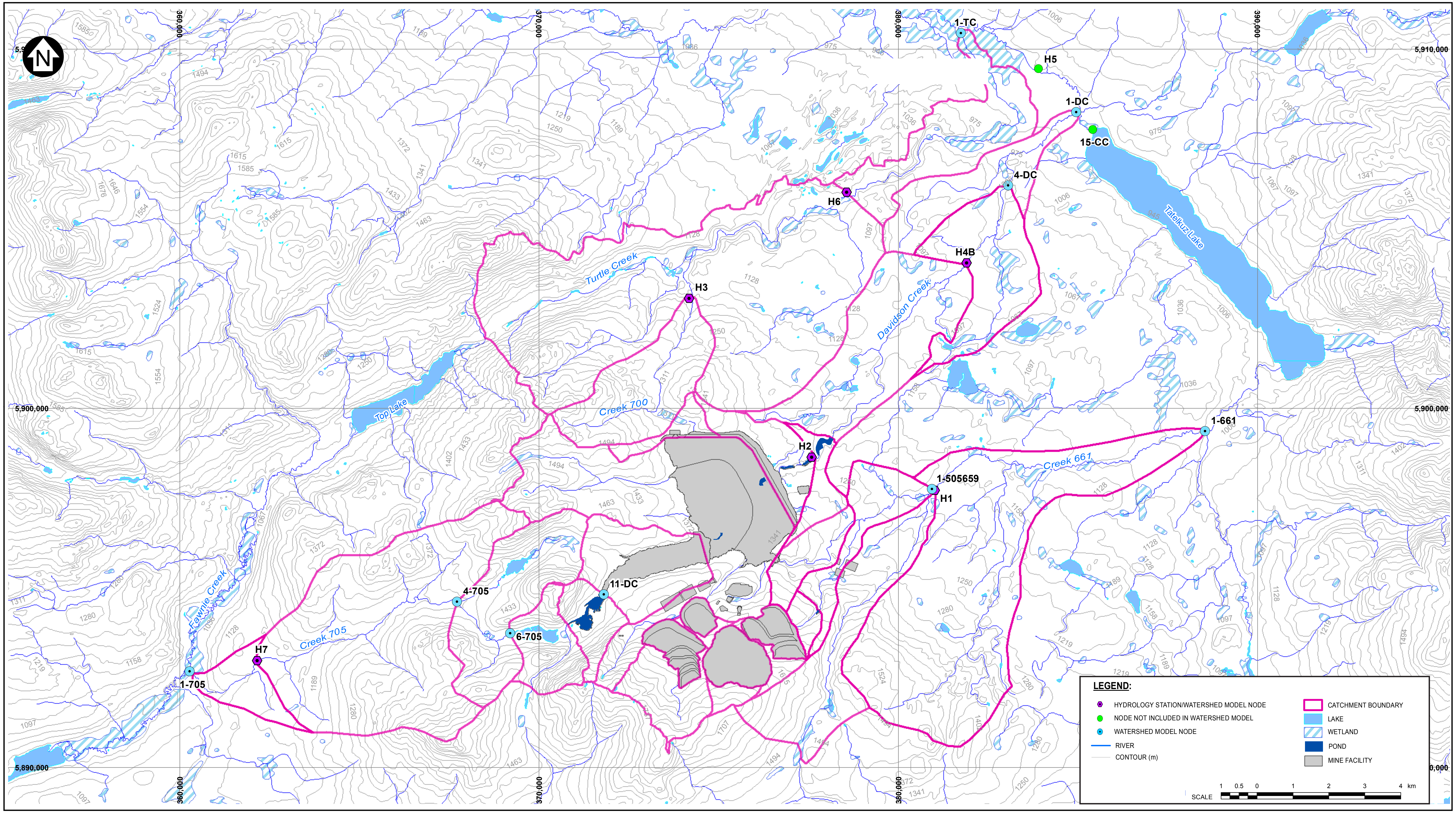

Notes:

Figure from Knight Piésold Watershed Modelling Report (VA101-457/6-6, Revision 1) dated 17 January 2014 (Appendix 5.1.2.1C).

CLIENT:	newgold
	AMEC Environment & Infrastructure 4445 Lougheed, Suite 600, Burnaby, B.C., V5C 0E4 Tel. 604-294-3811 Fax 604-294-4664
DWN BY:	MY
CHK'D BY:	JK
DATUM:	N/A
PROJECTION:	N/A
SCALE:	N/A
PROJECT	Blackwater Gold Project
TITLE	Closure and Post-Closure Watershed Model Discretization
DATE:	January 2014
PROJECT NO:	VE52277
REV. NO.:	A
FIGURE No.	5.3.2-10

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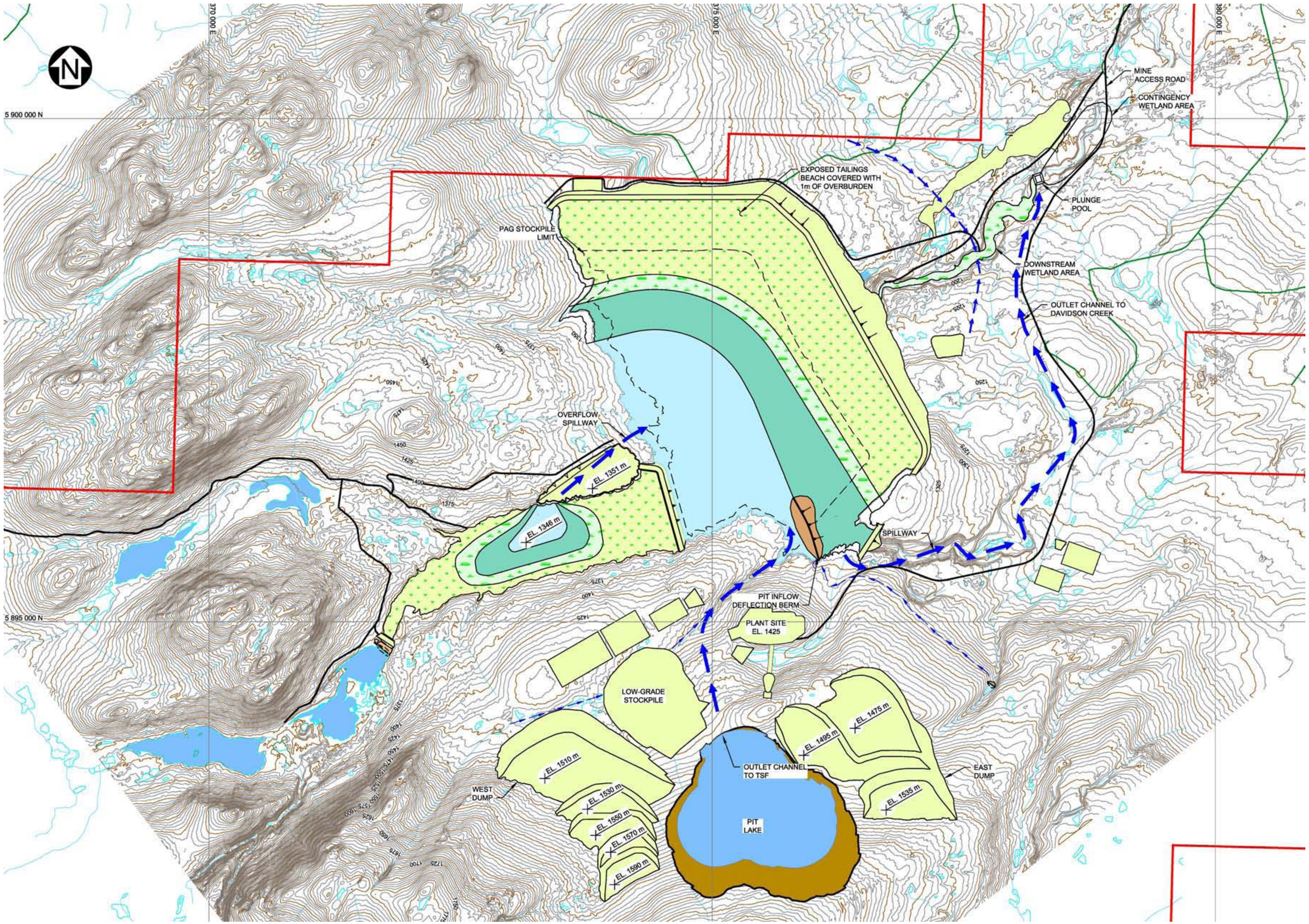
5.3.2.3.2.4 Post-Closure

Figure 5.3.2-11 shows the proposed mine arrangement during the post-closure phase of the Project (Figure shows full extent of the East Dump although a portion of its overburden will be reclaimed for use in reclamation on the mine site). **Figure 5.3.2-10** shows the discretization of sub-catchments for the post-closure phase of the project used for watershed modelling (Knight Piésold, 2013d). The post-closure phase will start once the TSF has filled, water quality release standards are met, and the TSF starts discharging water to Davidson Creek. It is expected that only maintenance and monitoring activities will be occurring at this time. Refer to the Project MWAMP (**Section 12.2.1.18.4.18**) for details on water management during post-closure. The watershed modelling for the post-closure phase of the Project is based on the following:

- All on-site Project facilities will have been decommissioned, removed, and their sites returned to a natural state. Accordingly, watershed model infiltration and evapotranspiration parameters have been adjusted to reflect mature vegetation;
- The open pit will be filled and is discharging to the TSF via a spillway. Water from the TSF will no longer be pumped to the open pit;
- The TSF seepage interception trench and the ECD will be decommissioned and wetlands established to polish TSF seepage. Groundwater and surface flows downstream of these former structures will discharge to Davidson Creek. Seepage from the TSF will also be contributing to Davidson Creek;
- The TSF will discharge via a spillway, discharge channel, and plunge pool to Davidson Creek (Refer to the closure section above, which discusses runoff permanently redirected to other watersheds due to the spillway); and
- In the mitigated scenario, the freshwater supply system has been decommissioned.

5.3.2.3.2.5 Climate Change

The operating mine life is estimated to be 17 years. It is expected that climate change would not have a significant effect on the current climatic and hydrologic parameters of the Project over this short period. Nevertheless, sensitivity analyses were performed for wet and dry extreme events during mine operation. Long-term monitoring of meteorological parameters during the Project lifetime and beyond at the Project mine site and the nearest Environment Canada (EC) weather stations will be carried out to assess trends in climate change. For closure and post-closure, the Project MWMP can be updated, if deemed necessary, to accommodate climate changes observed during operations, if any. For additional climate change considerations, refer to **Appendix 5.1.1.1A**.



Legend

- UPLAND BEACH
- UPLAND SLOPE
- BOG / WETLAND AREA
- EMERGENT VEGETATION WETLAND
- POND
- ROCK SLOPES
- MINE ACCESS ROAD
- DIVERSION CHANNEL
- SEEPAGE COLLECTION TRENCH
- SPILLWAY

Source
Knight Piésold Engineering and Environmental Services
http://www.knightpiesold.com/en/

CLIENT: newgold

PROJECT: Blackwater Gold Project

General Arrangement Post Closure Plan

DATE: May, 2014	ANALYST: KP	**Figure** 5.3.2-11
JOB No: VE52420	QA/QC: WR	PDF FILE: PostClosurePlanNov2012.pdf
AI FILE: PostClosurePlanNov2012.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

5.3.2.3.3 Potential Project Effects

The key hydrological indicators/factors considered in the assessment of the Surface Water Flow VC are changes to surface water flows and Tatelkuz Lake levels due to the Project. The potential effects on mean annual, peak, and low flows within the watersheds potentially affected by the Project are summarized in this section. Mean monthly flows have been presented to support surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetland VCs. Flood flows for events with return periods of up to 200 years and drought flows (7Q10 and 7Q20) (referred to as extreme events in the AIR) have been presented to provide sensitivity analysis, to support surface water and sediment quality and fish and fish habitat VCs, and to aid in mine operations strategies. This section also summarizes the potential effects of the Project on Tatelkuz Lake levels, and discusses the potential effects on surface water flows due to Project infrastructure such as the mine site access roads, transmission line, Project access road (Kluskus FSR), and airstrip. The potential Project effects are initially discussed with the assumption that the freshwater supply system (includes meeting IFN in Davidson Creek and aiding in open pit filling) from Tatelkuz Lake does not exist, as this is a mitigation measure discussed later on.

5.3.2.3.3.1 Watersheds Potentially Affected by the Project

5.3.2.3.3.1.1 Turtle Creek Watershed

The following surface water flow summary tables contain output from the watershed model and external statistical analyses for the Turtle Creek Watershed for all phases of the mine for the following scenarios: mean monthly and annual flows (**Table 5.3.2-8**); instantaneous peak flows (**Table 5.3.2-9**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-10**). Refer to **Appendix 5.3.2A** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-8 to **Table 5.3.2-10** show that the mean monthly, mean annual, peak, and low surface water flows in the Turtle Creek Watershed are not expected to be impacted by the Project from construction through post-closure.

5.3.2.3.3.1.2 Davidson Creek Watershed

The following surface water flow summary tables contain output from the watershed model and external statistical analyses for the Davidson Creek Watershed for all phases of the mine for the following scenarios: mean monthly and annual flows (**Table 5.3.2-11**); instantaneous peak flows (**Table 5.3.2-12**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-13**). Refer to **Appendix 5.3.2A** for surface water flow summary tables for the 1:5–, 1:10–, 1 in 20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-8: Estimated Mean Monthly and Annual Surface Water Flow Changes in Turtle Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
H3 (WQ11:upper watershed on tributary Creek 700)													
Baseline	6	4	4	52	226	185	49	21	18	31	27	10	53
Construction (Year -2)	6	4	4	52	226	185	49	21	18	31	27	10	53
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Operations (Year 17)	6	4	4	52	226	185	49	21	18	31	27	10	53
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Closure (Year 20)	6	4	4	52	226	185	49	21	18	31	27	10	53
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Post-closure	6	4	4	52	226	185	49	21	18	31	27	10	53
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H6 (midpoint of watershed)													
Baseline	112	99	102	325	710	550	225	159	143	168	165	126	241
Construction (Year -2)	112	99	102	325	710	550	225	159	143	168	165	126	241
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Operations (Year 17)	112	99	102	325	709	550	225	159	143	168	165	126	241
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Closure (Year 20)	112	99	102	325	709	550	225	159	143	168	165	126	241
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Post-closure	112	99	102	325	710	550	225	159	143	168	165	126	241
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
1-TC (WQ 13 upstream of confluence with Chedakuz Creek)													
Baseline	143	128	130	368	764	596	263	194	176	201	199	158	277
Construction (Year -2)	143	128	130	368	764	596	263	194	176	201	199	158	277
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Operations (Year 17)	143	128	130	368	764	596	263	194	176	201	199	158	277
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Closure (Year 20)	143	128	130	368	764	596	263	194	176	201	199	158	277
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Post-closure	143	128	130	368	764	596	263	194	176	201	199	158	277
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.

Note: L/s = litre per second; % = percent.

Table 5.3.2-9: Estimated Instantaneous Peak Surface Water Flow Changes at the Mouth of Turtle Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) Return Period (Years)						
			2	**5**	**10**	**20**	**50**	**100**	**200**
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
1-TC	Baseline	63.9	5.6	9.0	11.8	14.9	19.5	23.5	28.4
	Construction	63.9	5.6	9.0	11.8	14.9	19.5	23.5	28.4
	% change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Operations	63.9	5.6	9.0	11.8	14.9	19.5	23.5	28.4
	% change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Closure	63.9	5.6	9.0	11.8	14.9	19.5	23.5	28.4
	% change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Post-closure	63.9	5.6	9.0	11.8	14.9	19.5	23.5	28.4
	% change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**.
Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-10: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Turtle Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)		
	H3	**H6**	**1-TC**
7Q10			
Baseline	0.9	43	59
Construction (Year -2)	0.9	43	59
% Change from Baseline	0%	0%	0%
Operations (Year 17)	0.9	43	59
% Change from Baseline	0%	0%	0%
Closure (Year 20)	0.9	43	59
% Change from Baseline	0%	0%	0%
Post-closure	0.9	43	59
% Change from Baseline	0%	0%	0%
7Q20			
Baseline	0.7	41	56
Construction (Year -2)	0.7	41	56
% Change from Baseline	0%	0%	0%
Operations (Year 17)	0.7	41	56
% Change from Baseline	0%	0%	0%
Closure (Year 20)	0.7	41	56
% Change from Baseline	0%	0%	0%
Post-closure	0.7	41	56
% Change from Baseline	0%	0%	0%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.
Note: L/s = litre per second; % = percent.

Table 5.3.2-11: Estimated Mean Monthly and Annual Surface Water Flow Changes in Davidson Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
11-DC (upper extents of watershed upstream of proposed TSF)													
Baseline	0	0	0	8	49	46	11	3	1	2	2	0	10
Construction (Year -2)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Operations (Year 17)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Closure (Year 20)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Post-closure	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
H2 (WQ10 midpoint of watershed immediately downstream of proposed TSF)													
Baseline	133	123	115	204	816	834	318	191	163	166	160	141	281
Construction (Year -2)	101	93	87	145	623	654	251	148	126	127	121	108	216
% Change from Baseline	-24%	-24%	-24%	-29%	-24%	-22%	-21%	-22%	-23%	-24%	-24%	-24%	-23%
Operations (Year 17)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Closure (Year 20)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Post-closure	113	106	101	227	976	652	211	122	130	160	138	120	255
% Change from Baseline	-14%	-14%	-12%	11%	20%	-22%	-34%	-36%	-21%	-4%	-14%	-15%	-9%

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
H4B (WQ26)													
Baseline	168	152	145	297	964	949	391	246	210	215	210	183	345
Construction (Year -2)	138	123	119	239	771	769	324	204	174	176	173	151	280
% Change from Baseline	-18%	-19%	-18%	-20%	-20%	-19%	-17%	-17%	-17%	-18%	-18%	-18%	-19%
Operations (Year 17)	21	16	19	78	127	90	48	34	27	29	32	26	46
% Change from Baseline	-87%	-89%	-87%	-74%	-87%	-90%	-88%	-86%	-87%	-86%	-85%	-86%	-87%
Closure (Year 20)	22	17	19	91	189	133	61	38	30	35	37	28	58
% Change from Baseline	-87%	-89%	-87%	-69%	-80%	-86%	-85%	-85%	-86%	-84%	-82%	-85%	-83%
Post-closure	140	127	126	306	1,091	731	261	161	161	194	175	151	303
% Change from Baseline	-17%	-16%	-14%	3%	13%	-23%	-33%	-35%	-23%	-10%	-17%	-17%	-12%
4-DC													
Baseline	174	156	155	362	1,053	991	406	254	216	229	227	192	369
Construction (Year -2)	143	128	129	304	860	811	339	212	180	190	189	160	304
% Change from Baseline	-18%	-18%	-17%	-16%	-18%	-18%	-16%	-16%	-17%	-17%	-17%	-17%	-17%
Operations (Year 17)	27	20	29	143	216	132	64	41	33	44	49	35	70
% Change from Baseline	-85%	-87%	-81%	-61%	-79%	-87%	-84%	-84%	-85%	-81%	-79%	-82%	-81%
Closure (Year 20)	28	21	30	156	278	176	76	46	36	49	54	37	82
% Change from Baseline	-84%	-86%	-81%	-57%	-74%	-82%	-81%	-82%	-83%	-79%	-76%	-81%	-78%
Post-closure	146	131	136	371	1,179	773	276	168	168	208	192	160	327
% Change from Baseline	-16%	-16%	-13%	2%	12%	-22%	-32%	-34%	-22%	-9%	-16%	-17%	-11%

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
1-DC (WQ7 upstream of confluence with Chedakuz Creek)													
Baseline	203	185	184	404	1104	1033	441	286	247	260	258	223	403
Construction (Year -2)	173	156	157	346	910	852	374	244	211	221	220	190	339
% Change from Baseline	-15%	-15%	-15%	-14%	-18%	-17%	-15%	-15%	-15%	-15%	-15%	-15%	-16%
Operations (Year 17)	56	49	58	185	267	174	98	73	64	75	80	65	104
% Change from Baseline	-72%	-74%	-69%	-54%	-76%	-83%	-78%	-74%	-74%	-71%	-69%	-71%	-74%
Closure (Year 20)	57	50	58	198	329	217	110	78	67	80	85	67	117
% Change from Baseline	-72%	-73%	-68%	-51%	-70%	-79%	-75%	-73%	-73%	-69%	-67%	-70%	-71%
Post-closure	175	160	164	413	1230	815	311	200	199	239	223	191	361
% Change from Baseline	-14%	-13%	-11%	2%	11%	-21%	-29%	-30%	-20%	-8%	-14%	-14%	-10%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.
- There are no flows for Node 11-DC as this drainage area is directed towards the 705 Watershed. There are no flows for Node H2 during operations and closure as the freshwater supply system does not exist for this scenario. During post-closure Node H2 does not exist, therefore surface water flows for the TSF spillway plunge pool are used.

Note: L/s = litre per second; % = percent; - = not applicaple.

Table 5.3.2-12: Estimated Instantaneous Peak Surface Water Flow Changes at the Mouth of Davidson Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) – Return Period (Years) 2	5	10	20	50	100	200
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
1-DC	Baseline	76.2	6.4	10.4	13.7	17.3	22.6	27.3	32.9
	Construction	64.7	5.6	9.1	12.0	15.1	19.7	23.8	28.7
	% change from Baseline	*-15%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*
	Operations	31.9	3.1	5.0	6.5	8.2	10.8	13.0	15.7
	% change from Baseline	*-58%*	*-52%*	*-52%*	*-52%*	*-52%*	*-52%*	*-52%*	*-52%*
	Closure	34.8	3.3	5.3	7.0	8.8	11.5	13.9	16.7
	% change from Baseline	*-54%*	*-49%*	*-49%*	*-49%*	*-49%*	*-49%*	*-49%*	*-49%*
	Post-closure	79.5	6.7	10.9	14.3	18.0	23.6	28.5	34.3
	% change from Baseline	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**.

Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-13: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Davidson Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)				
	11-DC	**H2**	**H4B**	**4-DC**	**1-DC**
7Q10					
Baseline	0.0	64	75	76	94
Construction (Year -2)	-	48	60	60	78
% Change from Baseline	-	-25%	-21%	-21%	-17%
Operations (Year 17)	-	-	0.5	0.7	18
% Change from Baseline	-	-	-99%	-99%	-81%
Closure (Year 20)	-	-	0.9	1.1	18
% Change from Baseline	-	-	-99%	-99%	-81%
Post-closure	-	68	79	79	97
% Change from Baseline	-	6%	5%	5%	4%
7Q20					
Baseline	0.0	61	72	72	89
Construction (Year -2)	-	46	56	56	74
% Change from Baseline	-	-25%	-21%	-21%	-17%
Operations (Year 17)	-	-	0.0	0.0	16
% Change from Baseline	-	-	-100%	-100%	-82%
Closure (Year 20)	-	-	0.5	0.7	17
% Change from Baseline	-	-	-99%	-99%	-81%
Post-closure	-	66	77	78	95
% Change from Baseline	-	9%	8%	8%	7%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. There are no flows for Node 11-DC as this drainage area is directed towards the 705 Watershed. During post-closure Node H2 does not exist, therefore surface water flows for the TSF spillway plunge pool are used.

Note: L/s = litre per second; % = percent.

Table 5.3.2-11 shows that the mean monthly and annual surface water flows in the Davidson Creek Watershed are expected to decrease below baseline flows due to Project effects for all Project phases. The TSF will be constructed at the headwaters of the Davidson Creek Watershed, permanently eliminating Node 11-DC from this watershed and directing this drainage to the Creek 705 Watershed.

During construction, the decrease in mean annual flows could range from -23% immediately downstream of the TSF (H2) to -16% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the construction of the coffer dam at Node 11-DC which will permanently redirect drainage from the upper extents of the Davidson Creek Watershed to the Creek 705 Watershed. These decreased flows are slightly greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2A**).

During operations, the decrease in mean annual flows could range from -100% immediately downstream of the TSF (H2) to -74% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the construction of the TSF, which reduces the drainage area of the Davidson Creek Watershed. In addition, the interception trench and associated ECD downstream of the TSF prevent all flows from passing H2 (Knight Piésold, 2013d). These decreased flows are similar to the 1:50–year dry baseline flow estimated for the creek (**Appendix 5.3.2A**).

During closure, the decrease in mean annual flows could range from -100% immediately downstream of the TSF (H2) to -71% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the TSF, the interception trench and associated ECD downstream of the TSF and will also prevent all flows from passing H2 (Knight Piésold, 2013d). The slight increase over the flows expected during operations is attributed to the construction of the TSF spillway, which permanently adds drainage area (north of the spillway) to the Davidson Creek Watershed from the Creek 661 Watershed (Knight Piésold, 2013d). These decreased flows are less than the 1:50–year dry baseline flows estimated for the creek (**Appendix 5.3.2A**).

During post-closure, the decrease in mean annual flows could range from -9% immediately downstream of the TSF (H2) to -10% at the mouth of Davidson Creek (1-DC). It is important to note that Node H2 does not exist during post-closure as this area is reclaimed by a wetland and the TSF spillway plunge pool. Therefore, surface water flows for the TSF spillway plunge pool are used for post-closure values at Node H2. These permanent decreases are attributed to the construction of the TSF, which reduces the drainage area of the Davidson Creek Watershed. The increase in flows from closure to post-closure is attributed to more flow being added to this watershed from the TSF via the spillway, unrestricted seepage and groundwater flows downstream of the TSF, and more consistent drainage from waste rock dumps (Knight Piésold, 2013d). These decreased flows are slightly greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2A**).

Table 5.3.2-12 shows that the instantaneous peak surface water flows at the mouth of the Davidson Creek Watershed (1-DC) are expected to decrease below baseline flows from construction through closure but would increase over baseline at post-closure. These peak flows have been determined based solely on changes in drainage areas due to the different phases of the Project, rather than by using a hydrologic model. The decreases in peak flows at the mouth of Davidson Creek (1-DC) are expected to be -13%, -52%, and -49% during construction, operations, and closure, respectively. These decreases in flows from construction through closure are attributed initially to the construction of a coffer dam at Node 11-DC (during construction) and then to the construction of the TSF (during operations and closure), which reduces the drainage area in the Davidson Creek Watershed. During post-closure, the increase in peak flows at the mouth of Davidson Creek (1-DC) is expected to be 4.3%. This permanent increase is attributed to drainage area being added to this watershed from the Creek 661 Watershed through the construction of the TSF spillway. As the post-closure increase in flow is less than 5%, it is considered undetectable in flow measurements and therefore negligible.

Table 5.3.2-13 shows that the 7Q10 and 7Q20 low surface water flows in the Davidson Creek Watershed are expected to decrease below baseline flows from construction through closure but would increase over baseline at post-closure. During construction, the decrease in low flows could range from -25% immediately downstream of the TSF (H2) to -17% at the mouth of Davidson Creek (1-DC). During operations and closure, the decrease in low flows could range from -100% immediately downstream of the TSF (H2) to -82% at the mouth of Davidson Creek (1-DC). These decreases in low flows from construction through closure are attributed to the same reasons previously discussed above for mean annual surface water flows. During post-closure, the increase in 7Q10 flows could range from 6% immediately downstream of the TSF (H2) to 4% at the mouth of Davidson Creek (1-DC). The increase in 7Q20 flows could range from 9% immediately downstream of the TSF (H2) to 7% at the mouth of Davidson Creek (1-DC). These permanent increases are attributed to more flow being added to this watershed from the TSF via the spillway, unrestricted and constant seepage from the TSF, groundwater flows downstream of the TSF, and more consistent drainage from waste rock dumps (Knight Piésold, 2013d). This additional flow will have a greater impact on low flows than on mean flows.

Table 5.3.2-11 to **Table 5.3.2-13** show that, without mitigation, the Project would be expected to eliminate or significantly reduce mean annual, peak, and low surface water flows in the Davidson Creek Watershed during construction through closure. The reduction in mean annual flows is expected to continue into post-closure in the Davidson Creek Watershed. However, peak and low surface water flows are expected to increase during post-closure in the Davidson Creek Watershed. The Davidson Creek Watershed therefore requires mitigation for surface water flow during construction through closure.

5.3.2.3.3.1.3 Creek 661 Watershed

The following surface water flow summary tables contain output from the watershed model and external statistical analyses for the Creek 661 Watershed for all phases of the mine for the following scenarios: mean monthly and annual flows (**Table 5.3.2-14**); instantaneous peak flows (**Table 5.3.2-15**); and 7Q10 and 7Q20 low flows **Table 5.3.2-16**. Refer to **Appendix 5.3.2A** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-14: Estimated Mean Monthly and Annual Surface Water Flow Changes in Creek 661 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
H1 (WQ5)													
Baseline	6	4	3	20	117	122	38	16	11	11	11	8	31
Construction (Year -2)	5	4	3	19	115	120	37	16	11	11	11	7	30
% Change from Baseline	-1%	0%	0%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-2%	-1%	-2%
Operations (Year 17)	4	2	1	18	116	121	37	15	9	10	9	6	29
% Change from Baseline	-36%	-54%	-64%	-10%	-1%	-1%	-2%	-8%	-13%	-15%	-18%	-27%	-5%
Closure (Year 20)	4	2	1	18	116	121	37	15	9	10	9	6	29
% Change from Baseline	-36%	-54%	-64%	-10%	-1%	-1%	-2%	-8%	-13%	-15%	-18%	-27%	-5%
Post-closure	6	4	3	20	117	122	38	16	11	11	11	8	31
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1-505659 (upper extents of watershed on tributary potentially impacted by mine footprint)													
Baseline	12	9	8	60	289	275	89	36	26	37	34	17	75
Construction (Year -2)	12	9	8	63	302	284	88	36	26	38	34	17	77
% Change from Baseline	0%	0%	1%	5%	4%	3%	0%	-1%	0%	2%	2%	-1%	3%
Operations (Year 17)	11	8	7	50	212	170	60	28	22	30	28	16	54
% Change from Baseline	-10%	-8%	-6%	-16%	-27%	-38%	-32%	-23%	-16%	-18%	-16%	-10%	-28%
Closure (Year 20)	8	6	6	41	167	111	40	19	15	20	19	11	39
% Change from Baseline	-34%	-30%	-18%	-31%	-42%	-60%	-55%	-48%	-44%	-45%	-44%	-38%	-48%
Post-closure	9	7	6	42	167	112	41	19	15	21	19	11	39
% Change from Baseline	-31%	-27%	-13%	-31%	-42%	-59%	-54%	-46%	-43%	-44%	-43%	-35%	-47%
1-661 (upstream of confluence with Chedakuz Creek upstream of Tatelkuz Lake)													
Baseline	97	85	82	293	934	852	307	162	134	169	164	114	283
Construction (Year -2)	97	85	82	296	945	858	306	161	133	170	165	113	285
% Change from Baseline	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	1%
Operations (Year 17)	94	82	80	281	855	746	277	152	128	161	157	110	261
% Change from Baseline	-3%	-3%	-3%	-4%	-8%	-12%	-10%	-6%	-4%	-5%	-4%	-3%	-8%
Closure (Year 20)	91	81	80	273	811	688	258	144	121	151	148	106	247
% Change from Baseline	-6%	-5%	-3%	-7%	-13%	-19%	-16%	-11%	-9%	-11%	-10%	-7%	-13%
Post-closure	93	83	81	275	813	688	259	145	122	153	150	107	248
% Change from Baseline	-4%	-3%	-1%	-6%	-13%	-19%	-16%	-10%	-8%	-10%	-9%	-5%	-13%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.

Note: L/s = litre per second; % = percent.

Table 5.3.2-15: Estimated Instantaneous Peak Surface Water Flow Changes at the Mouth of Creek 661 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) Return Period (Years)						
			2	**5**	**10**	**20**	**50**	**100**	**200**
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
1-661	Baseline	56.3	5.0	8.1	10.7	13.5	17.6	21.3	25.7
	Construction	55.6	5.0	8.0	10.6	13.3	17.4	21.0	25.3
	% change from Baseline	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*
	Operations	51.3	4.7	7.6	10.0	12.6	16.5	19.9	24.0
	% change from Baseline	*-8.7%*	*-6.3%*	*-6.3%*	*-6.3%*	*-6.3%*	*-6.3%*	*-6.3%*	*-6.3%*
	Closure	50.1	4.6	7.4	9.8	12.3	16.1	19.5	23.5
	% change from Baseline	*-11%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*
	Post-closure	50.1	4.6	7.4	9.8	12.3	16.1	19.5	23.5
	% change from Baseline	*-11%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*	*-8.5%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**.

Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-16: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Creek 661 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)		
	H1	**1-505659**	**1-661**
7Q10			
Baseline	0.8	0.8	41
Construction (Year -2)	0.8	0.9	41
% Change from Baseline	0%	24%	0%
Operations (Year 17)	0.0	3.4	43
% Change from Baseline	-100%	Increase	5%
Closure (Year 20)	0.0	1.2	41
% Change from Baseline	-100%	64%	0%
Post-closure	0.8	1.3	41
% Change from Baseline	0%	68%	0%
7Q20			
Baseline	0.6	0.4	40
Construction (Year -2)	0.6	0.6	40
% Change from Baseline	0%	44%	0%
Operations (Year 17)	0.0	3.2	42
% Change from Baseline	-100%	Increase	6%
Closure (Year 20)	0.0	1.1	40
% Change from Baseline	-100%	Increase	1%
Post-closure	0.6	1.1	40
% Change from Baseline	0%	Increase	1%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. Where a % change is greater than 100% this has been noted as an “Increase” and no numeric value is presented.

Note: L/s = litre per second; % = percent.

Table 5.3.2-14 shows that the mean annual surface water flows in the Creek 661 Watershed are expected to have minor changes relative to baseline flows due to the Project during construction and decrease below baseline flows from operations through post-closure. The majority of mine facilities will be located in the Davidson Creek Watershed but will extend into the Creek 661 Watershed, including the open pit, east waste rock dump, and camps.

During construction, the changes in mean annual flows could range from -2% downstream of the mine site (H1) to 1% at the mouth of Creek 661 (1-661). These changes in flows are attributed to the construction and rerouting of surface water by sediment control ponds (Knight Piésold, 2013d). Nevertheless, as these changes in flows are less than 5%, they are considered undetectable in flow measurements. Hence, the changes in flow magnitude are negligible.

During operations, the decrease in mean annual flows could range from -28% downstream of the mine site (1-505659) to -8% at the mouth of Creek 661 (1-661). Flows at H1 are less affected, with an estimated decrease of -5%. These decreases are attributed to groundwater inflows to the open pit and a reduction in drainage area associated with the construction of the open pit and the southern portion of the TSF (Knight Piésold, 2013d). These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2A**).

During closure and post-closure, the decrease in mean annual flows could range from -48% downstream of the mine site (1-505659) to -13% at the mouth of Creek 661 (1-661). Flows at H1 are less affected, with an estimated decrease of -5%. These decreases are attributed to the permanent removal of drainage area from the Creek 661 Watershed by redirecting it to the Davidson Creek Watershed (Knight Piésold, 2013d). These decreased flows are less than the 1in10–year dry baseline flows estimated for the creek downstream of the mine site (1-505659) and greater than the 1:5–year dry baseline flows estimated for the mouth of Creek 661(1-661) (**Appendix 5.3.2A**).

Table 5.3.2-15 shows that the instantaneous peak surface water flows at the mouth of the Creek 661 Watershed (1-661) are expected to decrease below baseline from construction through post-closure. These peak flows have been determined based solely on changes in drainage areas due to the different phases of the Project, rather than by using a hydrologic model. During construction, the decrease in peak flows at the mouth of Creek 661 (1-661) is expected to be -1.2%. As this decrease in flow is less than 5%, it is considered undetectable in flow measurements. During operation, the decrease in peak flows at the mouth of Creek 661 (1-661) is expected to be -6.3%. During closure and post-closure, the decrease in peak flows at the mouth of Creek 661 (1-661) is expected to be -8.5%. These permanent decreases in peak flows from construction through post-closure are attributed to the reduction of drainage area within the watershed due to the open pit and the TSF spillway.

Table 5.3.2-16 shows that the 7Q10 and 7Q20 low surface water flows in the Creek 661 Watershed are expected to increase or have no change relative to baseline flows from construction through post-closure. During construction, the increases in 7Q10 flows could range from 24% downstream of the mine site (1-505659) to 0% at the mouth of Creek 661 (1-661). The increases in 7Q20 flows could range from 44% downstream of the mine site (1-505659) to 0% at the mouth of Creek 661 (1-661). During operation, the increase in 7Q10 flows could range from greater than 100% immediately downstream of the mine site (1-505659) to 5% at the mouth of Creek 661 (1-661). The increases in 7Q20 flows could range from greater than 100% immediately downstream of the mine site (1-505659) to 6% at the mouth of Creek 661 (1-661). During closure and post-closure, the increase in 7Q10 flows could range from approximately 66% immediately downstream of the mine site (1-505659) to 0% at the mouth of Creek 661 (1-661). The increases in 7Q20 flows could range from greater than 100% immediately downstream of the mine site (1-505659) to 1% at the mouth of Creek 661 (1-661). These permanent increases or no change at 1-505659 in low flows from construction through post-closure are attributed to the seepage from the east dump overcoming the losses of groundwater to the open pit. The wastershed model assumes that this seepage is directed to the Creek 661 Watershed and not to the TSF.

The expected changes in 7Q10 and 7Q20 flows at H1 could range from 0% to -100% from construction through post-closure. This can be attributed to groundwater inflows to the open pit.

Table 5.3.2-14 to **Table 5.3.2-16** show that the Project is expected to reduce mean annual and peak surface water flows and increase low surface water flows in the Creek 661 Watershed from construction through operations.

5.3.2.3.3.1.4 Creek 705 Watershed

The following surface water flow summary tables contain output from the watershed model and external statistical analyses for the Creek 705 Watershed for all phases of the mine for the following scenarios: mean monthly and annual flows (**Table 5.3.2-17**); instantaneous peak flows (**Table 5.3.2-18**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-19**). Refer to **Appendix 5.3.2A** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios. **Table 5.3.2-17** to **Table 5.3.2-19** show that the mean annual, peak, and low surface water flows in the Creek 705 Watershed are expected to increase over baseline flows from construction through post-closure. These increases in mean annual flows could range from 54% downstream of the mine site (6-705) to 5% at the mouth of Creek 705 (1-705). The increases in peak flows at the mouth of Creek 705 (1-705) are expected to be 5.3%, solely based on change in drainage area, rather than by using a hydrologic model. The increases in low flows could range from more than 100% downstream of the mine site (6-705) to 15% at the mouth of Creek 705 (1-705) for both the 7Q10 and 7Q20 events. These increases are attributed to the construction of the TSF, which will permanently redirect drainage from the Davidson Creek Watershed to the Creek 705 Watershed (Knight Piésold, 2013d). The Project is expected to increase mean annual, peak, and low surface water flows in the Creek 705 Watershed from construction through operations.

Table 5.3.2-17: Estimated Mean Monthly and Annual Surface Water Flow Changes in Creek 705 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
6-705 (WQ16 in upper extents of watershed downstream of fish compensation)													
Baseline	2	1	1	18	130	75	29	12	9	12	10	4	25
Construction (Year -2)	6	4	4	29	183	124	44	18	14	18	16	8	39
% Change from Baseline	Increase	Increase	Increase	60%	40%	66%	51%	52%	57%	48%	53%	Increase	54%
Operations (Year 17)	6	4	4	29	183	124	44	18	14	18	16	8	39
% Change from Baseline	Increase	Increase	Increase	60%	40%	66%	51%	52%	57%	48%	53%	Increase	54%
Closure (Year 20)	6	4	4	29	183	124	44	18	14	18	16	8	39
% Change from Baseline	Increase	Increase	Increase	60%	40%	66%	51%	52%	57%	48%	53%	Increase	54%
Post-closure	6	4	4	29	183	124	44	18	14	18	16	8	39
% Change from Baseline	Increase	Increase	Increase	60%	40%	66%	51%	52%	57%	48%	53%	Increase	54%
4-705 (midpoint of watershed)													
Baseline	5	2	1	74	437	238	85	33	23	38	33	11	82
Construction (Year -2)	8	5	4	85	490	288	100	39	28	44	39	15	96
% Change from Baseline	80%	Increase	Increase	14%	12%	21%	18%	19%	21%	15%	16%	37%	17%
Operations (Year 17)	8	5	4	85	490	288	100	39	28	44	39	15	96
% Change from Baseline	80%	Increase	Increase	14%	12%	21%	18%	19%	21%	15%	16%	37%	17%
Closure (Year 20)	8	5	4	85	490	288	100	39	28	44	39	15	96
% Change from Baseline	80%	Increase	Increase	14%	12%	21%	18%	19%	21%	15%	16%	37%	17%
Post-closure	8	5	4	85	490	288	100	39	28	44	39	15	96
% Change from Baseline	80%	Increase	Increase	14%	12%	21%	18%	19%	21%	15%	16%	37%	17%
H7 (lower extents of watershed)													
Baseline	27	17	16	252	1,181	670	222	100	80	131	116	46	239
Construction (Year -2)	31	20	19	262	1,233	719	237	106	85	136	121	50	253
% Change from Baseline	13%	20%	18%	4%	4%	7%	7%	6%	6%	4%	5%	9%	6%
Operations (Year 17)	31	20	19	262	1,233	719	237	106	85	136	121	50	253
% Change from Baseline	13%	20%	18%	4%	4%	7%	7%	6%	6%	4%	5%	9%	6%
Closure (Year 20)	31	20	19	262	1,233	719	237	106	85	136	121	50	253
% Change from Baseline	13%	20%	18%	4%	4%	7%	7%	6%	6%	4%	5%	9%	6%

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Post-closure	31	20	19	262	1,233	719	237	106	85	136	121	50	253
% Change from Baseline	13%	20%	18%	4%	4%	7%	7%	6%	6%	4%	5%	9%	6%
1-705 (upstream of confluence of Fawnie Creek)													
Baseline	41	30	31	282	1,218	694	239	114	94	146	132	61	258
Construction (Year -2)	45	33	34	292	1,271	744	254	121	99	152	137	65	272
% Change from Baseline	9%	11%	10%	4%	4%	7%	6%	6%	5%	4%	4%	7%	5%
Operations (Year 17)	45	33	34	292	1,271	744	254	121	99	152	137	65	272
% Change from Baseline	9%	11%	10%	4%	4%	7%	6%	6%	5%	4%	4%	7%	5%
Closure (Year 20)	45	33	34	292	1,271	744	254	121	99	152	137	65	272
% Change from Baseline	9%	11%	10%	4%	4%	7%	6%	6%	5%	4%	4%	7%	5%
Post-closure	45	33	34	292	1,271	744	254	121	99	152	137	65	272
% Change from Baseline	9%	11%	10%	4%	4%	7%	6%	6%	5%	4%	4%	7%	5%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. Where a % change is greater than 100% this has been noted as an Increase" and no numeric value is presented.

Note: L/s = litre per second; % = percent.

Table 5.3.2-18: Estimated Instantaneous Peak Surface Water Flow Changes at the Mouth of Creek 705 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) Return Period (Years)						
			2	5	10	20	50	100	200
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
1-705	Baseline	45.3	4.2	6.8	9.0	11.3	14.8	17.8	21.5
	Construction	47.9	4.4	7.2	9.4	11.9	15.6	18.8	22.7
	% change from Baseline	*5.9%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*
	Operations	47.9	4.4	7.2	9.4	11.9	15.6	18.8	22.7
	% change from Baseline	*5.9%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*
	Closure	47.9	4.4	7.2	9.4	11.9	15.6	18.8	22.7
	% change from Baseline	*5.9%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*
	Post-closure	47.9	4.4	7.2	9.4	11.9	15.6	18.8	22.7
	% change from Baseline	*5.9%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*	*5.3%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**.

Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-19: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Creek 705 from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)			
	6-705	**4-705**	**H7**	**1-705**
7Q10				
Baseline	0.0	0.0	8.5	9.1
Construction (Year -2)	1.1	3.7	9.8	11
% Change from Baseline	Increase	Increase	16%	15%
Operations (Year 17)	1.1	3.7	9.8	11
% Change from Baseline	Increase	Increase	16%	15%
Closure (Year 20)	1.1	3.7	9.8	11
% Change from Baseline	Increase	Increase	16%	15%
Post-closure	1.1	3.7	9.8	11
% Change from Baseline	Increase	Increase	16%	15%
7Q20				
Baseline	0.0	0.0	7.9	8.5
Construction (Year -2)	0.9	3.5	9.1	9.8
% Change from Baseline	Increase	Increase	16%	15%
Operations (Year 17)	0.9	3.5	9.1	9.8
% Change from Baseline	Increase	Increase	16%	15%
Closure (Year 20)	0.9	3.5	9.1	9.8
% Change from Baseline	Increase	Increase	16%	15%
Post-closure	0.9	3.5	9.1	9.8
% Change from Baseline	Increase	Increase	16%	15%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. Where a % change is greater than 100% this has been noted as an "Increase" and no numeric value is presented.

Note: L/s = litre per second; % = percent.

5.3.2.3.3.1.5 Chedakuz Watershed

The following surface water flow summary tables contain the flows estimated by adjusting the H5 and 15-CC baseline datasets by the changes in flows at Nodes 1-DC and 1-661 that are predicted by the watershed model for the Chedakuz Creek Watershed. Mean monthly and annual flows (**Table 5.3.2-20**); instantaneous peak flows (**Table 5.3.2-21**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-22**) are provided for all phases of the mine. Refer to **Appendix 5.3.2A** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-20: Estimated Mean Monthly and Annual Surface Water Flow Changes in Chedakuz Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
15-CC (outlet of Tatelkuz Lake)													
Baseline	954	942	1,071	2,027	4,301	3,913	1,811	1,070	1,123	1,106	1,341	1,066	1,727
Construction (Year -2)	954	942	1,071	2,030	4,312	3,919	1,810	1,069	1,123	1,106	1,341	1,066	1,729
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Operations (Year 17)	951	940	1,068	2,015	4,222	3,807	1,781	1,060	1,117	1,098	1,334	1,063	1,705
% Change from Baseline	0%	0%	0%	-1%	-2%	-3%	-2%	-1%	-1%	-1%	-1%	0%	-1%
Closure (Year 20)	949	938	1,068	2,007	4,178	3,748	1,762	1,052	1,110	1,088	1,325	1,058	1,690
% Change from Baseline	-1%	0%	0%	-1%	-3%	-4%	-3%	-2%	-1%	-2%	-1%	-1%	-2%
Post-closure	962	951	1,079	2,045	4,386	3,876	1,794	1,066	1,127	1,112	1,344	1,074	1,735
% Change from Baseline	1%	1%	1%	1%	2%	-1%	-1%	0%	0%	1%	0%	1%	0%
H5 (midway between Davidson Creek and Turtle Creek confluences)													
Baseline	1,434	1,416	1,609	3,047	6,464	5,880	2,721	1,607	1,688	1,662	2,015	1,602	2,595
Construction (Year -2)	1,403	1,388	1,582	2,991	6,281	5,705	2,654	1,565	1,651	1,624	1,978	1,570	2,533
% Change from Baseline	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-3%	-2%	-2%	-2%	-2%	-2%
Operations (Year 17)	1,284	1,278	1,480	2,815	5,548	4,915	2,349	1,386	1,499	1,468	1,830	1,442	2,274
% Change from Baseline	-10%	-10%	-8%	-8%	-14%	-16%	-14%	-14%	-11%	-12%	-9%	-10%	-12%
Closure (Year 20)	1,283	1,277	1,480	2,824	5,581	4,911	2,346	1,383	1,496	1,465	1,827	1,440	2,276
% Change from Baseline	-11%	-10%	-8%	-7%	-14%	-16%	-14%	-14%	-11%	-12%	-9%	-10%	-12%
Post-closure	1,414	1,400	1,598	3,073	6,675	5,625	2,575	1,518	1,643	1,647	1,983	1,578	2,561
% Change from Baseline	-1%	-1%	-1%	1%	3%	-4%	-5%	-6%	-3%	-1%	-2%	-2%	-1%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.

Note: L/s = litre per second; % = percent.

Table 5.3.2-20 shows that the Project is expected to slightly decrease or have no impacts on mean annual surface water flows in relation to baseline flows at Tatelkuz Lake outlet (15-CC) from construction through post-closure. Without the freshwater system in place, the Project is expected to decrease flows below baseline during operations and closure. These decreases in mean annual flows could range from -1% to -2% at the outlet of Tatelkuz Lake (15-CC). As these changes in flows are less than 5%, they are considered undetectable in flow measurements and therefore negligible.

Table 5.3.2-20 shows that the Project is expected to decrease mean annual surface water flows below baseline flows from construction through post-closure on Chedakuz Creek (H5). H5 is the last WMN within the LSA in the Chedakuz Creek Watershed. During construction and post-closure, the decreases in mean annual flows could range from -2% to -1%. These changes can be attributed to the reduction in drainage area in the Davidson Creek watershed during construction and post-closure. As the changes in flows are less than 5%, they are considered undetectable in flow measurements and therefore negligible. Without the freshwater system in place, the decreases in mean annual flows are expected to be -12% during operations and closure. These decreases are attributed to the downstream impacts of the Project on Davidson Creek due to the reduction in drainage area by the TSF. These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2A**).

Table 5.3.2-21: Estimated Instantaneous Peak Surface Water Flow Changes on Chedakuz Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) Return Period (Years)						
			2	5	10	20	50	100	200
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
H5	Baseline	593	33.4	54.1	71.2	89.7	117.4	141.6	170.8
	Construction	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% Change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*
	Operations	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% Change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*
	Closure	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% Change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*
	Post-closure	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% Change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**.

Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-21 shows that the instantaneous peak surface water flows on Chedakuz Creek (H5) are expected to decrease below baseline from construction through post-closure. These peak flows were determined based solely on changes in drainage areas of the different phases of the Project, rather than by using a hydrologic model. From construction through post-closure, without the freshwater system in place, the decrease in peak flows on Chedakuz Creek (H5) is expected to be -0.4%. These decreases in flows from construction through closure are attributed to the construction of the TSF within the Davidson Creek Watershed, which subsequently reduces the drainage area in the Chedakuz Creek Watershed. As these changes in flows are less than 5%, they are considered undetectable in flow measurements and are therefore negligible.

Table 5.3.2-22 shows that the 7Q10 and 7Q20 low surface water flows at the outlet of Tatelkuz Lake are expected to decrease or have no change relative to the baseline flows from construction through post-closure. Without the freshwater system in place, the Project is expected to decrease low flows below baseline flows during operations and closure by about -1% at the outlet of Tatelkuz Lake (15-CC). As these changes in flows are less than 5%, they are considered undetectable in flow measurements and are therefore negligible. Without the freshwater system in place, the decreases in low flows on Chedakuz Creek (H5) downstream of Davidson Creek could be -4%

during construction, -20% during operation and closure, and -8% during post-closure. These decreases are attributed to the reduction in drainage area of the Davidson Creek Watershed and seepage from the East Dump directed to the Creek 661 Watershed and not the TSF.

Table 5.3.2-20 to **Table 5.3.2-22** show that surface water flows in the Chedakuz Creek Watershed at the outlet of Tatelkuz Lake (15-CC) would not be impacted by the Project from construction through post-closure. However, it is expected that the surface water flows in the Chedakuz Creek Watershed downstream of the Davidson Creek confluence (H5) would be affected by the Project from construction through post-closure due to the reduction in drainage area in the Davidson Creek Watershed. It is anticipated that the surface water flows at these locations in Chedakuz Creek (15-CC and H5) would be impacted by the freshwater supply system mitigation measure required in the Davidson Creek Watershed to meet IFN.

Table 5.3.2-22: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Chedakuz Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)	
	15-CC	H5
7Q10		
Baseline	469	705
Construction (Year -2)	469	678
% Change from Baseline	0%	-4%
Operations (Year 17)	466	571
% Change from Baseline	-1%	-19%
Closure (Year 20)	464	571
% Change from Baseline	-1%	-19%
Post-closure	471	656
% Change from Baseline	0%	-7%
7Q20		
Baseline	459	690
Construction (Year -2)	459	662
% Change from Baseline	0%	-4%
Operations (Year 17)	456	556
% Change from Baseline	-1%	-20%
Closure (Year 20)	455	556
% Change from Baseline	-1%	-19%
Post-closure	461	636
% Change from Baseline	0%	-8%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.

Note: L/s = litre per second; % = percent.

5.3.2.3.3.2 Tatelkuz Lake Levels

As discussed previously, Tatelkuz Lake will be the primary source of supplemental freshwater to meet mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in open pit flooding (during closure). The freshwater needs of mining operations (gland and reagent make-up water) are small compared to those for IFN. The potential effects of the Project on surface water flows thus far presented in this section do not consider the freshwater supply system required for IFN in Davidson Creek.

5.3.2.3.3.3 Mine Site Access Road

The proposed mine site access road is located entirely within the Aquatics LSA for the Project (**Figure 5.3.2-1**). This road will connect to the Kluskus–Ootsa FSR and traverse the Turtle Creek, Davidson Creek, and Creek 661 Watersheds. This infrastructure is expected to affect approximately 0.3 km^2 of these watersheds, a very small portion of the combined area of these watersheds (196 km^2). Moreover, a system of ditches and culverts will essentially retain flows within their respective watersheds. Hence, it is assumed that any effects this infrastructure may have on surface water flows within the Aquatics LSA would be negligible.

5.3.2.3.3.4 Transmission Line and Access Roads

The proposed transmission line will run from near Fraser Lake to the Project and traverse the Turtle Creek, Davidson Creek, and Creek 661 Watersheds. This infrastructure is expected to affect approximately 0.8 km^2 of these watersheds, which is small compared to the combined area of these watersheds (196 km^2). Moreover, a system of ditches and culverts will essentially retain flows within their respective watersheds. Hence, it is assumed that any effects this infrastructure may have on surface water flows within the Aquatics LSA would be negligible.

Outside of the Aquatics LSA of the Project (**Figure 5.3.2-1**), the proposed transmission line is expected to affect approximately 0.4 km^2 of the Aquatics RSA (1,095 km^2). Any effects of this infrastructure on surface water flows in the Aquatics RSA are considered to be negligible as this infrastructure would be designed not to disrupt natural surface patterns.

Temporary and permanent access roads will be required to construct and maintain the transmission line. Eleven temporary and five new permanent access roads will be constructed (see **Section 2.2.3.4** for a detailed discussion). All access roads will be culverted so as not to impede stream flows at crossings. Temporary access roads will be deactivated, culverts removed and surfaces reclaimed once construction has been completed.

5.3.2.3.3.5 Project Access Road (Kluskus FSR)

The upgraded Project access road (Kluskus FSR) will run from Highway 16 near Engen to join the Kluskus–Ootsa FSR. The Kluskus FSR does not traverse the Project's Aquatics LSA or RSA (**Figure 5.3.2-1**). The upgrades to this existing road are minor and only to improve safety. The Kluskus FSR is therefore not included in the effects assessment for surface water flow.

5.3.2.3.3.6 Airstrip and Access Road

The proposed airstrip and its access road are located entirely within the Turtle Creek Watershed and within the Aquatics LSA of the Project (**Figure 5.3.2-1**). This infrastructure is expected to affect approximately 0.5 km^2. Hence, any effects this infrastructure may have on surface water flows within the Aquatics LSA are considered to be negligible as this infrastructure would be designed not to disrupt natural surface runoff patterns. Earlier analysis in this section showed that the Project is not expected to impact surface water flows in the Turtle Creek Watershed.

5.3.2.3.4 Mitigation Measures

The previous sections considered how the Project could affect surface water flows in Turtle Creek, Davidson Creek, Creek 661, Creek 705, and lower Chedakuz Creek and lake levels in Tatelkuz Lake for various flow scenarios and for all the phases of the mine from baseline through post-closure. The mitigation measures and effectiveness ratings presented for surface water quality (**Section 5.3.3**), fish (**Section 5.3.8**), and fish habitat (**Section 5.3.9**) are also applicable to surface water flow.

Where applicable, Best Management Practices (BMPs) will be applied to surface water that will follow the guidelines outlined in the Environmental Code of Practice for Metal Mines (Environment Canada, 2009). The proposed Project MWAMP for the site is detailed in **Section 12.2.1.18.4.18**. Aspects of this plan, such as the TSF operation, on-site water management, and surface water diversions were included in the watershed model, including:

- Plan for construction though controlling sediment, timing based on fisheries needs, isolating work area, and capturing water;
- Minimize water use, manage contact water, and recycle;
- No surface water discharge during operations by containing contact water and using a water supply pipeline for environmental needs; and
- Plan for closure through re-establishing where possible drainage areas and flow patterns and using a temporary pumping system to meeting IFN.

Surface water flows presented in the previous sections include the measures proposed by the Project MWMP, excluding the freshwater supply system.

The purpose of the freshwater supply system is to meet water supply needs and provide operational flexibility (Knight Piésold, 2013a). Tatelkuz Lake is the primary source of supplemental freshwater for the Project beyond runoff and direct precipitation. The system will use freshwater from Tatelkuz Lake to meet mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in open pit flooding (during closure) without adversely affecting Tatelkuz Lake. During mining operations, freshwater needs of the mill (gland and reagent make-up water) will be met by pumping a constant supply of water from Tatelkuz Lake. Upon closure of the mill, this constant supply of freshwater will be used to aid in the filling of the open pit (Knight Piésold, 2013c). A freshwater reservoir will provide storage capacity to Davidson Creek IFN contingency supply while meeting supply restrictions of Tatelkuz Lake and Chedakuz Creek (Knight Piésold, 2013a). For more information on the Instream Flow Study, refer to **Appendix 5.1.2.6D**.

The potential effect of the Project at Node H5 on Chedakuz Creek could be high when the freshwater system is in place due to less water being available in Tatelkuz Lake for Chedakuz Creek. It is proposed that during low flow conditions additional flow is released to Davidson Creek from the freshwater reservoir to compensate for this. It is estimated that an additional flow of 20 L/s would be required to avoid lower 7Q10 and 7Q20 flows.

Despite the inclusion of mitigation measures, such as those discussed above and the freshwater supply system, the Project could have residual effects on Davidson Creek, Creek 661, Creek 705, or Chedakuz Creek. Therefore, it is necessary to assess the significance of these residual effects after considering all mitigation measures, including the freshwater supply system, during operations and closure.

Table 5.3.2-23 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on surface water flow during mine site development.

Table 5.3.2-23: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Surface Water Flow during Mine Site Development*

Likely Environmental Effect	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Reduction in low flows in Davidson Creek and lower Chedakuz Creek	Operations and Closure	It is proposed that during low flow conditions additional flow is released to Davidson Creek from the freshwater reservoir	High

Note: *Other mitigation measures that apply to surface water flow are presented and rated in Surface Water Quality (**Section 5.3.3**), Fish (**Section 5.3.8**), and Fish Habitat (**Section 5.3.9**)

In summary, low success rating means mitigation has not been proven successful, moderate success rating means mitigation has been proven successful elsewhere, and high success rating means mitigation has been proven effective. The effectiveness of the proposed mitigation measure high because using stored water has been proven as an effective method for increasing surface water flows.

5.3.2.4 Residual Effects and their Significance

The potential residual effects on mean annual, peak, and low flows within the watersheds potentially affected by the Project with the freshwater supply system in place, including meeting IFN in Davidson Creek as discussed previously, are summarized in this section. Mean monthly flows have been presented to support the surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetland VCs. Wet and dry monthly and annual flows have been presented to provide sensitivity analysis, to support the surface water and sediment quality and fish and fish habitat VCs, and to aid in mine operations strategies. This section will also summarize the potential residual effects of the Project on Tatelkuz Lake levels, with consideration of the freshwater supply system. Despite the inclusion of the freshwater supply system, the Project could have residual effects on Davidson Creek, Creek 661, Creek 705, or Chedakuz Creek. This section will therefore assess the significance of these residual effects, if any.

5.3.2.4.1 Residual Project Effects

Surface water flows in the Turtle Creek watershed are not expected to be impacted by the Project from construction through post-closure. The potential impacts of the proposed airstrip, access roads, and transmission line within the Aquatics RSA are expected to be negligible. The Project access road (Kluskus FSR) does not traverse the Project's Aquatics LSA or RSA (**Figure 5.3.2-1**). The upgrades to this existing road are minor and only to improve safety. The Kluskus FSR is therefore not included in the assessment of surface water flow effects.

Table 5.3.2-24 summarizes the potential Project effects that will be brought forward into the evaluation of residual Project effects and key mitigation measures to be implemented. All significance ratings were made relative to baseline flows for the entire watershed at the mouth (the respective WMN or WN has been provided in the table) and so these are the only potential effects listed in this table, although all flows for the watershed are presented.

Table 5.3.2-24: Summary of Potential Project Effects to be Carried Forward into Residual Effects Evaluation

Valued Components (Identify Phase of Project)	Potential Effects on Surface Water Flows			Key Mitigation Measures (To be Implemented)
	Mean Annual	Peak	Low	
Davidson Creek (WMN 1-DC)				
Construction	Decrease	Decrease	Decrease	Project MWMP.
Operations	Decrease	Decrease	Decrease	Pumping from Tatelkuz Lake to meet IFN.
Closure	Decrease	Decrease	Decrease	Pumping from Tatelkuz Lake to meet IFN.
Post-closure	Decrease	NCF	Increase	Project MWMP.
Creek 661 (WMN 1-661)				
Construction	NCF	NCF	NCF	Project MWMP.
Operations	Decrease	Decrease	Increase	Project MWMP.
Closure	Decrease	Decrease	NCF	Project MWMP.
Post-closure	Decrease	Decrease	NCF	Project MWMP.
Creek 705 (WMN 1-705)				
Construction	Increase	Increase	Increase	None.
Operations	Increase	Increase	Increase	None.
Closure	Increase	Increase	Increase	None.
Post-closure	Increase	Increase	Increase	None.
Chedakuz Creek (WN H5)				
Construction	NCF	NCF	NCF	None.
Operations	Decrease	NCF	Decrease	Add flow to Davidson Creek from reservoir during low flow conditions to reduce the impact.
Closure	Decrease	NCF	Decrease	Add flow to Davidson Creek from reservoir during low flow conditions to reduce the impact.
Post-closure	NCF	NCF	NCF	None.

Source: Refer to **Section 5.3.2.3**.

Note: NCF = not carried forward into the assessment; Project MWMP = measures already assumed to be in place; IFN = Instream Flow Needs.

5.3.2.4.1.1 Watersheds Potentially Affected by the Project

5.3.2.4.1.1.1 Davidson Creek Watershed

The following surface water flow summary tables contain output from the watershed model and external statistical analyses for the Davidson Creek Watershed with the freshwater supply system mitigation measure in place, including meeting IFN in Davidson Creek, for the following scenarios: Mean monthly and annual flows (**Table 5.3.2-25**); instantaneous peak flows (**Table 5.3.2-26**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-27**) are provided for all phases of the Project. Refer to **Appendix 5.3.2B** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-25: Estimated Mean Monthly and Annual Surface Water Flow Changes in Davidson Creek from the Project with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
11-DC (upper extents of watershed upstream of proposed TSF)													
Baseline	0	0	0	8	49	46	11	3	1	2	2	0	10
Construction (Year -2)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Operations (Year 17)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Closure (Year 20)	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
Post-closure	-	-	-	-	-	-	-	-	-	-	-	-	-
% Change from Baseline	-	-	-	-	-	-	-	-	-	-	-	-	-
H2 (WQ10 midpoint of watershed immediately downstream of the proposed TSF)													
Baseline	133	123	115	204	816	834	318	191	163	166	160	141	281
Construction (Year -2)	101	93	87	145	623	654	251	148	126	127	121	108	216
% Change from Baseline	-24%	-24%	-24%	-29%	-24%	-22%	-21%	-22%	-23%	-24%	-24%	-24%	-23%
Operations (Year 17)	125	125	125	125	570	560	240	150	115	115	115	125	208
% Change from Baseline	-6%	2%	9%	-39%	-30%	-33%	-25%	-21%	-30%	-31%	-28%	-11%	-26%
Closure (Year 20)	125	125	125	125	570	560	240	150	115	115	115	125	208
% Change from Baseline	-6%	2%	9%	-39%	-30%	-33%	-25%	-21%	-30%	-31%	-28%	-11%	-26%
Post-closure	113	106	101	227	976	652	211	122	130	160	138	120	255
% Change from Baseline	-14%	-14%	-12%	11%	20%	-22%	-34%	-36%	-21%	-4%	-14%	-15%	-9%
H4B (WQ26)													
Baseline	168	152	145	297	964	949	391	246	210	215	210	183	345
Construction (Year -2)	138	123	119	239	771	769	324	204	174	176	173	151	280
% Change from Baseline	-18%	-19%	-18%	-20%	-20%	-19%	-17%	-17%	-17%	-18%	-18%	-18%	-19%
Operations (Year 17)	146	141	144	203	697	650	288	184	142	144	147	151	254
% Change from Baseline	-13%	-7%	-1%	-32%	-28%	-31%	-26%	-25%	-32%	-33%	-30%	-18%	-26%
Closure (Year 20)	147	142	144	216	759	693	301	188	145	150	152	153	266
% Change from Baseline	-13%	-6%	-1%	-27%	-21%	-27%	-23%	-24%	-31%	-30%	-28%	-17%	-23%
Post-closure	140	127	126	306	1091	731	261	161	161	194	175	151	303
% Change from Baseline	-17%	-16%	-14%	3%	13%	-23%	-33%	-35%	-23%	-10%	-17%	-17%	-12%

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
4-DC													
Baseline	174	156	155	362	1053	991	406	254	216	229	227	192	369
Construction (Year -2)	143	128	129	304	860	811	339	212	180	190	189	160	304
% Change from Baseline	-18%	-18%	-17%	-16%	-18%	-18%	-16%	-16%	-17%	-17%	-17%	-17%	-17%
Operations (Year 17)	152	145	154	268	786	692	304	191	148	159	164	160	277
% Change from Baseline	-13%	-7%	-1%	-26%	-25%	-30%	-25%	-25%	-32%	-31%	-28%	-17%	-25%
Closure (Year 20)	153	146	155	281	848	736	316	196	151	164	169	162	290
% Change from Baseline	-12%	-7%	0%	-22%	-19%	-26%	-22%	-23%	-30%	-28%	-26%	-16%	-21%
Post-closure	146	131	136	371	1179	773	276	168	168	208	192	160	327
% Change from Baseline	-16%	-16%	-13%	2%	12%	-22%	-32%	-34%	-22%	-9%	-16%	-17%	-11%
1-DC (WQ7 upstream of confluence with Chedakuz Creek)													
Baseline	203	185	184	404	1,104	1,033	441	286	247	260	258	223	403
Construction (Year -2)	173	156	157	346	910	852	374	244	211	221	220	190	339
% Change from Baseline	-15%	-15%	-15%	-14%	-18%	-17%	-15%	-15%	-15%	-15%	-15%	-15%	-16%
Operations (Year 17)	181	174	183	310	837	734	338	223	179	190	195	190	312
% Change from Baseline	-11%	-6%	-1%	-23%	-24%	-29%	-23%	-22%	-28%	-27%	-24%	-14%	-23%
Closure (Year 20)	182	175	183	323	899	777	350	228	182	195	200	192	324
% Change from Baseline	-11%	-5%	-1%	-20%	-19%	-25%	-21%	-20%	-26%	-25%	-23%	-14%	-20%
Post-closure	175	160	164	413	1,230	815	311	200	199	239	223	191	361
% Change from Baseline	-14%	-13%	-11%	2%	11%	-21%	-29%	-30%	-20%	-8%	-14%	-14%	-10%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.
- There are no flows for Node 11-DC as this drainage area is directed towards the 705 Watershed. During post-closure Node H2 does not exist; therefore surface water flows for the TSF spillway plunge pool are used.

Note: L/s = litre per second; % = percent.

Table 5.3.2-26: Estimated Instantaneous Peak Surface Water Flow Changes at the Mouth of Davidson Creek from the Project with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s)						
			Return Period (Years)						
			2	**5**	**10**	**20**	**50**	**100**	**200**
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
1-DC	Baseline	76.2	6.4	10.4	13.7	17.3	22.6	27.3	32.9
	Construction	64.7	5.6	9.1	12.0	15.1	19.7	23.8	28.7
	% change from Baseline	*-15%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*	*-13%*
	Operations	31.9	4.2	6.1	7.7	9.4	11.9	14.1	16.8
	% change from Baseline	*-58%*	*-35%*	*-42%*	*-44%*	*-46%*	*-47%*	*-48%*	*-49%*
	Closure	34.8	4.4	6.4	8.1	9.9	12.6	15.0	17.8
	% change from Baseline	*-54%*	*-32%*	*-38%*	*-41%*	*-43%*	*-44%*	*-45%*	*-46%*
	Post-closure	79.5	6.7	10.9	14.3	18.0	23.6	28.5	34.3
	% change from Baseline	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*	*4.3%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.2**. For operations and construction phases, a flushing flow of 1.123 m^3/s has been added as a mitigation measure.

Note: km^2 = square kilometre; m^3/s = cubic metre per second; % = percent.

Table 5.3.2-27 shows that the mean annual surface water flows in the Davidson Creek Watershed are expected to decrease below baseline flows from construction through post-closure, with the freshwater supply mitigation measure in place and pumping at a rate sufficient to provide the IFN. The TSF will be constructed at the headwaters of the Davidson Creek Watershed, permanently eliminating Node 11-DC and directing the upper extents of Davidson Creek to the Creek 705 Watershed. During the operations and closure phases of the Project, the freshwater supply system will meet IFN in Davidson Creek downstream of the TSF.

During construction, the decrease in mean annual flows could range from -23% immediately downstream of the TSF (H2) to -16% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the construction of the TSF, which will reduce the drainage area of the Davidson Creek Watershed. These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

Table 5.3.2-27: *Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Davidson Creek from the Project with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases*

Mine Phase	Estimated Surface Water Flows (L/s)				
	11-DC	H2	H4B	4-DC	1-DC
7Q10					
Baseline	0.0	64	75	76	94
Construction (Year -2)	-	48	60	60	78
% Change from Baseline	-	-25%	-21%	-21%	-17%
Operations (Year 17)	-	121	121	121	145
% Change from Baseline	-	89%	60%	60%	55%
Closure (Year 20)	-	122	122	122	146
% Change from Baseline	-	91%	61%	61%	56%
Post-closure	-	68	79	79	97
% Change from Baseline	-	6%	5%	5%	4%
7Q20					
Baseline	0.0	61	72	72	89
Construction (Year -2)	-	46	56	56	74
% Change from Baseline	-	-25%	-21%	-21%	-17%
Operations (Year 17)	-	119	119	119	143
% Change from Baseline	-	96%	66%	65%	61%
Closure (Year 20)	-	120	120	120	144
% Change from Baseline	-	98%	67%	67%	62%
Post-closure	-	66	77	78	95
% Change from Baseline	-	9%	8%	8%	7%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. During post-closure Node H2 does not exist; therefore surface water flows for the TSF spillway plunge pool are used.

Note: L/s = litre per second; % = percent.

During operations, with freshwater mitigation in place, the decrease in mean annual flows could range from -26% immediately downstream of the TSF (H2) to -23% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the construction of the TSF, which will reduce the drainage area in the Davidson Creek Watershed. In addition, the interception trench and associated ECD downstream of the TSF will prevent all flows from passing H2 (Knight Piésold, 2013d). These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

During closure, with freshwater mitigation in place, the decrease in mean annual flows could range from -26% immediately downstream of the TSF (H2) to -20% at the mouth of Davidson Creek (1-DC). These decreases are attributed to the construction of the TSF, which will reduce the drainage area in the Davidson Creek Watershed. In addition, the interception trench and associated ECD downstream of the TSF will prevent all flows from passing H2 (Knight Piésold, 2013d). The slight increase over the flows seen during operations is attributed to the construction of the TSF spillway, which will permanently add drainage area (north of the spillway) to the Davidson Creek Watershed from the Creek 661 Watershed (Knight Piésold, 2013d). These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

During post-closure, the freshwater supply system will be decommissioned. The decrease in mean annual flows could range from -9% immediately downstream of the TSF (H2) to -10% at the mouth of Davidson Creek (1-DC). These permanent decreases are, as above, attributed to the construction of the TSF. However, during post-closure, more flow is added to this watershed from the TSF via the spillway, from unrestricted seepage and groundwater flows downstream of the TSF, and from additional drainage from waste rock dumps (Knight Piésold, 2013d). These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

Table 5.3.2-26 shows that the instantaneous peak surface water flows at the mouth of the Davidson Creek Watershed (1-DC) are expected to decrease below baseline from construction through closure, with freshwater mitigation in place, but increase over baseline at post-closure when the freshwater supply is decommissioned. These peak flows were determined based solely on changes in drainage areas due to the different phases of the Project, rather than by using a hydrologic model. Freshwater mitigation in the form of a flushing flow of 1.1 m^3/s has been added during operation and closure. This flushing flow was estimated based on stream flow metrics, taking into account the morphological and hydrological characteristics of the creek. For more information on flushing flows, refer to the Instream Flow Study in **Appendix 5.1.2.6D** in **Section 5.1.2.6**. During construction, the decrease in peak flows at the mouth of Davidson Creek (1-DC) is expected to be -13%. During operations, the decrease in peak flows at the mouth of Davidson Creek (1-DC) is expected to be -49%. During closure, the decrease in peak flows at the mouth of Davidson Creek (1-DC) is expected to be -46%. These decreases in flows from construction through closure are attributed to the construction of the TSF, which will reduce the drainage area in the Davidson Creek Watershed. During post-closure, the increase in peak flows at the mouth of Davidson Creek (1-DC) is expected to be 4.3%. This permanent increase is attributed to drainage area being added to this watershed from the Creek 661 Watershed and to the construction and operation of the TSF spillway. As this post-closure increase in flows is less than 5%, it is considered undetectable in flow measurements.

Table 5.3.2-27 shows that the 7Q10 and 7Q20 low surface water flows in the Davidson Creek Watershed are expected to decrease below baseline flows during construction but increase over baseline from operation through post-closure with freshwater mitigation in place. During construction, the decrease in 7Q10 and 7Q20 flows could range from -25% immediately downstream of the TSF (H2) to -17% at the mouth of Davidson Creek (1-DC). These decreases in flows from construction through closure are attributed to the same reasons discussed above for mean annual surface water flows. During operations, the increase in 7Q10 flows could range from 89% immediately downstream of the TSF (H2) to 55% at the mouth of Davidson Creek (1-DC). The increase in 7Q20 flows could range from 96% immediately downstream of the TSF (H2) to 61% at the mouth of Davidson Creek (1-DC). During closure, the increase in 7Q10 flows could range from 91% immediately downstream of the TSF (H2) to 56% at the mouth of Davidson Creek

(1-DC). The increase in 7Q20 flows could range from 98% immediately downstream of the TSF (H2) to 62% at the mouth of Davidson Creek (1-DC). During post-closure, the increase in 7Q10 flows could range from 6% immediately downstream of the TSF (H2) to 4% at the mouth of Davidson Creek (1-DC). The increase in 7Q20 flows could range from 9% immediately downstream of the TSF (H2) to 7% at the mouth of Davidson Creek (1-DC). These permanent increases are attributed to more flow being added to this watershed from the TSF via the spillway, unrestricted seepage and groundwater flows downstream of the TSF, and additional drainage from waste rock dumps (Knight Piésold, 2013d). This additional flow would have a greater impact on low flows than it would on mean flows.

Table 5.3.2-25 to **Table 5.3.2-27** show that, with freshwater mitigation in place, the Project will affect mean annual, peak, and low surface water flows in the Davidson Creek Watershed from construction to post-closure.

5.3.2.4.1.1.2 Creek 661 Watershed

The freshwater supply system mitigation measure will not have an impact on the Creek 661 Watershed. Results from **Section 5.3.2.3** show that the Project has the potential to affect surface water flows in the Creek 661 Watershed.

5.3.2.4.1.1.3 Creek 705 Watershed

The freshwater supply system mitigation measure will not have an impact on the Creek 705 Watershed. Results from **Section 5.3.2.3** show that the Project has the potential to affect surface water flows in the Creek 705 Watershed.

5.3.2.4.1.1.4 Chedakuz Watershed

The following surface water flow summary tables contain flows estimated by adjusting the H5 and 15-CC baseline datasets by the changes in flows at Nodes 1-DC and 1-661 predicted by the watershed model for the Chedakuz Creek Watershed. The freshwater supply system mitigation measure is assumed to be in place (includes meeting IFN in Davidson Creek). In addition, if necessary, water from the freshwater reservoir can be used to supplement low flows. The following scenarios were considered for all the mine phases: mean monthly and annual flows (**Table 5.3.2-28**); instantaneous peak flows (**Table 5.3.2-29**); and 7Q10 and 7Q20 low flows (**Table 5.3.2-30**). Refer to **Appendix 5.3.2B** for surface water flow summary tables for the 1:5–, 1:10–, 1:20–, and 1:50–year dry and wet scenarios.

Table 5.3.2-28: Estimated Mean Monthly and Annual Surface Water Flow Changes in Chedakuz Creek from the Project with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Surface Water Flows (L/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**
15-CC (outlet of Tatelkuz Lake)													
Baseline	954	942	1,071	2,027	4,301	3,913	1,811	1,070	1,123	1,106	1,341	1,066	1,727
Construction (Year -2)	954	942	1,071	2,030	4,312	3,919	1,810	1,069	1,123	1,106	1,341	1,066	1,729
% Change from Baseline	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Operations (Year 17)	793	782	910	1,857	3,619	3,214	1,508	877	969	950	1,186	905	1,464
% Change from Baseline	-17%	-17%	-15%	-8%	-16%	-18%	-17%	-18%	-14%	-14%	-12%	-15%	-15%
Closure (Year 20)	791	780	910	1,853	3,591	3,166	1,492	870	963	941	1,178	901	1,453
% Change from Baseline	-17%	-17%	-15%	-9%	-17%	-19%	-18%	-19%	-14%	-15%	-12%	-16%	-16%
Post-closure	962	951	1,079	2,045	4,386	3,876	1,794	1,066	1,127	1,112	1,344	1,074	1,735
% Change from Baseline	1%	1%	1%	1%	2%	-1%	-1%	0%	0%	1%	0%	1%	0%
H5 (midway between Davidson Creek and Turtle Creek confluences)													
Baseline	1,434	1,416	1,609	3,047	6,464	5,880	2,721	1,607	1,688	1,662	2,015	1,602	2,595
Construction (Year -2)	1,403	1,388	1,582	2,991	6,281	5,705	2,654	1,565	1,651	1,624	1,978	1,570	2,533
% Change from Baseline	-2%	-2%	-2%	-2%	-3%	-3%	-2%	-3%	-2%	-2%	-2%	-2%	-2%
Operations (Year 17)	1,251	1,245	1,447	2,782	5,515	4,882	2,316	1,353	1,466	1,435	1,797	1,409	2,241
% Change from Baseline	-13%	-12%	-10%	-9%	-15%	-17%	-15%	-16%	-13%	-14%	-11%	-12%	-14%
Closure (Year 20)	1,250	1,244	1,447	2,791	5,548	4,878	2,313	1,350	1,463	1,432	1,794	1,407	2,243
% Change from Baseline	-13%	-12%	-10%	-8%	-14%	-17%	-15%	-16%	-13%	-14%	-11%	-12%	-14%
Post-closure	1,414	1,400	1,598	3,073	6,675	5,625	2,575	1,518	1,643	1,647	1,983	1,578	2,561
% Change from Baseline	-1%	-1%	-1%	1%	3%	-4%	-5%	-6%	-3%	-1%	-2%	-2%	-1%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC.

Note: L/s = litre per second; % = percent.

Table 5.3.2-28 shows that the Project is expected to decrease or have no impacts on mean annual flows in relation to baseline flows at the outlet of Tatelkuz Lake (15-CC) during construction and post-closure. With the freshwater mitigation, the Project is expected to decrease flows below baseline during operations and closure. These decreases in mean annual flows could be about -16% at the outlet of Tatelkuz Lake (15-CC) and are attributed to the freshwater system that removes water from Tatelkuz Lake to provide freshwater for mining operations and to meet IFN in Davidson Creek. These decreased flows are greater than the 1:5-year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

Table 5.3.2-29: Estimated Instantaneous Peak Surface Water Flow Changes on Chedakuz Creek from the Project for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-Closure Phases

Station Name		Area (km^2)	Instantaneous Peak Flows (m^3/s) Return Period (Years) 2	5	10	20	50	100	200
Index Flood Frequency Factor			**0.47**	**0.76**	**1.00**	**1.26**	**1.65**	**1.99**	**2.40**
H5	Baseline	593	33.4	54.1	71.2	89.7	117.4	141.6	170.8
	Construction	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*
	Operations	590	34.4	55.0	72.0	90.4	118.0	142.1	171.1
	% change from Baseline	*-0.4%*	*2.9%*	*1.6%*	*1.1%*	*0.8%*	*0.5%*	*0.3%*	*0.2%*
	Closure	590	34.4	55.0	72.0	90.4	118.0	142.1	171.1
	% change from Baseline	*-0.4%*	*2.9%*	*1.6%*	*1.1%*	*0.8%*	*0.5%*	*0.3%*	*0.2%*
	Post-closure	590	33.3	53.8	70.8	89.3	116.9	141.0	170.0
	% change from Baseline	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*	*-0.4%*

Source: Knight Piésold provided drainage areas. AMEC estimated the instantaneous peak flows using the data provided in **Section 5.3.2.1**. For operations and construction phases, a flushing flow of 1.123 m^3/s has been added as a mitigation measure.

Note: km^2 = square kilometre; m^3/s = cubic metres per second; % = percent.

Table 5.3.2-28 shows that, with the freshwater mitigation in place, the Project is expected to decrease mean annual flows below baseline flows from construction through post-closure on Chedakuz Creek (H5). H5 is the last node within the LSA in the Chedakuz Creek Watershed. During construction and post-closure, the decreases in mean annual flows could range from -2% to -1%. These changes can be attributed to the reduction in drainage area in the Davidson Creek watershed during construction and post-closure. As the changes in flows are less than 5%, they are considered undetectable in flow measurements. With the freshwater system in place, the changes in mean annual flows are expected to be -14% during operations and closure. These decreases are attributed to the downstream impacts of the Project on Davidson Creek, whose flows are expected to be affected by the reduction in drainage area due to the TSF. These decreased flows are greater than the 1:5–year dry baseline flows estimated for the creek (**Appendix 5.3.2B**).

Table 5.3.2-29 shows that the instantaneous peak surface water flows on Chedakuz Creek (H5) are expected to decrease below baseline flows during construction and post-closure. The peak flows would increase over baseline during operations and closure with freshwater mitigation in place. These peak flows were estimated based on changes in drainage areas for the different phases of the Project. Freshwater mitigation in the form of a flushing flow of 1.1 m^3/s was added during operations and closure. This flushing flow was estimated based on stream flow metrics, taking into account the morphological and hydrological characteristics of the creek. For more information on flushing flows, refer to the Instream Flow Study in **Appendix 5.1.2.6D**. During construction and post-closure, the decrease in peak flows on Chedakuz Creek (H5) is expected to be -0.4%. During operations and closure, the increase in peak flows on Chedakuz Creek (H5) is expected to range from 0.2% to 3%, with freshwater mitigation in place. The permanent decreases in flows in post-closure are attributed to the construction of the TSF within the Davidson Creek Watershed, which will subsequently reduce drainage area in the Chedakuz Creek Watershed. As these changes in flows are less than 5%, they are considered undetectable in flow measurements.

Table 5.3.2-30 shows that the 7Q10 and 7Q20 low surface water flows at the outlet of Tatelkuz Lake (15-CC) are expected to decrease or have no change relative to the baseline flows from construction through post-closure. The decreases could be up to -26% at 15-CC for both the 7Q10 and 7Q20 events. With the freshwater system in place, the 7Q10 and 7Q20 low flows on Chedakuz Creek (H5) downstream of Davidson Creek could be approximately -4% during construction, -20% during operations and closure, and -8% during post-closure, relative to baseline values. These decreases are attributed to the reduction in drainage area due to the Project.

Table 5.3.2-28 to **Table 5.3.2-30** show that surface water flows in the Chedakuz Creek Watershed at the outlet of Tatelkuz Lake (15-CC) and on Chedakuz Creek downstream of Davidson Creek (H5) would be affected by the Project from construction through post-closure with freshwater mitigation in place.

Table 5.3.2-30: Estimated 7Q10 and 7Q20 Surface Water Flow Changes in Chedakuz Creek from the Project with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Surface Water Flows (L/s)	
	15-CC	**H5**
7Q10		
Baseline	469	705
Construction (Year -2)	469	678
% Change from Baseline	0%	-4%
Operations (Year 17)	349	566
% Change from Baseline	-26%	-20%
Closure (Year 20)	348	566
% Change from Baseline	-26%	-20%
Post-closure	471	656
% Change from Baseline	0%	-7%
7Q20		
Baseline	459	690
Construction (Year -2)	459	662
% Change from Baseline	0%	-4%
Operations (Year 17)	341	550
% Change from Baseline	-26%	-20%
Closure (Year 20)	341	550
% Change from Baseline	-26%	-20%
Post-closure	461	636
% Change from Baseline	0%	-8%

Source: Flows are from **Appendix 5.1.2.1B** (Knight Piésold, 2013d). % change has been determined by AMEC. Flow has been added manual by AMEC at Node H5 during operations and closure to account for water from the reservoir being added as a mitigation measure.

Note: L/s = litre per second; % = percent.

5.3.2.4.1.2 Tatelkuz Lake Levels

Tatelkuz Lake is the primary source of supplemental freshwater for the Project. A freshwater supply system will only be required during the operations and closure phases of the Project to meet the needs of mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in open pit flooding (during closure). A Tatelkuz Lake IFN Withdrawal Model was prepared by Knight Piésold and is attached in **Appendix 5.3.2C** (Knight Piésold, 2013i). AMEC used the information provided in **Appendix 5.3.2C** to estimate the potential impacts of the Project on Tatelkuz Lake levels and compared these to estimated fluctuations between maximum and minimum baseline lake levels. **Table 5.3.2-31** summarizes the results of analyses on Tatelkuz Lake levels for mean monthly and annual flows for all mine phases. The greatest potential effects to lake levels will be during extreme dry conditions. **Table 5.3.2-32** summarizes the results of analyses on Tatelkuz Lake levels for 1:50–year dry conditions for all mine phases.

Table 5.3.2-31 and **Table 5.3.2-32** show that the Project will decrease Tatelkuz Lake mean and 1:50–year dry annual levels during operations and closure. During operations and closure, the mean annual Tatelkuz Lake level is expected to decrease by approximately 4 cm, or -3%, over baseline fluctuations. During operations, the annual 1:50–year dry Tatelkuz Lake level is expected to decrease by approximately 6 cm, or -4%, below baseline fluctuations. During closure, the annual 1 in 50–year dry Tatelkuz Lake level is expected to decrease by approximately 5 cm, or -3%, below baseline fluctuations. These changes in annual Tatelkuz Lake levels are less than 5%.

Table 5.3.2-31: Estimated Mean Monthly and Annual Tatelkuz Lake Levels with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

Mine Phase	Estimated Mean Monthly and Annual Tatelkuz Lake Elevations													Maximum Tatelkuz Lake Level Fluctuation used for the Effects Assessment
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual	
Baseline Elevation (masl)	926.93	926.93	926.95	927.11	927.37	927.33	927.08	926.95	926.96	926.96	927.00	926.95	927.07	147.8 cm
Estimated Baseline Fluctuation (cm)	19.6	18.5	27.9	76.2	131.2	129.3	105.6	84.3	34.3	34.5	38.9	33.0	147.8	
Construction (Year -2) Elevation (masl)	926.93	926.93	926.95	927.11	927.37	927.33	927.08	926.95	926.96	926.96	927.00	926.95	927.07	
Change from Baseline in cm	0.00	0.00	0.00	0.04	0.10	0.06	-0.01	-0.01	0.00	0.01	0.01	0.00	0.02	
% Change from Baseline Fluctuation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Operations (Year 17) Elevation (masl)	926.89	926.89	926.92	927.09	927.30	927.26	927.03	926.91	926.93	926.93	926.98	926.92	927.02	
Change from Baseline in cm	-3.61	-3.63	-3.36	-2.46	-6.72	-7.29	-4.78	-4.07	-3.12	-3.21	-2.85	-3.39	-4.25	
% Change from Baseline Fluctuation	-18%	-20%	-12%	-3%	-5%	-6%	-5%	-5%	-9%	-9%	-7%	-10%	-3%	
Closure (Year 20) Elevation (masl)	926.90	926.90	926.93	927.09	927.30	927.26	927.04	926.92	926.94	926.93	926.98	926.92	927.03	
Change from Baseline in cm	-2.89	-2.89	-2.64	-2.04	-6.67	-7.46	-4.51	-3.49	-2.56	-2.69	-2.37	-2.75	-3.88	
% Change from Baseline Fluctuation	-15%	-16%	-9%	-3%	-5%	-6%	-4%	-4%	-7%	-8%	-6%	-8%	-3%	
Post-closure Elevation (masl)	926.93	926.93	926.95	927.11	927.38	927.33	927.08	926.95	926.96	926.96	927.00	926.95	927.07	
Change from Baseline in cm	0.18	0.17	0.17	0.25	0.80	-0.37	-0.25	-0.08	0.08	0.12	0.05	0.15	0.12	
% Change from Baseline Fluctuation	1%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	

Source: Lake levels and % change have been determined by AMEC using data in **Appendix 5.3.2C** (Knight Piésold, 2013i).

Note: masl =metres above sea level; cm = centimetre; % = percent.

Table 5.3.2-32: Estimated 1:50–year Dry Monthly and Annual Tatelkuz Lake Levels with Mitigation Measures for Construction (Year -2), Operations (Year 17), Closure (Year 20), and Post-closure Phases

	Estimated 1:50 year Dry Monthly and Annual Tatelkuz Lake Elevations													Maximum Tatelkuz Lake Level Fluctuation used for the Effects Assessment
Mine Phase	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**	
Baseline Elevation (masl)	926.84	926.85	926.87	926.83	926.93	926.93	926.86	926.80	926.76	926.79	926.85	926.84	926.85	147.8 cm
Estimated Baseline Fluctuation (cm)	19.6	18.5	27.9	76.2	131.2	129.3	105.6	84.3	34.3	34.5	38.9	33.0	147.8	
Construction (Year -2) Elevation (masl)	926.84	926.85	926.87	926.83	926.93	926.93	926.86	926.80	926.76	926.79	926.85	926.84	926.85	
Change from Baseline in cm	0.00	0.00	0.00	0.04	0.14	0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.02	
% Change from Baseline Fluctuation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Operations (Year 17) Elevation (masl)	926.80	926.81	926.83	926.80	926.83	926.82	926.80	926.75	926.72	926.75	926.82	926.80	926.80	
Change from Baseline in cm	-4.42	-4.32	-3.94	-3.21	-10.15	-11.06	-5.85	-5.22	-4.08	-4.07	-3.47	-4.27	-5.50	
% Change from Baseline Fluctuation	-23%	-23%	-14%	-4%	-8%	-9%	-6%	-6%	-12%	-12%	-9%	-13%	-4%	
Closure (Year 20) Elevation (masl)	926.81	926.82	926.84	926.80	926.83	926.82	926.81	926.75	926.73	926.76	926.82	926.81	926.80	
Change from Baseline in cm	-3.54	-3.43	-3.09	-2.66	-10.00	-10.93	-5.39	-4.38	-3.27	-3.32	-2.84	-3.44	-4.87	
% Change from Baseline Fluctuation	-18%	-19%	-11%	-3%	-8%	-8%	-5%	-5%	-10%	-10%	-7%	-10%	-3%	
Post-closure (Year 45) Elevation (masl)	926.85	926.85	926.87	926.83	926.94	926.93	926.86	926.80	926.76	926.79	926.85	926.84	926.85	
Change from Baseline in cm	0.14	0.15	0.17	0.20	1.05	-0.53	-0.25	-0.07	0.08	0.18	0.08	0.12	0.12	
% Change from Baseline Fluctuation	1%	1%	1%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	

Source: Lake levels and % change have been determined by AMEC using data in **Appendix 5.3.2C** (Knight Piésold, 2013i).

Note: masl = metres above sea level; cm = centimetre; % = percent.

5.3.2.4.2 Significance of Residual Project Effects

The rating of significance of identified adverse residual Project effects after the application of effective and feasible mitigation, including meeting IFN in Davidson Creek as discussed previously, was based on both a quantitative assessment and professional judgement, as the rating is qualitative in nature. Significance of the predicted potential adverse residual Project effects (after mitigation, which includes meeting IFN in Davidson Creek) was assessed for the surface water flow VC based on the following factors:

- **Context:** this refers to the ability of the VC to accept change. For example, the effect of a project may have an impact if it occurs in areas that are ecologically sensitive, with little resilience to imposed stresses. Effects on surface water flow may affect such ecological components as surface water and sediment quality and fish and fish habitat. Refer to the EA sections dependent on surface water flow for ecological context;
- **Magnitude:** this refers to the severity of the impact. Impacts can be high magnitude or low magnitude. For surface water flow, the magnitude of an effect is quantified in terms of the percentage change in flows from baseline conditions found in **Section 5.3.2.2**;
- **Geographic Extent:** this refers to the area over which the predicted impact is expected to occur. The geographic extent of effects can be site-specific, local, or regional;
- **Duration:** this refers to the length of time the effect lasts. Duration can be defined as short term or long term;
- **Reversibility:** this refers to the ability of the VC to return to its original state once the stress is removed. The prediction of reversibility can be difficult, as environmental effects may or may not be reversible. Effects can be reversible or permanent;
- **Frequency:** this refers to how often an effect is expected to occur (may be described as frequent or infrequent or may be quantified);
- **Likelihood**: the likelihood of occurrence of a particular residual effect is an important element in understanding significance. Likelihood of occurrence is rated as low, moderate, or high; and
- **Confidence**: describes the certainty of the predicted outcome, allowing the decision-maker to evaluate risk. Confidence can be high, moderate, or low. A level of confidence has been provided for both likelihood and significance and are based on professional judgement and knowledge of the sources and nature of uncertainty as compounded through all steps in the effects assessment.

Each potential adverse residual Project effect determined to have an impact on surface water flow VC was evaluated with respect to the above-listed criteria using the metrics as defined in **Table 5.3.2-33**.

Table 5.3.2-33: Surface Water Flow Rating Criteria to Evaluate Significance of Adverse Residual Project Effects

Rating Criteria	Description
Magnitude	
Negligible	• Effects are not measurable (<5% change in flow from baseline conditions)
Low	• 5% to 10% change in flow from baseline conditions
Medium	• 10% to 20% change in flow from baseline conditions
High	• >20% change in flow from baseline conditions
Geographic Extent	
Point	• Effect generally does not exceed 100 m2 or distance from the source is less than 50 m
Site-Specific	• Effects confined to the Project site
Local	• Effect is confined to the LSA
Regional	• Effect is confined to the RSA
Duration	
Short term	• Less than two years (construction)
Medium term	• From 2 to less than 17 years (operations)
Long term	• From 17 to less than 35 years (closure)
Chronic (permanent)	• From 35 years and beyond (post closure and beyond)
Reversibility	
Yes	• Effect is reversible over one to a few cycles of the physical event after the impact ceases (physical). Effect is reversible over one to a few life cycles after the impact ceases (biological)
No	• Effect is not reversible over the timescales listed.
Frequency	
Once	• Effect occurs on one occasion.
Intermittent	• Effect occurs several times.
Continuous	• Effect occurs continuously.
Likelihood	
Low	• Low likelihood a residual effect will occur.
Moderate	• Moderate likelihood a residual effect will occur.
High	• High likelihood a residual effect will occur.
Significance	
Not significant (negligible)	• Effects are point-like or local in geographic extent, with a low context rating, and a negligible magnitude, short-term, reversible, and with a low frequency (once or intermittent)
Not significant (minor)	• Effects are local in geographic extent, with a low magnitude, and low context rating, short-term to chronic, reversible, and with a low frequency (once or intermittent)

Rating Criteria	Description
Not significant (moderate)	• Effects are local to regional in geographic extent, and medium in magnitude, medium context rating, medium term to chronic, reversible, and occur at all frequencies
Significant	• Effects occur to VCs with a medium to high context, high magnitude, regional in geographic extent, long term to chronic, non-reversible, and occur at all frequencies
Confidence	
Low	• VC is not well understood • Project-VC interaction is not well understood • Mitigation has not been proven effective
Moderate	• VC understood in similar ecosystems and effects documented in the larger regional area or in the literature • Mitigation proven effective elsewhere
High	All of the following must be met: • VC is well understood • Project-VC interaction is well understood • Mitigation has been proven effective

Note: m = metre; m^2 = square metre; % = percent; VC = Valued Component

Table 5.3.2-34 summarizes the significance determination of adverse residual Project effects on surface water flows (after mitigation, including meeting IFN in Davidson Creek as discussed previously). In this table, the adverse residual Project effects are grouped according to watershed, and are presented for each phase of the Project (construction, operations, closure, and post-closure). All ratings were made relative to baseline flows for the entire watershed at the mouth (the respective WMN or WN is provided in the table) for each surface water flow parameter.

Surface water flows can naturally range between highs and lows with no expected significant effects on the natural environment. **Table 5.3.2-34** shows that based solely on a percentage change in surface water flows (quantitative results in this section) at the mouth of the Davidson Creek Watershed, the magnitude of the residual effects from the Project (after mitigation including meeting IFN in Davidson Creek as discussed previously) could range from negligible to high, depending on which phase of the Project is being considered. At the mouth of the Creek 661 Watershed, the magnitude of the effect could range from negligible to medium. At the mouth of the Creek 705 Watershed, the magnitude of the effect could range from low to medium. On Chedakuz Creek at the LSA boundary, the magnitude of the effect could range from negligible to medium. Nevertheless, when all of the residual effects significance rating metrics are considered, the residual impacts of the Project (after mitigation that includes meeting IFN in Davidson Creek) on the above watersheds are expected to be “Not significant (minor or moderate)”. As stated in **Section 5.3.2.2** surface water flow is valued by local residents as lakes, rivers, and streams (i.e., Blackwater River, Stuart River and the Nechako River) are used for recreational use (i.e., canoeing, white water rafting and boating). The Project avoids the watersheds containing the Blackwater and Stuart Rivers and therefore will not impact these watercourses. Chedakuz Creek drains into the Nechako Reservoir which drains into the Nechako River. The magnitude of the residual effects of the Project estimated on Chedakuz Creek at the LSA boundary are expected to be "Not Significant (moderate)" and therefore will not measurably impact the Nechako River. Surface water flow at Chedakuz Creek (WN H5) and Creek 705 (WMN 1-705) are carried forward into the cumulative effects assessment. In addition, as surface water flow is an intermediate component in the effects pathway, the results herein are carried forward into other aquatics-related VCs such as fish and fish habitat.

Table 5.3.2-34: Significance of Adverse Residual Project Effects on Surface Water Flow

Categories for Significance Determination	Rating			
	Construction	**Operations**	**Closure**	**Post-closure**
Davidson Creek (WMN 1-DC)				
Mean Annual Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Medium	High	High	Low
Geographic Extent	Local	Local	Local	Local
Duration	Short	Medium	Long	Chronic
Reversibility	No	No	No	No
Frequency	Continuous	Continuous	Continuous	Continuous
Likelihood Determination	High	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High	High
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	Not significant (minor)
Statement of the level of Confidence for Significance	High	High	High	High
Peak Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Medium	High	High	n/a
Geographic Extent	Local	Local	Local	n/a
Duration	Short	Medium	Long	n/a
Reversibility	No	No	No	n/a
Frequency	Continuous	Continuous	Continuous	n/a
Likelihood Determination	High	High	High	n/a
Statement of the level of Confidence for Likelihood	High	High	High	n/a
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	n/a
Statement of the level of Confidence for Significance	High	High	High	n/a
Low Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Medium	High	High	Low
Geographic Extent	Local	Local	Local	Local
Duration	Short	Medium	Long	Chronic
Reversibility	No	No	No	No
Frequency	Continuous	Continuous	Continuous	Continuous
Likelihood Determination	High	High	High	High

Categories for Significance Determination	Rating			
	Construction	**Operations**	**Closure**	**Post-closure**
Statement of the level of Confidence for Likelihood	High	High	High	High
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	Not significant (minor)
Statement of the level of Confidence for Significance	High	High	High	High
Creek 661 (WMN 1-661)				
Mean Annual Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	Low	Medium	Medium
Geographic Extent	n/a	Local	Local	Local
Duration	n/a	Medium	Long	Chronic
Reversibility	n/a	No	No	No
Frequency	n/a	Continuous	Continuous	Continuous
Likelihood Determination	n/a	High	High	High
Statement of the level of Confidence for Likelihood	n/a	High	High	High
Significance Determination	n/a	Not significant (minor)	Not significant (moderate)	Not significant (moderate)
Statement of the level of Confidence for Significance	n/a	High	High	High
Peak Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	Low	Low	Low
Geographic Extent	n/a	Local	Local	Local
Duration	n/a	Medium	Long	Chronic
Reversibility	n/a	No	No	No
Frequency	n/a	Continuous	Continuous	Continuous
Likelihood Determination	n/a	High	High	High
Statement of the level of Confidence for Likelihood	n/a	High	High	High
Significance Determination	n/a	Not significant (minor)	Not significant (minor)	Not significant (minor)
Statement of the level of Confidence for Significance	n/a	High	High	High
Low Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	Low	n/a	n/a
Geographic Extent	n/a	Local	n/a	n/a
Duration	n/a	Medium	n/a	n/a
Reversibility	n/a	Yes	n/a	n/a
Frequency	n/a	Continuous	n/a	n/a
Likelihood Determination	n/a	High	n/a	n/a
Statement of the level of Confidence for Likelihood	n/a	High	n/a	n/a

Categories for Significance Determination	Rating			
	Construction	**Operations**	**Closure**	**Post-closure**
Significance Determination	n/a	Not significant (minor)	n/a	n/a
Statement of the level of Confidence for Significance	n/a	High	n/a	n/a
Creek 705 (WMN 1-705)				
Mean Annual Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Low	Low	Low	Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short	Medium	Long	Chronic
Reversibility	No	No	No	No
Frequency	Continuous	Continuous	Continuous	Continuous
Likelihood Determination	High	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High	High
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)
Statement of the level of Confidence for Significance	High	High	High	High
Peak Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Low	Low	Low	Low
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short	Medium	Long	Chronic
Reversibility	No	No	No	No
Frequency	Continuous	Continuous	Continuous	Continuous
Likelihood Determination	High	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High	High
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)
Statement of the level of Confidence for Significance	High	High	High	High
Low Surface Water Flows				
Context	Context is not applicable*			
Magnitude	Medium	Medium	Medium	Medium
Geographic Extent	Regional	Regional	Regional	Regional
Duration	Short	Medium	Long	Chronic
Reversibility	No	No	No	No
Frequency	Continuous	Continuous	Continuous	Continuous
Likelihood Determination	High	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High	High
Significance Determination	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)

Categories for Significance Determination	Rating			
	Construction	Operations	Closure	Post-closure
Statement of the level of Confidence for Significance	High	High	High	High
Chedakuz Creek (WN H5)				
Mean Annual Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	Medium	Medium	n/a
Geographic Extent	n/a	Regional	Regional	n/a
Duration	n/a	Medium	Long	n/a
Reversibility	n/a	No	Yes	n/a
Frequency	n/a	Continuous	Continuous	n/a
Likelihood Determination	n/a	High	High	n/a
Statement of the level of Confidence for Likelihood	n/a	High	High	n/a
Significance Determination	n/a	Not significant (moderate)	Not significant (moderate)	n/a
Statement of the level of Confidence for Significance	n/a	High	High	n/a
Peak Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	n/a	n/a	n/a
Geographic Extent	n/a	n/a	n/a	n/a
Duration	n/a	n/a	n/a	n/a
Reversibility	n/a	n/a	n/a	n/a
Frequency	n/a	n/a	n/a	n/a
Likelihood Determination	n/a	n/a	n/a	n/a
Statement of the level of Confidence for Likelihood	n/a	n/a	n/a	n/a
Significance Determination	n/a	n/a	n/a	n/a
Statement of the level of Confidence for Significance	n/a	n/a	n/a	n/a
Low Surface Water Flows				
Context	Context is not applicable*			
Magnitude	n/a	Medium	Medium	Low
Geographic Extent	n/a	Regional	Regional	Regional
Duration	n/a	Medium	Long	Chronic
Reversibility	n/a	No	No	No
Frequency	n/a	Continuous	Continuous	Continuous
Likelihood Determination	n/a	High	High	High
Statement of the level of Confidence for Likelihood	n/a	High	High	High
Significance Determination	n/a	Not significant (moderate)	Not significant (moderate)	Not significant (moderate)
Statement of the level of Confidence for Significance	n/a	High	High	High
Tatelkuz Lake				
Context	Context is not applicable*			

Categories for Significance Determination	Rating			
	Construction	Operations	Closure	Post-closure
Magnitude	n/a	Negligible	Negligible	n/a
Geographic Extent	n/a	Local	Local	n/a
Duration	n/a	Medium	Long	n/a
Reversibility	n/a	Yes	Yes	n/a
Frequency	n/a	Continuous	Continuous	n/a
Likelihood Determination	n/a	High	High	n/a
Statement of the level of Confidence for Likelihood	n/a	High	High	n/a
Significance Determination	n/a	Not significant (negligible)	Not significant (negligible)	n/a
Statement of the level of Confidence for Significance	n/a	High	High	n/a

Note: * Refer to the EA sections dependent on surface water flow for ecological context
n/a = not applicable as it was determined from this assessment that the effects are not measurable and therefore negligible and not carried forward into this assessment.

5.3.2.5 Cumulative Effects

A CEA for the Surface Water Flow VC is necessary because when all of the residual effects rating metrics are considered (**Section 5.3.2.4.2**), the residual effects of the Project (after mitigation that includes meeting IFN in Davidson Creek) on the watersheds are expected to be "Not significant (moderate)". Therefore, the VCs of surface water flow at Chedakuz Creek (WN H5) and Creek 705 (WMN 1-705) are carried forward into the cumulative effects assessment as summarized in **Table** 5.3.2-35. In addition, as surface water flow is an intermediate component in the effects pathway, the results herein are carried forward into other aquatics-related VCs such as fish and fish habitat.

Table 5.3.2-35: Surface Water Flow Project-Related Residual Effects; Rationale for Carrying Forward into the CEA

Project Component	Project Phase	Residual Effect	Rationale	Carried Forward in Cumulative Effects Assessment
Chedakuz Creek (WN H5)	D/C	Alteration of baseline surface water flow.	Potential to decrease flows in the Chedakuz Creek Watershed which would carry into the RSA.	Yes
Creek 705 (WMN 1-705)	D/C	Alteration of baseline surface water flow.	Potential to increase flows in the Creek 705 Watershed which would carry into the RSA.	Yes

Note: D/C = decommissioning and closure.

Cumulative effects are interactions between predicted residual effects from the Project that have the potential to combine cumulatively with residual effects from other past, present, or reasonably foreseeable future projects.

Past land use in the Project area includes mineral exploration, agricultural, recreational and forestry activities in addition to Aboriginal traditional use. The effects of these activities on the existing watersheds are included in the baseline conditions and are therefore reassessed as potential cumulative effects with the Project on surface water flow in the Aquatics RSA (**Figure 5.3.2-1**).

Present and future land use in the Project area that could potentially affect surface water flow include agriculture, forestry, and mineral exploration. For the purposes of the Surface Water Flow VC, the Aquatics RSA is divided into two major areas (**Figure 5.3.2-12**): the Upper Eutsuk Regional Watershed (includes the Creek 705 Watershed) and the Lower Nechako Regional Watershed (includes the Creek 661, Turtle Creek, Davidson Creek, and Chedakuz Creek Watersheds and Tatelkuz Lake).

Table 5.3.2-36 shows the major watershed components within the Aquatics RSA for the assessment of potential cumulative effects of present and future projects with the Project for the Surface Water Flow VC.

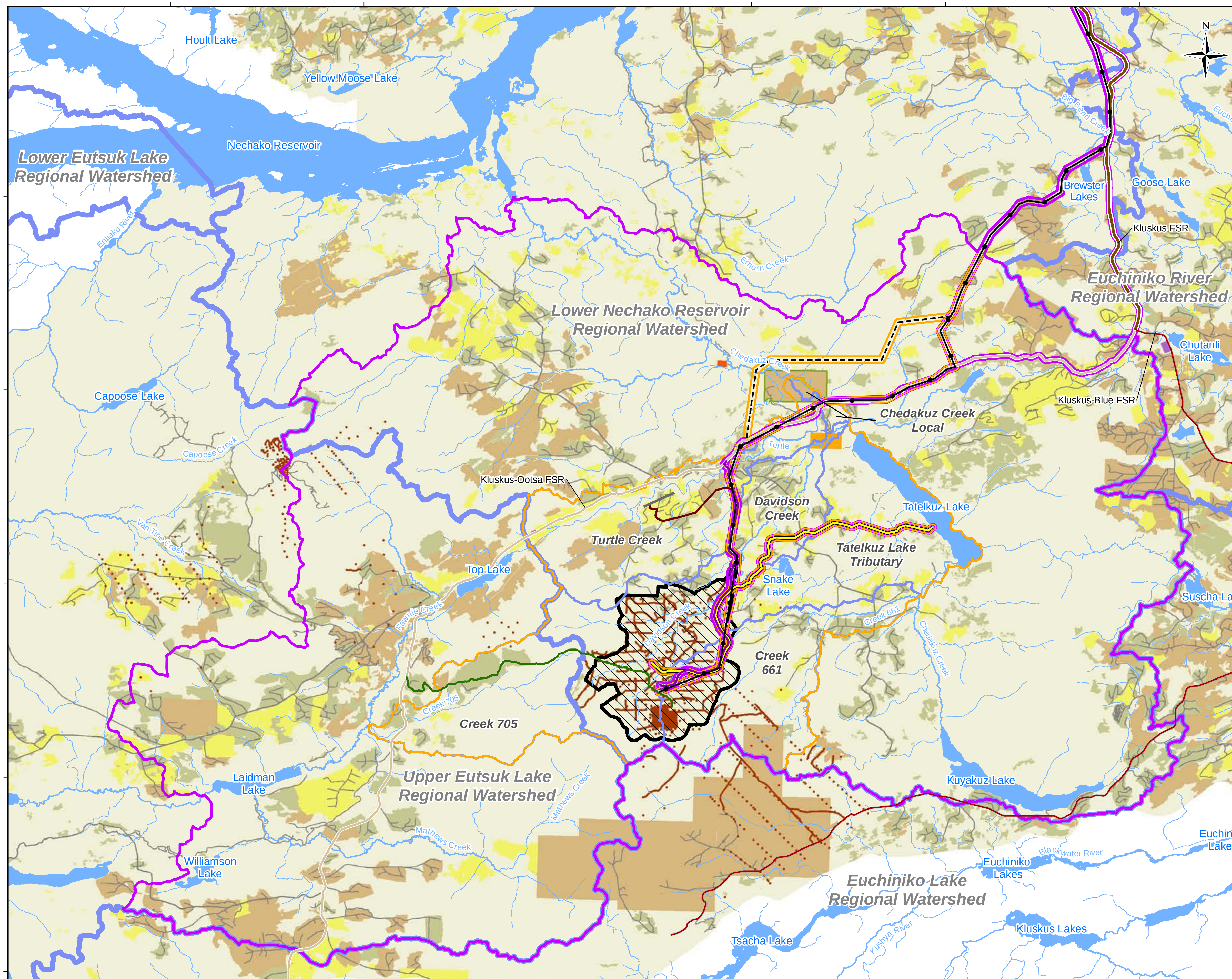
Table 5.3.2-36: Major Watershed Components of the Aquatics RSA

Watershed Component	Total Area (ha)
Upper Eutsuk Lake Regional Watershed component – includes Creek 705 Watershed	46,300
Lower Nechako Regional Watershed component – includes Chedakuz Creek, Creek 661, Turtle Creek and Davidson Creek Watersheds and Tatelkuz Lake	94,189
Subtotal	140,489
Remainder of RSA (Transmission Line and Kluskus Access Road components)	5,959
Total Aquatic RSA	146,448

Note: ha = hectare

The potential effects on surface water flow from agriculture, forestry, and mineral exploration within the Aquatics RSA were estimated based on change in weighted runoff coefficient. The runoff coefficient for natural drainage in the Aquatics RSA is estimated to be 0.31 as is discussed in the Hydrology Baseline summary section of the EA (**Section 5.1.2.1**). Current and future agricultural, forestry, and mineral exploration activities in the Aquatics RSA would change this runoff coefficient. It has been assumed for this assessment that agricultural activities would reduce the runoff coefficient to 0.2 and that forestry and mineral exploration would increase the runoff coefficient to 0.5 (Watt et al., 1989).

It was estimated that these current and future activities could increase the baseline weighted runoff coefficient of the Upper Eutsuk Lake (includes the Creek 705 Watershed) component of the Aquatics RSA from 0.31 to 0.37. For post-closure, it is estimated that the Project could increase this weighted runoff coefficient to 0.38. Therefore, the contribution of the Project to the cumulative effects of current and future activities in the Upper Eutsuk Lake component of the Aquatics RSA is 2.5%, which is less than 5% and considered not to be measurable and therefore negligible. The residual cumulative effects assessment for surface water flow in the Upper Eutsuk Lake Watershed is summarized in **Table 5.3.2-37**.



Legend

- Kluskus FSR
- Kluskus-Ootsa FSR

Project Components

- Exploration Road
- Proposed Mine Access Road
- Proposed Transmission Line
- Mills Ranch Reroute
- Proposed Fresh Water Pipeline
- Proposed Airstrip Access Road
- Proposed Airstrip Extent
- Proposed Mine Site
- Regional Watersheds
- Local Watersheds

AGRICULTURE

Crown Tenure Purpose

- Extensive
- Grazing
- Intensive

MINING

- Active Mining
- Current Prospecting
- Quarries (Tenure Purpose)

FORESTRY

Cutblocks and woodlots

- Retired (Past)
- Operational Activities (Present)
- Harvesting Inventory (Future)
- Logging Roads (ROW)

Woodlot Licenses

- Active (Present)
- Pending (Future)

Aquatic

- Local Study Area
- Regional Study Area
- Regional and Local Study Areas

Scale:1:200,000

0 2.5 5 10

Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Cumulative Effects Assessment
Surface Water Flow

DATE: December, 2013	ANALYST: WR	Figure	5.3.2-12
JOB No: VE52277	QA/QC: MY	PDF FILE: 09-100-019_CumulativeEffects_SA_WQ_sites.pdf	
GIS FILE: 09-100-019_CumulativeEffects.mxd			
PROJECTION: UTM Zone 10	DATUM: NAD83	amec	

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Table 5.3.2-37: Residual Cumulative Effects Assessment for Surface Water Flow in the Upper Eutsuk Lake Watershed

Effect Attribute	Current / Future Cumulative Effect(s) without Project	Project Contribution Cumulative Effect
Context	Context not applicable*	
Magnitude	Medium	Negligible
Geographic extent	Regional	n/a
Duration	Chronic	n/a
Reversibility	No	n/a
Frequency	Continuous	n/a
Likelihood Determination	High	n/a
Level of confidence for Likelihood	High	n/a
Significance Determination	Not Significant (moderate)	n/a
Level of confidence for Significance	Low	n/a

Note: * Refer to the EA sections dependent on surface water flow for ecological context
n/a = not applicable as it was determined from this assessment that the effects are not measurable and therefore negligible and not carried forward into this assessment.

It was estimated that these current and future activities could increase the baseline weighted runoff coefficient of the Lower Nechako (includes the Chedakuz Creek, Creek 661, Turtle Creek and Davidson Creek Watersheds and Tatelkuz Lake) component of the Aquatics RSA from 0.31 to 0.36. For post-closure, it is estimated that the Project could decrease this weighted runoff coefficient to 0.35. Therefore, the contribution of the Project to the cumulative effects of current and future activities in the Lower Nechako component of the Aquatics RSA is -1.7% which is less than 5% and considered not to be measurable and therefore negligible. The residual cumulative effects assessment for surface water flow in the Lower Nechako Watershed is summarized in **Table 5.3.2-38**.

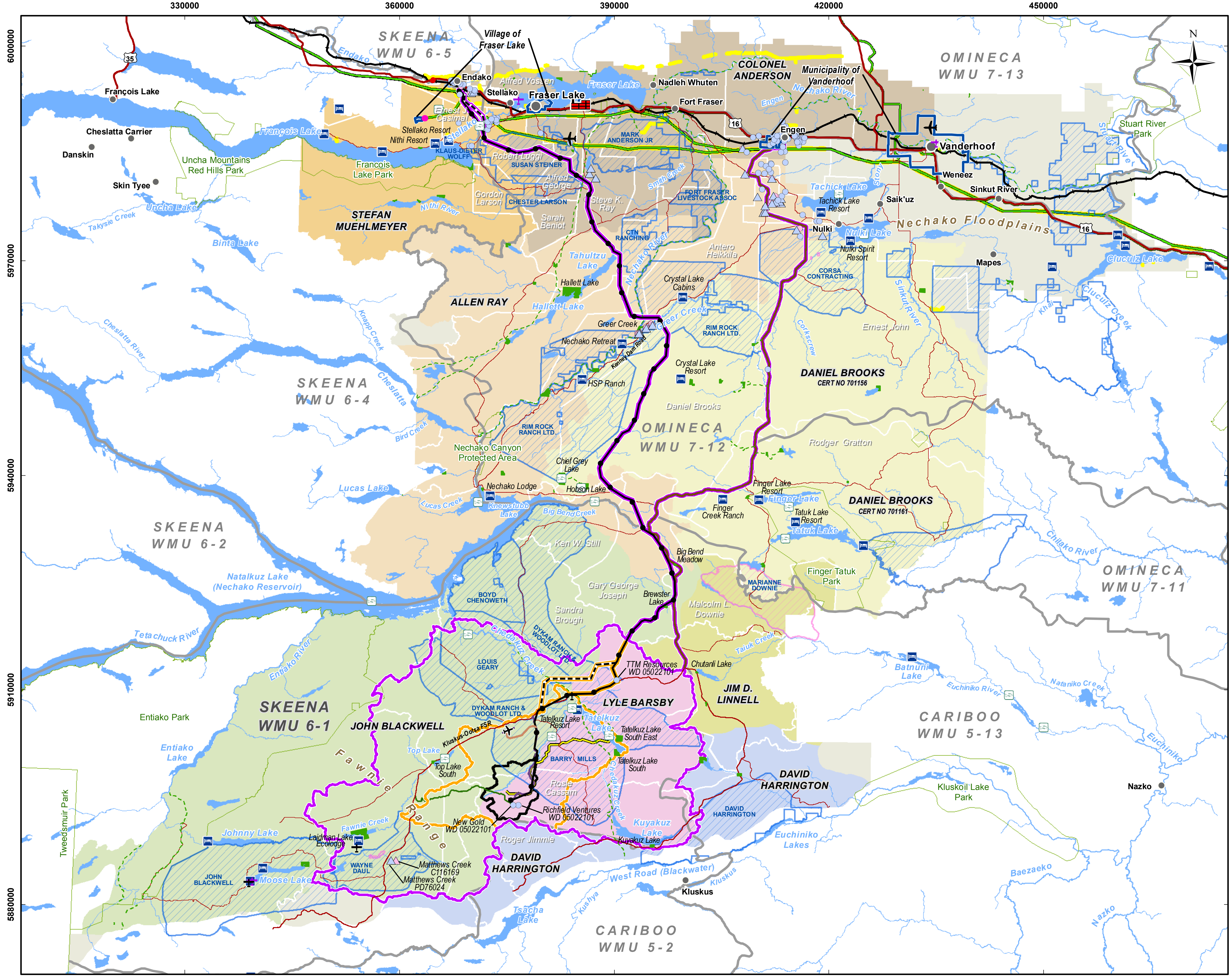
Table 5.3.2-38: Residual Cumulative Effects Assessment for Surface Water Flow in the Lower Nechako Watershed

Effect Attribute	Current / Future Cumulative Effect(s) without Project	Project Contribution Cumulative Effect
Context	Context not applicable*	
Magnitude	Medium	Negligible
Geographic extent	Regional	n/a
Duration	Chronic	n/a
Reversibility	No	n/a
Frequency	Continuous	n/a
Likelihood Determination	High	n/a
Level of confidence for Likelihood	High	n/a
Significance Determination	Not Significant (moderate)	n/a
Level of confidence for Significance	Low	n/a

Note: * Refer to the EA sections dependent on surface water flow for ecological context
n/a = not applicable as it was determined from this assessment that the effects are not measurable and therefore negligible and not carried forward into this assessment.

Figure 5.3.2-13 shows the current surface water licences near the Project. There are two current surface water licences in the Upper Eutsuk Lake component of the Aquatics RSA; one is a drinking water source and the other is a point of water diversion. Both of these licences are located on Matthews Creek, a tributary of Fawnie Creek, upstream of Laidman Lake. The Creek 705 Watershed is located in the upper extents of the Upper Eutsuk Lake Watershed. As can be seen in **Section 5.3.2.3**, the Project is expected to increase surface water flows in the Creek 705 Watershed. This is due to the fact that drainage will be permanently diverted from the Davidson Creek Watershed to the Creek 705 Watershed. These increases will have no effect on these two surface water licences, as they are located on a tributary upstream of Fawnie Creek.

Cumulative effects were assessed for the Surface Water Flow VC. When compared to the potential effect of current and future agricultural, forestry, and mineral exploration activities in the Aquatics RSA, the Project effects on surface water flow are expected not to be measurable and therefore negligible.



Legend

- Populated Place
- Highway
- Kluskus FSR
- Other FSRs
- Parks
- Municipal Boundaries

PROJECT COMPONENTS

- Proposed Airstrip
- Exploration Road
- Proposed Transmission Line
- Proposed Re-route
- Proposed Water Pipeline Route
- Proposed Airstrip Access Road
- Proposed Airstrip Extent
- Proposed Mine Site

AGRICULTURE

Range Tenures

- Active Range Tenures (Present)
- Pending Range Tenures (Future)

HUNTING

- Wildlife Management Units

Guide Outfitters

- Colonel Anderson
- Lyle Barsby
- John Blackwell
- Daniel Brooks
- David Harrington
- Jim D. Linnell
- Stefan Muelmeyer
- Allen Ray
- Other

Traplines

- Near the LSAs

RECREATION

- Recreation Lodge
- Recreation Fishing Location
- Active Recreation Trails
- Active Recreation Sites

INFRASTRUCTURE

- Airport
- Airstrip
- Waterdome
- Sawmill Biomass Project

Crown Tenure Purpose (ROW)

- Energy Production
- Transportation
- Utility

AQUATIC

- Local Study Area
- Regional Study Area

WATER LICENSES

In the Aquatic RSA and near the LSAs

- Drinking Water Source
- Groundwater Well
- Points of Diversion Water License
- Water Licensed Works

Scale: 1:530,000

0 5 10 20 Kilometres

Reference

BC Government GeoBC Data Distribution
NRCAN Geobase
Ministry of Forests, Lands and Natural Resource Operations

CLIENT: newgold

PROJECT: Blackwater Gold Project

Projects and Human Activities Included in the Cumulative Effects Assessment (Activities)

DATE: October, 2013	ANALYST: WR	**Figure** 5.3.2-13	
JOB No: VE52277	QA/QC: MY	PDF FILE: 17-100-097_CEA_AquaticACTIV.pdf	
GIS FILE: 17-100-097_CEA_AquaticACTIV.mxd			
PROJECTION: UTM Zone 10	DATUM: NAD83	amec	

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5.3.2.6 Limitations

The potential changes to surface water flows and Tatelkuz Lake levels due to the Project were assessed both quantitatively (baseline data, watershed modelling, and external statistical analysis) and qualitatively (residual significance effects ratings). The results of the effects assessment and subsequent residual effects ratings have the following limitations:

- The bathymetric survey for Tatelkuz Lake was completed on a high flow day but it is still limited to the depths recorded on that day. As such, levels above this depth were extrapolated (Knight Piésold, 2013i);
- The rating curve estimated for the Tatelkuz Lake outlet has been applied to monthly discharges to estimate lake levels;
- Due to the variability of snowmelt conditions and summer storms, it is difficult to determine smooth distributions for stream flow on a monthly basis, which may affect statistical analyses for wet and dry conditions (Knight Piésold, 2013g);
- Peak baseline flows and flows due to phases of the Project have been estimated based solely on drainage area, rather than by using a hydrologic model. Changes in runoff parameters have not been considered. In addition, the method used to determine these flows may result in an overestimation (Knight Piésold, 2013f);
- Watershed modelling results beyond the 1:50–year wet and dry events have a high level of uncertainty and were therefore not included (Knight Piésold, 2013h); and
- All modelling tools have inherent limitations in the assumptions made. This affects the certainty of the watershed analysis for the Project.

The Project residual effects of the flows were assessed to determine the cumulative effects based on both modelling results and the effects on runoff coefficients due to changes in land use and other activities. The model outcome and the estimation of the runoff coefficients have uncertainties due to the model assumptions and the variability in runoff coefficients.

5.3.2.7 Conclusion

Surface Water Flow was selected as a VC for the Project EA because impacts to surface water flows and Tatelkuz Lake levels could affect surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetlands. The watersheds assessed for potential effects from the Project on the Surface Water Flow VC include Turtle Creek, Davidson Creek, Creek 661, Creek 705, and lower Chedakuz Creek (contains Tatelkuz Lake). These watersheds are either within or adjacent to the Project footprint. Hence, the Project has the potential to affect surface water flow in these watersheds and Tatelkuz Lake levels during construction, operations, closure, and post-closure. All Project mining components are on the surface, and most of them are located in the Davidson Creek and Creek 661 watersheds. Drainage in the extreme upper extents of the Davidson Creek Watershed will be permanently directed to the Creek 705 Watershed due to the construction of the TSF. Water from Tatelkuz Lake in the Chedakuz Creek Watershed will be used to supplement mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in open pit flooding (during closure). In addition, the Project will include other infrastructure such as the access roads, transmission line, and an airstrip.

The key indicators of hydrological significance considered in this assessment of the Surface Water Flow VC were surface water flows and Tatelkuz Lake levels. The potential effects on mean annual, peak, and low flows within the watersheds and Tatelkuz Lake levels potentially affected by the Project were assessed. Mean monthly flows were presented to support surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetland VCs. Wet and dry monthly and annual flows were presented to provide sensitivity analysis, to support surface water and sediment quality and fish and fish habitat VCs, and to aid in mine operations strategies. These key parameters were evaluated in a quantitative manner, first without and then with the freshwater mitigation measure in place. The purpose of the freshwater supply system would be to provide freshwater from Tatelkuz Lake for mining water requirements (during operations), to meet IFN in Davidson Creek (during operations and closure), and to aid in flooding (during closure) without adversely affecting Tatelkuz Lake. This system would be in place only during the operations and closure phases of the mine.

It was determined in this assessment that surface water flows in the Turtle Creek watershed are not expected to be impacted by the Project. In addition, the potential impacts of the proposed airstrip, access roads, and transmission line within the Aquatics RSA are expected to be negligible. The changes in mean annual and 1:50–year dry Tatelkuz Lake levels are also expected to be negligible. The Project access road (Kluskus FSR) will not traverse the Aquatics LSA or the Aquatics RSA for the Project (**Figure 5.3.2-1**), and was therefore not included in the assessment of surface water flow. The changes in mean annual in 1:50–year dry Tatelkuz Lake levels are also expected to be negligible. However, effects on some of the mean annual, peak, and low flows in the Davidson Creek, Creek 661, Creek 705, and Chedakuz Creek Watersheds are not expected to be negligible (with mitigation measures including meeting IFN in Davidson Creek) and will have residual effects. Therefore, the significance of these residual effects on surface water flow were assessed in a quantitative and qualitative manner.

Surface water flows can naturally range between highs and lows with no expected significant effects on the natural environment. Based solely on a percentage change in surface water flows at the mouth of the Davidson Creek Watershed, the magnitude of the residual effects from the Project (with mitigation measures, including meeting IFN in Davidson Creek) could range from negligible to high, depending on which phase of the Project is being considered. At the mouth of the Creek 661 Watershed, the magnitude of the effect could range from negligible to medium. At the mouth of the Creek 705 Watershed, the magnitude of the effect could range from low to medium. On Chedakuz Creek at the LSA boundary, the magnitude of the effect could range from negligible to medium. Nevertheless, when all of the residual effects significance rating metrics are considered, the residual impacts of the Project (with mitigation measures including meeting IFN in Davidson Creek) on the above watersheds is expected to be “Not significant (minor or moderate).” Potential cumulative effects of these residual effects of the Project, considering other past, present (including water licenses), or reasonably foreseeable future projects, were assessed and are considered negligible.

The hydrological indicators of surface water flow and Tatelkuz Lake levels of the Surface Water Flow VC also play a critical role in surface water and sediment quality, fish and fish habitat, groundwater quantity and quality, and wetlands. Therefore, the extent to which surface water flow is affected is an important factor to how other VCs are affected. Therefore, other potentially affected VCs took the effects on surface water flow into account during their assessments.