BW GOLD LTD
a subsidiary company of Artemis Gold Inc

Blackwater Gold Project

Joint *Mines Act* / *Environmental Management Act* Permits Application

CHAPTER 3: MINE PLAN

November 2021

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ACRONYMS AND ABBREVIATIONS

µm	Micron
Aboriginal Groups or Indigenous nations	Ulkatcho First Nation, Lhoosk'uz Dené Nation, Nadleh Whut'en First Nation, Stellat'en First Nation, Saik'uz First Nation, and Nazko First Nation (as defined in Environmental Assessment Certificate #M19-01)
ACGIH	American Conference of Governmental Industrial Hygienists
AN	Ammonium nitrate
ARD	Acid rock drainage
Artemis	Artemis Gold Inc.
BAP	Best Available Practices
BAT	Best Available Technology
BC	British Columbia
Blackwater or Project	Blackwater Project or Blackwater Gold Project
BW Gold	BW Gold LTD.
CIL	Carbon-in-Leach
Code	Health, Safety and Reclamation Code for Mines in British Columbia
COT	Cut-off-trench
CSP	Corrugated steel pipe
DAF	Dissolved aeration flotation
DEF	Diesel exhaust fluid
DST	Downhole seismic testing
EAC or Certificate	Environmental Assessment Certificate
ECCC	Environment and Climate Change Canada
ECD	Environmental Control Dam
EDF	Environmental Design Flood
EDGM	Earthquake Design Ground Motion
EGBC	Engineers and Geoscientists of British Columbia
EMA	*Environmental Management Act*
EMLI	Ministry of Energy, Mines and Low Carbon Innovation
ENV	Ministry of Environment and Climate Change Strategy
ERM	ERM Consultants Canada Ltd

FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FoS	Factor of Safety
FSR	Forest Service Road
FWR	Freshwater Reservoir
HDPE	High density polyethylene
HVAC	Heat, Ventilation, Air Conditioning
IDF	Inflow design flood
IECD	Interim Environmental Control Dam
IFN	Instream flow needs
IRSA	Inter-ramp slope angle
JAIR	Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits
Joint MA/EMA Application or Application	Blackwater Gold Project Joint Application for *Mines Act* and *Environmental Management Act* Permits
kLCM	Thousand loose cubic metres
km	Kilometre
KP	Knight Piésold
L	Litres
L/sec	Litres per second
LGO	Low Grade Ore
LoM	Life of Mine
LPS	Low-permeability subgrade
m	Metre
MA	*Mines Act*
MAA	Multiple Accounts Analysis
MAR	Mine Access Road
masl	Metres above sea level
MBBR	Moving bed biofilm reactor
mbgs	Metres below ground surface
MCC	Motor control centre
MDE	Maximum Design Earthquake
ML	Metal leaching

MoH	Ministry of Health
MPU	Mobile process unit
Mt	Million tonnes
Mtpa	Million tonnes per annum
MWLAP	Ministry of Water, Land and Air Protection
MX	Mineral exploration
NBCC	National Building Code of Canada
New Gold	New Gold Inc.
NAG	Non-acid generating
NPR	Neutralization potential ratio
OMS	Operations, Maintenance and Surveillance
OSA	Overall slope angle
OVB	Overburden
PAG	Potentially acid generating
PMF	Probable Maximum Flood
PMSA	Probable maximum snow accumulation
PoF	Probability of Failure
Project	Blackwater Gold Project
RoM	Run of mine
RQD	Rock Quality Designation
Sa	Spectral acceleration
SCP	Sediment control pond
SCPT	Seismic cone penetration testing
SICT	Seepage Induced Consolidation Test
SO_2	Sulphur dioxide
SPMDD	Standard Proctor Maximum Dry Density
SWCC	Soil-Water Characteristic Curve
t	Tonne
TARP	Trigger Action Response Plan
tpd	Tonnes per day
TSF	Tailings Storage Facility
TSS	Total suspended solids

UPS	Uninterruptible power supplies
US	United States
VP	Vice President
VWP	Vibrating wire piezometer
WSRHC system	Waste Stockpile Rating and Hazard Classification system
WAD	weak acid dissociable
WHC	Waste hazard class
WMP	Water Management Pond
WSR	Waste dump and stockpile stability rating
WTP	Water Treatment Plant
Y	Year

3. MINE PLAN

This chapter provides an overview of the Blackwater Gold Project (Project) mine plan, including mining methods and rates, projected mine life, processing methods as well as descriptions of mine components and activities. The chapter addresses the requirements of Section 3 of the Joint Application Information Requirements for *Mines Act* and *Environmental Management Act* Permits (JAIR; BC EMPR & BC ENV 2019).

Mining operations are planned to be phased with the ore processing facilities expanded periodically during the life of the mine. Phase 1 throughput will be approximately 15,000 tonnes per day (tpd) or 5.5 million tonnes per annum (Mtpa) over the first five years of operations. Phase 2 throughput will increase to approximately 33,000 tpd or 12 Mtpa in approximately Year +6, and Phase 3 throughput will increase to approximately 55,000 tpd or 20 Mtpa from approximately Year +11 until the end of Year +23.

3.1 Mine Plan Overview

3.1.1 Mining Methods

The Project will be an open pit ore mining operation utilizing conventional drill, blast, load and haul techniques, which are suited to the Project location and local site requirements. At its greatest extent, the Open Pit will be 238 ha, approximately 2 km long on the east to west axis and 1.6 km long on the north to south axis. The anticipated depth of the pit will reach approximately 350 to 550 metres below ground surface (mbgs). The earlier mining phases will target higher-grade ore and higher economic marginal material, as well as overburden (OVB) and non-acid generating (NAG) waste rock for construction. The minimum bench pushback distance is 50 metres (m) with most of the bench pushbacks over 100 m. Pit designs are configured on 10 m bench heights, with berms placed every two benches. Bench face angles, inter-ramp angles, bench widths, and depressurization of pit walls are unique to each prescribed geotechnical domain (Section 3.5.1, Open Pit).

Phase 1 (Year +1 to the end of Year +5) will be undertaken using 400 tonne (t) class hydraulic shovels and 190 t payload class haul trucks. As production increases, the load and haul fleet will be expanded with 550 t class hydraulic shovels and 220 t payload class haul trucks. The initial drill and loading fleets are planned to be diesel drive; the expanded fleet will include electric drills and shovels after Year +5.

The mine site infrastructure will include both mine haul roads and mine service roads. Mine haul roads will service heavy duty mining vehicles within the Open Pit, transiting from the Open Pit to the primary crusher, Tailings Storage Facility (TSF), waste and ore stockpiles, mine maintenance, and the Ready Line and Bulk Fuel Storage area. Mine service roads will service all other facilities and vehicles types (Section 3.5.8, Mine Service and Haul Roads).

Ore, waste rock, and salvageable soils will be managed in engineered storage facilities, including the TSF, Low Grade Ore (LGO) Stockpile, Lower and Upper Waste Stockpiles, and several designated topsoil stockpiles located around the mine site. The waste stockpiles, LGO Stockpile, and topsoil stockpiles are described in Sections 3.5.4, 3.5.5, and 3.5.7, respectively. Ore from the Open Pit will be delivered directly to a run of mine (RoM) hopper for immediate processing or otherwise placed in the LGO Stockpile for processing over the remaining life of mine (LoM).

Mine waste was classified based on whether it is predicted to be potentially acid generating (PAG) or NAG as defined by the calculated neutralization potential ratio (NPR). NAG waste rock was further classified as to its metal leaching potential based on zinc (Zn) concentration. NAG4 and NAG5 waste rock and OVB will be prioritized for use in construction of mine facilities. NAG materials not used immediately for construction will be stored in the Lower Waste Stockpile and later in the Upper Waste Stockpile.

The TSF will permanently store all tailings and PAG and metal leaching (ML) waste rock generated during operation of the mine. The TSF will comprise two adjacent sites, TSF C and TSF D, progressively developed over the LoM. The TSF was designed to store 334 million tonnes (Mt) of tailings and 467 Mt of waste rock, including PAG1 and PAG2 waste rock and NAG3 potentially ML waste rock. These waste materials will be disposed in the TSF in such a manner that the interstitial space will be progressively saturated during operations to achieve geochemical objectives, including limiting oxidation and preventing acid generation. Tailings will be conveyed from the Processing Plant to the TSF via gravity pipeline during all phases of mine operations. Waste rock will be transported by the mine haul fleet from the Open Pit to designated PAG/ML waste rock disposal areas within the TSF. The TSF is described in detail in Section 3.5.3. Geochemical characterization is provided in Chapter 2, Section 2.4,1 Table 2.4-4 and the ML/ARD Management Plan (Appendix 9-D).

Recovery of gold and silver to produce gold silver doré will be done on-site and is described in Section 3.5.2.8. Doré bars will be trucked off-site to facilities for further processing.

3.1.2 Projected Mine Life

The Application assumes a two-year Construction phase (Year -2 and Year -1). Open pit stripping and construction of mine infrastructure will commence in Year -2 prior to Processing Plant start-up (Year +1). Open pit mining will occur from Year +1 to approximately Year +18. Once mining of the Open Pit ceases, stockpiled LGO will be processed until the end of approximately Year +23.

3.1.3 Mining and Processing Rates

There will be 334 Mt of ore mined from the Open Pit over the LoM. During the same period, approximately 667 Mt of waste materials will be stripped, comprising 83 Mt of OVB and 584 Mt of waste rock.

Mining will commence with the extraction of 1.1 Mt of waste from Construction Borrow Pit in Year -2, peaking in Year +13 at approximately 66.8 Mt. The last year of waste extraction is Year +18 with 0.4 Mt waste mined.

Over the LoM, the ratio of NAG to PAG waste is 1:2.3 by weight. Milling of ore from the Starter Pit will commence in Year +1, with the final 2.2 Mt of ore mined from the Open Pit in Year +18. From Year +19 to the end of Year +23, ore processing will be fed exclusively by ore from the LGO Stockpile. Over the LoM, the LGO Stockpile may supplement mill throughput as required.

The Processing Plant will be commissioned in Year+1 with an initial throughput of 13,000 tpd (4.5 Mtpa). Ore will be processed with a throughput of approximately 15,000 tpd (5.5 Mtpa) in Year +2, ramping up to a throughput of approximately 33,000 tpd (12 Mtpa) in Year +6 and a maximum throughput of approximately 55,000 tpd (20 Mtpa) by Year +11.

Figure 3.1-1 presents material handling rates over the LoM. Further details of the production schedule and the movement of ore and waste are provided in Section 3.3-2.

3.1.4 Processing Methods

The overall process flow sheet for ore processing and metal recovery is summarized in this section and illustrated in Figure 3.1-2. Further details of the processing methods are provided in Section 3.5.2.5 Process Design and Appendix 3-F.

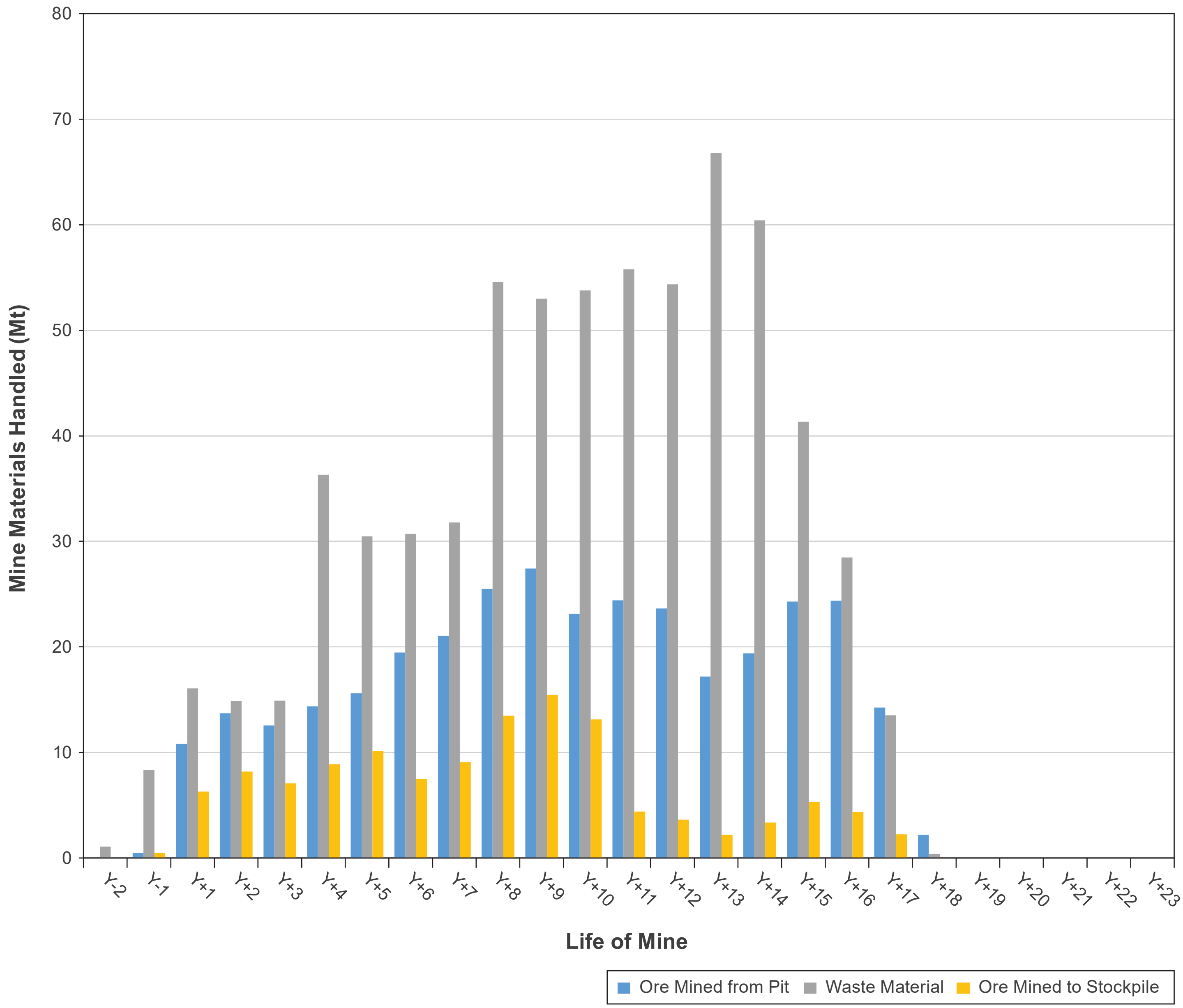


Figure 3.1-1: Material Handled over the Life of Mine

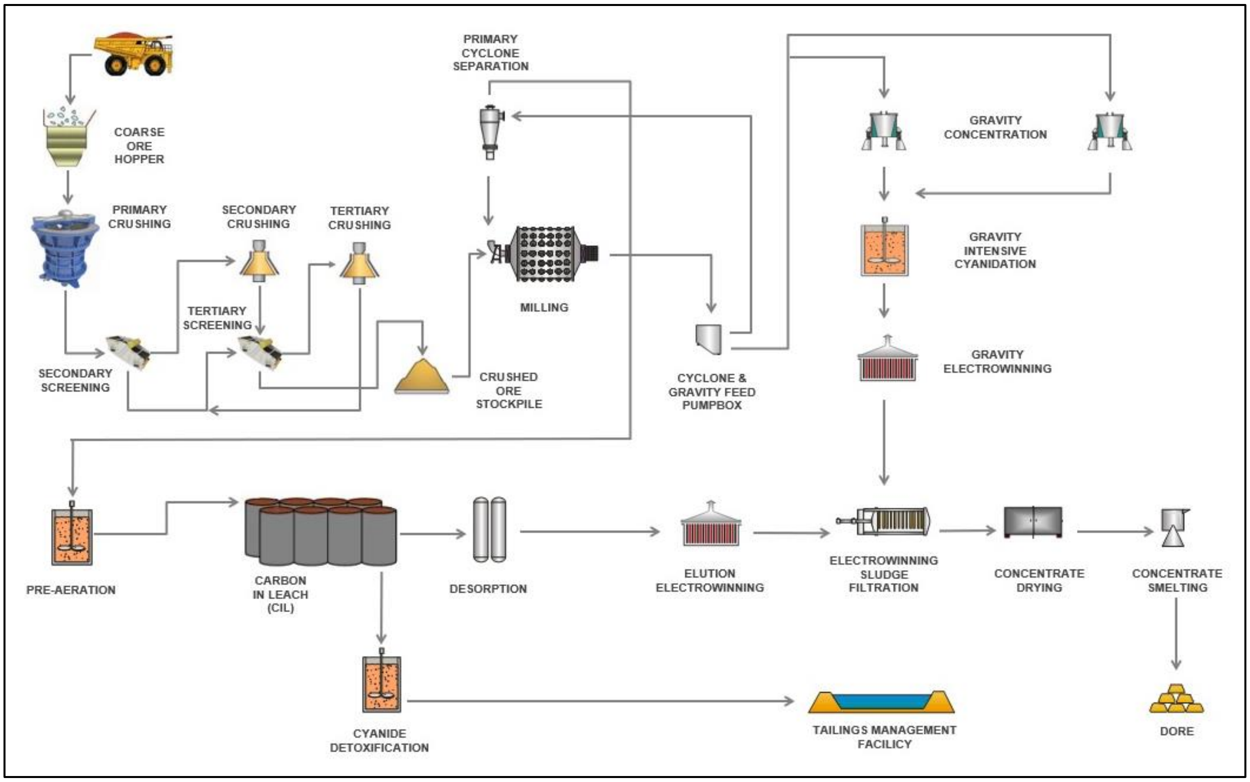


Figure 3.1-2: Blackwater Simplified Process Flow

- **Crushing Circuit** – Ore will be crushed in three stages using a gyratory crusher for primary ore size reduction and secondary and tertiary cone crushers. RoM ore will be fed from haul trucks or via front end loader from the RoM stockpile directly into the gyratory crusher. Primary crushed material will then be transferred to the secondary cone crusher and eventually the tertiary cone crushers. Crushed ore is conveyed via the stockpile feed conveyor to the coarse ore stockpile.
- **Milling** – Crushed ore will be conveyed from the crushed ore stockpile and to a single-stage ball mill for grinding. Ball mill discharge will report to a pump box from which the slurry will be pumped to the ball mill cyclone cluster or to the gravity concentrators.
  - **Primary Cyclone Separation** – The ball mill cyclone cluster will separate the P80 150 µm product. Cyclone underflow will flow back to the ball mill feed chute for further grinding. The cyclone overflow will report directly to the pre-leach thickener trash screen for trash removal prior to entering the Leach Circuit.
  - **Gravity Circuit** – The gravity concentrators will discharge concentrate to an intensive leach reactor in a dedicated leach system. The loaded solution will advance to the Gold Recovery and Smelting area, while the solids residue will return to the ball mill cyclone pump-box after rinsing.
- **Carbon in Leach (CIL) Process –** The main leach circuit will be a modified CIL process. In the first stage, the milled ore is placed in a pre-aeration tank with the cyanide solution introduced in subsequent leach tanks. Gold will be progressively leached from the ore solids by the cyanide solution in each tank. In the second stage, activated carbon will be used to absorb gold from the leach solution in the CIL tanks. The activated carbon will be held in retention screens in each tank and transferred counter to the flow of the slurry from the leach circuit. In this manner, the screens will be progressively loaded with gold-cyanide complex with the fully loaded screens will be transferred to carbon stripping and

elution for the separation of the carbon and gold. The exhausted CIL tails will be transferred to the cyanide destruction circuit.

- **Carbon Stripping and Elution** – The loaded carbon will be treated in an acid wash column to remove inorganic impurities prior to entering the elution circuit for gold and carbon separation. Two elution columns with sodium hydroxide and sodium cyanide strip solutions will separate the carbon and gold. Stripped carbon will report to the carbon regeneration kiln while the loaded strip solution with the gold will report to the pregnant eluate tank prior to electrowinning. Stripped carbon will be screened for removal of undersized carbon, with the screen-oversize carbon transferred to the CIL process for further gold adsorption.
- **Electrowinning** – Electrowinning will recover gold from the loaded strip solution. The precious metal sludge and sludge from the cells and cathodes will be pressure washed into a filter press to be dried into oven-dried filter cakes prior to refining. Barren solution from the electrowinning of gold from carbon strip solution and intensive leach eluate will be transferred to the CIL process for further gold adsorption.
- **Refining** – Filter cakes will be smelted in an induction furnace. Excess slag will be poured into slag moulds and the molten metal will be poured into bar moulds. The doré bars will be cleaned, numbered and weighed prior to shipping. The slag will be broken up, any large pieces of metal recovered manually, and the rest will be recycled to the mill.
- **Cyanide Destruction** – Destruction of cyanide from the CIL circuit, as well as containment sump drainage from various areas, will be treated for destruction of free and weak acid dissociable (WAD) cyanide by asperging sulphur dioxide (SO_2) into the cyanide detox tanks with agitation. After treatment, the discharge from the cyanide destruction tanks will be pumped to the TSF for final disposal.

3.1.5 Infrastructure Requirements

The Project includes the following mine components:

- Open Pit and dewatering systems – Section 3.5.1.
- Processing Plant and associated facilities – Section 3.5.2:
  - crushing facility;
  - stockpile pad;
  - grinding facility;
  - CIL and leaching circuits;
  - gold room; and
  - plant administration building, plant office, assay laboratory, and warehouse/workshop.
- TSF – Section 3.5.3:
  - dams (Main Dam C, Saddle Dam, West Dam, Main Dam D, Interim Environmental Control Dam [IECD] and final Environmental Control Dam [ECD]);
  - ponds (TSF C Pond and TSF D Pond);
  - tailings distribution system;
  - seepage management system;
  - water reclaim systems; and
  - borrow areas.

- Waste stockpiles – Section 3.5.4:
  - Lower Waste Stockpile, and
  - Upper Waste Stockpile.
- LGO Stockpile – Section 3.5.5.
- Water management structures and systems – Section 3.5.6:
  - Northern and Central Diversions Systems;
  - Water Management Pond (WMP) and associated dams;
  - Freshwater Reservoir (FWR) and associated dam;
  - Water treatment – Section 5.6 Effluent Water Quality Mitigation Methods in Chapter 5:
    - lime neutralization system;
    - Metals Water Treatment Plant (WTP); and
    - Membrane WTP.
- Topsoil stockpiles – Section 3.5.7.
- Mine service and haul roads – Section 3.5.8.
- Power supply and distribution – Section 3.5.9:
  - main substation;
  - on-site power distribution; and
  - standby/emergency power.
- Explosives storage area – Section 3.5.10.
- Ancillary facilities and supporting infrastructure – Section 3.5.11:
  - camp facilities;
  - truck shop and wash/mine office;
  - contractor laydown areas;
  - concrete batch plant;
  - Ready Line and Bulk Fuel Storage area;
  - waste management facilities;
  - mobile and supporting mine fleet;
  - security;
  - communications; and
  - helipad.

Project offsite infrastructure that will be permitted separately from this Application includes:

- Airstrip and airstrip access road;
- Freshwater supply system from Tatelkuz Lake to the FWR; and
- Transmission line from the Glenannan substation to the mine site, access roads, borrow, equipment and laydown areas.

Mine site infrastructure, off-site infrastructure, and the transmission line route are presented in Figures 3.1-3, 3.1-4, and 3.1-5, respectively.

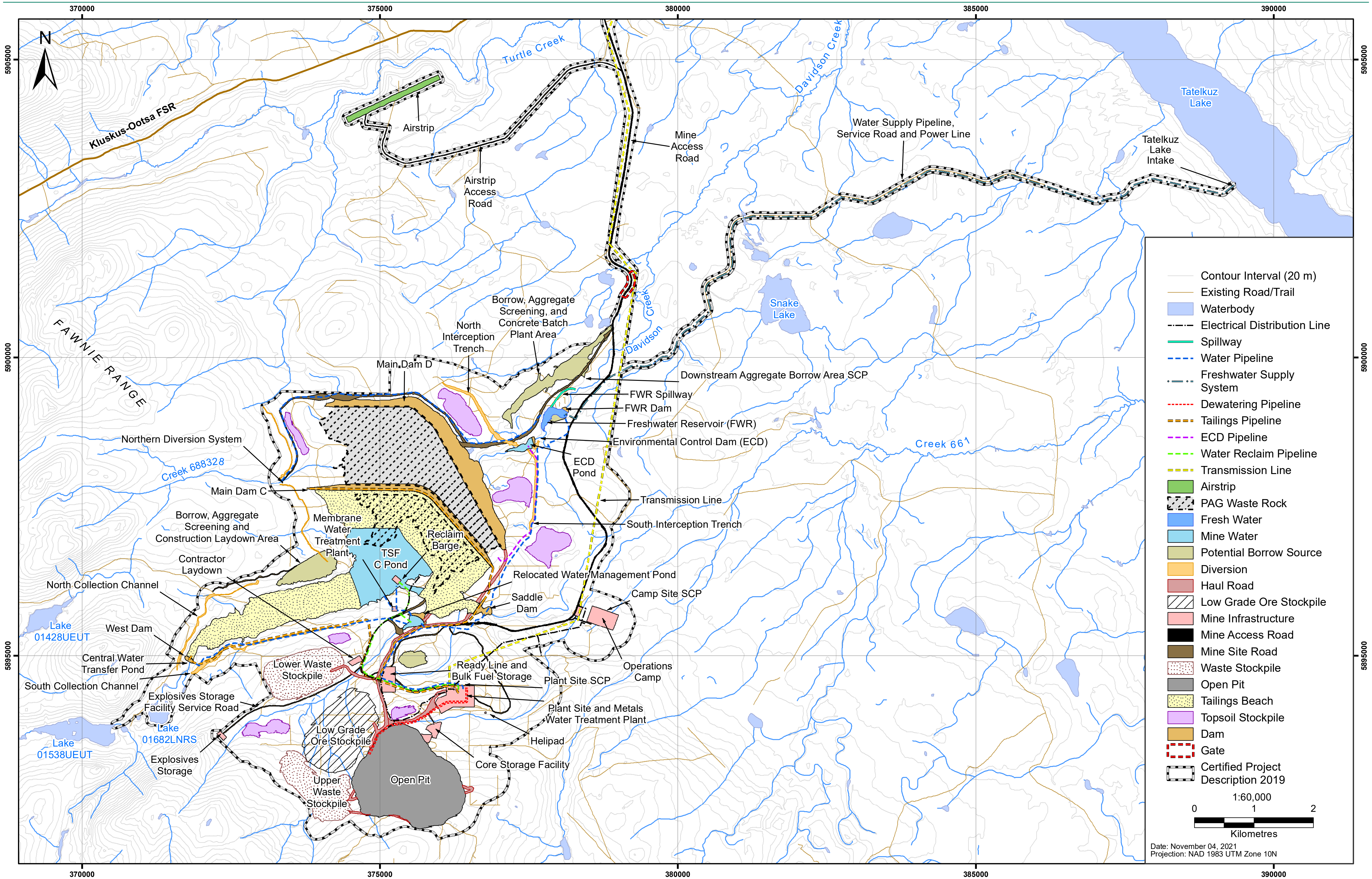


Figure 3.1-3: Mine Site Infrastructure at Year +13 (Maximum Materials Handled)

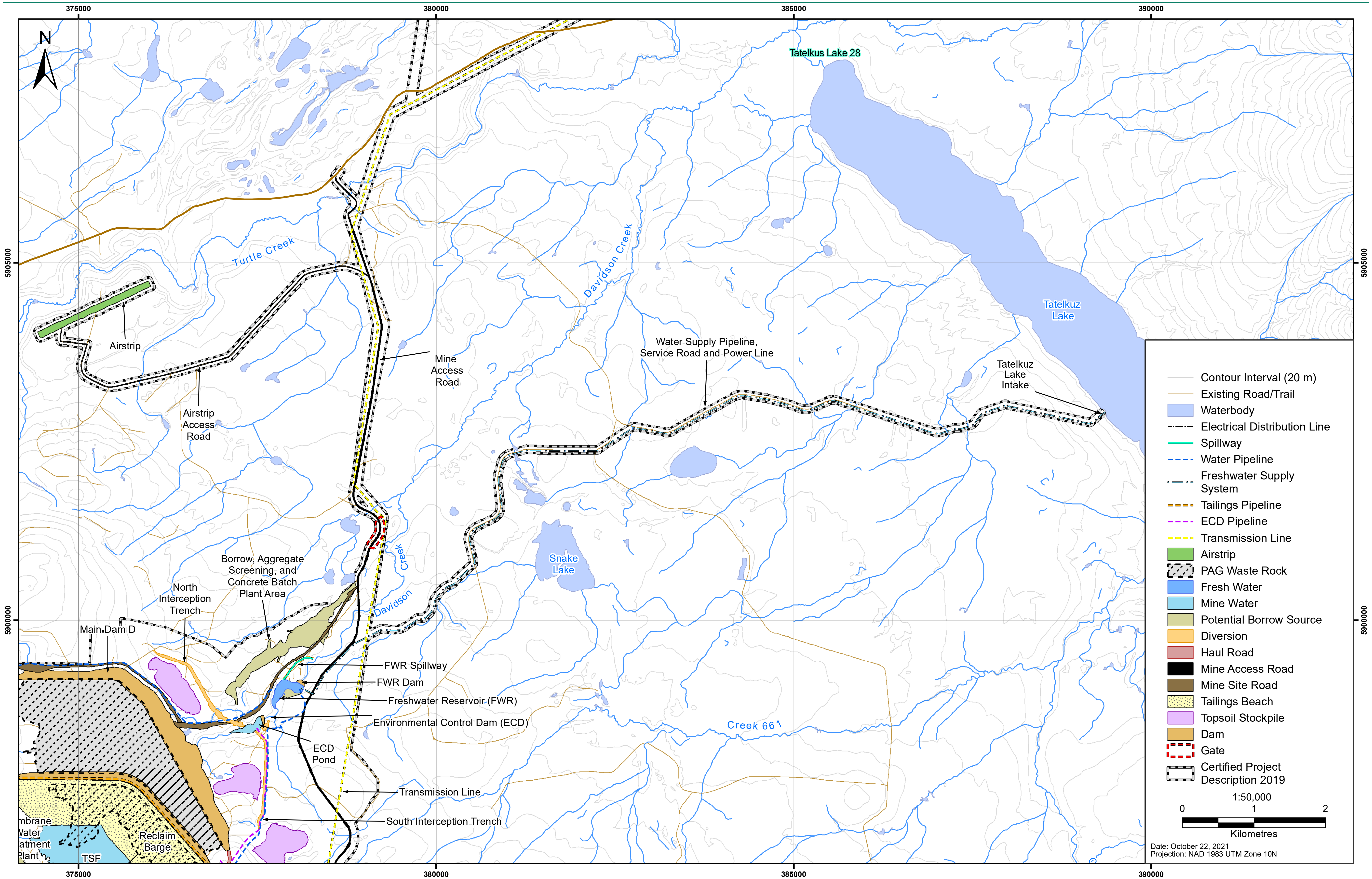


Figure 3.1-4: Off-Mine Site Project Infrastructure

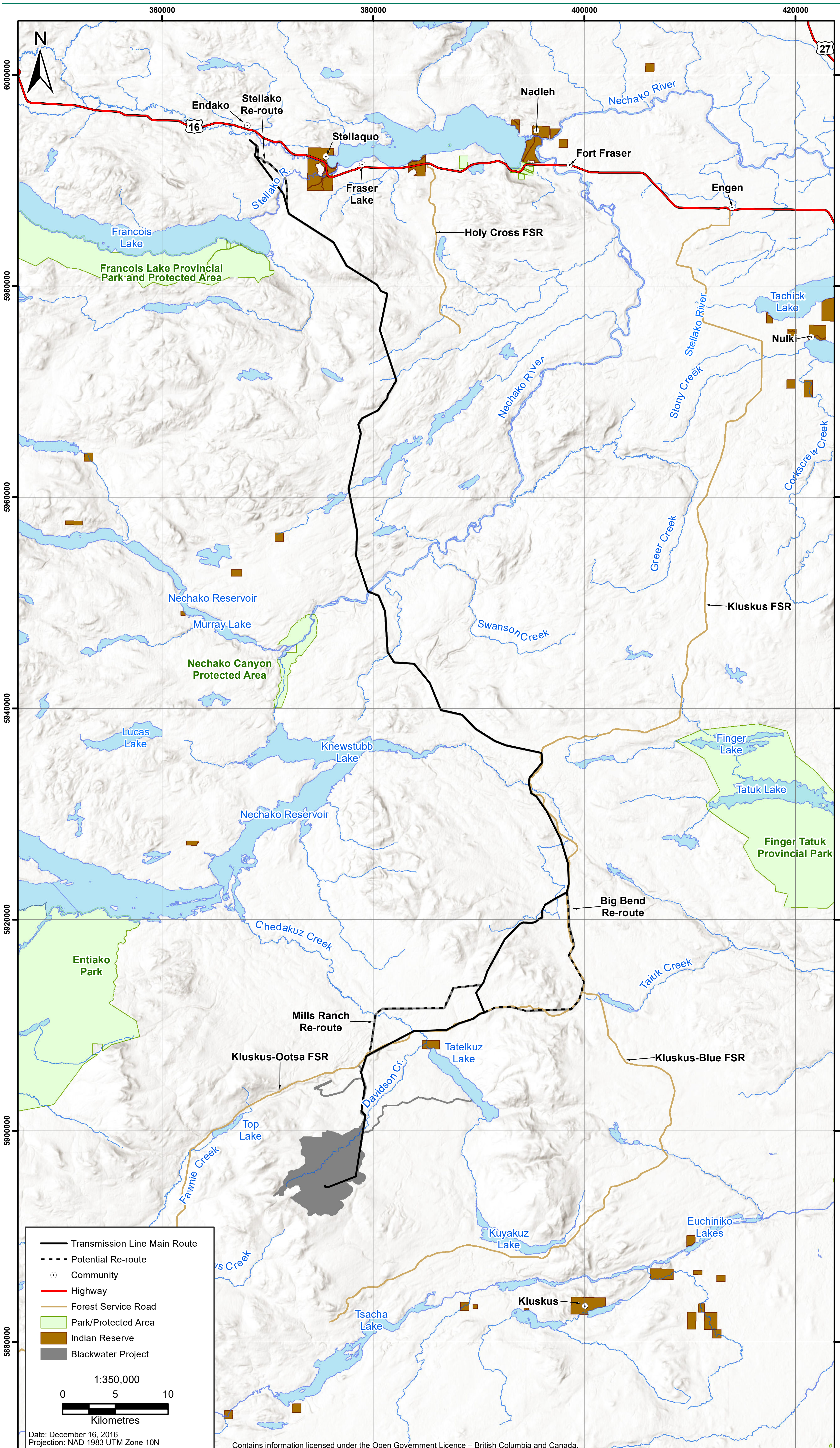


Figure 3.1-5: Transmission Line Route

3.2 Existing Development

3.2.1 Existing Non-mining Disturbances

There has been little non-mining disturbance within the mine site. Chapter 2 describes baseline pre-mining biophysical conditions. Logging has occurred within the boundaries of the proposed mine site with the most recent being in 2021. Watercourses on the mine site are not impounded and drain waters have not been affected by mineral exploration. Section 2.6 describes the baseline surface and groundwater hydrological condition of the mine site.

The Project area has been used by Indigenous nations as discussed in Section 2.13. The mine site overlaps guiding and trapline tenures as discussed in Section 2.11.

3.2.2 Mineral Exploration, 1973 to 2020

Mineral exploration on the property was initiated in 1973 and following discovery of gold-silver mineralization, significantly expanded from 2012 onwards with an extensive drilling program and baseline studies to support preparation of the Project's Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS; New Gold 2015).

Current mineral exploration (MX) permits include MX-13-177 (valid to December 31, 2022) and MX-13-319 (November 13, 2020 to November 12, 2025). MX-13-250 (valid to December 31, 2022) covers the western areas of the mine site. The mine site includes a network of access trails and drill pads to support exploration and geotechnical site investigations (Figure 3.2-1). Access trails and drill pads are shown by the fine white lines and polygons on Figure 3.2-1. The older drill pads and access trails have naturally regenerated with vegetation and are no longer visible. Existing infrastructure includes the exploration camp, core processing and storage areas, and sewage treatment and discharge field (Figure 3.2-2). Approved disturbance for pads, trenches, trails and other structures for MX-13-177 and MX-13-319 is 240.7 ha and MX-13-250 is 20 ha. The amount of unreclaimed disturbance from the MX permits is 148.2 ha.

Existing physical works and infrastructure is detailed in a letter report in Appendix 3-A, which was prepared to address Condition 14 (Existing Disturbance) of the Project's Environmental Assessment Certificate (EAC) #M19-01.

3.3 Life of Mine

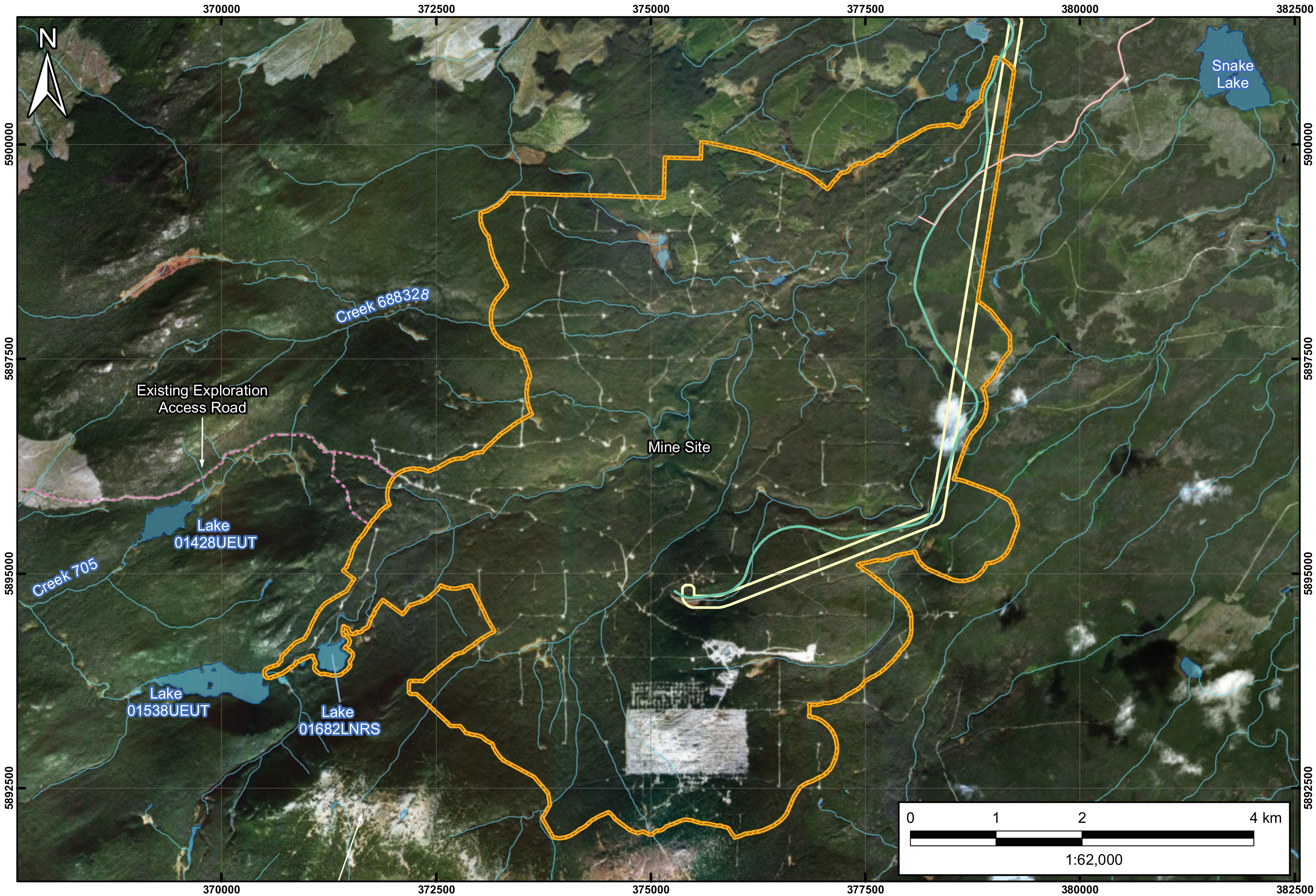
3.3.1 Mine Development Phases

This Project has four phases:

1. Initial Construction phase: Year -2 to Year -1;
2. Operations phase: Year +1 to Year +23;
3. Closure phase: Year +24 to approximately Year +45, ending when the Open Pit has filled and the TSF is allowed to passively discharge to Davidson Creek; and
4. Post-closure phase: Year 46+.

3.3.2 Production Scenario

The overall mine production schedule is summarized in Table 3.3-1, including estimated values. Development of the Open Pit is described in Section 3.5.1.6. Geochemical characterizations of ore, OVB, and PAG and NAG waste rock are summarized in Section 2.4.1.3 Geochemical Characterization and Appendix 2-H.



Mine Site
Freshwater Supply System
Mine Access Road
Transmission Line Corridor
Existing Exploration Access Road

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA USGS, AeroGRID, IGN, and the GIS User Community
Contains information licensed under the Open Government Licence – British Columbia and Canada. Imagery from 2013 and 2016.

Note: Access trails and drill pads are denoted by fine white lines and polygons

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Figure 3.2-1: Exploration Permits MX-13-250, MX-13-177, and MX-13-319 Existing Mine Site Disturbance

Key	Name
1	Sewage discharge field
2	Ore zone clear cut
3	Core storage area
4	Laydown area and incinerator area
5	Core processing facilities
6	Core storage area
7	Geology office
8	Sewage treatment and laydown area

Key	Name
9	Maintenance facility, cold storage, laydown area
10	Main Camp including Rec Area, Office, Kitchen & PowerPlant
11	Upper East Camp Trailers
12	Lower West Camp Trailers
13	Main fuel island
14	Communications tower
15	Exploration access road

Spatial Reference
Name: NAD 1983 UTM Zone 10N
GCS: GCS North American 1983
Datum: North American 1983
Projection: Transverse Mercator

Source: Newgold (2021).

Figure 3.2-2: Existing Project Infrastructure and Facilities

Table 3.3-1: Mine Production Schedule (Mt)

Parameter	Life of Mine	Y-2	Y-1	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7	Y+8	Y+9	Y+10	Y+11	Y+12	Y+13	Y+14	Y+15	Y+16	Y+17	Y+18	Y+19	Y+20	Y+21	Y+22	Y+23
TOTAL Ore Milled	**334.0**	**-**	**-**	**4.5**	**5.5**	**5.5**	**5.5**	**5.5**	**12.0**	**12.0**	**12.0**	**12.0**	**12.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**7.5**
TOTAL Ore Mined from Open Pit	**334.0**	**-**	**0.5**	**10.8**	**13.7**	**12.6**	**14.4**	**15.6**	**19.5**	**21.1**	**25.5**	**27.5**	**23.2**	**24.4**	**23.7**	**17.2**	**19.4**	**24.3**	**24.4**	**14.2**	**2.2**	**-**	**-**	**-**	**-**	**-**
Ore Mined Directly to Mill	208.7	-	-	4.5	5.5	5.5	5.5	5.5	12.0	12.0	12.0	12.0	10.0	20.0	20.0	15.0	16.0	19.0	20.0	12.0	2.2	-	-	-	-	-
Ore Mined to LGO Stockpile	125.3	-	0.5	6.3	8.2	7.1	8.9	10.1	7.5	9.1	13.5	15.5	13.2	4.4	3.7	2.2	3.4	5.3	4.4	2.2	-	-	-	-	-	-
LGO Stockpile Retrieval to Mill	125.3	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	5.0	4.0	1.0	-	8.0	17.8	20.0	20.0	20.0	20.0	7.5
LGO Stockpile Balance		-	0.5	6.8	15.0	22.1	31.0	41.1	48.6	57.6	71.1	86.6	97.7	102.2	105.8	103.0	102.4	106.7	111.1	105.3	87.5	67.5	47.5	27.5	7.5	-
TOTAL Waste Mined	**667.1**	**1.1**	**8.3**	**16.1**	**14.9**	**14.9**	**36.3**	**30.5**	**30.7**	**31.8**	**54.6**	**53.0**	**53.8**	**55.8**	**54.4**	**66.8**	**60.4**	**41.3**	**28.5**	**13.5**	**0.4**	**-**	**-**	**-**	**-**	**-**
NAG Rock Waste (NAG4/NAG5)	116.9	0.2	4.2	1.5	3.3	1.3	3.6	10.8	4.2	1.2	5.4	5.2	4.1	10.4	21.9	24.1	13.3	2.0	0.09	0.04	-	-	-	-	-	-
PAG Rock Waste (PAG1, PAG2, NAG3)	467.3	0.1	1.1	8.8	9.4	7.0	15.6	16.3	25.5	24.5	36.0	43.8	49.0	37.9	27.3	36.5	47.0	39.4	28.4	13.5	0.4	-	-	-	-	-
OVB Waste	82.9	0.8	3.0	5.8	2.2	6.7	17.1	3.4	1.0	6.1	13.2	4.1	0.6	7.5	5.1	6.2	-	-	-	-	-	-	-	-	-	-
Wasted Inferred	0.020	-	-	-	-	0.002	-	-	-	-	-	-	-	-	-	0.018	-	-	-	-	-	-	-	-	-	-
Waste Destination Summary																										
OVB to Construction	3.3	0.3	0.3	-	-	-	2.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAG to Construction	4.5	0.2	0.2	0.2	0.2	0.2	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	-	-	-	-
OVB to Tailing Dam	41.2	0.5	2.5	1.8	1.8	0.2	0.4	0.8	0.9	5.8	13.0	4.0	0.6	3.7	0.7	4.8	-	-	-	-	-	-	-	-	-	-
NAG to Tailing Dams	91.1	-	4.1	1.3	3.1	1.1	3.2	10.6	4.0	1.0	5.2	4.9	3.6	9.9	11.7	13.8	12.7	1.4	0.1	-	-	-	-	-	-	-
PAG to TSF Ponds	467.3	0.1	1.1	8.8	9.4	7.0	15.6	16.3	25.5	24.5	36.0	43.8	49.0	37.9	27.3	36.5	47.0	39.4	28.4	13.5	0.4	-	-	-	-	-
Lower Waste Stockpile	29.1	-	0.3	4.1	0.4	6.5	14.0	2.6	0.2	0.4	0.2	0.1	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Waste Stockpile	30.7	-	-	-	-	-	-	-	-	-	-	-	-	4.1	14.5	11.4	0.4	0.3	0.04	0.04	-	-	-	-	-	-
Strip Ratio (OVB/Resource Mined)	2.0	-	17.3	1.5	1.1	1.2	2.5	1.9	1.6	1.5	2.1	1.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative Strip Ratio		-	19.6	1.6	1.6	1.5	1.8	1.8	1.8	1.7	1.8	1.8	1.9	1.9	2.0	2.1	2.2	2.1	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total Material Mined	**1,001.2**	**1.1**	**8.8**	**26.9**	**28.6**	**27.5**	**50.7**	**46.1**	**50.2**	**52.9**	**80.1**	**80.5**	**76.9**	**80.2**	**78.0**	**84.0**	**79.8**	**65.7**	**52.9**	**27.8**	**2.6**	**-**	**-**	**-**	**-**	**-**
Cumulative Material Mined	**-**	**1.1**	**8.8**	**28.0**	**56.6**	**84.1**	**134.8**	**180.9**	**231.1**	**284.0**	**364.1**	**444.5**	**521.4**	**601.6**	**679.7**	**763.6**	**843.4**	**909.1**	**962.0**	**989.7**	**992.3**	**992.3**	**992.3**	**992.3**	**992.3**	**992.3**
Total Material Moved	**1,126.5**	**1.1**	**8.8**	**26.9**	**28.6**	**27.5**	**50.7**	**46.1**	**50.2**	**52.9**	**80.1**	**80.5**	**78.9**	**80.2**	**78.0**	**89.0**	**83.8**	**66.7**	**52.9**	**35.8**	**20.4**	**20.0**	**20.0**	**20.0**	**20.0**	**7.5**

3.3.2.1 Ore

Figure 3.3-1 presents the ore processing and transfer rates over the LoM.

A total of 334.0 Mt of ore will be mined from the Open Pit. Of this amount, 208.7 Mt will be sent directly to the processing facility, and 125.3 Mt will be stored in the LGO Stockpile for later processing. The live tonnages of the LGO Stockpile may vary depending on prevailing economic factors over the LoM.

In Year -1, the initial development of the Starter Pit will produce 0.5 Mt of ore which will be placed at the LGO Stockpile.

From Year +1 to Year +5, the ore processing facility is sized for a nominal throughput of approximately 5.5 Mtpa. The Year +1 ore throughput was assumed to be approximately 4.5 Mtpa, but the actual throughput will be dependent of a variety of factors, including mill commissioning activities, mining rates, and recovery. Ore throughput will be approximately 5.5 Mtpa between Year +2 and Year +5. During this period, 40.6 Mt of ore will be delivered to the LGO Stockpile.

From Year +6 to Year +10, the throughput of the ore processing facility will increase to approximately 12 Mtpa. During this period, 58.8 Mt of ore will be delivered to the LGO Stockpile, with 2 Mt of the stockpiled ore reclaimed for processing in Year +10.

From Year +11 to Year +18, the throughput of the ore processing facility will increase to approximately 20 Mtpa. During this period, 25.6 Mt of ore will be delivered to the LGO Stockpile. At the end of Open Pit mining, the LGO Stockpile is anticipated to store approximately 87.5 Mt of ore with 35.8 Mt of the stockpiled ore reclaimed for processing over this period.

From Year +19 to Year +23, the processing facility throughput will remain at 20 Mtpa until the end of Year +22. In Year +23, the remaining 7.5 Mt of ore will be processed depleting the material held at the LGO Stockpile. During this period, all ore will be sourced from LGO Stockpile (87.5 Mt).

3.3.2.2 Overburden

Figure 3.3-2 presents the OVB transfer and deposition rates over the LoM.

OVB from the Open Pit will be used for construction projects on the mine site, TSF dams and other TSF facilities, or placed in the waste stockpiles. The live tonnages of the waste stockpiles may vary based on actual yields from open pit mining and construction requirements over the LoM. A total of 82.9 Mt of OVB will be produced. Of this amount, 3.3 Mt is planned for mine site construction and 41.2 Mt for construction of the TSF dams. Remaining OVB will be placed initially at the Lower Waste Stockpile and later in mine life at the Upper Waste Stockpile.

From Year -2 to Year -1, the Construction Borrow pits and initial development of the Starter Pit will generate approximately 3.8 Mt of OVB. Most of the OVB (3.0 Mt) will be used for the construction Main Dam C to form TSF C. An estimated 0.5 Mt will be used for other mine site construction, including upgrading mine site roads, and leveling of infrastructure pads. Approximately 0.3 Mt of OVB will be stockpiled at the Lower Waste Stockpile.

From Year +1 to Year +5, initiation of East and West pushbacks of the Open Pit will produce an additional 35.2 Mt of OVB. Approximately, 5.0 Mt of OVB will be used for the lifts of the Main Dam C and construction of the Main Dam D while 2.8 Mt OVB will be used for other mine site construction. The remaining OVB (27.4 Mt) will be stockpiled at the Lower Waste Stockpile.

From Year +6 to Year +10, initiation of the North and South pushbacks of the Open Pit will produce an additional 25.0 Mt of OVB. Approximately, 24.3 Mt of OVB will be used for the lifts of the Main Dam C and Main Dam D. With the completion of mine site infrastructure, no OVB will be required for construction and the remaining OVB (0.7 Mt) will be stockpiled at the Lower Waste Stockpile.

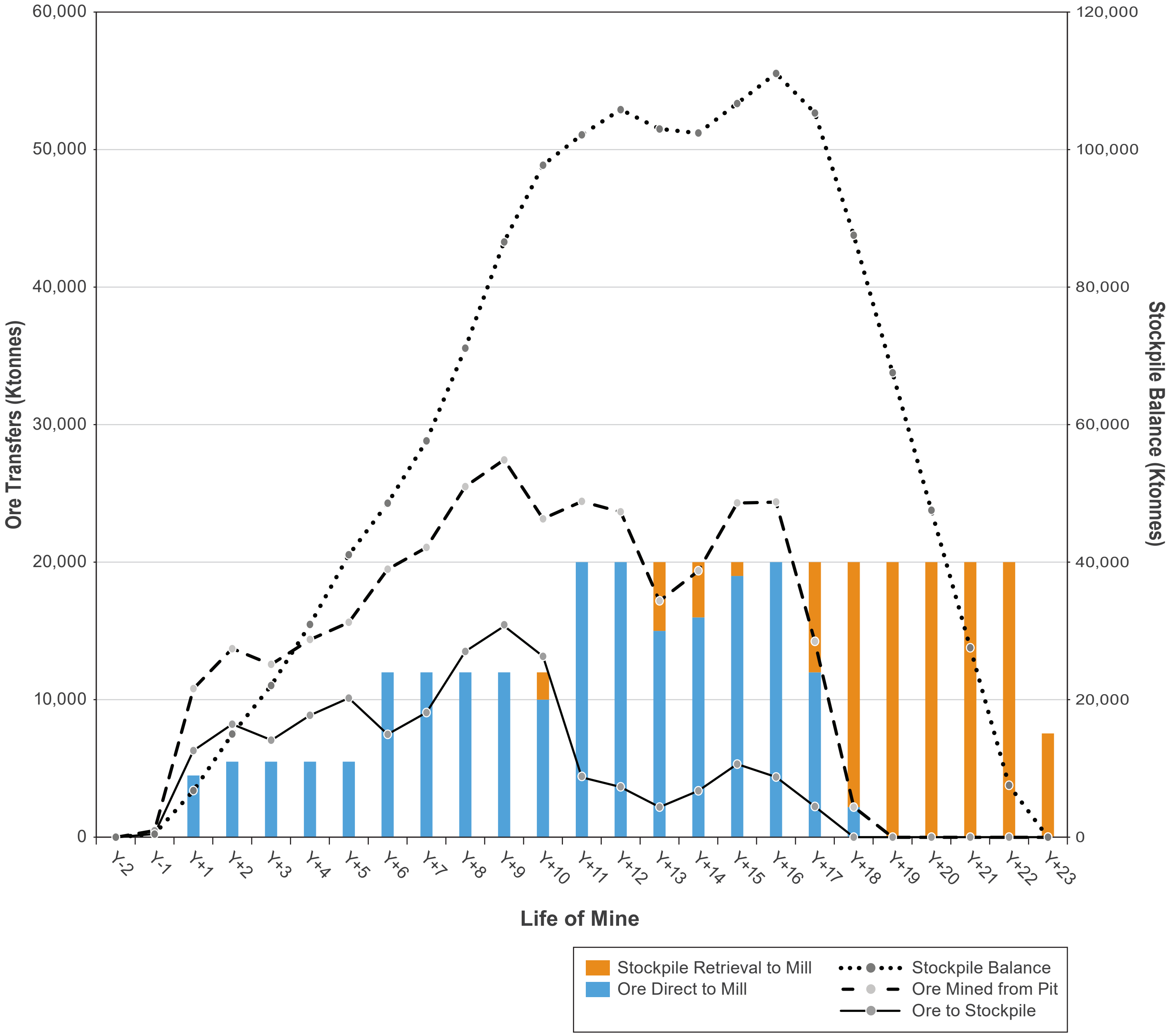


Figure 3.3-1: Ore Processing and Transfer Rates over the Life of Mine

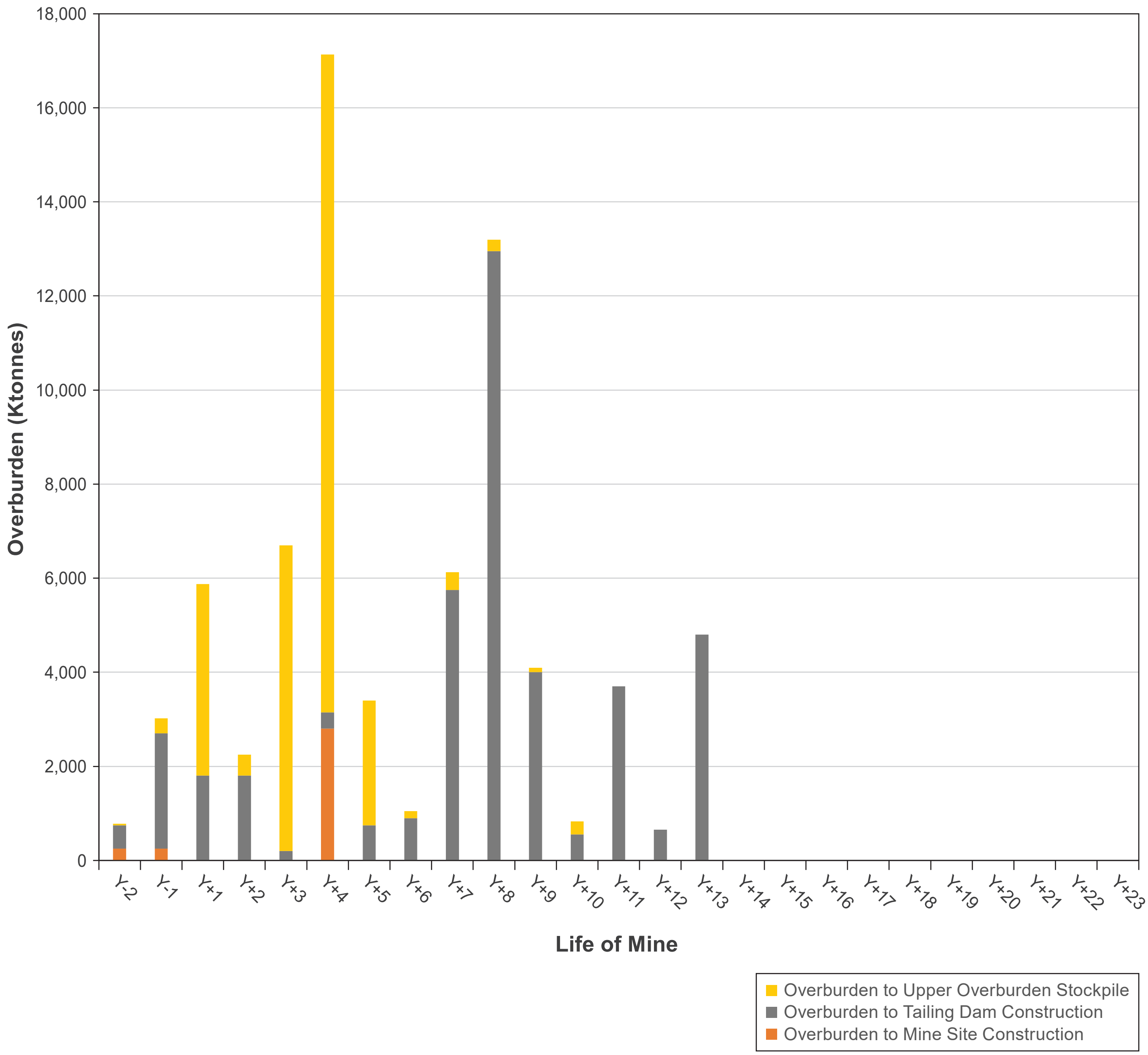


Figure 3.3-2: Overburden Transfer and Deposition Rates over the Life of Mine

From Year +11 to Year +14, continued expansion of North and South pushbacks of the Open Pit will produce an additional 18.9 Mt of OVB. Approximately, 9.2 Mt of OVB will be used for the lifts of the Main Dam C and Main Dam D. The remaining OVB (9.7 Mt) will be stockpiled at the Upper Waste Stockpile. No OVB will be mined after Year +14.

3.3.2.3 Potentially Acid Generating Waste[1]

The PAG1, PAG2, and NAG3 waste rock (referred to collectively below as PAG waste rock) will be disposed in the TSF in such a manner that the interstitial space will be progressively saturated during operations to achieve geochemical objectives, including limiting oxidation and preventing acid generation. The PAG waste rock disposal areas within the TSF footprint will be developed as part of preproduction construction and expanded progressively over the LoM to provide a location for PAG disposal from the pit stripping to expose the orebody. Details related to the PAG disposal areas within TSF C and TSF D, including description of the disposal areas, anticipated tonnages, and target dump elevations are provided in Section 3.5.3 and the associated reference reports. PAG waste rock transfer and deposition rates over the LoM are summarized below and presented on Table 3.3-1 and Figure 3.3-3.

From Year -2 to Year -1, approximately 1.2 Mt of PAG waste rock will be mined and placed in the designated pre-production PAG disposal area at TSF C.

From Year +1 to Year +5, approximately 57.0 Mt of PAG waste rock will be mined and placed in the disposal area at TSF C. The disposal areas and approximate elevations are further described

From Year +6 to Year +10, 178.7 Mt of PAG waste rock will be mined with 12.7 Mt of PAG waste rock placed at TSF C and 166.0 Mt placed in the PAG disposal area at TSF D.

From Year +11 to Year +18, 230.3 Mt of PAG waste rock will be mined and placed in the disposal area at TSF D. With the cessation of mining of the Open Pit, no PAG waste will be produced after Year +18.

3.3.2.4 Non-Acid Generating Waste[2]

The NAG4 and NAG5 waste rock (referred to collectively below as NAG waste rock) transfer and deposition rates over the LoM are presented on Figure 3.3-4 and summarized below.

NAG waste rock from the Open Pit will be used for construction between Year -2 and Year +15, and stockpiled after Year +15. The live tonnages of NAG waste in the waste stockpiles may vary based on actual yields from open pit mining and construction requirements over the LoM. A total of 116.9 Mt of NAG waste rock will be produced. Of this amount, 4.5 Mt will used for mine site construction, 91.0 Mt for construction of the tailing dams, and 21.4 Mt will be placed in the waste stockpiles.

From Year -2 to Year -1, 4.4 Mt. of NAG waste rock will be produced. Most of the NAG waste rock (4.0 Mt) will be used for the construction of the Main Dam C. An estimated 0.4 Mt of NAG waste will be used for other construction, including upgrading mine site roads, and leveling of infrastructure pads. A small amount of NAG waste (0.03 Mt) will be stockpiled at the Lower Waste Stockpile.

[1] See Section 2.4 for classification of PAG waste includes PAG1, PAG2, and NAG3.

[2] See Section 2.4 for classification of NAG waste includes NAG4 and NAG5.

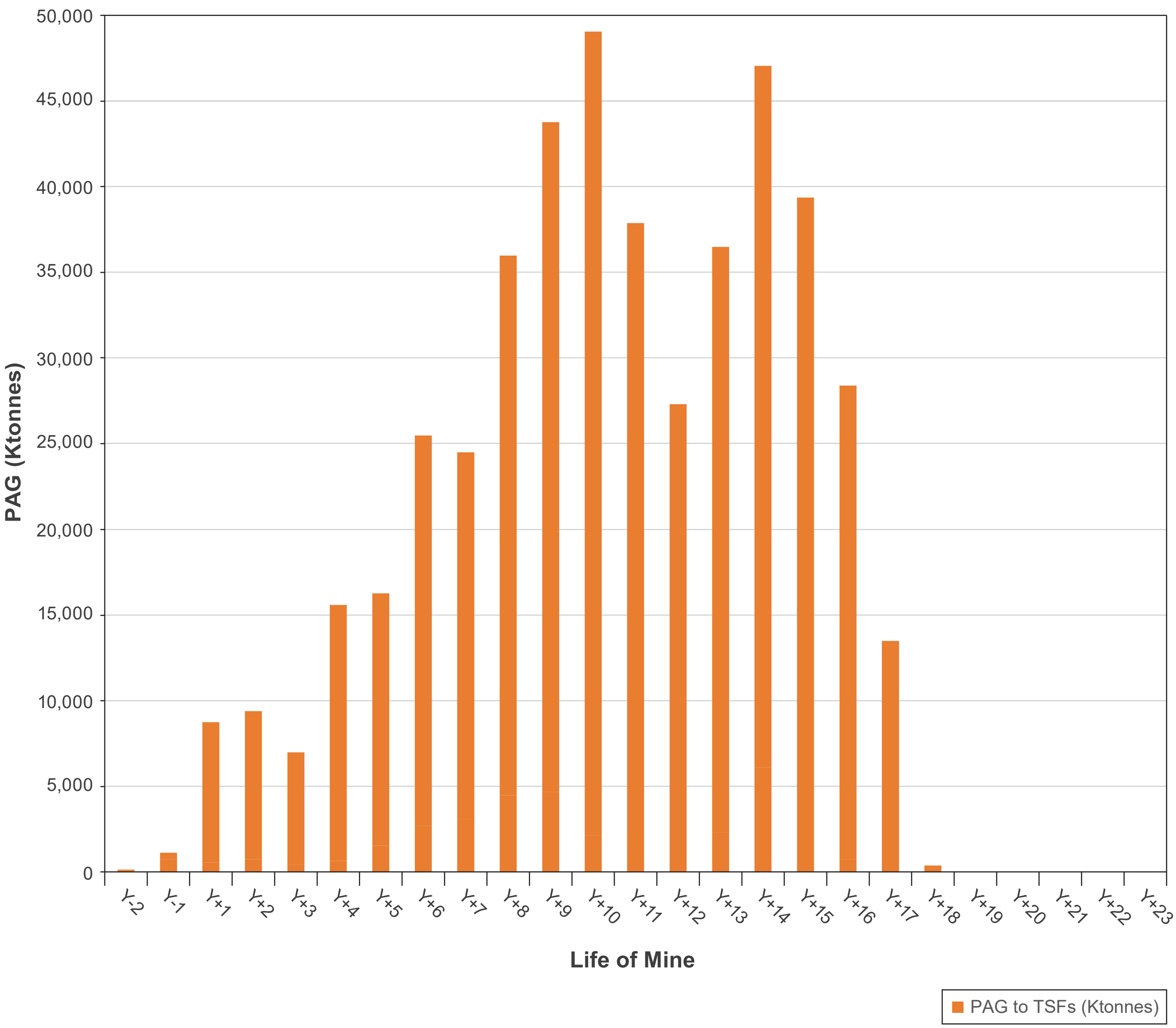


Figure 3.3-3: PAG Waste Transfer and Deposition Rates over the Life of Mine

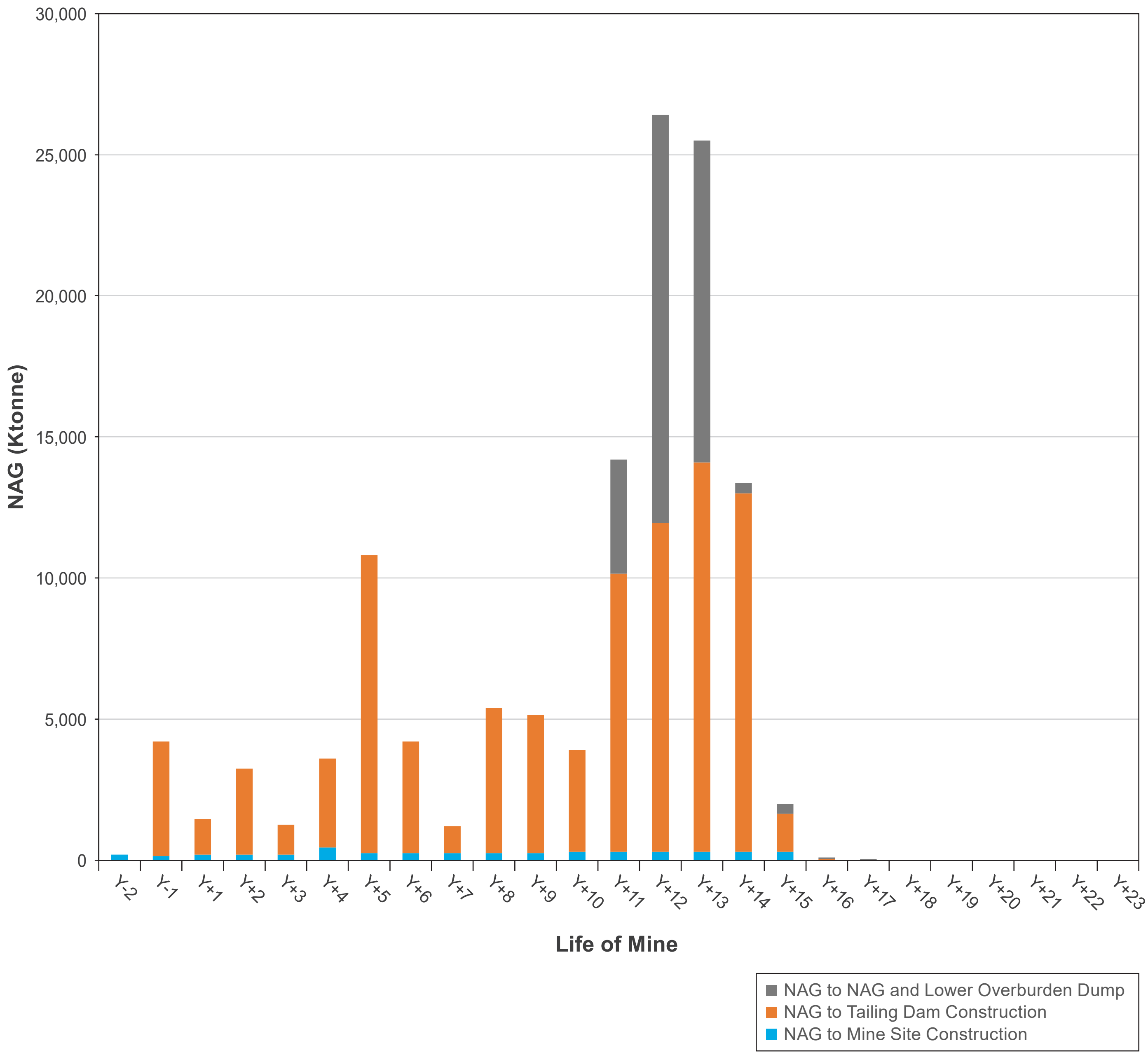


Figure 3.3-4: NAG Waste Transfer and Deposition Rates over the Life of Mine

From Year +1 to Year +5, 20.4 Mt. of NAG waste will be produced. Approximately, 19.0 Mt of NAG waste will be used for the lifts of the Main Dam C and construction of the Main Dam D while 1.3 Mt NAG waste has been budgeted for other mine site construction. The remaining NAG Waste (0.1 Mt) will be stockpiled on the Lower Waste Stockpile.

From Year +6 to Year +10, 20.2 Mt. of NAG waste will be produced. Approximately, 18.6 Mt of NAG waste will be used for the lifts of the Main Dam C and Main Dam D while 1.3 Mt NAG waste has been budgeted for other mine site construction. The remaining NAG Waste (0.3 Mt) will be stockpiled on the Lower Waste Stockpile. The Lower Waste Stockpile is not planned to be expanded after Year +10.

From Year +11 to Year +18, 71.8 Mt. of NAG waste will be produced. Approximately 49.4 Mt of NAG waste will be used for the lifts of the Main Dam C and Main Dam D while 1.5 Mt NAG waste has been budgeted for other mine site construction. The remaining NAG waste (20.9 Mt) will be stockpiled at the Upper Waste Stockpile.

3.3.3 Scheduling Considerations

The development schedule is based on the following considerations:

- The schedule is based on 24-hour, year-round mining operations with limited weather delays and scheduled maintenance shutdowns. The total annual schedule is 355 operating days, or 8,520 hours. The mine will operate on two 12-hour shifts per day.
- The rate of construction and commissioning to full production are key inputs for Project feasibility.
- Staged and coordinated development of key Project components, including Open Pit expansion, processing facility throughput, stockpile management of graded ore, and waste handling.
- Open Pit development targets higher economic margin material earlier in the LoM. The initial year, Year -2, will target suitable OVB and waste rock for construction while exposing near-surface, high-grade ore. The early Operations stages will target higher-grade, lower-strip-ratio ore and provide processing facility feed and stockpiled ore during development of the TSF. The remaining stages target progressively deeper ore to the ultimate pit limits.
- Construction of the TSF requires specific material types to be produced from the mine or borrowed on a defined schedule. Much of the development schedule is driven by the need to excavate NAG4 and NAG5 waste rock for construction purposes.

3.3.4 Development Schedule

This section provides an overview of the mine development schedule, including the mining phases and related materials handling.

3.3.4.1 Construction Year -2 and Year -1

The section includes the Early Works (authorized by *Mines Act* Permit M-246 dated June 22, 2021) and the Mine Access Road (MAR) (authorized by Special Use Permit [SUP] SP0001 dated July 14, 2021). Table 3.3-2 identifies activities authorized by *Mines Act* Permit M-246 and SUP Permit SP0001. Construction activities to be permitted by this Application are identified in Table 3.3-3 and discussed in Sections 3.4.1 and 3.4.2 for Years -2 and -1, respectively. Figures 3.3-5, 3.3.6, and 3.3-7 present the mine site general arrangement for Year -2, the TSF general arrangement for Year -2 and the mine site general arrangement for Year -1, respectively.

Table 3.3-2: Summary of Permitted Early Works

- **Workforce** – maximum 250
- Open Pit
  - Tree clearing
- Plant Site
  - Vegetation clearing, grubbing and site-leveling
- TSF
  - Partial tree clearing of TSF pond, Main Dam C, and FWR
- Waste Stockpiles
  - Tree clearing of Lower Waste Stockpile area
- LGO Stockpile
  - Tree clearing
- Water Management Structures
  - Construction and operation of perimeter drainage channels, sediment control pond (SCP), and infiltration basins around the Plant Site
- Mine Service and Haul Roads
  - Construction and operation of mine service roads, and ex-pit mine haul roads
- Explosives Storage Facility
  - Tree clearing
- Ancillary Structures
  - Tree clearing of operations camp, laydown area, Ready Line and Bulk Fuel Storage area
  - Construction, commissioning, and operation of security gate
- Borrow Pits and Aggregate and Cement Plant
  - Tree clearing of Mine Access Borrow Area, Borrow and Preparation Area, and Southern TSF C Borrow Area
- MAR
  - Tree clearing, bulk excavation and grading, surfacing and installation of bridges

Table 3.3-3: Summary of Construction Phase Activities

- **Workforce** – maximum 500 per year
- Open Pit
  - Vegetation clearing, grubbing and surface preparation of initial pit phases
  - Extraction Method – Diesel drill and shovel
  - Commissioning of initial mine fleet (Year -2) and addition to in-pit mine fleet (Year -1)
  - Starter Pit – Mining to 1,610 metres above sea level (masl) bench (Year -2)
  - Construction Borrow Pit – Mining to 1,510 masl bench (Year -2)
- Processing Plant
  - Foundation construction and initial stockpiling (Year -2, Year -1)
  - Construction of facilities to pre-commissioning (Year -1)
- TSF
  - Additional vegetation clearing of TSF
  - Construction of the diversion works including the Davidson Creek Diversion System and Mine Area Creek Diversion
  - SCP and the associated inlet channels
  - Main Dam C – Excavation of cut-off-trench (COT) and initial fill placement (Year -2) followed by Main Dam C Stage 1 construction to 1,273 masl (Year -1)
  - TSF C Pond – Starter pond initiation at the Diversion Berm (Year -2); Receipt of water from drainage area
  - Disposal of PAG and ML waste rock in designated disposal area located between the Diversion Berm and Main Dam C
  - Water reclaim pipeline and reclaim pump systems from TSF C Pond – Siting and construction to pre-commissioning
  - Tailings distribution pipeline constructed from processing facility to the west side TSF C – Siting and construction to pre-commissioning
  - Construction of the IECD, pond and pumpback system (Year -1)
- Waste Stockpiles
  - Vegetation clearing, grubbing, and surface preparation as required
  - Construction of Lower Waste Stockpile water management systems, including water collection channels and the Lower Waste Stockpile Collection Pond
  - Lower Waste Stockpile – Development of lift to 1,420 masl (Year -1)

- LGO Stockpile
  - Vegetation clearing, grubbing, and surface preparation as required
  - Construction of water management systems, including non-contact water diversions, contact water collection channels, LGO Collection Pond, stockpile sub-grade preparation, and associated liner systems
  - Stockpiling of LGO Stockpile (lower grade ore) to 1,440 masl (Year -1)
  - Stockpiling of LGO Stockpile Pile A (higher grade ore) to 1,440 masl (Year -1)
- Water Management Structures
  - Vegetation clearing, grubbing, and surface preparation as required
  - WMP construction, including berm construction, liner placement to form the pond, pond filling, and construction of associated water supply and discharge pump systems and pipelines
  - Open Pit dewatering activities, including construction and operation of pit dewatering and depressurization infrastructure with discharge to the Metals WTP or WMP
  - Central Diversion System construction, including diversion channels, collection channels, water transfer pond, pump systems and pipelines
  - FWR construction, commissioning, and operation
  - Surface drainage for infrastructure – construction and operation
- Water Treatment
  - Construction of the Metals WTP
  - Construction of the Membrane WTP
  - Construction of the lime neutralization system
- Topsoil Stockpiles
  - Vegetation clearing, grubbing, site leveling, stockpiling, and maintenance of salvaged soils
- Mine Service and Haul Roads
  - Mine Service Roads – Completion of service road network; Operations and maintenance
  - Ex-pit Haul Roads – Upgrading width and foundation; Construction and maintenance of pit access
  - In-pit Haul Roads – Construction and maintenance within operational pits
- Power Supply and Distribution
  - Vegetation clearing, grubbing, and surface preparation as required
  - Power to worksites provided by the portable gensets (Year -2)
  - Main substation and emergency power system developed to pre-commissioning (Year -1)
  - Connection of the mine site by the 230 kV transmission line (Year -1)
- Explosives Storage Facility
  - Complete vegetation clearing, grubbing and surface preparation as required
  - Construction, commissioning, and operation
- Ancillary Structures
  - Complete vegetation clearing, grubbing, and surface preparation as required (Year -2)
  - Construction laydown areas – Construction, commissioning, and operation (Year -2)
  - Operations camp – Construction, commissioning, and operation (Year -2)
  - Exploration camp – Operation (Year -2); relocation of facilities to operations camp pad (Year -1)
  - Truck shop and wash/Mine office – Construction, commissioning, and operation (Year -1)
  - Ready Line and Bulk Fuel Storage area – Construction, commissioning, and operation (Year -1)
  - Waste management facilities – Construction, commissioning, and operation (Year -1)
  - Potable and fire water supplies – Construction, commissioning, and operation (Year -1)
  - Helipad – Construction, commissioning, and operation (Year -1)
- Borrow Pits, and Aggregate Screening and Concrete Batch Plants
  - Borrow, aggregate screening and concrete batch plant area – Construction and operation (Year -2)
  - Borrow, aggregate screening and construction laydown area – Construction and operation (Year -2)
  - TSF and FWR embankment borrow areas (Year -1)
- Off-Site Infrastructure (Non-Application Components)
  - Decommissioning of Exploration Access Road
  - Decommissioning of the Mount Davidson Exploration Road
  - Construction from of transmission line from Glenannan substation to mine site
  - Airstrip and airstrip access road – Construction and connection to MAR (Year -2)

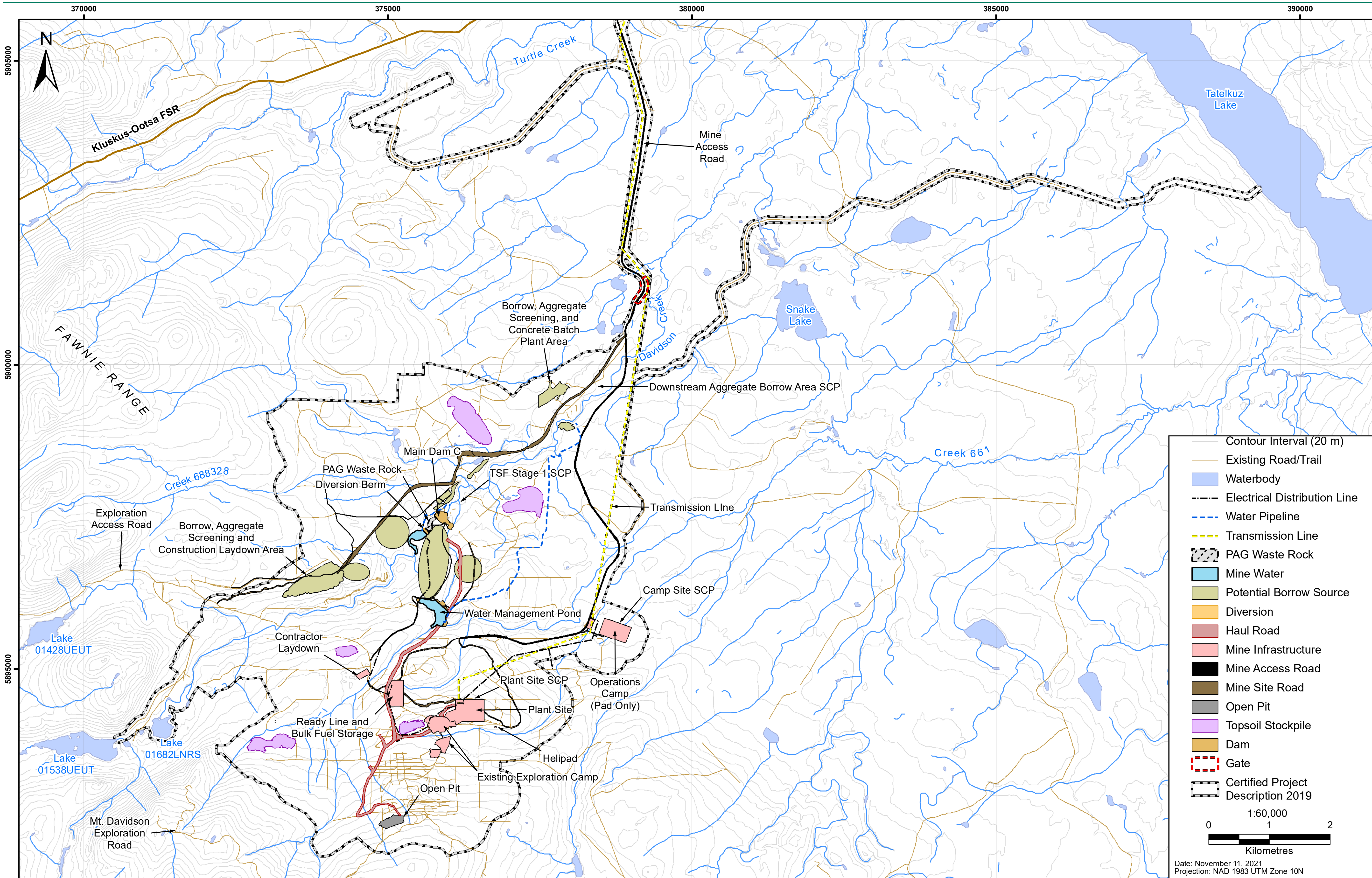
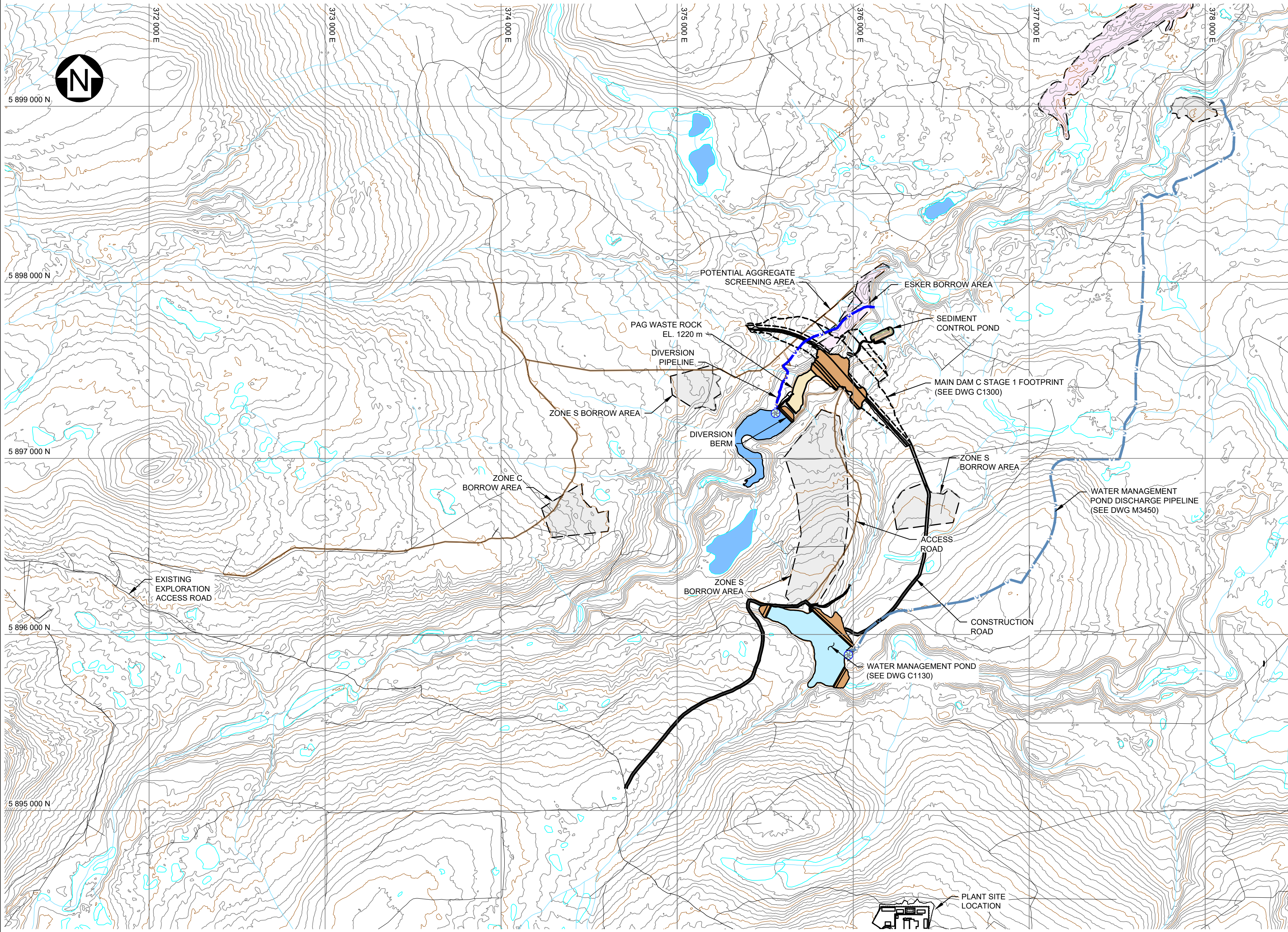


Figure 3.3-5: General Arrangement of Blackwater Mine for Construction Year -2



PLAN
YEAR -2
SCALE A

LEGEND:

- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- ESKER BORROW (ESKER)
- BORROW AREA (ZONES S AND C)
- PUMP STATION
- MINE ACCESS ROAD
- ACCESS ROAD
- EXISTING ACCESS TRAILS
- DIVERSION PIPELINE
- WATER MANAGEMENT POND DISCHARGE SYSTEM PIPELINE

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. MECHANICAL SYSTEM DETAILS NOT SHOWN FOR CLARITY, SEE MECHANICAL SYSTEMS DRAWINGS FOR DETAILS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

250 125 0 250 500 750 1000 1250 m
SCALE A

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BLACKWATER GOLD PROJECT

TAILINGS STORAGE FACILITY
GENERAL ARRANGEMENT
YEAR -2

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	G0019	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
M3450	WATER MANAGEMENT POND DISCHARGE SYSTEM - PIPLINE - PLAN & PROFILE
G0006	CIVIL GENERAL NOTES
C1130	TSF - WATER MANAGEMENT POND - GENERAL ARRANGEMENT
C1300	TSF - MAIN DAM C - STAGE 1 DAM GRADING - PLAN

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15NOV'21	ISSUED FOR PERMITTING	DDF	ABN		

SAVED: M:\1\01\00457\33\A\Acad\DWGS\G0019\G0019, 11/12/2021 3:15:25 PM , SCAMMAYO PRINTED: 11/12/2021 3:22:09 PM, G0019, SCAMMAYO ACAD VERSION: 23.1S (LMS TECH)

Figure 3.3-6: General Arrangement of Blackwater Tailings Storage Facility for Construction Year -2

Source: Knight Piésold Consulting (2021).

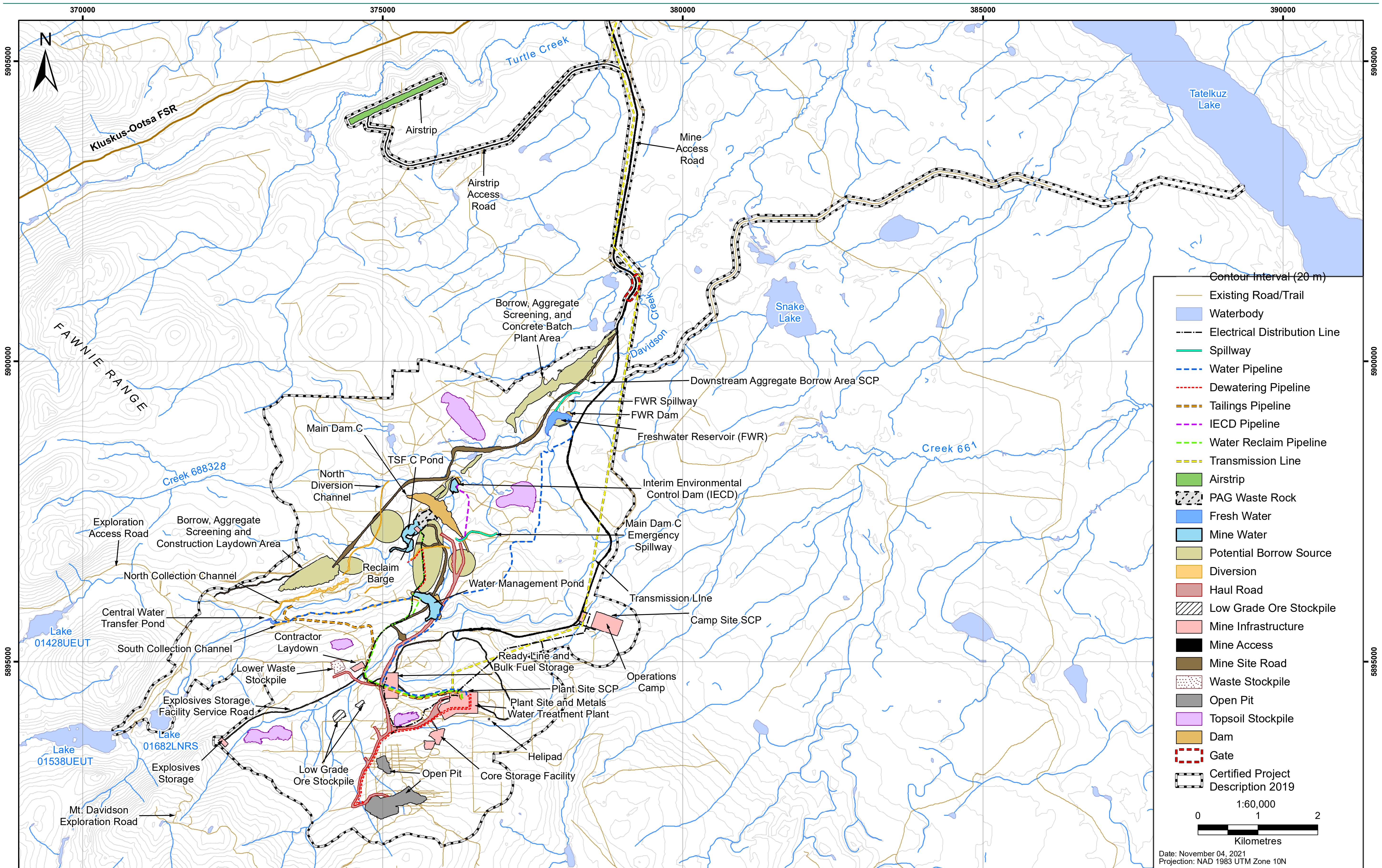


Figure 3.3-7: General Arrangement of Blackwater Mine for Construction Year -1

3.3.4.2 Operations Year +1 to Year +5

During this stage of operations, the mine will be commissioned for processing approximately 5.5 Mtpa. As a result of commissioning activities, approximately 4.5 Mtpa of ore will be processed in Year +1 and 5.5 Mtpa from Year +2 to the end of Year +5. During Year +5, construction and commissioning will be undertaken to increase to mill throughput to 12 Mtpa for Year +6. Activities for the first years of operations are summarized in Table 3.3-4. Further details on Year +1 to the end of Year +3 activities are presented in Sections 3.4.3 to 3.4.5. Figures 3.3-8, 3.3-9, and 3.3-10 present the mine site general arrangement for Year +1, Year +2, and Year +3, respectively.

Table 3.3-4: Summary of Year +1 to Year +5 Activities

- **Workforce** – maximum 266 per year (Year +1 to Year +4); maximum 532 (Year +5)
- Open Pit
  - Continued clearing of pit area
  - Extraction Method - Diesel drill, blast and shovel; Addition of electric drill and shovel (Year +5)
  - Installation of 4.16 kV substation to power electric drill and shovel (Year +5)
  - Staged increase to in-pit mine fleet (Year +1, Year +4, Year +5)
  - Construction Borrow Pit – Mining to pit bottom 1,450 masl (Year +2)
  - Starter Pit – Mining to pit bottom 1,450 masl (Year +3)
  - East Pushback 1 – Mining to pit bottom 1,460 masl (Year +4)
  - East Pushback 2 – Mining to 1,460 masl bench (Year +5)
  - West Pushback – Mining to 1,540 masl bench (Year +5)
- Processing Facilities
  - Phase 1 commissioning and operations to 4.5 Mt per annum (Year +1) and 5.5 Mt per annum (Year +2)
  - Conduct upgrades to increase throughput to12 Mt per annum (Year +5)
- TSF
  - Main Dam C – Monitoring and annual raises up to 1,312 masl (Year +5)
  - TSF C Pond – Receipt of discharge from mine site drainage network, IECD pond, and final ECD pond and water accumulated behind Main Dam D initial fill areas; Impoundment of PAG and ML waste rock and tailings; Serves as process water source
  - Main Dam D – Initial construction of Stage 1 to 1,256 masl (Year +5)
  - Water reclaim pipeline and reclaim pump systems in the TSF C Pond used to reclaim water to the mill to support ore processing
  - Expansion of water reclaim pipeline and reclaim pump systems from TSF C Pond coinciding with processing facility expansions – Siting and construction to commissioning (Year +5)
  - PAG/NAG3 waste rock disposal occurs within TSF C adjacent to Main Dam C
  - Tailing distribution systems and pipeline convey tailings to discharge location at west side of TSF C
  - IECD and pond – Operational with pumpback to the TSF C Pond
- Waste Stockpiles
  - Vegetation clearing, grubbing, and surface preparation as required
  - Lower Waste Stockpile – Stockpiling to 1,450 masl (Year +5)
- LGO Stockpile
  - Vegetation clearing, grubbing, and surface preparation as required
  - Stockpiling of LGO Stockpile (lower grade ore) to lift height 1,500 masl (Year +3)
  - Stockpiling of LGO Stockpile Pile A (higher grade ore) to lift height 1,470 masl (Year +3)

- Water Management Structures
  - Open Pit dewatering
  - WMP outflows pumped to Processing Plant and FWR
- Water Treatment
  - Neutralization of LGO Stockpile runoff with lime before discharging to the TSF C Pond along with tailings
  - Treatment of waters accumulating in the Open Pit (dewatering and pit sump) and runoff from the Lower Waste Stockpile treated by Metals WTP; treated water is used at the mill and excess treated water conveyed to WMP
  - Excess TSF C Pond water treatment at Membrane WTP and discharge to the WMP, if required due to prevailing climate conditions.
- Mine Service and Haul Roads
  - Ex-pit haul roads – Expansion to service development of the pit
  - In-pit haul roads – Expansion to service development of the pit
- Ready Line and Bulk Fuel Supply Area
  - Fuel storage expanded to 300,000 L (Year +4)
- Ongoing Use and Maintenance
  - Topsoil stockpiles
  - Central Diversion System, WMP, and FWR
  - Surface drainage for infrastructure
  - Mine service roads
  - Power supply and distribution
  - Explosives storage facility
  - Ancillary facilities
  - Borrow pits and aggregate and concrete batch plants (Plant expansion)
  - Off-Site Infrastructure (Non-Application Components)
    - Transmission line
    - Airstrip and airstrip access road

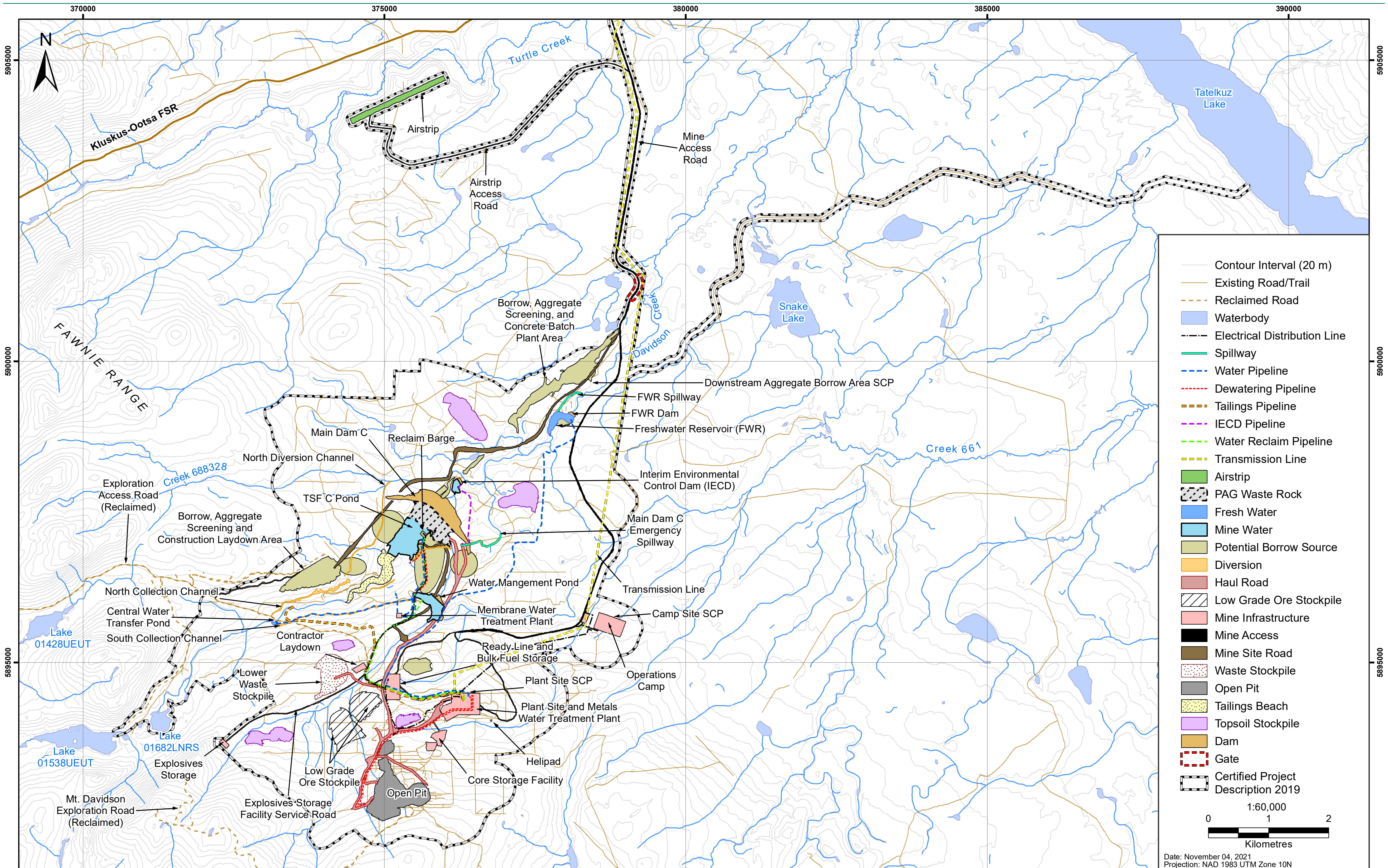


Figure 3.3-8: General Arrangement of Blackwater Mine for Operations Year +1

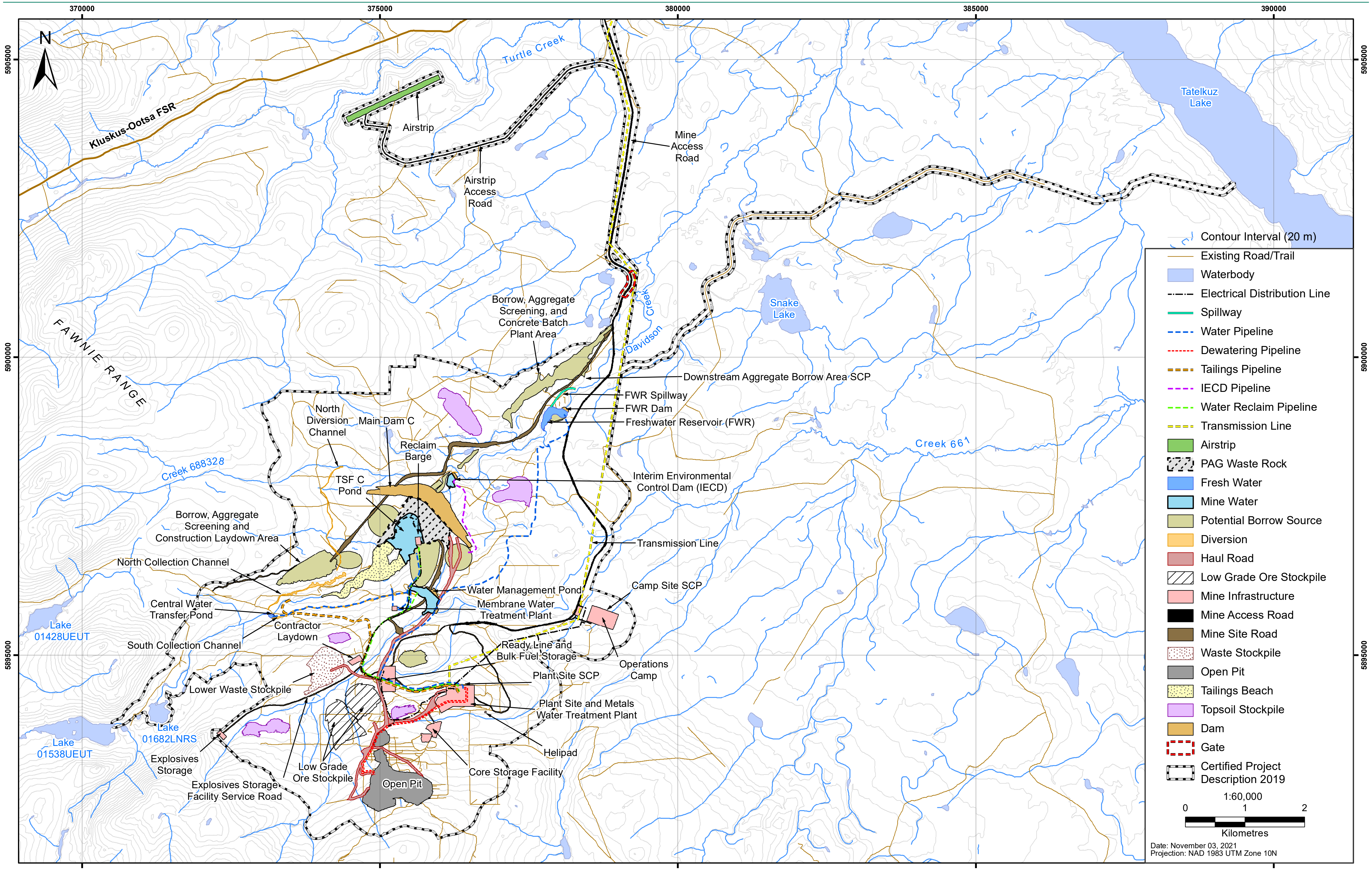


Figure 3.3-9: General Arrangement of Blackwater Mine for Operations Year +2

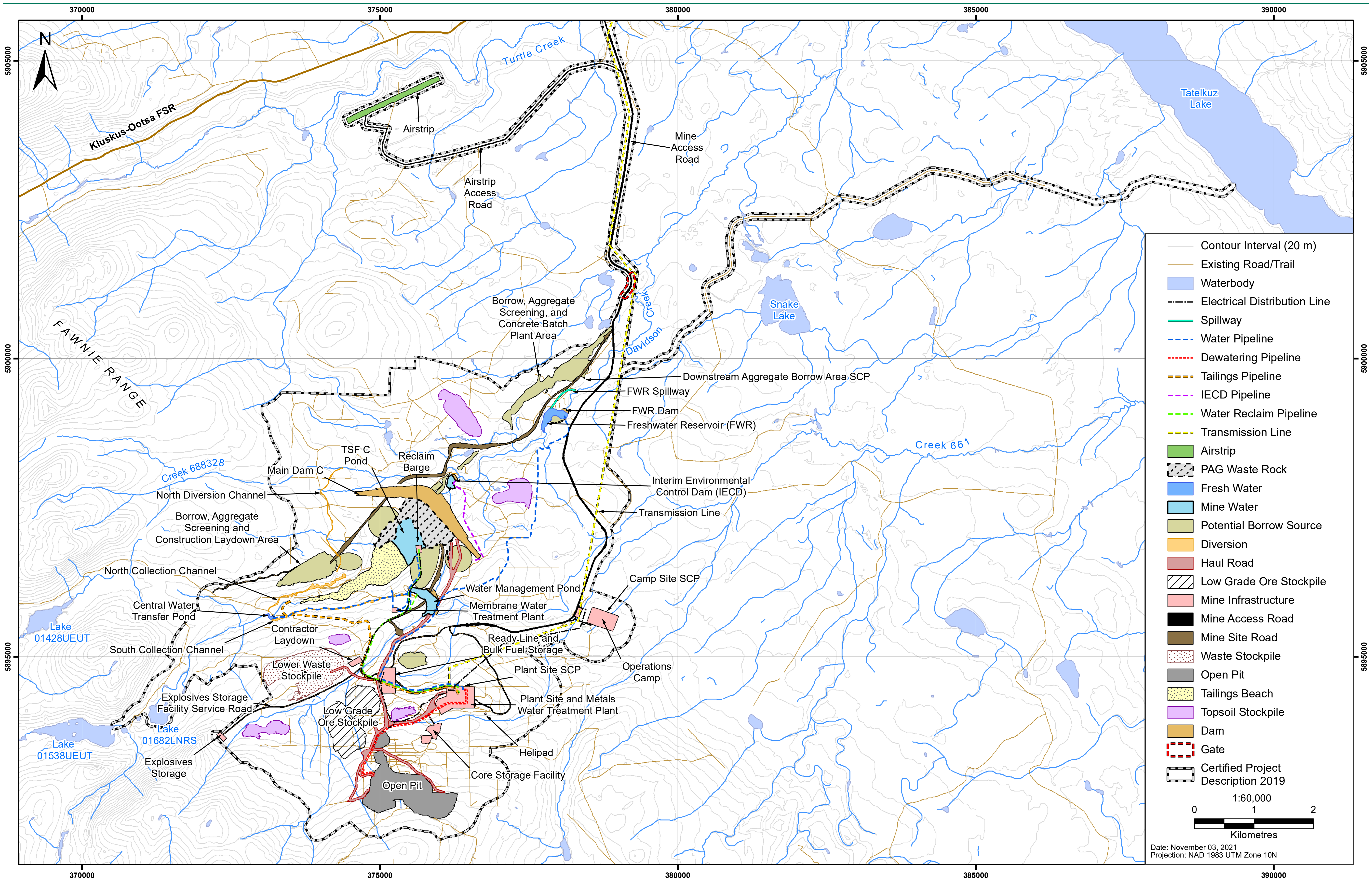


Figure 3.3-10: General Arrangement of Blackwater Mine for Operations Year +3

3.3.4.3 Operations Year +6 to Year +10

During this stage of operations, the mine will be processing 12 Mtpa. During Year +10, construction and commissioning will be undertaken to increase the mill throughput to 20 Mtpa for Year +11. Activities for Year +6 to the end of Year +10 are summarized in Table 3.3.5. Figure 3.3-11 presents the mine site general arrangement for Year +8.

Table 3.3-5: Summary of Year +6 to Year +10 Activities

- **Workforce** – maximum 532 (Year +6 to Year +9); increase in workforce in Year +10 to support Processing Plant upgrades
- Open Pit
  - Continued clearing of pit to final pit limits
  - Extraction Method – Diesel drill and shovel; Addition of a second electric drill and shovel (Year +9)
  - Installation of second 4.16 kV substation to power electric drill and shovel (Year +9)
  - Staged increase to in-pit mine fleet (Year +6, Year +8, Year +10)
  - East Pushback 2 – Mining to pit bottom 1,380 masl bench (Year +7)
  - West Pushback – Mining to pit bottom 1,300 masl bench (Year +9)
  - North Pushback 1 – Mining to 1,310 masl bench (Year +10)
  - North Pushback 2 – Mining to 1,410 masl bench (Year +10)
  - South Pushback – Mining to 1,670 masl bench (Year +10)
- Processing Plant
  - Phase 2 plan commissioning and operations to 12 Mtpa (Year +6)
  - Initiate upgrades to increase annual throughput to 20 Mtpa (Year +10)
- TSF
  - West Dam – First stage lift construction to 1,345 masl including seepage monitoring sump and pumpback system (Year +6)
  - Main Dam C – Monitoring and raises to 1,329 masl (Year +10)
  - TSF C Pond – Receipt of discharge from mine site drainage network, flows pumped from TSF D, and neutralized low-grade ore stockpile runoff; impoundment of PAG and ML waste rock ends during Year +6; Continued impoundment of tailings; Serves as process water source
  - Main Dam D – Monitoring and annual raises to 1,298 masl (Year +10)
  - TSF D Pond – Starting Year +7 may also receive discharge from mine site drainage network, ECD pond; serves as process water source; Impoundment of PAG and ML waste rock beginning in Year +6
  - Expansion of tailings distribution infrastructure in Year +6 with the addition of a secondary line to the southwest end of TSF C (approximately 4,300 m in length) to West Dam, commissioned and operational in approximately Year +6
  - Construction and commissioning of two pipelines to convey tailings along the crest of Main Dam C to discharge into TSF C (beginning Year +7) to cover PAG/NAG3 disposal area - siting and construction to pre-commissioning (approximately 7,300 m long each).
  - Expansion of water reclaim pipeline and reclaim pump systems from TSF C Pond coinciding with processing facility expansions – Siting and construction to pre-commissioning (Year +10)
  - IECD and Pond – Decommissioned and buried by PAG/NAG3 disposal area in TSF D following development of the Main Dam D (Year +6)
  - Final ECD – Construction and operation of dam and pond starting in Year +6; Pumpback of water to the TSF D Pond

- Waste Stockpiles
  - Vegetation clearing, grubbing, and surface preparation as required
  - Lower Waste Stockpile – Expansion to ultimate 1,470 masl (Year +8); completion of stockpiling (Year +10)
  - Upper Waste Stockpile – Grubbing and site preparation, foundation preparation, and water management construction (Year +10)
- LGO Stockpile
  - Vegetation clearing, grubbing, and surface preparation, as required
  - Stockpiling of LGO Stockpile (lower grade ore) to lift height 1,520 masl (Year +8)
  - Stockpiling of LGO Stockpile Pile A (higher grade ore) to lift height 1,480 masl (Year +8)
- Water Management Structures
  - Open Pit dewatering
  - Northern Diversion System construction, including associated collection channels, water transfer pond, intake structure and pipeline to the FWR (Year +6)
  - Relocation of Central Diversion System infrastructure to Phase 2 positions, including associated collection channels, water transfer pond, pump system and pipeline to the WMP (Year +6)
- Mine Service and Haul Roads
  - In-pit Haul Roads – Expansion to service pit expansion
- Power Supply and Distribution
  - Expansion of power distribution network to Processing Plant for increased throughput
  - Expansion of power distribution network to Open Pit for addition of electric drilling and shovel extraction
- Ready Line and Bulk Fuel Supply
  - Fuel storage expanded to 675,000 L (Year +9)
- Water Treatment
  - Neutralization of LGO Stockpile runoff with lime before discharging to the TSF C Pond along with tailings
  - Treatment of waters accumulating in the Open Pit (dewatering and pit sump) and runoff from the Upper and Lower Waste stockpiles treated at the Metals WTP; treated water is used at the mill and excess treated water conveyed to WMP
  - Excess TSF C Pond water treatment at Membrane WTP and discharge to the WMP, if required due to prevailing climate conditions
- Ongoing Use and Maintenance
  - Topsoil stockpiles erosion control and invasive plant management
  - Central and Northern Diversion systems and Central Water Transfer Pond North and South Interception trenches
  - Pit dewatering
  - FWR
  - Surface drainage for Infrastructure
  - Mine service roads
  - Ex-pit haul roads
  - Power supply and distribution to other mine site components
  - Explosives storage facility
  - Ancillary structures
  - Borrow pits and aggregate and concrete batch plant (Plant expansion)
- Off-Site Infrastructure (Non-Application Components)
  - Transmission line
  - Freshwater supply system (FWSS) intake, pump stations and pipeline
  - Airstrip and airstrip access road

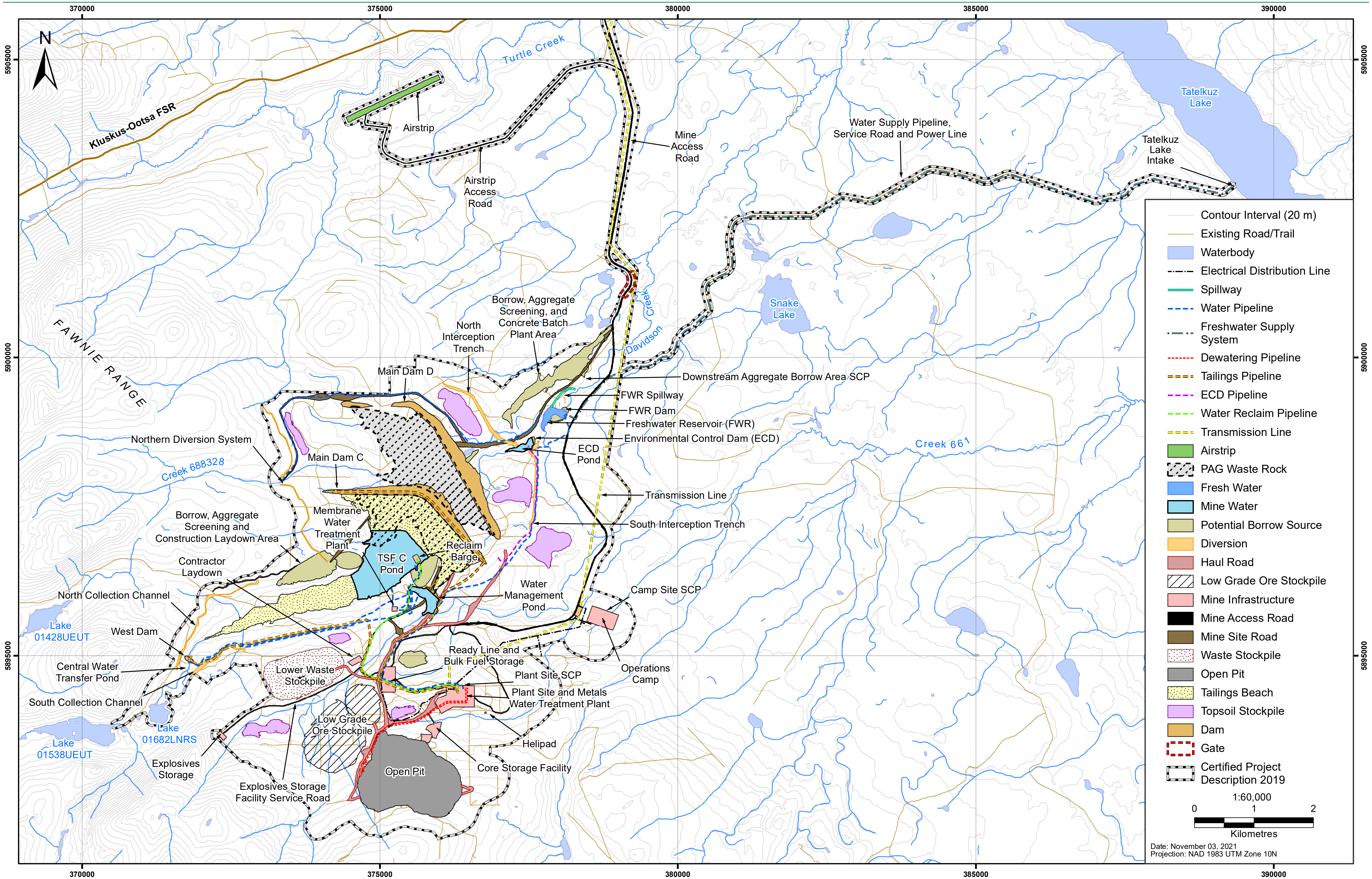


Figure 3.3-11: General Arrangement of Blackwater Mine for Operations Year +8

3.3.4.4 Operations Year +11 to Year +18

During this stage of operations, the mine will be processing 20 Mtpa. Mining operations at the Open Pit will cease at the end of Year +18. Activities for Year +11 to the end of Year +18 are summarized in Table 3.3-6. Figures 3.3-12 and 3.3-13 present the mine site general arrangement for Year +13 and Year +18, respectively.

Table 3.3-6: Summary of Year +11 to Year +18 Activities

- **Workforce** – maximum 532
- Open Pit
  - Extraction Method – Diesel drill and shovel, and electric drill and shovel
  - Staged decrease to in-pit mine fleet (Year +15, Year +16, Year +17, Year +18)
  - North Pushback 1 – Mining to pit bottom 1,260 masl bench (Year +11)
  - North Pushback 2 – Mining to pit bottom 1,140 masl bench (Year +14)
  - South Pushback – Mining to pit bottom 1,160 masl bench (Year +18)
- Processing Plant
  - Phase 3 of plant commissioning and operations to 20 Mtpa (Year +11)
- TSF
  - Main Dam C – Monitoring and annual raises to final elevation of 1,353 masl (Year +18)
  - West Dam – Monitoring and raised to final elevation of 1,353 masl (Year +12)
  - Saddle Dam – Initial construction to 1,337 masl (Year +12) and raise in two stages to final elevation of 1,353 masl by Year +18)
  - TSF C Pond – Receipt of discharge from mine site drainage network and Open Pit; Impoundment of tailings ends in approximately Year +21; Serves as process water source.
  - Main Dam D – Monitoring and annual raises to the ultimate build of 1,324 masl (Year +18)
  - TSF D Pond - Receipt of discharge from mine site drainage network, ECD Pond, and Open Pit until Year +19; Impoundment of PAG; Serves as process water source
  - ECD and Pond– Monitoring of dam and pond; Pumpback of water to the TSF D Pond
- Waste Stockpiles
  - Lower Waste Stockpile – Resloping, geotechnical stabilization, and monitoring
  - Upper Waste Stockpile – Expansion to 1,620 masl lift with cessation of stockpiling (Year +18)
- LGO Stockpile
  - Vegetation clearing, grubbing, and surface preparation as required
  - Stockpiling of LGO Stockpile to lift height 1,540 masl (Year +13) and 1,520 masl (Year +18)
  - Stockpiling of LGO Stockpile Pile A to lift height 1,480 masl (Year +13), handling to commence in Year +15, and will be depleted by Year +18
- Water Treatment
  - Neutralization of LGO Stockpile runoff with lime before discharge along with tailings to TSF C
  - Treatment of waters accumulating in the Open Pit (dewatering and pit sump) and runoff from the Upper and Lower Waste Stockpiles treated by Metals WTP; treated water is used at the mill and excess treated water conveyed to WMP
  - Excess TSF C Pond water treatment at Membrane WTP and discharge to the WMP, if required due to prevailing climate conditions

- Water Management Structures
  - Water Management Pond relocated to accommodate continued filling of TSF C (Year +12)
- Mine Service and Haul Roads
  - In-pit haul roads – Expansion to service pit expansion
- Components Ongoing Use and Maintenance
  - Topsoil stockpiles
  - Central and Northern Diversion Systems
  - ECD, interception trenches, and pumpback system
  - FWR
  - Surface drainage for infrastructure
  - Mine service roads
  - Ex-pit haul roads
  - Power supply and distribution
  - Explosives storage facility
  - Ancillary facilities
  - Borrow pits and aggregate sources
- Off-Site Infrastructure (Non-Application Components)
  - Transmission line
  - FWSS pumphouse and pipeline
  - Airstrip and airstrip access road

3.3.4.5 Operations Year +19 to Year +23

During this stage of operations, the mine will process ore exclusively from the LGO Stockpile. With the closure of the Open Pit, the pit will be allowed to fill with water to form the Pit Lake with additional pumping of water from TSF C Pond supernatant. In conjunction with the cessation of mining operations, other closure and reclamation activities will start in Year +19. Activities for Year +19 to the end of Year +23 are summarized in Table 3.3-7. Figure 3.3-14 presents the mine site general arrangement for Year +23.

3.3.4.6 Closure Year +24 to Year +45

The Closure phase starts with the cessation of ore processing. Decommissioning of mine infrastructure is anticipated to be completed in Year +24 and Year +25, followed by revegetation. Water management activities will largely be driven by backfilling the Open Pit with site water to create a Pit Lake. Components will be progressively closed and reclaimed as they are no longer required. Activities to support the Closure phase are identified in Table 3.3-8.

3.3.4.7 Post-Closure Year 46+

The Post-closure phase is planned for approximately Year 46+, following the completion of closure activities including the filling of the Pit Lake and initiation of water discharge to the environment. The Project components and activities to support the Post-closure phase are presented in Table 3.3-9. Components will be progressively closed and reclaimed to their final state as they are no longer required. Figure 3.3-15 presents the general arrangement for the Post-closure phase.

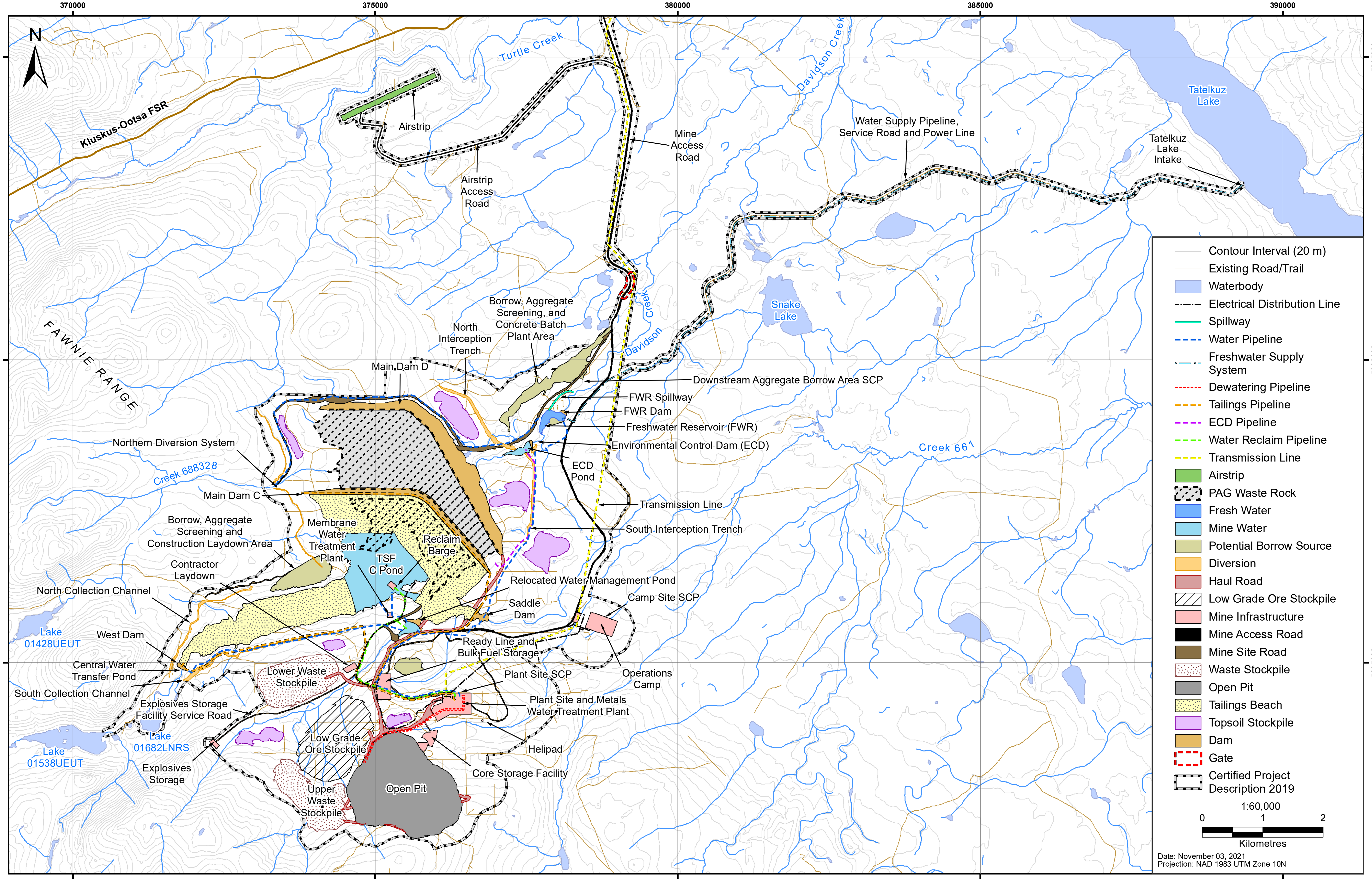


Figure 3.3-12: General Arrangement of Blackwater Mine for Operations Year +13

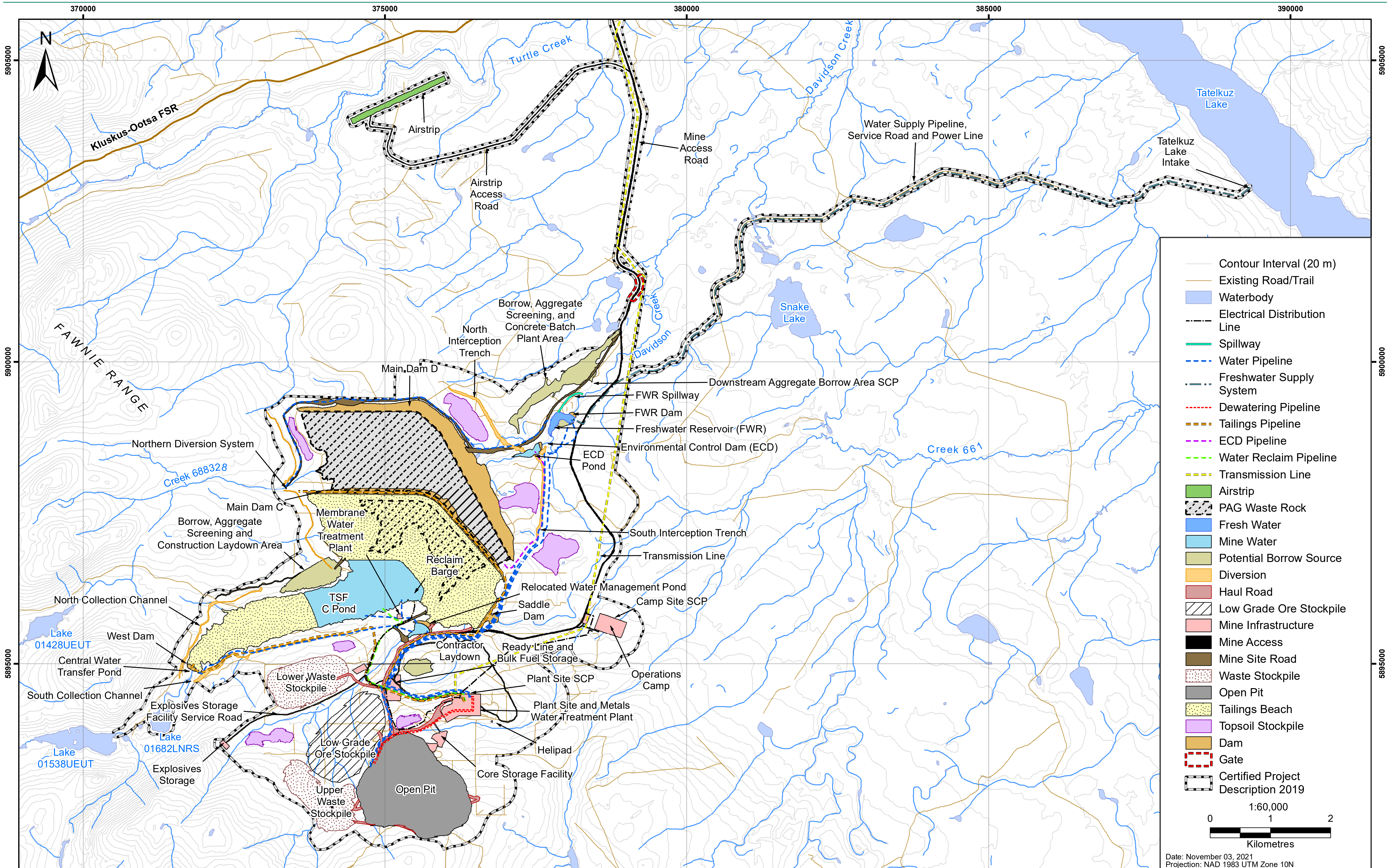


Figure 3.3-13: General Arrangement of Blackwater Mine for Operations Year +18

Table 3.3-7: Summary of Year +19 to Year +23 Activities

- **Workforce** – maximum 325
- Open Pit
  - Decommissioning of mine fleet and electrical distribution system, de-watering wells, sumps, and related works
  - Initiate filling of Pit Lake (sSee Water Management Structures)
- Processing Plant
  - Milling of LGO Stockpile reclaim at 20 Mt per annum (Year +19 to Year +22)[3]
- TSF
  - West Dam – Monitoring and maintenance
  - Main Dam C – Monitoring and maintenance of dam
  - TSF C Pond – Conveyance of supernatant to Open Pit starting Year +19; Serves as process water source; tailings infill ceases Year +21
  - Main Dam D – Monitoring and maintenance and raised to final elevation of 1,331 masl (Year +20)
  - TSF D Pond – Receipt of discharge from mine site drainage network; impoundment of PAG, impoundment of tailings starting in Year +21; serves as process water source
  - ECD and Pond – Monitoring of dam and pond; Conveyance of captured flows to Open Pit starting Year +19
- Waste Stockpiles
  - Lower Waste Stockpile – Resloping, geotechnical stabilization, and monitoring
  - Upper Waste Stockpile – Resloping, geotechnical stabilization, and monitoring
- LGO Stockpile
  - Re-handling of ore to Processing Plant with depletion by Year +23
  - Closure and progressive reclamation
- Water Management Structures
  - Pit Lake – Filling with natural groundwater and TSF C Pond supernatant (Year +20 to Year +23), and ECD Pond
  - Lower Waste Stockpile runoff directed to TSF C Pond and Upper Waste Stockpile runoff directed to Open Pit
  - Continued operation of FWR for mill processing supply and Davidson Creek instream flow needs (IFN)
  - Continued operation of the Central and Northern Diversion Systems with water conveyed to the WMP and FWR, respectively
- Water Treatment
  - Continued operation of the lime neutralization for LGO Stockpile runoff
  - Metals treatment for pit dewatering, the Upper and Lower Waste Stockpiles not required. Pit water will be allowed to naturally flow into the Open Pit to aid in pit filling. Lower Waste Stockpile water will be directed to the TSF; Upper Waste Stockpile water will be directed to the Open Pit and TSF.
  - Membrane treatment of excess TSF C water not required as it will be pumped to the Open Pit to aid in pit filling
- Mine Service and Haul Roads
  - Ex-pit haul roads – Progressive closure and reclamation
  - In-pit haul roads – Closure and progressive inundation of in-pit haul roads (Year +19)
- Power Supply and Distribution
  - Decommissioning of electrical distribution to Open Pit for drills and shovels
- Explosives Storage Facility
  - Progressive closure and reclamation
- Components Ongoing Use and Maintenance
  - Topsoil stockpiles
  - Central and Northern Diversion Systems
  - ECD, interception trenches, and pumpback system
  - FWR Surface drainage for infrastructure
  - Mine service roads
  - Power supply and distribution
  - Ancillary facilities
  - Borrow pits and aggregate sources
- Off-Site Infrastructure (Non-Application Components)
    - Transmission Line
    - FWSS pumphouse and pipeline
    - Airstrip and airstrip access road

[3] Year +23 will process the remaining ore calculated to be 7.5 Mt.

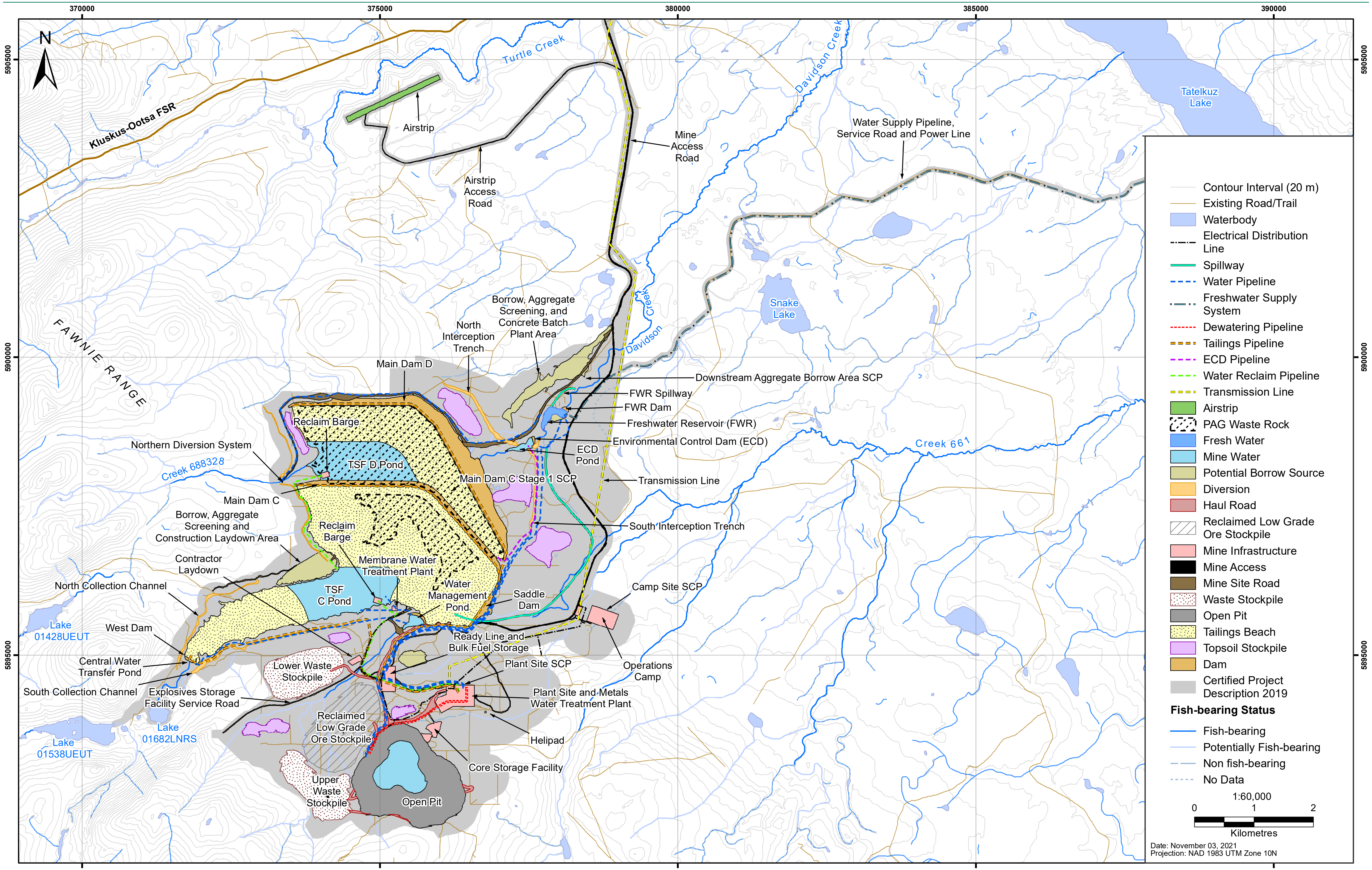


Figure 3.3-14: General Arrangement of Blackwater Mine for Operations Year +23

Table 3.3-8: Summary for Year +24 to Year +45 Activities

- **Workforce** – staffing as required for closure and reclamation activities
- Open Pit
  - Filling of Pit Lake to be completed (Year +45)
- Processing Facilities
  - Decommissioning (Year +24 and Year +25) and reclamation (Year +26 onwards)
- TSF
  - Reclamation of dams/tailings beaches
- Waste Stockpiles
  - Lower Waste Stockpile – Rehandling material for reclamation purposes followed by reclamation and monitoring
  - Upper Waste Stockpile – Reclamation followed by monitoring
- LGO Stockpile
  - Reclaimed with monitoring and maintenance as required
- Topsoil Stockpiles
  - Handling and distribution of salvaged soil with eventual closure and reclamation of the stockpiles (Year +26)
- Mine Service and Haul Roads
  - Operation and maintenance of roads needed for the Closure phase
  - Decommissioning and reclamation of other roads
- Power Supply and Distribution
  - Operation and maintenance of power supply and distribution needed for the Closure phase
  - Decommissioning and reclamation of other components of the power supply
- Ancillary Structures
  - Helipad – Decommissioning and reclamation (Year +25)
  - Camp Facilities – Decommissioning and reclamation (Year +26)
  - Construction Laydown Areas – Decommissioning and reclamation (Year +26)
  - Truck shop and wash/Mine office – Modification for vehicle servicing, fuel storage and dispensing, mine site shop, warehousing, offices and accommodations for Closure Phases (Year +26)
  - Ready Line and Bulk Fuel Storage area – Decommissioning and reclamation (Year +26)
  - Waste Management Facilities – Decommissioning and reclamation (Year +26)
  - Potable and fire water supplies – Decommissioning and reclamation (Year +26)
  - Communications – Decommissioning and reclamation (Year +27)
  - Security - Replace manned gatehouse with security gate and fencing (Year +27 to Year +44)
- Borrow Pits, and Aggregate Screening and Concrete Batch Plants
  - Decommissioning and reclamation (Year +27)
- Off-Site Infrastructure (Non-Application Components)
  - Airstrip and airstrip access road – Decommissioning and reclamation (Year +25)
  - FWSS pumphouse and pipeline – Decommissioning and reclamation (Year +45)
  - Transmission Line – Operation and maintenance for water treatment plants at mine site then decommissioning and reclamation

Table 3.3-9: Summary for Post-closure Year 46+ Activities

- **Workforce** – minimum staff, as required.
- Open Pit
  - Open Pit pond level maintained at or below design maximum
- Tailings Storage Facility
  - Closed when water quality objectives met
  - Ongoing monitoring and reporting on stability of TSF dams
- Water Treatment
  - Relocation of the Membrane WTP to a new facility adjacent to the ECD
  - Treatment of water from the ECD, Pit Lake, and TSF C at the Membrane WTP prior to discharge to Davidson Creek
- Mine Service and Haul Roads
  - Operation and maintenance of roads needed for the Post-closure phase
  - Decommissioning and reclamation of unused roads
- Power Supply and Distribution
  - Operation and maintenance of power supply and distribution needed for the Post-closure phase
  - Decommissioning and reclamation of other components of the power supply
- Security
  - Security gate access

The Post-closure phase ends when water treatment is no longer needed to meet water quality requirements in EAC certificate #M19-01 (June 21, 2019) for EAC Condition #26 (Water Quality Management) and EAC Condition #28 (Chedakuz Creek and Tatelkuz Lake Surface Water Quality Monitoring Plan), and EMA effluent discharge permit requirements. At that time, the remaining Project facilities and infrastructure are decommissioned and/or removed, final reclamation activities are complete and ongoing monitoring is no longer required for reclamation measures and/or water quality. A *Mines Act* permit is anticipated to remain indefinitely for monitoring and reporting on the TSF and Open Pit.

3.3.5 Planned Investigation Works

Additional investigation may be undertaken to verify conditions previously characterized or assumptions made for the detailed design of the Stage 1 TSF and associated water management works concomitant with their construction. The purpose of the work program outlined below is to reduce uncertainties in the site characterization. Investigations would be executed in order to progressively refine the site geological model, verify conditions assumed for the detailed design of the Stage 1 TSF and water management works. The site investigation methods may change depending on encountered ground conditions and findings during the execution of the investigation work. The detailed design of Stage 1 components and future design concepts may be modified in relation to this ongoing process based on the progressive enhancement of the knowledge base.

Work conducted will be reviewed as required by an Independent Tailings Review Board, in accordance with an approved Terms of Reference for that Board. The recommendations are broken down into a phased five year investigation plan. Additional investigations will occur thereafter over the LoM to progressively enhance the knowledge base, and the characterization of the site should be updated periodically to incorporate this additional information.

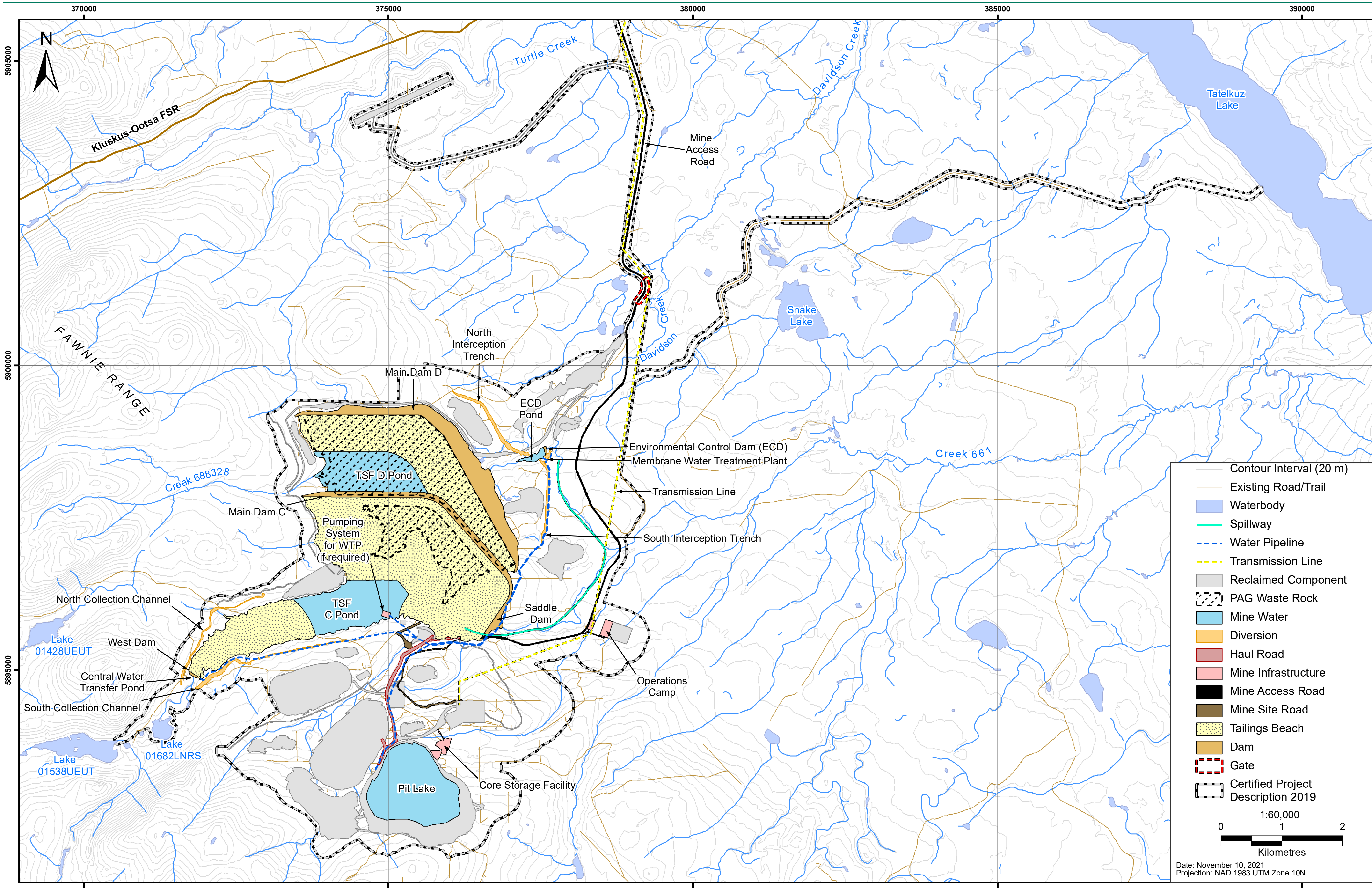


Figure 3.3-15: General Arrangement of Blackwater Mine at Post-closure Year 46+

The following TSF and water management investigations are planned concomitant with construction activities during Years -2 and -1:

- Field verification of 2012-2013 drillhole logs, to the extent practicable, to confirm revised interpretation.
- Conduct seismic refraction surveys along the Main Dam C alignment to confirm the bedrock profile.
- Conduct geotechnical drilling investigations at the WMP to verify that the ground conditions are consistent with design assumptions, and to evaluate alternatives to the WMP lining strategy if natural ground conditions within the basin are more favorable than assumed in the design.
- Conduct geotechnical drilling investigations within the IECD footprint area to verify ground conditions at the maximum section of the dam.
- Conduct additional geotechnical and hydrogeological investigations between the Main Dam C alignment and IECD to verify the extent and connectivity of the inferred glaciofluvial subglacial corridor.
- Conduct in-situ testing of near surface glaciolacustrine units at the FWR using seismic cone penetration testing and downhole seismic testing methods to verify the nature and expected behavior of the near surface glaciolacustrine units encountered at the FWR are consistent with the design parameters.

Specific TSF and water management early Operations phase (Years +1 to +3) investigations include:

- Conduct supplemental site investigations at the Main Dam C alignment to support detailed design for Stages 3 to 6.
- Conduct site investigations including sonic drilling and in-situ testing methods, as appropriate, at the West Dam to support the detailed design for Stage 1.
- Conduct additional drilling investigations, in-situ testing, and laboratory testing at the Main Dam D, TSF D basin, and ECD to support detailed design as well as the installations of additional piezometric monitoring locations within the surficial materials and bedrock.

Additional site investigation work will be completed within the stockpiles area prior to construction, which will be performed to verify that the ground conditions are consistent with design assumptions. The recommended work program includes geotechnical drilling and in-situ testing at select locations within the stockpile footprints, and test pits to further investigate the nature and consistency of the surficial materials in the general vicinity of the proposed stockpiles.

Supplemental geomechanical drilling in the Southeast, East, and Northwest pit design sectors may be performed to refine the boundaries between the Broken Zone and Competent Zone in these areas for early phase pit development and to refine pit slope designs. Several vertical sonic drillholes are proposed to further characterize the OVB materials for potentially steeper OVB slope angles and assess consistency and suitability of OVB materials for use in dam construction.

3.3.6 Anticipated Permit Amendments and Expansions

This Application includes the design of the processing facilities to support Phase 1 throughput of 5.5 Mtpa. Designs for all other facilities are developed to support the LoM throughput of 20 Mtpa. Amendments to the *Mines Act* permit will be required to authorize production rate increases and associated infrastructure modifications, to support Phase 2 and Phase 3 throughout increases in Year +6 and Year +11, in addition to staged raises of the TSF throughout the Operations phase. At that time, other mine components involved with the production rate increase will be reviewed, and if substantive changes are required, then these will be addressed in the amendment applications. Amendments to *Environmental Management Act* discharge permits may also be required to support increases to throughput in Year +6 and Year +11. The *Fisheries Act* authorization reflects the LoM and is not anticipated to require amendment. The *Water Sustainability Act* water licence for diversion of water from Tatelkuz Lake is planned to accommodate the full Davidson Creek IFN and LoM water requirements. Minor changes to the mine plan or works which are consistent with the *Mines Act* permit conditions may be administered through the Notice of Departure from Approvals process.

3.4 Detailed Five-Year Mine Plan

This section details activities for the first five years of the mine plan, commencing in the first year of the Construction phase (Year -2) through the third year of Operations (Year +3). During the first five years, it is anticipated that all construction to support the 5.5 Mtpa throughput will have been completed, processing and waste management facilities will be commissioned, and the mine will have operated for three years. As infrastructure becomes operational with additional upgrades in the first five years, it will be removed from the subsequent years of the five year mine plan.

3.4.1 Year -2

Major activities during Year -2 are:

- Development and operation of TSF construction water management infrastructure (mine area creek diversion, diversion berm, diversion pump system and pipeline, SCP);
- Clearing, grubbing, and site-levelling of most infrastructure sites;
- Clearing and grubbing of Open Pit areas, development of in-pit and pit access roads, Construction Borrow Pit and Starter Pit, and water management system for the Open Pit;
- Continued foundation establishment and early construction work on processing plant;
- Construction of the WMP and associated discharge pump system and pipeline to the FWR;
- Commence construction of Main Dam C;
- Construction of the Lake 15 / 16 connector channel;
- Development of water management systems and initial lift for the Lower Waste Stockpile;
- Development of LGO Stockpile water management systems;
- Development and stockpiling of salvageable soils to topsoil stockpiles;
- Power supplied by portable gensets;
- Operation of existing exploration camp and construction to pre-commissioning of operations camp;
- Construction of explosives storage facility;
- Construction of foundation for truck shop/mine dry/office, contractor laydown areas, and Ready Line and Bulk Fuel Storage area;
- Installation of potable water and fire water systems, and sewage and solid waste facilities to pre-commissioning;
- Installation of communications including internet, telephone, and mobile radio network and closed circuit television networks;
- Development and operation of borrow sources, aggregate production and screening, and concrete batch plant;
- Early construction works for the FWR including low-level outlet and initial fill placement in preparation for creek diversion;

- Commencement of construction of the transmission line from Glenannan substation to the mine site; and
- Commencement of construction of the airstrip access road and airstrip and support facilities.

Mine site and TSF general arrangements for Year -2 are presented in Figures 3.3-5 and 3.3-6, respectively. Details for specific components and activities are presented below.

3.4.1.1 Vegetation Clearing and Topsoil Salvage

Vegetation clearing and grubbing of logged areas will continue beyond the areas authorized for clearing by *Mines Act* Permit M-246 (Early Works). Timber will be felled and decked by logging/clearing crew(s) using a feller-buncher where suitable, or other means, and sold to local forest licensees where a market exists. Timber will be loaded and hauled from the mine site by the purchaser. Non-merchantable timber will be decked, and along with ground vegetation, a portion will be mulched and decked, with a suitable portion incorporated into the topsoil stockpiles. The site will be assessed after completion of logging and brushing activities to determine if the establishment of supplemental sediment and erosion control measures are required (Surface Erosion Prevention and Sediment Control Plan in Appendix 9-A).

Soil will be salvaged in a single lift and then stockpiled. The Soil Management Plan (Appendix 9-B) describes procedures for evaluation, oversight and management of salvaged soil.

Vegetation clearing and topsoil salvage will occur as required, prior to construction projects throughout the LoM.

3.4.1.2 Open Pit

A Construction Borrow Pit [4] will be developed within the northwest area of the ultimate Open Pit limit. The pit is planned to be mined to the 1,650 masl pit bottom bench. The Starter Pit will be initiated and mined to 1,630 masl. Near surface NAG waste rock and OVB will be targeted for construction. A small amount of PAG waste rock will be contained within the Construction Borrow Pit, which will be mined and placed in the designated pre-production PAG disposal area at TSF C.

Initially, diesel generators will provide power to the Open Pit, dewatering pumps and lighting for 24-hour operations (Section 3.5.9). The in-pit mine fleet will consist of four diesel drills (including two grade control drills), a wheel loader and five haul trucks (Section 3.5.1.9).

3.4.1.3 Processing Facilities

By the end of Year -2, the following construction is planned to be initiated:

- Crusher area – foundation construction and pre-assembly layout of primary, secondary, and tertiary crushers.
- Stockpile feed conveyor – foundation construction, and pre-assembly layout of conveyor systems.
- Coarse ore stockpile – foundation and perimeter works construction.
- Completion of concrete foundation, exterior concrete, backfill, interior steel frames, heating/lighting, elevated slabs, cladding and roofing for:
    - Grinding area;
    - Leach area;

[4] The first phase of Open Pit development (Section 3.5.1.6 Phased Development)

  - Reagent area;
  - Gold Room;
  - Plant administration building;
  - Plant office and central control room;
  - Assay laboratory; and
  - Warehouse.
- Stormwater drainage system and drainage pond.
- Plant site roads.

3.4.1.4 Tailing Storage Facilities

Construction of Stage 1 of Main Dam C begins in Year -2. Construction will commence once sediment control and diversion works are in place to support maintenance of a dry working area for embankment construction. The TSF Stage 1 Detailed Design Report is provided in Appendix 3-J.

A SCP will be built prior to the start of Main Dam C construction to collect and settle sediment-laden runoff from dam construction. The pond will be located approximately 300 m downstream of the Stage 1 Main Dam C centreline.

A diversion berm will be constructed upstream of the Stage 1 Main Dam C to retain the inflows from Davidson Creek, as well as the inflows from the mine area creek diversion works, with the aim of maintaining a dry working area for the initial embankment construction. The diversion berm is located approximately 500 m upstream of the Stage 1 Main Dam C centerline. The purpose of the berm and diversions is to collect the upper catchment of Davidson Creek and then convey it downstream. The Davidson Creek diversion berm will be approximately 12 m wide, 110 m long, have a crest elevation of 1231 masl, be a maximum height of 14 m, and will include primary (diversion pumping system) and secondary outlets (emergency spillway). Together, the Diversion Berm and outlets are referred to as the Davidson Creek Diversion System.

Water collected upstream of the Diversion Berm will be pumped around the construction works. The pumping system comprises three operating end-suction centrifugal pumps and one installed spare unit. The system will be mounted on a floating barge, anchored to the shore, and will be controlled via a level control float system, or equivalent. The system will discharge into a stilling basin downstream of the Stage 1 TSF construction works.

A temporary diversion channel and berm will be constructed to divert flows from the mine area creek to the northwest and into the Davidson Creek catchment, at a point upstream of the original confluence. Flows diverted from the mine area creek will be ultimately managed by the Davidson Creek Diversion System. The Mine Area Creek Diversion is designed to convey water away from the southern portion of Main Dam C cut-off trench excavation and initial fill placement area during initial construction. The upstream portion of the diversion utilizes a berm, with a maximum fill height of 5 m, to maintain an elevated channel invert and minimize required excavation quantities at the western end of the channel. To pass the diverted flows beyond the northwest saddle and under a planned construction access road, the berm transitions to an excavated channel and flows to two parallel culverts, which will pass flows under the access road. The culvert outlets are on the northwest side of the access road where the resulting flows will follow existing drainage pathways through the forest before reaching Davidson Creek further to the north.

The general arrangement for Main Dam C site establishment is illustrated in Figure 3.4-1 and development sequence of the initial diversion works is presented in Figure 3.4-2.

Construction of Stage 1 of the Main Dam C will commence following completion of the diversion and sediment control works. Specific features of Stages 1 and 2 of Main Dam C:

- water retaining earthfill seal zone (Zone S);
- filter and transition zones (Zones F and T);
- downstream earthfill/rockfill shell zones (Zone C);
- COT;
- seepage collection drains, including embankment and foundation drains;
- emergency spillways, outlet channels, and stilling basins;
- geotechnical instrumentation; and
- designated PAG/NAG3 waste storage area within the TSF upstream of Zone S.

Construction of the IECD will also begin in late Year -2 and continue into Year -1. The IECD is approximately 500 m downstream of the Main Dam C and will manage seepage from the Main Dam C and stormwater inflows. The IECD pond will utilize a pumpback system to the TSF C Pond. Seepage through the IECD will be captured in a foundation drain system and sump and pumped back to the IECD.

The tailings distribution pipeline and water reclaim pipeline corridors between the Plant Site and the TSF will be cleared and bulk earthworks completed achieve corridor design grades.

3.4.1.5 Waste Stockpiles

Vegetation clearing, grubbing, site leveling, and construction of water management systems including collection channels along the stockpile periphery and the Lower Waste Stockpile Collection Pond.
The stockpile water management design is provided in Appendix 3-N. Any overflows not pumped will exit the pond via emergency spillway at the southeast corner and flow to the mine area creek and hence to the WMP.

The initial lift (1,415 masl) at the Lower Waste Stockpile will be developed.

3.4.1.6 Low Grade Ore Stockpile

Vegetation clearing, grubbing, site leveling and regrading, and construction of the water management systems. The stockpile water management design is provided in Appendix 3-N. The water management systems include the following components to be constructed beginning in Year -2:

- Foundation drains;
- Till liner (stockpile foundation);
- Non-contact water diversion channels;
- Contact Water collection channels;
- LGO Collection Pond with emergency spillway;
- High density polyethylene (HDPE) liner (contact water channels and pond); and
- Pumping system and pipeline discharge.

The area of the developed foundation is approximately 147 ha. No ore will be stockpiled in Year -2.

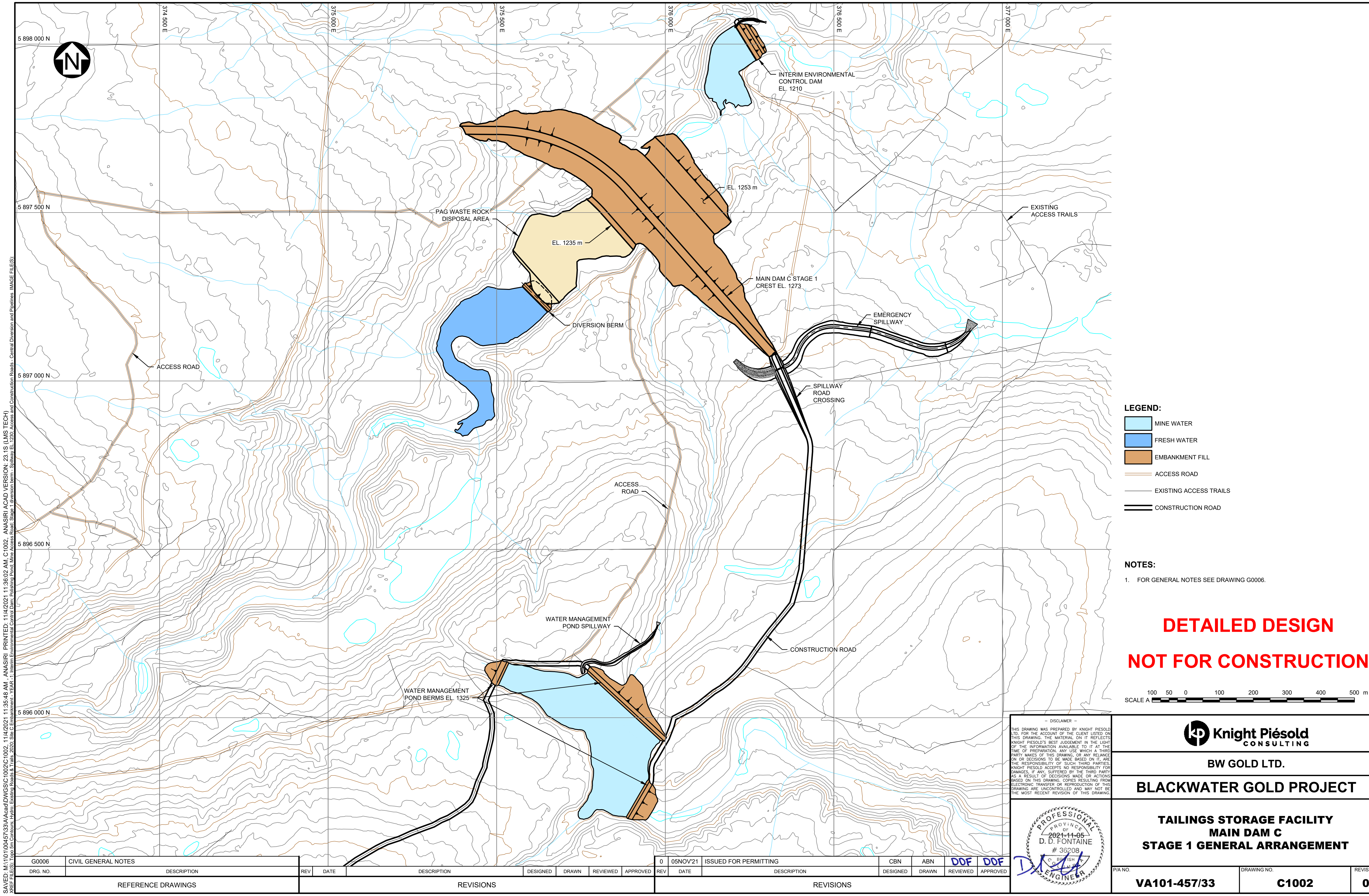
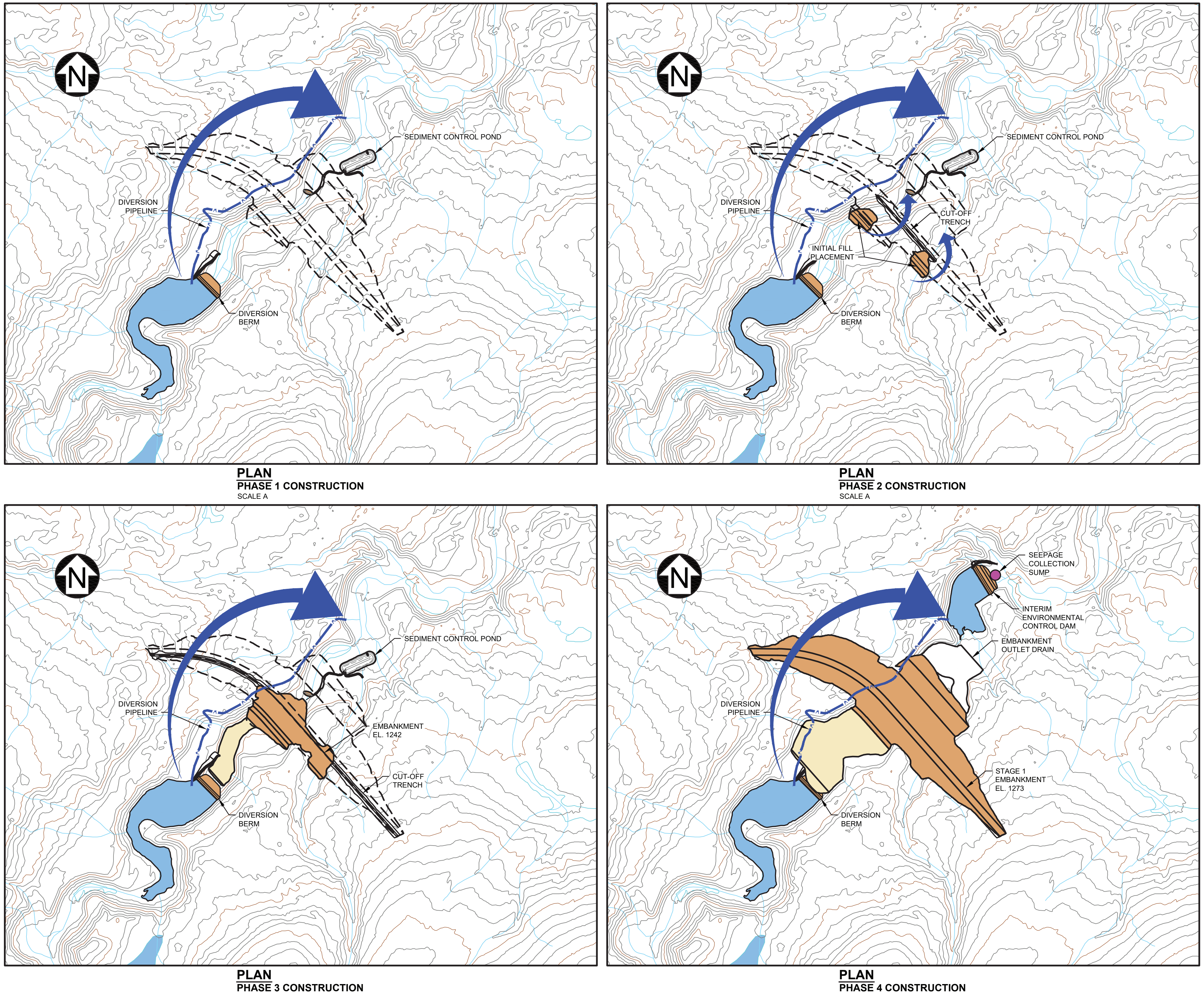


Figure 3.4-1: Main Dam C Site Establishment General Arrangement

Source: Knight Piésold Consulting (2021h; Appendix 3-J).



CONSTRUCTION SEQUENCE NOTES:

PHASE 1:

1. CONSTRUCT SEDIMENT CONTROL POND.
2. CONSTRUCT DAVIDSON CREEK DIVERSION SYSTEM.
3. DIVERT FLOW AROUND STAGE 1 CONSTRUCTION AREA.

PHASE 2:

1. CONSTRUCT INITIAL FILL PLACEMENT AREAS IN DAVIDSON CREEK AND MINE AREA CREEK BASINS.
2. PUMP FLOW COLLECTED AT INITIAL FILL PLACEMENT AREAS.
3. EXCAVATE CUT-OFF TRENCH IN TOPOGRAPHICAL LOW POINTS.

PHASE 3:

1. BACKFILL CUT-OFF TRENCH EXCAVATION TO DAVIDSON CREEK DIVERSION SYSTEM ELEVATION.
2. CONSTRUCT UPSTREAM PORTION OF STAGE 1 DAM UP UP TO EL.1242 METERS.
3. EXCAVATE AND BACKFILL CUT-OFF TRENCH TO THE NORTH AND SOUTH OF DAVIDSON CREEK IN AREAS PREVIOUSLY UTILIZED FOR DIVERSION.

PHASE 4:

1. CONSTRUCT INTERIM ECD DOWNSTREAM OF SEDIMENT CONTROL POND.
2. DECONSTRUCT AND REMOVE SEDIMENT CONTROL POND.
3. COMPLETE CONSTRUCTION OF STAGE 1 EMBANKMENT TO EL. 1273 METERS.
4. CONSTRUCT STAGE 1 BUTTRESS AND EMBANKMENT OUTLET DRAIN.
5. DECOMMISION DIVERSION PIPELINE AND START IMPOUNDING WATER AT THE TSF.

LEGEND:

- FRESH WATER
- MINE WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- WATER DIVERSION PIPELINE
- FLOW

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. CONTOUR INTERVAL IS 5 METRES.
3. SEE STAGE 1 EROSION AND SEDIMENT CONTROL PLAN FOR BEST MANAGEMENT PRACTICES AND DETAILS.

DETAILED DESIGN NOT FOR CONSTRUCTION

150 75 0 250 500 750 m
SCALE A

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BLACKWATER GOLD PROJECT

TAILINGS STORAGE FACILITY MAIN DAM C STAGE 1 DIVERSION WORKS PHASED CONSTRUCTION SEQUENCE

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C1100	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
G0006	CIVIL GENERAL NOTES

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	05NOV'21	ISSUED FOR PERMITTING	CBN	ABN	DDF	DDF

Figure 3.4-2: Stage 1 Diversion Works Phased Construction Sequence

Source: Knight Piésold Consulting (2021h; Appendix 3-J).

3.4.1.7 Water Management Infrastructure

Water Management Pond

The WMP will be constructed downslope of the Open Pit and stockpiles area and within the ultimate footprint of TSF C to provide make-up water for the mill and manage runoff from contributing areas prior to discharge via a pumping system and pipeline into the FWR.

Construction of the WMP will be completed at the end of Year -2 and the WMP will receive direct runoff from the mine area creek catchment and water pumped from other collection points and water management systems. The WMP will have three geomembrane-lined earthfill berms on the West, North, and East sides of the pond; the crest elevation for all berms is 1,325 masl. Stored water in the WMP will be managed via pumping systems and two secondary outflow mechanisms designed to maintain TSF dam safety. The pumping systems will be the primary control for water level within the WMP on a day-to-day basis, and a culvert at the West Berm will provide supplemental outflow capacity to the TSF supernatant pond during periods of elevated runoff. The WMP discharge system pipeline will be installed in Year -2 and will be operated until the end of Year +12 (when the WMP will be relocated).

Freshwater Reservoir

The FWR will be formed as an in-creek reservoir using natural topography enclosed by construction of an earthfill berm on the northeast side of the reservoir. The FWR embankment is designed with a crest elevation of 1,167.5 masl and will be created by constructing a dam approximately 15.5 m high across Davidson Creek. The embankment will be approximately 125 m in length and will impound a total volume of around 370,000 m^3 from its foundation level to the spillway invert elevation. The purpose of the FWR is to maintain a suitable source of fresh water to provide flows to lower Davidson Creek as required to reduce the potential environmental impacts of the project and to support mine operations when required.

Construction of the FWR will begin in Year -2, with construction of a right bank inlet and embankment, followed by placement of a temporary cofferdam to complete the embankment in the dry. Borrow materials for the embankment will be sourced from within the reservoir footprint or nearby esker borrow area.

3.4.1.8 Topsoil Stockpiles

Vegetation clearing, grubbing, site-levelling and stockpiling of salvageable soils from construction projects will be conducted. Salvaged soil will be distributed to one or more of seven topsoil stockpiles, which have a total capacity of 7.89 Mm^3.

The water management design for the topsoil stockpiles includes a series of water collection and diversion channels as well as one SCP per stockpile. The intent is to divert non-contact surface runoff around the stockpile facilities to natural water courses. The topsoil stockpile collection channels will be constructed along the stockpile peripheries to collect and convey the contact-water surface runoff to the SCPs. The topsoil stockpile water management designs are provided in Appendix 3-N along with an evaluation of the preferred locations to support initial development activities.

3.4.1.9 Mine Service and Haul Roads

Roads authorized by *Mines Act* Permit M-246 will be widened where required to support LoM activities based on the design criteria described in Section 3.5.8. This Application also seeks approval to construct:

- East Plant Site Service Road;
- West Plant Site Service Road;
- TSF access and construction roads;

- Borrow and preparation area access roads;
- Diversion access roads
- Pipeline access roads;
- Lower Waste Stockpile Haul Road; and
- Main Dam C Haul Road.

Ex-pit roads will be widened as required from 5 m to 8 m running surface to the Construction Borrow Pit will be accessed by an ex-pit haul road constructed to access the north side of the Open Pit.

In-pit roads will continue to be developed to support the Open Pit expansion.

Mine access, mine service, and haul roads are presented in Figure 3.5-68.

3.4.1.10 Power Supply and Distribution

Power will be provided by portable generators.

Concrete foundation, and development of the grounding grid for the main substation will be completed. Siting and clearing for the power distribution network will be initiated.

3.4.1.11 Explosives Storage Facility

Vegetation clearing, grubbing, site-levelling will be completed. The following facilities will be installed: mobile processing unit (MPU) washbay/garage complex, facility office, raw materials containers, ammonium nitrate (AN) prill storage silo, AN emulsion storage containers, AN emulsion transfer shed, motor control centre/utility container, explosives magazine, detonator magazine, site security system, and site power and utilities.

3.4.1.12 Ancillary Structures

Camps

The existing 250 person exploration camp will continue to operate in Year -2. The operations camp area will be cleared of vegetation, grubbed, and site-levelled. Foundation construction and utility routing will be initiated for the operations camp. Initially, the operations camp will have a 266 bed capacity.

During Year -2, offices within the exploration camp will continue to serve as the administrative and emergency services buildings.

Contractor Laydown Areas

Two laydown areas will be constructed and operational in Year -2:

- The contractor laydown area (6.3 ha) will be cleared of vegetation, grubbed, site-levelled, and over fill surfaced. Perimeter drainage will be installed.
- The borrow aggregate screening and construction laydown area (29.4) will be constructed and operated north of the TSF C Pond. This area will be 29.4 ha and the area will be cleared of vegetation, grubbed, site levelled, and over fill surfaced. Perimeter drainage will be installed.

Concrete Plant

A high volume plant (100 m^3/h) will be constructed, commissioned, and operating in Year -2. The plant will be located in the borrow, aggregate screening and concrete batch plant area near the MAR on the eastern side of the mine site.

Ready Line and Bulk Fuel Storage Area

The Ready Line and Bulk Fuel Storage area will be developed to commissioning. Diesel and gasoline will be stored and dispensed within secondary containment. Bulk fuel storage tanks will be installed to store 150,000 litres (L) of diesel fuel and 5,000 L of gasoline.

Utilities

Potable water and fire water systems will be supplied by two wells, located 1 km east of the mine site. An underground tank and pipeline for the groundwater will be constructed. A second modular portable WTP will be added to the existing modular portable WTP to treat water at the wellsite.

3.4.1.13 Borrow Pits, and Aggregate Sources

Borrow areas will be developed and operational in Year -2. The primary aggregate site will be the borrow area, aggregate screening and concrete batch plant area near the MAR. This area will support development of the mine site during construction and throughout the LoM as required.

A second aggregate site will be located in the borrow, aggregate screening and construction laydown area to support construction of the Main Dam C. Cut and fill surplus will be used for development and construction of service roads around the TSF and other nearby construction projects.

Other borrow areas have been identified and will be developed as required.

3.4.1.14 Off-Site Infrastructure (Non-Application Components)

Transmission Line

Construction of the 230 kilovolt (kV) transmission line, access roads, equipment and laydown areas from Glenannan substation to mine site will commence in Year -2. The alignment of the transmission line is approximately 140 km, with 7 km located within the mine site area.

Airstrip and Airstrip Access Road

Vegetation clearing, grubbing, and site-grading and construction of an airstrip and airstrip access road will be completed. The runway will be 1,700 m long x 30 m wide, gravel-surfaced, and include a 7.5 m graded area along each edge and a 60 m long graded area beyond each end.

3.4.2 Year -1

Major activities in Year -1 are:

- Continued development of Construction Borrow Pits and Starter Pit with the first year of ore extraction;
- Processing facilities developed to pre-commissioning;
- Construction of the Metals WTP and Membrane WTP;
- Continued construction of Main Dam C to 1,273 masl;
- Continued operation of the Davidson Creek Diversion System;
- Continued construction and commissioning of the IECD, pond, and pumpback system;
- Expansion and development of an additional lift at the Lower Waste Stockpile;
- Development of initial lifts at the LGO Stockpile with initial ore extraction;
- Completion of water management structures and continued development of perimeter drainage and hook-up to the mine site drainage network for newly constructed infrastructure;

- Continued development and stockpiling of salvageable soils;
- Commissioning of connection to the 230 kV transmission line from Glenannan Substation, main substation and mine site power grid within the mine site;
- Closure of the exploration camp, and transfer of exploration camp facilities to the operations camp location, commissioning of the operations camp;
- Expansion of Ready Line and Bulk Fuel Storage area to store up to 400,000 L of diesel fuel;
- Commissioning of the explosives storage facility, truck shop and wash/mine offices, and communications systems;
- Construction and commissioning of helipad;
- Continued construction and commissioning of FWR; and
- Commissioning of airstrip, airstrip access road and support facilities.

The general arrangement for Year -1 is presented in Figure 3.3-7. Activities associated with major components are described below.

3.4.2.1 Open Pit

Excavation of two additional construction borrow pits along the northwest pit limit and within the southwest area of the pit. Both are planned to be mined to 1,510, and 1,590 masl, respectively. The Starter Pit will continue excavation between the Construction Borrow pits within the central west area of the ultimate pit limit and will be mined to the 1,610 masl bench. The excavated area will be 35 ha.

Ore is planned to be extracted and will be placed in the LGO Stockpile while the processing facilities are being completed. This ore will be used to commission the processing facilities at the end of Year -1/early Year +1. OVB and NAG waste rock will be targeted for Main Dam C construction along with smaller amounts of OVB and all NAG waste rock for mine site construction. Excess OVB and NAG waste rock will be stored in the Lower Waste Stockpile. PAG waste rock will be mined and placed in the designated pre-production PAG disposal area at TSF C.

The primary power supply to the Open Pit will be from the Primary Distribution Centre at the main substation. Power to the main substation will be supplied from the Project’s transmission line.

The in-pit mine fleet consists of four diesel drills (including two grade control drills), diesel hydraulic excavator, wheel loader and eight haul trucks (Section 3.5.1.9).

3.4.2.2 Processing Plant

All facilities including electrical rooms, water storage tanks and fire water pump skid will continue to be constructed to pre-commissioning and ready for the commencement of commissioning at the end of Year -1.

3.4.2.3 Tailing Storage Facilities

The SCP will be deconstructed and removed once the IECD construction has advanced to provide downstream containment of construction runoff. The IECD will be built to elevation 1,210 masl by the end of Year -1. The IECD spillway outlet will be a 100 m long channel with an invert elevation of 1,208.7 masl. A small riprap lined stilling basin is required downstream of the IECD spillway outlet channel to reduce velocity, dissipate energy, and minimize erosion potential. The stilling basin will discharge to Davidson Creek.

The Main Dam C embankment will be constructed to the Stage 1 design crest elevation of 1,273 masl by the end of Year -1. Stage 1 of Main Dam C comprises a zoned earth-rockfill dam requiring placement of approximately 3.25 Mm^3 of fill material that will be sourced from local external borrow sources or pre-stripping of the open pit during Year -1 of mine development. The Stage 1 dam will be approximately 1.2 km in length and averages 25 m high with a maximum height of approximately 60 m where Davidson Creek is heavily incised.

Stage 1 of TSF C will provide sufficient capacity to impound tailings and PAG/NAG3 waste rock generated during the first year of operations and a supernatant pond up to 2 Mm^3, with additional capacity to manage seasonal water volume fluctuations. The Main Dam C Stage 1 emergency spillway was designed to pass the inflow design flood (IDF) assuming the supernatant pond water elevation at the spillway invert elevation (1,268.3 masl) at the start of the storm. The Stage 1 spillway was included in the design as an emergency dam safety component and will not be operational due to the TSF capacity at 1,273 masl, the anticipated waste/water storage volumes, and the plan for continued Main Dam C construction up to 1,283 masl during Year +1 of operations.

The Stage 1 TSF C reclaim water system comprises a mobile main intake pump station (consisting of floating feed pumps and a high-head shore-mounted pump station), a permanent booster pump station, and a pipeline to convey flows between these two pump stations and hence to the ore processing facility. The reclaim water system will be constructed to pre-commissioning and ready for the commencement of commissioning at the end of Year -1.

The tailings distribution system will be constructed to pre-commissioning and ready for the commencement of commissioning at the end of Year -1. The initial stage of tailings distribution will consist of a single, gravity-fed pipeline to convey tailings from the Plant Site to the southwest side of TSF C (approximately 4,700 m in length). The tailings distribution system was sized with sufficient capacity to convey a design flowrate of between 1,250 and 1,430 m^3/h, which is equivalent to tailings throughput of up to 6.0 Mtpa.

The TSF general arrangement at the end of Year -1 is provided in Figure 3.4-3.

3.4.2.4 Waste Stockpiles

The Lower Waste Stockpile will add the 1,420 masl lift with OVB and NAG waste rock.

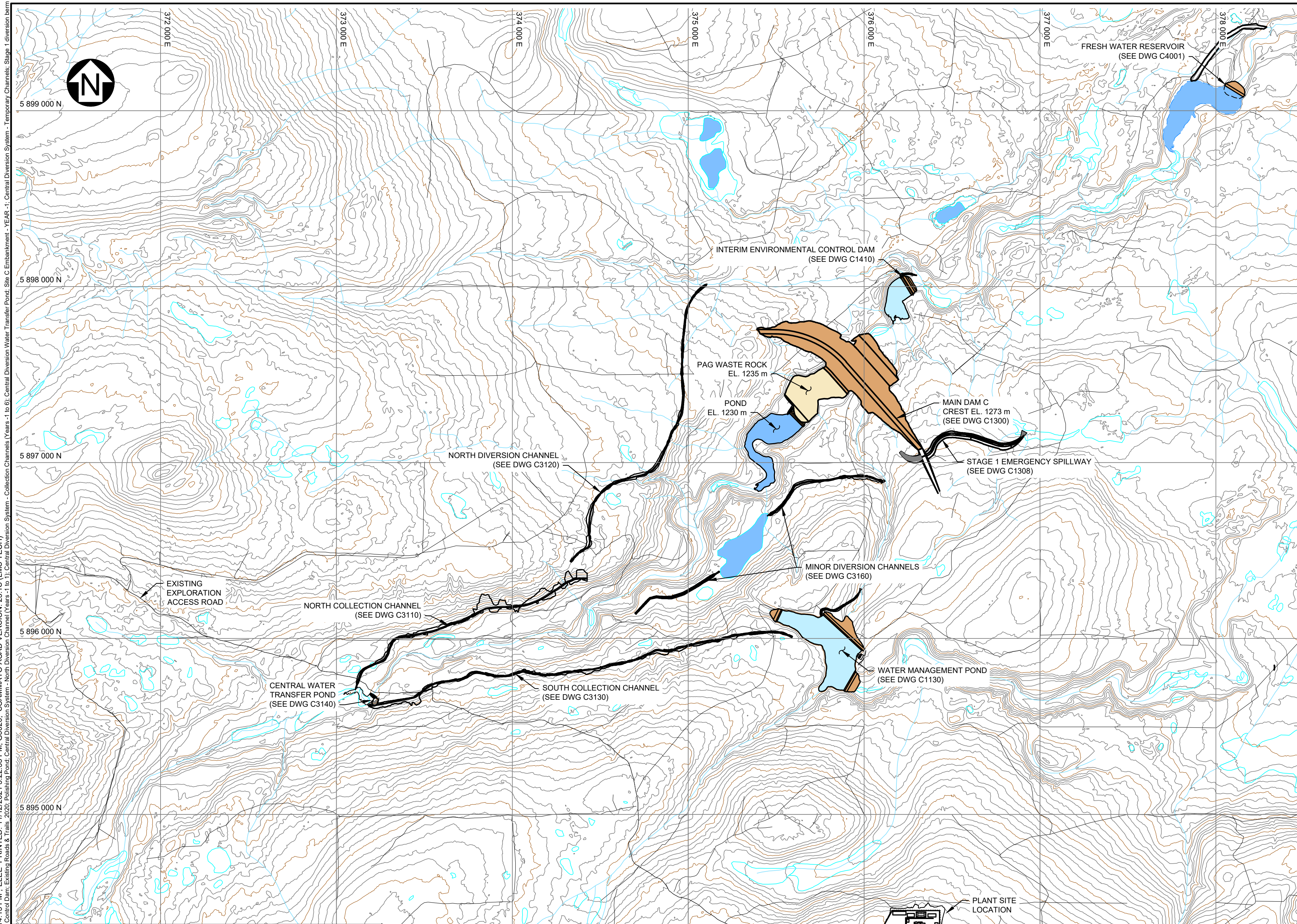
Water collected in the Lower Waste Stockpile Collection Pond will be pumped to the Metals WTP Pond for treatment if required prior to being conveyed to WMP.

3.4.2.5 Low Grade Ore Stockpile

Mining of ore is anticipated to begin in Year -1. The initial placement of ore will separated into the LGO Stockpile and LGO Stockpile Pile A[5]. An initial lift of 1,440 masl will be developed for the LGO Stockpile. The area of the LGO Stockpile will be 0.5 ha. An initial lift of 1,440 masl will be developed for the LGO Stockpile Pile A. The area of the LGO Stockpile Pile A will be 0.5 ha.

A lime neutralization system will be constructed and commissioned in the process plant in Year -1 (Appendix 3-F). Water collected in the LGO Collection Pond will be pumped up to the lime neutralization circuit at the process plant or Metals WTP Pond for treatment and conveyance to TSF C or the WMP depending on the system arrangement.

[5] Ore will be sorted with higher grade ore placed in LGO Stockpile Pile A (Appendix 3-C).



PLAN
YEAR -1
SCALE A

LEGEND:

- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- EXISTING ACCESS TRAILS

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. MECHANICAL SYSTEM DETAILS NOT SHOWN FOR CLARITY, SEE MECHANICAL SYSTEMS DRAWINGS FOR DETAILS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

250 125 0 250 500 750 1000 1250 m
SCALE A

DRG. NO.	DESCRIPTION
G0006	CIVIL GENERAL NOTES
C4001	FRESH WATER RESERVOIR - EMBANKMENT AND RESERVOIR - GENERAL ARRANGEMENT
C3160	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - MINOR DIVERSION DITCHES
C3140	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - WATER TRANSFER POND - PLAN
C3130	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE
C3120	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH DIVERSION CHANNEL - PLAN AND PROFILE
C3110	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE
C1410	TSF - MAIN DAM C - INTERIM ENVIRONMENTAL CONTROL DAM - PLAN AND PROFILE
C1308	TSF - MAIN DAM C - STAGE 1 EMERGENCY SPILLWAY - PLAN AND PROFILE
C1300	TSF - MAIN DAM C - STAGE 1 DAM GRADING - PLAN
C1130	TSF - WATER MANAGEMENT POND - GENERAL ARRANGEMENT

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15NOV'21	ISSUED FOR PERMITTING	DDF	ABN		

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BLACKWATER GOLD PROJECT

TAILINGS STORAGE FACILITY
GENERAL ARRANGEMENT
YEAR -1

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	G0020	0

Figure 3.4-3: Tailings Storage Facility General Arrangement at End of Year -1

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

3.4.2.6 Water Management Infrastructure

Open Pit Dewatering

Open pit dewatering will start in Year -1. The Open Pit dewatering system comprises a combination of the following three sub-systems:

- Surface water management;
- In-pit groundwater depressurization, and
- Perimeter depressurization.

Surface water dewatering system is designed to manage surface water inflows from rainfall events and the associated snowmelt. A combination of in-pit and perimeter pumping wells and sumps will be implemented over the life of the mine to achieve acceptable slope depressurization and pit dewatering.

Existing in–pit groundwater pumping wells (PW31-1 and PW13-3) will be re-developed and commissioned during Year -1, and used remove water from storage in the higher permeability zone. Additional drawdown will result in the surrounding lower permeability bedrock as groundwater flows towards the higher permeability zone. The in-pit wells will have submersible turbine pumps and will be connected to the overall pit water management system by an HDPE pipeline. The flow from the depressurization system will be combined with flow from the surface water system at a junction header near the rim of the Open Pit.

The surface water management system is designed for a maximum pumping flow rate of 700 m^3/h. The maximum pumping flow rate was selected as the optimal flow rate of a 40.64 cm (16 inch) diameter DR11 HDPE pipe. The optimal flow rate was determined for a flow velocity between 2.0 m/s and 2.5 m/s. The surface water management pipelines will be installed adjacent to the Open Pit haul roads. A pump unit will be placed adjacent to sump areas at the base of the pit after a storm, and the water will be pumped to the crest of the pit wall using a series of booster pumps positioned along the pipeline. Water from the surface water management system will flow by gravity in the pipeline approximately 200 m to the dewatering system junction after exiting the pit before discharging by gravity to the Metals WTP Pond located at the Plant Site.

Groundwater depressurization activities during Year -1 will include:

- Commission in-pit wells PW13-1 and PW13-3; and
- Pit water will be directed to the Metals WTP Pond located at the Plant Site for treatment before discharge to the WMP.

Water Management Pond

The primary control for water level within the WMP on a day-to-day basis during Year -1 will be the WMP discharge system diverting flows to Davidson Creek downstream of the FWR. A culvert at the West Berm also provides supplemental outflow capacity towards the TSF construction area, which would direct flows upstream of the Davidson Creek Diversion System. Flows directed this way would result in increased pumping rates at the diversion system and discharge of flows to Davidson Creek downstream of the construction area.

The Raw Water System will be constructed at the WMP to convey flows to the processing facility in Year -1 or early Year +1 depending on the needs of the processing facility for commissioning. These pumps will be the same make and model as those installed at the TSF reclaim intake pump station within the TSF C supernatant pond. The pumps will feed a secondary shore-mounted centrifugal pump at the permanent booster station, also the same make and model as that used for the main reclaim water system. This pump will feed an independent pipeline which will discharge to the raw water tank at the process Plant Site.

Freshwater Reservoir

Construction of the FWR will continue in Year -1. The FWR and mechanical release mechanism will be constructed and commissioned during Year -1 in preparation for the start of operations. The FWR includes the following specific design features to be constructed and commissioned during Year -1:

- water retaining zoned earthfill embankment;
- HDPE geomembrane on the upstream face of the embankment and select areas of the reservoir;
- low level outlet pipes;
- a surface level outlet pipe;
- temperature and flow control chamber;
- overflow spillway and stilling basin; and
- geotechnical instrumentation and flow monitoring devices.

Central Diversion System

The Phase 1 Central Diversion System will be constructed and commissioned during Year -1 and operated until Year +6, when it will be relocated. The Central Diversion System includes:

- North Diversion Channel to route water around the TSF to Creek 668328, which ultimately flows to Davidson Creek downstream of the TSF.
- North Collection Channel and South Collection Channel to route water from upstream of the TSF to the Central Water Transfer Pond.
- Minor diversions to divert water towards a natural pond for pumping up to the WMP.
- The Central Water Transfer Pond will be constructed upstream of the TSF within the Davidson Creek watershed and has a total contributing catchment area of approximately 8.6 km^2. Water will be impounded by a weir structure that will be constructed using a combination of fill and concrete lock blocks. The weir will have a base elevation of 1,298 masl and a crest elevation of 1,300 masl and will impound approximately 2,500 m^3 at the weir crest.
- A pumping system and pipeline, which has a design flow of 300 L/s, to transfer water to the WMP.

3.4.2.7 Power Supply and Distribution

Mine site overhead power lines, including final drops and switchyards, will be developed to pre-commissioning. Main substation and emergency power system will be developed to pre-commissioning. The 230 kV transmission line will be connected to the mine site and the power distributed to the operations camp.

Expansion of the power distribution network to all mine site infrastructure to allow for 24-hour operations as required.

3.4.2.8 Utilities

Freshwater (potable, process, and firefighting) for the mine site and operations camp will be serviced by an underground pipeline and all remaining supporting infrastructure developed to pre-commissioning by end of Year -1.

3.4.3 Year +1

Year +1 represents the first operational year for the Project. Major activities during Year +1 are:

- Continued development of Construction Borrow pits and Starter Pit;
- Completion of commissioning of processing facilities with stockpiled ore;
- Raise of Main Dam C to the Stage 2 elevation of 1,283 masl, including additional rockfill placement within the downstream step-out buttressing the dam;
- Continued PAG/NAG3 waste rock disposal upstream of Main Dam C and commencement of tailings discharge into TSF C from the west side of the facility downstream of the Central Water Transfer Pond;
- Expansion and development of additional lift(s) at the Lower Waste Stockpile; and
- Expansion and development of additional lifts at the LGO Stockpile.

The general arrangement for Year +1 is presented in Figure 3.3-8. Activities associated with major facilities are described below.

3.4.3.1 Open Pit

Continued excavation of two additional Construction Borrow pits along the northwest edge and within the southwest area of the ultimate pit limit. Both are planned to be mined to 1,490, and 1,590 masl, respectively. The Starter Pit is planned to be mined to the 1,510 masl bench. The excavated area will be 66 ha.

With the expansion of the Starter Pit, the ore delivered will increase. Any additional mined ore will be placed at the LGO Stockpile. Continued development of in-pit roads as the pit develops. The in-pit mine fleet consists of five diesel drills, one wheel loader, two hydraulic excavators and fourteen haul trucks (Section 3.5.1.9).

3.4.3.2 Processing Facilities

Commissioning and operation of the processing facilities to 4.5 Mt per annum with feed from the LGO Stockpile.

3.4.3.3 Tailing Storage Facilities

Construction of the Stage 2 TSF requires placement of an additional 2.1 Mm^3 of fill material by the end of Year +1, the majority of which will be OVB and NAG waste rock supplied from stripping of the open pit. Continued construction of Main Dam C Stage 2 to 1,283 masl will occur immediately following substantial completion of Stage 1. Stage 2 will have a total capacity of 35 Mm^3. The Stage 2 dam will include an emergency spillway sized to pass the IDF with an invert elevation of 1,279 masl.

Perimeter ditches will be constructed downstream of Main Dam C in Year +1 to collect and convey surface runoff and any seepage surfacing downstream of the dam to low points that flow away from the dam towards the IECD. Ditches are positioned beyond the toe of the Stage 2 embankment and can constructed any before the end of Year +1.

The tailings distribution, reclaim water, and raw water systems will be commissioned and operated to support ore processing.

Tailings will be discharged from the west side of the TSF and will flow east towards the PAG/NAG3 waste rock disposal area. The supernatant pond will form near the reclaim intake pumps at the interface of the two disposal areas (tailings and waste rock) to allow for efficient saturation of the waste rock interstitial space within one year to meet geochemical objectives. The TSF filling model indicates that waste rock saturation will be achieved much more rapidly due to the relative rate of rise of the TSF pond compared to the waste rock disposal area during Year +1. Managing water quantity within TSF C before process plant commissioning and during the first year of operations will be an important consideration to maintain a dry working platform for waste rock disposal.

The TSF general arrangement at the end of Year +1 is provided in Figure 3.4-4.

3.4.3.4 Waste Stockpile

Development of the 1,435 masl lift at the Lower Waste Stockpile will be continued. The footprint of the Lower Waste Stockpile will be 3.8 ha.

Water collected in the Lower Waste Stockpile Collection Pond will continue to be pumped to the Metals WTP Pond for treatment if required prior to being conveyed to WMP.

3.4.3.5 Low Grade Ore Stockpile

The LGO Stockpile will be developed to a lift height of 1,480 masl and an area of 30.6 ha. The LGO Stockpile Pile A will be developed to a lift height of 1,450 masl and an area of 17.9 ha.

Water collected in the LGO Collection Pond will be pumped up to the lime neutralization circuit at the process plant prior to incorporation in ore processing and/or conveyance to TSF C with tailings.

3.4.3.6 Water Management Infrastructure

The North Diversion Channel will be relocated in late Year +1 or early Year +2 to accommodate the growing TSF footprint.

No further changes to the water management infrastructure are anticipated in Year +1. Facilities will be operated to support ore processing and other water management priorities as appropriate.

Open Pit Dewatering

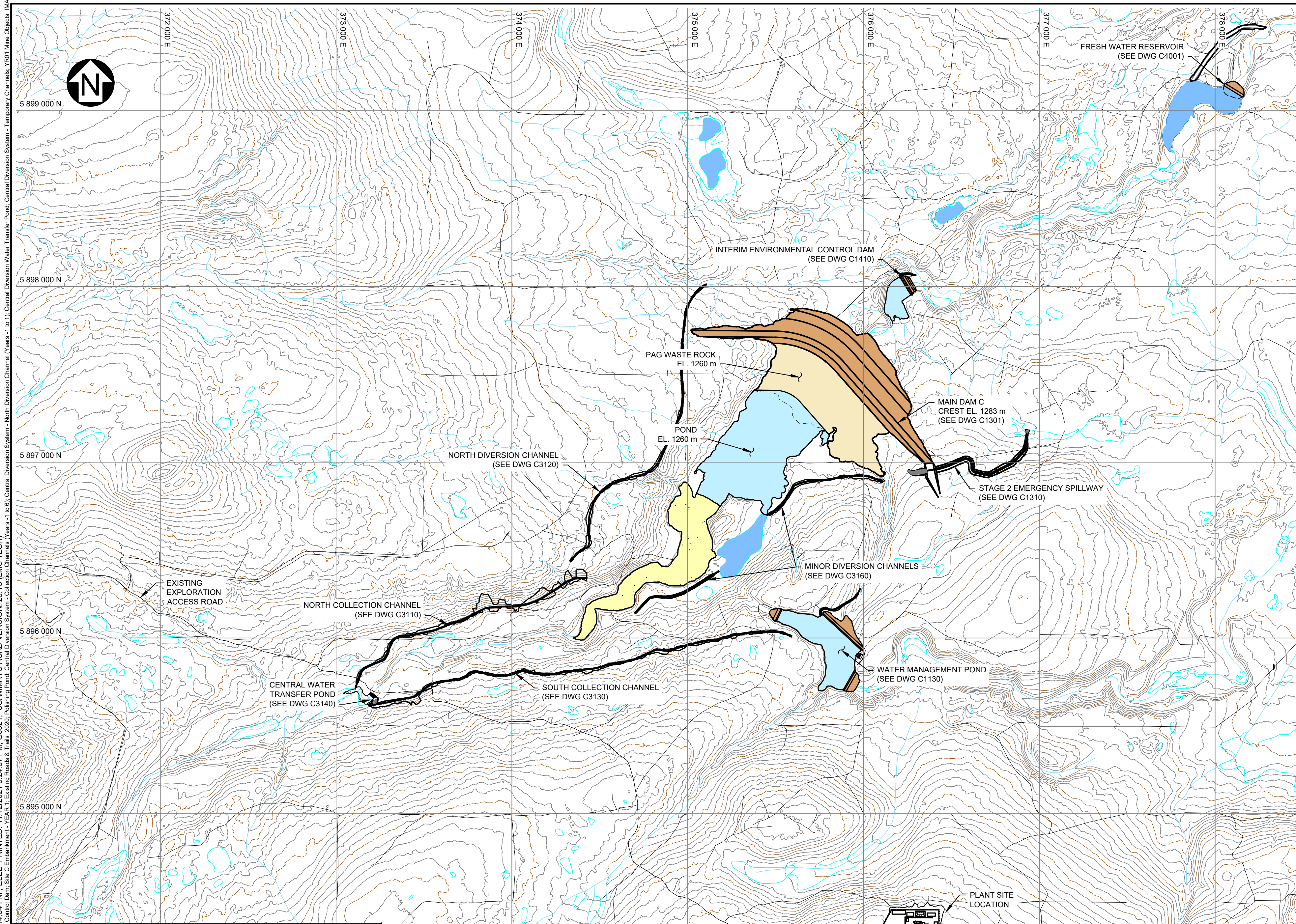
During Year +1, groundwater depressurization activities will include:

- Evaluation of performance of pumping wells to determine if backup wells will be required in areas where elevated pore pressures resulting from well failure has the potential to compromise pit slope stability and result in major interruptions to mining operations.; and
- Installation and monitoring of 13 observation wells (OW1 to OW13) to measure groundwater levels around the open pit perimeter.

3.4.4 Year +2

Major activities during Year +2 are:

- Completed extraction from the Construction Borrow pits;
- Continued extraction from the Starter Pit, and initiation of the East Pushback 1;
- Processing Plant facilities operational to 5.5 Mt per annum for the first full year;
- Raise of Main Dam C to the Stage 3 elevation of approximately 1,295 masl and continued filling of TSF C;
- Expansion and development of additional lifts at the Lower Waste Stockpile; and
- Expansion and development of additional lifts at the LGO Stockpile.



PLAN
YEAR 1
SCALE A

LEGEND:

- TAILINGS BEACH
- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- EXISTING ACCESS TRAILS

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. MECHANICAL SYSTEM DETAILS NOT SHOWN FOR CLARITY, SEE MECHANICAL SYSTEMS DRAWINGS FOR DETAILS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

250 125 0 250 500 750 1000 1250 m
SCALE A

DRG. NO.	DESCRIPTION
G0006	CIVIL GENERAL NOTES
C4001	FRESH WATER RESERVOIR - EMBANKMENT AND RESERVOIR - GENERAL ARRANGEMENT
C3160	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - MINOR DIVERSION DITCHES
C3140	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - WATER TRANSFER POND - PLAN
C3130	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE
C3120	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH DIVERSION CHANNEL - PLAN AND PROFILE
C3110	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE
C1410	TSF - MAIN DAM C - INTERIM ENVIRONMENTAL CONTROL DAM - PLAN AND PROFILE
C1310	TSF - MAIN DAM C - STAGE 2 EMERGENCY SPILLWAY - PLAN AND PROFILE
C1301	TSF - MAIN DAM C - STAGE 2 DAM GRADING - PLAN
C1130	TSF - WATER MANAGEMENT POND - GENERAL ARRANGEMENT

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15NOV'21	ISSUED FOR PERMITTING	DDF	ABN		

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BW GOLD LTD.

BLACKWATER GOLD PROJECT

TAILINGS STORAGE FACILITY
GENERAL ARRANGEMENT
YEAR 1

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	G0021	0

Figure 3.4-4: Tailings Storage Facility General Arrangement at End of Year +1

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

The general arrangement for Year +2 is presented in Figure 3.3-9. Activities associated with major components are described below.

3.4.4.1 Open Pit

The final Construction Borrow pit will be mined to the pit bottom bench 1,450 masl. The Starter Pit will be mined to the 1,490 masl bench. Along the eastern boundary of the Starter Pit, the East Pushback 1 will remove OVB and expand the pit and mine to the 1,580 masl bench. The excavated area will be 86 ha.

There will be continued expansion of in-pit roads as the pit develops. The in-pit mine fleet will remain the same as Year +1.

3.4.4.2 Tailing Storage Facilities

The Main Dam C will be raised to 1,295 masl during Stage 3 construction and will have a total capacity of 55 Mm^3. Continued tailings deposition and PAG/NAG3 waste rock placement will raise the TSF C Pond to 1,268 masl and waste rock disposal elevation to 1,269 masl during Year +2.

The TSF general arrangement at the end of Year +2 is provided in Figure 3.4-5.

3.4.4.3 Waste Stockpile

The Lower Waste Stockpile will be developed to the 1,440 masl lift and a footprint of 25.4 ha. The water management strategy remains unchanged from Year +1.

3.4.4.4 Low Grade Ore Stockpile

The LGO Stockpile will be developed to a lift height of 1,490 masl and an area of 35.7 ha. The LGO Stockpile Pile A will be developed to a lift height of 1,460 masl and an area of 24.4 ha. The water management strategy remains unchanged from Year +1.

3.4.4.5 Water Management Infrastructure

Open Pit Dewatering

Installation and commissioning of surface water management pumps and pipelines and in-pit dewatering wells will continue in Year +2.

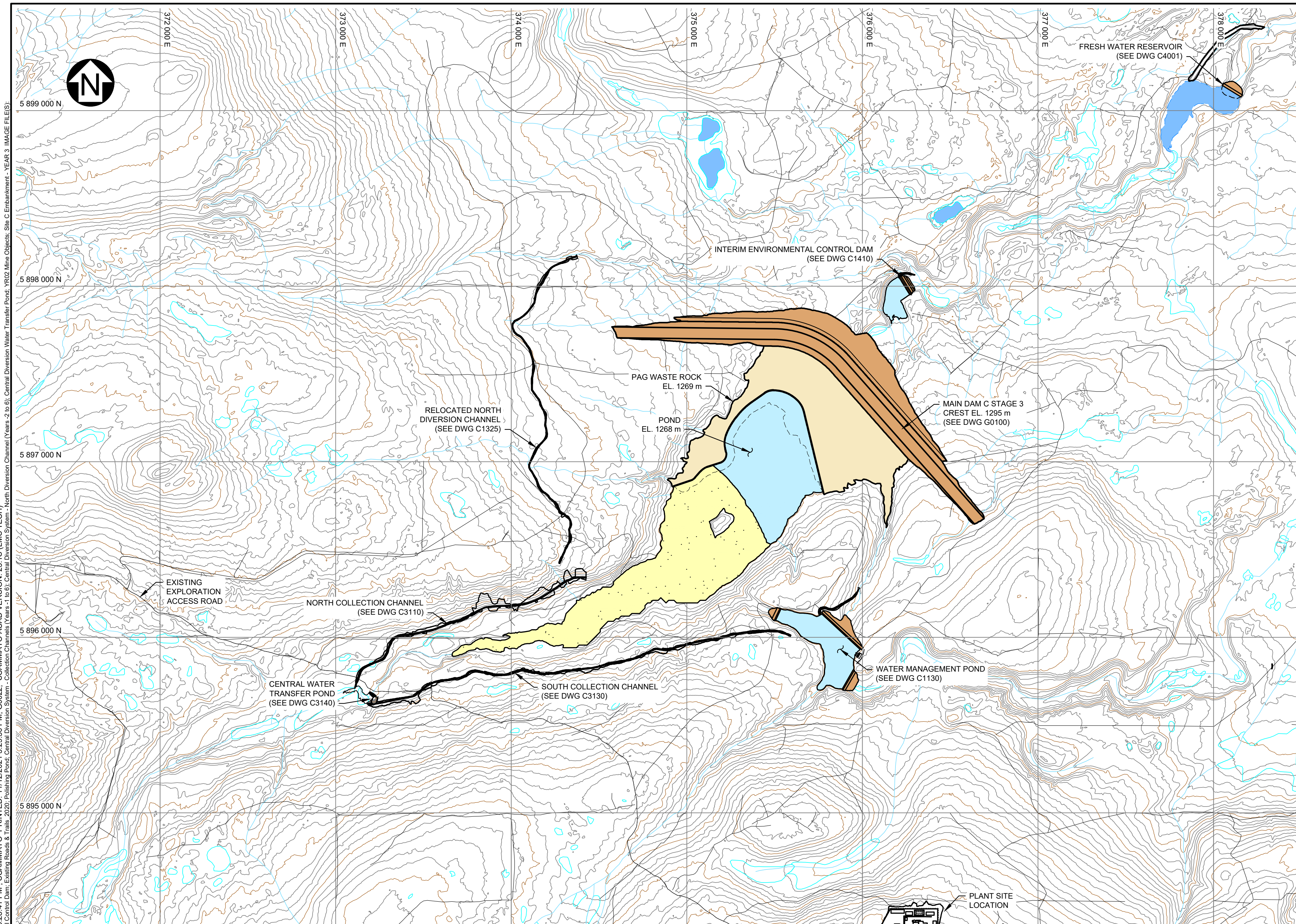
During Year +2, groundwater depressurization activities will include:

- Evaluation of performance of pumping wells to determine if backup wells will be required in areas where elevated pore pressures resulting from well failure has the potential to compromise pit slope stability and result in major interruptions to mining operations; and
- Monitoring of 13 observation wells (OW1 to OW13) to measure groundwater levels around the open pit perimeter.

3.4.5 Year +3

Major activities during Year +3 are:

- Completed extraction from the Starter Pit, and continued mining of the East Pushback 1;
- Raise of the Main Dam C to 1,301 masl and continued filling of TSF C;
- Expansion and development of additional lift at Lower Waste Stockpile; and
- Expansion and development of additional lifts at LGO Stockpile.



PLAN
YEAR 2
SCALE A

LEGEND:

- TAILINGS BEACH
- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- EXISTING ACCESS TRAILS

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. MECHANICAL SYSTEM DETAILS NOT SHOWN FOR CLARITY, SEE MECHANICAL SYSTEMS DRAWINGS FOR DETAILS.

FOR INFORMATION ONLY
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250 125 0 250 500 750 1000 1250 m
SCALE A

DRG. NO.	DESCRIPTION
G0100	TSF - MAIN DAM C - LIFE OF MINE - PLAN AND PROFILE
G0006	CIVIL GENERAL NOTES
C4001	FRESH WATER RESERVOIR - EMBANKMENT AND RESERVOIR - GENERAL ARRANGEMENT
C3140	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - WATER TRANSFER POND - PLAN
C3130	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE
C3125	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - RELOCATED NORTH DIVERSION CHANNEL - PLAN, PROFILE AND SECTIONS
C3110	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE
C1410	TSF - MAIN DAM C - INTERIM ENVIRONMENTAL CONTROL DAM - PLAN AND PROFILE
C1130	TSF - WATER MANAGEMENT POND - GENERAL ARRANGEMENT

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15NOV'21	ISSUED FOR PERMITTING	DDF	ABN		

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TAILINGS STORAGE FACILITY
GENERAL ARRANGEMENT
YEAR 2

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	G0022	0

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Figure 3.4-5: Tailings Storage Facility General Arrangement at End of Year +2

Source: Knight Piésold Consulting (2021i; Appendix 3-K)

The general arrangement at the end of Year +3 is presented in Figure 3.3-10. Activities associated with major components are described below.

3.4.5.1 Open Pit

The Starter Pit will be mined to the pit bottom bench of 1,450 masl in the central part of the pit. The East Pushback 1 will continue to be mined to the 1,520 masl bench. Pushback 2 will be initiated and mined to the 1,600 masl bench. The excavated area will be 113 ha.

Expansions on the eastern pushbacks are supported by construction of an extension to the ex-pit haul road accessing the east side of the Open Pit. The in-pit mine fleet will remain the same as Year +1 and Year +2.

3.4.5.2 Tailing Storage Facilities

The Main Dam C will be raised to 1,301 masl during Stage 4 and will have a total capacity of 68 Mm^3. The TSF C Pond will increase to 1,274 masl due to on-going tailings deposition and the PAG/NAG3 waste rock disposal elevation will increase to 1,276 masl during Year +3.

The TSF general arrangement at the end of Year +3 is provided in Figure 3.4-6.

3.4.5.3 Waste Stockpile

The Lower Waste Stockpile will be developed to the 1,450 masl lift and a footprint of 25.4 ha. The water management strategy remains unchanged from Year +1.

3.4.5.4 Low Grade Ore Stockpile

The LGO Stockpile will be developed to a lift height of 1,500 masl and an area of 40.1 ha. The LGO Stockpile Pile A will be developed to a lift height of 1,470 masl and an area of 27.1 ha. The water management strategy remains unchanged from Year +1.

3.4.5.5 Water Management Infrastructure

Open Pit Dewatering

Installation and commissioning of surface water management pumps and pipelines and in-pit dewatering wells will continue in Year +3.

During Year +3, groundwater depressurization activities will include:

- Evaluation of performance of pumping wells to determine if backup wells will be required in areas where elevated pore pressures resulting from well failure has the potential to compromise pit slope stability and result in major interruptions to mining operations; and
- Monitoring of 13 observation wells (OW1 to OW13) to measure groundwater levels around the Open Pit perimeter.

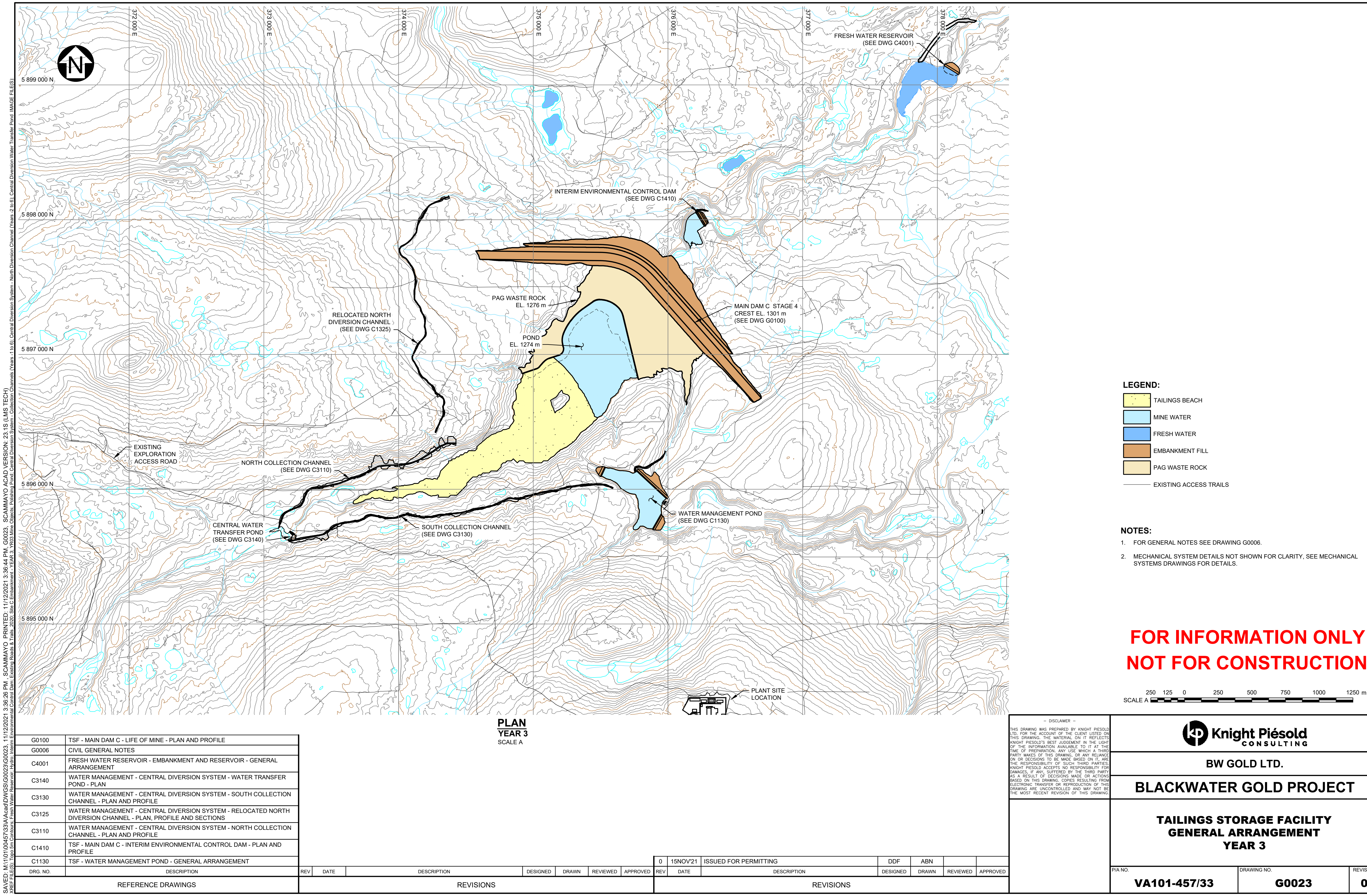

Figure 3.4-6: Tailings Storage Facility General Arrangement at End of Year +3

Source: Knight Piésold Consulting (2021i; Appendix 3-K)

3.5 Mine Facility Designs and Development

3.5.1 Open Pit

3.5.1.1 General Description

At its greatest extent, the Open Pit will be 238 ha, extending approximately 2.0 km long on the east to west axis and 1.8 km wide on the north to south axis (Figure 3.5-1). The anticipated depth of the pit when fully developed will range between 350 to 550 mbgs. The surrounding ground surface for the final limits of the pit will be 1,690 masl at the southeast corner with a downslope to 1,490 masl at the northwest corner. Construction of the Open Pit will commence in Year -2 with excavation of the Construction Borrow Pit. By Year -1, the full outline of the Open Pit will be progressively cleared of vegetation as required as ore and waste extraction is initiated. Development of the Open Pit will target construction materials for the TSF and mine site and near surface high grade ore, then progress through a series pushbacks to access progressively deeper ore.

Mining operations of the Open Pit will cease in Year +18 and the pit will be filled by allowing groundwater accumulation after removal of pit dewatering systems, pumping water from TSF C, the ECD, and run-off from the Upper Waste Stockpile to the pit to create the Pit Lake. Estimated time to fill the Pit Lake is approximately 20 years.

During the Post-closure phase, water from the Pit Lake will be pumped to the Membrane WTP such that the Pit Lake maximum water elevation will be maintained at the design level to avoid overland drainage from the pit. The Membrane WTP primarily treats TSF seepage water contained in the ECD and is supplemented with Pit Lake water and TSF C water to maintain a constant throughput. Retentate (brine by-product) from the Membrane WTP will be conveyed to the bottom of the Pit Lake throughout Post-closure to support meromixis.

Key infrastructure components of the Open Pit are:

- Pit development phases – Section 3.5.1.6;
- Dewatering system – Section 3.5.1.7;
- Drilling and blasting – Section 3.5.1.8;
- In-Pit equipment and power supplies – Section 3.5.1.9; and
- Operations monitoring – Section 3.5.1.10.

3.5.1.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction, operation, closure and reclamation of the Open Pit. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Specific regulatory guidance is as follows:

- Part 6 Mine Design and Procedures; Section 6.23 Surface Mines –Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10 Permitting, Reclamation, and Closure; Section 10.7.13 Open Pits – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

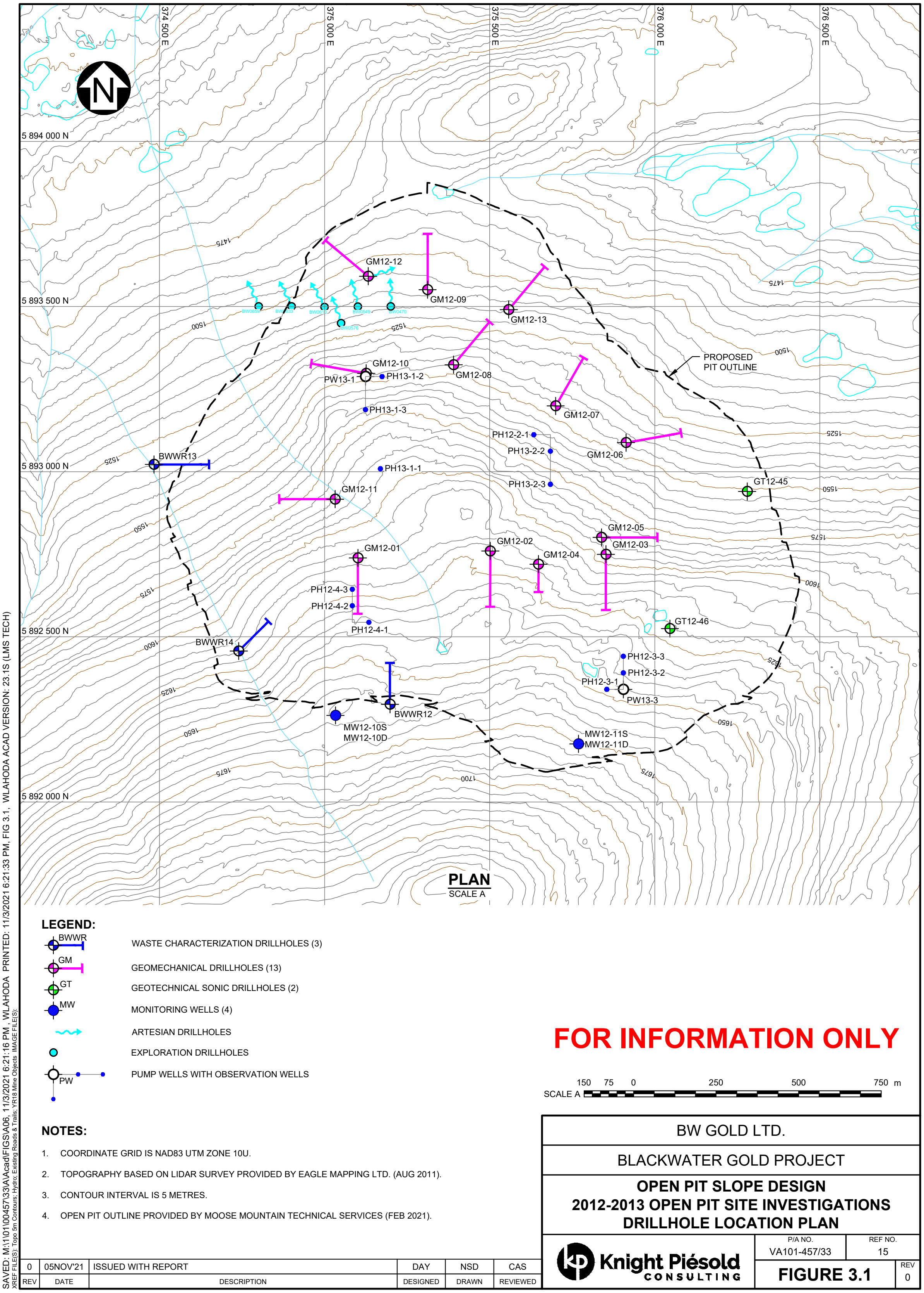

Figure 3.5-1: Open Pit Site Investigation Drillhole Locations

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

Technical Guidance

Technical guidance is as follows:

- Large Scale Slope Stability in Open Pit Mining – A Review. Technical Report (Sjoberg 1996);
- Rock Slope Engineering – Civil and Mining, 4th Edition (Wyllie and Mah 2004);
- Guidelines for Open Pit Slope Design (Read and Stacey 2009);
- Part 3 Mine Plan; Section 3.5.1 Open Pits – JAIR (BC EMPR & BC ENV 2019a); and
- Part 4 Reclamation and Closure Plan; Section 4.7.4 Open Pit Reclamation Prescriptions – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Key reports and other documentation are as follows:

- Blackwater Gold Project Open Pit Slope Design Report (KP 2021a) – Appendix 3-B;
- Open Pit and Stockpile Design Report (MMTS 2021*)* – Appendix 3-C;
- Blackwater Gold Project British Columbia NI 43-101 Technical Report on Pre-feasibility Study (Artemis 2020a);
- Blackwater Gold Project Feasibility Open Pit Slope Design – (Volumes 1 and 2; KP 2013a);
- Blackwater Gold Project 2019 Site Investigation Data Report (KP 2021b) – Appendix 3-D;
- Blackwater Gold Project 2020-2021 Site Investigation Data Report (KP 2021c) – Appendix 3-E; and
- Blackwater Gold Project Numerical Groundwater Modelling Report (KP 2021d).

EAC Conditions

EAC Condition 21 requires the development and implementation of a Noise and Vibration Effects Monitoring and Mitigation Plan that includes measures to mitigate noise and vibrations impacts. This plan must be developed in consultation with EMLI, ENV, Northern Health and Aboriginal Groups.

3.5.1.3 Site Characterization

The Open Pit site characterization is described in Chapter 2 (Baseline Information):

- Section 2.2.2 Local Climate and Appendix 2-B: 2020 Hydrometeorology Report (KP 2021e);
- Section 2.3.2 Deposit (Ore) Geology;
- Section 2.3.3 Surficial Geology, Terrain, and Geohazards; and
- Section 2.5 Topography and Surface Drainage Features.

3.5.1.4 Geotechnical Characterization

Site Investigations

The Open Pit design is based on geomechanical data collected from site investigation programs executed from 2012 to 2013 laboratory test results, updated pit shell, and characterization of geological, rock mass structure, rock mass quality, and hydrogeological data (KP 2013f and summarized in Appendix 3-B). The drillhole locations for the Open Pit site investigations are presented in Figure 3.5-1.

Based on the data from site investigation programs, five models were applied to the design of the Open Pit:

1. **Geological model:** examines the characteristics and spatial distribution of the various rock units relative to the Open Pit walls.
2. **Alteration model:** examines clays and other fine mineral aggregates found within and near mineral deposits.
3. **Structure model:** examines major structures (such as shears and faults) and the smaller scale rock mass fabric (discontinuities and the associated joint-set families).
4. **Rock Mass Characteristics model:** examines the engineering properties of the rock masses that will be encountered during Open Pit development and are fundamental to the performance of the Open Pit slopes, design of bench configurations, and placement of the pit slope instrumentation.
5. **Hydrogeology model:** examines the groundwater pressures that can adversely affect the stability of slopes and provides groundwater data required for water management of the Open Pit.

Geological Model

The geological model is based on exploration and geotechnical drill core lithology logs and incorporates the inferred distribution of the main geological units:

- OVB;
- Laminated Volcanics;
- Fragmentals;
- Andesite;
- Sediments; and
- Intrusive Rocks.

Figure 3.5-2 presents the distribution of the geological units within the final pit walls. Details of the geological model are presented in Section 4.0 Site Characterization in Appendix 3-B.

Overburden

OVB is composed of glacial till. The generally hummocky deposit area varies from 5 to 20 m in thickness. The southern upslope areas within the pit limit have the least OVB with thicker OVB in the west, north, and east downslope areas. Drilling indicated the deepest OVB on the east side of the pit, where it may be greater than 100 m thick. Figure 3.5-3 presents the OVB thickness and bedrock elevations within and in the vicinity of the Open Pit.

Laminated Volcanics Unit

The Laminated Volcanics unit is a fine grained laminated to massive rock of felsic composition with localized dark laminations. These laminations vary from planar to wavy. The unit is commonly bleached and altered to silica-sericite-clay. The Laminated Volcanics unit is a small unit in the east central part of the pit with limited exposure during the LoM.

Fragmentals Unit

The Fragmentals unit encompasses three subunits: Felsic Lapilli Tuffs, Andesite Breccia and volcaniclastic rocks. Felsic Lapilli Tuffs is a poorly sorted white to pale green volcanic breccia with massive or laminated clasts of felsic composition. Andesite Breccia is a clast to matrix supported mafic breccia with angular to sub-angular andesite clasts. Volcaniclastic rocks are poorly to moderately sorted polymicitic volcanic breccia with a light to dark coloured matrix. The matrix of all these lithologies can be bleached and altered to silica, sericite and/or clay. The Fragmentals unit is located on the west and southwest walls of the final pit and will be exposed over most of the pit wall configurations.

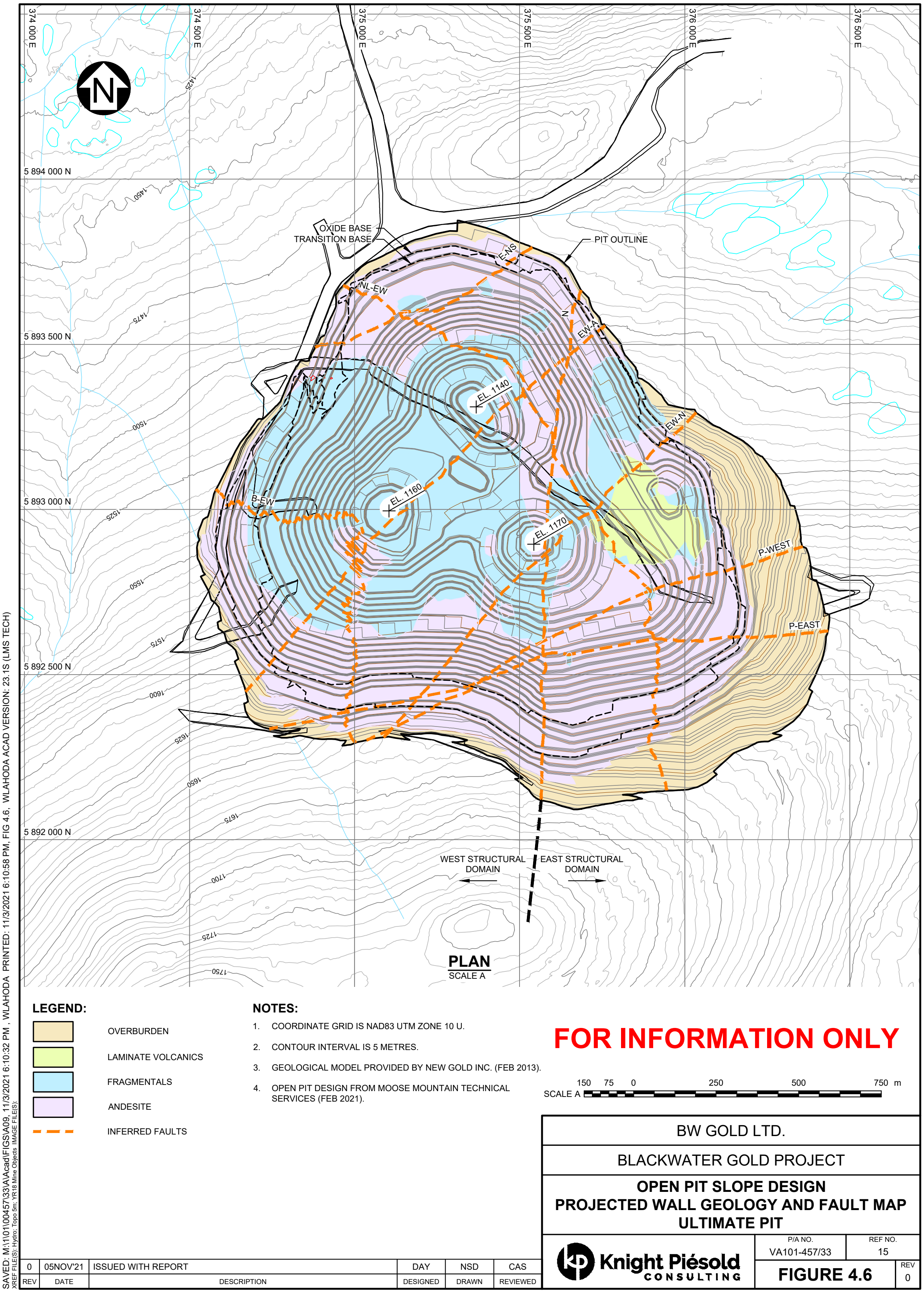

Figure 3.5-2: Projected Wall Geology and Fault Map, Ultimate Pit *Source: Knight Piésold Consulting (2021a; Appendix 3-B).*

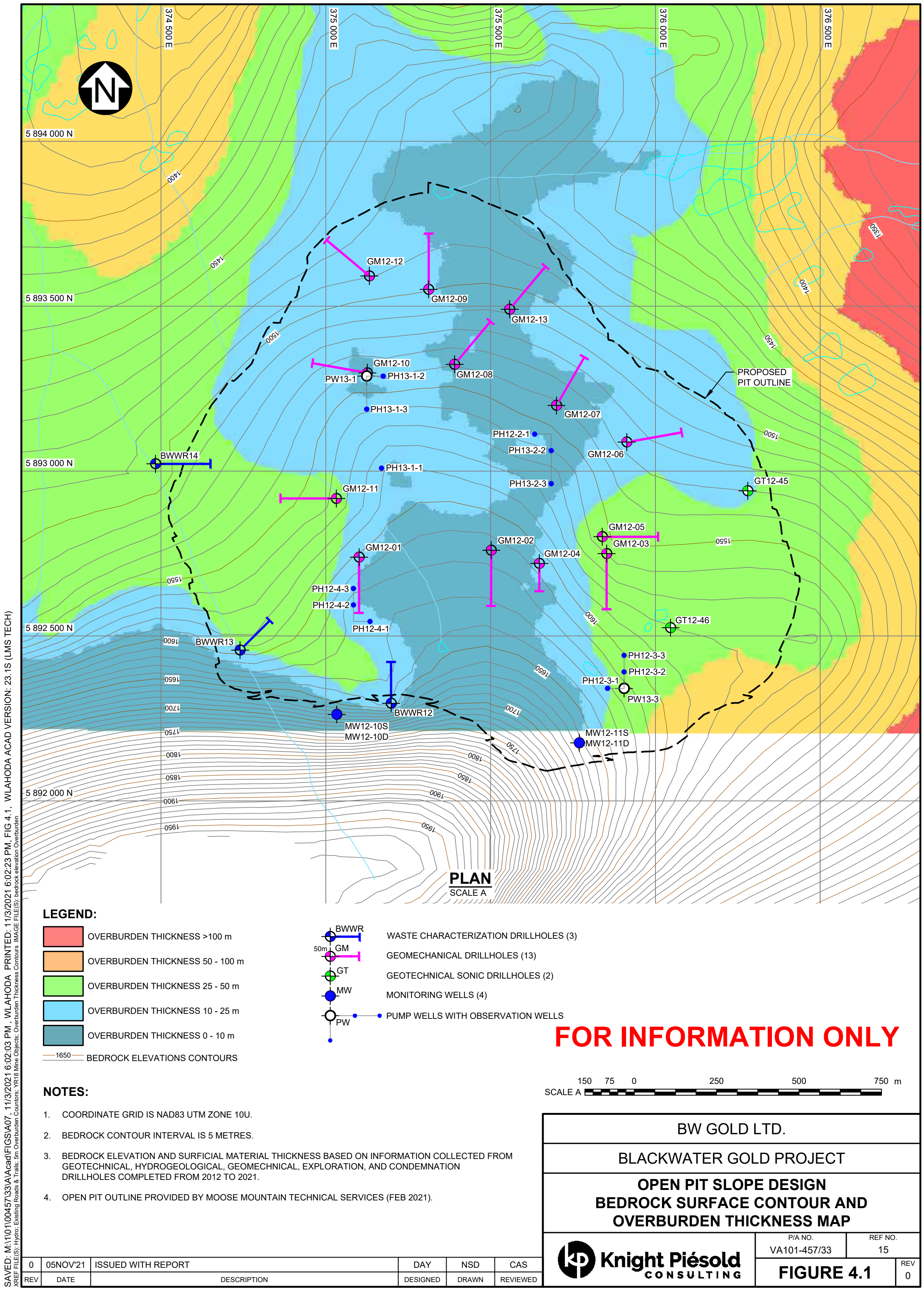

Figure 3.5-3: Open Pit and Vicinity Bedrock Elevation and Estimated Overburden Thickness

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

Andesite Unit

The Andesite unit is a dark grey to black microcrystalline to aphanitic volcanic rock. It is the dominant geologic unit in the pit. The majority of the final pit walls will be exposed within the Andesite unit.

Sediments Unit

The Sediments unit encompasses the mudstone, sandstone, and conglomerate rocks of the Bowser Lake Group formation. These sedimentary rocks are the basement geological unit and are only found at the bottom of the pit with limited exposure in the pit walls.

Intrusive Rocks Units

Intrusive Rocks Unit encompasses undifferentiated intrusive rocks, equigranular monzonite, and dacite/latite porphyry. Intrusive Rocks are not expected to be exposed on proposed pit walls and are not further characterized for the Open Pit designs.

Alteration Model

Alteration assemblages identified are sericite and potassic alteration. Sericite alteration is identified in the centre of the deposit and it generally occurs within the Fragmentals unit, which will be mined out during the pit development. Potassic alteration surrounds the deposit and will be encountered in the rock units exposed on the final pit walls. An oxidized weathered zone generally occurs along the bedrock surface. Details of the Alteration Model are presented in KP 2013a and Appendix 3-B.

Structural Model

The structural model generally consists of major structures (such as shears and faults) and smaller scale rock mass fabric (discontinuities and the associated joint-set families). The orientation, position and characteristics of the structures that exist in the pit walls will strongly influence rock mass performance. Based on the results of core logging observations and supported by lithological, alteration and mineralization models, eight delineated sub-vertical faults are present on the mine site (Table 3.5.1-1 and Figure 3.5-2). These fault zones are likely responsible for the majority of the broken zones encountered during drilling. These major structures influence the achievable inter-ramp and overall slope angles (OSAs).

Table 3.5.1-1: Summary of Blackwater Open Pit Major Faults[1]

Fault ID	Strike	Direction	Azimuth[2] (°)	Dip (°)	Dip Direction (°)	Correlated Regional Fault System
N	N - S	185	87	W	275	D_3 Fault
E-NS	E - W	065	69	SW	155	D_1 – D_2 Fault
EW-A	SW - NE	223	83	NE	313	D_1 – D_2 Fault
EW-N	SW - NE	222	82	NE	312	D_1 – D_2 Fault
P-WEST	E - W	245	76	N	335	D_1 – D_2 Fault
P-EAST	E - W	260	75	N	350	D_1 – D_2 Fault
NL-EW	SE - NW	330	47	E	060	D_2 – D_3 Fault
B-EW	SE - NW	328	43	E	058	D_2 – D_3 Fault

[1] *Fault data based on New Gold internal report, February 2013.*

[2] *Azimuth degrees using the right hand rule.*

Structural domains have been developed for groups of rock masses that are expected to have similar discontinuity orientations (i.e., joint-set families). The spatial distribution of the collected discontinuity data indicate that three structural domains exist within the region of the Open Pit, i.e. Main, Northwest and Southeast domains (Figure 3.5-2). The dominant discontinuities dip steeply toward the northwest and the northeast and are consistent with the orientations of identified fault systems. Details of the Structure Model are presented in Section 4.3 Structure in Appendix 3-B.

Rock Mass Characteristics Model

The rock mass characteristics model summarizes the engineering properties of the rock masses that will be encountered during pit development and are fundamental to the performance of the pit slopes. The rock mass quality was characterized using Rock Quality Designation (RQD) and the Rock Mass Ratings classification system. A detailed description of the rock mass characteristics model is presented in Section 4.4.2 Rock Mass Quality in Appendix 3-B.

A three dimensional RQD block model was developed utilizing the exploration drillhole database. RQD blocks are delineated into three categories:

- GOOD Rock: RQD greater than 75%;
- FAIR Rock: RQD between 40% and 75%; and
- POOR Rock: RQD less than 40%.

The rock mass quality data indicates that Andesite, Fragmentals, Laminated Volcanics and Sediments units are generally classified as GOOD Rock (means RMR values range between 63 and 69). These three units all have similar average RMR, RQD and apparent joint spacing values.

Areas of intensely fractured rock (RQD < 40%, mean = 38) were identified within all geological units and are classified as Broken Zones. Broken Zones are distinct and pervasive, with fairly well established geospatial locations. Logging indicates that the Broken Zone is a heterogeneous mix of highly fractured intact rock with some instances of disintegrated rock or gravel. A significant transition zone exists between the Broken Zone and competent rock. The Broken Zone can transition rapidly from gravel sized particles to highly fractured but intact core and back within short (<5 m) distances. The Broken Zone is classified as POOR Rock with a mean RMR of 38. The distribution of Broken Zones with the Open Pit is a key consideration in phasing of mine development.

Table 3.5.1-2 summarizes the rock mass quality data for each geological unit. The distribution of RQDs over the final pit walls are shown on Figure 3.5-4.

Hydrogeology Model

The mean annual precipitation at the site is estimated to be 595 mm (Appendix 3-D). Average annual groundwater recharge is estimated to be 90 mm across the Project and may be as high as 120 mm in higher elevation areas such as the deposit (KP 2021d).

Bedrock in the vicinity of the deposit is separated into two zones of hydraulic interest based on the results of in-situ permeability testing, water level monitoring, and geological interpretation:

- A higher permeability bedrock zone with an estimated bulk hydraulic conductivity of 5x10-6 m/s.
- A lower permeability bedrock zone with an estimated bulk hydraulic conductivity of 1x10-7 m/s.

Pumping test results suggest the higher permeability bedrock zone may be surrounded in all directions by lower permeability bedrock or by other boundaries to groundwater flow.

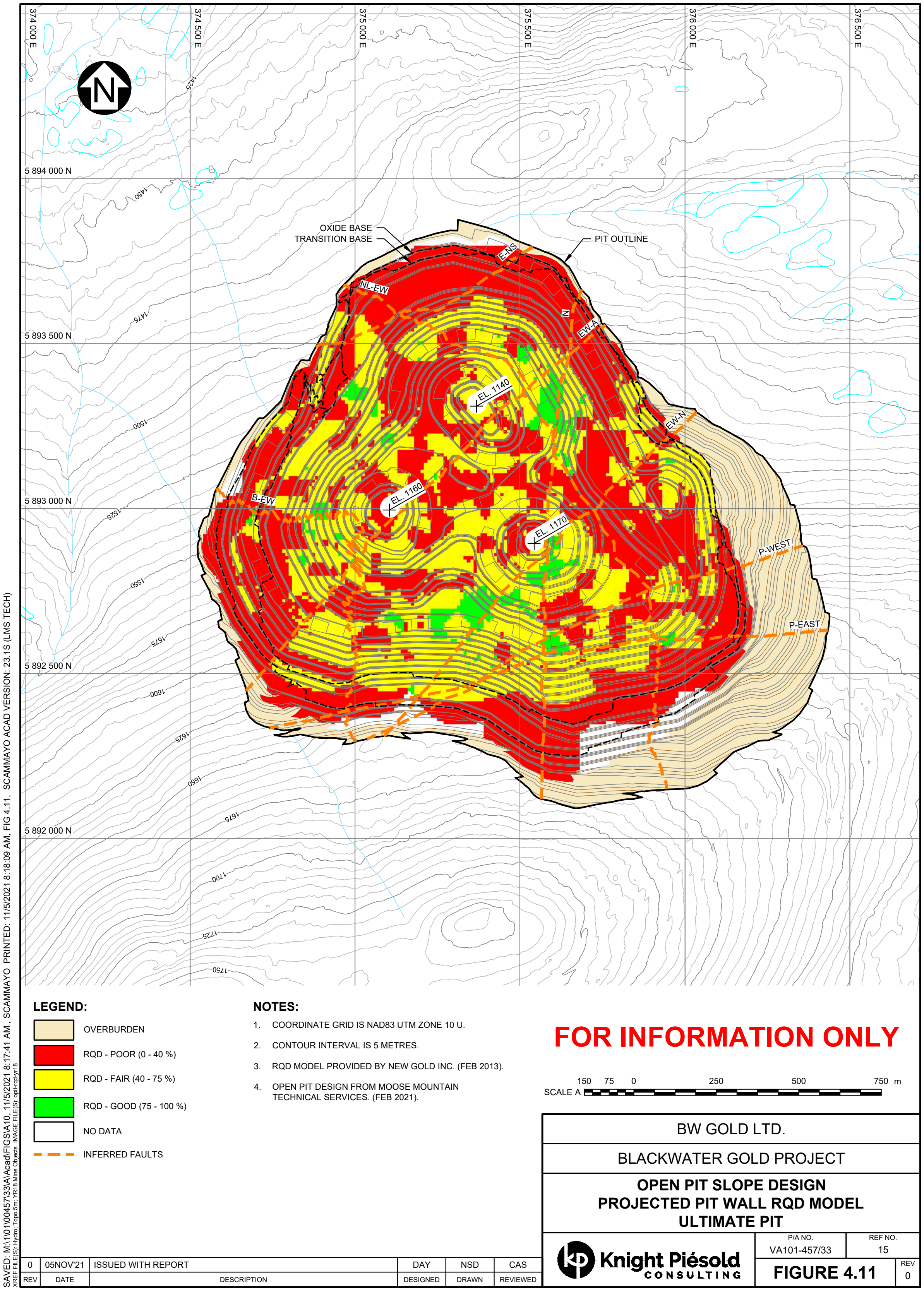

Figure 3.5-4: Rock Quality Designations within the Open Pit

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

Table 3.5.1-2: Summary of Rock Mass Characteristics and Ratings

Parameter		Geology Unit				
		Andesite	Fragmentals	Laminated Volcanics	Sediments	Broken Zone
Density	g/cm^3	2.79	2.70	2.70	2.68	2.73
Rock Quality Designation (RQD) (%)	No. of Runs	1,257	1,300	129	175	1,572
	RQD Average	87	78	85	81	9
	RQD Median	95	81	95	88	0
Rock Mass Rating (RMR)[89]	No. of Discontinuities	1,257	1,300	129	175	1,572
	RMR[89] Mean[1]	69	63	64	65	38
	RMR[89] Median	65	60	59	61	43
	RMR[89] Std. Dev.[1]	12	12	12	8	9
	Maximum	98	97	95	90	78
	Minimum	35	35	38	43	24
	RMR Classification[3]	Good	Good	Good	Good	Poor
Apparent Fracture Spacing (mm)[2]	Average	444	346	399	327	61
	Median	300	247	294	294	21
	Maximum	1,700	1,599	1,600	1,500	1,500
	Minimum	5	5	17	5	0

[1] *Weighted RMR and standard deviation based on the average joint condition and weighted using the run length.*
[2] *Apparent joint spacing calculated using the number of fractures and the length of the run.*
[3] *The RQD blocks were coded in three categories: GOOD Rock: RQD greater than 75; FAIR Rock: RQD between 40% and 75%, and POOR Rock: RQD less than 40%.*

Groundwater elevations in the higher permeability bedrock zone are generally flat, averaging 1,520 masl, and are hydrostatic (negligible vertical hydraulic gradient) owing to the relatively high permeability. Groundwater elevations in the lower permeability bedrock zone immediately upslope of the proposed open pit perimeter average 1,620 masl with evidence of steeper horizontal hydraulic gradients. The groundwater system exhibits seasonal variability, with groundwater levels rising by up to 10 m in response to spring freshet. The direction of groundwater flow in the deposit area is toward the north, with groundwater flowing downslope from the lower permeability bedrock zone into the higher permeability bedrock and again into the lower permeability bedrock.

Details of the hydrogeological data and analysis are presented in Section 4.5 Hydrogeology of Appendix 3-B.

Overall Geotechnical Domains within Open Pit

Based on the geotechnical characterization within the pit, three geotechnical domains were categorized for slope design:

- **Surficial material:** glacial till deposits (OVB) predominantly range from 5 m to 20 m thick across the Open Pit. Surficial material thickness increases up to 110 m along the eastern side of the deposit;
- **Broken zone:** this domain is recognized in the RQD block model as zones with RQD of less than 40% and was encountered in all deposit rock types; and
- **Competent rock:** defined as all zones with RQD greater than 40% and a rock mass quality of fair to good.

Figures 3.5-5 and 3.5-6 present the distribution of these classifications within the Open Pit.

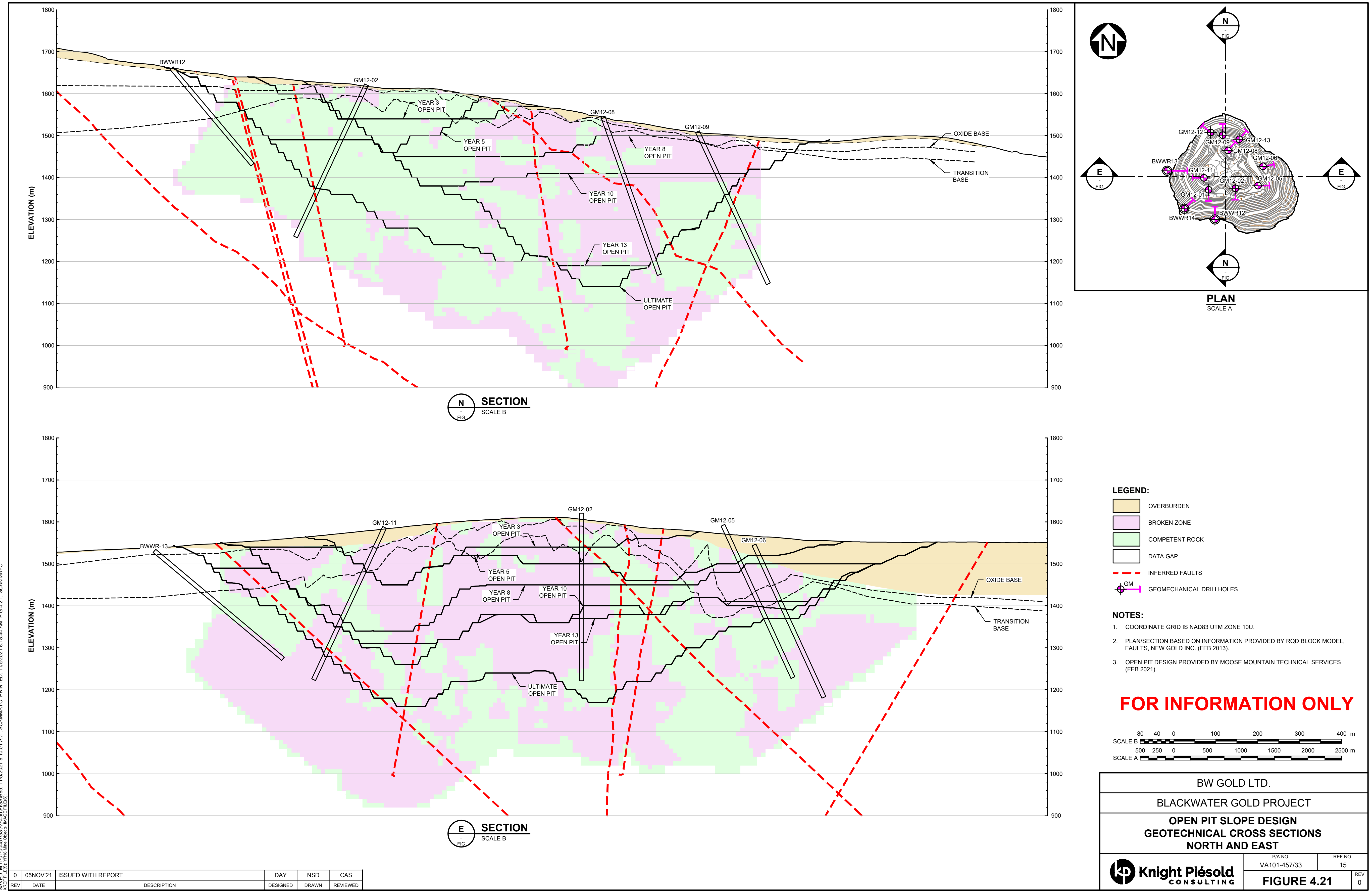

Figure 3.5-5: Open Pit Geotechnical Domains North and East Cross Sections

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

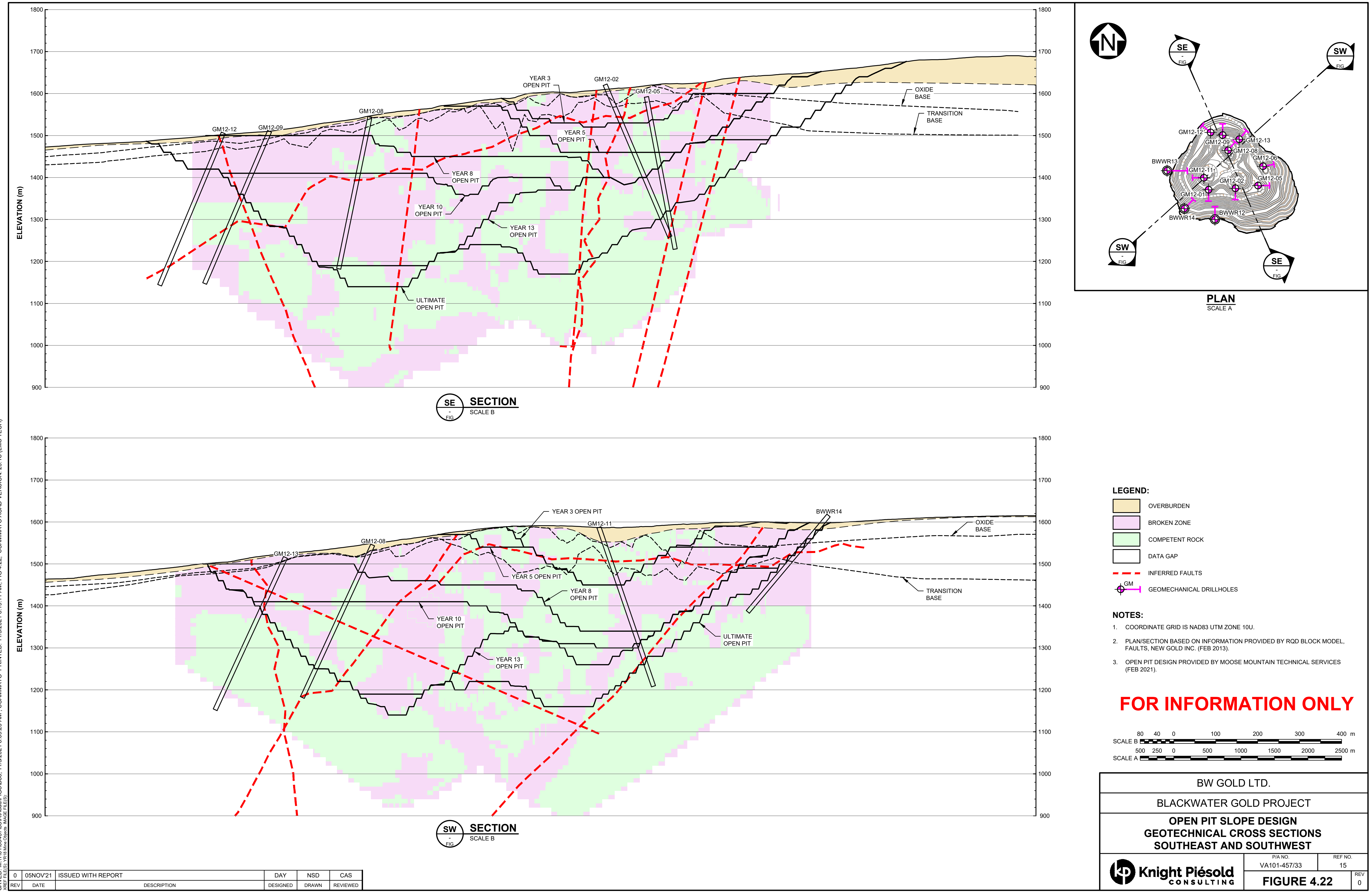

Figure 3.5-6: Open Pit Geotechnical Domains Southeast and Southwest Cross Sections

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

3.5.1.5 Slope Stability Analyses

Stability analyses were undertaken to determine appropriate slope angles for each sector of the Open Pit. The overall objective for pit slope design is to determine the steepest practical slope angles in order to maximize the extraction of ore resources while minimizing the strip ratio. Balanced against this, is the increased likelihood of overly steep slopes leading to the development of slope instability issues that could impact worker safety and profitability of the mine. The approach adopted here is to base the pit design on achieving an acceptable level of risk and incorporating this into the stability analyses as a Factor of Safety (FoS) and/or Probability of Failure (PoF).

Design methods used to determine appropriate pit slope angles included kinematic stability assessments and evaluation of the overall rock mass stability. Pit slope geometries for each region of the pit were determined based on achieving the acceptance criteria for each of these design methods.

Methodology and Acceptance Criteria

Appropriate slope angles for each region of the Open Pit were determined by conducting stability analyses for each wall, including the following:

- **Kinematic Stability Analyses** – Stereographic analyses were conducted using the available structural data to identify the kinematically possible failure modes within the final pit walls. Further probabilistic analyses were completed for the areas where adverse kinematic features were encountered. Appropriate bench face angles and/or inter-ramp slope angles (IRSAs) were assigned to reduce the potential for discontinuities to form unstable wedges or planes. It is not cost-effective to eliminate all potentially unstable blocks and a certain percentage of bench face instability is acceptable. Most of the smaller unstable features will be removed by scaling procedures.
- **OVB and Rock Mass Stability Analyses** – Limit equilibrium analyses of the soil and rock slopes were performed to estimate the FoS against large-scale, multiple-bench slope failures through the soil and the jointed rock masses. The targeted FoS for this type of failure varies with the consequences of failure.

The pit slope design criteria are summarized below (after Read and Stacey 2009) and suggested FoS targets for the Open Pit are in **bold** in Table 3.5.1-3.

Table 3.5.1-3: Pit Slope Factor of Safety Acceptance Criteria

Slope Scale	Consequences of Failure	Acceptance Criteria		
		FoS (min) (Static)	FoS (min) (Dynamic)	PoF (max) P[FoS≤1]
Bench	Low to High	1.1	N/A	25% - 50%
Inter-ramp	Low	1.15 - 1.2	1.0	25%
	Medium[1]	**1.2**	**1.0**	**20%**
	High	1.2 – 1.3	1.1	10%
Overall	Low	1.2 – 1.3	1.0	15% - 20%
	Medium[1]	**1.3**	**1.05**	**5% - 10%**
	High	1.3 – 1.5	1.1	≤5%

[1] *The suggested FoS and Probability of Failure (PoF) targets for the Open Pit are based on Read and Stacey 2009 and professional experience with mines with similar geomechanical conditions.*

Details of the Kinematic Stability and Rock Mass Stability analyses are presented in Section 5.5 Kinematic Slope Stability Analyses and Section 5.6 Overburden and Rock Mass Stability Analyses, respectively, in Appendix 3-B.

Pit Slope Geometry Definitions

Pit slope geometries for each region of the pit have been determined based on achieving the acceptance criteria for each of these design methods while applying appropriate FoS and/or PoF (Table 3.5.1-4).

Table 3.5.1-4: Recommended Pit Slope Configurations for Final Pit

Pit Design Sector	Pit Wall Height (m)	Geotech Unit	Geotech Wall Height (m)	Bench Height (m)	Bench Width (m)	Bench Face Angle (°)	Inter-ramp Angle (°)	# of Stepouts or Ramps	OSA (°)
Northeast	360	Broken Zone	140	20	14.5	65	40		41
		Competent Rock	220	20	9	65	48	1	
East	380	OVB	100	10	8	40	27	1	35
		Competent Rock	280	20	10	65	46	1	
Southeast	510	OVB	60	10	8	40	27	1	34
		Broken Zone	180	20	14.5	65	40	1	
		Competent Rock	270	20	10	65	46	1	
South	500	Competent Rock	500	20	11	70	48	2	42
Southwest	460	Broken Zone	240	20	14.5	65	40	1	37
		Competent Rock	220	20	14	70	43	1	
West	360	Competent Rock	360	20	11	70	48	1	42
North	350	Broken Zone	130	20	14.5	65	40	1	40
		Competent Rock	220	20	11	70	48		

[1] *OSAs for the East and Southeast sectors include flatter OVB slopes.*

[2] *Maximum inter-ramp slope heights: approximately 50 m in OVB, 150 m in Broken Zone, and 200 m in Competent Rock.*

[3] *It is recommended that 20 m wide step-outs be placed in the OVB slopes and 35 m wide step-outs/haul ramps be placed in the bedrock slopes, to provide additional capacity for rockfall containment.*

[4] *For the broken rock slopes, double benching configurations (20 m bench height and 14.5 m bench width) are used*

The primary deliverables from pit slope design are:

- **Bench Geometry** – The height of benches is typically determined by the size of the shovel selected for the mining operation. The bench face angle is usually selected in such a way as to reduce to an acceptable level the amount of material that will fall from the face or crest of benches. The bench width is sized to capture small wedges and blocks from the bench faces and to help prevent rock falls from impacting men and equipment. The bench geometry that results from the height, bench face angle and bench width will ultimately dictate the IRSA. Double or triple benches can be used in certain circumstances to steepen inter-ramp slopes where rock conditions permit operations close to the bench faces.
- **Inter-ramp Slope** – The maximum IRSA is typically dictated by the bench geometry. However, it is also necessary to evaluate the potential for multiple bench scale instabilities due to large-scale structural features, such as: faults, shear zones, bedding planes and foliation. In some cases, these

persistent features may completely control the achievable inter-ramp angles and the slope may have to be flattened to account for their presence. The IRSAs may also be controlled by the strength of weak rock mass.

- **Overall Slope** – The OSA that is typically flatter than the maximum inter-ramp angle due to the inclusion of haulage ramps and step-outs. Other factors, such as rock mass strength, groundwater pressures, blasting disturbance, stress conditions, and mine equipment requirements can also reduce the OVAs.

Pit Design Sectors

Detailed Pit Slope Geometry Analysis of Design Sectors

Site-specific geotechnical information was utilized to identify geotechnical domains, specific design sectors (for both the proposed interim and ultimate pits), and to develop the required slope design parameters (for benches, inter-ramp slopes, and overall slopes). The results of the slope stability analyses undertaken on each pit design sector suggest that there are generally few geotechnical controls on pit slope design, other than rock mass failure through the Broken Zone and the associated slope depressurization requirements. As such, the achievable slope geometry is largely controlled by the location and extent of the Broken Zone during all phases of the pit development. The recommended IRSAs for the final pit are illustrated on Figure 3.5-7. Detailed pit slope design criteria including bench configurations, IRSAs, and OSAs are summarized in Table 3.5.1-4. Detailed discussions of the bench configurations, inter-ramp and overall slopes and initial broken zone excavations in Section 7.1 Pit Slope Recommendations in Appendix 3-B.

Operational Pit Slope Geometry for Design Sectors

Based on the analytical design sectors from the previous section, a 3D slope sector zone solids were created to support the phased development of the Open Pit. The generalized pit slope geometry is presented in Table 3.5.1-5 and Figure 3.5-8. Detailed discussions of the pit slope sectors are presented in Section 2.2 Pit Slopes in Appendix 3-C.

Table 3.5.1-5: Open Pit Slope Sectors for Development

Slope Zone	Pit Wall Height (m)	Bench Height (m)	Bench Width (m)	Bench Face Angle (°)	Inter-ramp Angle (°)
1	North Lower	20	70	48	10.7
2	North Upper	20	60	35	17.0
3	Northeast	20	70	48	10.7
4	East	20	70	48	10.7
5	Southeast	20	60	40	12.3
6	South	20	70	48	10.7
7	Southwest	20	70	43	14.2
8	West	20	70	48	10.7
9	Overburden	20	25	20	12.1

Key Mitigation Features for Geohazards and Other Risks

The primary risk for the Open Pit is slope deterioration caused by detachment of small rock blocks defined by rock mass discontinuities. The primary mitigation is measure for the preservation of rock mass integrity during mining using “controlled production blasting” or “buffer blasting”. Trial blasts are recommended wherever there is a substantial change in rock mass conditions.

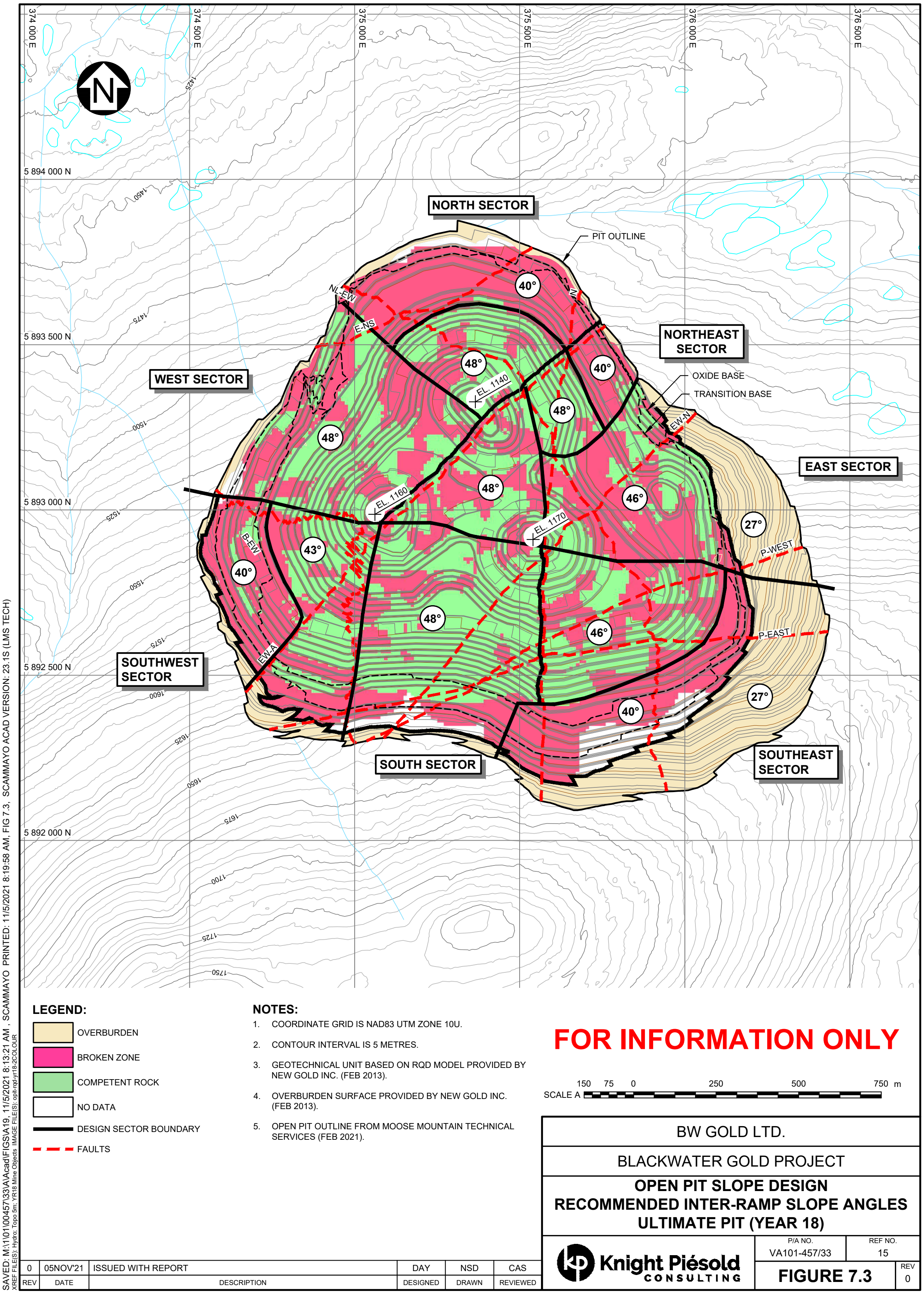

Figure 3.5-7: Inter-Ramp Slope Angles for Ultimate (Year +18) Pit *Source: Knight Piésold Consulting (2021a; Appendix 3-B).*

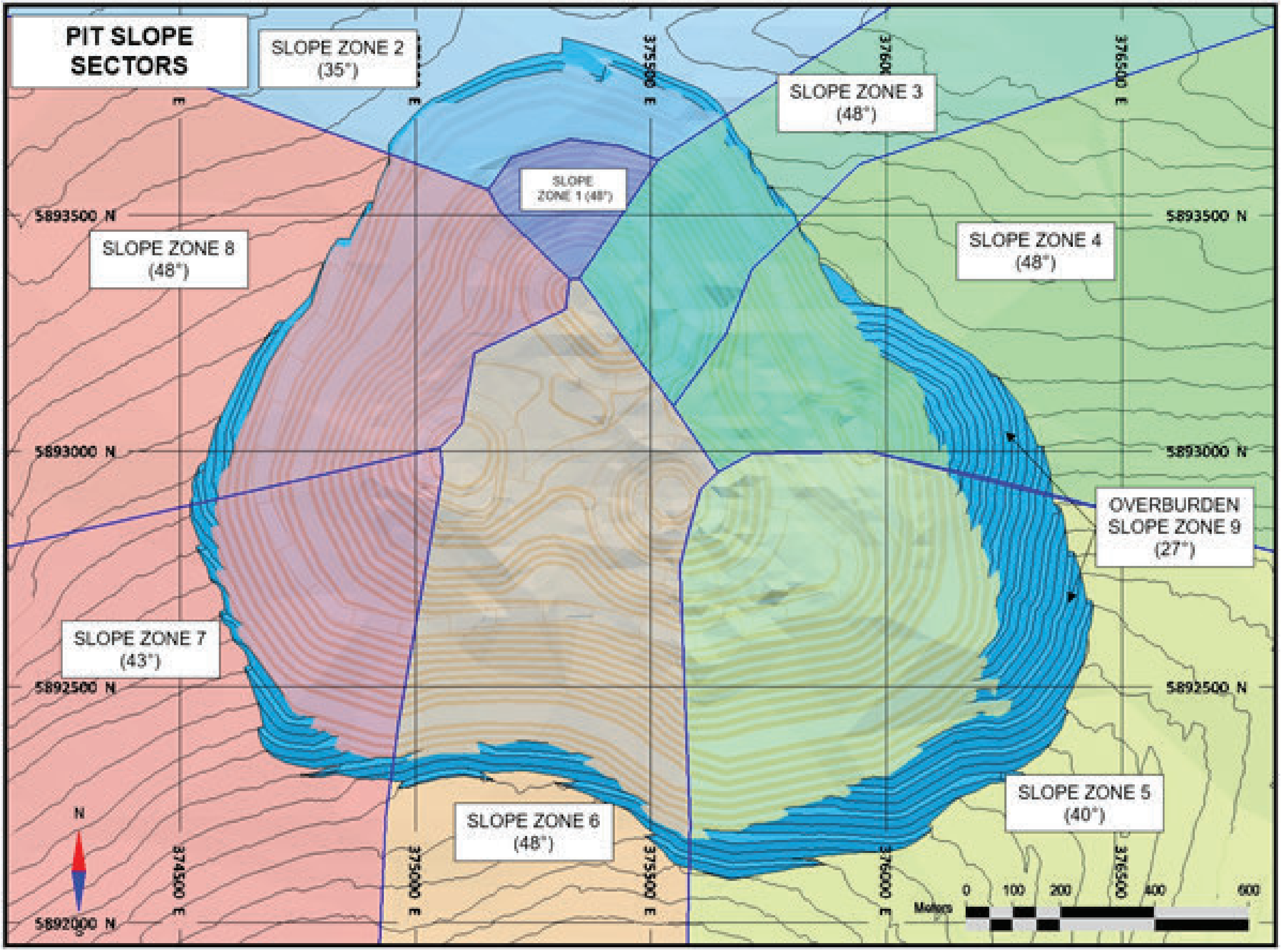

Figure 3.5-8: Open Pit Slope Sectors for Development

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

3.5.1.6 Phased Development

Ultimate pit limits have been split up into eight phases. The development of phases focuses on:

- Early extraction of NAG waste rock for construction;
- Aligning of PAG waste rock extraction with the TSF dam construction and subaqueous deposition;
- Targeting higher economic margin material earlier in the LoM; and
- Distributing the waste stripping ratio over the LoM to match infrastructure development and processing throughput.

Open Pit phases consist of a series of pushbacks after the initial phases; Construction Borrow Pits and the Starter Pit phases. The minimum pushback distances are 75 m with most bench pushbacks over 100 m.

The LoM schedule for development of Open Pit phases is presented in Table 3.5.1-6. Figures 3.5-9 to 3.5-16 provides the ultimate builds for each pushback. Further details of Open Pit phase development are presented in Section 4.0 Detailed Pit Designs in Appendix 3-C.

Construction Borrow Pits, P650[6]

This phase of Open Pit development commences in Year -2 and will be finished in Year +2 (Table 3.5.1-6) and targets near surface NAG waste rock for construction. Three small Construction Borrow pits will be developed to provide initial construction materials for the Project (Figure 3.5-9). A total of 0.2 Mt of ore, 3.2 Mt of OVB, 1.2 Mt of PAG waste, and 6.6 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). The Construction Borrow pits will be mined from 1,650 to 1,450 masl. All three pits will be accessed by ex-pit haul roads from the west pit crest.

Starter Pit, P651i

Mining of the Starter Pit will begin in Year -2 and will be finished in Year +3 (Table 3.5.1-6). The Starter Pit targets the high grade ore with a low-strip-ratio, 0.9 (Table 3.5.1-7). This phase contains approximately three or four years of ore for processing within two separately accessed pit bottoms (Figure 3.5-10). A total of 24.8 Mt of ore, 6.8 Mt of OVB, 14.5 Mt of PAG waste, and 1.6 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). The western portion of the Starter Pit starts at the pit crest (1,640 masl) and will mine to a pit bottom of 1,450 masl. The ramp runs counter clockwise down from the pit exit at the 1,560 masl elevation in the west. The eastern portion of the Starter Pit is accessed from the 1,580 masl elevation down to the 1,520 masl elevation from a secondary ramp running clockwise from the pit exit in the north. Upper benches and ramps of the Starter Pit will be accessed via ex-pit haul roads from the pit crest.

East Pushback 1, P652i

Mining of the East Pushback 1 will begin in Year +2 and will be finished in Year +4 (Table 3.5.1-6). The East Pushback 1 expands the eastern portion of the Starter Pit, and continues mining of high grade ore with a low stripping ratio, 0.8 (Figure 3.5-11). A total of 16.2 Mt of ore, 2.4 Mt of OVB, 9 Mt of PAG waste, and 1.1 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). This phase mines from the pit crest at 1,640 masl down to a pit bottom of 1,460 masl. The main ramp runs clockwise from the pit crest at the 1,570 masl in the north of the pit.

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[6] The first digit signifies the type of design. P6 signifies open pit designs. The middle digit signifies the design series. The final digit signifies the pit phase number. The suffix ‘i’ indicates that the reserve tonnage for the phase is incremental from the previous phase. If there is no ‘i’ specified, it is cumulative up to the phase indicated.

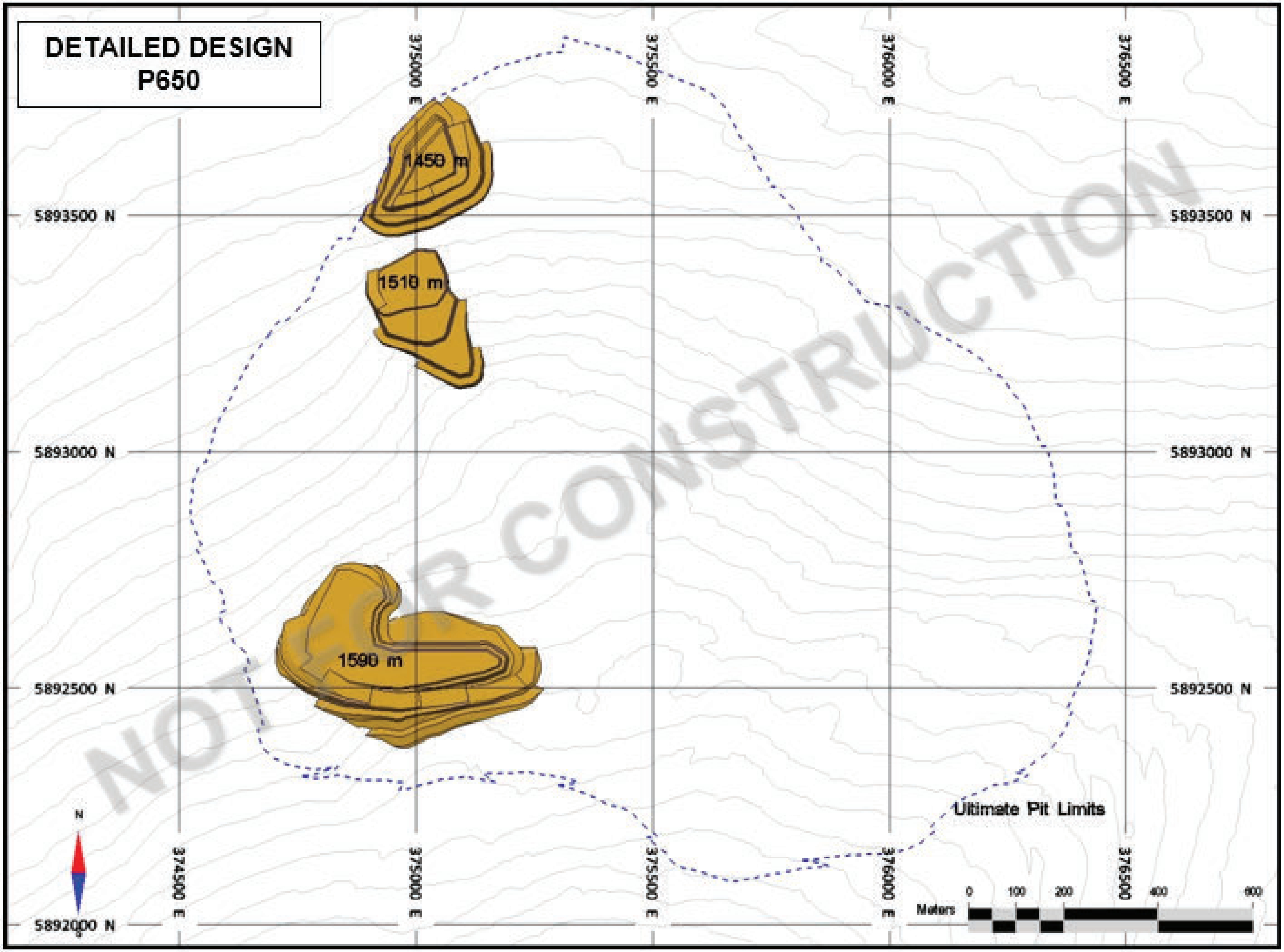


Figure 3.5-9: Construction Borrow Pits, P650 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

Table 3.5.1-6: Life of Mine Schedule for Open Pit Phases

Phase	Y-2	Y-1	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7	Y+8	Y+9	Y+10	Y+11	Y+12	Y+13	Y+14	Y+15	Y+16	Y+17	Y+18
Construction Borrow Pits - P650	1,650	1,510	1,490	1,450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Starter Pit - P651i	1,630	1,610	1,550	1,480	1,450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Pushback 1- P652i	-	-	-	1,580	1,520	1,460	-	-	-	-	-	-	-	-	-	-	-	-	-	-
East Pushback 2 - P653i	-	-	-	-	1,600	1,510	1,460	1,390	1,380	-	-	-	-	-	-	-	-	-	-	-
West Pushback - P654i	-	-	-	-	-	1,620	1,540	1,470	1,390	1,310	1,300	-	-	-	-	-	-	-	-	-
North Pushback 1 - P655i	-	-	-	-	-	-	-	-	1,520	1,450	1,390	1,310	1,260	-	-	-	-	-	-	-
North Pushback 2 - P656i	-	-	-	-	-	-	-	1,580	1,540	1,490	1,460	1,410	1,350	1,260	1,190	1,140	-	-	-	-
South Pushback - P657i	-	-	-	-	-	-	-	-	-	-	-	1,670	1,620	1,570	1,480	1,390	1,320	1,260	1,190	1,160

Note: All values in masl.

Table 3.5.1-7: Production from Open Pit Phases

Phase	Ore (Mt)	OVB (Mt)	PAG1 (Mt)	PAG2 (Mt)	NAG3 (Mt)	NAG4 (Mt)	NAG5 (Mt)	Undefined[1] (Mt)	Strip Ratio Waste: Ore
Construction Borrow Pits - P650	0.2	3.2	0.0	0.7	0	0.7	5.9	0.5	5.5
Starter Pit - P651i	24.8	6.8	10.6	2.3	0.6	0.6	1.1	1	0.9
East Pushback 1- P652i	16.3	2.4	6.3	1.6	0.8	0.6	0.5	0.3	0.8
East Pushback 2 - P653i	33.6	22.9	17.0	5.8	2.3	0.7	5.8	0.8	1.7
West Pushback - P654i	37.2	4.2	35.5	9.3	1.8	3.9	9.5	0.6	1.7
North Pushback 1 - P655i	53.3	3.7	48.5	4.6	1.2	0.4	2.6	0.7	1.2
North Pushback 2 - P656i	83.9	20.2	106.0	31.2	9	6.5	15.6	1.8	2.3
South Pushback - P657i	84.8	19.5	114.8	41.7	8.3	9.2	53.3	1.4	2.9

[1] *Undefined is classified as PAG.*

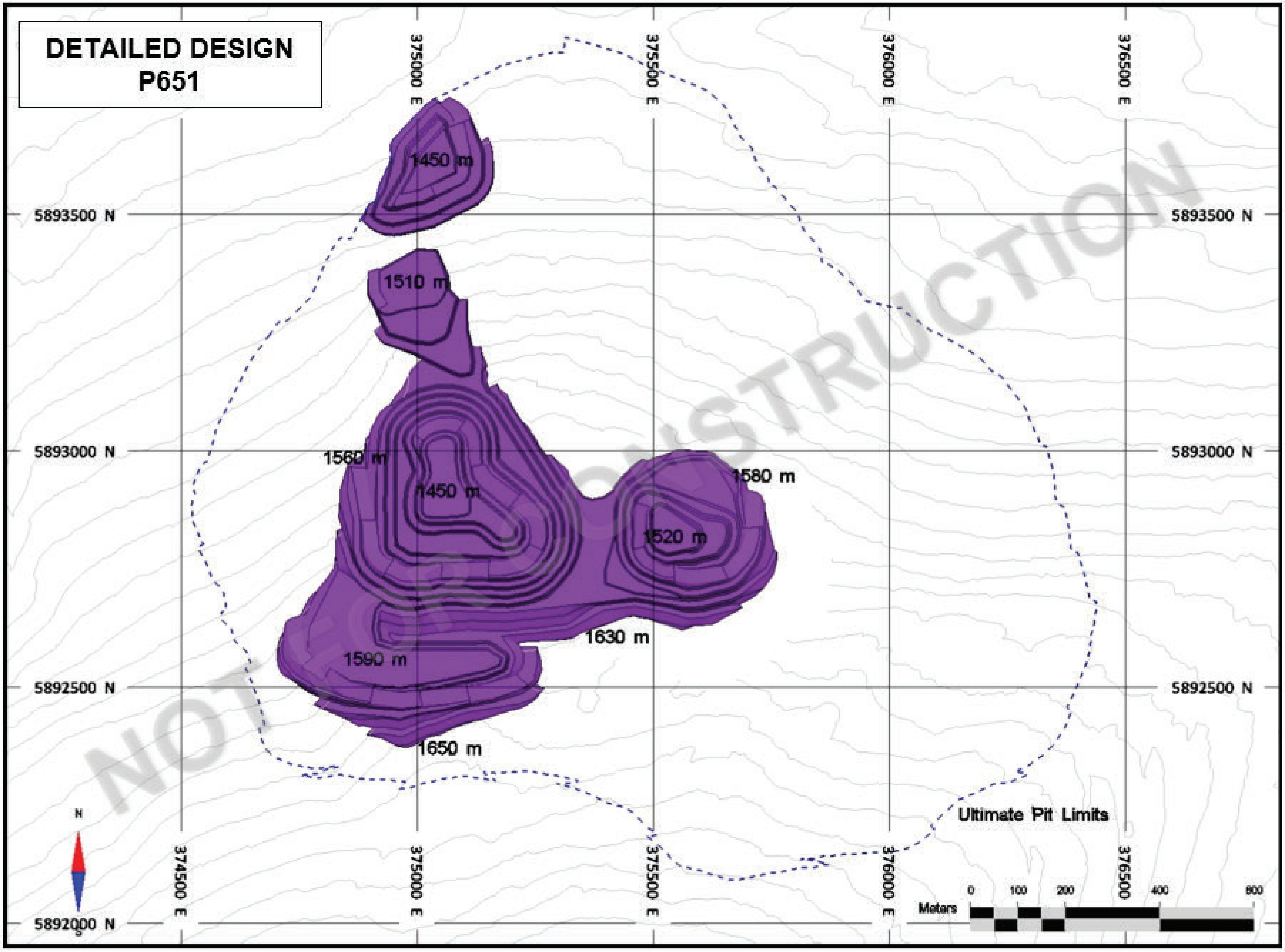


Figure 3.5-10: Starter Pit, P651 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

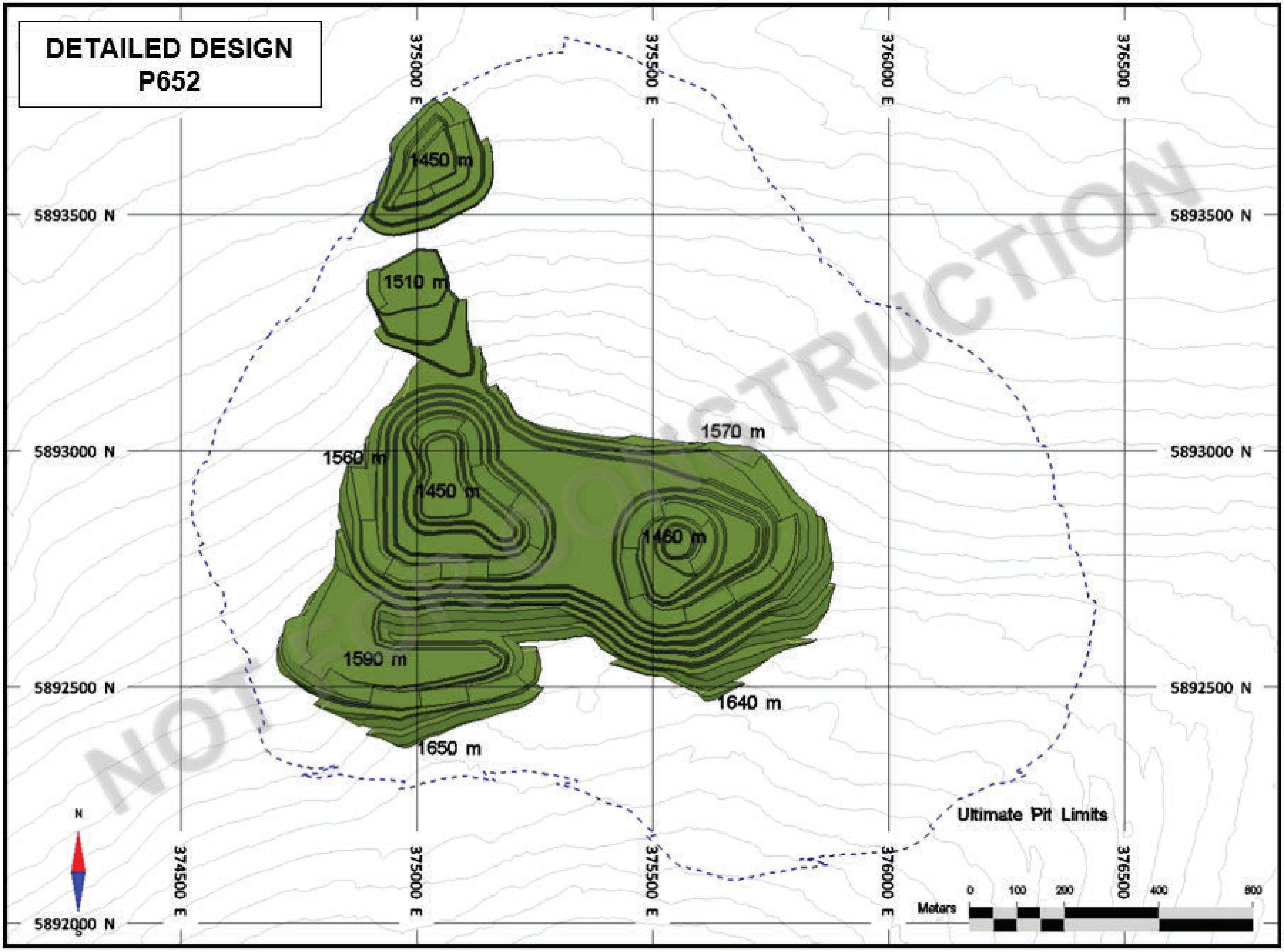


Figure 3.5-11: East Pushback 1, P652 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

East Pushback 2, P653i

Mining of the East Pushback 2 will begin in Year +3 and be finished in Year +7 (Table 3.5.1-6). The East Pushback 2 continues to expand the East Pushback 1 towards the eastern ultimate pit limit (Figure 3.5-12). With this phase, high grade ore is being supplemented by low grade ore increasing the stripping ratio to 1.7. A total of 33.6 Mt of ore, 22.9 Mt of OVB, 25.9 Mt of PAG waste and 6.5 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). This phase mines from the pit crest at 1,650 masl down to a pit bottom at the 1,380 masl. The main ramp runs clockwise from the pit exit at the 1,550 masl elevation in the northeast of the pit.

West Pushback, P654i

Mining of the West Pushback will begin in Year +4 and be finished in Year +9 (Table 3.5.1-6). The West Pushback expands the western edge of the starter pit towards the western ultimate pit limit. It also expands the upper benches of the north and south areas between the east and west parts of the starter pit (Figure 3.5-13). With this phase, high grade ore continues to be supplemented by low grade ore with a strip ratio of 1.7. A total of 37.2 Mt of ore, 4.2 Mt of OVB, 47.2 Mt of PAG waste, and 13.4 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). The phase mines from the pit crest at 1,640 masl, down to a pit bottom at 1,300 masl. The main ramp runs counter clockwise from the pit exit at the 1,550 masl in the west of the pit.

North Pushback 1, P655i

Mining of the North Pushback 1 will begin in Year +7 and be finished in Year +11 (Table 3.5.1-6). The North Pushback 1 expands the existing pit to the north (Figure 3.5-14). With this phase, the strip ratio will be 1.2. A total of 53.3 Mt of ore, 3.7 Mt of OVB, 55 Mt of PAG waste and 3 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). The phase mines from the pit crest at 1,560 masl, down to two pit bottoms at 1,350 masl and 1,260 masl. Bridging these two pit bottoms is the 1,390 masl bench. The main ramp runs clockwise from the pit exit at the 1,530 masl in the west of the pit with switchbacks on the 1,350 masl and 1,320 masl benches.

North Pushback 2, P656i

Mining of the North Pushback 2 will begin in Year +6 and be finished in Year +14 (Table 3.5.1-6). The North Pushback 2 expands the existing pit to the ultimate limits in the north and east (Figure 3.5-15). With this phase, LGO is being mined with a strip ratio of 2.3. A total of 83.9 Mt of ore, 20.2 Mt of OVB, 148 Mt of PAG waste, and 22.1 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). The phase mines from the pit crest at the 1,610 masl, down to a pit bottom at 1,140 masl. The main ramp runs clockwise from the pit exit at the 1,490 masl in the north of the pit. Upper benches of the pit will be accessed via ex-pit haul roads on the hillside. A geotechnical berm will be left behind on the 1,420 masl bench.

South Pushback, P657i

Mining of the South Pushback will begin in Year +10 and be finished in Year +18 (Table 3.5.1-6). The South Pushback expands the existing pit to the ultimate pit limits in the south and west and completes mining operations in the Open Pit (Figure 3.5-16). With this phase, LGO is being mined with a strip ratio of 2.9. A total of 84.8 Mt of ore, 19.5 Mt of OVB, 166.2 Mt of PAG waste and 62.5 Mt of NAG waste will be mined from this phase (Table 3.5.1-7). This phase mines from the pit crest at the 1,690 masl, down to the two pit bottoms at 1,170 masl and 1,160 masl. Bridging these two pit bottoms is the 1,240 masl bench. The main ramp runs counter clockwise from the pit exit at the 1,500 masl in the west of the pit, with switchbacks on the 1,300 masl and 1,220 masl benches. Additional geotechnical berms will be left behind on the 1,580 masl and 1,520 masl benches in the south and on the 1,400 masl bench in the west. With completion of mining during South Pushback, Open Pit mining operations will have finished under the proposed mine plan.

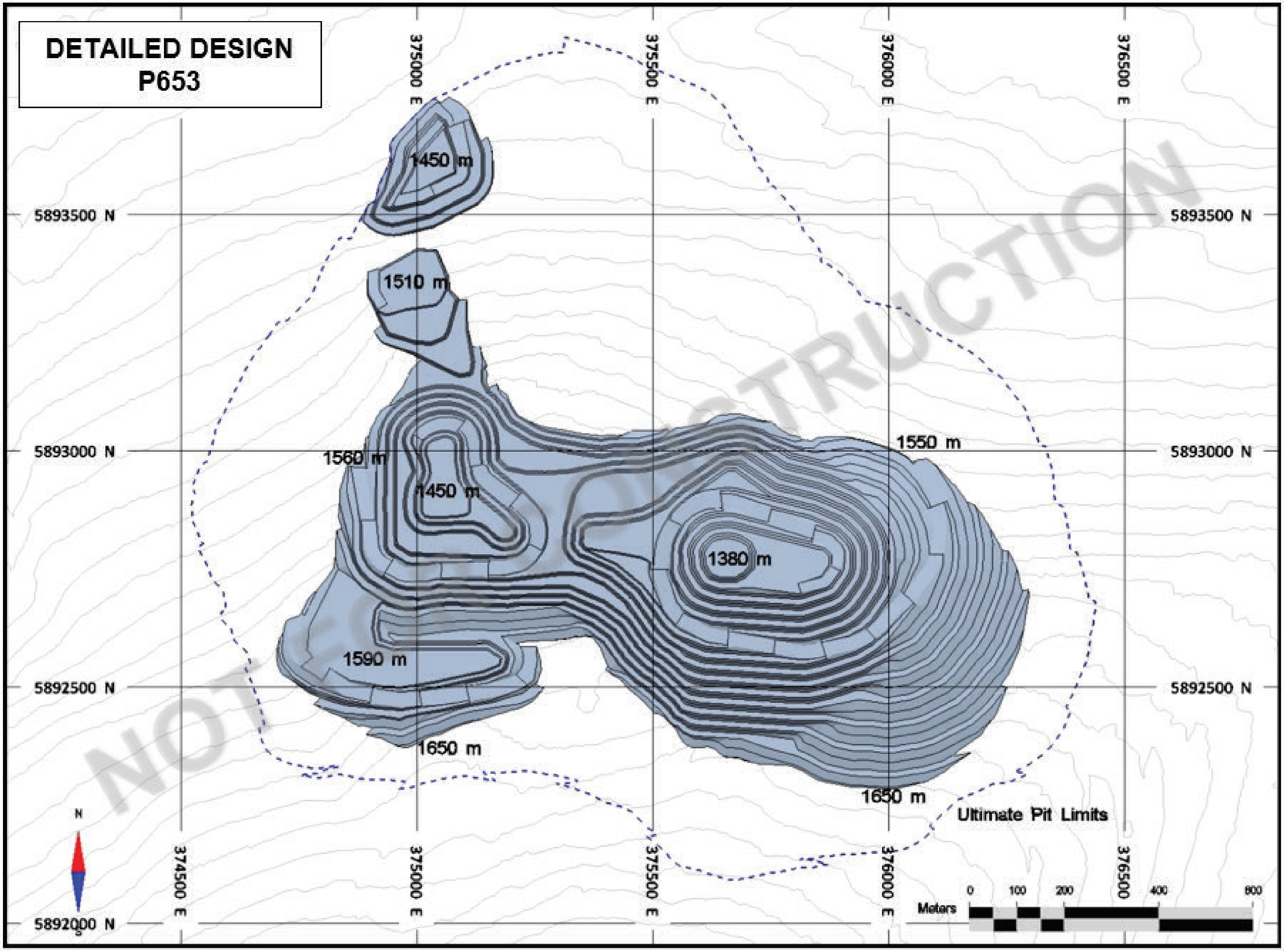


Figure 3.5-12: East Pushback 2, P653 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

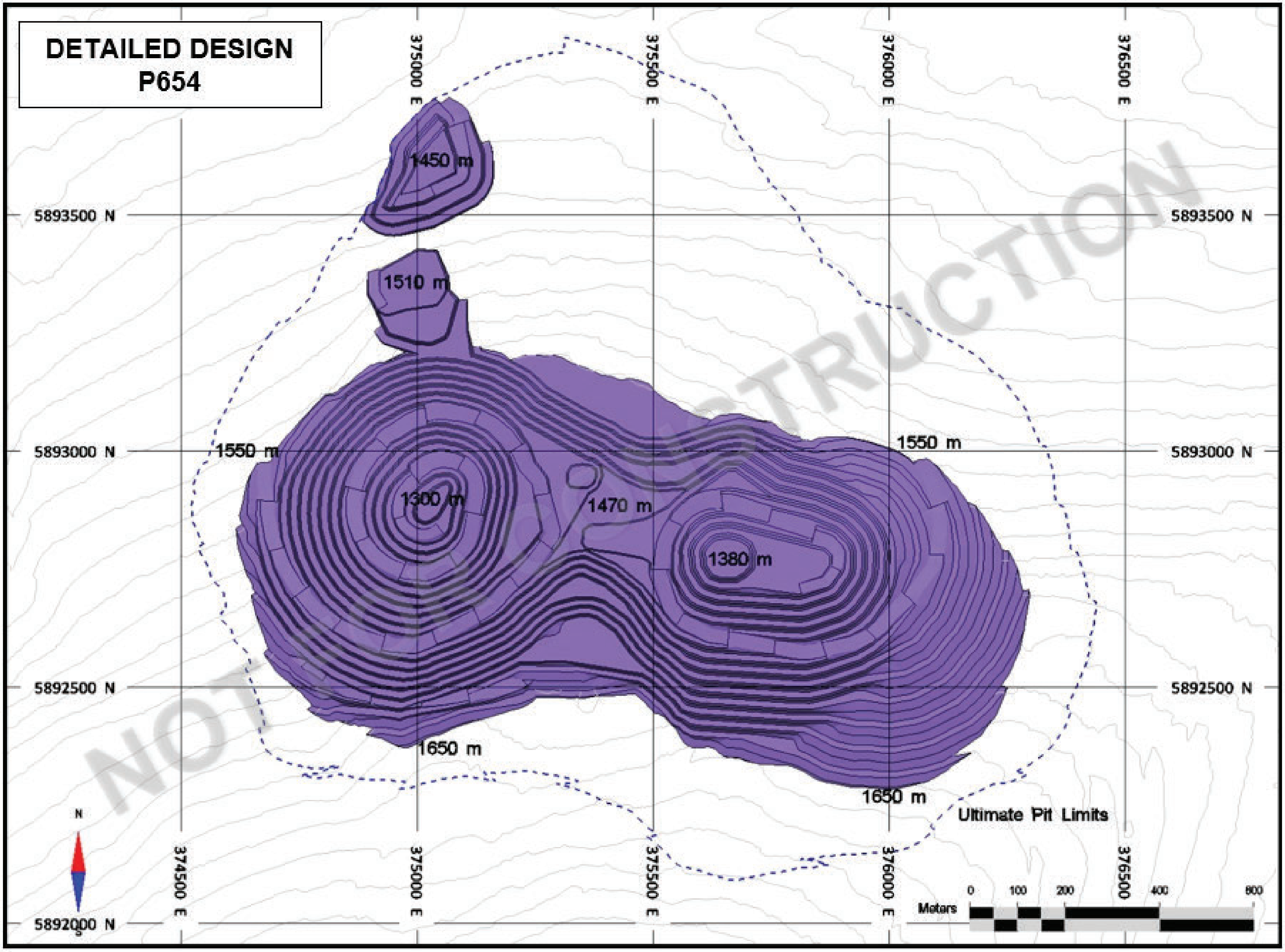


Figure 3.5-13: West Pushback, P654 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

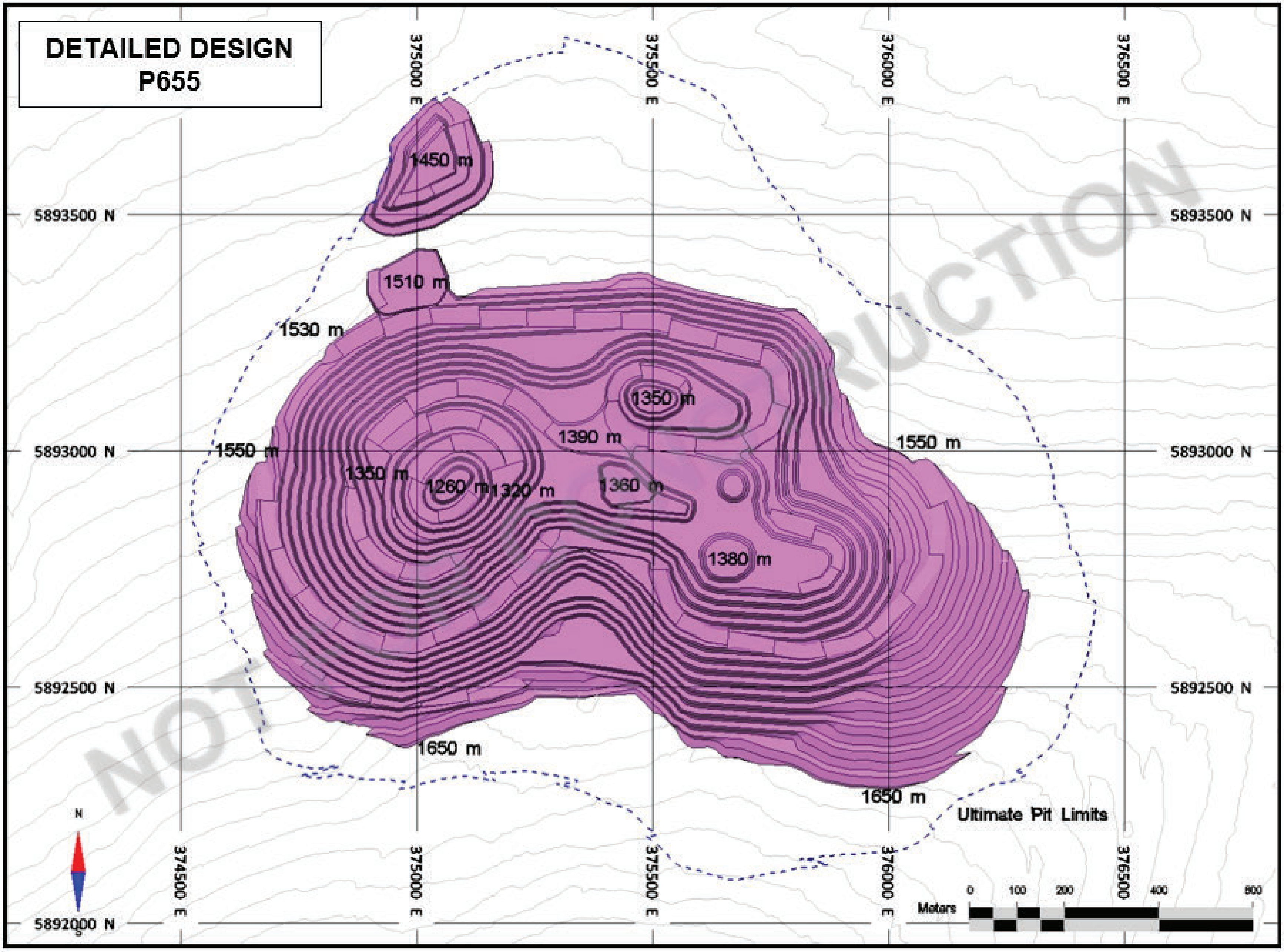


Figure 3.5-14: North Pushback 1, P655 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

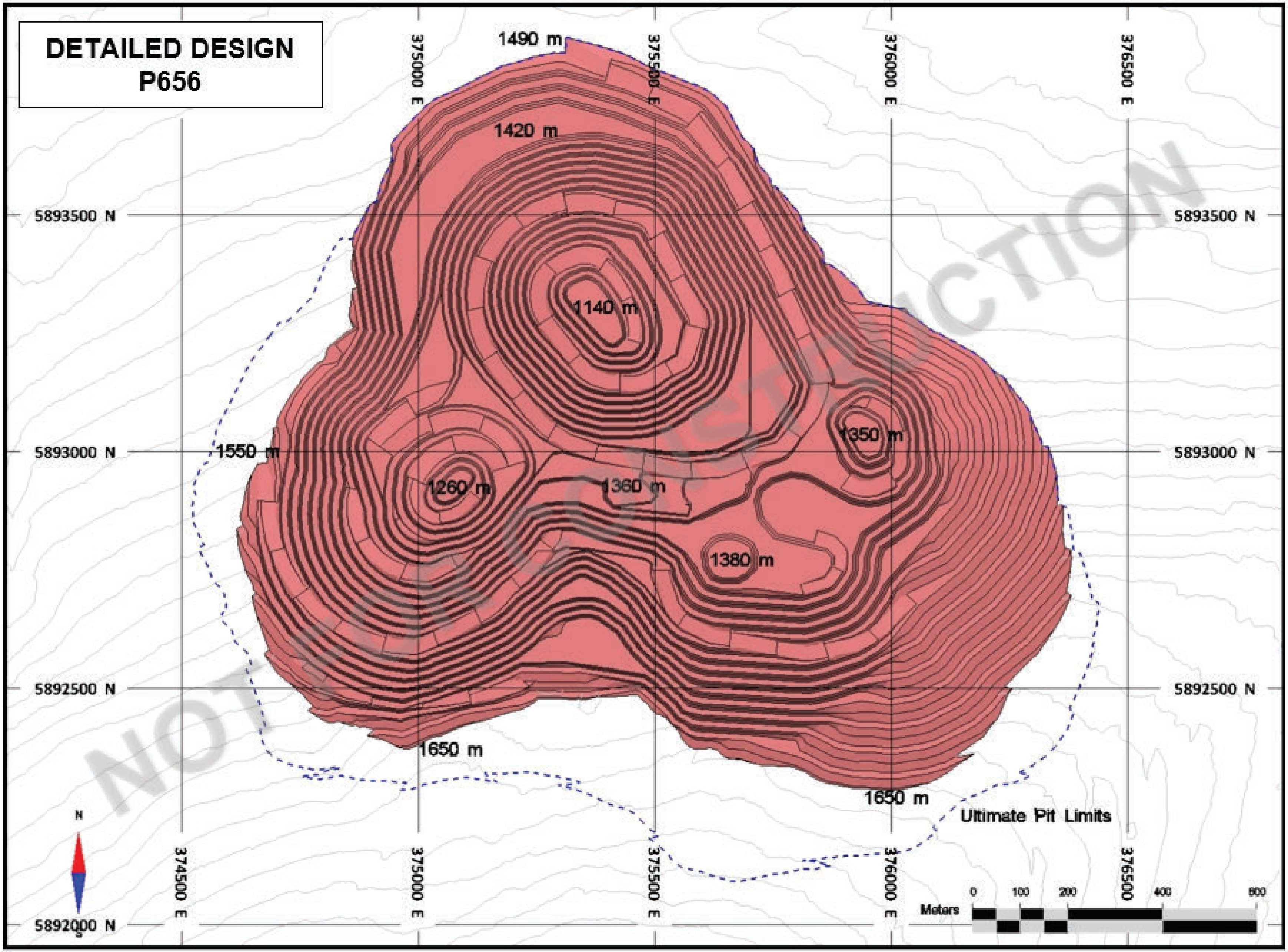


Figure 3.5-15: North Pushback 2, P656 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

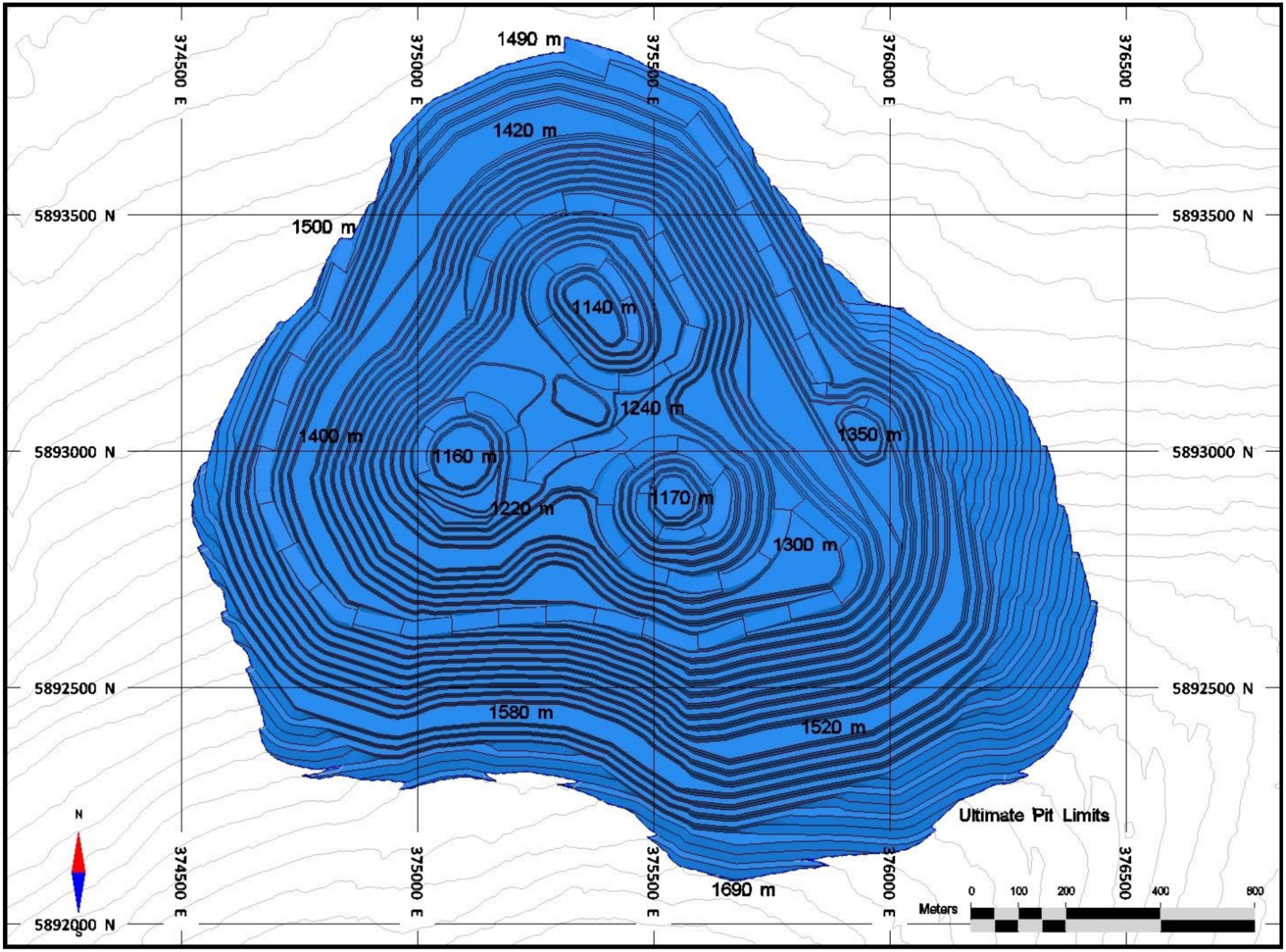


Figure 3.5-16: South Pushback, P657 Ultimate Build

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

3.5.1.7 Open Pit Water Management

The Open Pit is located on the flank of Mount Davidson where the existing topography differs by 200 m between the southern and northern pit edge. This sloped topography is expected to control the surface and groundwater flow direction and to cause groundwater inflows and the radius of influence to vary radially around the open pit. Surface water flows are anticipated to originate from the surrounding upslope areas and direct precipitation falling into the Open Pit. As the Open Pit develops in size over the LoM, the greater perimeter and area will intercept more surface flows and direct precipitation. The contributions from groundwater will progressively increase as the pit extends below the groundwater table.

Surface Water Management

Surface water will be directed to in-pit sumps via in-pit ditching. Skid mounted pumps will be used to dewater the sumps and direct water, via piping, to ex-pit settling ponds and into the Metals WTP.
The design criteria for the surface water management system is sized for a one-in-100-year return period storm and was estimated to be approximately 142,000 m^3.

Pit Water Management

Pit Dewatering Requirements

Open pit groundwater dewatering will be achieved using both in-pit dewatering wells and perimeter dewatering wells. In–pit groundwater wells will target water removal from storage in the higher permeability zone and groundwater inflow to the higher permeability zone from the surrounding lower permeability bedrock. Perimeter dewatering wells will be established as needed to lower and extend the cone of depression (when natural drainage is not sufficient) to provide the required depressurization identified from the open pit wall stability analyses.

The bedrock slope depressurization requirements are summarized in Table 3.5.1-8 by pit wall sector and for Year +5, Year +10 and Year +18.

Table 3.5.1-8: Pit Slope Depressurization Requirements

Wall Sector	Baseline Groundwater Level (masl)	Pit Rim El. (masl)	Wall Geology	Horizontal Slope Depressurization Required (m)		
				Y+5	Y+10	Y+18
East	1,530	1,600	OVB, CR, BZ	0	0	50 below 1,300 masl
Southeast	1,600	1,650	OVB, BZ, CR	120	120	120 above 1,440 masl
Southwest	1,640	1,620	BZ, CR	0	150 above 1,380 masl	150 above 1,380 masl
North	1,500	1,500	BZ, CR	0	0	50 above 1,360 masl
Northeast	1,500	1,500	BZ, CR	0	0	80 above 1,360 masl

Notes:
OVB = Overburden; BZ = Broken Zone; CR = Competent Rock
The exposed OVB slope must be fully drained.
Slope depressurization is measured as the horizontal distance between the phreatic surface and the pit slope.

Perimeter dewatering wells were determined to be required along the southeast and southwest sectors to maintain dry working conditions and/or meet the required depressurization identified in the pit wall stability. The estimated drawdown required by the perimeter wells is shown in Table 3.5.1-9. The cone of depression surrounding each perimeter dewatering well was evaluated to provide a cursory spacing layout. The spacing and number of perimeter dewatering wells was refined so that the cumulative drawdown required between each perimeter dewatering well was met. Actual cumulative drawdown will be monitored in the field with observation wells to meet required dewatering conditions. Additional mitigation measures will be provided that include horizontal or vertical drainage measures if the required slope depressurization requirements are not sufficiently met by the in-pit wells by the target date in mid to late Operations phase.

Table 3.5.1-9: Perimeter Dewatering Well Drawdown Requirements

Segment	Drawdown to be Provided by Perimeter Dewatering Wells (m)				
	Year +1	Year +2	Year +5	Year +10	Year +18
Southeast	0	0	150	40	40
Southwest	40	40	70	70	0

Notes:

Drawdown to be provided by perimeter dewatering wells represents the estimated water level drawdown that is required in addition to what is estimated to occur by lowering the water table in the higher permeability bedrock zone to 15 m below the base of the Open Pit. Values were derived with the analytical calculation.

Perimeter wells are not specified along the North Sector as it is assumed that the higher permeability bedrock zone extends beyond the North Wall and dewatering will be achieved with in-pit wells. The West Sector is mostly within competent rock.

Details of depressurization and drawdown requirements are presented in Section 6.2 Groundwater Mine Inflow Estimates and Dewatering Requirements and Section 6.3 Open Pit Groundwater Dewatering System in Appendix 3-B.

Dewatering Well Development

A preliminary schedule for development for Year +1, Year +2, Year +5, Year +10, and Year +18 of the dewatering system is provided below:

- **Construction Phase Year -1:**
  - Re-develop and commission existing pumping wells PW13-1 and PW13-3.
- **Operations Phase Years +1 to +3:**
  - Install 13 observation wells to measure groundwater levels around the open pit perimeter (OW1 to OW13).
- **Operations Phase Year +4:**
  - Install and commission nine perimeter dewatering wells along the south wall:
    - PW1 to PW5 along the southwest wall.
    - PW6, PW7, PW8, and PW9 along the southeast wall.
  - Install five observation wells (OW14 to OW18) around the northern edge of the ultimate extent of the open pit.
- **Operations Phase Year +5:**
  - Install and commission in-pit dewatering well (PW-IN-PIT2) in advance of expanding the open pit north.

- **Operations Phase Year +11:**
  - Install and commission perimeter dewatering wells: PW10, PW11, and PW12.
  - Decommission PW6 and PW13-3 prior to push-back of the southeast wall.

A spacing of 200 m is recommended for the perimeter dewatering wells along the southwest wall based on the dewatering requirements. Wells along the southeast wall are recommended to be installed with a spacing of 150 m. The tighter spacing along the southeast wall is due to the greater depressurization requirements of the southeast wall in Year +5 (Table 3.5.1-8). There is a greater reliance on perimeter wells to meet the depressurization requirements in Year +5 as the Open Pit is not yet deep enough to meet the requirement primarily through natural drainage. The projected maximum groundwater dewatering rate was estimated to be 87 litres per second (L/s) during Year +6 and Year +7.

The Open Pit depressurization system will be designed for the “best estimate” of required pumping. The drilling and development of productive dewatering wells can be highly variable in bedrock. Therefore, the early performance of these wells will need to be evaluated to refine the dewatering plan. This dewatering design includes minimum allowances for the number of dewatering wells and observation wells. Ongoing assessment of the dewatering system performance will be an integral part of Open Pit water management.

The final extent of the Open Pit groundwater dewatering system is shown on Figure 3.5-17 and includes the locations of the perimeter and in-pit dewatering wells, pipelines, and monitoring sites (Table 3.5.1-10).

The groundwater dewatering system will include flow measurement devices, water level meters, and observation wells with vibrating wire piezometer (VWPs) installed to verify the effectiveness of the system.

Dewatering Well Design

The dewatering wells are planned to be installed using an air rotary drill rig to a nominal depth of 350 m and maximum depth of 450 m depending on drilling conditions encountered. Steel well screens will be installed upon completion with a minimum diameter of 8" for the perimeter wells and 10" for the in-pit wells. If ground conditions limit the well size or achievable depth of installation, adjustments to the dewatering system will be required to achieve the design objectives.

The perimeter wells will have installed 6" submersible turbine pumps individually rated for a flow rate of either 4 or 6 L/s (60 or 90 USgpm), depending on the installed well location. The perimeter wells will be interconnected by a pipeline around the perimeter of the open pit. The pipeline will be 4′ to 6′ diameter DR17 HDPE pipe. Staged installation of pumping wells will provide additional data on aquifer characteristics and will enable a more efficient dewatering system design.

The in-pit wells will have 10" diameter well screens and 8" diameter submersible turbine pumps. The in-pit well pumps will be rated for a flow rate of 22 L/s (350 USgpm) and will be connected to the overall Open Pit water management system by a 6′ diameter DR17 HDPE pipeline.

The flow from both depressurization systems will be combined with flow from the surface water system at a junction header near the rim of the open pit before discharging by gravity to the Metals WTP.

Details of depressurization and drawdown requirements are presented in Section 6.4 Dewatering Well Design Considerations in Appendix 3-B.

Table 3.5.1-10: Open Pit Slope Groundwater Dewatering Plan

Year:	Collar Elevation (masl)	Y-1	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7	Y+8	Y+9	Y+10	Y+11	Y+12	Y+13	Y+14	Y+15	Y+16	Y+17	Y+18
Min. Pit Base Elevation (masl):		1,510	1,490	1,450	1,450	1,450	1,450	1,390	1,390	1,340	1,300	1,300	1,260	1,260	1,190	1,140	1,140	1,140	1,140	1,140
Well ID		Estimated Pumping Rate (L/s)																		
In-Pit Wells																				
PW13-1	1,531	10	10	10	10	10	10	25	25	25	25	25	25	25	50	50	50	50	50	50
PW13-IN-PIT2	1,655	-	-	-	-	-														
Perimeter Wells – South and Southeast Sectors																				
PW13-3	1,655	-	6.5	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	-	-	-	-	-	-	-	-
PW6	1,660	-	-	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	-	-	-	-	-	-	-	-
PW7	1,656	-	-	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	3	3	3	3	3	3	3	3
PW8	1,642	-	-	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	3	3	3	3	3	3	3	3
PW9	1,630	-	-	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	3	3	3	3	3	3	3	3
PW10	1,619	-	-	6.5	6.5	6.5	6.5	6.5	6.5	3	3	3	3	3	3	3	3	3	3	3
PW11	1,686	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	3	3	3	3
PW12	1,680	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	3	3	3	3
PW13	1,668	-	-	-	-	-	-	-	-	-	-	-	3	3	3	3	3	3	3	3
Perimeter Wells – Southwest Sector																				
PW1	1,660	3.5	3.5	3.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-
PW2	1,643	3.5	3.5	3.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-
PW3	1,614	3.5	3.5	3.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-
PW4	1,590	-	-	-	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-
PW5	1,561	-	-	-	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	-	-	-	-	-	-
Total Flow (L/s)		**21**	**27**	**60**	**72**	**72**	**72**	**87**	**87**	**66**	**66**	**66**	**69**	**69**	**71**	**71**	**71**	**71**	**71**	**71**

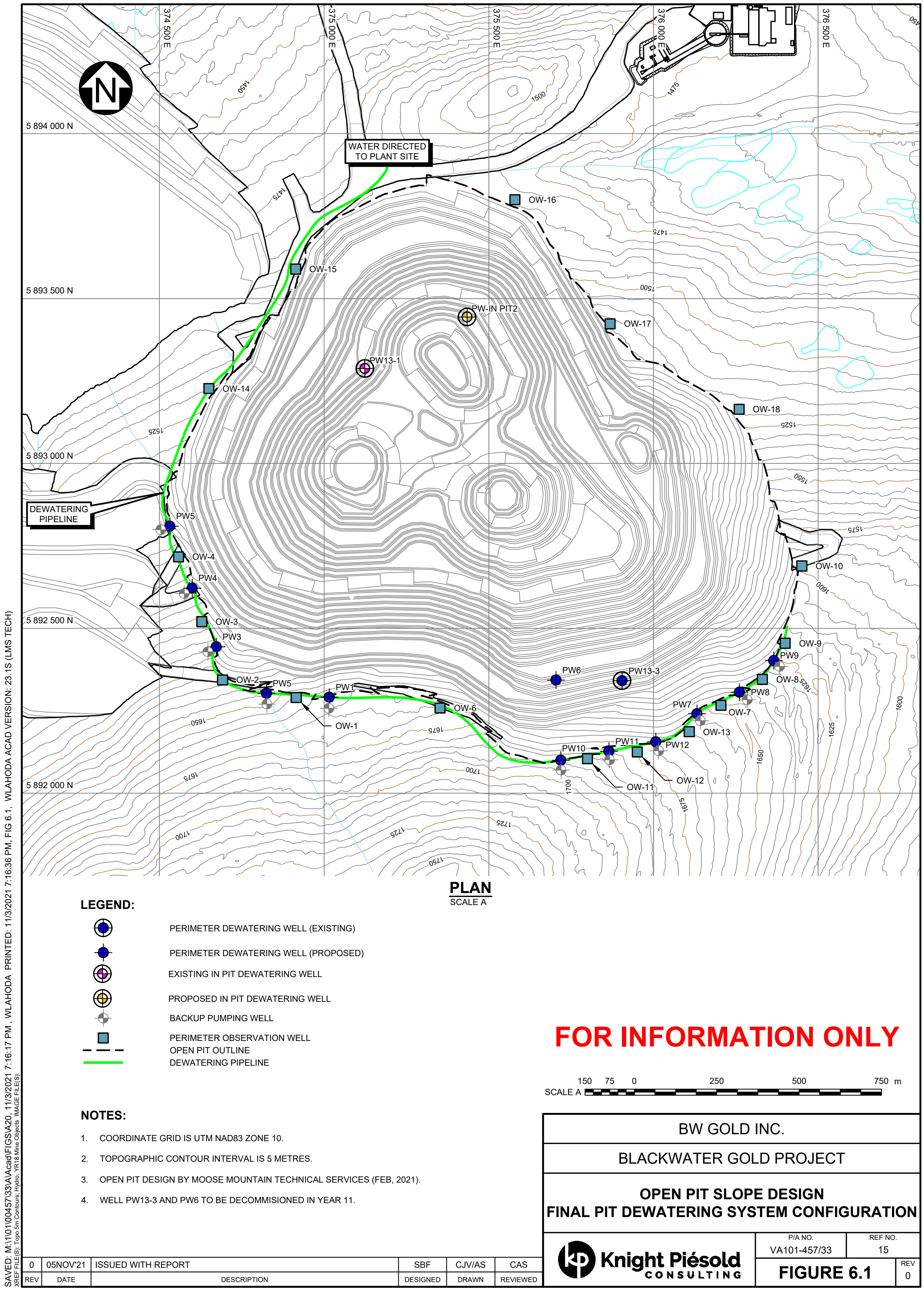


Figure 3.5-17: Final Pit Dewatering System

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

3.5.1.8 Drilling and Blasting

Drill and blasting operations will be carried out during construction and mining of the Open Pit.

Grade Control Drilling

Grade control drilling will be carried out in advance of mining over a number of benches to delineate ore and waste prior to mining. An ore control system is planned to provide field control for the loading equipment to selectively mine ore-grade material separately from the waste. Grade control drilling will be carried out with 140 mm (5.5") diesel RC drills, with sampling and assaying on 3 m intervals. The designation of ore, OVB, and waste rock will follow the geochemical characterization presented in Section 2.4.1.3.

Table 3.5.1-11 provides the planned utilization of drills in the Open Pit over the life of mining operations; however, these are subject to change as mining progresses. Grade control drilling will be scheduled in accordance with the development of the Open Pit phases to support the routing of ore, OVB, and PAG and NAG waste to their appropriate destination.

Production Drilling and Blasting

Once full mine production is reached, drilling and blasting of approximately 5 Mt (dry) per month will be required to maintain production levels. Production drilling will be carried out with 254 mm (10") diesel rotary drills in waste and 203 mm (8") diesel rotary drill in ore. Table 3.5.1-12 provides the planned utilization of drills in the Open Pit during mining operations; however, these are subject to change as mining progresses.

In-situ rock will be drilled and blasted on 10 m benches to create suitable fragmentation for efficient loading and hauling of both ore and waste rock. There may be a requirement for frost blasting in the winter months; otherwise no drilling or blasting is planned for the OVB materials. Various drill and blast patterns and powder factors are planned for various in pit materials, as well as for wet and dry in-situ conditions.

Powder factors average 0.32 kg/t in ore and 0.20 kg/t in waste. Cushion blasting will be used for any blast patterns adjacent to an interim or final pit wall to prevent overbreak of the wall and to maintain its overall stability and integrity. This will also reduce the surface area of the ultimate walls and limit acid production and metal leaching. Detailed blasting patterns will be prepared prior to initiation of Open Pit phases.

Blasting in both wet and dry conditions is proposed using a blended emulsion product, with the proportion of emulsion varying with in-hole water conditions. On average an estimated 25% of blast holes are expected to be wet. Blasting activities are planned to fall under a contract service agreement with the explosive supplier.

The explosives storage facility is described in Section 3.5.10 and will be submitted for authorization under the F05-01: Division 1 Factory License or Satellite Site Certificate (Natural Resources Canada 2021).

Table 3.5.1-11: Drill Types Utilized in the Open Pit during Mining Operations

	Y-2	Y-1	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7	Y+8	Y+9	Y+10	Y+11	Y+12	Y+13	Y+14	Y+15	Y+16	Y+17	Y+18
Diesel Rotary tracked drill 254 mm (10") holes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Electric Rotary tracked drill 254 mm (10") holes	-	-	-	-	-	-	1	1	1	1	2	2	2	2	2	2	2	2	2	2
Diesel Rotary tracked drill 203 mm (8") holes	1	1	2	2	2	3	3	3	4	4	4	4	4	4	4	4	4	4	2	2
Diesel Remote Controlled tracked drill 144 mm (5.5") holes	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 3.5.1-12: In-Pit Mining Equipment Utilized in the Open Pit over the Life of Mining Operations

	Y-2	Y-1	Y+1	Y+2	Y+3	Y+4	Y+5	Y+6	Y+7	Y+8	Y+9	Y+10	Y+11	Y+12	Y+13	Y+14	Y+15	Y+16	Y+17	Y+18	Y+19	Y+20	Y+21	Y+22	Y+23
Loading																									
Diesel Hydraulic front shovel 27 m^3 bucket	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-
Electric Hydraulic front shovel 27 m^3 bucket	-	-	-	-	-	-	1	1	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1
Diesel Hydraulic excavator 22 m^3 bucket	-	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	-	-	-	-	-
Wheel loader 19 m^3 bucket	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hauling																									
Rigid frame haul truck 191 t payload	3	4	10	10	10	18	19	19	19	19	19	19	19	19	19	19	16	12	8	3	-	-	-	-	-
Rigid frame haul truck 230 t payload	-	-	-	-	-	-	-	4	4	11	11	16	16	16	16	16	16	16	10	3	3	3	3	3	3
Articulated haul truck 40 t payload	2	4	4	4	4	4	4	4	4	2	2	2	2	2	2	2	2	2	-	-	-	-	-	-	-

3.5.1.9 In-Pit Equipment and Power Requirements

In-Pit Equipment

Equipment selection is based on pit geology and configuration, required production levels, and mining constraints. Table 3.5.1-12 provides the planned in-pit equipment for the Open Pit over the life of mining operations; however, these are subject to change as mining progresses.

Hydraulic excavators (22.0 m^3 bucket) will be used for ore loading, based on their ability to minimize losses and dilution for the ore control operations. Hydraulic front shovels (27 m^3 bucket) are proposed for waste loading based on their efficient pass match to the haulers and their productivity on 10 m benches. A wheel loader (19.0 m^3 bucket) will also be available for work in smaller spaces and smaller loads.

Initially, mining will be undertaken using 190 t payload class haul trucks. As production requirements increase, the load and haul fleet will be expanded with 230 t payload class haul trucks. Rigid-frame 190 t payload class haulers are flexible enough to meet the targeted production levels and to maintain productivity of the loading units. Larger rigid 230 t payload class haulers are proposed for waste hauling as the stripping ratio increases in Year +6. The haul distances are longer beyond Year +6 and additions to the fleet will be required. Four articulated 40 t payload class haulers are proposed to supplement the fleet and provide additional flexibility for construction of the pits, haul roads, and tailings dams.

Additional equipment for in-pit and pit access works, include graders (5.5 m and 4.9 m blade) to maintain the haul routes and track dozers (325 kW) for construction and movement of materials within the Open Pit.

In Year +5, the electrification of the Open Pit will be expanded and electric waste production drills and hydraulic front shovels will supplement the existing diesel fleet of mine equipment. Initially all equipment is planned to be diesel driven. Options to retrofit existing diesel drive units from Year +5 onwards will be investigated.

The in-pit fleet will be remotely serviced by mobile fuel/lube trucks, mobile vehicles can be fueled and lubed at the Ready Line and Bulk Fuel Storage area, and at the truck shop and wash at the Plant Site.

Traffic and vehicle management in-pit and ex-pit for the heavy vehicles of the Open Pit are provided in the Mine Site Traffic Control Plan (Appendix 9-K).

Power Supply

The primary power supply to the Open Pit will be a single 25 kV feed pole line running from the Primary Distribution Centre at the main substation. Power to the main substation will be supplied from the Project’s transmission line which connects to the provincial electrical grid. Progressive electrification of the Open Pit is proposed to commence in Year +5 to support 24-hour operations. A portable substation in the Open Pit will transform power to 7.6 kV to support an electric drill and electric shovel. A second portable substation will be added in Year +9 to support an additional electric drill and electric shovel. Additional portable substations, also powered from the mine 25 kV pole line, will be installed to support Open Pit dewatering as the pit expands.

3.5.1.10 Operations Monitoring

Geotechnical Monitoring

Pro-active geotechnical monitoring is recommended for all phases of Open Pit development, particularly when OVB slopes exceed 30 m and bedrock slopes exceed 100 m. The monitoring program will be phased and include regular visual inspections, bench wall geological mapping, as well as surface displacement monitoring (surface prisms, wireline extensometers, radar/laser scanning) and porewater pressure monitoring. Staffing resources will be allocated to collect, process and interpret the geotechnical monitoring data on a weekly basis or as frequently as required. The timely identification of accelerated movements from surface displacement monitoring and tension cracks will be critical. Up-to-date reports on the status of highwall stability will be compiled and discussed regularly with operation personnel. These reports will also assist mine engineering staff in their efforts to optimize final pit slopes and improve the effectiveness of the controlled blasting program. All seeps and springs will be inspected, mapped and photographed.

A preliminarily geotechnical monitoring schedule for the Open Pit is listed in Table 3.5.1-13.

Table 3.5.1-13: Geotechnical Monitoring Schedule

Monitoring Items	Estimated Quantity	Monitoring Schedule	
		Active Mining Area	Inactive Mining Area
Visual inspection	N/A	Daily	Weekly
Geological mapping	Newly developed benches, starting South Wall	Monthly	Twice monthly
Surface prism monitoring	50 to 100, after Year +2, automated total station can be set up in late years	Bi-weekly to Daily – Depends on the rate of displacement and location	Weekly
Automated slope radar or laser scanning	Critical walls only, 2 to 3 units, after Year +5	Real time 24/7	None
Pore water pressure monitoring	20 to 40 vibrating wire piezometers, installed after Year +2 in conjunction with pit dewatering program	Twice monthly	Monthly

Bench Mapping

Bench mapping is especially important during initial pit development to provide quality structural information. Drillhole orientation data have shadow zones, noise, and cannot be characterized as to persistence, planarity and aperture as compared to detailed bench mapping. Additionally, orientations are more difficult to capture in poor quality rock masses, which has implications for data uncertainty in the Broken Zone. Bench mapping should take the form of cell mapping to capture discontinuity parameters in statistically valid ways. Kinematic stability analyses should be revised as these new data are developed, which will permit the quantification of shear modes likely to be found in the pit walls. Rock mass characterization should be applied to all exposed benches in conjunction with discontinuity mapping.

3.5.1.11 Open Pit Closure

Starting in Year +18 after the completion of mining operations, the Open Pit will fill with water from the TSF Pond C and seepage collected from the ECD Pond. In the Closure phase, these sources will be supplemented by run-off from the Upper Waste Stockpile. The Pit Lake is projected to be filled by the end of Year +45 which marks the end of the Closure phase. Filling and reclamation of the Open Pit is detailed in Section 4.7.7 Open Pit.

3.5.1.12 Open Pit Post-Closure

During the Post-closure phase (Year 46+), waters from the Pit Lake will be treated by WTPs with the treated effluent to be discharged to the FWR. Insoluble brine from the Membrane WTP will be deposited at the base of the Pit Lake. Pit Lake will be monitored during the Post-closure phase.

3.5.2 Processing Plant and Associated Facilities

3.5.2.1 General Description

The Project will utilize a CIL (primary extraction) and a gravity concentration/intensive leach (secondary extraction) gold recovery processes, with gold doré being produced on-site. The processing facilities are located north/north-east of the Open Pit to minimize haul costs, and to facilitate drainage to the TSF (Figure 3.1-3). The processing facilities will be commissioned in Year +1 at 4.5 Mtpa and operate on at 5.5 Mtpa from Year +2 to Year +5, 12 Mt per annum throughput from Year +6 to Year +10, and a 20 Mt per annum throughput from Year +11 to Year +23, the end of operations. Processing plant expansions to accommodate future throughput rate increases will take place to the south and east of the initial processing facilities footprint.

The Plant Site general arrangement at Year +1 is provided in Figure 3.5-18. A detailed plan view of the processing facilities is provided in Figure 3.5-19.

Key facilities are:

- Crusher area – Sections 3.5.2.7;
- Stockpile feed conveyor – Sections 3.5.2.7;
- Stockpile pad – Sections 3.5.2.7;
- Processing Plant area – Section 3.5.2.7; and
- Other Plant Site facilities – Section 3.5.2.9.

3.5.2.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction operation, closure and reclamation of the processing facilities. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Specific regulatory guidance is as follows:

- BC Building Code 2018 (Government of BC 2018a);
- BC Fire Code 2018 (Government of BC 2018b);
- BC Fire Plumbing Code 2018 (Government of BC 2018c); and
- Part 4.1 Buildings – General; Sections 4.1.1, 4.1.3 to 4.1.11 – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Key Reports and Other Documentation

Key reports and other documentation are as follows:

- Blackwater Gold Project 2019 Site Investigation Report (KP 2021b) – Appendix 3-D;
- Blackwater Gold Project 2020-2021 Site Investigation Report (KP 2021c) – Appendix 3-E;
- Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F;
- Condemnation Report of the Blackwater Project (Baker & Popelka 2021) – Appendix 3-G;
- Blackwater Gold Project Plant Site Foundation Assessment (KP 2021f) – Appendix 3-H;

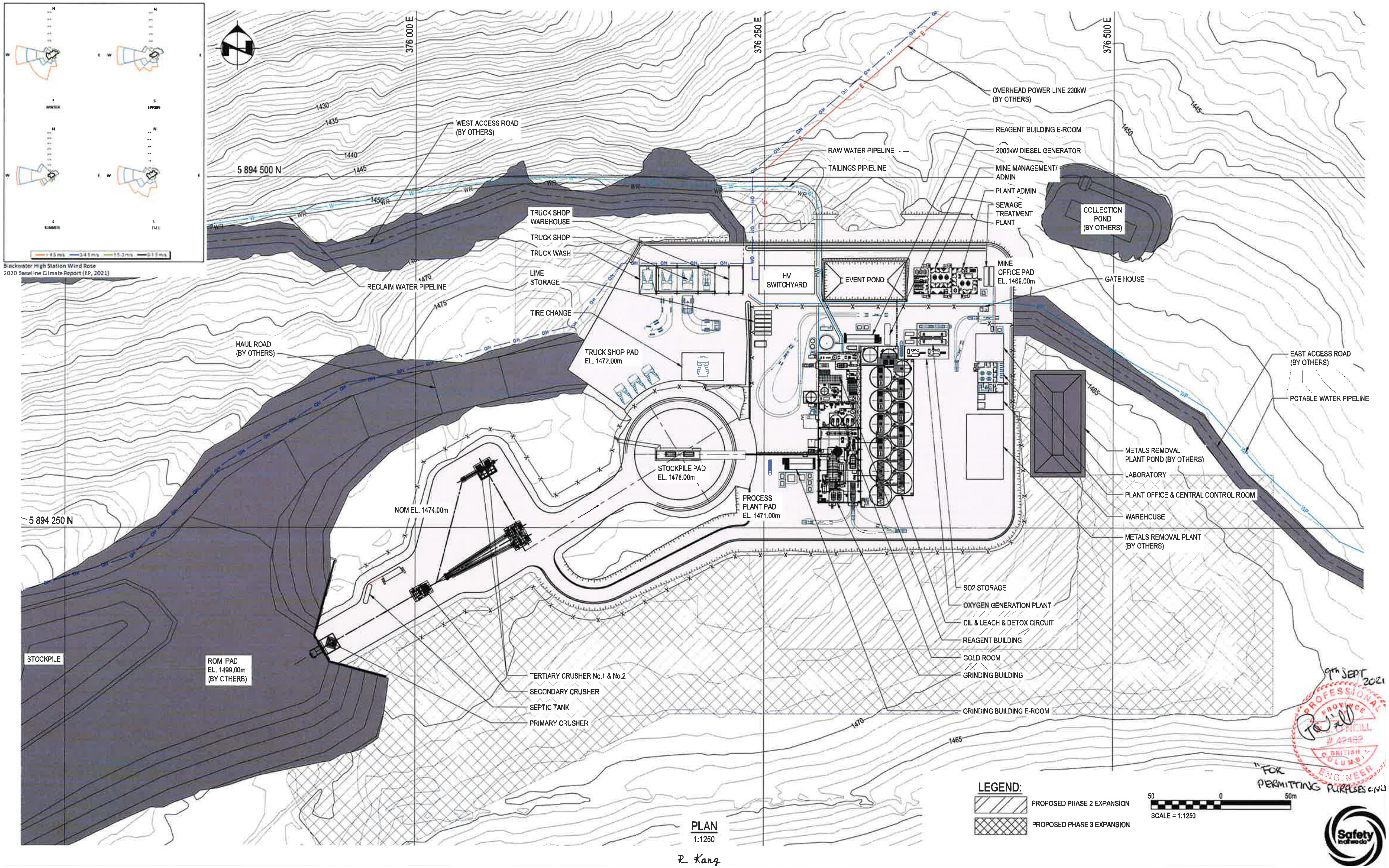


Figure 3.5-18: Processing Plant Site and Associated Facilities

Source: Knight Piésold Consulting (2021a; Appendix 3-B).

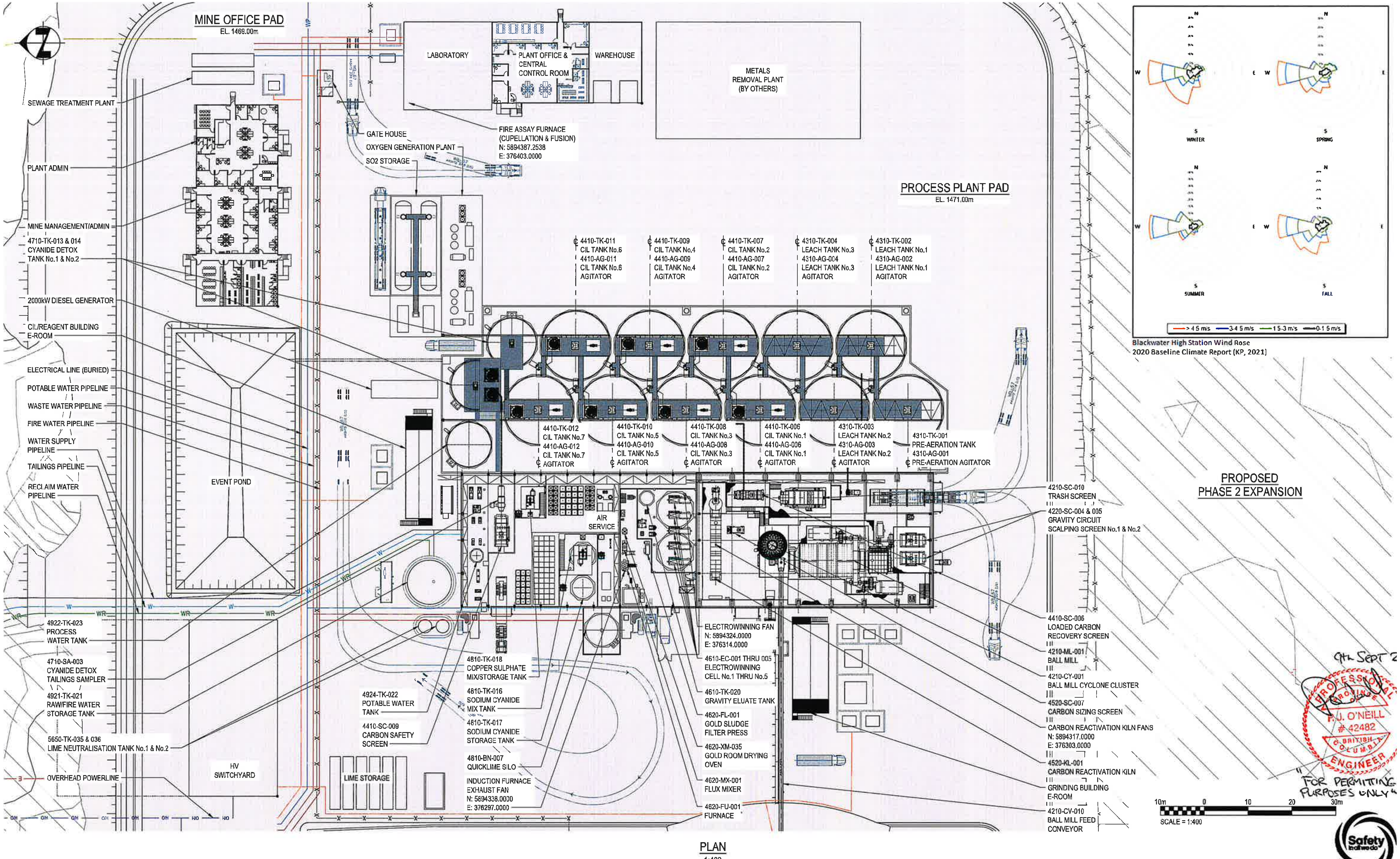


Figure 3.5-19: Plan View of Processing Plant

Source: Ausenco (2021; Appendix 3-F).

- Part 3 Mine Plan; Section 3.5.3 Processing Plant (Mill) and Associated Facilities – JAIR (BC EMPR & BC ENV 2019a);
- Part 4 Reclamation and Closure Plan; Section 4.7.1 Infrastructure and Equipment – JAIR (BC EMPR & BC ENV 2019a); and
- Blackwater Gold Project Seismic Hazard Assessment (KP 2021g) – Appendix 2-E.

EAC Conditions

EAC Condition 32 requires the development and implementation of a Cyanide Management Plan, which is provided as an appendix in the Chemicals and Materials Storage, Transfer and Handling Plan (Appendix 9-M).

3.5.2.3 Condemnation Assessment

Condemnation of resources in the processing facilities footprint was investigated with drilling programs described in Appendix 3-G. A total of 131 drill holes were drilled across the Project area on 400 x 400 m centres, including the Plant Site area. The results of condemnation drilling were reinterpreted for the recent Project optimizations. The results of the reinterpretation indicate that there is no economically viable mineralization beneath the processing facilities footprint, or immediately adjacent and outside of the Open Pit.

3.5.2.4 Geotechnical Characterization

The geotechnical characteristics beneath the processing facilities footprint are covered by site investigations from 2021 (Appendices 3-D and 3-E). Plant site investigations include:

- Drilling of five sonic drillholes (GT21-11 to GT21-15) with a total drilling length of 188 m;
- Geotechnical logging of all sonic drill core;
- Collection of grab core samples at least every 3 m;
- Downhole seismic testing (DST) in drillholes GT21-11 and GT21-12;
- Installation of three VWPs in drillholes GT21-12 and GT21-14; and
- Laboratory soil testing of 29 grab soil samples.

The subsurface stratigraphy at the Plant Site can be grouped using the following material units:

- Topsoil – A topsoil layer is present over the entire Plant Site area. It comprises silty to gravelly sand mixed with gravel, roots, and organic cover, non-plastic, brown, loose, and moist, with a typical thickness of 0.2 to 0.3 m.
- Glacial Till – The dominant OVB material encountered across the site, immediately below the Topsoil layer, includes ablation till, lodgement till, and undifferentiated till. It comprises silty to gravelly sand and gravelly silt, with fine to coarse subangular to subrounded gravel, trace cobbles and clay. The glacial till encountered during the site investigation program was typically well-graded, low plasticity, greyish brown, massive, dense to very dense (SAND) or stiff to very stiff (SILT), moist, and varied in thickness from approximately 23 m to 46 m.
- Glaciolacustrine – A localized 1-m thick layer was encountered in drillhole GT21-15 only, in between glacial till layers, at a depth of approximately 16 mbgs. The Glaciolacustrine unit comprised sand and silt, with trace clay, and was uniformly graded, low plasticity to non-plastic, brown, firm, and wet.

- Reworked Regolith – A transitional layer between the Glacial Till and Bedrock units. The reworked regolith comprised gravelly to sandy silt and/or silty to gravelly sand, and was well-graded, low plasticity, yellowish brown to brown with iron oxide staining, massive, moist, and varied in thickness from 2.5 m to 8 m.
- Bedrock – Highly weathered to slightly weathered andesite rock, fine to coarse grained, grey, strong intact rock, fractured due to various degrees of weathering. The bedrock surface was found ranging from 22 mbgs to greater than 50 mbgs.

Foundation Geotechnical Profiles

Based on the results of the site investigations, the geotechnical profiles for the processing facilities are provided in Table 3.5.2-1.

Groundwater Conditions

Groundwater levels were measured in open holes during and immediately after the drilling program in February 2021. The open hole groundwater levels varied from 6 to 38 mbgs. VWPs were installed after the completion of drillholes GT21-12 and GT21-14. The measured static groundwater levels in March 2021 were 30 and 25 mbgs, respectively.

Table 3.5.2-1: Geotechnical Profiles for Processing Plant Facilities

Geotechnical Unit	Crusher / Stockpile Zone		Processing Plant Zone	
	Surface Elevation (masl)	Thickness (m)	Surface Elevation (masl)	Thickness (m)
Upper Till (Medium Dense)	1,476	5	1,472	4
Middle Till (Dense)	1,471	9	1,468	35
Lower Till (Very Dense)	1,462	9	1,433	5
Reworked Regolith	1,453	2	1,428	2
Weathered Bedrock	1,451	-	1,426	-

The Glacial Till unit is considered a low permeable material. Previous laboratory permeability testing results on remolded soil samples also show a low permeability of the Glacial Till unit, with measured hydraulic conductivity on the order of approximately 10^{-7} cm/sec.

Foundation Design and Construction

The site is favourable to apply shallow foundations for the processing facilities. A combination of shallow spread footings and mat foundations will be used for facilities. Spread footings are recommended for buildings. Mat foundations are recommended for the grinding area and the milling building where heavy loads and vibrating forces are expected. The Upper Till unit is considered the primary bearing layer for shallow foundations. Engineered structural fill will be needed for over-excavated foundation areas and for earthwork structures. The design criteria and recommended foundation types are provided in Table 3.5.2-2.

Shallow foundations are favourable given the presence of dense and thick glacial till materials and a low groundwater table. The overconsolidated upper till unit is expected to be the primary bearing layer for various shallow foundations. The unsuitable surficial materials, such as topsoil or loose surficial materials, should be removed prior to construction. Engineered structural fill can be used to backfill the over excavated areas and act as a subgrade layer for shallow foundations. The engineered structural fill should be a well-graded, free-draining, granular material with a maximum particle size of 75 mm. It is assumed that the compacted structural fill would have a unit weight of 20 kN/m3, a 37-degree frictional strength with zero cohesion, and an elastic modulus of approximately 30 MPa.

Table 3.5.2-2: Design Criteria and Foundation Types for Processing Plant Facilities

Facility	Foundation Type	Dimensions	Allowable Bearing Capacity	Settlement and Differential Settlements
Primary crusher	Assumed Mat	Assumed 17 m x 22 m x 1.5 m	Assumed 300 kPa for vibrating equipment	Assumed < 25 mm
Coarse ore stockpile	Assumed Mat	Assumed 10 m x 50 m x 1.5 m	Assumed 900 kPa	TBD
Grinding area	Mat	20 m x 30 m x 1.5 m	100 kPa for vibrating equipment	<5 mm
Buildings	Spread Footings	3 m x 5 m x 0.8 m	150 kPa	<25 mm
Carbon-in-Leach and Ore Leach Tanks	Ring Footings / Mat	16 m diameter	300 kPa	<25 mm

Appendix 3-H provides detailed foundation evaluation for the processing facilities including:

- Site seismic classification;
- Frost penetration depth;
- Bearing capacity and settlement for shallow foundations (spread footings and mat foundations);
- Modulus of subgrade reaction;
- Dynamic shear modulus;
- Lateral earth pressure coefficients; and
- Interface friction coefficients.

Mines Act Permit M-246 (Early Works) authorizes levelling only of the Plant Site foundation. This Application is seeking approval for Plant Site excavations or engineered fill placement. Foundation development will continue for each building commencing in Year -2. Section plans are provided in Appendix 2 Design Drawings in Appendix 3-F.

3.5.2.5 Seismicity and Geohazards

The potential risk to the mine site of natural and seismic hazards are discussed in Section 2.3.4 Natural and Seismic Hazards Assessments and in Appendix 2-E.

The National Building Code of Canada (NBCC 2015) defines six site classes (A to F) for seismic response evaluation. The Plant Site is categorized as a Class C site covered by very dense soil and soft rock with an average shear wave velocity in the range of 360 to 760 m/sec.

The foundations for the Plant Site structures will be placed on glacial till or compacted structural fill. Earthquake loading for buildings and structures shall be in accordance with NBCC Part 4. For structural design, the parameters used to represent seismic hazard are the 5%-damped horizontal spectral acceleration (Sa) values for periods (T) of designated seconds (e.g., 0.2, 0.5, 1.0, 2.0, etc.) and the horizontal Peak Ground Acceleration (PGA) value, that have a 2% probability of being exceeded in 50 years (return period of about 1 in 2,475 years).

For BC, a low seismic region is classified as Sa (0.2) $\leq$ 0.70 (BC Ministry of Municipal Affairs and Housing 2018); hence, the mine site is well below the threshold for a low seismic region. Buildings and other structures for the processing facilities will follow or exceed the BC Building Code 2018 (Government of BC 2018a) seismic guidelines.

In general, the overall risk to landslides and mass wasting, snow avalanches, flooding, subsidence, and volcanic events is very low. Forest fires will vary according to season and on an annual basis. Process facilities will meet BC Fire Code 2018 and the mine site has fire fighting facilities.

3.5.2.6 Design Criteria

The design criteria for the processing facilities are provided in Appendix 3-F. Specific sections in Appendix 3 Design Criteria of Appendix 3-F are as follows:

- Process Design Criteria – Ausenco Doc. No. 105177-ER-E0000-22222-001;
- Mechanical Design Criteria – Ausenco Doc. No. 105177-EM-E0000-22222-001;
- Piping Design Criteria – Ausenco Doc. No. 105177-EP-E0000-22222-001;
- Structural Design Criteria – Ausenco Doc. No. 105177-ES-E0000-22222-001;
- Electrical Design Criteria – Ausenco Doc. No. 105177-EE-E0000-22222-001;
- Instrumentation and Control Design Criteria – Ausenco Doc. No. 105177-EI-E0000-22222-001;
- Civil Design Criteria – Ausenco Doc. No. 105177-EB-E0000-22222-001; and
- Site Conditions Design Criteria – Ausenco Doc. No. 105177-GX-E0000-22221-001.

3.5.2.7 Processing Plant

The processing facilities will have a number of different areas. Figures 3.5-18 and 3.5-19 presents the layout of these areas. The overall process flow sheet provides the relationship between each area and the names for structures and equipment in the process (Figure 3.5-20). Processing plant design details are provided in Appendix 3-F for the initial throughput production through Year +5.

Crushing Area

The crushing area will be approximately 325 m southwest of the processing facilities. The area will be approximately 140 m x 90 m (at its widest) and will be separated from the RoM pad by a 25 m mechanically stabilized earth retaining wall to the southwest. The stockpile feed conveyor will be on the eastern boundary of the crushing area. The primary, secondary and tertiary crusher areas have baghouses to control dust.

Stockpile Feed Conveyor

The stockpile feed conveyor area will be to the southwest of the processing facilities. The area will be approximately 115 m x 30 m. The stockpile feed conveyor will transport crushed ore from the tertiary screen undersize conveyor to the crushed ore stockpile.

Crushed Ore Stockpile

The crushed ore stockpile will be west of the processing facilities. The area will be circular with an approximately 70 m dia. The covered crush ore stockpile will be designed with a 37 degree angle of repose and will store a maximum of 32,100 tonnes. There will be baghouses in the stockpile conveyor tunnel to control dust.

Processing Plant

The Processing Plant pad will be approximately 175 m x 130 m. Buildings and structures within this area includes:

- Grinding area;
- Leach area;
- Reagents area;
- Gold room;
- Cyanide destruction area; and
- Other processing plant facilities.

Buildings will be steel frame, with the exception of the gold room, with sandwich panel covering, fitted with crane rails along their whole length and furnished with a travelling crane. At least one large equipment door will be fitted with three personnel doors. All the main plant buildings will be in close proximity and will be joined by covered corridors. The gold room will be constructed with tilt up concrete to provide a more secure environment.

3.5.2.8 Process Flow

The overall process flow sheet is presented in Figure 3.5-20. The process design criteria is presented in Appendix 3-F (Ausenco 2021).

Crushing

There will be three crushing circuits within the crushing areas. Each circuit will be in a separate building to help suppress noise, vibration, and dust. The crushing circuits within the crushing area will have the following components:

- Primary crushing:
  - Primary crusher dump pocket;
  - Primary gyratory crusher;
  - Primary crusher discharge vault;
  - Primary crusher belt feed; and
  - Primary crusher E-room.
- Secondary crushing:
  - Secondary screen feed conveyor;
  - Secondary screen;
  - Secondary screen oversize conveyor;
  - Secondary cone crusher;
  - Secondary crusher discharge conveyor; and
  - Secondary and tertiary crusher area E-room.
- Tertiary crushing;
  - Tertiary screen feed conveyor x 2;
  - Tertiary screens x 2;
  - Tertiary crusher surge bin feed conveyor;
  - Tertiary screen undersize conveyor;
  - Tertiary crusher surge bins x 2;
  - Tertiary crusher vibrating belt feeders x 2;
  - Tertiary crusher x 2; and
  - Tertiary crusher discharge conveyor x 2.

Primary crushing will start with ore fed directly from haul trucks into the primary crusher dump pocket that feeds the primary gyratory crusher. Crushed material will report to the primary crusher discharge vault with discharge to the primary crusher belt feed for transport to the secondary crusher.

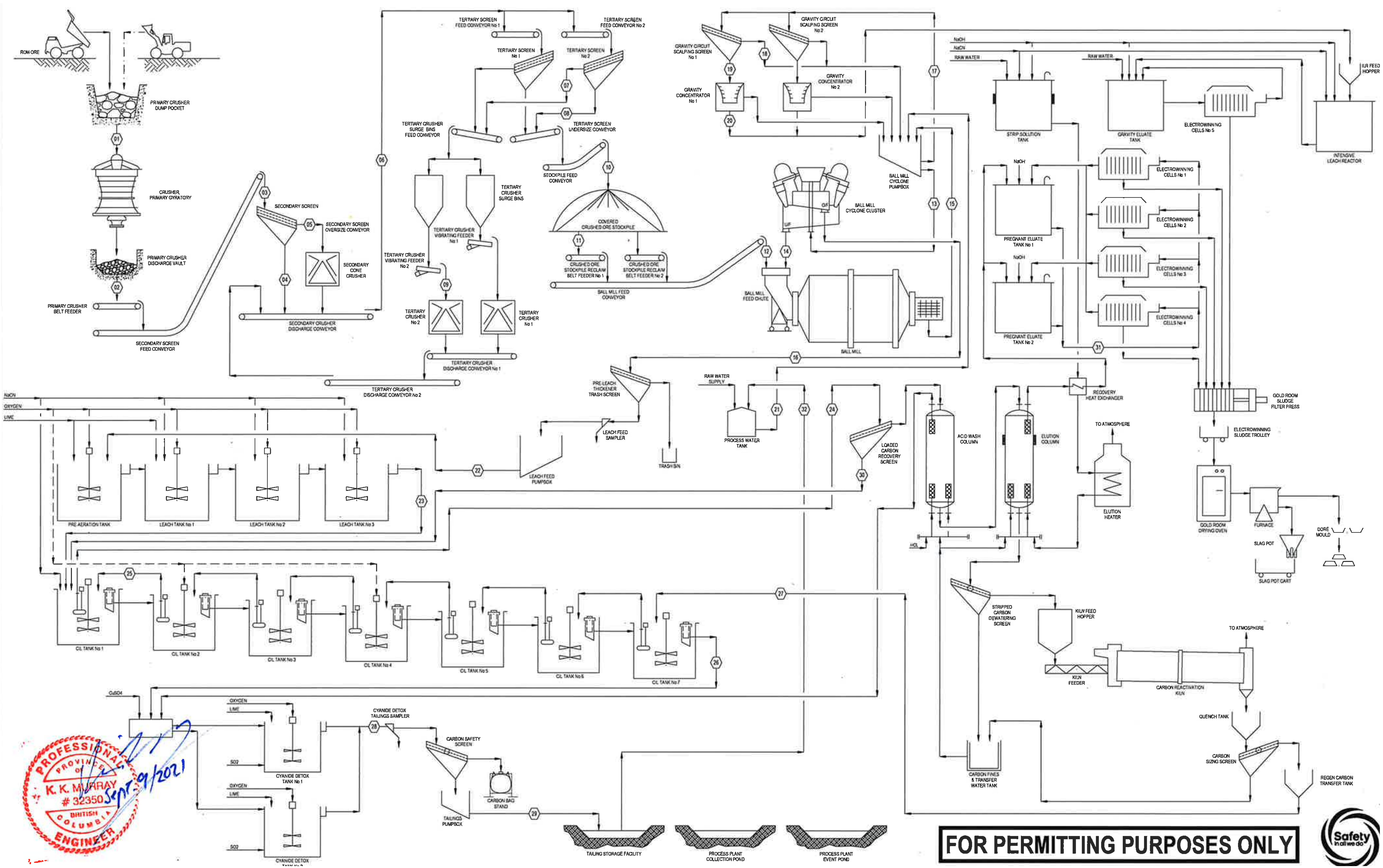


Figure 3.5-20: Overall Flow Sheet

Source: Ausenco (2021; Appendix 3-F).

Secondary crushing will start with the feed from the secondary screen feed conveyor for sorting by the secondary screen then comminution in the secondary cone crusher. Crushed undersized material will report directly to the tertiary screen feed conveyor. Oversize material will report to the secondary screen oversize conveyor for discharge back to the secondary crusher belt feeder for refeed through the secondary cone crusher.

Tertiary crushing will start with the material on the tertiary screen feed conveyor being fed to one of two tertiary screens. Undersize materials will report directly to the tertiary screen undersize conveyor for transfer to the stockpile feed conveyor. Oversize material will report to the tertiary crusher surge bin feed conveyor for transfer to one of two tertiary crusher surge bins, then to the tertiary crusher belt feeders, and fed into one of two tertiary cone crushers. The crushers will then discharge onto the tertiary crusher discharge conveyor for transport back to the tertiary screen feed conveyor where undersize material will report to the stockpile feed conveyor to the crushed ore stockpile. Oversize materials will continue to recycle through the tertiary crushers until they are minus 15 mm.

Stockpile Feed Conveyor

The stockpile feed conveyor transports crushed ore from the tertiary screen undersize conveyor to the crushed ore stockpile.

Crushed Ore Stockpile

Crushed ore is conveyed from the stockpile by two crushed ore stockpile reclaim belt feeders which discharge onto the ball mill feed conveyor.

Milling

The milling circuit will be located in the grinding area and have the following components:

- Ball mill (14,000 kW);
- Ball mill feed chute;
- Trommel screen;
- Ball mill cyclone pumpbox;
- Gravity circuit scalping screen x 2;
- Gravity concentrator x 2; and
- Ball mill cyclone cluster.

The ball mill feed conveyor will transport the crushed ore to the ball mill feed chute, where it will mix with process water, lime, and cyclone underflow slurry to become ball mill feed. The ball mill discharge is a P80 150 µm product. Ball mill discharge will gravitate through the trommel screen and into the ball mill cyclone pumpbox. The ball mill cyclone pumpbox is equipped with two pumps and each will feed one of two gravity circuit scalping screens. The underflow will feed one of two centrifugal gravity concentrators. Overflow will join the ball mill cyclone cluster feeding the ball mill.

The other pump will feed slurry to the ball mill cyclone cluster (four operating, two standby) which will separate the P80 150 µm product and the underflow. The latter will be recycled into the ball mill. The cyclone overflow will report to the pre-leach thickener trash screen for trash removal prior to entering the Leach Circuit.

Leaching and Carbon Adsorption

The leach circuit is the primary gold recovery process (Figure 3.5-19). The circuit will be located in the leaching area on the north side of the processing facility and have the following components:

- Pre-leach thickener trash screen;
- Leach feed sampler;
- Leach feed pumpbox;
- Pre-aeration tank;
- Leach tanks x 3 (15.5 m h. x 15 m dia.);
- Carbon-in-leach (CIL) tanks x 7 (15.5 m h. x 15 m dia.); and
- Loaded carbon recovery screen.

The leaching process will start with the ball mill cyclone overflow that passes through the pre-leach thickener trash screen. This material will be sent to the pre-aeration tank with lime added to the tank to adjust the pH. A leach feed sampler will provide information to adjust the lime and cyanide levels for the leach circuit. As the solution is sent to leach tank #1 and subsequent leach tanks #2 and #3, oxygen and cyanide will be added to maintain pH and to dissolve gold into solution. The gold pregnant leach solution will then be sent to the CIL tanks.

Carbon-in-leach adsorption will use activated carbon to adsorb gold from the gold pregnant leach solution. Retention screens will hold the activated carbon within each of the seven CIL tanks. For maximum extraction efficiency, the solution will be moved from tanks #1 to #7 while the carbon retention screens are moved counter current from tanks #7 to #1. The carousel of carbon retention screens will be progressively exposed to higher concentrations of gold in solution producing maximum saturation of the active sites on the carbon. With maximum saturation achieved at tank #1, the loaded carbon recovery screen will be transferred to the loaded carbon recovery screen for the start of the elution circuit for gold recovery. Exhausted tails from the CIL tank #7 will report to the cyanide detox tank #1 and tank #2.

Elution

Elution takes place in the grinding area and will have the following components:

- Loaded carbon recovery screen;
- Acid wash column;
- Strip solution tank;
- Recovery heat exchanger;
- Elution heater;
- Elution column; and
- Pregnant eluate tank #1 and tank # 2.

The screened carbon from the loaded carbon recovery screen will be transferred to the acid wash column. Undersized materials will be returned to the CIL tank #1 for reprocessing. In the acid wash column, hydrochloric acid will be used to dissolve inorganic contaminants to maximize exposure of the remaining gold-cyanide complexes for efficient stripping. The acid washing will also prevent excessive carbon deterioration during the thermal regeneration caused by swelling of inorganic species. The washed loaded carbon will be forwarded to the elution column.

The strip solution of water, sodium hydroxide and cyanide for the elution column will be mixed in the strip solution tank. The solution is heated to 140 degrees Celsius in the elution heater prior to entering the elution column. The elution process will take upwards of 10 hours. At the end of the process, the gold pregnant eluate solution will pass through a recovery heat exchanger then will discharge into one of two pregnant eluate tanks prior to electrowinning in one of electrowinning column #1 to #4. The recovered heat exchange will use the outgoing eluate to pre-heat the incoming strip solution to save on energy and help cool the gold pregnant eluate solution prior to storage.

Gravity Concentrate

The gravity recovery circuit will provide secondary processing of the ball mill slurry. This will improve the efficiency of processing and increase recovery of gold. The gravity recovery circuit will have the following components:

- Gravity circuit scalping screens x 2;
- Gravity concentrator x 2;
- Intense leach reactor feed hopper;
- Intensive leach reactor; and
- Gravity eluate tank.

Material passed through each of the two gravity circuit scalping screens will report to one of two gravity concentrators. Oversized materials will be transferred back to the ball mill cyclone underflow. Concentrate from the gravity concentrators will be conveyed to the intense leach reactor feed hopper for feed into the intensive leach reactor for intense cyanidation of the gravity concentrate. The loaded solution will then be stored and separated with a flocculent in the gravity eluate tank. The gold pregnant leach solution will be sent to the dedicated electrowinning cells #5 in the gold room. The gold-free flocculate will be rinsed to remove residual cyanide and directed for tailings placement. The rinse water will be sent to one of the two cyanide detox tanks.

Electrowinning

Electrowinning will be carried out in the gold room. Five sets of electrowinning cells will be utilized. Electrowinning cells #1 to #4 will be dedicated to the primary recovery process while electrowinning cell #5 will be dedicated to the gravity concentrate recovery. The cells will be immersed in the pregnant eluate solution or gravity eluate solution. The precious metal sludge and sludge from the cells and cathodes will be pressure washed into the gold room sludge filter press to be oven dried into filter cakes prior to refining.

Refining Room

Refining Room where the following key components will be housed:

- Gold room sludge filter press;
- Electrowinning sludge trolley;
- Gold room drying oven;
- Induction furnace;
- Slag pot;
- Doré mold; and
- Slag pot cart.

Filter cakes from the gold room sludge filter press will be transferred via the electrowinning sludge trolley into the gold room drying oven to remove excess moisture prior to placement into an induction furnace. Borax, silica, sodium carbonate, and niter will be added as fluxes for the smelting process. The molten gold will be poured into doré moulds. The doré bars will be cleaned, numbered and weighed prior to secure storage and shipping. Slag will be poured into the slag pot and transferred via the slag pot cart. Slag will be broken up, any large pieces of metal recovered manually, and the rest will be recycled to the mill.

Carbon Regeneration

Carbon regeneration will take place in the grinding area and will have the following components:

- Stripped carbon dewatering screen;
- Carbon fines and transfer water tank;
- Kiln feed hopper;
- Carbon pre-dryer hopper;
- Kiln feeder;
- Carbon reactivation kiln;
- Quench tank; and
- Carbon sizing screen.

The stripped carbon from the elution column will be forwarded to the stripped carbon dewatering screen. Screened carbon will discharge to the kiln feed hopper while undersize passed materials are discharged to the carbon fines and transfer water tank. The kiln feed hopper will discharge to the carbon pre-dryer hopper and then onto a kiln feeder for entry into the carbon reactivation kiln. After heating and reactivation of the carbon, material will be quenched, and then sized through a carbon sizing screen. Screened carbon is loaded on retention screens for eventual placement back into the CIL tank #7. Undersized carbon is sent to the carbon fines and transfer water tank. All materials in the carbon fines and transfer water tank is recycled through the elution process either through the acid wash or elution columns.

Cyanide Destruction

Cyanide destruction will be housed in the leaching area and has the following components:

- Cyanide detox tanks x 2;
- Cyanide detox tailings sampler;
- Carbon safety screen;
- Carbon bag stand; and
- Carbon safety screen discharge to tailings pumpbox.

Cyanide detox tank # 1 and tank # 2 will receive cyanide bearing tailings from the leach circuit, inorganic materials from the acid wash column, and the carbon fines area sump drainage. A number of chemicals will be added to detoxify the cyanide residues; lime to adjust the pH, copper sulphate as a catalyst, and SO_2 will be asparged into tanks with agitation. The process will utilize two sequential tanks to support the volume of cyanide bearing tailings and to allow for fine-tuning of treatment. After treatment, the tailings will be sampled. The carbon will be removed via a carbon safety screen with the carbon bagged and appropriately disposed as a hazardous waste (Waste (Refuse and Emissions) Management Plan in Appendix 9-N).

3.5.2.9 Other Plant Site Facilities

In addition to Plant Site roads, other facilities located at the Plant Site include:

- Plant administration building;
- Plant office and central control room;
- Laboratory;
- Warehouse;
- Electrical rooms;
- Water storage tanks and fire water pumpskid;
- Stormwater drainage system and drainage pond;
- Truckshop and Wash including warehouse, tire change shop, and ready line – discussed in Section 3.5.11.7 Truckshop and wash/Mine Office;
- Sewage Treatment Plant – discussed in Section 3.5.11.12 Waste Management Facilities, Section 5.7 Domestic Water/Sewage Treatment, and Appendix 3-I;
- Lime neutralization system – discussed in Section 5.6.6 Lime Neutralization System and Section 3.0 Lime Neutralization System of Appendix 3-F; and
- Metals WTP – discussed in Section 5.6.4 Metals Water Treatment Plant and Appendix 5-G.

Plant Administration Building

The plant administration building will contain offices, break-out rooms, lunchroom, washrooms and office and records storage rooms. The mine office will be of modular construction, and supported by a cast-in-place concrete spread footings. HVAC will be provided by stand-alone electric units.

Plant Office and Central Control Room

The plant office will house all plant operation and maintenance offices. A central control room will be located in this complex, with closed circuit TV coverage of all parts of the processing facilities. The building will also have offices, breakout rooms, lunchrooms, change and wash facilities, and lockers. The plant office will be of modular construction, and supported by a cast-in-place concrete spread footings. HVAC will be provided by stand-alone electric units.

Assay Laboratory

The assay laboratory will be of pre-engineered modular construction, modified to allow solid floors where necessary for heavy equipment such as crushers or fire assay furnaces. The building will have lab benches and fume hoods, reagent handling areas, and emergency wash facilities. These will be segregated from offices and records, and toilets, and change rooms.

Warehouse

The warehouse will maintain the equipment associated with the processing facilities. The building will be insulated, pre-engineered, and sprinklered, and will be supported on cast-in-place concrete spread footings. The building will have overhead under-slung crane, as well as an electrical and instrumentation shop, workbays, warehouse space, tool crib, tool box storage, compressor, and electrical room.

Electrical Rooms

E-rooms will be used to house the following equipment:

- Incoming load break switches and dry type distribution transformers;
- Medium and low voltage switchgear, variable frequency drives and motor control centre assemblies;
- Power factor correction capacitors and controllers;
- Special power equipment (e.g., variable speed controllers, electronic brakes, rectifiers, etc.);
- Process control system equipment;
- Service transformers and panels; and
- Grounding bar shall be contained within each equipment such as transformers, switchgears, motor control centre (MCC), etc.

The following E-rooms will service the processing plant area:

- Primary crusher E-room – primary crusher;
- Secondary and tertiary crusher E-room – secondary and tertiary crushers;
- Process plant E-room - grinding area; and
- Carbon-in-leach/reagents E-room – leaching area and reagents area.

E-rooms will be prefabricated, preassembled, pre-tested (off site) modular units, complete with heating, ventilation, lighting, and air conditioning to meet the requirements of the equipment contained within. E-rooms will be constructed with non-combustible cladding and roofing material and built to maintain one-hour fire rating in accordance with BC Fire Code 2018. E-Rooms room temperature will be maintained, during winter and summer months, within a range of 10°C to 30°C, including when any one component of the air-conditioning system is out of service.

Further details of E-rooms are found in Appendix 3 Electrical Design Criteria Section 9.2 Electrical and Control Rooms of Appendix 3-F.

Water Storage Tanks

Two aboveground water storage tanks will be located to the southeast of the reagents areas. Each will be cylindrical with a 750 m^3 capacity.

The process water tank will primarily receive reclaim water from the TSF pumped via the TSF reclaim water barge and as a secondary source from the contact water pond at the process plant via a pumping system in the pond. The primary output for the process water will be to the ball mill cyclone pumpbox.

The raw water storage tank will contain potable water for use in all buildings and be an input into the firewater pumpskid for fire suppression.

Details are found in Appendix 3 Process Design Criteria of Appendix 3-F.

Stormwater Drainage System and Drainage Pond

The stormwater drainage design conveys the surface water from the crushing area, stockpile feed conveyor, crushed ore stockpile, and processing plant area through a series of ditches, culverts and spillways to the drainage pond (Figure 3.5-18). The pads are designed to drain the surface water towards the pad ditches which convey the water to the pond.

Details of the stormwater drainage system are found in Appendix 3 Civil Design Criteria Section 7.0 Stormwater Drainage of Appendix 3-F.

Plant Site Roads

All Plant Site roads will be gravel surfaced, uniformly graded, free draining and compacted to meet the requirements of traffic loads based on the vehicle designs referenced in Section 3.5.11.13 Mobile and Supporting Mine Equipment. Details of the Plant Site roads and parking areas are found in Appendix 3 Civil Design Criteria Section 6.0 Roadworks Stormwater Drainage of Appendix 3-F.

3.5.2.10 Heating, Ventilation, and Air Conditioning (HVAC), and Dust Control

Ventilation systems have been designed according to the Appendix 3 Mechanical Design Criteria Section 16 HVAC and Dust Control of Appendix 3-F which specifies required indoor temperature of 5 degrees Celsius and outdoor temperatures ranging from minus 20 degrees Celsius to plus 20 degrees Celsius. HVAC and dust collection systems have been designed for the crushing circuit, reclaim tunnel, process plant, reagent preparation, and gold room areas. Air flow rates and stack velocities were determined based on the Industrial Ventilation Handbook published by ACGIH (2000).

HVAC equipment for process buildings, where specified, is propane fired. Interior design temperatures are for normal plant running. Abnormal extreme temperatures or non-running conditions will be supported by mobile gas heaters.

Processing and handling equipment will be in enclosed buildings:

- Primary crusher building will be enclosed, cladded, insulated, and heated.
- Secondary and tertiary crusher building will be enclosed, cladded, insulated, and heated.
- Stockpile cover will be covered without insulation or heating (HVAC – natural ventilation only).
- Crushed ore stockpile reclaim belt feeders in reclaim tunnel will be covered, without insulation or heating (HVAC – natural ventilation only).
- Grinding, leach, reagent areas will be enclosed, cladded and insulated (HVAC – heated to 10°C minimum and ventilated).
- Electrical equipment, control rooms, office and mine dry will be in modular buildings with standalone electric HVAC system.

Fugitive dust suppression measures will be applied in the following areas:

- ROM dumping;
- Crushing and screening transfer areas; and
- Stockpile feed conveyors.

Details of the fugitive dust suppression measures are detailed in Appendix 9-O Air Quality and Fugitive Dust Management Plan.

Dust collection will be provided for the following areas:

- Primary Crusher Building – baghouse collector including blower and ducting with pickups at the primary crusher dump pocket and primary crusher discharge vault;
- Secondary and Tertiary Crusher Building – baghouse collector including fan and ducting with pickups at screen feed, discharge chutes and cone crusher feeder head;

- Crushed ore stockpile reclaim belt feeders in reclaim tunnel – cartridge style collector including fan and ducting with pickups at each reclaim feeder discharge; and
- Lime silo – a collector and ducting with pick-ups.

3.5.2.11 Process Reagents

Process reagents, including their purpose, addition rates, and area of use are presented in Table 3.5.2-3. Other minor reagents may include anti-scalants, leach acid and sulfamic acid (H_3NSO_3) (used for periodic cleaning of heat exchangers) and chemicals such as nitric acid used in the assay laboratory. The storage, transfer, and handling of these reagents are discussed in the Chemicals and Materials Storage, Transfer, and Handling Management Plan (Appendix 9-M).

3.5.3 Tailings Storage Facility and Associated Infrastructure

3.5.3.1 General Description

The TSF will permanently store tailings, PAG/NAG3 waste rock, provide a continuous source of process water during mine operations for ore processing, and support mine site water balance management. The TSF general arrangement at Year +23 is shown in Figure 3.5-21. The TSF was designed to hold a total of 469 Mm^3 of tailings and waste rock material and up to 12 Mm^3 of mine contact water under normal operating conditions. Additional freeboard allowances were included to manage seasonal inflows and design storm events. The TSF will comprise two adjacent sites, TSF C and TSF D, which will be developed in stages over the life of the Project as described in the following sections.

The TSF Stage 1 Detailed Design Report is provided in Appendix 3-J and presents the detailed design of Main Dam C to form TSF C, including Stage 1 to be constructed during the pre-production period (Years -2 and -1) and Stage 2 to be constructed immediately following Stage 1 during Year +1. The TSF Life of Mine Design Report is provided in Appendix 3-K and provides additional details for the Application relating to the life of mine development plan for the TSF.

TSF C will be constructed first to provide storage capacity for start-up of the process plant. It was designed to contain tailings for approximately 21 years of mine operations and PAG/NAG3 waste rock generated during the first six years of mining, which is equivalent to approximately 232 Mm^3 of tailings and 32 Mm^3 of waste rock. The supernatant pond volume allowance in each year ranges from 1 to 10 Mm^3 is equivalent to approximately 4 months of process water considering the planned ore throughput rate and tailings slurry solids content. TSF C will comprise a valley-fill style impoundment formed by construction of three embankments in the upper reaches of Davidson Creek drainage area. Specific overall features of TSF C are listed below:

- three (3) zoned water-retaining earth-rockfill dams referred to as Main Dam C, the Saddle Dam, and the West Dam;
- designated PAG/NAG3 waste rock disposal area between Year -1 and Year +6;
- the IECD and TSF pumpback system to recover potential seepage downstream of Main Dam C;
- the WMP located downslope of the open pit and stockpiles area within the ultimate footprint of TSF C to manage runoff from contributing areas and water pumped from collection points;
- diversion channels that route undisturbed runoff around the TSF;
- the Central Diversion System comprising collection channels that redirect undisturbed runoff upslope of the TSF to collection points and water transfer pumping systems to convey these flows to the WMP;
- tailings distribution system;

- tailings beaches;
- supernatant water pond; and
- reclaim water system.

TSF D will be constructed adjacent to and downstream of TSF C beginning in approximately Year +5 to provide additional storage capacity for PAG/NAG3 waste rock and tailings. TSF D will comprise a valley-fill style impoundment formed by construction of one embankment within the Davidson Creek drainage area. TSF D was designed to contain PAG/NAG3 waste rock generated during mining between Years +6 and +18 and up to approximately two years of tailings beginning in Year +21 when TSF C reaches design capacity. TSF D was sized to contain approximately 180 Mm^3 of waste rock and up to 25 Mm^3 of tailings. The design includes a nominal pond storage allowance of up to 2 Mm^3 beginning in Year +21 to allow for recycling of process water to TSF C and sufficient additional capacity for seasonal inflows and design storm events. Specific overall features of TSF D are listed below:

- one (1) zoned water-retaining earth-rockfill dam referred to as Main Dam D;
- designated PAG/NAG3 waste rock disposal area between Year +6 and Year +18;
- the ECD, interception trenches, and TSF pumpback system to recover potential seepage downstream of Main Dam D;
- the Northern Diversion System comprising collection channels that redirect undisturbed runoff upslope of the TSF to an intake structure and gravity pipeline to convey flows to the FWR;
- TSF water management pumps;
- tailings distribution system (beginning in Year +21);
- tailings beaches (beginning in Year +21);
- supernatant water pond (beginning in Year +21); and
- reclaim water system (beginning in Year +21).

Key TSF components are summarized below including references to sections containing additional information:

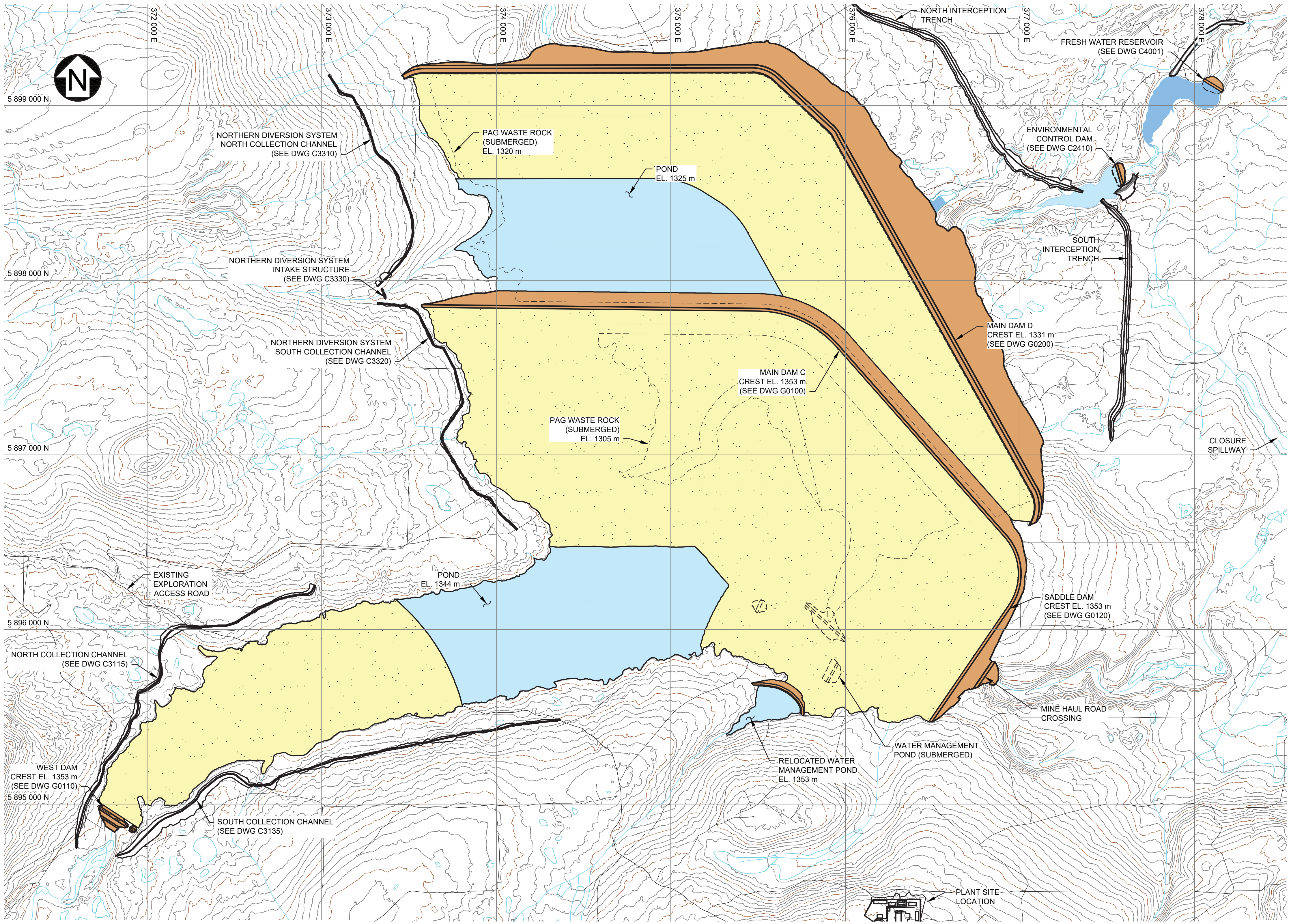
- Four water-retaining earth-rockfill dams – Section 3.5.3.8;
- Two storage ponds – Section 3.5.3.9;
- Tailings distribution systems and water reclaim systems – Section 3.5.3.11;
- Seepage management systems – Section 3.5.3.12;
- Water management structures and sediment control ponds to manage water and sediment transport during construction – Section 3.5.3.13;
- Monitoring instrumentation – Section 3.5.3.14; and
- Construction, operations, closure and post-closure water management structures – Sections 3.5.3.15 and 3.5.3.16.

Details on other TSF components are:

- Mine service and haul roads – Section 3.5.8; and
- Power supply and distribution – Section 3.5.9.

Table 3.5.2-3: Process Reagents Use and Quantities

Reagent	Purpose	Process Use	Addition Rate (G/T Ore)	Addition Rate (Kg/H Operating)	Annual Average Addition (tonnes)	Comment
Borax	Reduces slag viscosity and melting point	Gold smelting	4.9	3.31	26.7	Based on 4 smelts per week at 213 Kg of precious metals per smelt. 60 kg borax /100 kg of precious metals.
Carbon	Adsorbent for gold cyanide from leach solution	CIL process	35	23.8	192	
Copper sulphate	Catalyst for cyanide destruction	Cyanide detoxification	83	56.6	456	
Flocculant	Settling of ore slimes in intensive leaching of gravity concentrate	Gravity concentrate intensive leaching	0.06	0.0424	0.342	Extremely low dose of non-toxic chemical. Assume 1 drum is 205 kg of liquid flocculent. Consumption expected to be 1.67 drums per year.
Grinding media	Size reduction for ore prior to gold recovery	Grinding circuit	778	529	4,260	
Hydrochloric acid	Cleaning mineral deposits from loaded carbon	Acid wash column in elution area	-		1,398	Batch process, consumption at as received purity of 33%.
Hydrated lime	pH adjustment	CIL process	1,100	747	6,023	
		Cyanide destruction process	1,100	747	6,023	
		Total	**2,200**	**1,495**	**12,045**	Any difference is rounding error.
Hydrogen peroxide	Source of oxygen for intensive leach cyanidation	Gravity Concentrate Intensive Leach	0.73	0.496	4.00	2.4 tonnes per year is for 3 tpd; this is extrapolated to 5 tpd of gravity concentrate.
Nitre	Oxidizing agent for any base-metals in the electrowinning sludge	Gold smelting	0.41	0.276	2.22	Based on 4 smelts per week at 213 kg of precious metals per smelt. 5 kg nitre /100 kg of precious metals.
Silica	Primary slag- forming constituent; dissolves metal oxides	Gold smelting	2.4	1.65	13.3	Based on 4 smelts per week at 213 kg of precious metals per smelt. 30 kg silica /100 kg of precious metals.
Sodium carbonate	Reduces slag viscosity, improves slag clarity	Gold smelting	0.41	0.276	2.22	Based on 4 smelts per week at 213 kg of precious metals per smelt. 5 kg sodium carbonate /100 kg of precious metals
Sodium cyanide	Gold dissolution	Gravity concentrate intensive leaching	Not calc'd			Any cyanide used here eventually reports to the CIL process.
		CIL process	500	340	2,738	
		Gold elution process	33.3	23	183	Any cyanide used here eventually reports to the CIL process.
		Total	**533**	**362**	**2,920**	
Sodium hydroxide	Protective alkalinity for mixing of cyanide solutions plus electrolyte for electrowinning	Sodium cyanide mixing	Not calc'd			
		Elution / Electrowinning	-		2,485	Batch process, consumption at as received purity of 50%.
		Gravity concentrate intensive leaching	33	22.5	181	109 tpy for 3 tpd of gravity con; extrapolated for 5 tpd of gravity con.
		Total	**Not calc'd**			
Sulphur dioxide	Oxidizing agent for destruction of weak acid dissociable cyanide in tailings streams	Cyanide detoxification	1,867	1,268	10,220	



PLAN
YEAR 23
SCALE A

G0200	TSF - MAIN DAM D - LIFE OF MINE - PLAN AND PROFILE
G0120	TSF - SADDLE DAM - LIFE OF MINE - PLAN AND PROFILE
G0110	TSF - WEST DAM - LIFE OF MINE - PLAN AND PROFILE
G0100	TSF - MAIN DAM C - LIFE OF MINE - PLAN AND PROFILE
C4001	FRESH WATER RESERVOIR - EMBANKMENT AND RESERVOIR - GENERAL ARRANGEMENT
C3330	NORTHERN DIVERSION - INTAKE STRUCTURE - GENERAL ARRANGEMENT - PLAN AND SECTION
C3320	WATER MANAGEMENT - NORTHERN DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE - YEAR 7
C3310	WATER MANAGEMENT - NORTHERN DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE - YEAR 7
C3135	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE - YEAR 7
C3115	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE - YEAR 7
C2410	ENVIRONMENTAL CONTROL DAM - PLAN AND PROFILE

LEGEND:

- TAILINGS BEACH
- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- EXISTING ACCESS TRAILS

NOTES:

1. COORDINATE GRID IS UTM NAD83 ZONE 10U.
2. NATURAL GROUND CONTOUR INTERVAL IS 5 METRES.
3. DIMENSIONS ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
4. MECHANICAL SYSTEM DETAILS NOT SHOWN FOR CLARITY, SEE MECHANICAL SYSTEMS DRAWINGS FOR DETAILS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE A 400 200 0 400 800 1200 1600 2000 m

Figure 3.5-21: Tailing Storage Facility Simplified General Arrangement Year +23

Source: Knight Piésold Consulting (2021).

3.5.3.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework relating to the design, construction, operation, closure, and reclamation of the TSF. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements include:

- Part 10.5 Operations; Section 10.5.1 Construction of Tailings and Water Management Facilities – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.5 Operations; Section 10.5.2 Operations, Maintenance and Surveillance (OMS) Manual – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.5 Operations; Section 10.5.3 Annual Dam Safety Inspection – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.5 Operations; Section 10.5.4 Dam Safety Reviews – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.6 Mine Closure; Section 10.6.6 Impoundments – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.6 Mine Closure; Section 10.6.7 Closure of a Tailings Storage Facility or Dam – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.6 Mine Closure; Section 10.6.8 Tailings Storage Facility Closure OMS Manual – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.6 Mine Closure; Section 10.6.9 On-going Management Requirements – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10.6 Mine Closure; Section 10.6.10 Permanent Spillways – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance includes:

- Tailings Dams and Seismicity: Review and Recommendations. Bulletin 98.International Commission on Large Dams (ICOLD 1995);
- Dam Safety Guidelines (CDA 2007);
- Draft Technical Bulletin: Mining Dams – Application of 2007 Dam Safety Guidelines to Mining Dams. (CDA 2013);
- Site Characterization for Dam Foundations in BC. V1.2 (APEGBC 2016);
- Technical Guidance 7: Assessing the Design, Size and Operation of Sediment Ponds Used in Mining (ENV 2015);
- A User Guide for Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining (ENV 2016);
- Part 3 Mine Plan; Section 3.5.4 Tailings Storage Facility and Associated Infrastructure – JAIR (BC EMPR & BC ENV 2019a); and
- Part 4 Reclamation and Closure Plan; Section 4.7.3 Tailings Storage Facility Reclamation – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Key reports and other documentation are:

- Blackwater Gold Project Mine Waste and Water Management Design Report (KP 2013d);
- Blackwater Gold Project Construction Sediment and Erosion Control Plan (KP 2013d);
- Tailings Storage Facility Failure Modes and Effects Assessment Report (KP 2015a);
- Letter: 100 Year Flood Flow Depths (KP 2015b);
- Blackwater Gold Mine Project Dam Breach Effects Assessment (ERM 2015);
- Section 2.2 Project Description; Subsection 2.2.3.4.7.3 Tailings Dam Hazard Classification (Application/EIS; New Gold 2015);
- Section 2.2 Proposed Project Description; Subsection 2.2.3.4.8 Tailings Storage Facility (Application/EIS; New Gold 2015);
- Section 2.6.7 Revegetation Plan; Subsection 2.6.7.2.1.2 Tailings Storage Facilities (Application/EIS; New Gold 2015);
- TSF Stage 1 Detailed Design Report (KP 2021h) – Appendix 3-J;
- TSF Life of Mine Design Report (KP 2021i) – Appendix 3-K;
- Dam Site Characterization Report (KP 2021j) – Appendix 3-L;
- Blackwater Gold Project, Assessment of Alternatives for Mine Waste Disposal (ERM 2021) – Appendix 3-M; and
- Water Management Structures Design Report (KP 2021k) – Appendix 3-O.

EAC Conditions

Conditions related to the design, construction, operation, closure and reclamation of the TSF include:

- Condition 11 (Care and Maintenance Plan) – requires the development and implementation of a plan that covers care and maintenance periods for both definite and indefinite time frames, including measures to monitor, manage, and avoid build-up of water surplus;
- Condition 33 (Mine Waste and Water Management Plan) – requires the development and implementation of a plan to manage mine waste and water that is protective of the receiving environment;
- Condition 34 (Closure and Post-Closure Water Quality Management Plan) – requires development and implementation of a plan for water quality management during closure and post-closure;
- Condition 35 (Tailings Dam Safety Transparency Plan) – requires identification and description of reports, reviews, inspections and meetings pertaining to dam safety and requires preparation of annual report related to dam safety.

The Care and Maintenance Plan must be developed in consultation with EMLI, ENV, Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) and Aboriginal Groups. The other three plans referenced above must be developed in consultation with EMLI, ENV, and Aboriginal Groups.

3.5.3.3 Alternatives Assessment

Two alternative assessments were previously completed and submitted with the Project's Application/EIS (New Gold 2015):

- Assessment of Alternatives for the Blackwater Gold Project Tailings Storage Facility (ERM 2015a): This report assessed alternatives to identify the most suitable candidate to locate the TSF, waste dumps, and LGO Stockpile. The waste dump and LGO Stockpile alternatives assessment was based on the preferred TSF location. This report followed Guidelines for the Assessment of Alternatives for Mine Waste Disposal (EC 2011).
- Evaluation of Alternative Tailings Technologies for the Blackwater Project (ERM 2015b): This report was prepared in response to BC Office request that all mine proponents consider the implementation of Best Available Technology (BAT) and Best Available Practices (BAP) identified by the Mount Polley Independent Investigation Review Panel. The report assessed tailings and waste rock storage alternatives and BAT/BAP for tailings management, considering the safety, technical, water balance, and lifecycle costs aspects for all Project phases, as well as the implications for environmental, health, social and economic values.

At the request of Environment and Climate Change Canada (ECCC), these reports were combined into one stand-alone report to incorporate the Project optimizations in the 2020 Pre-feasibility Study (Artemis 2020a). This report was prepared in accordance with 16 Guidelines for the Assessment of Alternatives for Mine Waste Disposal (ECCC 2016) and is provided in Appendix 3-M.

New Gold (previous owner) engaged with government agencies, Indigenous nations, local communities and the public on the alternatives assessment throughout the EA process. This included engagement with Indigenous nations and government agencies on the assessment methodology, identification of candidates and threshold criteria, "fatal flaw" screening criteria, high level risk assessment, multiple accounts and weightings, sensitivity analyses, and overall results. Since acquiring the Project in August 2020, BW Gold has continued to engage with Indigenous nations to provide updates on the Project, including the Project's requirement for and plans to submit documents in support of the Schedule 2 amendment. BW Gold has met with Indigenous nations and Fisheries Oceans Canada to discuss the proposed fish compensation plan.

Step 1 of the TSF alternatives assessment identified 23 reasonable, conceivable, and realistic options for technologies and storage locations for tailings and waste rock classified as PAG or NAG-potentially ML. Candidates for management of mine waste were developed based on topographical maps of the Project area with the threshold criteria considered in terms of terrain and storage capacity and the maximum production rate of 55,000 tpd.

A critical flaw assessment screened the TSF and PAG/NAG3 storage sites and technologies to eliminate those that:

- would result in deposition of tailings into a lake frequented by fish;
- are located in the sensitive Blackwater River watershed;
- are located in Ungulate Winter Range;
- are located on provincially or federally designated lands and/or private lands;
- have insufficient capacity to store waste produced during the mine life; or
- render collection and treatment of surface discharges impractical or improbable.

Thirteen candidates passed the pre-screening step and were carried through to a high level risk assessment. The risk assessment identified four candidates with the lowest risk profile for each of the distinct tailings and waste rock technologies. The four TSF and PAG/NAG3 waste rock candidates carried forward into the multiple accounts analysis (MAA) were:

- Candidate 1 – thickened slurry tailings with submerged PAG/NAG3 waste rock;
- Candidate 7 – 'dry stack' (filtered) tailings with submerged PAG/NAG3 waste rock;
- Candidate 10 – paste tailings with submerged PAG/NAG3 waste rock; and
- Candidate 22 – 'dry stack' (filtered) tailings with PAG/NAG3 waste rock on land.

The results of the MAA indicated that Candidate 1 (thickened slurry tailings with submerged PAG/NAG3 waste rock) scored highest overall and is the preferred alternative TSF location/technology. Candidate 1 scored highest for all accounts except Physical Stability. Candidate 22 scored highest with respect to Physical Stability because it meets many of the best available technology principles (e.g., water not stored within the active waste storage facility and dry, compacted tailings promote strength). However, Candidate 22 did not score high in the other accounts because of the technical challenges of operating a filtered TSF at the Project throughput, operating in the climate (i.e., precipitation), and the geochemical risks associated with unsaturated storage of PAG waste rock.

Candidate 1 scored highest for the Technical Account because this candidate allows for the best management of seepage through development of a long tailings beach. With Candidate 1, slurry deposition allows the greatest flexibility in the event of plant upset conditions as the tailings can easily be rerouted to other depositional areas. The saturation of PAG/NAG3 waste rock by submergence under water within the TSF is very important in ameliorating geochemical conditions so that metal leaching/acid rock drainage (ML/ARD) is minimized; long-term monitoring and maintenance is reduced with only the TSF runoff to capture (and anticipated quality of water will improve with saturation of PAG/NAG3 materials).

Candidate 1 scored highest for the Environment Account because the effects from poor water quality (ML/ARD) are minimized by submergence. Deposition by slurry maintains a wetted beach that minimizes dust generation. The seepage quantity is less than the other candidates as water is kept away from the dam by a large beach. The better water quality and lower dust emissions means toxicological risk to wildlife is minimized. Candidate 1 also scored highest for the Socio-economic Account because less dust and better water quality minimize the potential health effects from harvested resources.

To improve the physical stability of the chosen candidate further and to determine the BAP, a failure modes effects assessment was conducted that catalogued many of the practices identified in the EA and identified additional operational design elements (northern and southern diversions, relocation of tailings pond) and contingency measures (emergency overflows) (KP 2015a). Those design elements and contingency measures result in more robust water management, and thus improve physical stability. BAT for tailings and waste rock management was also evaluated, including a comprehensive assessment of the tailings facility design alternatives and management strategies for tailings and PAG/ML waste rock (KP 2015c).

3.5.3.4 Foundation Characterization

Condemnation Assessment

Condemnation drilling in the TSF footprint is detailed in the 2013 Blackwater Project Feasibility Study (AMEC 2013) and Condemnation Drilling Program – New Gold data 2012[7]. Condemnation drilling indicates that no mineral resources will be sterilized due to the TSF and associated infrastructure.

[7] Data available from BW Gold upon request.

Geotechnical Characterization

Geotechnical characterization of the TSF site and associated dam foundations was based on an extensive geotechnical database, which incorporates geological and geotechnical data from 2012, 2013, 2019, 2020, and 2021 site investigations (Appendix 3-L). Characterization was completed as per Engineers and Geoscientists of British Columbia (EGBC) guidelines. Characteristics of surface and subsurface materials and a summary of interpreted potential hydraulic conductivity for the main TSF components is provided below.

Main Dam C

The Main Dam C will be constructed initially during the mine pre-production phase (Years -2 and -1) to form TSF C and raised in stages over the life of the mine. The dam alignment was established to optimize use of the natural topography of the Davidson Creek watershed, allowing for efficient and long-term storage of mine waste rock and tailings. The detailed design of Stages 1 and 2 of Main Dam C is supported by extensive geotechnical investigations, laboratory testing of recovered samples, in-situ testing of select foundation units, and data from the piezometric monitoring instrumentation. Recommendations for additional work were outlined (see Section 3.3.5) to progressively enhance the knowledge base, reduce uncertainties in the site characterization, and support the detailed design for subsequent dam stages.

Information from 33 test pits, 19 geotechnical drillholes, and 4 condemnation drillholes completed along the Main Dam C alignment were used to characterize the geotechnical and hydrogeological conditions. A geological cross section (profile) along the Main Dam C alignment is presented on Figure 3.5-22. The dam will be founded on a thick glacial sequence ranging thickness from approximately 15 to 70 m. Ablation till typically occurs at surface along the dam footprint with localized surficial kettle and kame complexes also present locally along the East-West trending limb of Main Dam C and to the southeast of Davidson Creek within the Stage 1 dam footprint. Surficial esker deposits are located along the left abutment of the Davidson Creek valley on a terrace at approximately 1,240 masl trending towards the northeast to the IECD. The esker is truncated by a tributary to Davidson Creek downstream of the IECD and appears to extend further northeast towards the main esker field located approximately 2 km downstream. This localized esker deposit was identified as a potential aggregate borrow source for initial dam construction.

The dominant subsurface material is low-permeability glacial till. The lodgement and undifferentiated till occurs below the ablation till and surficial glaciofluvial deposits and extends to the reworked regolith or weathered bedrock units at depth with interval thickness ranging from 6 to 66 m. These glacial till materials are interbedded with glaciofluvial and glaciolacustrine deposits. The inferred glaciolacustrine deposits were grouped by elevation ranges and assessed to infer lateral continuity. The glaciolacustrine units encountered in the Main Dam C foundation generally comprised uniformly graded, stiff to very stiff, sandy silt with trace to some clay. These materials were typically deeply seated and heavily over consolidated. In-situ testing, including seismic cone penetration testing (SCPT) and downhole seismic testing (DST), indicates that the glaciolacustrine materials in this area are typically sand-like and strongly dilative at current stress levels. The SCPT probing also indicates that the glaciolacustrine materials are more dilative at lower confining pressures, which is consistent with expectations for a heavily overconsolidated glaciolacustrine unit that was unloaded during downcutting by fluvial erosion during deglaciation.

Buried glaciofluvial deposits were intersected interbedded with glaciolacustrine materials at the left abutment of Main Dam C with a depth of approximately 40 m and a thickness of approximately 5 m and a top elevation at approximately 1,200 masl. Similar glaciofluvial deposits interbedded with glaciolacustrine materials were encountered approximately 500 m farther downstream near the IECD location with a top elevation of approximately 1,196 masl. It is inferred that these glaciofluvial deposits could represent a buried channelized glaciofluvial deposit; however, more information on the continuity and connectivity of these units is required to conclude if a buried channel is present in this location.

A completely to highly weathered bedrock horizon underlies the glacial deposits with an elevation range from 1,228 to 1,169 masl, and overlies the intact bedrock horizon. The upper horizon of the completely weathered bedrock unit near Davidson Creek in proximity to the maximum section of the dam is typically weathered to silt and clay sized particles and is highly plastic and lightly overconsolidated. DST indicates that the upper horizon is the relatively less stiff than the overlying glacial soils and underlying bedrock. SCPT probing was advanced in the upper clayey horizon of the completely weathered bedrock unit to evaluate the soil behavior type and in-situ state of the material. The SCPT indicates the upper horizon is typically clay-like and could behave in a contractive manner if subjected to large strains.

The bedrock along the dam alignment can be generally described as a strong rock with 'FAIR' Rock Mass Rating (RMR_{89}) (Bieniawski1989). Geotechnical drillholes completed within the dam footprint did not penetrate deep enough to intercept intact bedrock. Condemnation drillholes indicate that the bedrock horizon is generally deeper than 1,150 masl towards Davidson Creek and generally shallower between 1,230 and 1,200 masl away from Davidson Creek. Condemnation drillholes within the vicinity of the dam alignment indicate that the bedrock lithology is predominantly andesite. Volcaniclastics, felsic intrusives, and andesites occur at the northwestern part of the dam alignment. Regional and structural geology are further discussed in the characterization report.

Static groundwater levels are relatively consistent in the vicinity of Davidson Creek with a piezometric elevations ranging from approximately 1,225 to 1,215 masl, which coincides with the approximate elevation of Davidson Creek in the area. Measured groundwater elevations along the dam alignment range up to 1,330 masl north of Davidson Creek and 1,286 masl south of Davidson Creek. Artesian conditions were encountered at the northwestern part of the dam alignment.

West Dam

The West Dam will be constructed in stages to form the western limit of TSF C beginning in Year +6. Information from two test pits and three geotechnical drillholes completed in the vicinity of the dam were used to characterize the geotechnical and hydrogeological conditions of the site. A geological cross section (profile) along the West Dam alignment is presented in Figure 3.5-23. Additional sites located further from the West Dam were used to supplement the available information, including seven test pits, two geotechnical drillholes, two condemnation drillholes, and seismic refraction surveys completed nearby. The current site characterization at the West Dam is primarily based on rotary drilling methods within the OVB and bedrock with packer testing to determine bedrock hydraulic conductivity. Additional investigation of the OVB units is required during the first few years of mine operations to refine the understanding of the OVB materials prior to detailed design of the West Dam.

The West Dam will be founded on surficial materials approximately 10 to 15 m thick underlain by bedrock. The glacial sequence is inferred to be dominated by undifferentiated till overlain by glaciofluvial deposits, including kame deposits and surficial terrace deposits along Davidson Creek. Fluvial sand and gravel deposits may be locally present. The bedrock lithology is dominated by volcaniclastics and felsic tuffs. A healed fault zone was intercepted in one drillhole. Measured groundwater elevations along the West Dam alignment and upstream range from 1,345 to 1,344 masl, which coincides with the elevation of the headwater lake located upstream. Groundwater levels are inferred to be approximately 1,336 masl in lower lying areas near the watercourse, which is approximately coincident with the elevation of Davidson Creek nearby.

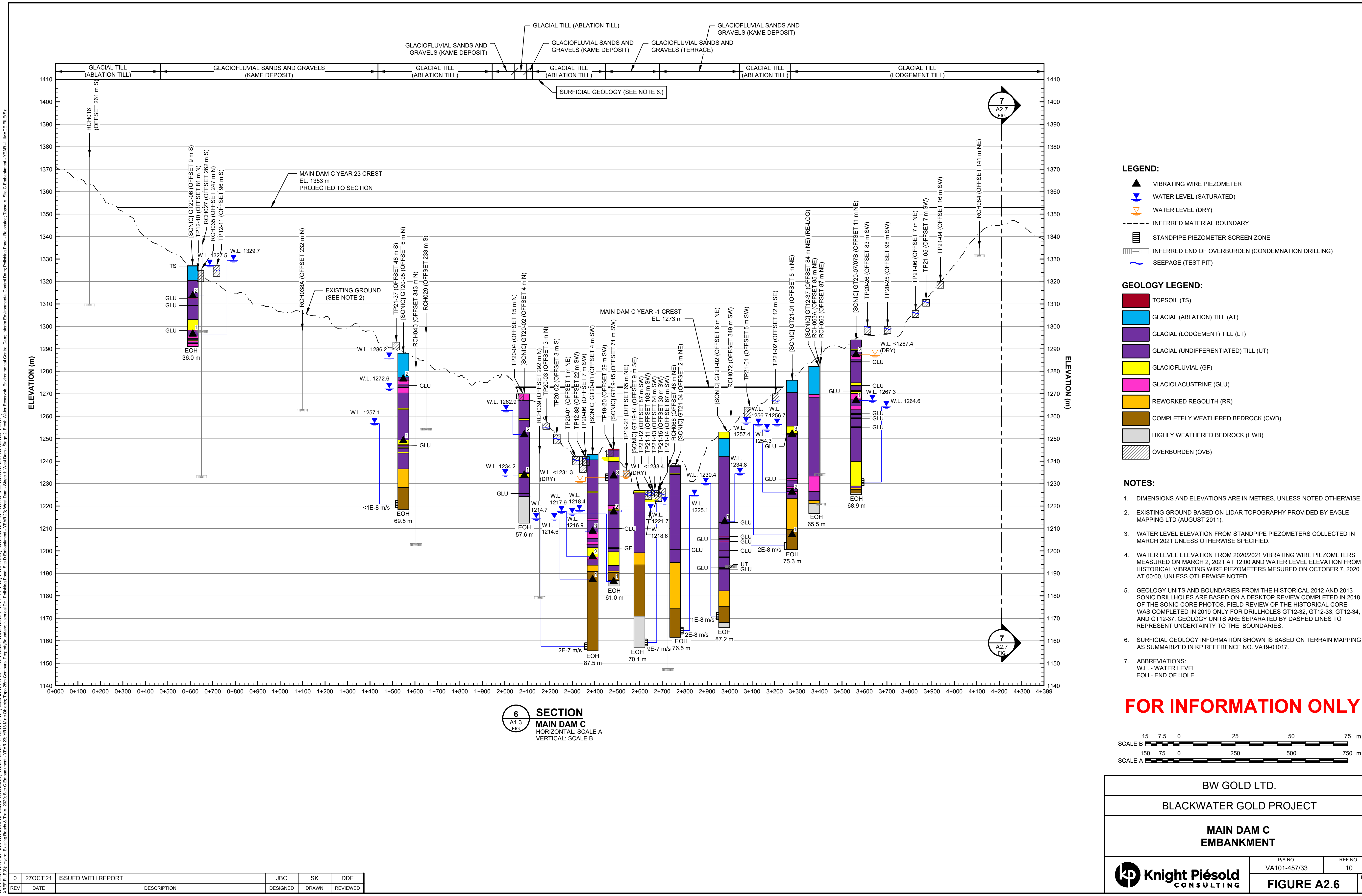


Figure 3.5-22: Geological Cross Section of Main Dam C Alignment

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

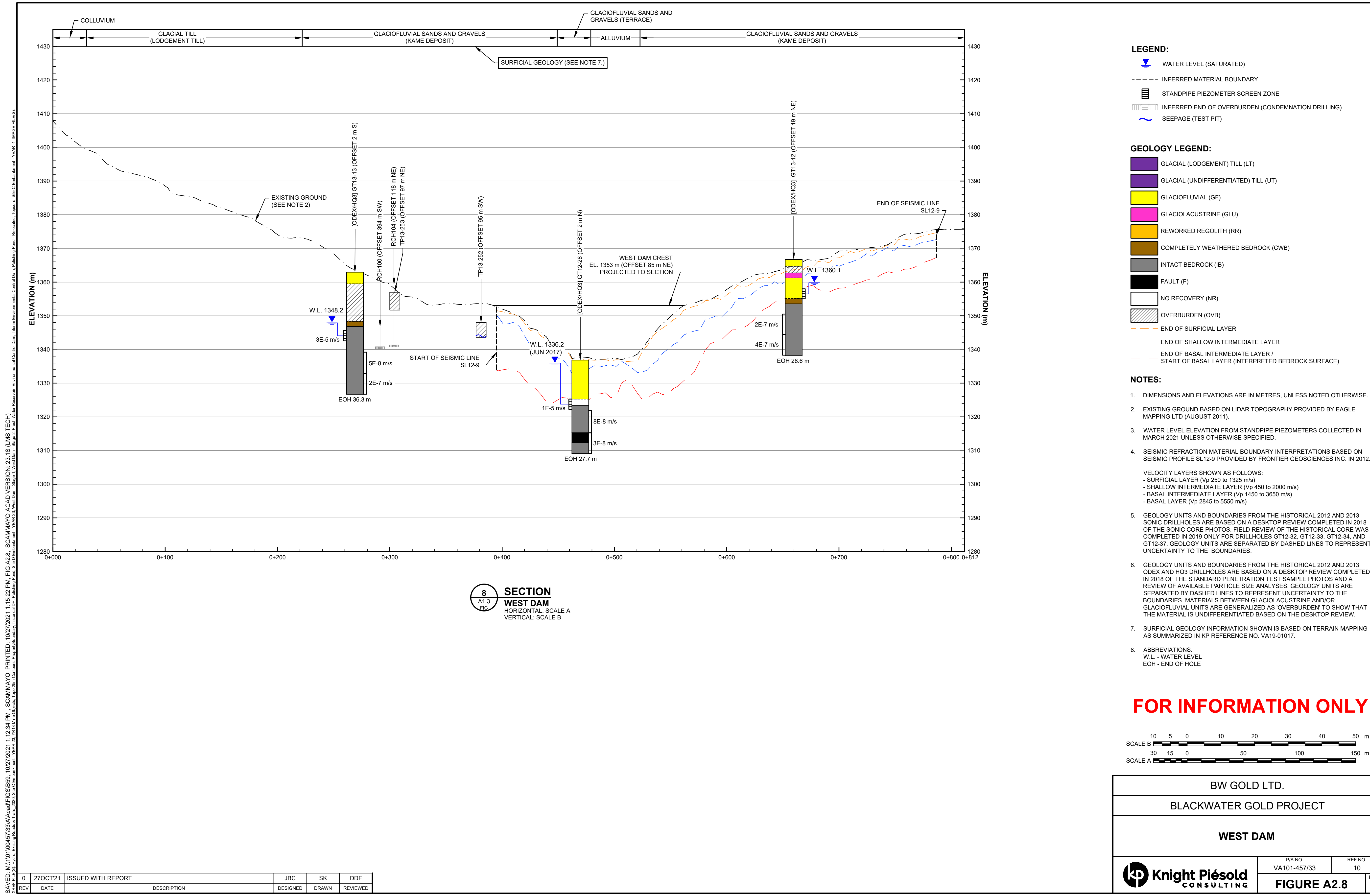


Figure 3.5-23: Geological Cross Section of TSF C West Dam

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

Saddle Dam

The Saddle Dam will be constructed in stages beginning in Year +12 to constrain TSF C along the southeast side. The final stage of the Saddle Dam will combine with Main Dam C to form one continuous embankment. Information from four test pits, two geotechnical drillholes, and a seismic refraction survey line completed in the vicinity of the Saddle Dam were used to characterize the geotechnical and hydrogeological conditions of the site. A geological cross section (profile) along the Saddle Dam alignment is included in Figure 3.5-24. Additional geotechnical and hydrogeological investigations will be required during the first ten years of mine operations to support detailed design of the Saddle Dam.

The glacial sequence encountered at the Saddle Dam location was approximately 20 m thick based on two geotechnical drillholes. The glacial deposits may be locally thicker at the creek bottoms where intrusive investigation work was not performed, and seismic refraction surveys indicated the start of the basal (bedrock) layer at depths ranging up to approximately 50 mbgs. Undifferentiated glacial till was encountered at both abutments, but locally thicker at the northeast abutment. Glaciofluvial materials, comprising kames and terrace deposits, were encountered at the southwest abutment and are expected to be present along and on either side of the creek. Two separate glaciolacustrine units were identified at the Saddle Dam with the lower unit located at the northeast abutment and upper unit at the southwest abutment. The bedrock geology consists of andesitic volcanic rocks that are highly to moderately weathered. The rock mass has relatively low permeability with hydraulic conductivity values of 2×10^{-8} m/s and 6×10^{-8} m/s measured during two packer tests. The groundwater levels are not known, but are constrained by a dry piezometer at 1,312 masl on the northwest abutment and the creek elevation nearby at approximately 1,300 masl.

TSF C Basin

The TSF C Basin will have a maximum length of 4,600 m and a maximum width of 3,200 m. The TSF will gradually fill over approximately 21 years to cover a surface area of approximately 680 ha to form the TSF C Pond. Information from 139 test pits, 29 geotechnical drillholes, and 40 condemnation drillholes completed within the footprint of the TSF C Basin were used to characterize the geotechnical and hydrogeological conditions of the site. A geological cross section (profile) through the TSF C Basin and extending downstream is included in Figure 3.5-25.

Glacial sequences were identified within the TSF C Basin ranging in thickness from 6.7 to 87.5 m with an average of 36.4 m based on 28 geotechnical drillholes. The thickest layers occur at the central part of the basin near Davidson Creek. Ablation till is present at surface with thickness ranging from 0.4 to 15.5 m. Glaciofluvial deposits were identified as surficial kame deposits along Davidson Creek with thickness ranging up to 8.5 m. The surficial kame deposits were found to extend as far as 800 m from Davidson Creek on either side. Surficial terrace deposits were also found along Davidson Creek with observed thickness up to 4 m. Buried glaciofluvial deposits are also possible and warrant continued consideration.

Lodgement and undifferentiated till are the dominant subsurface materials occurring below the surficial deposits at depth with interval thickness ranging from 3.9 to 86.8 m. Several glaciolacustrine units were identified within the basin with interval thickness ranging from 0.1 to 16.9 m and top elevations ranging from 1,372 to 1,229 masl. The inferred main glaciolacustrine deposits are summarized by elevation range below:

- 1,299 to 1,292 masl – Occurrences are located near the center of the TSF C Basin with an interval thickness range from 0.5 to 6.9 m. There are two occurrences that appear on both sides of Davidson Creek and are inferred to be disconnected. This unit may have been continuous across Davidson Creek prior to downcutting during glaciation.
- 1,287 to 1,284 masl – Major occurrence at the center of the TSF C Basin with an interval thickness range from 0.3 to 1.8 m. The occurrence appears along a terrace on the north side parallel to Davidson Creek. It possibly extends further northwest from the center of the TSF C Basin, has not been observed further downstream in the basin.

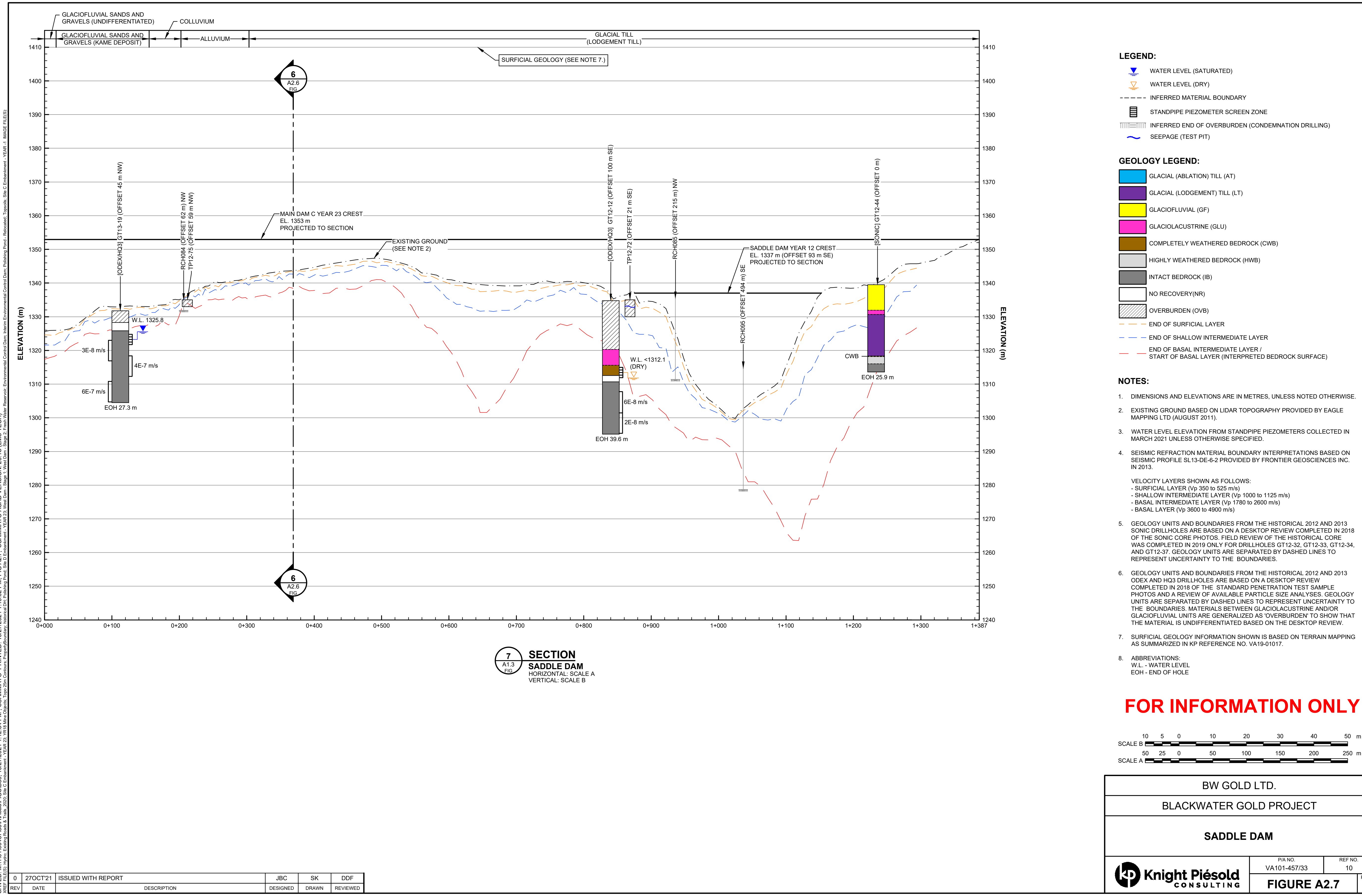


Figure 3.5-24: Geological Cross Section of TSF C Saddle Dam

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

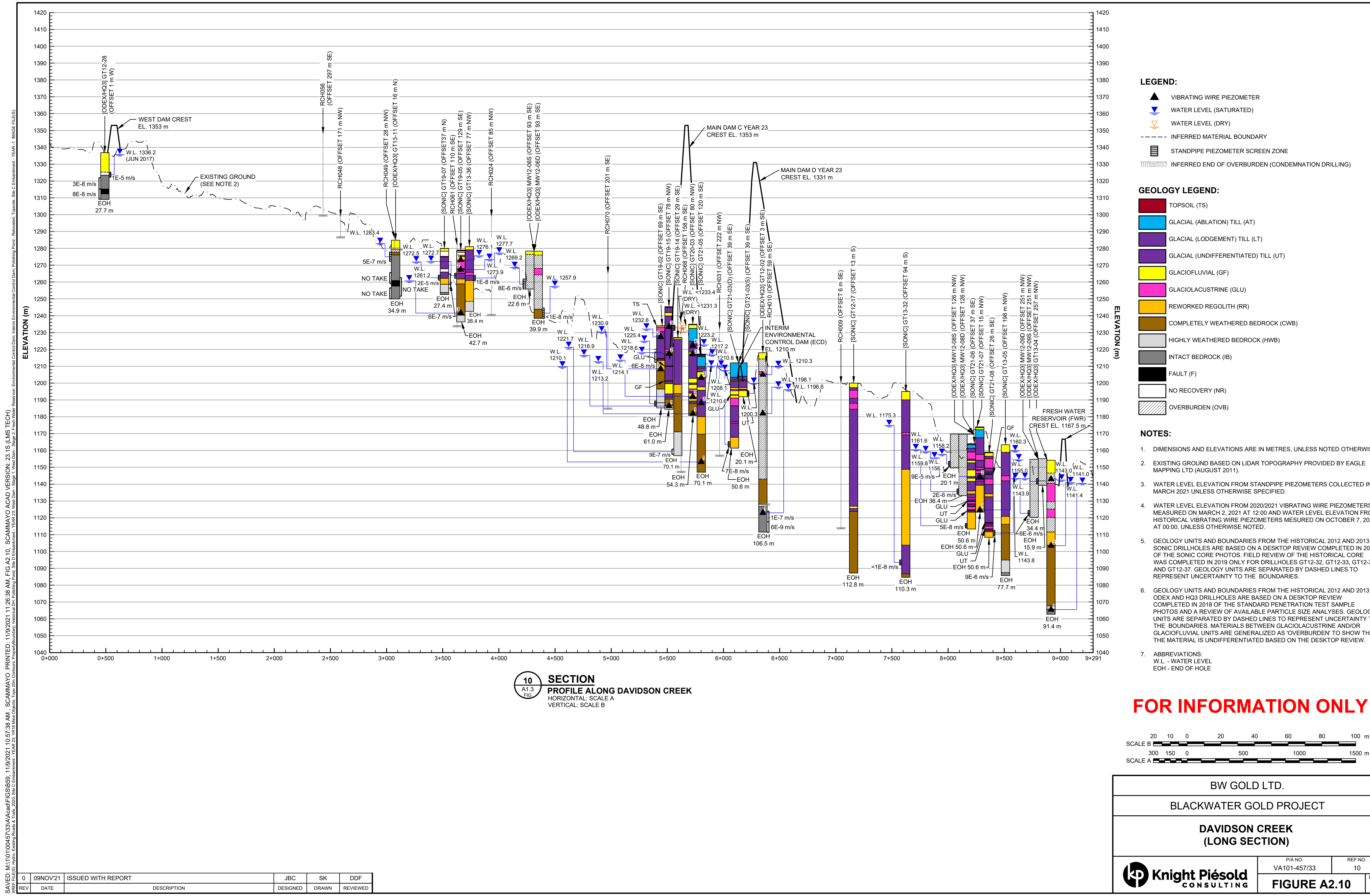


Figure 3.5-25: Geological Cross Section of TSF C Pond

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

- 1,277 to 1,270 masl – Several occurrences at the western and eastern areas of the TSF C Basin with an interval thickness range from 0.4 to 15.2 m. This unit may be broadly present where the natural ground surface is above 1,270 masl and glaciolacustrine deposition was not constrained by the bedrock surface elevation. This unit was intercepted within the TSF C Basin on both sides of the valley and may have been one continuous unit prior to deglaciation. The active channel floors were progressively lowered by fluvial erosion as the ice melted during deglaciation. It is inferred that this unit was eroded during this downcutting and is not present when the natural ground surface is below 1,270 masl.
- 1,239 to 1,231 masl – Major occurrence upstream of the central section of the Main Dam C alignment with an interval thickness ranging from 2.8 to 6.3 m. This unit was not encountered in most of the drillholes completed along the centreline of Main Dam C, which provides evidence that it is constrained to the upstream side of the dam. This unit was encountered up to approximately 300 m upstream of the Main Dam C alignment and approximately 300 m on either side of Davidson Creek.
- 1,204 to 1,196 masl – Major occurrence identified along the left and right abutments of the Main Dam C alignment within the Stage 1 dam footprint with an interval thickness range from 0.1 to 1.6 m. Drillhole observations indicate that the unit is constrained to the west and east by the bedrock surface at depth and therefore the unit does not extend beyond the Stage 1 dam footprint, but limited information is available to conclude if it extends further upstream in the TSF C Basin. Drillholes completed close to Davidson Creek did not encounter this unit, which indicates it is locally absent near the maximum dam section.

Reworked regolith is identified within the basin with thickness ranging up to approximately 35 m. The unit is generally thicker towards the east of the basin with and thinner towards the center and west of the basin. The glacial sequence and reworked regolith is typically underlain by completely to highly weathered bedrock. The extent of the completely weathered bedrock unit is confined within an approximate 600 m distance on either side of Davidson Creek and thins out towards the southwest of the basin. Highly weathered bedrock, with an elevation range from 1,295 to 1,173 masl, is generally deeper towards the northeastern part of the basin especially along Davidson Creek. The intact bedrock is generally deeper towards Davidson Creek. The bedrock lithology at the northeastern half of the basin is predominantly andesite. The bedrock lithology at the western half of the basin is dominated by volcaniclastics, andesites, and sediments. The bedrock within the basin is generally described as a strong rock with 'FAIR' RMR^{89} Rating.

Groundwater elevations in the vicinity of TSF C are topographically controlled and influenced locally by differences in permeability. Groundwater flow is expected to occur primarily through glaciofluvial (channelized and non-channelized) deposits, coarse grained glacial till, and highly weathered bedrock. Groundwater flow in OVB is expected to be restricted by the multiple glaciolacustrine units mapped in the area along with lower permeability zones of glacial till and the soil-like horizon of completely weathered bedrock. Groundwater flow in bedrock is expected to be conveyed primarily in the highly weathered bedrock, with lesser amounts of flow occurring as preferential flow through fractures in less weathered bedrock. The low permeability completely weathered bedrock horizon in Davidson Creek valley is expected to limit groundwater flow to deeper bedrock.

Main Dam D

Main Dam D will be constructed adjacent to and downstream of TSF C beginning in approximately Year +5 to form TFS D and provide additional storage capacity for PAG/NAG3 waste rock and tailings. The Main Dam D alignment will use the Davidson Creek watershed's natural topography, allowing for efficient and long-term storage of mine waste. Information from 19 test pits, 21 geotechnical drillholes, seismic refraction survey lines, and 3 condemnation drillholes completed along the Main Dam D alignment were used to characterize the geotechnical and hydrogeological conditions. The characterization is based primarily on the observations during the geotechnical drilling programs in 2012 and 2013, and the subsequent desktop review of the associated records. A geological cross section (profile) along the Main Dam D alignment is included in Figures 3.5-26 and 3.5-27.

The foundation is characterized by a surficial glacial sequence ranging up to 96 m thick, overlying bedrock. These deposits are thickest in the centre of the Davidson Creek valley. Surficial materials at the north abutment are particularly thick, ranging from 14 to 96 m. Ablation till occurs at surface with thickness ranging up to approximately 12 m. Surficial kame deposits with thickness ranging up to 15 m were found along the dam alignment extending approximately 250 m southeast and up to 1,250 m to the northwest of Davidson Creek.

Lodgement and undifferentiated till occur below at depth with interval thickness ranging from up to 66 m. These glacial till materials are interbedded with glaciofluvial and glaciolacustrine deposits. Subsurface (buried) glaciofluvial deposits are identified at the western and central part of the dam alignment near Davidson Creek with thickness ranging up to 11.2 m. Several glaciolacustrine layers were identified along the alignment with interval thickness ranging from 1 to 30 m. The lateral continuity of these major glaciolacustrine deposits could range from several hundred metres to greater than one thousand metres; however, the understanding of the nature and extent of each unit is limited by the available drilling information and in-situ testing data. The level of investigation of the surficial material sequence at Main Dam D is suitable to support the preliminary life of mine design for the Application, and additional investigations will be required prior to detailed design of Main Dam D Stage 1 and subsequent stages.

Completely weathered bedrock was identified along the entire embankment alignment at elevations between 1,292 to 1,143 masl. The unit is thicker with thickness ranging up to 15 m within approximately 400 m on either side of Davidson Creek. The unit thins out away from the creek with thickness ranging from approximately 3 to 9 m towards the abutments. Heavily weathered bedrock is broadly present above the intact bedrock horizon, which was intercepted at an elevation range of 1,326 to 1,155 masl at seven drillholes along the dam alignment. The intact bedrock is generally deeper towards Davidson Creek.

The bedrock geology consists of andesitic volcanic rocks that are highly to moderately weathered to approximately 20 m depth. The rock mass has low permeability with hydraulic conductivity values ranging from 1×10^{-6} m/s to 1×10^{-9} m/s. An inactive fault was inferred on the south side of Davidson Creek. Subsequent investigations found that the fault zone has low permeability with hydraulic conductivity values ranging from 6×10^{-7} m/s to 9×10^{-9} m/s.

Measured groundwater elevations along the dam alignment range from 1,284 to 1,197 masl north of Davidson Creek and from 1,326 to 1,206 masl south of Davidson Creek. No artesian conditions were encountered from the drillholes along the dam alignment.

TSF D Basin

The TSF D Basin will be constructed adjacent to and downstream of TSF C beginning in Year +5 and will gradually fill over approximately 18 years to cover a surface area of approximately 420 ha. Information from 39 test pits, 10 geotechnical drillholes, and 19 condemnation drillholes completed within the footprint of the TSF D Basin were used to characterize the geotechnical and hydrogeological conditions of the site. Geological cross sections (profiles) through the TSF D Basin and extending downstream are included in Figure 3.5-28.

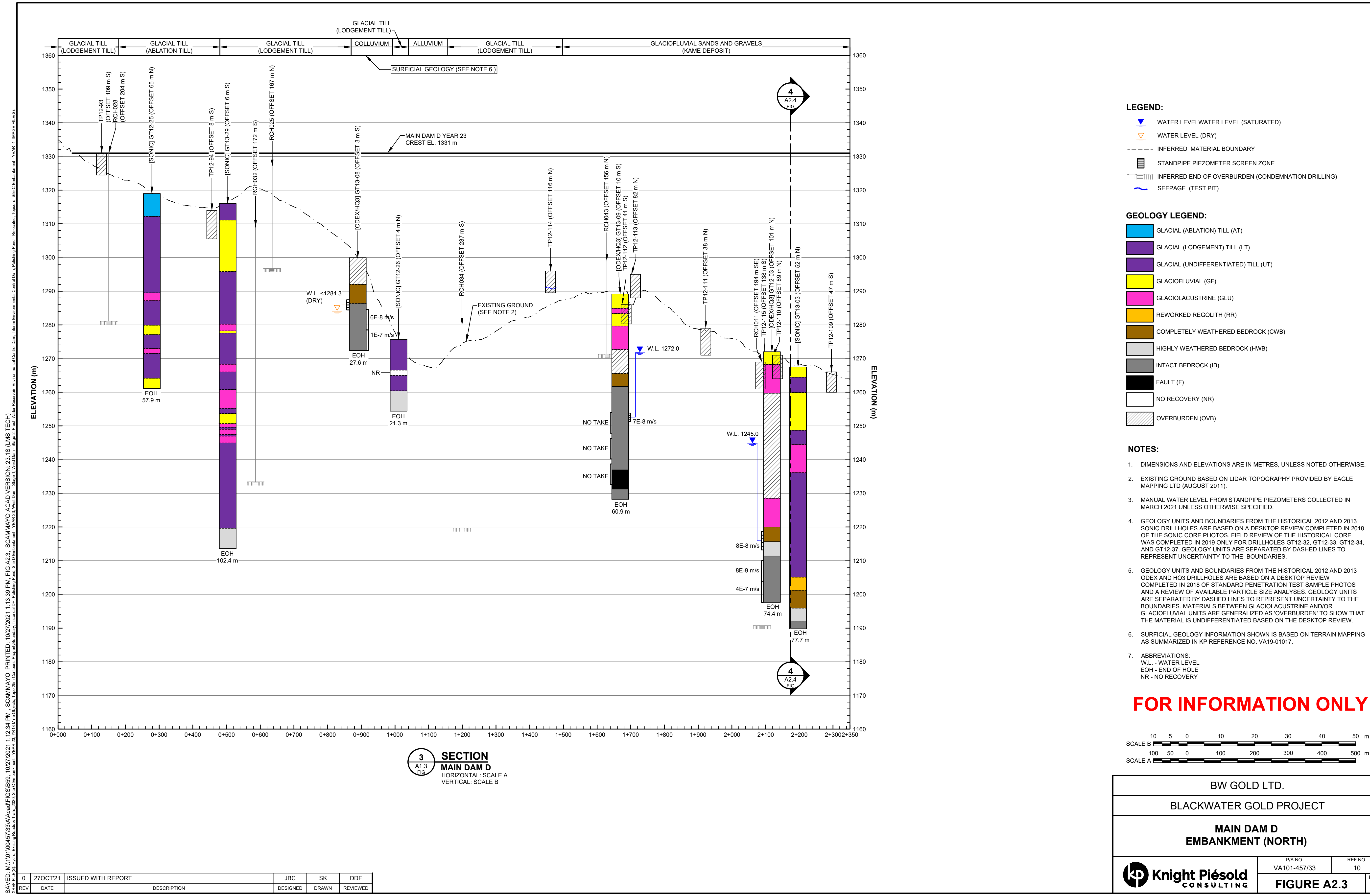


Figure 3.5-26: Geological Cross Section of TSF D Alignment (Northern Arm)

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

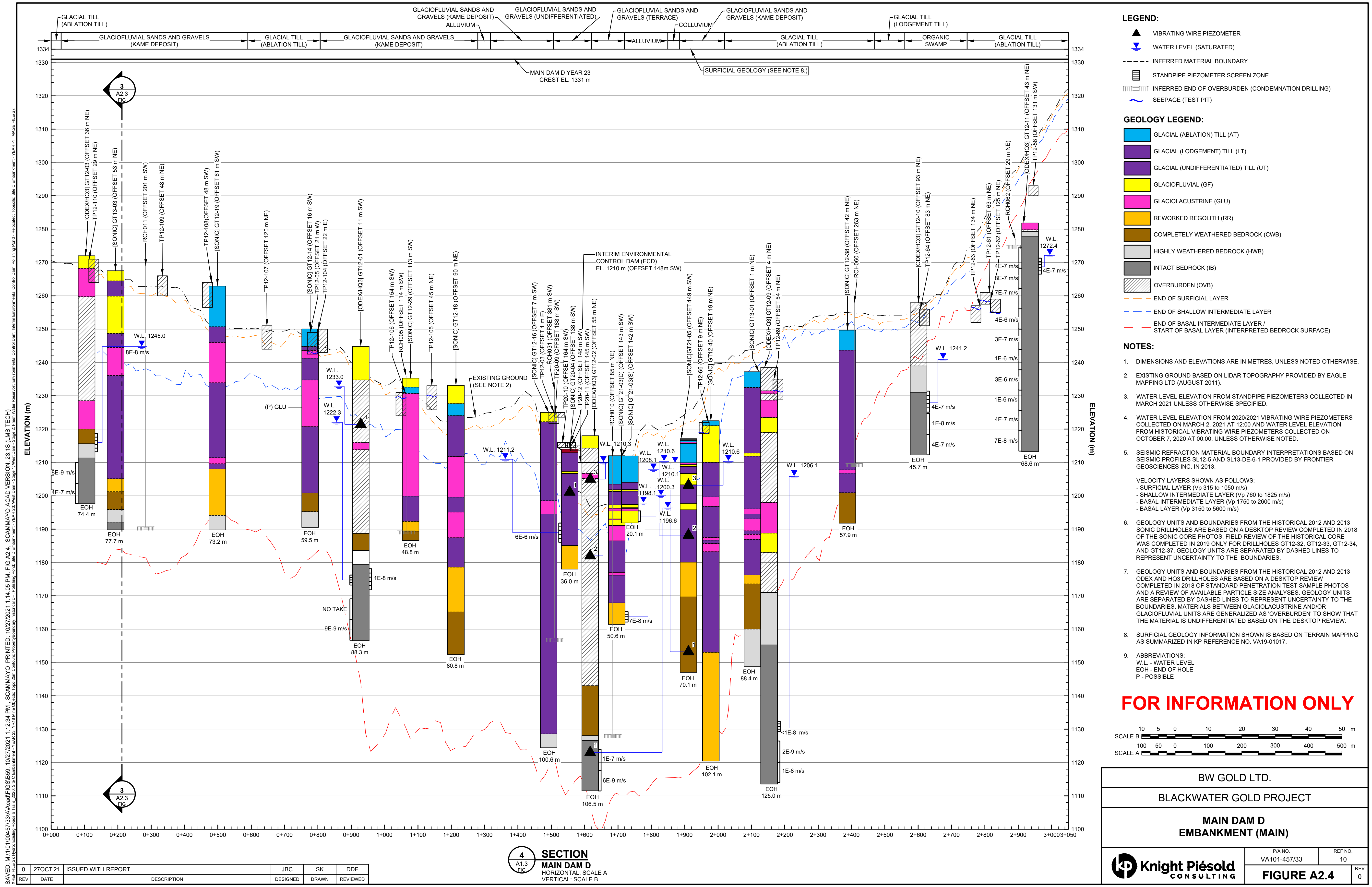


Figure 3.5-27: Geological Cross Section of TSF D Alignment (Southern Arm)

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

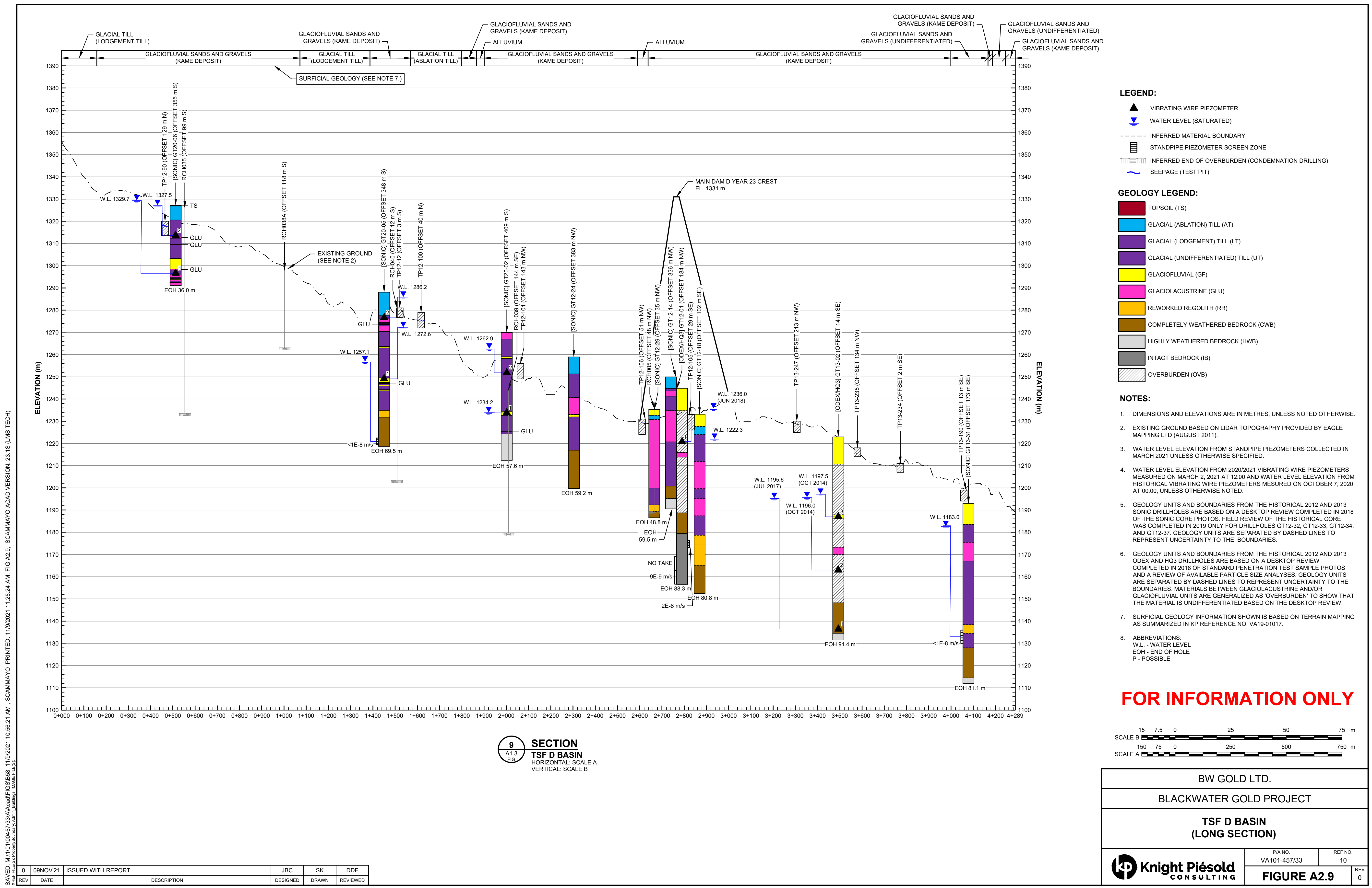


Figure 3.5-28: Geological Cross Section of TSF D Pond

Source: Knight Piésold Consulting (2021j; Appendix 3-L).

The TSF D Basin is characterized by a surficial glacial sequence ranging up to approximately 70 m thick overlying bedrock, which is deepest in the centre of the Davidson Creek valley. Ablation till is typically present at surface with thickness ranging up to approximately 8 m except near the northeastern corner where lodgement till is mapped at surface. Surficial terrace and esker deposits were identified northwest of Davidson Creek and kame complexes are commonly mapped within the center of the basin. Lodgement and undifferentiated till occur below at depth with interval thickness ranging up to 67 m and are interbedded with glaciofluvial and glaciolacustrine materials. Several glaciolacustrine units are identified within the basin with interval thickness ranging up to 14 m and top elevations ranging from 1,263 to 1,184 masl. Completely weathered bedrock ranges up to approximately 20 m thick.

Static groundwater levels range from 4 to 25 m depth. Groundwater elevations in the vicinity of TSF D are anticipated to be topographically controlled and influenced locally by differences in permeability similar to the TSF C Basin. There are currently limited piezometric monitoring points within the surficial materials in the TSF D Basin as most monitoring points reside in the bedrock system and at Main Dam D, so the interpretation of the groundwater condition is limited by the currently available knowledge base.

Tailings Dam Hazard Classification

The Canadian Dam Association Dam Safety Guidelines (CDA 2019) and Part 10 of the Code were used to determine the dam hazard classification and suggested minimum target levels for some design criteria, such as the IDF and Earthquake Design Ground Motion (EDGM) for the TSF. The dam hazard classification for the Project tailings dams was determined to be VERY HIGH. The methodology and basis of the hazard classification is summarized in the TSF design reports (Appendices 3-J and 3-K).

3.5.3.5 Tailings Dam Hazard Classification and Dam Breach and Inundation Studies

The following minimum target design flood and earthquake levels are recommended by the Code (EMLI 2021) and associated guidelines (EMPR 2016; CDA 2013, 2019) for a **Very High** dam hazard classification during the construction, operations, and active-care closure phases of the project:

- Inflow Design Flood (IDF): 2/3 between the 1/1,000-year return period event and the Probable Maximum Flood (PMF); and
- EDGM: 1/2 between the 1/2,475-year and the 1/10,000-year (or Maximum Credible Earthquake [MCE]) return period seismic events.

For a **Very High** dam classification during the passive-care closure phase (i.e., post-closure), the Code and associated guidelines suggest the following minimum target levels for the IDF and EDGM:

- IDF: the PMF; and
- EDGM: the 1/10,000-year return period seismic event or MCE.

Target design flood and earthquake criteria were selected for the TSF while considering the long-term design life of the facility, the minimum target levels listed above, and emerging international best practices for tailings management (GTR 2020; MCA 2019). The following target levels were adopted for the TSF design basis:

- IDF: the PMF; and
- EDGM: the 1/10,000-year return period seismic event or MCE, whichever is greater.

Dam Breach and Inundation Studies

A dam breach and inundation study (KP 2016) and a dam breach effects assessment on biophysical, social, and cultural components (ERM 2015c) were undertaken during the environmental assessment review.

Dam Breach and Inundation Studies

The dam breach inundation study was conducted to provide an understanding of the potential consequences of a tailings dam failure. The study was structured to estimate the potential inundation limits that would result from a hypothetical dam breach during sunny day and flood induced conditions while considering the ultimate extents of the proposed facilities. The potential consequences of a breach at any time during operations would be conservatively addressed by these two scenarios. The methodology of the analysis is provided in (KP 2016).

A TSF breach would cause severe flooding and damage to downstream mine infrastructure in the Davidson Creek floodplain. The flood wave would also be expected to damage the MAR, transmission line, water supply pipeline, and Forest Service Roads (FSRs). Areas downstream of the TSF within Davidson Creek would need to be evacuated and road access restricted shortly after a breach occurred. Further downstream, a breach would be expected to cause severe flooding in the Chedakuz Creek floodplain. The velocity and depth of the floodwater varies between the scenarios but is typically higher in the rainy day scenarios (which assumes the occurrence of the PMF triggers the dam breach) than in the sunny day scenarios, and generally diminishes with distance from the TSF. In lower Chedakuz Creek, the time to reach peak flows ranges from 2.2 to 4.9 hours and the duration of the flood could last up to approximately 16 hours following the onset of the dam breach.

Damage would be expected to occur to the Tatelkuz 28, private properties in the area, and the Kluskus FSR as well as any bridge structures on the Kluskus and smaller FSRs in the area. Flooding in this area would be similar to the natural flooding, although the flood depth could be up to 3 m deeper. The areas would need to be evacuated and access along the Kluskus FSR would need to be restricted within an hour of a breach occurring. The flooding impacts of the TSF dam breach on the Nechako Reservoir and the changes in water levels are expected to be minimal. The flood wave would be expected to arrive at the reservoir approximately 4 to 10 hours after the breach.

Dam Breach Effects Assessment

The dam breach effects assessment focused on the potential effects of a hypothetical dam failure on selected valued components that were assessed in the Application/EIS (New Gold 2015; ERM 2015c). As communicated in January 5, 2015 meeting with New Gold (Part C, Item 1) DFO has asked in the event of a catastrophic dam failure had an analysis of the effects to Commercial, Recreational and Aboriginal (CRA) Fisheries been completed.

A number of water quality parameters are predicted to be greater than water quality guidelines for the protection of aquatic life, wildlife water supply guidelines, or drinking water guidelines in areas downstream of the TSF in the event of a dam breach. Water quality is predicted to improve with distance from the TSF, particularly in the rainy day scenarios when more water is present in the receiving environment. Tailings from tailings slumping may also be entrained in the floodwater (as TSS) and could settle in depositional areas of Davidson Creek, Chedakuz Creek, and Tatelkuz Lake where water velocities are slower, as well as in the adjacent floodplain areas as the floodwater recede. Deposition of tailings could affect soil and vegetation quality, and could lead to movement of metals into the food chain. However, these areas may not be attractive to wildlife since there would be limited or no vegetation and areas with significant tailings deposition (e.g., slumped tailings downstream of the TSF dam) are likely to be remediated with tailings put back into a repaired TSF. While there is some potential for tissue concentrations of metals to increase in wildlife (and traditional use foods), remediation and recovery of affected areas will decrease the risk over time.

Areas closest to the TSF breach will have a greater impact on surface water flow, changes to surface water quality and changes to sediment. Effects on fish and aquatic habitat are likely to be caused from erosion and sedimentation resulting from the smothering of eggs, decreased feeding efficiency, habitat avoidance, smothering of aquatic invertebrates, and loss of productive habitat capacity. Kokanee, Rainbow Trout and other fish species in Davidson Creek, Chedakuz Creek, and Tatelkuz Lake will be affected. Fish and aquatic organisms immediately downstream of the TSF, particularly in Davidson Creek, could experience direct mortality or habitat loss as a result of flooding and mobilization of debris, and erosion and sedimentation.

In the two modelled scenarios, i.e. sunny day and rainy day, there is a predicted loss or alteration of 100 km of stream fish habitat and 676 ha of lake or pond habitat or 198 km of stream fish habitat and 735 ha of lake or pond habitat, respectively. The greatest losses will occur closest to the dam breach with lesser effects further downstream (Section 7.2.4 Fish and Fish Habitat).

Terrestrial habitats closest to the source of inundation waters on near Davidson Creek include wetlands and old growth forest ecosystems and are the most likely terrestrial ecosystems to be affected, with listed ecosystems and floodplain ecosystems affected to a lesser extent. The terrestrial habitats lost by sunny day and rainy day dam breaches are described in Section 7.2.6 Effects Terrestrial Ecology of ERM (2015c).

For wildlife species, sunny and rainy day dam breaches would result in the downstream habitats. These would include: woodland caribou, moose, grizzly bear, american marten, little brown myotis, ring-necked duck, yellow rail, olive-sided flycatcher, red-tailed hawk, and western toad. The greatest affects would be to habitat would be those which are near low lying or riparian areas. Hence, grizzly bear, american marten, ring-necked duck, yellow rail, and western toad would lose a greater portion of their baseline habitat in the Regional Study Area (6 to 11%). Details of the effect on wildlife and wildlife habitat are found in Section 7.2.5 Effects on Wildlife and Wildlife Habitat of ERM (2015c).To support the assessment of dam breach and other potential mine impacts, BW continues to collect baseline information on surface and groundwater quality and quantity, fish and aquatic resources, wetlands and wildlife.

Guide outfitting and trapping tenures may be affected due to the loss of wildlife and wildlife habitat. The immediate effect to these tenures would be due to direct wildlife mortality and the flushing of trapping equipment and camps located within the Davidson Creek and lower Chedakuz Creek valleys. Range tenure holders may also be affected due to impacts on grazing habitat and the direct mortality of livestock if they are present within the areas predicted to be inundated, and the flushing of range fencing or equipment. Four private properties (DL 1844 R4C, DL 1843 R4C, DL 1848 R4C, and DL 1851 R4C) located northwest of Tatelkuz Lake may experience reduced property values and elimination of buildings and livestock as a result of an inundation.

Due to the localized nature of the extent of a potential dam breach, and the lack of site-specific data on traditional use for most Aboriginal groups, the effects of a dam breach are predicted on the Lhoosk'uz Dene Nation, and to a lesser extent on the Saik'uz First Nation, Ulkatcho First Nation, Skin Tyee Nation, Tsihqot'in Nation, or Métis Nation BC. Potential effects to Aboriginal land users in the study area may occur due to reduced availability of fish resources in Davidson Creek, Tatelkuz Lake, and Chedakuz Creek. Reduced availability of wildlife and harvestable plants as a result of inundated habitat along the flood path or direct mortality during a potential dam breach may also have potential affects Aboriginal land users.

The course of action for the restoration or offsetting that may be required as a result of a dam breach would depend on the nature and timing of the breach and the subsequent extent and nature of effects to fish productivity.

Baseline studies including habitat type, stream flow and fish distribution/use of habitats would provide metrics or end points for restoration (summarized in Section 2.9 Fisheries and Aquatic Resources). Further, the life history requirements of species in the Project area are known and would support proven stream restoration techniques e.g., channel and habitat creation. These may include:

- Channel construction and habitat complexing;

- Channel bank and bed stabilization; and
- Riparian planting.

On completion of habitat restoration it is expected that spawning adults from neighboring watersheds would return to the restored channel(s) and juveniles would colonise the newly available habitat. Techniques to supplement recolonization could be explored to support natural recovery, e.g., egg propagation.

3.5.3.6 Design Criteria

Design criteria for TSF considers the following requirements:

- Permanent, secure, and total confinement of all solid waste materials within engineered disposal facilities.
- Control, collection, and removal of free-draining liquids from the waste rock and tailings during operations for recycling as process water to the maximum practicable extent.
- Prevention of ARD and minimization of ML from potentially reactive tailings and waste rock to the extent practicable, which will be achieved by following the waste management concepts described previously.
- The inclusion of monitoring features for all aspects of the facility to confirm performance goals are achieved and design criteria and assumptions are met.
- Staged development of the facility over the LoM.

TSF design criteria are discussed below.

Design Flood Criteria

General

Design flood criteria were selected for the TSF in consideration of the TSF dam hazard classification and the following needs:

- Temporary storage of the Environmental Design Flood (EDF). The EDF is the most severe flood that is to be managed without release of untreated water to the environment. Selection of the EDF is site-specific, with typical return period events of 50 to 200 years considered.
- Storage and/or safe passage of the IDF runoff to maintain the integrity of the containment dams. The IDF is the most severe flood (considering peak flow, volume, shape, duration, and timing) for which a dam and its associated facilities are designed to withstand.

The PMF was selected as the IDF for design of the TSF dams. The Code requires consideration of a minimum event duration of 72 hours for storage of the IDF. The 72-hour requirement does not apply to facilities with no requirement to store the IDF. The PMF is a deterministic value that is calculated as the flood resulting from the probable maximum precipitation (PMP) event plus corresponding snowpack melt. The PMF was calculated in accordance with the CDA Dam Safety Guidelines (CDA 2013) as the maximum of:

- The summer-autumn PMF, which is generated by the summer-autumn PMP;
- The spring PMF, which is the maximum of:
  - The spring PMP and the 1-in-100-year return period snow accumulation, and
  - The 1-in-100-year spring rain event and the probable maximum snow accumulation (PMSA, calculated as the 1-in-10,000-year snowpack).

Inflow Design Flood

The IDF for Stages 1 and 2 of TSF C was estimated to be 721 mm, generated by the 1-in-100-year spring storm plus the PMSA. Emergency spillways for Stages 1 and 2 of Main Dam C were designed to pass the IDF, meaning that the peak flow and total volume of water associated with the IDF can be safely conveyed, avoiding the need for storage of the IDF until completion of Stage 3.

The 72-hour event duration requirement was applied to estimate the IDF runoff volume associated with the PMF for determining the staged crest elevation of Main Dam C beginning with the Stage 3 and for all stages of the Main Dam D. The 72-hour PMF runoff depth was estimated to be 745 mm. The IDF runoff volumes for TSF C and TSF D were estimated to be 22 Mm^3 and 10 Mm^3, respectively.

Environmental Design Flood

The selected EDF for the initial design of Main Dam C was the 24-hour, 1-in-200-year precipitation event, with a total runoff depth of 95 mm. The volume of water associated with the EDF that must be stored in the facility was estimated to be 2.8 Mm^3. Storage of the EDF will require storm storage freeboard of approximately 2 to 3 m below the invert elevation of the emergency spillway, and the facility water level will be managed to accommodate seasonal inflows without impacting the storage requirement for the EDF.

Freeboard

The design freeboard comprises storm storage freeboard to safely manage floods and additional minimum freeboard allowance for wave run-up. Embankment construction will be completed in staged lifts, and therefore the total actual freeboard will tend to be larger than the design freeboard until just before operations cease.

The design freeboard for Stages 1 and 2 of Main Dam C includes freeboard to manage the EDF and additional freeboard required to pass the IDF through an emergency spillway.

The storm storage freeboard for Main Dam C beginning with the Stage 3 and for all stages of Main Dam D is based on storage of the IDF runoff volume (72-hour PMF). The storm storage freeboard required at each stage is dependent on the storage characteristics of TSF at each stage and generally decreases with increasing surface area of the facility. The storm storage freeboard for the TSF generally ranged between 2 m and 12 m to accommodate storage of the IDF. A minimum freeboard requirement of 1 m is incorporated in the design for wave run-up above and beyond the storm storage freeboard.

Seismic Design Criteria

A Maximum Design Earthquake (MDE) was selected for the TSF, based on the seismic hazard at the site and the dam classification assigned to the TSF. Limited deformation of the TSF is acceptable under seismic loading from the MDE, provided that the overall stability and integrity of the facility is maintained and that there is no release of stored tailings or water (ICOLD 1995).

The results of deaggregation of the seismic hazard indicated that for long return periods of thousands of years (annual exceedance probability of 1/2,475 and 1/10,000) the majority of the seismic hazard for long period ground motions is from large magnitude (M8+) earthquakes associated with the distant (> 400 km) Queen Charlotte fault and closer moderate to large (M5 to M7) for shallow crustal earthquakes within northern BC. Long period ground motions are typically the most significant for embankment design and soil liquefaction assessments. The results of the deterministic seismic analysis indicated relatively low MCE acceleration values of approximately 0.05 g for the site, resulting from a M9.2 subduction earthquake on the Cascadia subduction zone and movement along the Queen Charlotte fault. This does not account for the potential for shallow crustal earthquakes occurring closer to the Project site, where it is not currently possible to define a minimum source to site distance and the geological fault structures associated with seismicity are not well defined or are unknown.

The EDGM comprises the probabilistic 1/10,000 year event (return period of 1-in-10,000 years). A design earthquake magnitude of M8.2 was selected for the 1/10,000 MDE, corresponding to the value provided by the deaggregation analysis for long period ground motions at the site. Site-specific ground motion parameters were calculated for the TSF embankments using a representative Vs30 value of 600 m/sec, based on the results of DSTs performed at the site in late 2020 and early 2021. The PGA for the 1/10,000 MDE is 0.10 g.

3.5.3.7 Stability Analysis

Liquefaction Assessment

The liquefaction susceptibility of the foundations materials at the Main Dam C was analyzed with index testing results, in-situ downhole seismic tests (DST) shear wave velocity data and standard penetration test (SPT) blow count data. The liquefaction assessment indicates that the foundation materials are not susceptible to liquefaction. Additional details are presented in the TSF Stage 1 Detailed Design Report provided in Appendix 3-J.

Slope Stability

Limit equilibrium slope stability analyses were carried out using SLOPE/W®, a two-dimensional limit equilibrium stability analysis software package, to evaluate the estimated Factor of Safety (FoS) against rotational failure modes. The Morgenstern-Price method was used to estimate the FoS for all models. The embankment sections selected for the stability analyses represent the locations where the embankments have the greatest overall height while considering the current understanding of the foundation conditions and potential variations in the material strength properties.

Stability modelling results present the FoS for a slip-surface scenario in which a loss of freeboard would occur within the facility (i.e., failure of embankment slope and crest). The minimum FoS for the tailings embankment under static conditions is 1.5 end of construction and long-term operating conditions (steady-state and post-closure) of the TSF (EMPR 2016). A factor of safety of less than 1.0 is generally acceptable under earthquake loading conditions provided that calculated embankment deformations resulting from the seismic loading are limited and do not result in a loss of containment. The minimum target FoS for post-earthquake stability of the embankment is 1.2, implying there is no flow slide potential.

Main Dam C was separated into three analysis sections with two stages analyzed for each section. The stability analyses confirmed that the detailed design of Main Dam C, comprising Stages 1 and 2, meets the required FoS for the long-term static, post construction static, pseudo-static, and post-seismic loading conditions.

The upper horizon of the completely weathered bedrock material is characterized as a clay-like contractive material based on the SCPT completed at the site. The peak undrained shear strength ratio was estimated to be approximately 0.67, which is approximately equivalent to the inferred frictional strength of the material. The residual undrained shear strength ratio was estimated to be 0.22 based on the available SCPT data. The completely weathered bedrock unit was treated as a contractive material type with potential for strength loss at high strains in the stability assessment for Main Dam C. This unit is located relatively deep within the foundation of Main Dam C and therefore has a limited impact on the calculated FoS values for the dam.

Sensitivity analyses were also performed to evaluate the significance of the behavior of the glaciolacustrine units present within the foundation of Main Dam C using an undrained shear strength ratio of 0.2. These analyses indicate that these units will have no significance when considering a minimum target FoS of 1.2 for post-earthquake loading conditions. Additional follow up drilling and in-situ testing investigations are recommended concomitant with construction of Main Dam C to verify the extent and expected behavior of the deeply seated glaciolacustrine units within its footprint.

Additional details are presented in the TSF Stage 1 Detailed Design Report provided in Appendix 3-J.

3.5.3.8 Tailings Storage Facility Construction

Construction Materials

Approximately 102 Mm^3 of construction material are required for TSF construction over the LoM.

The earth-rockfill dams will comprise the following zones:

- **Earthfill seal zone (Zone S)** – low-permeability glacial till from nearby borrows and from pit stripping. The material will consist of well-graded silty sand and some gravel with a fines content of 20 to 60% passing the #200 sieve. This material will generally require no processing except for the removal of oversized particles. The material will be placed in maximum 300 mm lifts loose and compacted by combination of smooth drum vibratory rollers and pad foot compactors to 95% Standard Proctor Maximum Dry Density (SPMDD).
- **Filter zone (Zone F)** – clean, fine to coarse sand. It will be placed adjacent to and downstream of the Zone S material to prevent piping of the Zone S material and to reduce pore pressures within the embankment. This material will be a processed non-reactive sand material from the aggregate screening areas in the esker deposits located adjacent to Main Dam C and downstream of TSF D. Zone F will be placed and spread in maximum 600 mm lifts loose and compacted by 4 to 6 passes with smooth drum vibratory rollers.
- **Transition zone (Zone T)** – processed non-reactive fluvial, colluvial, or selected NAG waste rock. It will be placed adjacent to and downstream of Zone F. The transition zone will prevent the migration of fines from the core zone and Zone F into the pervious downstream shell zone (Zone C). Zone T will be placed and spread in maximum 600 mm lifts loose and compacted by 4 to 6 passes with smooth drum vibratory rollers.
- **Shell zones (Zone C)** – OVB and specific waste rock material types. It will be placed on both the downstream side of the dam. The Zone C materials will be dumped and spread in maximum 1,000 mm lifts loose. Compaction will be achieved with smooth drum vibratory rollers or by routing haul truck patterns to produce a uniformly compacted lift. A vibratory smooth drum roller will be used on the edges of lifts with a minimum four to six passes.

Material for Zones F and T will come from the aggregate screening area downstream of the TSF. Local material borrows will be developed to provide fill materials as required for construction of the Stage 1 TSF and subsequent stages as required. The Zone S and Zone C materials are naturally occurring and will be sourced from local glacial till and glaciofluvial borrow areas. The Zone F, T, D, wearing course and riprap bedding will require processing and will be sourced from local esker borrow areas or pit materials.

An esker complex is in close proximity to the Main Dam C Stage 1 construction area, on the northwest side of Davidson Creek, immediately downstream of Main Dam C. The eskers override the glacial till plain locally with an estimated aggregate volume of greater than 200,000 m^3. The location of this esker deposit is described in Appendix 3-L. The esker complex is free draining and dry and, in most instances, covered with a veneer of organic matter. Groundwater may be encountered at the glacial till contact; however, the static groundwater levels in the area are relatively consistent with the Davidson Creek channel elevation located approximately 20 m below the glacial till contact. The esker deposit is characterized as a relatively clean, well sorted, free-draining sand and gravel. Cobbles and smaller boulders were encountered during test pit excavation. Laboratory testing on selective test pits has shown that the esker deposit is suitable for use in embankment construction and portions will be suitable for use as aggregate. The area adjacent to the esker complex is relatively flat and should be suitable to establish an aggregate screening area during construction.

A larger esker complex is located further downstream along the planned MAR. The local esker complex described above is an extension of this larger complex further downstream. This resource was characterized during the 2014 FS (KP 2014 and 2013f) and the volume of available aggregate material was estimated to be in excess of 3 Mm3. This additional aggregate source is being permitted as an external borrow area and represents a contingency borrow area for Stage 1 TSF construction.

Borrow areas were identified for naturally occurring materials that meet the Zone S and Zone C material gradations, as described in Appendix 3-L.

Winter Construction Considerations

Open pit mining will be a continuous process, and the construction of the tailings embankments will reflect this process. Winter construction will be necessary to reduce material re-handling and to maintain the required crest elevation from year to year. Zone C material will be placed upstream and downstream during the winter. The Zones S, F, and T materials will be placed in the summer months as much as possible, but from time to time will be done in the winter if delays are encountered during summer construction.

To meet density requirements, embankment fill, particularly in the core, filter, and transition zones, must be compacted before it freezes. Haul time and compaction methods will address this priority. For example, sheep's foot packers leave depressions in the fill that increase the rate of heat loss and collect snow, and it may be more efficient to have loaded haul trucks make several passes over a lift before dumping.

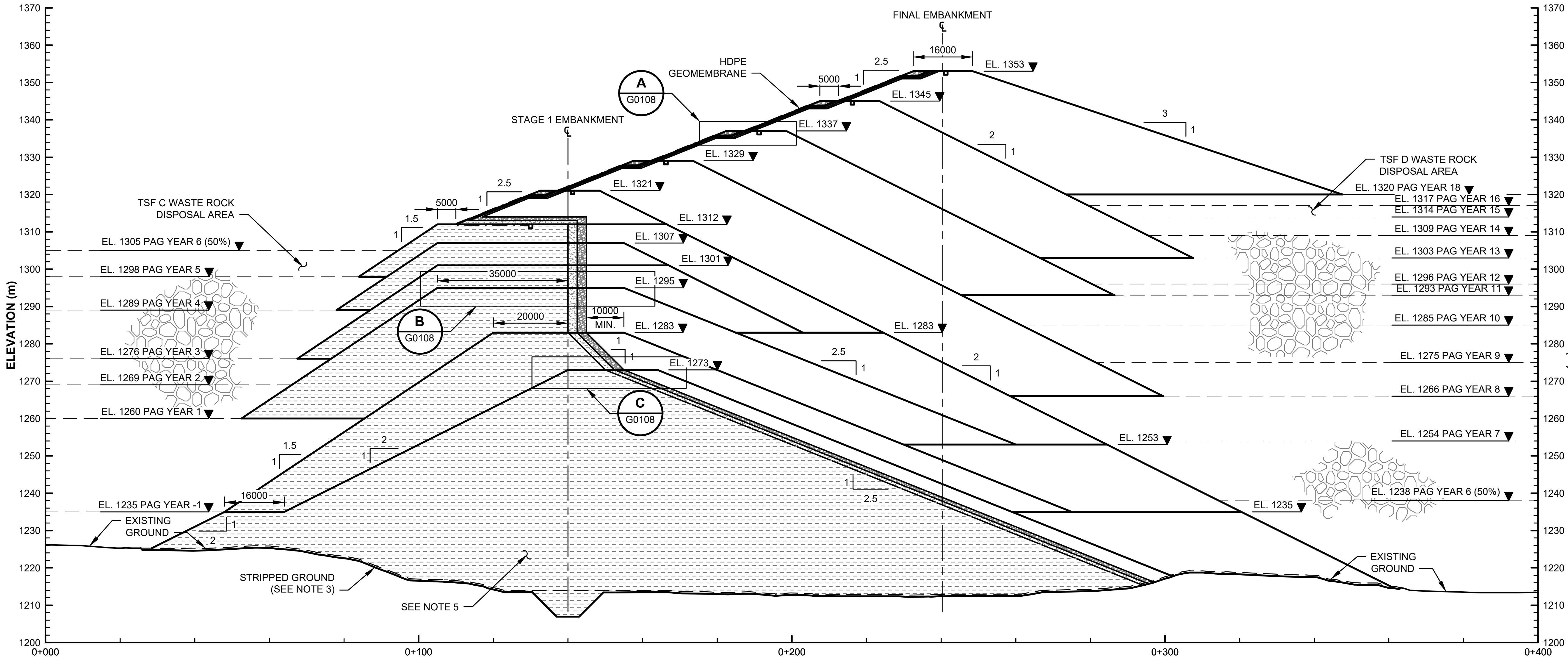
It is possible for a lift to freeze after it has been compacted without significantly reducing its density. Material may be placed on top of a frozen lift if ice, snow, and loose frozen material are removed first and the density has not been significantly altered. An acceptable fill surface is 90% free of ice and snow, with the remaining 10% consisting of small discontinuous patches. Small areas will be prepared immediately in front of the advancing lift and covered as quickly as possible.

Spoil factors and equipment downtime could increase as temperatures decrease. The loss of efficiency during winter can be reduced by clearly outlining a set of construction procedures in advance. All quality assurance staff, operators, and supervisors will be aware of the procedures.

It may not be possible to place Zone S material properly when temperatures are consistently below approximately -15°C, even with quality procedures in place. It may be more efficient to place coarse rockfill in the embankment shell zones during these times and to schedule OVB material removal from the pit in the summer months so it can be used efficiently in embankment construction.

Main Dam C Construction

Main Dam C will be constructed in approximately eleven stages using a combination of centreline and downstream construction methods to an ultimate elevation of 1,353 masl. The ultimate dam will be approximately 4 km long with an average height of 50 m. The embankment height will be over 100 m high along a 600 m segment near the centre of the dam in the general vicinity of Davidson Creek with a maximum height of approximately 140 m at the narrow, heavily incised area where the creek currently flows. A cross section of Main Dam C is provided in Figure 3.5-29.



2 G0100 **SECTION**
MAIN DAM C
SCALE A

LEGEND:

- PAG WASTE ROCK
- CLAY / ZONE S (CORE ZONE)
- SAND / ZONE F (FILTER)
- GRAVEL / ZONE T (TRANSITION) / WEARING COURSE
- ZONE C (SHELL ZONE)

NOTES:

1. ALL DIMENSION ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
2. PRELIMINARY ELEVATIONS FOR EACH STAGE OF DAM CONSTRUCTION ARE SHOWN IN SECTION ALONG WITH THE APPROXIMATE YEAR OF STAGE CONSTRUCTION COMPLETION.
3. EXCAVATE ORGANICS AND UNSUITABLE MATERIAL TO ENGINEER APPROVED SUBGRADE.
4. SAFETY BERMS NOT SHOWN FOR CLARITY. SAFETY BERMS SHALL BE AT LEAST 3/4 OF TIRE HEIGHT OF THE LARGEST WHEELED VEHICLE.

SCALE A 15 7.5 0 25 50 75 m

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Figure 3.5-29: Main Dam C Cross Section

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

Construction of Main Dam C Stage 1 will commence following completion of the site establishment and water management features. The embankment foundations will be cleared and stripped in preparation for fill placement for each stage. Main Dam C Stage 1 is designed as a water retaining dam with a crest elevation of 1,273 masl. TSF C Stage 1 will provide sufficient capacity to impound tailings and PAG/NAG3 waste rock generated during the first year of operations and a supernatant pond up to 2 Mm^3, with additional capacity to manage seasonal water volume fluctuations and the EDF. Continued construction of Main Dam C Stage 2 to elevation 1,283 masl will occur immediately following substantial completion of the Stage 1 TSF and provide sufficient capacity for the Year +2 tailings, PAG/NAG3 waste rock, and water. Main Dam C comprises a zoned earth-rockfill dam requiring placement of approximately 3.25 Mm^3 of fill material for Stage 1 that will be sourced from local external borrow sources or pre-stripping of the Open Pit during Year -1 of mine development. Construction of Stage 2 TSF requires placement of an additional 2.1 Mm^3 of fill material, the majority of which will be OVB and NAG waste rock supplied from stripping of the Open Pit. The Stage 1 and Stage 2 TSF designs include emergency spillways to pass the IDF.

Main Dam C will be raised annually through Year +6 to an elevation of 1,321 masl using centreline construction methods. Main Dam C will be constructed out of NAG open pit materials and locally sourced OVB. The embankment section for Stages 1 to 6 comprises an impervious earthfill seal zone, designated Zone S, flanked on the downstream side by two filter zones, designated Zones F and T. A downstream shell zone (Zone C) will be constructed using a combination of pervious rockfill and sand and gravel from the open pit and less pervious OVB, such as glacial till. Internal drainage collection systems were designed to control seepage through the embankment.

Thereafter, the dam will be raised periodically in stages approximately 8 m high using downstream construction methods. The earthfill seal zone (Zone S) will be replaced with HDPE geomembrane facing for Stages 7 to 11 once PAG/NAG3 placement ceases in TSF C. The tailings distribution system will be extended along the crest of Main Dam C during Year +6 to allow for tailings discharge from the dam crest beginning in approximately Year +7 to cover and submerge the PAG/NAG3 waste rock dump. Thereafter, the downstream shell zone (Zone C) will be progressively constructed using a combination of pervious rockfill and sand and gravel from the Open Pit and less pervious OVB, such as glacial till. The HDPE geomembrane facing will be constructed periodically (approximately every 8 m) to increase the available storage capacity of the facility. The HDPE liner will be bedded on Zone F material underlain by Zone T material and supported by the downstream shell zone (Zone C). A horizontal bench for the tailings distribution system corridor is included on the upstream side of each stage of the dam to allow continuous tailings discharge from the embankment crest during construction of the staged raises.

Construction of Main Dam C requires placement of approximately 52 Mm^3 of fill material to reach a final elevation of 1,353 masl, the majority of which will be sourced from pit stripping. The plan, profile, and sections of Main Dam C projected over the life of the mine are in the TSF Life of Mine Design Report in Appendix 3-K.

West Dam Construction

The West Dam for TSF C will be constructed in two stages beginning in Year +6 to form the western limit of the TSF. The Stage 1 embankment will initially be constructed to an elevation of 1,345 masl and raised to an ultimate elevation of 1,353 masl in approximately Year +12 or as required to support on-going tailings deposition. The embankment foundations will be cleared and stripped in preparation for fill placement for each stage. Topsoil excavated from the foundation footprints will be stockpiled for use in reclamation. The ultimate dam will be approximately 250 m long with height of up to approximately 20 m. The West Dam will comprise a zoned earth-rockfill dam with an HDPE geomembrane facing to limit seepage from the TSF to the maximum practicable extent.

Construction of the West Dam requires placement of approximately 150,000 m^3 of fill material to reach a final elevation of 1,353 masl, the majority of which will be sourced from local excavations within the TSF basin. A cross section of TSF C West Dam is provided in Figure 3.5-30.

Saddle Dam Construction

The Saddle Dam for TSF C will be constructed in three stages beginning in Year +12 using downstream construction methods to an ultimate elevation of 1,353 masl. The embankment foundations will be cleared and stripped in preparation for fill placement for each stage. Topsoil excavated from the foundation footprints will be stockpiled for use in reclamation. The ultimate dam will be approximately 900 m long with a typical height of less than approximately 20 m and a maximum height of approximately 55 m. It will join with Main Dam C above an elevation of 1,350 masl to form one continuous embankment. The Saddle Dam will comprise a zoned earth-rockfill dam with an HDPE geomembrane facing with staged elevations consistent with Stages 9 to 11 of Main Dam C.

Construction of the Saddle Dam requires placement of approximately 2 Mm^3 of fill material to reach a final elevation of 1,353 masl, the majority of which will be sourced from pit stripping. A cross section of Saddle Dam is provided in Figure 3.5-31.

Main Dam D Construction

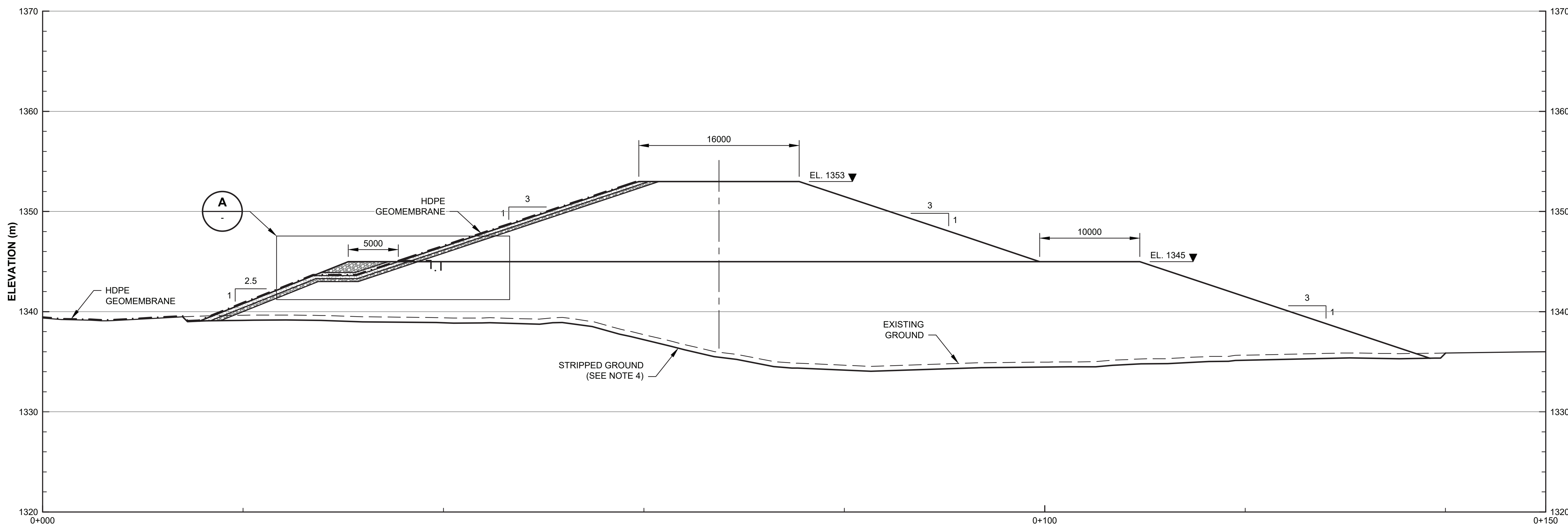
TSF D will be constructed adjacent to and downstream of TSF C to provide additional storage capacity for PAG/NAG3 waste rock and tailings. TSF D will comprise a valley-fill style impoundment formed by construction of one embankment, referred to as Main Dam D. Main Dam D will be constructed in approximately twelve stages using centreline construction methods to an ultimate elevation of 1,331 masl. The ultimate dam will be approximately 5 km long with an average height of approximately 50 m and maximum height of approximately 130 m at the narrow, heavily incised area where Davidson Creek currently flows.

Stage 1 of Main Dam D comprises a zoned earth-rockfill dam, consistent with the Main Dam C design concept, requiring placement of approximately 5 Mm^3 of fill material that will be sourced from local external borrow sources and the open pit waste materials beginning in approximately Year +5 of operations. The Stage 1 dam was designed with a crest elevation of 1,256 masl. The Stage 1 dam will be approximately 2.1 km in length and averages 25 m high with a maximum height of approximately 55 m where Davidson Creek is heavily incised. Main Dam D will be raised annually through Year +15 to an elevation of 1,324 masl using centreline construction methods. Thereafter, the dam will be raised to a final elevation of 1,331 masl prior to tailings deposition into TSF D. Construction of Main Dam D requires placement of approximately 48 Mm^3 of fill material to reach a final elevation of 1,331 masl, the majority of which will be sourced from pit stripping. The plan, profile, and sections of Main Dam D projected over the life of the mine are in the TSF Life of Mine Design Report in Appendix 3-K.

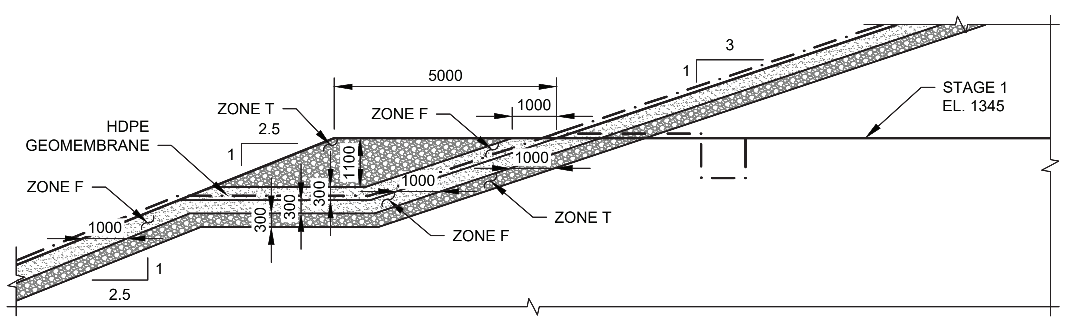
3.5.3.9 Tailings Storage Facility Operations

TSF Filling Schedule

The filling schedules for TSF C and TSF D are developed based on the mine waste release schedule, supernatant pond water inventory and seasonal water storage allowances, design flood criteria, and TSF storage characteristics.



2 SECTION
WEST DAM
G0110
SCALE A



A DETAIL
STAGE 1 - STAGE 2 CONNECTION
SCALE B

LEGEND:

- PAG WASTE ROCK
- CLAY / ZONE S (CORE ZONE)
- SAND / ZONE F (FILTER)
- GRAVEL / ZONE T (TRANSITION) / WEARING COURSE
- ZONE C (SHELL ZONE)

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. ALL DIMENSION ARE IN MILLIMETRES AND ELEVATIONS ARE IN METRES, UNLESS NOTED OTHERWISE.
3. PRELIMINARY ELEVATIONS FOR EACH STAGE OF DAM CONSTRUCTION ARE SHOWN IN SECTION ALONG WITH THE APPROXIMATE YEAR OF STAGE CONSTRUCTION COMPLETION.
4. EXCAVATE ORGANICS AND UNSUITABLE MATERIAL TO ENGINEER APPROVED SUBGRADE.
5. SAFETY BERMS NOT SHOWN FOR CLARITY. SAFETY BERMS SHALL BE AT LEAST 3/4 OF TIRE HEIGHT OF THE LARGEST WHEELED VEHICLE.

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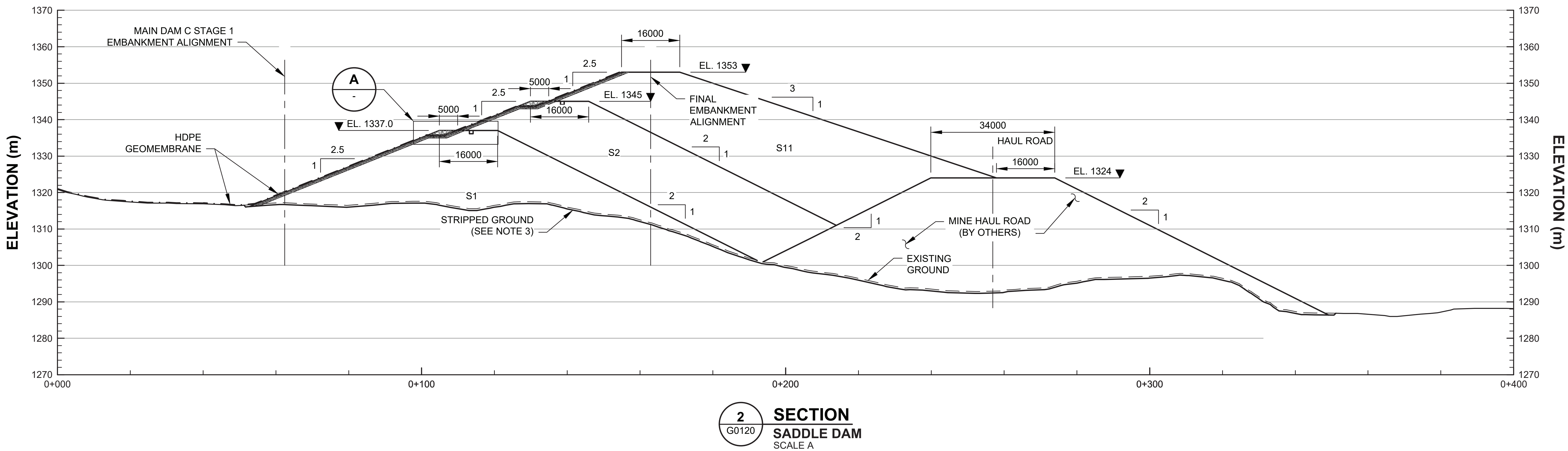
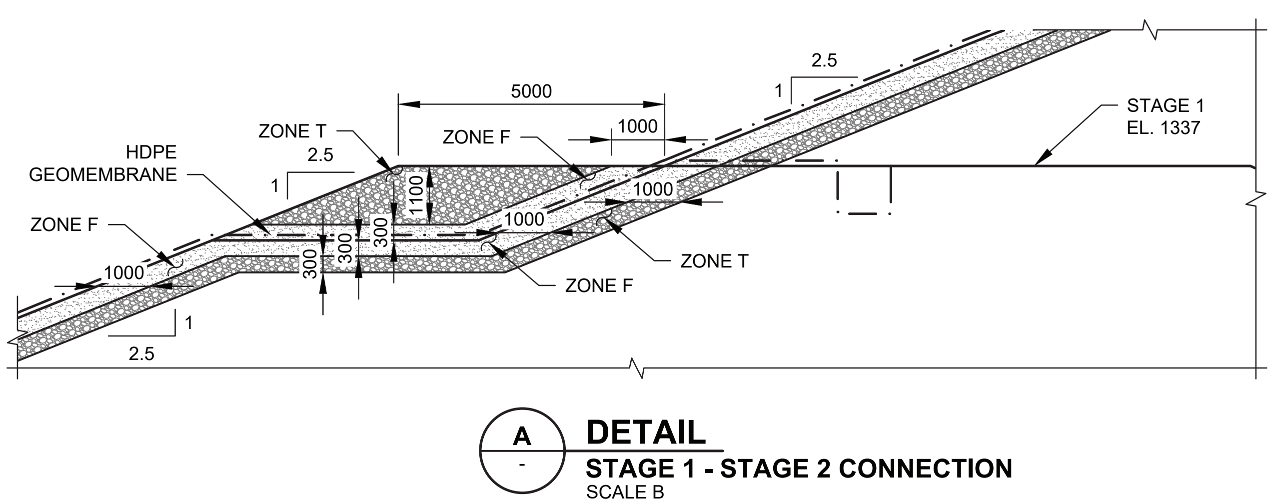
SCALE B 2 1 0 2 4 6 8 10 m
SCALE A 5 2.5 0 5 10 15 20 25 m

Figure 3.5-30: West Dam Section

Source: Knight Piésold Consulting (2021i; Appendix 3-K).





LEGEND:

- CLAY / ZONE S (CORE ZONE)
- SAND / ZONE F (FILTER)
- GRAVEL / ZONE T (TRANSITION) / WEARING COURSE
- ZONE C (SHELL ZONE)

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FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE B 2 1 0 2 4 6 8 10 m
SCALE A 15 7.5 0 25 50 75 m

Figure 3.5-31: Saddle Dam Section

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

The TSF filling schedules are based on estimated initial dry densities of 2.2 tonnes per cubic metre (t/m^3) for PAG/NAG3 waste rock and 1.3 t/m^3 for tailings. The actual rate of TSF filling during operations will be affected by a variety of factors, including the mining rate and pit development sequence, ore processing rates, tailings beach slopes, the supernatant pond area and volume, variability of tailings density throughout the facility, and on-going consolidation of the tailings mass throughout operations.

TSF C will be constructed first to provide storage capacity for start-up of the Processing Plant. It is designed to contain tailings for approximately 21 years of mine operations, PAG/NAG3 waste rock for the first six years of mining and includes a storage allowance for the supernatant pond to provide a continuous source of process water to the mill operations. The design considers additional allowances to manage seasonal inflows, EDF and IDF. The annual filling schedule for TSF C is summarized in Table 3.5.3-1. TSF C is sized to contain approximately 232 Mm^3 of tailings and 32 Mm^3 of waste rock.

TSF D will be constructed adjacent to and downstream of TSF C to provide additional storage capacity for PAG/NAG3 waste rock and tailings. It is designed to contain PAG/NAG3 waste rock generated during mining between Years +6 and +18 and up to approximately two years of tailings beginning in Year +21 when TSF C reaches design capacity. The design includes a nominal pond storage allowance beginning in Year +21 to allow for recycling of process water to TSF C and sufficient capacity for seasonal inflows and storage of the IDF. The annual filling schedule for TSF D is summarized in Table 3.5.3-2. TSF D is sized to contain approximately 25 Mm^3 of tailings and 180 Mm^3 of waste rock.

TSF C Dam Staging

TSF C is sized to contain approximately 232 Mm^3 of tailings, 32 Mm^3 of waste rock, and a supernatant pond volume ranging from 1 to 10 Mm^3. The supernatant pond volume allowance was estimated based on the planned ore throughput rates and is equivalent to approximately 4 months of process water. Additional freeboard allowances are included to manage seasonal inflows and the EDF and IDF runoff volumes. A detailed filling schedule is provided in Appendix 3-K.

The actual rate of TSF C filling during operations will be affected by a variety of factors, including the mining rate and pit development sequence, ore processing rates, tailings beach slopes, the supernatant pond area and volume, variability of tailings density throughout the facility, and on-going consolidation of the tailings mass throughout operations.

The filling schedules and embankment staging conservatively ignore tailings consolidation processes for the LoM staging projections. Interstitial water will be liberated from the tailings mass during consolidation resulting in additional storage availability when the water is reclaimed for ore processing or otherwise removed from the facility.

Filling curves (Figure 3.5-32) and embankment staging estimates were developed from the filling schedule for TSF C based on the elevation-capacity relationship of the facility. A summary of the estimated year of embankment stage construction, preliminary elevations of each stage, and associated total volumetric capacity is provided for TSF C in Table 3.5.3-3.

TSF D Dam Staging

TSF D is designed to contain PAG/NAG3 waste rock generated during mining between Years +6 to +18 and up to approximately two years of tailings beginning in Year +21 when TSF C reaches design capacity. TSF D is sized to contain approximately 180 Mm^3 of waste rock and 25 Mm^3 of tailings. The design includes a nominal pond storage allowance of up to 2 Mm^3 beginning in Year +21 to allow for recycling of process water to TSF C and sufficient additional capacity for seasonal inflows and storage of the IDF. A detailed filling schedule is provided in Appendix 3-K.

Knight Piésold CONSULTING

TABLE 3.5.3-1

BW GOLD LTD.
BLACKWATER GOLD PROJECT

TSF LIFE OF MINE DESIGN
TSF C ANNUAL FILLING SCHEDULE

Print May/14/21 9:19:19

Mine Period	End of Year	TAILINGS SOLIDS				WASTE ROCK (WR) INTO TSF C						TSF C STORAGE REQUIREMENT			SEASONAL FLUCTUATION & EDF/IDF STORAGE REQUIREMENT				TOTAL REQUIRED STORAGE VOLUME
		Annual Tailings Production	Total Tailings Cumulative	Annual Tailings Production	Total Tailings Cumulative	Annual NAG3 WR	Annual PAG WR	Annual WR Total	Cumulative WR Total	Annual WR Total	Cumulative WR Total	Tailings Solids + WR	Supernatant Pond Allowance	Total Required Mine Waste and Pond Storage Volume	Seasaon Fluctuation Allowance	EDF Storage Allowance	IDF Storage Allowance	Seasonal Fluctuation and Design Flood Storage	
		tonnes	tonnes	m^3	m^3	tonnes	tonnes	tonnes	tonnes	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
1	-2	0	0	0	0	0	119,664	119,664	119,664	54,393	54,393	54,393	0	54,393	0	0	0	0	54,393
2	-1	0	0	0	0	16,634	1,106,552	1,123,186	1,242,849	510,539	564,932	564,932	1,000,000	1,564,932	0	0	0	0	1,564,932
3	1	4,500,000	4,500,000	3,461,538	3,461,538	760,837	7,997,946	8,758,783	10,001,632	3,981,265	4,546,196	8,007,735	2,000,000	10,007,735	3,000,000	2,780,650	0	5,780,650	15,788,385
4	2	5,500,000	10,000,000	4,230,769	7,692,308	743,328	8,651,158	9,394,486	19,396,118	4,270,221	8,816,417	16,508,725	2,000,000	18,508,725	3,000,000	2,780,650	0	5,780,650	24,289,375
5	3	5,500,000	15,500,000	4,230,769	11,923,077	423,467	6,563,302	6,986,769	26,382,887	3,175,804	11,992,221	23,915,298	2,000,000	25,915,298	3,000,000	0	21,806,150	24,806,150	50,721,448
6	4	5,500,000	21,000,000	4,230,769	16,153,846	1,619,558	13,976,589	15,596,147	41,979,033	7,089,158	19,081,379	35,235,225	2,000,000	37,235,225	3,000,000	0	21,806,150	24,806,150	62,041,375
7	5	5,500,000	26,500,000	4,230,769	20,384,615	1,707,757	14,561,249	16,269,006	58,248,039	7,395,003	26,476,381	46,860,997	5,000,000	51,860,997	3,000,000	0	21,806,150	24,806,150	76,667,147
8	6	12,000,000	38,500,000	9,230,769	29,615,385	243,362	12,484,921	12,728,282	70,976,321	5,785,583	32,261,964	61,877,349	5,000,000	66,877,349	3,000,000	0	21,806,150	24,806,150	91,683,499
9	7	12,000,000	50,500,000	9,230,769	38,846,154	0	0	0	70,976,321	0	32,261,964	71,108,118	5,000,000	76,108,118	3,000,000	0	21,806,150	24,806,150	100,914,268
10	8	12,000,000	62,500,000	9,230,769	48,076,923	0	0	0	70,976,321	0	32,261,964	80,338,887	5,000,000	85,338,887	3,000,000	0	21,806,150	24,806,150	110,145,037
11	9	12,000,000	74,500,000	9,230,769	57,307,692	0	0	0	70,976,321	0	32,261,964	89,569,656	5,000,000	94,569,656	3,000,000	0	21,806,150	24,806,150	119,375,806
12	10	12,000,000	86,500,000	9,230,769	66,538,462	0	0	0	70,976,321	0	32,261,964	98,800,426	5,000,000	103,800,426	3,000,000	0	21,806,150	24,806,150	128,606,576
13	11	20,000,000	106,500,000	15,384,615	81,923,077	0	0	0	70,976,321	0	32,261,964	114,185,041	10,000,000	124,185,041	3,000,000	0	21,806,150	24,806,150	148,991,191
14	12	20,000,000	126,500,000	15,384,615	97,307,692	0	0	0	70,976,321	0	32,261,964	129,569,656	10,000,000	139,569,656	3,000,000	0	21,806,150	24,806,150	164,375,806
15	13	20,000,000	146,500,000	15,384,615	112,692,308	0	0	0	70,976,321	0	32,261,964	144,954,272	10,000,000	154,954,272	3,000,000	0	21,806,150	24,806,150	179,760,422
16	14	20,000,000	166,500,000	15,384,615	128,076,923	0	0	0	70,976,321	0	32,261,964	160,338,887	10,000,000	170,338,887	3,000,000	0	21,806,150	24,806,150	195,145,037
17	15	20,000,000	186,500,000	15,384,615	143,461,538	0	0	0	70,976,321	0	32,261,964	175,723,503	10,000,000	185,723,503	3,000,000	0	21,806,150	24,806,150	210,529,653
18	16	20,000,000	206,500,000	15,384,615	158,846,154	0	0	0	70,976,321	0	32,261,964	191,108,118	10,000,000	201,108,118	3,000,000	0	21,806,150	24,806,150	225,914,268
19	17	20,000,000	226,500,000	15,384,615	174,230,769	0	0	0	70,976,321	0	32,261,964	206,492,733	10,000,000	216,492,733	3,000,000	0	21,806,150	24,806,150	241,298,883
20	18	20,000,000	246,500,000	15,384,615	189,615,385	0	0	0	70,976,321	0	32,261,964	221,877,349	10,000,000	231,877,349	3,000,000	0	21,806,150	24,806,150	256,683,499
21	19	20,000,000	266,500,000	15,384,615	205,000,000	0	0	0	70,976,321	0	32,261,964	237,261,964	10,000,000	247,261,964	3,000,000	0	21,806,150	24,806,150	272,068,114
22	20	20,000,000	286,500,000	15,384,615	220,384,615	0	0	0	70,976,321	0	32,261,964	252,646,580	10,000,000	262,646,580	3,000,000	0	21,806,150	24,806,150	287,452,730
23	21	14,700,000	301,200,000	11,307,692	231,692,308	0	0	0	70,976,321	0	32,261,964	263,954,272	10,000,000	273,954,272	3,000,000	0	21,806,150	24,806,150	298,760,422
24	22	0	301,200,000	0	231,692,308	0	0	0	70,976,321	0	32,261,964	263,954,272	10,000,000	273,954,272	3,000,000	0	21,806,150	24,806,150	298,760,422
25	23	0	301,200,000	0	231,692,308	0	0	0	70,976,321	0	32,261,964	263,954,272	10,000,000	273,954,272	3,000,000	0	21,806,150	24,806,150	298,760,422

M:\1\01\00457\33\A\Report\5-TSF Life of Mine Design Report\Appendix E - TSF Filling Details\Appendix E2 - TSF Filling Details\[TSF Site C + D Filling Schedule_Sch8b_rD.xlsx]Filling Schedule-TSF C

Tailings Density (t/m^3)	1.3
Waste Rock Density (t/m^3)	2.2

NOTES:

1. WASTE ROCK INTO TSF INCLUDES ALLOWANCE FOR ALL PAG (PAG1, PAG2, AND UNDEFINED) AND NAG3 WASTE ROCK WITHOUT CONSIDERATION FOR WASTE ROCK USED FOR DAM CONSTRUCTION.
2. WASTE ROCK DELIVERED TO TSF C IN YEARS -1 TO 6 AND TSF D IN YEARS 6 TO 18.
3. TAILINGS DELIVERED TO TSF IN YEARS -2 TO 21 AND TO TSF D BEGINNING IN LATE YEAR 21 UNTIL THE END OF OPERATIONS.
4. TSF C HAS CAPACITY FOR STORAGE OF THE INFLOW DESIGN FLOOD (IDF) VOLUME OF APPROXIMATELY 22 Mm^3 FOLLOWING CONSTRUCTION OF STAGE 3 OF MAIN DAM C DURING YEAR 2.
5. DURING YEARS 1 AND 2 OF MINE OPERATION, PRIOR TO CONSTRUCTION OF STAGE 3, THE IDF IS PASSED BY AN EMERGENCY OUTFLOW CHANNEL.

D	30MAR'21	ISSUED WITH REPORT VA101-457/33-5	JSP	DDF
REV	DATE	DESCRIPTION	PREP'D	REV'D

Knight Piésold CONSULTING

TABLE 3.5.3-2

BW GOLD LTD.
BLACKWATER GOLD PROJECT

TSF LIFE OF MINE DESIGN
TSF D ANNUAL FILLING SCHEDULE

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Mine Period	End of Year	TAILINGS SOLIDS				WASTE ROCK (WR) INTO TSF D						TSF D STORAGE REQUIREMENT			SEASONAL FLUCTUATION & IDF STORAGE REQUIREMENT			TOTAL REQUIRED STORAGE VOLUME
		Annual Tailings Production	Total Tailings Cumulative	Annual Tailings Production	Total Tailings Cumulative	Annual NAG3 WR	Annual PAG WR	Annual WR Total	Cumulative WR Total	Annual WR Total	Cumulative WR Total	Tailings Solids + WR	Supernatant Pond Allowance	Total Required Mine Waste and Pond Storage Volume	Seasaon Fluctuation Allowance	IDF Storage Allowance	Seasonal Fluctuation and Design Flood Storage	
		tonnes	tonnes	m^3	m^3	tonnes	tonnes	tonnes	tonnes	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
1	**-2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	**-1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	**3**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	**6**	0	0	0	0	243,362	12,484,921	12,728,282	12,728,282	5,785,583	5,785,583	5,785,583	0	5,785,583	1,350,000	9,834,000	11,184,000	16,969,583
9	**7**	0	0	0	0	221,928	24,265,347	24,487,276	37,215,558	11,130,580	16,916,163	16,916,163	0	16,916,163	1,350,000	9,834,000	11,184,000	28,100,163
10	**8**	0	0	0	0	1,900,399	34,081,043	35,981,442	73,197,000	16,355,201	33,271,364	33,271,364	0	33,271,364	1,350,000	9,834,000	11,184,000	44,455,364
11	**9**	0	0	0	0	3,586,168	40,180,333	43,766,501	116,963,501	19,893,864	53,165,228	53,165,228	0	53,165,228	1,350,000	9,834,000	11,184,000	64,349,228
12	**10**	0	0	0	0	3,073,587	45,956,171	49,029,759	165,993,259	22,286,254	75,451,482	75,451,482	0	75,451,482	1,350,000	9,834,000	11,184,000	86,635,482
13	**11**	0	0	0	0	869,831	37,006,915	37,876,746	203,870,005	17,216,703	92,668,184	92,668,184	0	92,668,184	1,350,000	9,834,000	11,184,000	103,852,184
14	**12**	0	0	0	0	3,012,899	24,292,730	27,305,629	231,175,634	12,411,649	105,079,834	105,079,834	0	105,079,834	1,350,000	9,834,000	11,184,000	116,263,834
15	**13**	0	0	0	0	2,741,135	33,717,345	36,458,479	267,634,113	16,572,036	121,651,870	121,651,870	0	121,651,870	1,350,000	9,834,000	11,184,000	132,835,870
16	**14**	0	0	0	0	2,127,004	44,918,615	47,045,619	314,679,733	21,384,372	143,036,242	143,036,242	0	143,036,242	1,350,000	9,834,000	11,184,000	154,220,242
17	**15**	0	0	0	0	902,439	38,456,274	39,358,713	354,038,446	17,890,324	160,926,566	160,926,566	0	160,926,566	1,350,000	9,834,000	11,184,000	172,110,566
18	**16**	0	0	0	0	102,866	28,284,427	28,387,294	382,425,739	12,903,315	173,829,881	173,829,881	0	173,829,881	1,350,000	9,834,000	11,184,000	185,013,881
19	**17**	0	0	0	0	3,738	13,499,877	13,503,615	395,929,354	6,138,007	179,967,888	179,967,888	0	179,967,888	1,350,000	9,834,000	11,184,000	191,151,888
20	**18**	0	0	0	0	0	381,368	381,368	396,310,723	173,349	180,141,238	180,141,238	0	180,141,238	1,350,000	9,834,000	11,184,000	191,325,238
21	**19**	0	0	0	0	0	0	0	396,310,723	0	180,141,238	180,141,238	0	180,141,238	1,350,000	9,834,000	11,184,000	191,325,238
22	**20**	0	0	0	0	0	0	0	396,310,723	0	180,141,238	180,141,238	0	180,141,238	1,350,000	9,834,000	11,184,000	191,325,238
23	**21**	5,300,000	5,300,000	4,076,923	4,076,923	0	0	0	396,310,723	0	180,141,238	184,218,161	2,000,000	186,218,161	1,350,000	9,834,000	11,184,000	197,402,161
24	**22**	20,000,000	25,300,000	15,384,615	19,461,538	0	0	0	396,310,723	0	180,141,238	199,602,776	2,000,000	201,602,776	1,350,000	9,834,000	11,184,000	212,786,776
25	**23**	7,546,000	32,846,000	5,804,615	25,266,154	0	0	0	396,310,723	0	180,141,238	205,407,391	2,000,000	207,407,391	1,350,000	9,834,000	11,184,000	218,591,391

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Tailings Density (t/m^3)	1.3
Waste Rock Density (t/m^3)	2.2

NOTES:

1. WASTE ROCK INTO TSF INCLUDES ALLOWANCE FOR ALL PAG (PAG1, PAG2, AND UNDEFINED) AND NAG3 WASTE ROCK WITHOUT CONSIDERATION FOR WASTE ROCK USED FOR DAM CONSTRUCTION.
2. WASTE ROCK DELIVERED TO TSF C IN YEARS -1 TO 6 AND TSF D IN YEARS 6 TO 18.
3. TAILINGS DELIVERED TO TSF C IN YEARS -2 TO 21 AND TO TSF D BEGINNING IN LATE YEAR 21 UNTIL THE END OF OPERATIONS.
4. THE TSF HAS CAPACITY FOR STORAGE OF THE INFLOW DESIGN FLOOD VOLUME OF APPROXIMATELY 10 Mm^3 FOLLOWING CONSTRUCTION OF MAIN DAM D DURING YEAR 5.

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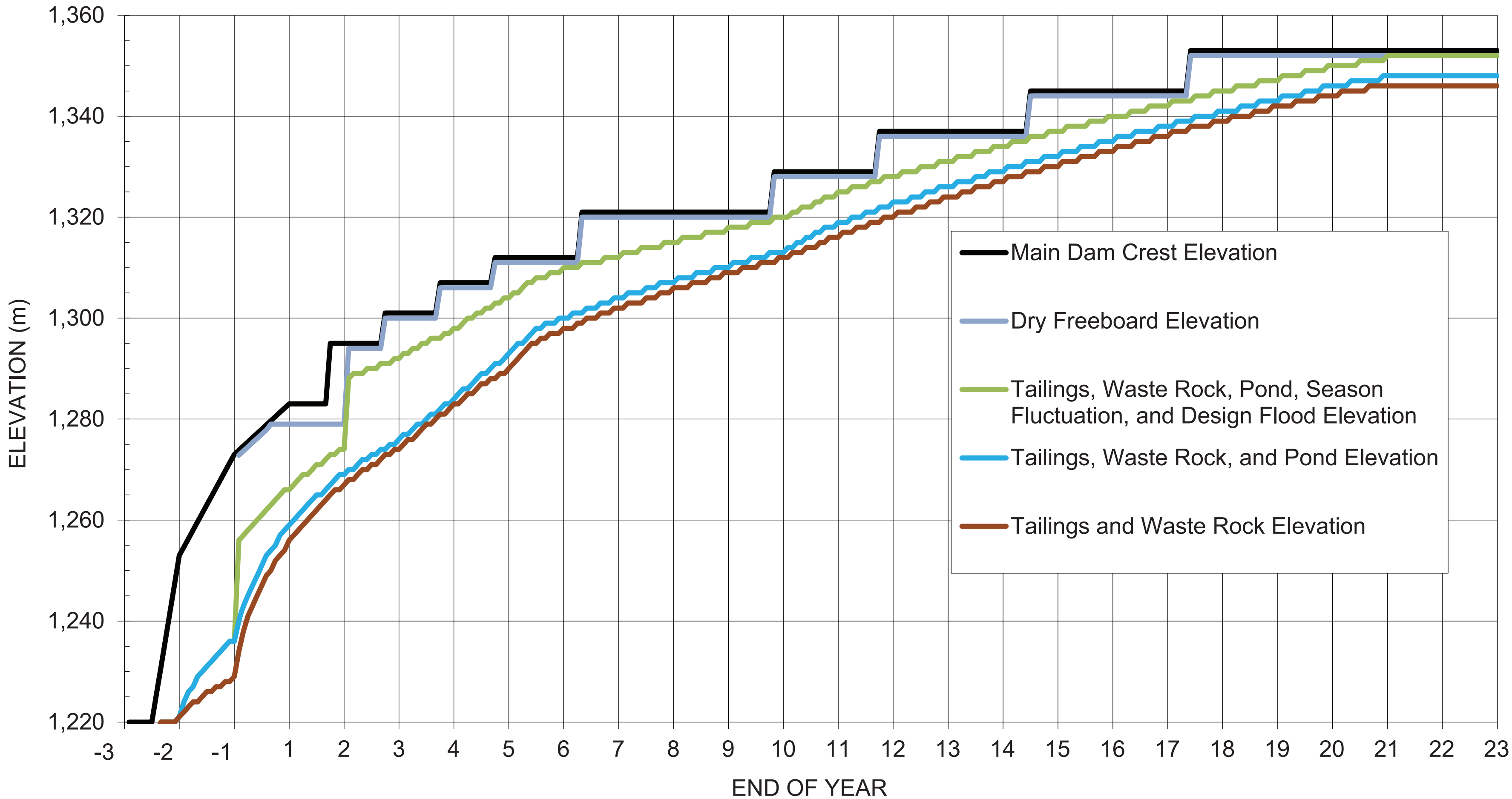


NOTES:

1. BASED ON WASTE MATERIAL QUANTITIES FROM MOOSE MOUNTAIN TECHNICAL SERVICES (MINE SCHEDULE SCH8B).
2. THE EMERGENCY OVERFLOW CHANNEL INVERT IS BASED ON PASSING THE INFLOW DESIGN FLOOD (IDF) WITH ADEQUATE FREEBOARD DURING YEARS 1 AND 2 OF MINE OPERATIONS.
3. THE TSF HAS CAPACITY FOR STORAGE OF THE IDF VOLUME OF APPROXIMATELY 22 Mm^3 FOLLOWING CONSTRUCTION OF STAGE 3 OF MAIN DAM C DURING YEAR 2.
4. A MINIMUM DRY FREEBOARD ALLOWANCE OF 1 m IS INCLUDED FOR STAGE 3 AND THEREAFTER, IN EXCESS OF THE STORM STORAGE FREEBOARD REQUIRED FOR THE IDF.

Figure 3.5-32: Filling Curve for TSF C Pond

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

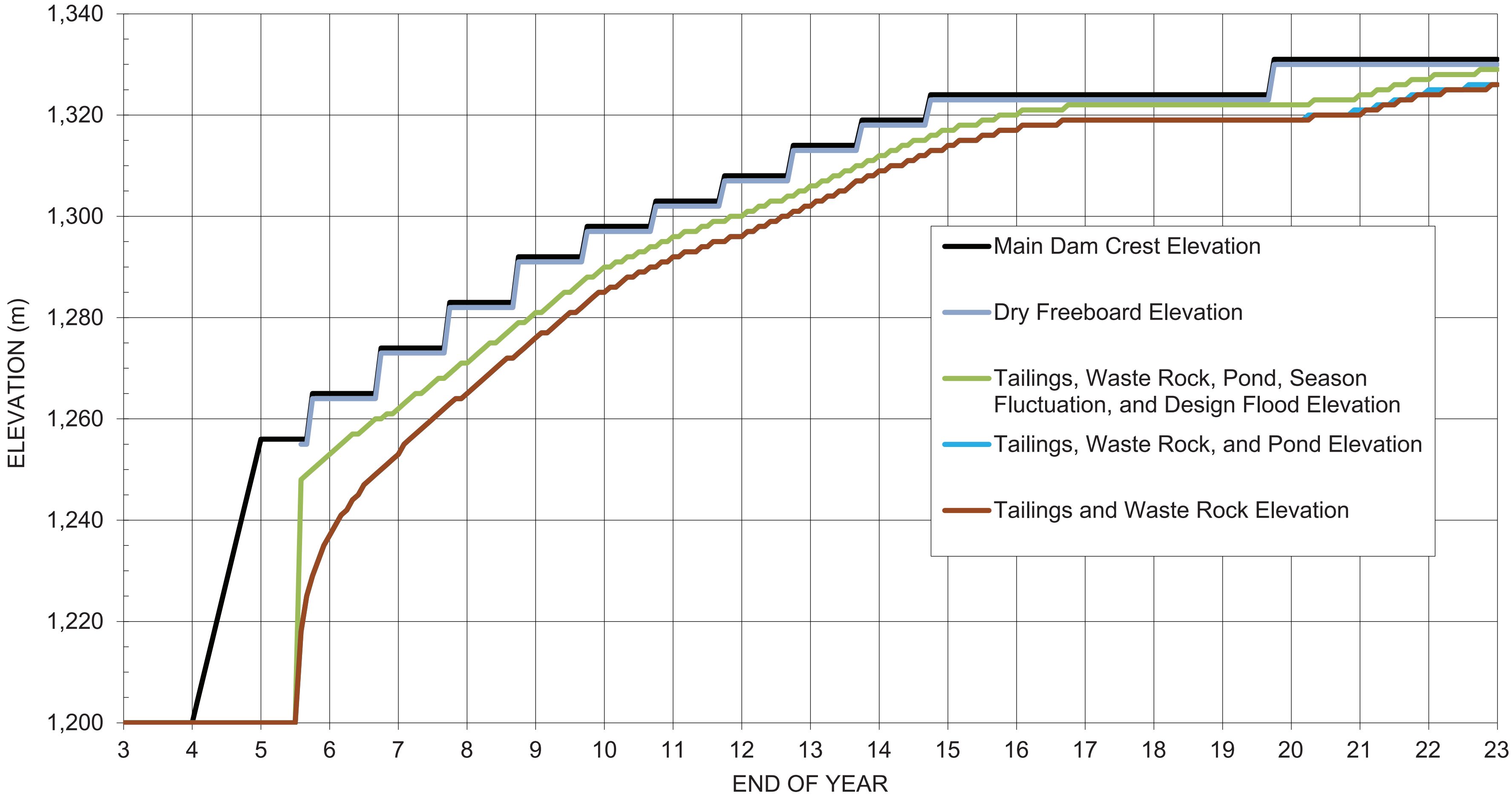
Table 3.5.3-3: TSF C Embankment Raising Schedule

Stage	Mine Year Built	Elevation (masl)	Total Capacity (Mm^3)
1	Pre-Production	1,273	22
2	1	1,283	35
3	2	1,295	55
4	3	1,301	68
5	4	1,307	83
6	5	1,312	98
7	6	1,321	131
8	10	1,329	166
9	12	1,337	207
10	15	1,345	254
11	18	1,353	305

Filling curves (Figure 3.5-33) and embankment staging estimates were developed from the filling schedule for TSF D based on the elevation-capacity relationship of the facility, as described in Appendix 3-J. A summary of the estimated year of embankment stage construction, preliminary elevations of each stage, and associated total volumetric capacity is provided for TSF D in Table 3.5.3-4.

Table 3.5.3-4: TSF D Embankment Raising Schedule

Stage	Mine Year Built	Elevation (masl)	Total Capacity (Mm^3)
1	5	1,256	19
2	6	1,265	32
3	7	1,274	49
4	8	1,283	69
5	9	1,292	92
6	10	1,298	108
7	11	1,303	123
8	12	1,308	139
9	13	1,314	159
10	14	1,319	178
11	15	1,324	197
12	20	1,331	225



NOTES:

1. BASED ON WASTE MATERIAL QUANTITIES FROM MOOSE MOUNTAIN TECHNICAL SERVICES (MINE SCHEDULE SCH8B).
2. THE TSF HAS CAPACITY FOR STORAGE OF THE INFLOW DESIGN FLOOD (IDF) VOLUME OF APPROXIMATELY 10 Mm^3 FOLLOWING CONSTRUCTION DURING YEAR 5 OF MAIN DAM D.
4. A MINIMUM DRY FREEBOARD ALLOWANCE OF 1 m IS INCLUDED IN CONSTRUCTION COMPLETE IN YEAR 5 AND THEREAFTER, IN EXCESS OF THE STORM STORAGE FREEBOARD REQUIRED FOR THE IDF.

Figure 3.5-33: Filling Curve for TSF D Pond

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

3.5.3.10 Tailings Characteristics and Distribution

Laboratory testing was completed in 2013 and 2021. The tests were performed for a target solids content of 50% in 2013 and 45% and 35% in 2021. The 2013 and 2021 test work included the following techniques:

- Index testing, including Particle Size Analysis (ASTM D6913 and D7928), Specific Gravity (ASTM D854), and Atterberg Limits (ASTM D4318);
- Drained and Undrained Slurry Settling Tests (KP Lab Procedure);
- Air Drying (KP Lab Procedure); and
- High Stress Slurry Consolidation (KP Procedure) and Rigid Wall Permeability Testing (ASTM D5856).

Further testing in 2013 included:

- Low stress (LS) slurry consolidation (KP Procedure) by the KP Denver laboratory;
- Bench scale thickening testing by FLSmidth (FLS);
- Soil-Water Characteristic Curve (SWCC) testing by SNC-Lavalin; and
- Rheological testing by Paterson & Cooke (P&C).

Further testing in 2021 included:

- Seepage Induced Consolidation Testing (Znidarčić et al. 1992).

Index Tests

Index testing is used to evaluate composition (size and distribution), particle density, and plasticity characteristics of a material. The index properties can be used to develop comparisons to typical material properties, including compressibility, permeability, and shear strength. A summary of the index testing is provided in Table 3.5.3-5.

Table 3.5.3-5: Summary of Tailings Index Tests

Sample	Specific Gravity of Solids	Atterberg Limits			Particle Size Analysis			Material Classification
		Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Sand (%)	Silt (%)	Clay (%)	
2013 Tailings	2.79	Non-plastic	Non-plastic	Non-plastic	44	46	10	Sandy SILT (ML)
2021 Tailings	2.75	Non-plastic	Non-plastic	Non-plastic	52	35	13	Silty SAND (SM)

Notes:
Sand limits defined as 4.75 mm to 0.075 mm by the Unified Soil Classification System.
Silt limits defined as 0.075 mm to 0.002 mm and clay limits defined as < 0.002 mm by the US Department of Agriculture.

Slurry Settling and Air Drying Tests

Slurry settling and air drying tests were completed to measure the tailings density under three types of settling conditions (undrained, drained, and air drying). A summary of test results is provided in Table 3.5.3-6 and detailed in Appendix 3-K.

The 2013 and 2021 tailings samples required approximately 18 and 15 days, respectively, to complete air drying (achieving the shrinkage limit) under laboratory conditions.

Table 3.5.3-6: Summary of Tailings Settling and Drying Tests

Sample	Test	Actual Percent Solids (%)	Void Ratio		Dry Density (t/m³)		Total Water Recovery[1]	Falling Head Permeability
			Initial	Final	Initial	Final	(%)	(cm/s)
2013 Tailings	Undrained Settling	50.2	2.58	1.35	0.78	1.19	52.3	-
2021 Tailings		47.9	2.31	1.15	0.83	1.28	64.0	-
		35.7	3.66	1.35	0.59	1.17	72.4	-
2013 Tailings	Drained Settling	50.1	2.53	1.07	0.79	1.35	62.1	2E-05
2021 Tailings		45.9	2.44	1.04	0.80	1.35	67.7	2E-05
		34.1	4.61	1.15	0.49	1.28	78.2	2E-05
2013 Tailings	Air Drying	49.8	2.28	0.76	0.85	1.59	42.1	-
2021 Tailings		46.1	1.86	0.64	0.96	1.68	-	-
		34.5	3.50	0.68	0.61	1.64	-	-

[1] *Total water recovery is defined as a percentage of the total water in the initial slurry.*

Slurry Consolidation and Permeability Tests

A High Stress Slurry Consolidation Test was performed to evaluate the consolidation, compressibility, and permeability characteristics of the tailings over a range of effective confining stresses. The tests were conducted by placing a slurry sample in a specialized slurry consolidometer and allowing the tailings to settle and consolidate under self-weight loading. Further consolidation of the tailings was induced by increasing the confining stresses in incremental loading stages. A summary of high stress slurry consolidation and permeability test work results is provided in Table 3.5.3-7 for the 2013 tailings sample and Table 3.5.3-8 for the 2021 tailings sample.

Table 3.5.3-7: 2013 Slurry Consolidation and Permeability Testing Summary

Load Increment	Average Effective Stress	Void Ratio, e	Dry Density[1]	Coefficient of Consolidation (c_v)	Coefficient of Compressibility (m_v)	Vertical Permeability[2] (k_v)
(kPa)	(kPa)	-	(t/m^3)	(m^2/year)	(m^2/kN)	(cm/sec)
14		0.93	1.45			-
	24			340	9E-04	
34		0.90	1.47			9E-06
	52			490	5E-04	
69		0.87	1.50			7E-06
	103			760	3E-04	
138		0.83	1.52			6E-06
	207			1,140	1E-04	
276		0.80	1.55			5E-06
	414			1,520	9E-05	

Load Increment	Average Effective Stress	Void Ratio, e	Dry Density[1]	Coefficient of Consolidation (c_v)	Coefficient of Compressibility (m_v)	Vertical Permeability[2] (k_v)
(kPa)	(kPa)	-	(t/m^3)	(m^2/year)	(m^2/kN)	(cm/sec)
552		0.75	1.59			4E-06
	690			2,070	6E-05	
827		0.73	1.62			4E-06

Notes: Actual percent solids content of sample was 48.0%.

[1] *Dry density calculated using measured void ratio and tailings specific gravity (S.G. = 2.79).*

[2] *k_V = Coefficient of Permeability measured at the end of loading stage.*

Table 3.5.3-8: 2021 Slurry Consolidation and Permeability Testing Summary

Load Increment	Average Effective Stress	Void Ratio, e	Dry Density[1]	Coefficient of Consolidation (c_v)	Coefficient of Compressibility (m_v)	Vertical Permeability[2] (k_v)
(kPa)	(kPa)	-	(t/m^3)	(m^2/year)	(m^2/kN)	(cm/sec)
34		0.93	1.43			7E-06
	52			174	1E-03	
69		0.85	1.48			6E-06
	103			292	6E-04	
138		0.78	1.55			5E-06
	207			257	5E-04	
276		0.67	1.65			4E-06
	414			498	2E-04	
552		0.63	1.69			3E-06

Notes: Actual percent solids content of sample was 44.6%.

[1] *Dry density calculated using measured void ratio and tailings specific gravity (S.G. = 2.75).*

[2] *k_v = Coefficient of Permeability measured at the end of loading stage.*

A low stress slurry consolidation test was completed to characterize the consolidation and permeability characteristics for the 2013 tailings at low stress ranges. The summary of low stress consolidation results is provided in Table 3.5.3-9.

Table 3.5.3-9: Summary of Low Stress Consolidation Test

Sample	Self-Weight Loading	Average Effective Stress	Void Ratio, e	Dry Density	c_v [1]	m_v [1]	Vertical Permeability[2] (k_v)
	(kPa)	(kPa)	-	(t/m^3)	(m^2/year)	(m^2/kN)	(cm/sec)
2013 Tailings	0.7		1.50	1.12			
		1.6			20	6E-02	4E-05
	2.4		1.27	1.23			

[1] *c_v = Coefficient of Compressibility, m_v = Volumetric Compressibility*

[2] *Calculated coefficient of vertical permeability*

Seepage Induced Consolidation Testing

A Seepage Induced Consolidation Test (SICT) was completed to characterize the consolidation and permeability characteristics for the 2021 tailings at low stress ranges.

The analysis of the SICT results was performed using the software program SICTA (Seepage Induced Consolidation Test Analysis; Znidarčić et al. 1992). The SICT calculates compressibility and permeability curve fitting parameters that can be used in consolidation modelling. These consolidation model parameters can be used to calculate the void ratio (e) and coefficient of vertical permeability (k_v) with the equations listed below.

Equation 1 (Void Ratio): $e = A(\sigma' + Z)^B$

Equation 2 (Coefficient of Vertical Permeability): $k = Ce^D$

The void ratios and permeability values can then be used to estimate the coefficient of consolidation for each effective stress increment. The parameters calculated through the SICTA computer program are summarized in Table 3.5.3-10.

Table 3.5.3-10: SICTA Consolidation Model Parameters

Parameter	Blackwater Tailings
A	1.08
B	-0.075
Z	0.009 kPa
C	1.29×10^{-2} m/day
D	3.748

Soil Water Characteristic Curve

A test was carried out to determine the Soil-Water Characteristic Curve (SWCC) defining the relationship between water content and suction pressure (KP 2013f) for the 2013 tailings sample. The relationship is presented in Figure 3.5-34.

Rheological Testing

Rheology tests were conducted on the 2013 tailings sample to provide information for tailings slurry pipeline design and to guide decisions regarding required pipe slope, size, and preferred pipe material. These tests were carried out on the whole tailings slurry and on the carrier fluid only (tailings fine fraction). Both tailings materials were characterized as a Bingham plastic slurry. The rheology of the entire tailings stream indicated that slurry with solids content above 70% would rapidly increase the yield stress and plastic viscosity. This would result in decreased slurry flowability and increased frictional losses and pumping requirements (KP 2013f).

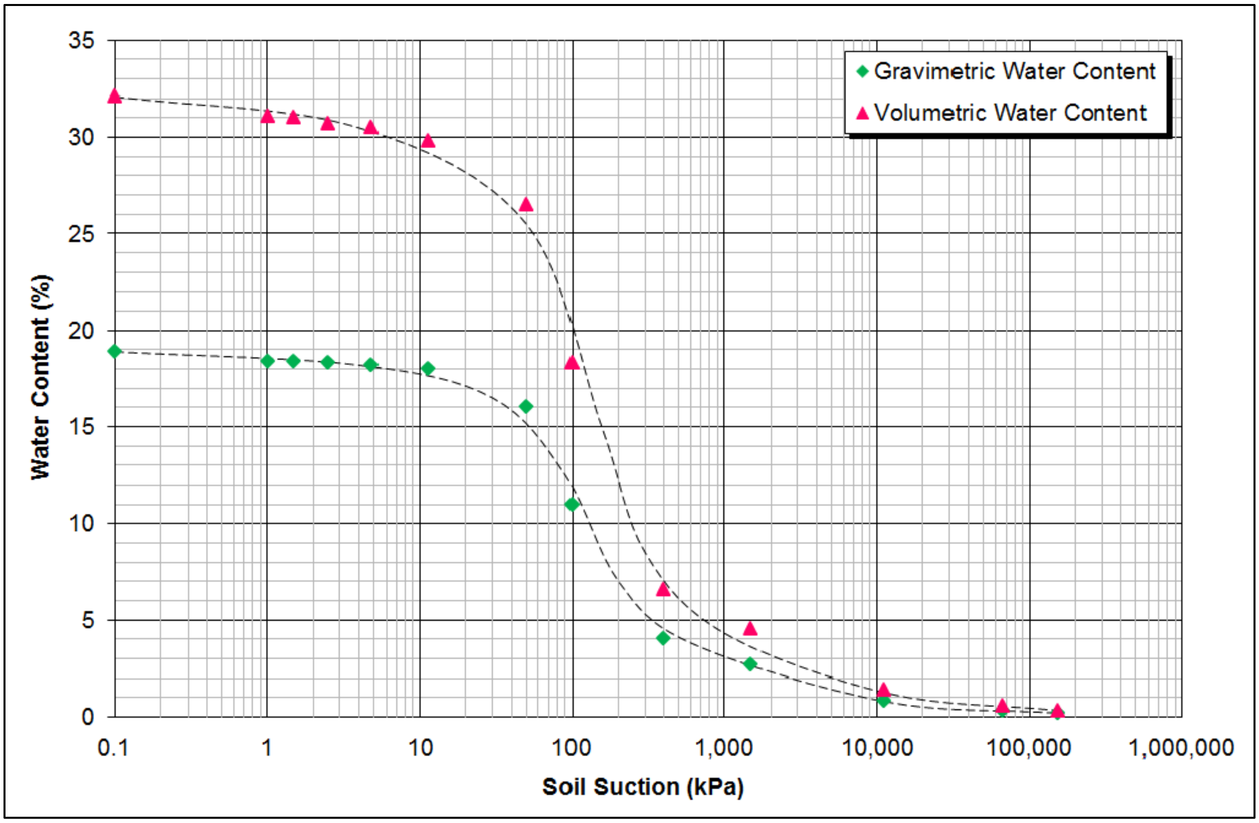


Figure 3.5-34: Gravimetric and Volumetric Water Content vs. Soil Suction, 2013 Tailings Sample

3.5.3.11 Tailings Distribution and Water Reclaim Systems

Tailings Distribution System

The tailings distribution system will transport tailings slurry from the tailings discharge box within the Plant Site to TSF C. There will be three phases of tailings distribution infrastructure sized to accommodate mill throughput capacities of up to 6 Mtpa, 12 Mtpa, and 20 Mtpa beginning in Year +1, Year +6, and Year +11, respectively. All phases of operations will consist of gravity-fed pipelines with full-diameter discharge spigots located around the facility to accommodate tailings beach development to manage the supernatant pond location and PAG waste rock cover as required.

The initial section of pipe, within the Plant Site boundaries, will be buried as the tailings discharge box is located below the Plant Site pad surface elevation. All subsequent pipelines will be installed on ground surface.

The initial stage of tailings distribution will consist of a single, gravity-fed pipeline to convey tailings from the Plant Site to the southwest side of initial TSF C disposal area (approximately 4,700 m in length and an elevation difference of 120 m). The pipeline will comprise ND 500 mm HDPE pipe with full-diameter slurry knife gate valves as required to manage tailings deposition locations. The tailings distribution system was sized with sufficient capacity to convey a design flowrate of between 1,250 and 1,430 m^3/h, which is equivalent to a nominal tailings throughput of up to 6 Mtpa. Pipe specifications have been selected to eliminate the need for energy dissipation infrastructure prior to discharge into TSF C.

The tailings distribution infrastructure will be expanded in Year +5 with the addition of a secondary line to the southwest end of TSF C (approximately 4,700 m in length), as well as two pipelines to convey tailings along the crest of Main Dam C to discharge into the northeast side of the TSF (approximately 7,300 m long each) in Year +6. The additional pipelines are required to manage the supernatant pond location, and to cover the PAG/NAG3 waste rock disposal area with an oxygen limiting barrier. The pipelines are sized to distribute tailings slurry flows from the plant of approximately 2,500 m^3/h to 2,900 m^3/h.

The final stage of tailings distribution will require the addition of a third pipeline from the plant to both the southwest and northeast sides of the TSF, to accommodate a maximum mill throughput of 20 Mtpa. The pipeline alignment from the plant to the southwest side of the facility and to the northeast side of the facility are approximately 6,200 m and 8,600 m in length, respectively. The pipeline to the southwest side comprises approximately 6,200 m of ND500 mm DR11 HDPE pipe, while the pipeline to the northeast side comprises approximately 1,500 m (shared with the southwest discharge) ND500 mm DR11 HDPE, and approximately 7,100 m ND600 mm DR7 HDPE. The total tailings flowrate will be approximately 4,180 m^3/h to 4,760 m^3/h.

Figures 3.5-35 to 3.5-39 illustrate the evolution of the discharge pipe infrastructure.

Water Reclaim System

Various sources of water will contribute to the development of the supernatant pond, including water from the tailings slurry, runoff from precipitation and snowmelt within the catchment areas reporting to the TSF, and direct precipitation. The water reclaim system will transport water from the south side of the TSF C supernatant pond to the process water tank at the Plant Site to be used for ore processing.

The Stage 1 reclaim water system comprises a mobile intake pump station (consisting of floating feed pumps and a high-head shore-mounted pump station), a permanent booster pump station, and a pipeline to convey flows between these two pump stations and subsequently to the process water tank.

The high rate of rise of the tailings surface and supernatant pond in the initial years of operation necessitates frequent relocation of the intake pump station. The pumps will therefore be contained within a mobile, weather-protected sea-can unit that will be moved up the slope as the tailings surface and pond rise.

Low-head, floating submersible feed pumps installed within the supernatant pond will feed the high-head, shore-mounted centrifugal pump, equipped with a variable frequency drive at the main pump station. The booster station will utilise the same sea-can contained unit as the main intake pump station to maintain uniformity of components to the maximum extent practical. The booster station unit will not require relocation as its initial location is beyond the maximum TSF footprint.

System redundancy will be achieved through the installation of floating submersible pumps within the WMP. These pumps will be the same make and model as those installed at the reclaim intake pump station within the supernatant pond. The pumps will feed a secondary shore-mounted centrifugal pump at the permanent booster station, also the same make and model as that used for the main reclaim system. This pump will feed an independent pipeline which will discharge to the raw water tank. The reclaim pumps and the pumps installed within the WMP will be connected through a series of valves to allow for discharge from either pipeline between the permanent booster station and the process water tank or the raw water tank.

The pumps will be controlled from the mill control room, based on the water level in the process water tank and/or raw water tank. All necessary control, check, drainage, and isolation valves will be installed as per the attached design drawings. One pump will operate at all times during winter to reduce the potential for freezing of the water in the reclaim pipeline. The WMP system will be heat traced and insulated to mitigate the risk of freezing during intermittent operation during freezing periods.

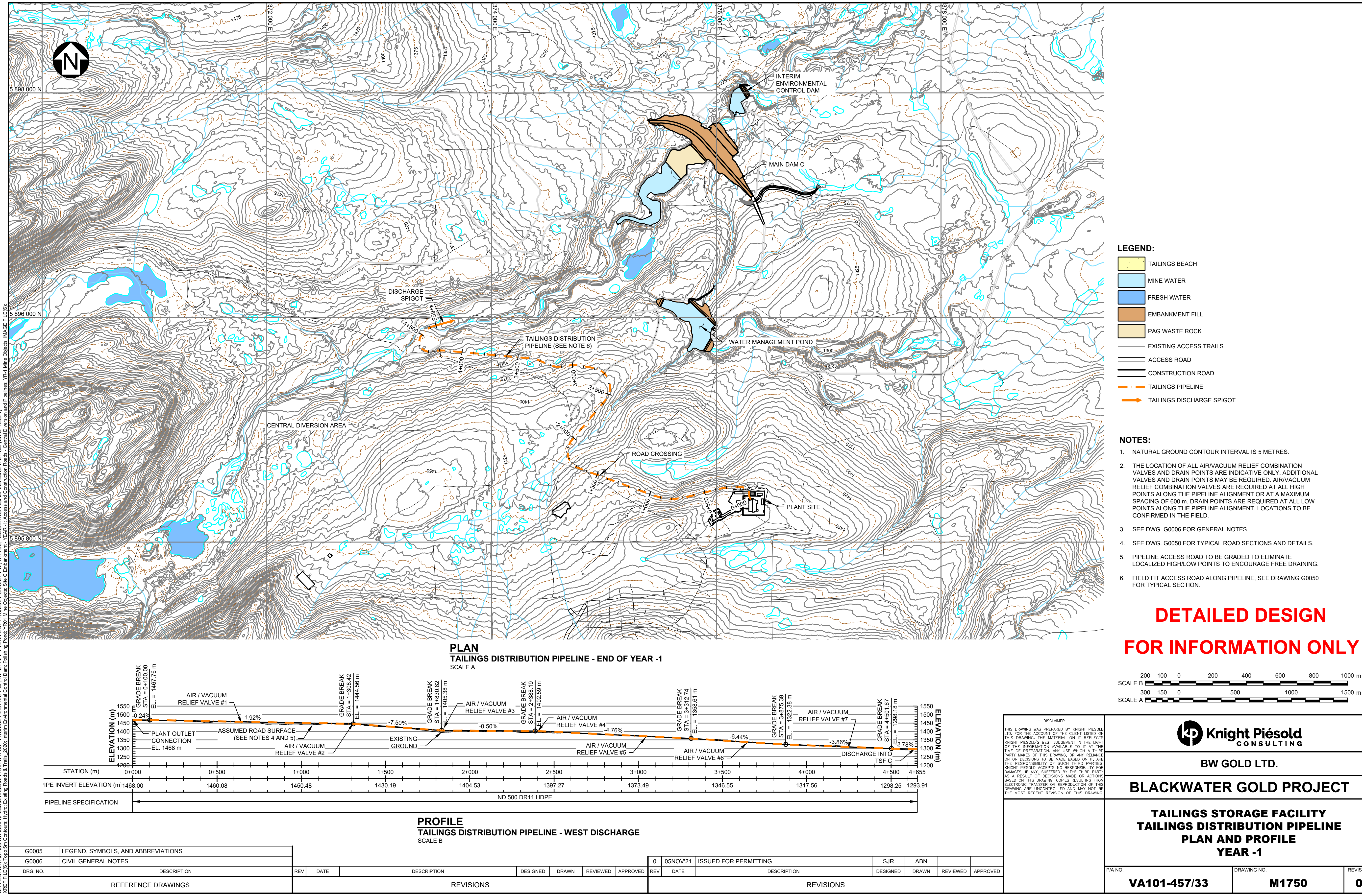


Figure 3.5-35: Development of Tailings Distribution Pipeline Year -1

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

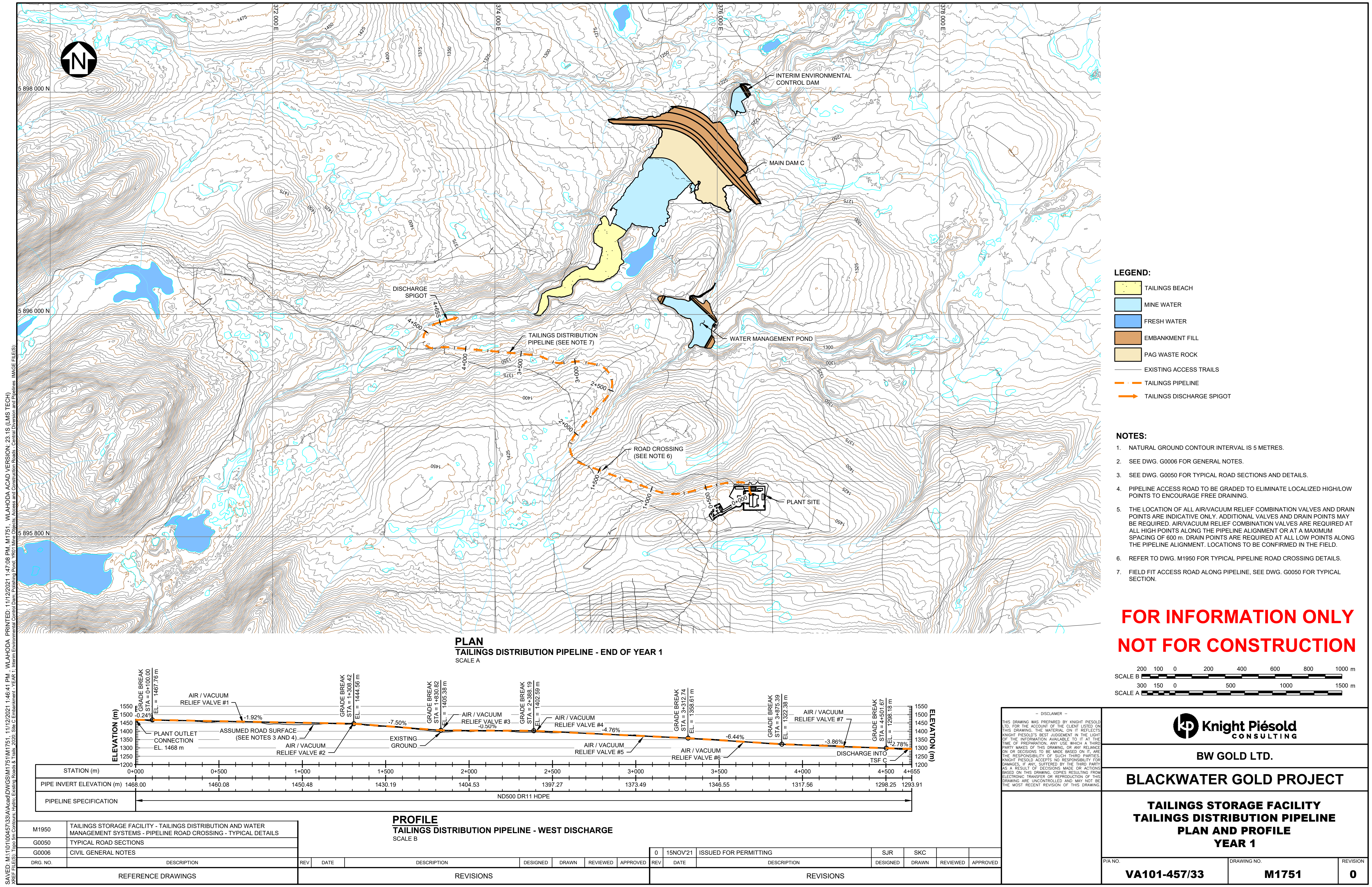


Figure 3.5-36: Development of Tailings Distribution Pipeline Year +1

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

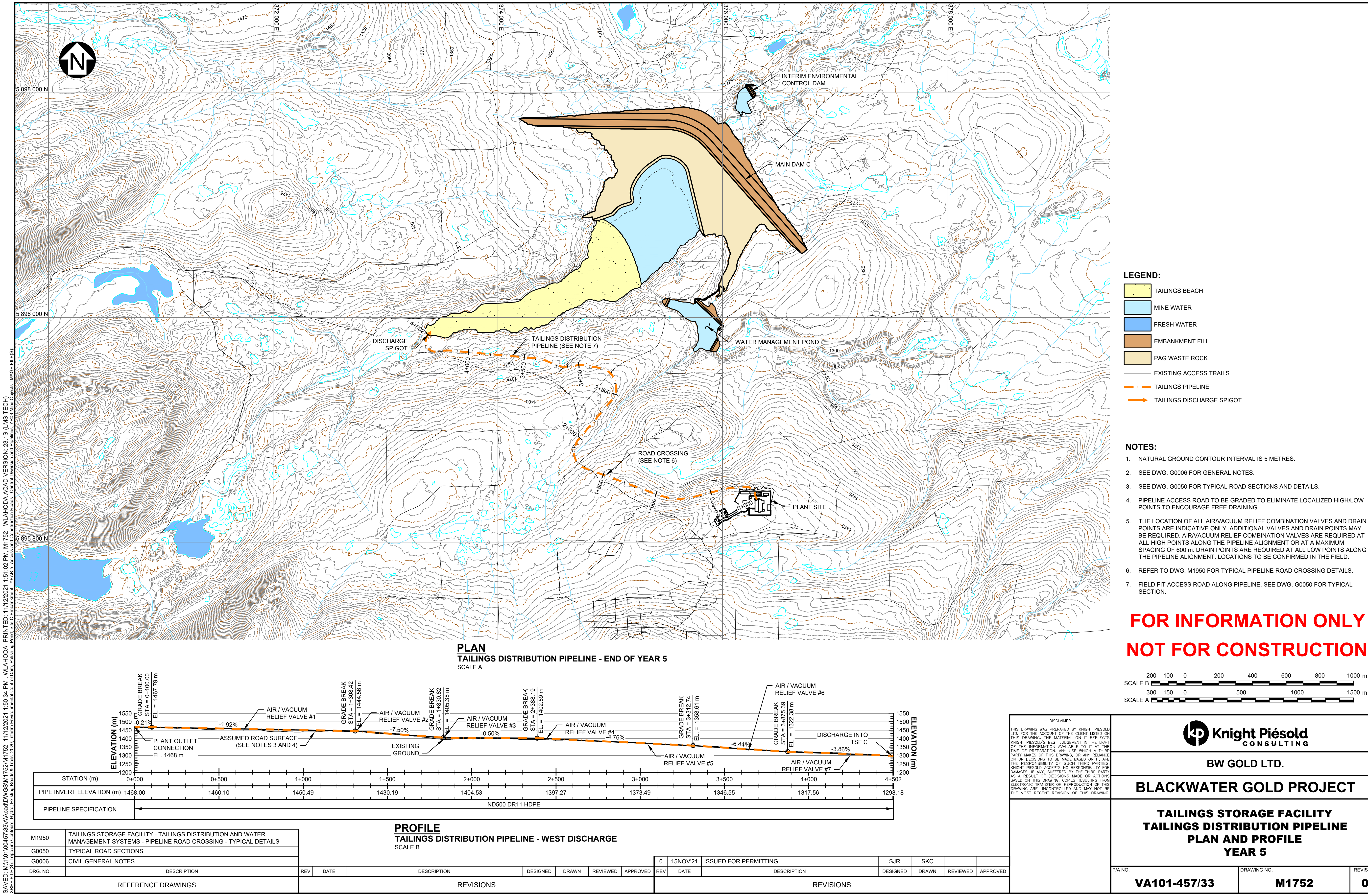


Figure 3.5-37: Development of Tailings Distribution Pipeline Year +5

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

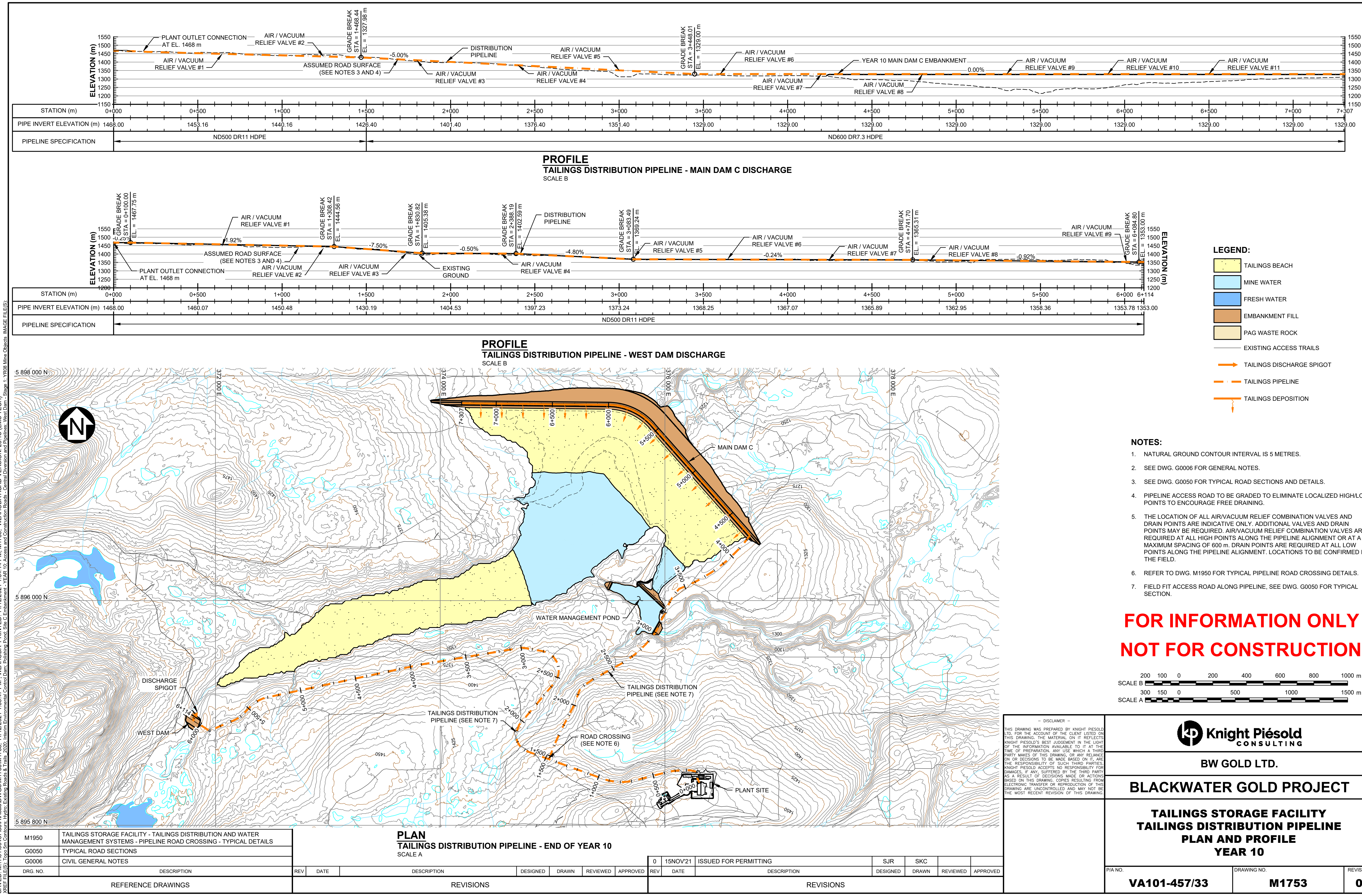


Figure 3.5-38: Development of Tailings Distribution Pipeline Year +10

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

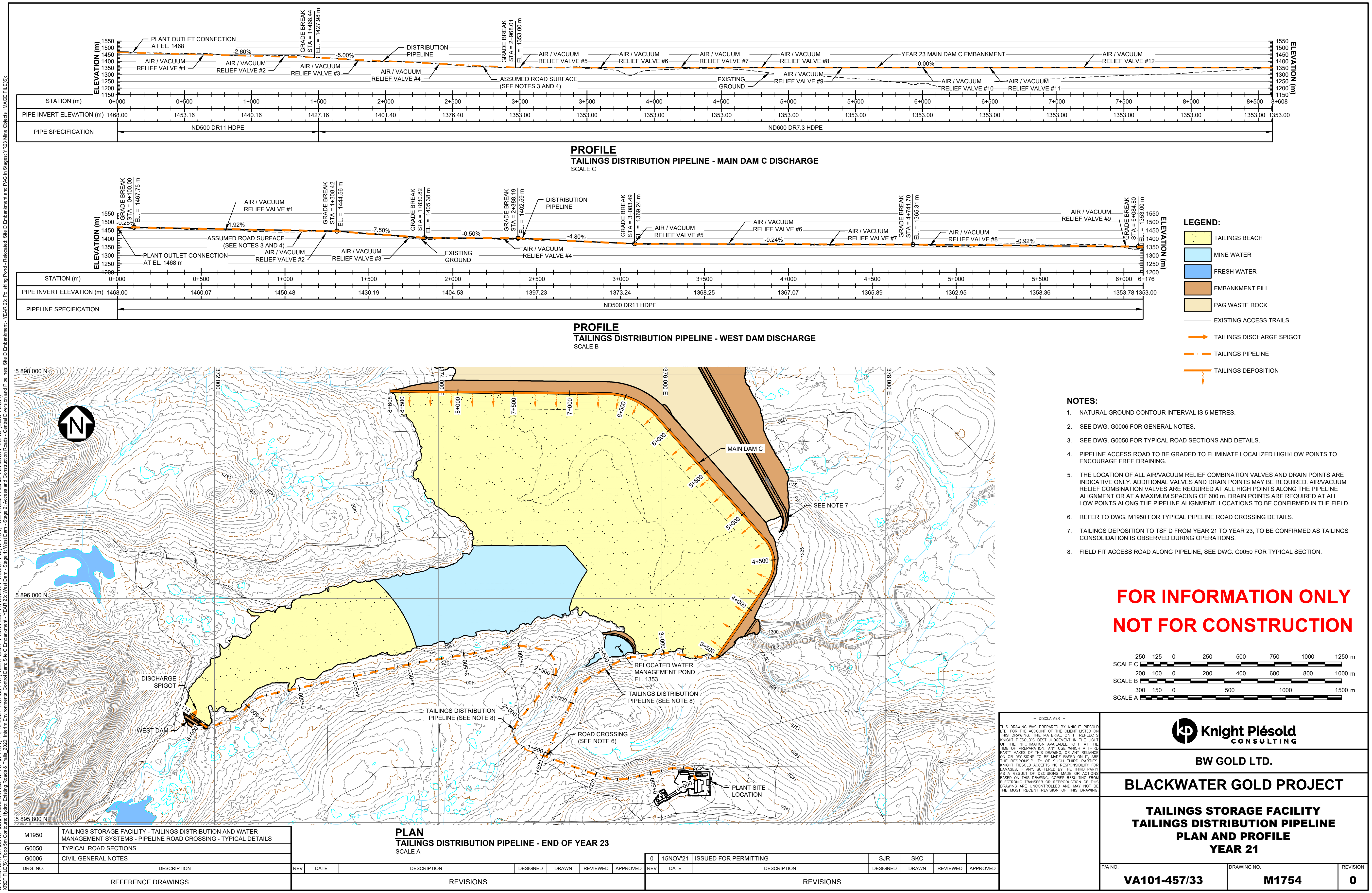


Figure 3.5-39: Development of Tailings Distribution Pipeline Year +23

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

The first stage of the reclaim system will convey a flow of approximately 1,066 m^3/h utilizing a single pipeline with floating submersible intake pumps, a single main pump, and a single booster pump. The pipeline will consist of a combination of ND 450 mm DR11 and ND 500 mm DR7.3 HDPE pipe, with the lower of the two pressure ratings being utilized as operating pressure limits allow. The second stage will require duplication of the system in parallel, to accommodate water reclaim flowrates up to approximately 2,480 m^3/h. The final stage of the water reclaim system will also add one more pump train in parallel to accommodate water reclaim flowrates up to approximately 3,640 m^3/h.

3.5.3.12 Seepage Management

TSF seepage will be controlled by three sets of measures:

- Dam design and construction;
- Near dam collection measures; and
- Secondary collection measures.

Groundwater monitoring wells will be installed at suitable locations downstream of the TSF, as defined in the groundwater monitoring and mitigation plans for the Project (Mine Site Water and Discharge Monitoring and Management Plan (Appendix 9-E). The monitoring wells will be used to recover samples for groundwater quality monitoring.

Specific seepage control measures for the TSF dams are described in the following sections.

Main Dam C

TSF seepage will be controlled primarily by the low-permeability Zone S, the cut-off trench, and the low-permeability subgrade (LPS) foundation materials. Seepage from the TSF will result from infiltration of ponded water directly through the embankment fill and the natural ground, and from expulsion of pore water as the tailings mass consolidates. The tailings dam design incorporates embankment drainage collection systems to control and collect seepage and direct the flow initially to the IECD and later to the ECD. The embankment drainage collection systems comprise the following:

- longitudinal drains within the Zone T material to collect and convey seepage through the dam longitudinally;
- a vertical chimney drain spanning the length of the embankment up to elevation 1,242 masl;
- foundation drains in select locations downstream of the cut-off trench to collect seepage and control seepage gradients;
- embankment outlet drains constructed in the Davidson Creek and Mine Area Creek basins to convey seepage downstream to the IECD; and
- perimeter ditches along the downstream toe of the embankment to collect seepage and surface runoff.

Longitudinal embankment drains comprising 150 mm diameter Perforated Corrugated Polyethylene Tubing (CPT) drain pipes and non-woven geotextile were designed to convey seepage along the dam profile to topographical low points at the embankment outlet drains. The longitudinal drains follow the base of the Zone T for Stages 1 and 2.

A vertical chimney drain was designed downstream of the Main Dam C centerline, spanning the length of the embankment up to elevation 1,242 masl. The chimney drain will control seepage gradients within the earthfill seal zone of the embankment. The seepage collected by the chimney drain will be conveyed to the foundation drain blankets and eventually downstream of the embankment as described in the following section. The chimney drain is designed with a width of 1 m and fill materials are to consist of granular materials meeting the gradation and placement specification of Zone F. It will be constructed by excavating a vertical trench in the Zone S seal zone every second lift and backfilling to a depth of 600 mm.

Three foundation drain blankets will be constructed between the cut-off trench and the filter zone (Zone F) at topographical low points. These foundation drains will collect any seepage travelling under or through the cut-off trench and convey flows to the longitudinal drains and embankment outlet drains. The foundation drains will be integrated with the vertical chimney drain to enhance seepage control through the Zone S seal zone. The foundation drains were designed with a base width of 5 m (minimum) and a depth of 1 m, comprising Zone F and Zone T materials.

Flow through rockfill drains were designed at the downstream toe of Main Dam C Stages 1 and 2 to manage embankment seepage and to convey flows downstream to the IECD. The embankment outlet drains will be constructed of Zone T material surrounded by NAG waste rock and are approximately 300 to 400 m in length. The drains will be a minimum of 2 m thick and positioned within the incised sections of Davidson Creek and the Mine Area Creek between the downstream toe of the Stage 1 dam and the confluence of these two creeks.

Two perimeter ditches were designed along the downstream side of Main Dam C Stage 2 to collect and convey surface runoff from the downstream face of the dam and seepage surfacing beyond the downstream toe of the dam to low points that ultimately flow to the IECD.

TSF D will be constructed adjacent to and downstream of TSF C to provide additional storage capacity for PAG/NAG3 waste rock beginning in Year +6. The interstitial space within the waste rock in TSF D will be progressively saturated to limit oxidation and subsequent acid generation. The rising phreatic level within the saturated TSF D waste rock disposal area will reduce the hydraulic gradient between TSF C and TSF D, resulting in reduced seepage between the two facilities. The HDPE geomembrane facing will be the primary barrier to seepage above the Stage 6 crest elevation of approximately 1,312 masl.

Saddle Dam

TSF seepage will be controlled primarily by the LPS foundation materials, HDPE geomembrane facing, and upstream HDPE basin liner. The upstream HDPE basin liner is included in the preliminary design concept due to the current level of uncertainty related to ground conditions resulting from site investigation access limitations. Embankment drainage collection systems will be incorporated into the design to control and collect seepage and any upwelling groundwater discharge within the dam foundation, and an outlet drain will direct the flow to a small downstream collection sump for pumpback to the TSF.

West Dam

TSF seepage will be controlled primarily by the LPS foundation materials, HDPE geomembrane facing, upstream HDPE basin liner, and long tailings beach providing separation from the supernatant pond. The upstream HDPE basin liner is included in the preliminary design concept due to the current level of uncertainty related to ground conditions resulting from site investigation access limitations. Embankment drainage collection systems will be incorporated into the design to control and collect seepage and any upwelling groundwater discharge within the dam foundation. An outlet drain will direct the flow to a small downstream collection sump for monitoring and pumpback to the TSF, if required. The Central Water Transfer Pond will also act as an impediment to seepage flow from the TSF.

Main Dam D

TSF D seepage will be controlled primarily by the low-permeability Zone S, COT, and the LPS foundation materials. Seepage from the TSF will result from infiltration of ponded water directly through the embankment fill and the natural ground. The tailings dam design incorporates embankment drainage collection systems to control and collect seepage and direct the flow to the ECD.

The embankment drainage collection systems will comprise the following:

- longitudinal drains within the Zone T material to collect and convey seepage through the dam longitudinally;
- foundation and chimney drains in select locations downstream of the COT to collect seepage and control seepage gradients;
- embankment outlet drains constructed in the Davidson Creek basins to convey seepage downstream to the ECD; and
- perimeter ditches along the downstream toe of the embankment to collect seepage and surface runoff.

Secondary Collection Measures

The secondary collection measures are the downstream IECD and ECD for the Main Dam C and the Main Dam D, respectively. Detailed descriptions and plans of the IECD and ECD are presented in Appendices 3-J and 3-K, respectively.

Interim Environmental Control Dam

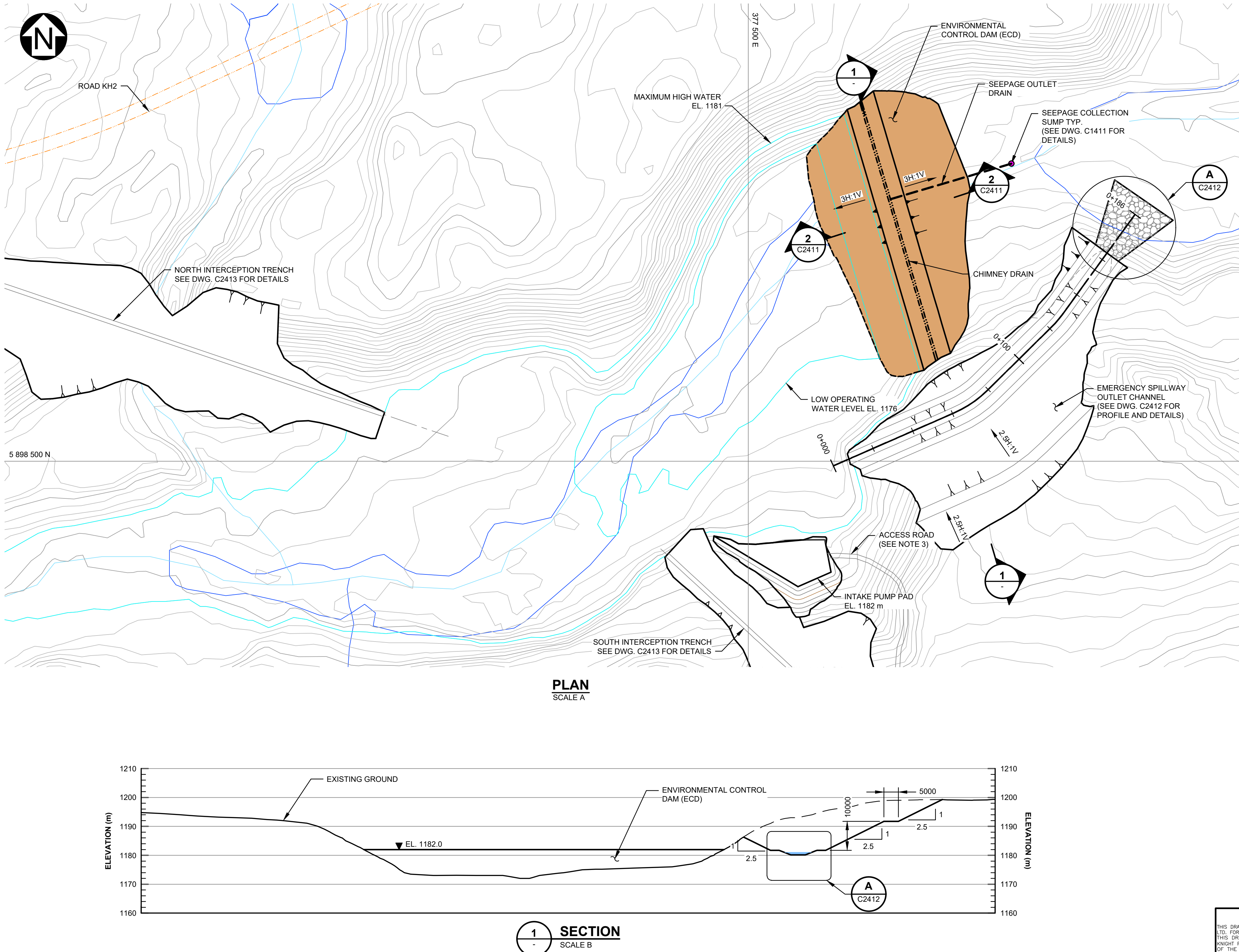
The IECD will capture downstream seepage from the Main Dam C from Year -1 to the end of Year +6, Seepage collection at the IECD will be achieved by constructing a collection dam approximately 500 m downstream at a topographic low point in Davidson Creek. The IECD will be positioned upstream of the confluence of a tributary, which drains a relatively large catchment area located to the northeast of TSF C. The IECD will manage seepage and storm water inflows and will utilize a pumpback system to convey the recovered flows to the TSF. The dam will be maintained in a dewatered condition to the maximum extent practical. Seepage through the IECD will be captured in a foundation drain system and sump and pumped back to the IECD. The IECD will be fully constructed prior to start of operations and is designed to manage seepage and runoff until the construction of Main Dam D to form TSF D beginning in approximately Year +5. The IECD will be decommissioned and buried within the TSF D PAG/NAG3 disposal area during Year +6. Seepage collection following commissioning of TSF D will occur at the ECD.

The IECD was designed to contain continuous seepage and runoff from events up to the 1-in-100-year, 24-hour storm. The IECD will have a maximum storage capacity of 58,000 m^3 below the spillway invert with approximately 1 m of freeboard during the 1-in-100-year, 24-hour storm. The emergency spillway was designed to maintain 0.5 m of freeboard during the 1-in-200-year, 24-hour storm.

The dam will be constructed primarily of locally borrowed low-permeability glacial till (Zone S). The foundations will be stripped to remove any organics and unsuitable foundation materials. A key-in trench will be excavated a minimum 1 m into LPS materials to tie the seal zone of the embankment into the low-permeability foundation materials. The upstream face will be lined with coarse-grained material and a non-woven geotextile to provide erosion protection. A chimney drain comprising Zone F material and a foundation drain comprising Zone T material will control any seepage through the dam or upwelling groundwater discharge. The foundation drain will convey flows to a seepage outlet drain and hence to a small downstream collection sump for pumpback to the IECD pond. The IECD design details are summarized in the Table 3.5.3-11.

Environmental Control Dam

The ECD will serve to capture downstream seepage from the Main Dam D beginning in Year +6 (Figure 3.5-40). The dam crest will be located approximately 1 km downstream at a topographic low point in Davidson Creek and is designed to contain continuous seepage, daylighting groundwater, and runoff from events up to the 1-in-10-year, 24-hour storm. A riprap lined emergency spillway was designed to pass the 1-in-1,000-year, 24-hour storm.



LEGEND:

EMBANKMENT FILL

RIPRAP

NOTES :

1. SEE DWG. G0006 FOR GENERAL NOTES.
2. MECHANICAL DESIGN DETAILS NOT INCLUDED FOR CLARITY, SEE DWG M2450 FOR DETAILS.
3. FIELD FIT ACCESS ROAD ALIGNMENT TO ACHIEVE A MAXIMUM TEN PERCENT GRADE. SEE DWG. G0050 FOR TYPICAL ROAD SECTIONS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE B 15 7.5 0 25 50 75 m

SCALE A 20 10 0 20 40 60 80 100 m

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BW GOLD LTD.

BLACKWATER GOLD PROJECT

TAILINGS STORAGE FACILITY
MAIN DAM D
ENVIRONMENTAL CONTROL DAM
PLAN AND SECTION

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C2410	0

DRG. NO.	DESCRIPTION
M2450	TSF- ENVIRONMENTAL CONTROL DAM - PIPELINE PLAN AND PROFILE - YEAR 6
G0006	CIVIL GENERAL NOTES
C2413	TAILINGS STORAGE FACILITY - MAIN DAM D - ENVIRONMENTAL CONTROL DAM - INTERCEPTION TRENCHES - PLAN, PROFILES AND SECTION
C2412	TAILINGS STORAGE FACILITY - MAIN DAM D - ENVIRONMENTAL CONTROL DAM - EMERGENCY SPILLWAY OUTLET CHANNEL - PROFILE, SECTIONS & DETAILS
C2411	TAILINGS STORAGE FACILITY - MAIN DAM D - ENVIRONMENTAL CONTROL DAM - SECTIONS AND DETAILS
C1411	TAILINGS STORAGE FACILITY - MAIN DAM C - INTERIM ENVIRONMENTAL CONTROL DAM - SECTIONS AND DETAILS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	15NOV'21	ISSUED FOR PERMITTING	CAP	ELG		

REVISIONS

Figure 3.5-40: Sectional Diagram the Environmental Control Dam and Pond

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

Table 3.5.3-11: IECD Design Summary

	Value
Basin Elevation (masl)	1,202.0
Spillway Invert Elevation (masl)	1,208.7
Dam Crest Elevation (masl)	1,210.0
Dam Crest Width (m)	12
Peak Inflow (m^3/s)	2.5
Peak Outflow (m^3/s)	1.5
Side Slopes (H:V)	2.5:1
Spillway Base Width (m)	1
Spillway Inlet Depth (m)	1.25
Spillway Inlet Riprap Sizing D_{50} (mm)	100
Spillway Inlet Riprap Thickness (mm)	200

The dam will be constructed primarily of locally borrowed low-permeability glacial till (Zone S). The foundations will be stripped to remove any organics and unsuitable foundation materials. A key-in trench will be excavated a minimum 1 m into LPS materials to tie the seal zone of the embankment into the low permeability foundation materials. The embankment is designed with an average height of 9 m at the maximum section and the crest will have a length of approximately 125 m and a width of 14 m. The upstream face will be lined with riprap and coarse-grained bedding material underlain by a non-woven geotextile to provide erosion protection. A chimney drain comprising Zone F material and a foundation drain comprising Zone T material will control any seepage through the dam or upwelling groundwater discharge. The foundation drain will convey flows to a seepage outlet drain and hence to a small downstream collection sump for pumpback to the ECD pond.

Two seepage interception trenches (one on each side of Davidson Creek) will be excavated through the surficial sand and gravel terraces downstream of the Main Dam D and will report to the ECD pond. The seepage interception trenches (North and South) are located based on the results of geotechnical drilling along the proposed alignments. The trenches will be excavated and keyed into the low-permeability subgrade to prevent seepage out of the trench base and convey water to the ECD.

3.5.3.13 Stage 1 Construction Water Management Structures

The construction water management works associated with Stage 1 of Main Dam C were designed to convey catchment runoff around the work areas and manage sediment laden water from the active dam construction area prior to construction of the IECD. The construction water management plan combines diversion, pumping, and collection schemes prior to and throughout the construction of the Stage 1 TSF. Specific design drawings and specifications for each component are provided in TSF Stage 1 Detailed Design Report in Appendix 3-J and additional details related to each component are summarized in the sections below.

Operations phase water management structures are discussed separately in Section 3.5.6.

The eventual construction of Main Dam D in Year +5 will also require additional diversion works along tributary drainages entering Davidson Creek downstream of TSF C, to be constructed similarly. Detailed designs will be presented when appropriate along with the detailed design of Main Dam D Stage 1.

Davidson Creek Diversion System

Construction of the TSF requires a diversion berm to provide a dry working environment for the excavation of the dam foundations and cut-off trenches. The diversion system will remain active throughout initial embankment construction until ore processing operations commence, if required to manage start-up water quantity stored in the TSF. Waters collected on the upstream side of the diversion berm will be diverted by a pumping system and pipeline away from the construction area and discharge to Davidson Creek or a tributary drainage (Creek 668328).

A diversion berm will be constructed 500 m upstream of the Main Dam C Stage 1 work area to retain the inflows from Davidson Creek, as well as the inflows from the Mine Area Creek Diversion works. The berm will retain a direct catchment area of 6.9 km^2 in addition to inflows from the 11.6 km^2 mine area creek catchment. Inflows will be controlled via a primary and secondary outlet (emergency spillway).

The Diversion Berm was designed with a crest elevation of 1,231 masl and a maximum height of 14 m. The berm crest is 12 m wide and 110 m in length. The Diversion Berm will impound up to a total volume of 306,000 m^3 at its crest elevation. The berm will be constructed with locally sourced material meeting the Zone S material specification. Material meeting the Zone C specification is specified on the upstream and downstream slopes to protect the berm from scour and erosion. The Diversion Berm has a design life of up to approximately two years.

Water collected upstream of the Diversion Berm will be pumped around the construction works. The pumping system comprises three operating end-suction centrifugal pumps and one installed spare unit, providing a total design flowrate of approximately 61,000 m^3/d or 2,540 m^3/h. The system will be mounted on a floating barge and will be controlled via a level control float system, or equivalent. It will be installed in Year -2 and operated until the end of Year -1. The pipeline will be approximately 1,000 m in length and will consist of a combination of nominal diameter ND300 mm DR21 HDPE, ND450 mm DR21 HDPE, and ND600 mm DR21 HDPE pipe. The pipeline corridor will be graded to minimize high or low sections to the extent practicable and to allow for gravity flow to the discharge point after initial lifting from the pumping system. The system will discharge into a stilling basin downstream of the construction works.

The storage capacity within the Diversion Berm impoundment, in combination with pumping, is sufficient to contain and convey inflows up to the 1-in-10-year, 24-hour event provided that minimal volume of water is retained behind the berm prior to the storm event. An emergency spillway was designed as a secondary outlet for the Diversion Berm for controlled release of flows above the primary outlet design storm event. The emergency spillway is designed to safely convey the 1-in-200-year, 24-hour return period storm event around the Diversion Berm while maintaining a minimum of 500 mm of freeboard.

Eventual construction of Main Dam D will also require additional diversion works on Davidson Creek, to be constructed similarly.

The Diversion Berm design criteria are summarized in Table 3.5.3-12. Detailed descriptions and plans are presented in Appendix 3-J.

Table 3.5.3-12: Design Criteria for Davidson Creek Diversion Berm

Design Criteria	Diversion Berm
Exposure Time	Y-2 to Y-1 (2 years)
Storage Requirements[1]	▪ 1-in-10-year, 24-hour return period storm event ▪ Inclusion of flow routed from the Mine Area Creek Diversion
Crest Approx. Height (m)	14
Crest Elevation (masl)	1,231

Design Criteria	Diversion Berm
Slope H:V	2:1
Max Water Height (masl)	1,229.5 (at spillway invert)
Total Storage Capacity	305,000 m^3
Emergency Spillway IDF	1-in-200-year, 24-hour return period storm event
Design Freeboard (mm) during IDF	500
Post Decommissioning Runoff Routing	None as it will be incorporated into TSF C

[1] *Details of the design volumes are presented in Knight Piésold 2021k.*

Mine Area Creek Diversion Berm

A diversion channel and berm will be constructed in the Mine Area Creek confluence to divert Mine Area Creek flows to the northwest and into the Davidson Creek upstream catchment, ultimately managed by the Davidson Creek Diversion Berm. The Mine Area Creek Diversion is designed to convey water away from the southern portion of Main Dam C COT excavation during initial construction. The upstream portion of the diversion utilizes a berm to maintain an elevated water level and minimize required earthfill quantities. To pass the northwest saddle under the MAR, the berm transitions to an excavated channel which flows to two parallel culverts and ultimately outlets on the northwest side of the access road.
The Mine Area Creek Diversion will be constructed after the Davidson Creek Diversion is operational and will remain operational until the WMP is constructed.

The design life of the Mine Area Creek Diversion will be less than 1 year (Year -2) and the diversion is sized for the 1-in-10-year, 24-hour return period flow while maintaining 500 mm freeboard at both the berm and channel sections. The return period peak flows at the Project site are expected to result from rain-on-snow events. The peak flows are therefore calculated using return period peak flow relationships developed for undisturbed areas, for an instantaneous peak flow of 2.84 m3/s diverted during the 10-year event.

The minimum dimensions and key design parameters for the Mine Area Creek Diversion are presented in Table 3.5.3-13. Trapezoidal channels with 2H:1V side slopes with minimum 0.5% bed slopes were selected for the diversion berm outlets.

Table 3.5.3-13: Design Criteria for Mine Area Creek Diversion Berm

	Mine Area Creek Diversion in Fill (Berm)	Mine Area Creek Diversion in Cut (Channel)
Design Freeboard (mm)	500	500
Min. Slope (%)	0.5	0.5
Min. Depth (m)	1.5	1.8
Min. Base Width (m)	Varies	1.0
Peak Design Flow (m^3/s)	2.84	2.84
Side Slopes (H:V)	2:1	1.5:1

Sediment Control Ponds

Construction of each dam will require a SCP downstream of works to capture potentially sediment laden waters. The Main Dam C SCP will be located downstream of the Stage 1 Main Dam C COT and initial fill placement areas and is positioned to collect runoff from the Davidson Creek basin as well as the Mine

Area Creek Basin. The SCP design follows Technical Guidance 3 (Developing a Mining Erosion and Sediment Control Plan; MOE 2015). It is designed to accommodate a live storage equal to the 1-in-10-year, 24-hour storm event with at least a half metre of freeboard and with a spillway to convey a flood event from a 1-in-200-year, 24-hour storm event. The SCP outlet includes energy dissipation mechanisms to reduce the potential for erosion in the downslope environment.

Initial Fill Placement Areas

Two locations on the upstream toe of the Main Dam C were selected as initial fill placement areas to manage water from the minor catchment areas upstream of the construction works that are not captured by the Davidson Creek Diversion System and the Mine Area Creek Diversion. The initial fill placement areas will be constructed prior to cut-off trench excavation to aid with construction water management until the Main Dam C COT is completed in the maximum section and the Stage 1 embankment fill reaches an elevation that provides adequate protection for the work area. Temporary surge ponds will be formed and managed by pumping the captured flow around the construction work area while maintaining the required freeboard. The total inflow volumes generated by 24-hour inflow events of varying return periods were calculated, along with the corresponding minimum initial fill placement heights required to impound these volumes. The target heights of these initial fill areas and associated standby pumping capacity will be selected by BW Gold and the constructor based on risk tolerances.

3.5.3.14 Surveillance and Monitoring

Geotechnical instrumentation will be installed along three planes through the Main Dam C and one plane through each of the WMP West Berm, North Berm, East Berm, and the IECD. Instrumentation sections are shown on Figures 3.5.3-41 to 3.5.3-43. Instrumentation will be installed during initial construction and will be supplemented with additional instrumentation over the LoM. The geotechnical instrumentation will be used to assess the performance of Main Dam C, WMP berms, and IECD to identify any conditions different to those assumed during design and analysis. Amendments to the future staged designs and/or remediation work will be implemented to respond to a change in the knowledge base or facility performance, should conditions warrant a change. Instrumentation details for the West Dam, Saddle Dam, Main Dam D, and the ECD will be developed during the detailed design of each dam.

The geotechnical instrumentation will comprise vibrating wire piezometers, slope inclinometers, and survey prisms, and will be installed in the foundations, embankment fill, and on the embankment crests. Other instrumentation to be installed include flow monitoring devices and water level meters.
The instrumentation systems include some degree of overlap and redundancy to enable verification of problems that may be detected. The instrumentation will to be installed according to the detailed instructions provided by the manufacturer and in accordance with any project technical specifications.

Piezometers

Vibrating wire type piezometers will be installed in the foundation materials, embankment fill, tailings, and PAG/NAG3 waste rock disposal area to measure pore water pressures and piezometric elevations within these units. The piezometers will be distributed throughout the various foundation and fill zones to provide a spectrum of monitoring data. The piezometer leads will be routed from the fill to read-out panels for ease of monitoring and to simplify on-going construction to the extent practicable.

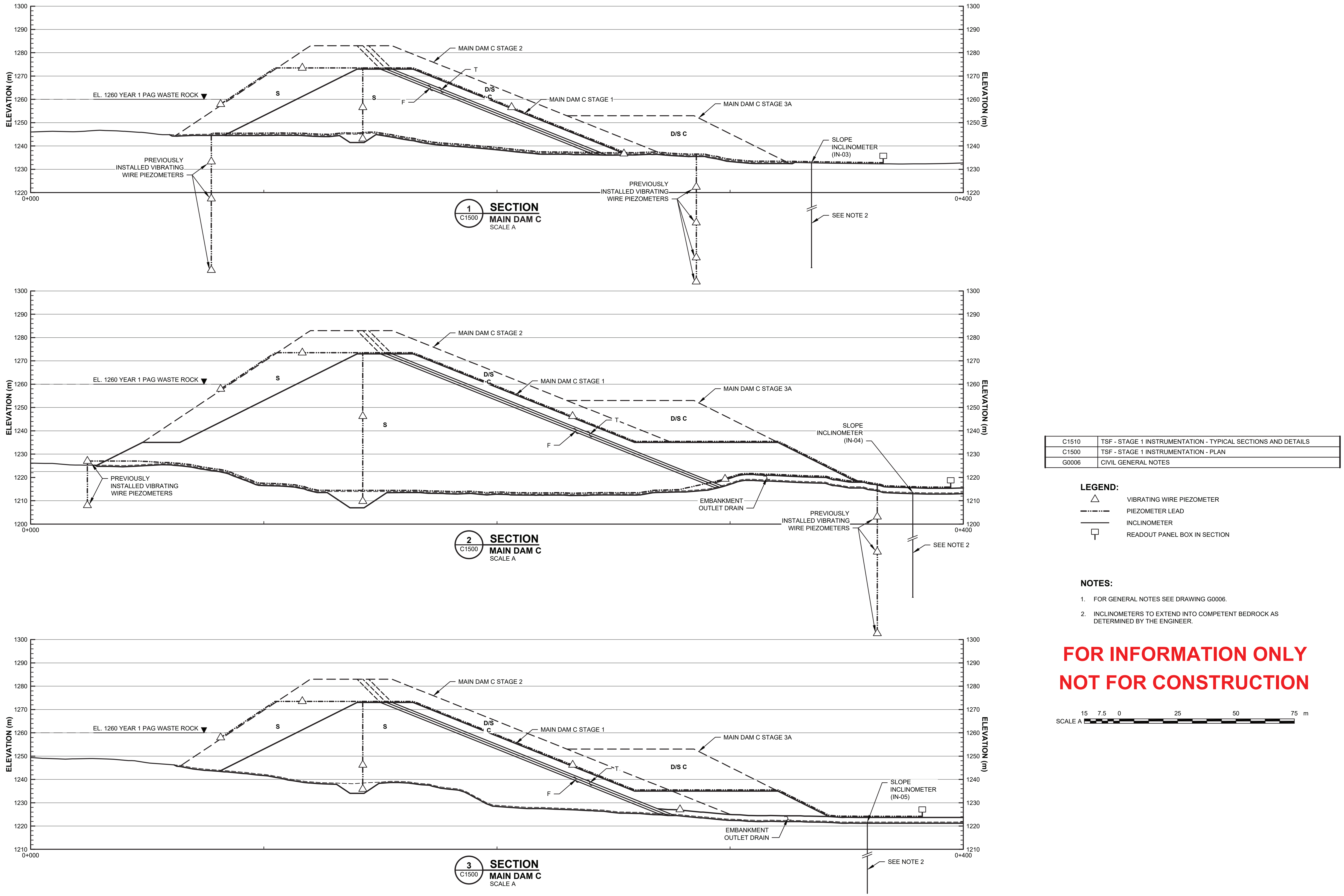
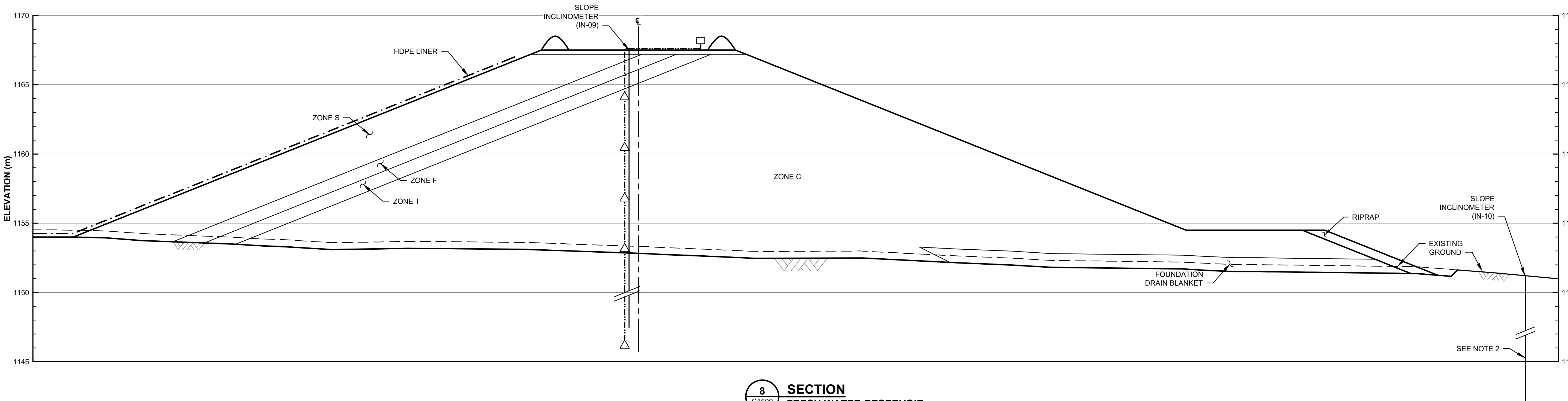
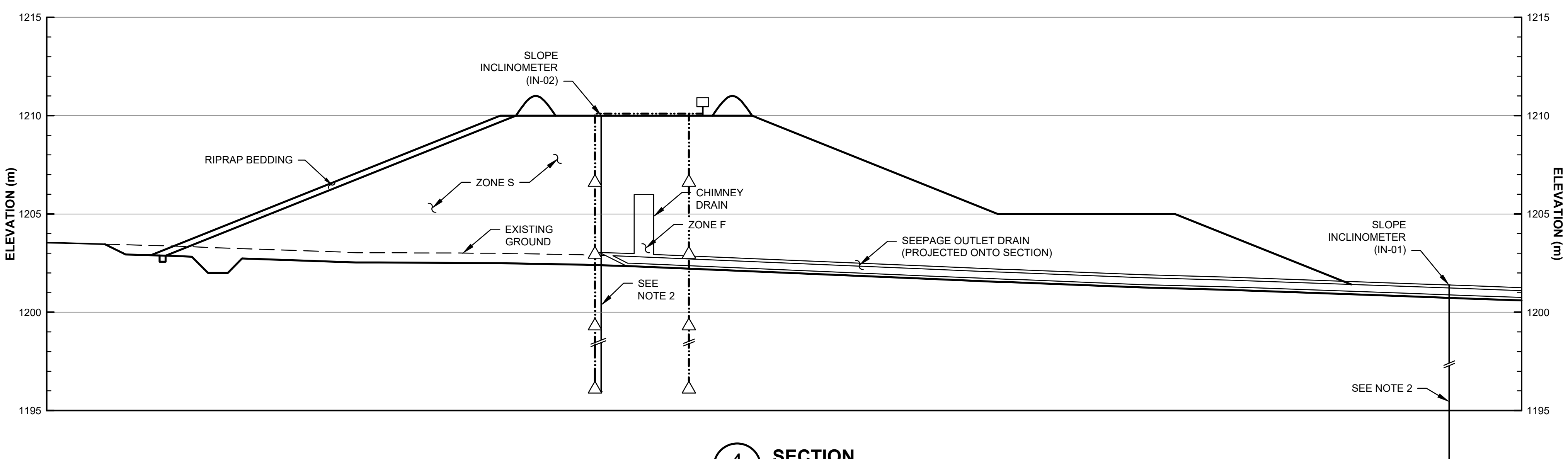


Figure 3.5-41: Main Dam C Monitoring Instrumentation Section

Source: Knight Piésold Consulting (2021i; Appendix 3-K).



8 C1500 **SECTION**
FRESH WATER RESERVOIR
SCALE A



4 C1500 **SECTION**
INTERIM ECD
SCALE A

LEGEND:

- VIBRATING WIRE PIEZOMETER
- PIEZOMETER LEAD
- INCLINOMETER
- READOUT PANEL BOX IN SECTION

NOTES:

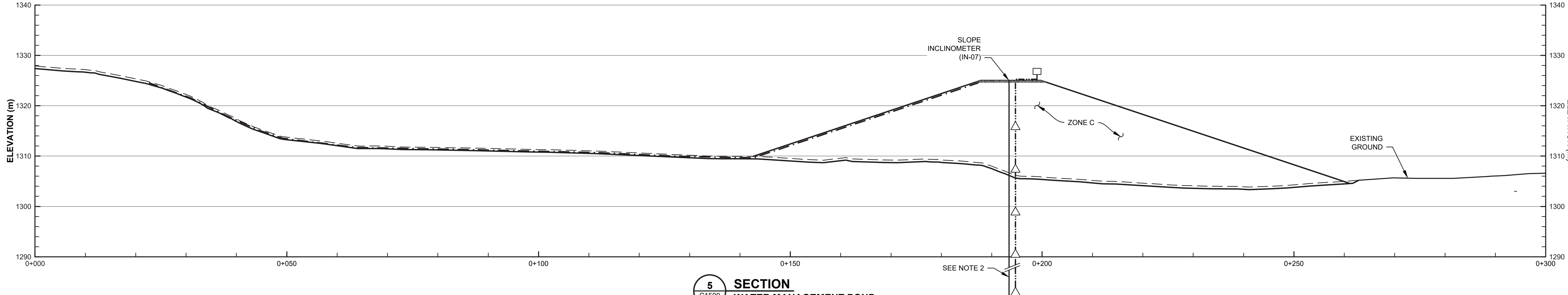
1. FOR GENERAL NOTES SEE DRAWING G0006.
2. INCLINOMETERS TO EXTEND INTO COMPETENT BEDROCK AS DETERMINED BY THE ENGINEER.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

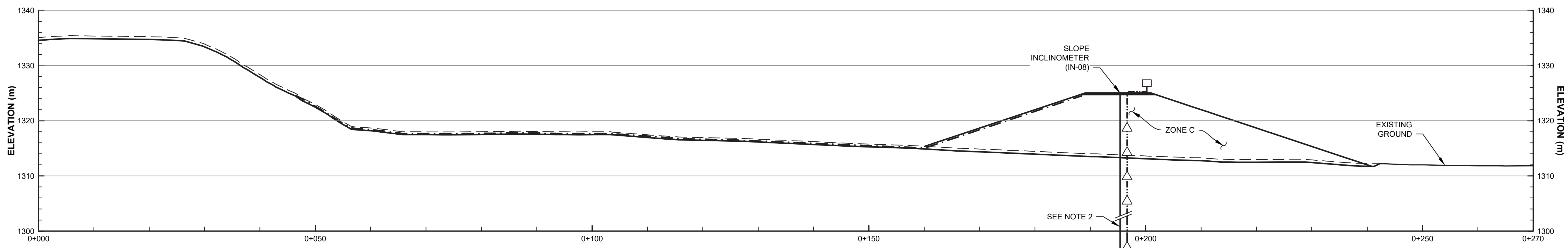
SCALE A 3 1.5 0 5 10 15 m

Figure 3.5-42: Interim Environmental Control Dam Instrumentation Section

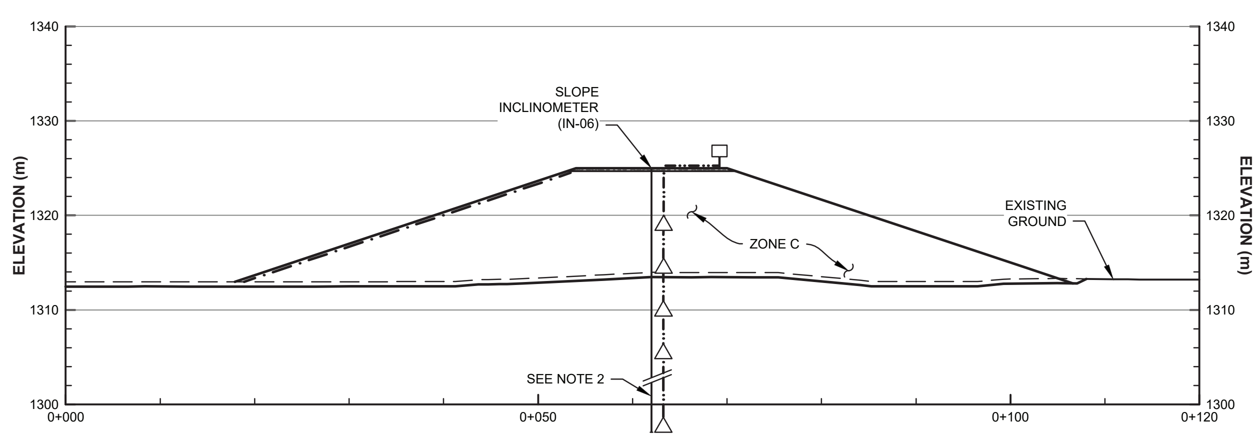
Source: Knight Piésold Consulting (2021i; Appendix 3-K).



5
C1500
SECTION
WATER MANAGEMENT POND
NORTH BERM
SCALE A



6
C1500
SECTION
WATER MANAGEMENT POND
EAST BERM
SCALE A



7
C1500
SECTION
WATER MANAGEMENT POND
WEST BERM
SCALE A

LEGEND:

- VIBRATING WIRE PIEZOMETER
- PIEZOMETER LEAD
- INCLINOMETER
- READOUT PANEL BOX IN SECTION
- HDPE GEOMEMBRANE

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. INCLINOMETERS TO EXTEND INTO COMPETENT BEDROCK AS DETERMINED BY THE ENGINEER.

C1510	TSF - STAGE 1 INSTRUMENTATION - TYPICAL SECTIONS AND DETAILS
C1500	TSF - STAGE 1 INSTRUMENTATION - PLAN
G0006	CIVIL GENERAL NOTES

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

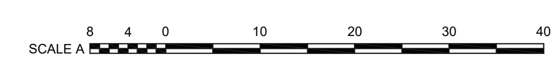


Figure 3.5-43: Water Management Pond Monitoring Instrumentation Section

Source: Knight Piésold Consulting (2021i; Appendix 3-K).

Inclinometers

Slope inclinometers will be installed immediately downstream of the major dams to monitor any movement that may occur in the subsurface foundation units. Inclinometers may also be installed along the centrelines of dams once construction is complete (e.g., the WMP berms and IECD), but is not planned during staged raising of the TSF dams. Inclinometers will extend through the dam fill materials and/or foundation materials into competent bedrock, as determined by the engineer.

Survey Prisms

Survey prisms will be installed on the crests of the dams approximately 100 m apart following construction completion to monitor surficial deformation. A combination of manual surveys and continuous real-time survey via automatic total stations will record movements and provide warning of any acceleration of movement that may be critical to dam safety. Survey prism and total station locations will be recorded and presented in the as-built drawings.

Flow Monitoring Devices

Flow monitoring devices will be installed in permanent primary outflow locations as shown on to monitor flow quantity. Flow monitoring devices are to be digital ultrasonic flow meters on pumps or v-notch weirs installed on the ends of culverts/pipes. Flow monitoring devices may be measured automatically or manually depending on the location and monitoring setup, as determined by the engineer.

Water Level Meters

Water level meters will be installed immediately upstream embankments, berms, and dams to quickly identify current water levels and changes as they occur. Water level meters will be installed initially at the Main Dam C supernatant pond, the WMP, the FWR, and upstream of the IECD.

Groundwater Wells

Groundwater monitoring wells will be installed at suitable locations downstream of the TSF, as defined in the groundwater monitoring and mitigation plans for the Project. The monitoring wells will be used to recover samples for groundwater quality monitoring.

Instrumentation Monitoring

Piezometers, inclinometers, and survey prisms/total stations will be installed and connected to an automated data acquisition system that provides the engineer and mine operator real-time access to the monitoring data. Measurements during construction will be taken and analyzed to monitor the response of the embankment fill and foundation materials. Flow monitoring devices, water level meters, and groundwater wells may be measured manually in non-critical areas as prescribed by the engineer. An OMS Manual will be prepared following construction and prior to TSF commissioning provide comprehensive operating instructions and monitoring frequencies for the TSF instrumentation.

Additional risk controls will be implemented in preparation for construction and operations, including the following:

- Preparation of the Technical Specifications and QA/QC Manual complementing the design drawings and describing construction specifications and procedures to control and assure the construction quality of the works respectively;
- Construction supervision and field reviews during construction execution;

- Preparation of the Operation, Maintentenance, and Surveillence (OMS) Manual, including protocols for operation of the facilities and threshold conditions in the form of quantitative performance objectives and associated Trigger Action Response Plans (TARPs);
- Preparation of an Emergency Preparedness and Response Plan and conducting mine rescue and staffing training exercises to prepare operators for an emergency event; and
- Surveillance audits, dam safety inspections, dam safety reviews at intervals specified within the OMS Manual and the Code.

3.5.3.15 Closure

During the Closure phase, water from the TSF D will continue to be transferred to the TSF C. Discharge from the Lower Waste Stockpile and run-off from the mine site will also be discharged to TSF C Pond. TSF C will be the source of water for filling the Pit Lake. Details of the water management in the Closure phase are presented in Appendix 5-B.

The tailings and water reclaim systems will be reconfigured to support closure water inputs to and from the TSF C. Pipes that will not be in use will be either removed from site, disposed on-site, stored for later or back-up use.

A surface pond will also exist in both TSF C and TSF D. The Main Dam C downstream embankment will mostly be submerged by the waste rock and tailings. Only the final upstream and downstream embankments of Main Dam C above the waste rock and tailings will remain exposed, as will the crest of Main Dam C. Main Dam D will have a small upstream embankment and the crest exposed, and the entire downstream embankment will be exposed. No resloping of any of the TSF dams is planned for closure. The constructed slopes are those applicable for closure. TSF beaches will grade gently towards the supernatant ponds.

Tailings will be deposited strategically in TSF C and TSF D to create the final pond configuration. Specifically, the final years of tailings will be distributed in a manner encourage ponds to shift towards and adjacent to the closure spillways for each facility. Thus, runoff on the final tailings surface will drain to the respective ponds.

The tailings beaches will be covered with a combination of strategically placed OVB and NAG tailings cover to control dust generation and erosion via wave action (approximately 30 cm), which will be slurried and deposited to cover the beaches (like all tailings placed during operations). Growth medium will placed over zones that are not actively affected by the rise and fall of water over the embankments. These areas will be permanently reclaimed. Growth mediums and appropriate stock for planting will be confirmed through trials during the LoM.

The final configuration of the TSF is shown in Figure 4.1-5. Details for the closure and reclamation of the TSF at the Closure phase are provided in Section 4.7.4 Tailings Storage Facility Reclamation.

3.5.3.16 Post-Closure

Two spillways will be constructed in from the Saddle Dam and Main Dam D to convey water from the TSF to the downstream environment. The spillways will be designed to pass the PMF. Should the water quality in the TSF require treatment post-closure, a pumping system will be installed in the supernatant ponds to actively pump water to the Membrane WTP located adjacent to the ECD. Seepage will continue to be collected at the ECD and treated at the Membrane WTP. Once treated, the water will be discharged to Davidson Creek. The sludge from the Membrane WTP will be deposited into the Pit Lake. Details of the water management in the Post-closure phase are presented in Appendix 5-B.

The Northern Diversion System will be decommissioned for post-closure with the runoff from this catchment to report to the TSF C and D. Discharge from Lower Waste Stockpile will continue to be discharged to the TSF C and runoff from the Upper Waste Stockpile will be directed to the Pit Lake.

Details for the closure and reclamation of the TSF at the Post-closure phase are provided in Section 4.7.4 Tailings Storage Facility Reclamation.

3.5.4 Waste Stockpiles

3.5.4.1 General Description

Two stockpiles will store OVB and NAG waste rock from stripping and Open Pit mining (Figure 3.5-44). The Lower Waste Stockpile will be located between the TSF and Explosives Storage Facility Road, 1.5 km northwest of the Open Pit limits. This stockpile will start receiving OVB in Year -2 and receive the final material in Year +10. The stockpile will be a source of reclamation material for progressive reclamation, and Closure and Post-closure phases.

The Upper Waste Stockpile will be located directly west of the Open Pit limits (Figure 3.5-44). This stockpile will start receiving OVB in Year +11 and receive the final material in Year +17 with the cessation of mining operations in the Open Pit when the final pushbacks are complete. At that point, the stockpile will be re-contoured, decommissioned, and progressively reclaimed.

3.5.4.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework relating to the design, construction, operation, closure, and reclamation of the waste stockpiles. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements include:

- Part 10.6 Mine Closure; Section 10.6.5 Major Dumps – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10.7 Mine Closure; Section 10.7.11 Dumps – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance is as follows:

- Mine Rock and Overburden Piles: Investigation and Design Manual – Interim Guidelines, May 1991 (BC MWRPRC 1991);
- Part 3 Mine Plan; Section 3.5.5 Waste Rock Dumps – JAIR (BC EMPR & BC ENV 2019a);
- Part 4 Reclamation and Closure Plan; Section 4.7.2 Waste Rock Dump Reclamation – JAIR (BC EMPR & BC ENV 2019a); and
- Part 6.10 Dumps – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

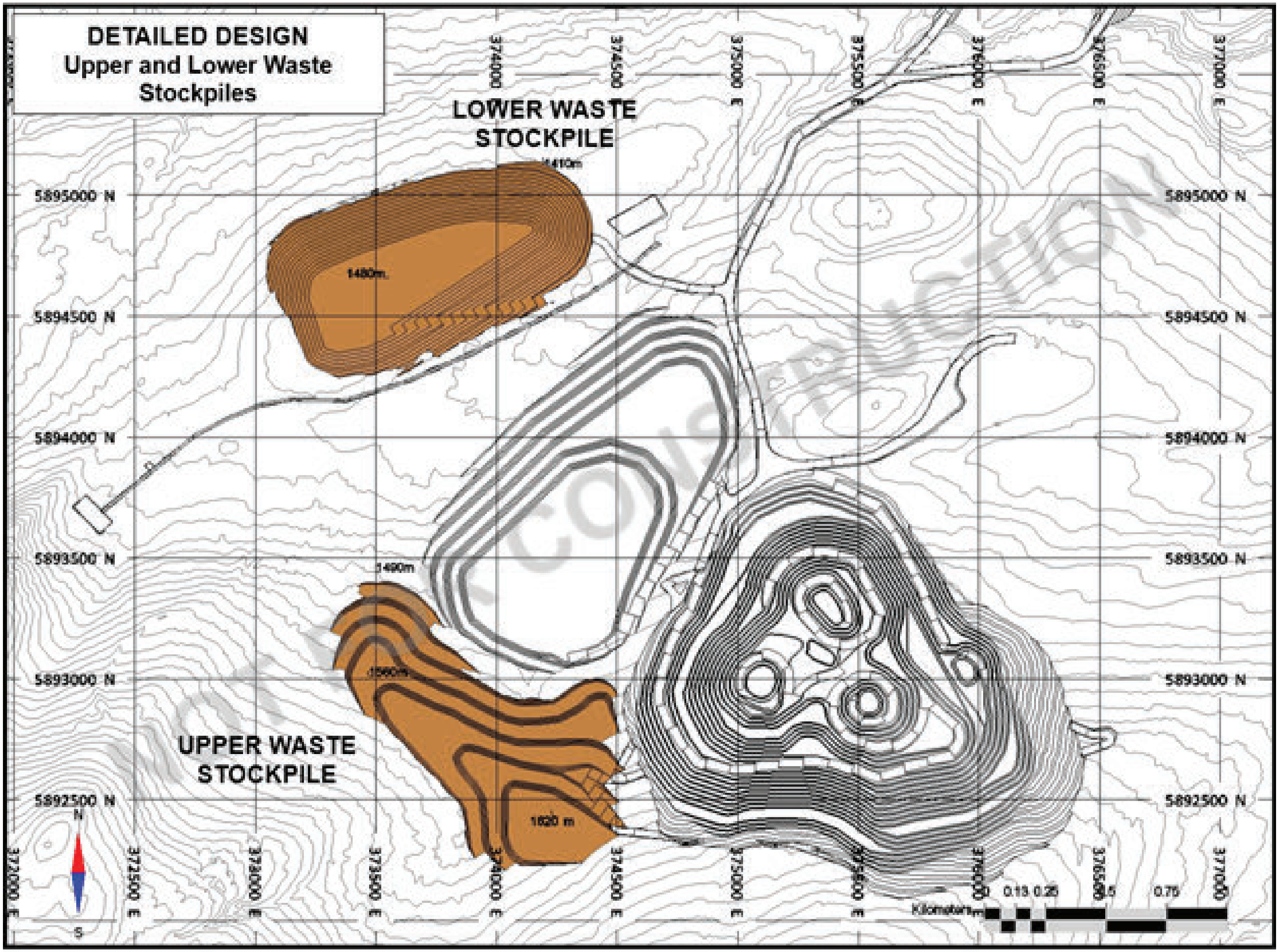


Figure 3.5-44: Maximum Build of the Upper and Lower Waste Stockpile

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

Key Reports and Other Documentation

Key reports and other documentation is as follows:

- Blackwater Gold Project Feasibility of the Open Pit – Part 1 (KP 2013a);
- Blackwater Gold Project Geotechnical Characterization Report (KP 2013f);
- Blackwater Gold Project Mine Waste and Water Management Design Report (KP (2014);
- Blackwater Gold Project British Columbia NI 43-101 Technical Report on Pre-feasibility Study (Artemis 2020a);
- Blackwater Gold Project 2019 Site Investigation Report (KP 2021b) – Appendix 3-D;
- Blackwater Gold Project 2020-2021 Site Investigation Report (KP 2021c) – Appendix 3-E;
- Blackwater Gold Project Stockpiles Geotechnical and Water Management Design Report (KP 2021l) – Appendix 3-N;
- Blackwater Gold Project Seismic Hazard Assessment (KP 2021g) – Appendix 2-E;
- Blackwater Gold Project ML/ARD Management Plan (Lorax 2021) – Appendix 9-D;
- Blackwater Gold Project Assessment of Alternatives for Mine Waste Disposal (ERM 2021) – Appendix 3-M;
- Blackwater Gold Project – Open Pit and Stockpile Design Report (MMTS 2021) – Appendix 3-C; and
- Condemnation Report of the Blackwater Project (Baker & Popelka 2021) – Appendix 3-G.

EAC Conditions

Condition related to the design, construction, operation, closure and reclamation of the waste stockpiles as EAC conditions:

- Condition 33 (Mine Waste and Water Management Plan) – requires the development and implementation of a plan to manage mine waste and water that is protective of the receiving environment.

The Mine Waste and Water Management Plan must be developed in consultation with EMLI, ENV, and Aboriginal Groups.

3.5.4.3 Multiple Accounts Analysis

Candidate alternatives were also assessed for locating the NAG waste rock and OVB stockpile(s) (Appendix 3-M). Two candidate alternatives were brought forward for characterization and assessment in a MAA (separate from the tailings assessment):

- Candidate 1: Upper and Lower NAG Waste Rock and OVB Storage; and
- Candidate 2: West NAG Waste Rock and OVB Storage.

The results of the NAG waste rock and OVB MAA indicated that Candidate 1 (upper and lower) is the most appropriate candidate, with the highest rating. Although Candidate 1 has a slightly larger footprint when compared to Candidate 2, the dual stockpile design has the ability to split the waste into two streams and reduces overall waste haulage distances. In addition, the two stockpiles provide more flexibility for a phased approach/ramping up the mine throughput by providing more space for the low grade ore stockpile. This important aspect in terms of flexibility will support the project economics associated with a phased mining development.

3.5.4.4 Condemnation Assessment

Condemnation of resources of waste stockpile footprints were investigated with drilling programs described in the *Geotechnical Characterization Report* (KP 2013f). The results of condemnation drilling were reinterpreted for the recent Project optimizations (Appendix 3-G), which confirmed there is no economically viable mineralization beneath the waste stockpiles.

3.5.4.5 Geotechnical Characterization

Geotechnical characterization of the waste stockpile foundations was developed from an extensive geotechnical database, which incorporates geological and geotechnical data from the 2012, 2013, and 2019 to 2021 site investigations to support the stockpile design (KP 2013f, Appendix 3-D and 3-E). Drill locations are shown in Figure 3.1 in Appendix 3-N.

Lower Waste Stockpile

The deglaciation model map and the terrain and landform maps developed for the Project indicate that the surficial material at the Lower Waste Stockpile footprint is predominantly glacial (lodgement) till at the northern section and glacial (ablation) till at the southern section. The stratigraphy underlying the Lower Waste Stockpile is inferred to be:

- **Topsoil:** Thickness ranging from 0.1 to 0.2 m with an average of 0.1 m based on 11 test pits.
- **Glacial Deposits:** Glacial sequences with thickness of 75.7 m were identified from a sonic drillhole located approximately 250 m northeast of the footprint.
    - **Glacial Till** – Ablation till was not observed during drilling but is expected along the southern section. Lodgement and undifferentiated till occur below at depth with interval thickness ranging from 3.1 to 45.7 m.
    - **Glaciofluvial Deposits** – This unit was not intercepted at GT12-34.
    - **Glaciolacustrine Units** – A 15.2 m thick glaciolacustrine unit was intercepted with a top elevation at 1,367 masl at drillhole GT12-34. This interval was generally observed as firm to stiff, greyish brown silt with some clay and trace fine sand and fine gravel.
- **Reworked Regolith:** This unit was intercepted at GT12-34 with a thickness of 5.6 m.
- **Completely Weathered Bedrock:** This unit was not intercepted at GT12-34.
- **Highly Weathered Bedrock:** This unit is shallowest at the western part of the stockpile footprint as intercepted in test pit TP12-248 at an elevation of 1,448 masl and becomes deeper towards the east as intercepted in test pit TP13-278 at 1,424 masl and drillhole GT12-34 at 1,338 masl.
- **Intact Bedrock:** Intact bedrock was not intercepted by any of the geotechnical drillholes as they were not drilled deep enough. Several condemnation drillholes resulted in a bedrock horizon elevation range between 1,325 to 1,448 masl. Test pits on the west side of the footprint were terminated at the bedrock contact. The bedrock lithology is predominantly Volcaniclastics which can be described as a strong rock with FAIR RMR89 Rating.

No installation or groundwater measurement is available within the footprint of the proposed Lower Waste Stockpile. One historical well (Well 3) located northeast of the footprint indicated a groundwater elevation of approximately 1,332 masl based on measurements in March 2012. The geotechnical characterization for the Lower Waste Stockpile is summarized in Appendix 3-N.

Upper Waste Stockpile

The Upper Waste Stockpile will be situated on a gentle sloping area draining to the northwest. The geotechnical foundation conditions in this area were previously described in Section 4.4.3 West Dump in KP (2014). The stratigraphy of this area is characterized by surficial materials ranging from 18 m to 75 m in thickness, being thickest at lower elevations. Several eskers and localized kames and ablation till were identified in the footprint area of the stockpile. Bedrock is shallow on the upper slopes at 3 to 4 m depth. The bedrock geology consists of highly weathered andesitic volcanic rocks at less than 5 m depth. Static groundwater levels range from 3 m to 4 m below surface and mirror the surficial topography.

The Upper Waste Stockpile will be constructed in the late stages of mine operations and will be assessed further once detailed geotechnical and design information is available.

3.5.4.6 Seismicity and Other Geohazards

Seismicity information is incorporated in the determination of the waste dump and stockpile stability (WSR) rating and classification of the hazard rating. Details of the seismicity for the mine site are presented in Appendix 2-E.

The potential risk to the mine site to other geohazards are discussed in Section 2.3.4 Natural and Seismic Hazards Assessments. In general, the overall risk to landslides and mass wasting, snow avalanches, flooding, subsidence, seismic events, and volcanic events is low.

3.5.4.7 Waste Stockpile Stability Rating and Hazard Classification

The stability of stockpiles has been assessed using the waste stockpile rating and hazard classification (WSRHC) system (Hawley & Cunning 2017) for comprehensive dump stability assessments. The WSRHC system requires evaluation of 22 key factors or attributes that are considered to affect stability. These factors are organized into seven groups. Numerical ratings are assigned to each factor, and the sum of these ratings defines the waste stability rating (WSR).

The maximum possible WSR is 100, with a higher rating indicating a more stable configuration. The WSR values have been subdivided into several waste hazard classes (WHCs). Waste dumps or stockpiles with a very high WSR rating (more than 80) are assigned to WHC I and are characterized as presenting a relatively very low potential for instability (i.e., a very low instability hazard). Conversely, waste dump or stockpiles with a very low WSR rating (less than 20) are assigned to WHC V and are characterized as presenting a relatively very high potential for instability (i.e., a very high instability hazard).

The Lower Waste Stockpile has a WSR of 46.5 and assigned a WHC of III, a moderate instability hazard. Details of the analysis and results are presented in Section 3.4 Stability Rating and Hazard Classification of Appendix 3-N.

As the Upper Waste Stockpile will be developed later during the LoM, the WSR and WHC will be assessed as detailed geotechnical and design information becomes available.

3.5.4.8 Stockpile Stability Assessment

Detailed slope stability analyses for the Lower Waste Stockpile using two-dimensional limit equilibrium analysis software SLOPE/W (GeoStudio 2021) was conducted to evaluate the estimated FoS against rotational failure modes. The Morgenstern-Price method was used to estimate the FoS.

Critical slope sections were modelled for the Year +3 and Year +18 (Ultimate) configurations to represent the maximum slope heights and the steepest slope angles for the Lower Waste Stockpile. Sections were analyzed along the northeast-southwest and northwest-southeast slopes of the Lower Waste Stockpile.

Details of the analysis and results are presented in Section 4.0 Stockpile Stability Assessment of Appendix 3-N.

As the Upper Waste Stockpile will be developed later during the LoM, the slope stability analyses will be assessed as detailed geotechnical and design information becomes available.

Acceptance Criteria

The minimum FoS targets for the Lower Waste Stockpile based on the waste dump design guideline (Hawely & Cunning 2017), Part 10 of the Code (EMLI 2021) and the CDA Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (CDA 2019) are as follows:

- Short term Static: 1.3 – Modelled for Year +3 configuration;
- Long term Static: 1.5 – Modelled for Year +18 (Ultimate) configuration;
- Pseudo-static: 1.1 – Modelled for Year +18 (Ultimate) configuration; and
- Post-earthquake: 1.2 – Modelled for Year +18 (Ultimate) configuration.

Characterization of Stockpile Fill and Foundation Soils

Overburden and Waste Rock Geochemistry

OVB and NAG waste rock from the Open Pit has been classified according their NPR and metal content (Table 3.5.4-1). NAG4 and NAG5 are considered non-reactive and will be stockpiled for the long-term in the Lower Waste Stockpile and Upper Waste Stockpile. Details of the geochemical properties of waste rock and OVB are presented in Section 2.4.1.3 Geochemical Characterization.

Table 3.5.4-1: Acid Rock Classification of OVB and Waste Rock

Classification	NPR	Metal Content	Waste Material
PAG1	NPR ≤ 1.0	-	PAG waste
PAG2	NPR > 1.0 and ≤ 2.0	-	PAG waste
NAG3	NPR > 2.0	zinc ≥ 1,000 ppm	NAG/ML waste
NAG4	NPR > 2.0	zinc < 1,000 and ≥ 600 ppm	NAG waste
NAG5	NPR > 2.0	zinc < 600 ppm	NAG waste, OVB

Notes:
NPR = neutralization potential ratio
ppm = parts per million
PAG = potentially acid generating; NAG = non-acid generating; OVB = overburden

Material Parameters for the Stockpile Fill and Foundation Soils

The following material parameters for the stockpile and foundation soils were incorporated into the stability analyses (Table 3.5.4-2).

Seismicity

A value of 0.021 gravity (g) was used as the horizontal ground acceleration (Kh) for the pseudo-static analysis. The suggested Kh value is the PGA value for the 1/475-year MDE.

Table 3.5.4-2: Foundation and Stockpile Material Parameters

Material	Unit Weight (kN/m³)	Internal Friction Angle (degree)	Cohesion (kPa)	Undrained Shear Strength Ratio	
				Peak	Residual
Foundation					
Glacial (Ablation) Till	23	32	0	-	-
Glacial (Lodgement) Till	23	35	0	-	-
Glaciofluvial	23	35	0	-	-
Glaciolacustrine Unit	21	31	0	-	0.2
Reworked Regolith	21	37	0	-	-
Completely Weathered Bedrock	19	-	-	0.67	0.22
Highly Weathered Bedrock	20	15	0	-	-
Stockpile					
Stockpile Material	20	Lower bound Leps (1970) function			

Stockpile Stability Results

FoS were computed for the Year +3 and Year +18 (Ultimate) for the Lower Waste Stockpile against deep-seated global slip surfaces. All modelling sections incorporate groundwater at surface since there is a shallow groundwater table at the site. Section 4 showing a deep-seated slip surface for the ultimate Lower Waste Stockpile configuration is shown in Figure 3.5-45. The stability analysis results are summarized in Table 3.5.4-3. The stability analysis of the Lower Waste Stockpile was evaluated and confirmed that the design meets the required FoS for all loading conditions.

Table 3.5.4-3: Lower Waste Stockpile Stability Results

Stage	Section	Slope – Crest Elevation (masl)	Factor of Safety			Appendix 3-N Reference
			Static	Pseudo-static	Post-seismic	
Y+3	3	NW – 1,450	2.9	-	-	Figure C2.9 of Appendix C.2
	4	NW – 1,450	3.0	-	-	Figure C2.10 of Appendix C.2
Target[1]			**>1.3**	**-**	**-**	
Y+18 Ultimate	3	NW – 1,480	3.2	2.9	See Note 4	Figures C2.11 to C2.12 of Appendix C.2
	4	NW – 1,480	2.9	2.6	2.1	Figures C2.13 to C2.15 of Appendix C.2
Target[2,3]			**>1.5**	**>1.1**	**>1.2**	

Notes:

[1] Minimum factors of safety for end of construction year 3 static based on the requirements outlined in EMLI 2021.

[2] Minimum factors of safety for static and pseudo-static based on the requirements outlined in Hawely & Cunning 2017.

[3] Minimum factors of safety for post-seismic based on the requirements outlined in CDA 2019.

[4] Post-seismic case not applicable to underlying foundation soils.

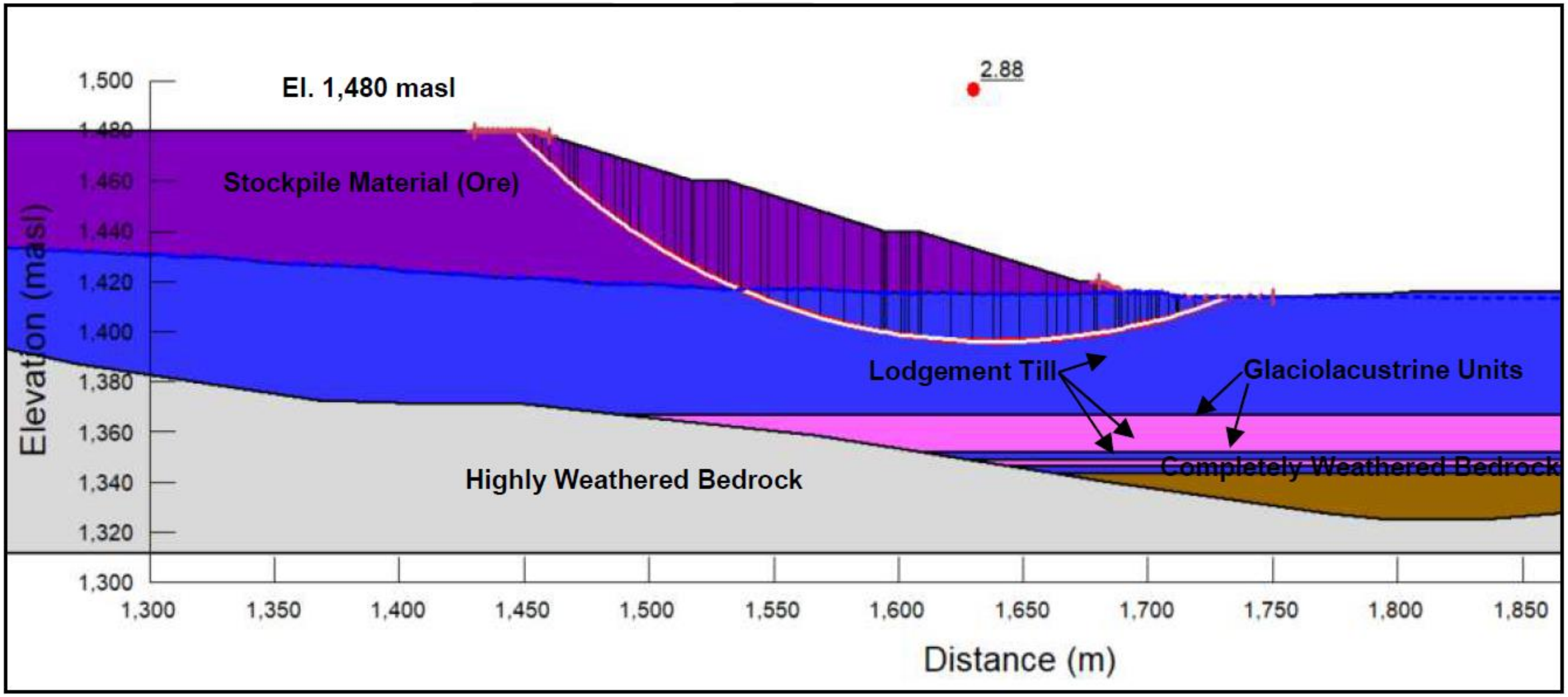


Figure 3.5-45: Lower Waste Stockpile Y+18 Deep Seated Failure Static Stability

3.5.4.9 Planned Storage Capacity

The planned storage capacity and compositions of Lower Waste Stockpile and Upper Waste Stockpile are presented in Table 3.5.4-4.

Table 3.5.4-4: Waste Stockpile Design Capacity

	Lower Waste Stockpile		Upper Waste Stockpile	
	OVB	NAG Waste	OVB	NAG Waste
Maximum Capacity (Mt)	457	28,692	4,893	20,916

The maximum capacity of the Lower Waste Stockpile is 29.1 Mt (14,574 thousand loose cubic metres [kLCM]) of OVB and NAG. The placed ratio of OVB to NAG waste rock is 63:1 by weight (28.7 Mt OVB and 0.5 Mt NAG waste rock). The high ratio is due to the use of NAG waste for construction.

The maximum capacity of the Upper Waste Stockpile is 30.7 Mt (14,400 kLCM) of OVB and NAG. The placed ratio of OVB to NAG waste rock is 0.5:1 by weight (9.8 Mt OVB and 20.9 Mt NAG waste rock). The low ratio of OVB is the due to the mining of the deeper benches of the Open Pit.

3.5.4.10 Design Standards

To support the storage capacities presented in Table 3.5.4-3, Table 3.5.4-5 identifies the design standards.

Table 3.5.4-5: Waste Stockpile Design Standards

Parameter	Value
Typical waste rock stockpile lift height (m)	20
Maximum slope angle (degrees)	37 (1.3H:1V)
Overall slopes once berms and ramps are accounted	3H:1V to 4.5H:1V
Maximum Reclaimed Slope Angle (degrees)	18 (3H:1V)

3.5.4.11 Construction

The Construction phase for the waste stockpiles includes:

- site preparation;
- boulder rollout catchberms;
- access roads; and
- water management structures.

Site Preparation

In order to ensure good ground contact between waste rock material and geotechnically competent surficial materials, a number of steps are required during construction. These steps will:

- reduce the risk of slope failure through weak foundation materials; and
- provide suitable salvageable materials for reclamation purposes.

In general, site preparation will include:

- Additional logging of the ultimate footprint the Lower Waste Stockpile not included in *Mines Ac*t Permit M-246.
- Inspection trenches running across the width of the stockpile will be cut by a dozer for identification of organic layers, and an excavator for gravel deposits that extend below the dozed trenches; and will be built with adequate drainage to avoid any water pooling prior to material placement.
- Mineral soils and organics will be stripped, salvaged and stockpiled in accordance with the Soil Management Pan (Appendix 9-B).
- The final foundation footprints will be inspected by a qualified geotechnical engineer prior to material placement. Any unsuitable foundation materials will be removed from the footprint areas prior to placement of waste rock materials.

Boulder Rollout Catchberms

Prior to placement of each stockpile lift, a rollout catch berm will be constructed along the toe of the lift and will be constructed from run-of mine waste.

Access Road Construction

Detailed drawings of access road cut and fill designs are presented in Section 7 Mine Haul Road Designs of Appendix 3-C.

Water Management Structures

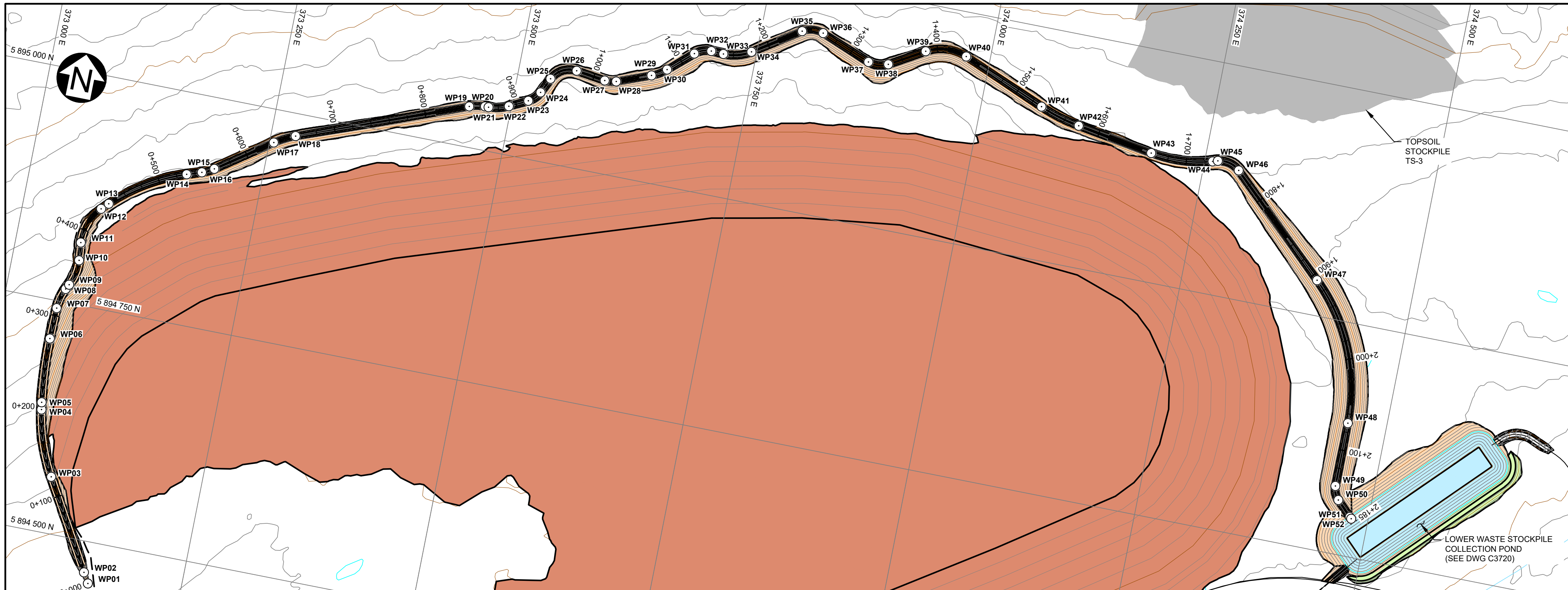
Surface contact water is to be managed in a manner that allows for safe containment and control. Collection channels will be constructed along the stockpile periphery (Figures 3.5-46 and 3.5-47) to collect and convey contact surface runoff to the Lower Waste Stockpile Collection Pond where the flows can be pumped to the Metals WTP Pond, for treatment if required prior to being conveyed to WMP. The emergency spillway from the collection pond releases flows to Mine Area Creek and hence to the WMP, which would allow passive release of water to the WMP if the quality was suitable for direct release to the WMP. The WMP will provide make-up water to support ore processing. Water not needed to support mine operations will be discharged from the WMP to the FWR and used to mitigate flow reductions in lower Davidson Creek.

Details of the water management system for the Lower Waste Stockpile are presented in the Stockpiles Geotechnical and Water Management Design Report in Appendix 3-N. The water management system for the Upper Waste Stockpile is anticipated to be similar in design and operation but will be developed when the stockpile is needed later in mine operations.

Design Criteria for Water Management Structures

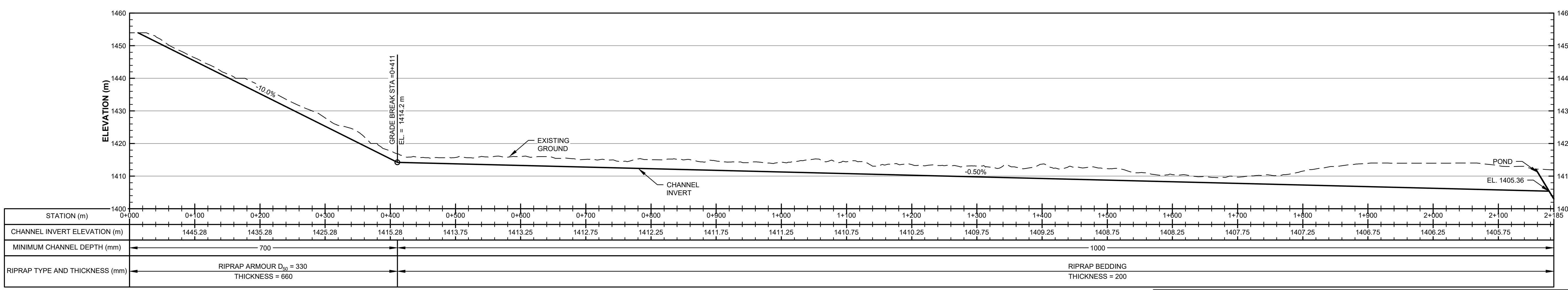
Key water management structures are:

- North Collection Channel;
- South Collection Channel;
- Lower Waste Stockpile Collection Pond;
- Pumping and pipeline system for Lower Waste Stockpile collection pond to the Metals WTP.



NORTH COLLECTION CHANNEL WORK POINTS			
POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP01	373149.8	5894455.2	1454.0
WP02	373143.4	5894466.3	1454.0
WP03	373088.3	5894561.2	1443.0
WP04	373063.7	5894630.6	1435.6
WP05	373062.4	5894638.5	1434.8
WP06	373057.7	5894708.1	1427.8
WP07	373058.3	5894741.9	1424.5
WP08	373064.0	5894764.1	1422.1
WP09	373066.9	5894769.6	1421.5
WP10	373072.3	5894797.6	1418.6
WP11	373070.4	5894816.7	1416.7
WP12	373084.8	5894856.9	1414.1
WP13	373091.8	5894863.9	1414.1
WP14	373168.7	5894911.7	1413.6
WP15	373184.4	5894917.1	1413.5
WP16	373197.0	5894923.5	1413.4
WP17	373254.7	5894964.0	1413.1
WP18	373276.5	5894975.6	1413.0
WP19	373455.3	5895043.8	1412.0
WP20	373472.1	5895047.1	1411.9
WP21	373476.0	5895047.1	1411.9
WP22	373497.4	5895052.4	1411.8
WP23	373516.9	5895062.2	1411.7
WP24	373528.4	5895073.9	1411.6
WP25	373536.1	5895090.4	1411.5
WP26	373562.2	5895104.6	1411.4
WP27	373594.1	5895100.1	1411.2
WP28	373606.5	5895101.5	1411.1
WP29	373642.8	5895115.3	1410.9
WP30	373658.3	5895124.8	1410.8
WP31	373683.9	5895147.7	1410.7
WP32	373701.5	5895154.0	1410.6
WP33	373715.0	5895153.5	1410.5
WP34	373744.3	5895161.7	1410.4
WP35	373793.9	5895194.3	1410.1
WP36	373816.7	5895196.7	1409.9
WP37	373871.0	5895175.6	1409.6
WP38	373892.6	5895177.3	1409.5
WP39	373929.9	5895199.0	1409.3
WP40	373974.2	5895202.0	1409.1
WP41	374064.9	5895164.6	1408.6
WP42	374108.4	5895152.1	1408.4
WP43	374191.5	5895138.3	1408.0
WP44	374258.7	5895142.5	1407.6
WP45	374264.1	5895144.1	1407.6
WP46	374288.4	5895138.3	1407.5
WP47	374395.0	5895038.0	1406.7
WP48	374458.0	5894892.3	1405.9
WP49	374458.0	5894822.9	1405.6
WP50	374464.0	5894808.5	1405.5
WP51	374480.0	5894793.0	1405.4
WP52	374481.8	5894791.3	1404.6

PLAN
NORTH COLLECTION CHANNEL
SCALE A



PROFILE
NORTH COLLECTION CHANNEL
HORIZONTAL: SCALE C
VERTICAL: SCALE B

SCALE C 10 5 0 10 20 30 40 50 60 m
SCALE B 60 30 0 100 200 300 m
SCALE A 50 25 0 50 100 150 200 250 m

NOTES:

1. FOR GENERAL NOTES, SEE DWG. G0006.
2. TYPICAL CHANNEL EROSION PROTECTION DETAILS SHOWN ON DWG. G0060.
3. SEE DWG. C3712 FOR CHANNEL CROSS SECTIONS.

LEGEND:

- MINE WATER
- WASTE STOCKPILE
- FILL AREAS
- CUT AREAS
- RIPRAP
- WP01 WORK POINT

DETAILED DESIGN
NOT FOR CONSTRUCTION

DRG. NO.	DESCRIPTION
G0060	EROSION PROTECTION - TYPICAL CHANNEL SECTIONS
G0006	CIVIL GENERAL NOTES
C3720	WATER MANAGEMENT - LOWER WASTE STOCKPILE - COLLECTION POND - PLAN
C3712	WATER MANAGEMENT - LOWER WASTE STOCKPILE - NORTH COLLECTION CHANNEL - TYPICAL SECTIONS AND CROSS SECTIONS

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	16NOV'21	ISSUED FOR PERMITTING	MJB1	ABN		

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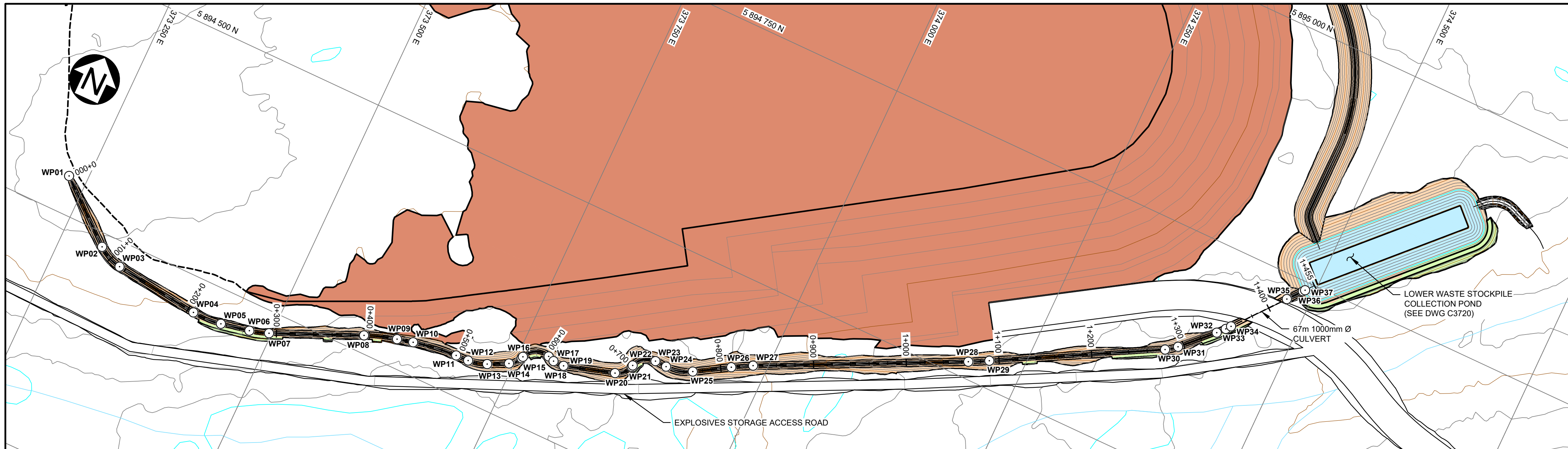
BLACKWATER GOLD PROJECT

WATER MANAGEMENT
LOWER WASTE STOCKPILE
NORTH COLLECTION CHANNEL
PLAN AND PROFILE

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C3711	0

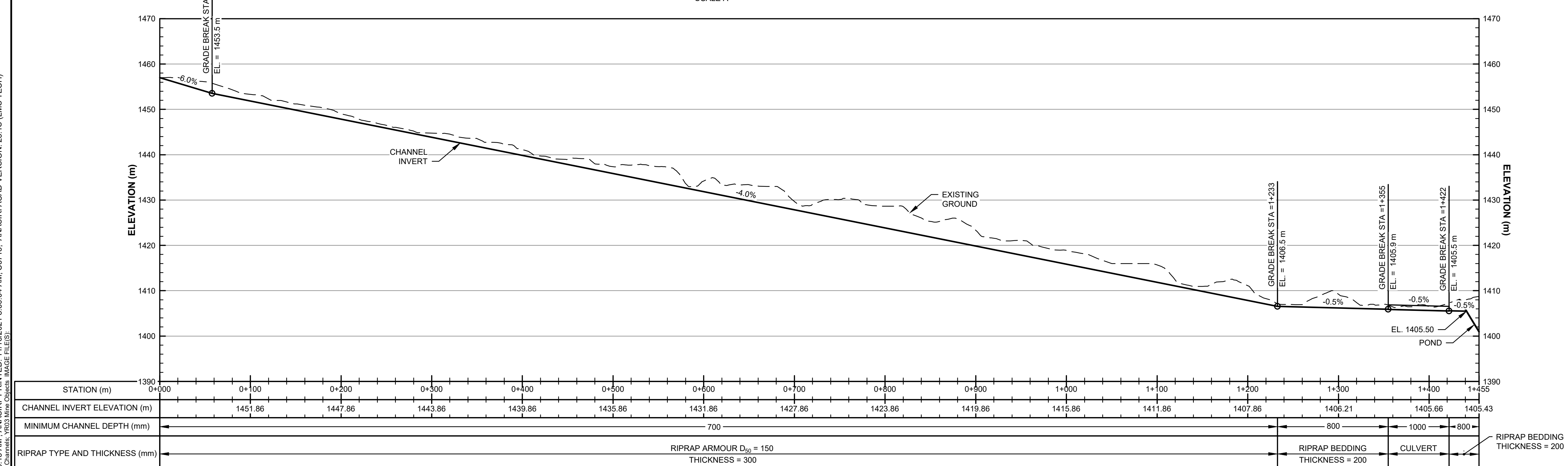
Figure 3.5-46: Northern Plan View of Water Management System for Lower Waste Stockpile

Source: Knight Piésold Consulting (2021l; Appendix 3-N).



PLAN
SOUTH COLLECTION CHANNEL
SCALE A

SOUTH COLLECTION CHANNEL WORK POINTS			
POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP01	373230.3	5894289.8	1457.0
WP02	373294.8	5894235.7	1452.5
WP03	373321.0	5894224.3	1451.3
WP04	373414.0	5894213.1	1447.6
WP05	373445.9	5894214.4	1446.3
WP06	373477.0	5894220.8	1445.0
WP07	373497.2	5894227.2	1444.2
WP08	373591.1	5894268.5	1440.1
WP09	373624.9	5894279.9	1438.6
WP10	373642.2	5894284.0	1437.9
WP11	373690.2	5894290.7	1436.0
WP12	373704.2	5894291.3	1435.4
WP13	373724.5	5894296.5	1434.6
WP14	373745.5	5894307.0	1433.6
WP15	373755.3	5894317.9	1433.0
WP16	373756.0	5894319.8	1433.0
WP17	373780.9	5894331.9	1431.7
WP18	373787.9	5894329.7	1431.4
WP19	373799.8	5894329.6	1431.0
WP20	373853.4	5894345.9	1428.7
WP21	373866.8	5894359.7	1427.9
WP22	373867.3	5894361.4	1427.8
WP23	373887.4	5894376.0	1426.8
WP24	373900.4	5894375.5	1426.3
WP25	373928.7	5894382.8	1425.1
WP26	373964.2	5894404.6	1423.4
WP27	373985.0	5894416.0	1422.5
WP28	374193.3	5894518.1	1413.2
WP29	374213.4	5894528.5	1412.3
WP30	374380.0	5894619.6	1406.3
WP31	374391.3	5894628.1	1406.2
WP32	374422.8	5894659.5	1406.0
WP33	374429.8	5894667.3	1406.0
WP34	374433.7	5894672.2	1405.9
WP35	374475.9	5894724.3	1405.6
WP36	374488.0	5894739.3	1405.5
WP37	374489.6	5894741.2	1404.7



PROFILE
SOUTH COLLECTION CHANNEL
HORIZONTAL: SCALE A
VERTICAL: SCALE B

LEGEND:
- MINE WATER
- WASTE STOCKPILE
- FILL AREAS
- CUT AREAS
- RIPRAP
- WP01 WORK POINT

NOTES:
1. FOR GENERAL NOTES, SEE DWG. G0006.
2. TYPICAL CHANNEL EROSION PROTECTION DETAILS SHOWN ON DWG. G0060.

SCALE B: 10 5 0 10 20 30 40 50 m
SCALE A: 50 25 0 50 100 150 200 250 m

DETAILED DESIGN
NOT FOR CONSTRUCTION

DRG. NO.	DESCRIPTION
G0060	EROSION PROTECTION - TYPICAL CHANNEL SECTIONS
C3720	WATER MANAGEMENT - LOWER WASTE STOCKPILE - COLLECTION POND - PLAN
G0006	CIVIL GENERAL NOTES

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	16NOV'21	ISSUED FOR PERMITTING	MJB1	ABN		

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WATER MANAGEMENT
LOWER WASTE STOCKPILE
SOUTH COLLECTION CHANNEL
PLAN AND PROFILE

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C3715	0

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Figure 3.5-47: Southern Plan View of Water Management System for Lower Waste Stockpile

Source: Knight Piésold Consulting (2021l; Appendix 3-N).

The design criteria for the water management structures are presented in Table 3.5.4-6. The design floods were estimated using the return period peak flow results presented in Appendix 2-B.

Table 3.5.4-6: Lower Waste Stockpile Water Management Design Criteria

Structure	Catchment Area (ha)	1-in-10-year Return Period Flood (m^3/s)[1]	1-in-200-year Return Period Flood (m^3/s)[2]
North Collection Channel	44	1.91	3.95
South Collection Channel	40	1.73	3.56
Lower Waste Stockpile Collection Pond	84		
Lower Waste Stockpile Collection Pond spillway	-		4.83[3]

Notes:

[1] *Minimum of 300 mm of freeboard.*

[2] *A bank full conditions.*

[3] *Minimum of 500 mm of freeboard.*

Design Parameters for Water Management Structures

Parameters for the Lower Waste Stockpile water management structures are presented in Table 3.5.4-7. Details for design parameters are presented in:

- Section 6.4 Collection Channels of Appendix 3-N;
- Section 6.5 Collection Pond of Appendix 3-N; and
- Section 6.6 Pumping System and Pipeline Design of Appendix 3-N.

Detailed design drawings are presented in Appendix D Detailed Design Drawings Water of Appendix 3-N.

Discharge collected in the Lower Waste Stockpile Collection Pond will be pumped to the Metals WTP. The pumping system will consist of one operating shore-mounted end-suction centrifugal pump, and one uninstalled spare unit, providing a total design head of 90 m at a flowrate of 62.5 L/s. The system will be controlled via a level control float system, or equivalent, and will operate for the LoM. The pumps will be located on the crest of the collection pond at an elevation of approximately 1,407 masl. There will be approximately 0.5 m dead storage depth within the pond to prevent suction of sediment from pond bottom. All system components, including pumps, pipe, valves, fittings, and instrumentation, will be equipped with weather protection in the form of insulation and heat tracing or weatherproof enclosures, except for free-draining sections of the pipeline, which do not require weather protection.

3.5.4.12 Operation

Material Placement Methods

The stockpiles will be oriented at angle of response, with stockpiled materials being dumped out directly over the progressive dump face. When lifts are completed, they will be re-sloped to the overall target closure slopes. All facilities will have a 36 m dual lane haul road wrapping around the sides of the facility for progressive access to all lifts or access via external haul roads, suitable for 230 t payload haulers. The maximum grade on access haul ramps is 10%. Further details of material placement are presented Section 3.8 Stockpile Foundation Preparation and Dumping Operations in Appendix 3-N.

Table 3.5.4-7: Lower Waste Stockpile Water Management Design Parameters

Structure	Side Slopes	Depth (mm)	Volume (m^3)	Width (mm)	Length (m)	Ave. Gradient (%)	Erosion Protection
North Collection Channel	2H:1V	Segment 1 – 1,330 Segment 2 – 1,200	-	1,000	Segment 1 – 411 Segment 2 – 1,774	Segment 1 – 10.0 Segment 2 – 0.5	Segment 1 – riprap D_{50} 330 mm Segment 2 – riprap bedding
South Collection Channel	2H:1V	1,000	-	1,000	Segment 1 – 1,223 Segment 2 – 189	Segment 1 – 4.0 Segment 2 – 0.5	Segment 1 – riprap D_{50} 150 mm Segment 2 – riprap bedding
Lower Waste Stockpile Collection Pond[4]	3H:1V interior (cut) slopes 2H:1V exterior (fill) slopes	7,000 1,399.75 to 1,406.75 masl	50,000	25,500 (base width)	174	-	-
Lower Waste Stockpile Collection Pond spillway	1.5H:1V	1,250 at inlet 1,000 along slope and toe	-	6,000	-	-	Riprap thickness – 300 mm Riprap D_{50} 150 mm

Notes

[1] *Minimum of 300 mm of freeboard.*

[2] *At bank full conditions.*

[3] *Minimum of 500 mm of freeboard.*

Waste Material Production Schedule

Waste material production and distribution over the LoM is presented in Table 3.3-1 (Figures 3.3-2 and 3.3-4). The values in Table 3.3-1 are estimates. The realized annual estimate will largely be dependent on the staged construction of the TSF as excavated materials will be prioritized for initial construction and subsequent dam raises. Suitable construction materials will be prioritized and routed for the construction of the TSF and only residual amounts of NAG produced within a year will be stored in the waste stockpile.

In addition to the TSF construction, several other considerations potentially affect the waste stockpiling schedule:

- minimizing OVB extraction in wet periods (nominally April, May, and September);
- maximizing extraction mining in frozen periods (nominally December to February);
- in later years leave final slopes composed of OVB to facilitate reclamation;
- minimize haul distances / times for waste haulage to manage haulage costs; and
- provide progressive reclamation opportunities, where practical.

Lower Waste Stockpile Sequence and Development

The Lower Waste Stockpile development plan is presented in (Table 3.5.4-8). An initial lift will be developed in Year -1 at 1,415 masl with three subsequent lifts sequenced to a maximum of 1,470 masl. The maximum angle repose for the placement of lifts is 1.3.2H:1V with an overall slope of 4H:1V. End of period plan and sectional views are presented in Figures 8-64 to 8-78 of Appendix 3-C.

Table 3.5.4-8: Lower Waste Stockpile End of Period Details

Parameter	Y -1	Y+1	Y+2	Y+3	Y+8	Y+13	Y+18	Y+23
Cumulative NAG Waste Rock (Mt)	0.03	0.07	0.07	0.1	0.2	0.5	0.5	0.5
Cumulative OVB (Mt)	0.3	4.4	4.8	11.3	28.6	28.7	28.7	28.7
Cumulative Volume (kLCM)	175	2,211	2,434	5,683	14,385	14,574	14,574	14,574
Start Elevation (masl)	1,415	1,410	1,410	1,410	1,410	1,410	1,410	1,410
End Elevation (masl)	1,420	1,435	1,440	1,450	1,470	1,470	1,470	1,470
Mean Pile Slope (degree)	14°	14°	14°	14°	14°	14°	14°	14°
Mean Foundation Angle (degree)	2°	3°	3°	4°	4°	4°	4°	4°
Footprint area (ha)	-	3.8	25.4	31.3	67.9	82.5	82.5	82.5

Upper Waste Stockpile Sequence and Development

The Upper Waste Stockpile development plan is presented in (Table 3.5.4-9). An initial lift will be developed in Year +11 at 1,490 masl with five subsequent lifts sequenced to a maximum of 1,620 masl. Material will be dumped out at an angle of repose (1.3H:1V) with an overall slope of 4.5H:1V. The upper lifts of the eastern side of this facility will be used as a haul road to access the upper benches of the final South Pushback (P657i) pit highwall. End of period plan and sectional views are presented in Figures 8-79 to 8-84 of Appendix 3-C.

Table 3.5.4-9: Upper Waste Stockpile Sequence

Parameter	Y -1	Y+1	Y+2	Y+3	Y+8	Y+13	Y+18	Y+23
Cumulative NAG Waste Rock (Mt)	-	-	-	-	-	20.2	20.2	20.2
Cumulative OVB (Mt)	-	-	-	-	-	9.75	9.79	9.79
Cumulative Volume (kLCM)	-	-	-	-	-	14,040	14,400	14,400
Start Elevation (m)	-	-	-	-	-	1,490	1,490	1,490
End Elevation (m)	-	-	-	-	-	1,620	1,620	1,620
Average Pile Slope (degree)	-	-	-	-	-	14°	14°	14°
Average Foundation Angle (degree)	-	-	-	-	-	8°	8°	8°
Footprint area (ha)	-	-	-	-	-	73.8	73.8	73.8

3.5.4.13 Monitoring

Stockpile monitoring will be performed via visual inspection and instrumentation as deemed required. A detailed monitoring and management plan will be developed prior to active dumping operations, which will employ appropriate status and monitoring sign off sheets. The plan will include preliminary locations, installation schedules, monitoring frequency, and initial threshold response criteria for all proposed instrumentation. The monitoring plan will be updated periodically as required.

3.5.4.14 Closure and Post-closure

As the opportunity arises, stockpile face resloping will be carried out progressively as the construction of the stockpile advances. There should only be a single non-resloped stockpile lift maintained between the active bench and the resloped area. This non-resloped lift allows for the maintenance of a bench and catchberm between the active lift and resloped ground.

Closure plans for these facilities will require resloping the crests for each lift while maintaining the footprints for the facilities. The slopes will be rounded from the top of each lift to create a concave lower slope with a 20% inflection point. A 10 m high, 50 m wide curvilinear berms is left on top of the Lower Waste Stockpile, parallel with prevailing winds, to reduce snow accumulation. The closure plan and sectional views are presented in Figures 5.8 to 5-12 of Appendix 3-C.

In the Closure and Post-closure phases, the Lower Waste Stockpile will discharge to the TSF C Pond.

Other Closure phase activities include:

- decommissioning of all equipment, debris, signage, culverts, power lines etc.;
- removal or burial of geotechnical instrumentation on the waste stockpiles unless required for long term monitoring;
- distribution and contour of cover material;
- revegetation of waste stockpiles in accordance with end land use objectives (Section 4.1 End Land Use and Capability Objectives);
- reconfiguration of water management features on reclaimed stockpiles and supporting water management structures to drain stockpiles in accordance to the Post-closure water management plans; and
- monitoring and reporting on reclamation success (Section 4.2.6 Reclamation Monitoring).

3.5.5 Low Grade Ore Stockpile

3.5.5.1 General Description

The LGO Stockpile will store ore for processing towards the end of the mine life and is located north of the Open Pit (Figure 3.5-48). The LGO Stockpile will be placed on a low permeability foundation, 147 ha in area. From Year -1 to the end of Year +15, ore will be stored in one of two compartments; LGO Stockpile and LGO Stockpile Pile A. Ore will separated into each compartment by net smelter return grade with higher grade ore placed in LGO Stockpile Pile A which will be depleted by Year +15. Ore will continue to be stored in the LGO Stockpile until the ultimate LGO Stockpile[8] footprint will be reached by Year +18. Ore will be depleted at the end of Year +23.

3.5.5.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction, operation, decommissioning/ closure, and reclamation of the LGO Stockpile. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements include:

- Part 6.10 Dumps – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance is as follows:

- Mine Rock and Overburden Piles: Investigation and Design Manual – Interim Guidelines (BC MWRPRC 1991);
- Part 3 Mine Plan; Section 3.5.5 Waste Rock Dumps – JAIR (BC EMPR & BC ENV 2019a); and
- Part 3 Mine Plan; Section 3.5.7 Ore, Overburden, Soil, and Construction Stockpiles – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Key reports and other documentation is as follows:

- Blackwater Gold Project ML/ARD Management Plan (Lorax 2021) – Appendix 9-D;
- Condemnation Report of the Blackwater Project (Baker & Popelka 2021) – Appendix 3-G;
- Blackwater Gold Project Stockpiles Geotechnical and Water Management Design Report (KP 2021l) – Appendix 3-N;
- Blackwater Gold Project Assessment of Alternatives for Mine Waste Disposal (ERM 2021) – Appendix 3-M;
- Blackwater Gold Project Open Pit and Stockpile Design Report (MMTS 2021) – Appendix 3-C;
- Blackwater Gold Project 2019 Site Investigation Report (KP 2021b) – Appendix 3-D;
- Blackwater Gold Project 2020-2021 Site Investigation Report (KP 2021c) – Appendix 3-E;
- Blackwater Gold Project Geotechnical Characterization Report (KP 2013f); and
- Blackwater Gold Project Seismic Hazard Assessment (KP 2021g) – Appendix 2-E.

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[8] The LGO Stockpile compartment for lower grade ore becomes the entire LGO Stockpile after Year +13. Hence, this name for the compartment avoids having to change names after Year +13.

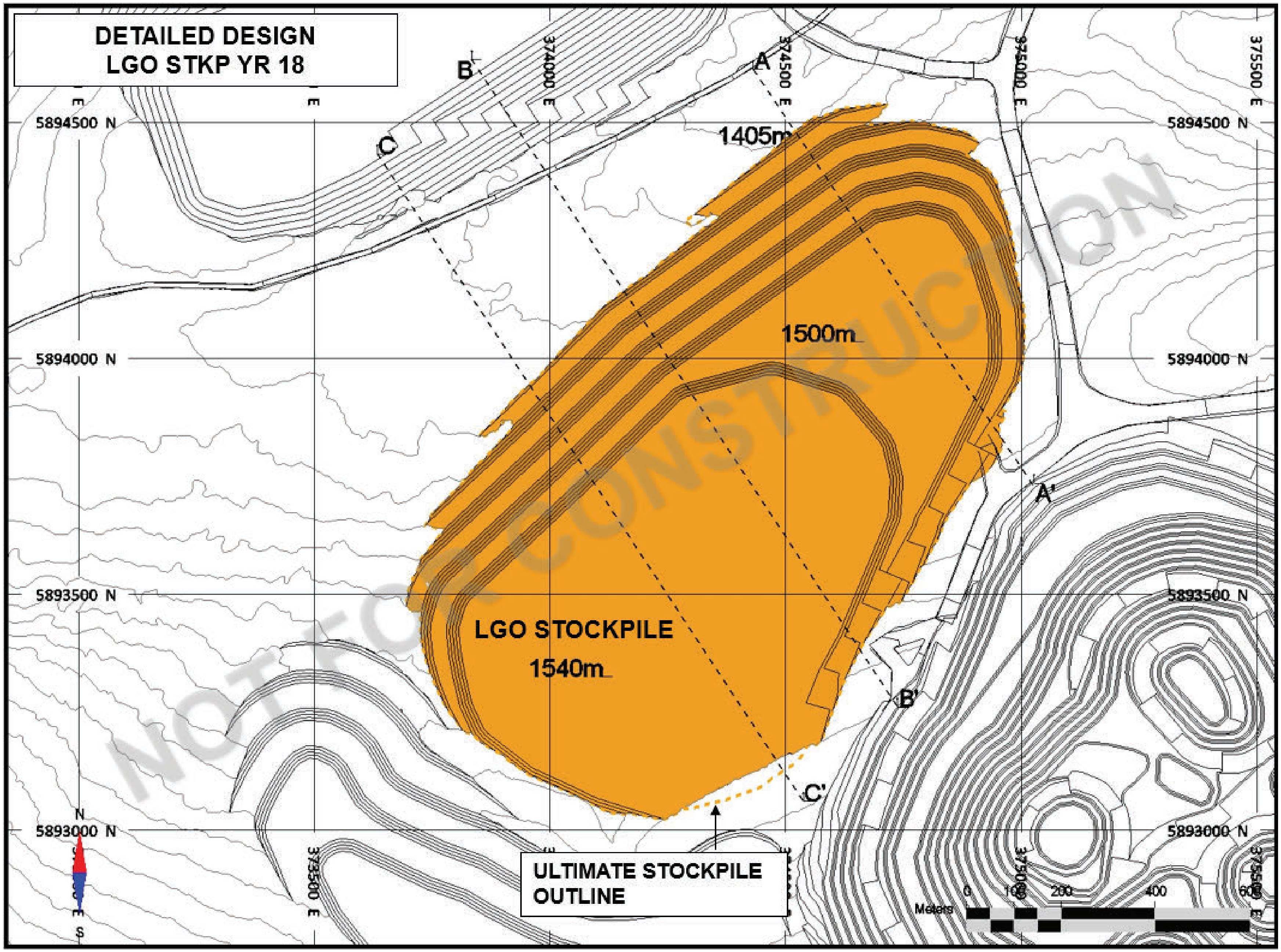


Figure 3.5-48: Maximum Build of Low Grade Stockpile

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

EAC Conditions

EAC conditions related to the design, construction, operation, closure, and reclamation of the LGO Stockpile include:

- Condition 33 (Mine Waste and Water Management Plan)

  "d) the management of ML/ARD from low grade ore stored on land during Operations, which must include placement of the ore on a low permeability foundation and collection, monitoring, and treatment of low grade ore contact water;

  e) a requirement that any remaining low-grade ore stockpile be backfilled into the pit or TSF at the end of Operations;"

3.5.5.3 Multiple Accounts Analysis

An alternative assessment of the LGO stockpile was also completed (separate from the tailings and NAG waste rock assessments; Appendix 3-M). The location of the LGO stockpile is based on the prior selection of the TSF location and the NAG waste stockpiles' location, such that the preferred locations for either was not available for the storage of low grade ore. Following the pre-screening assessment, two LGO ore candidate alternatives were deemed acceptable for further characterization:

- Candidate 1: North of the Open Pit; and
- Candidate 2: Northwest of the Open Pit.

Both candidate alternatives are located in the same general area (which would already be disturbed by the mine site) and utilize the same technology for their construction, operation, closure and post-closure therefore a full alternative characterization of the alternatives' environmental, technical, and socio-economic considerations was not deemed to be necessary. Following a qualitative comparison of the two candidates, Candidate 1 was preferred over Candidate 2 for all characteristics considered (with the exception of impact to fish habitat). Candidate 1 (LGO stockpile immediately north of the open pit) is the preferred location for the Project because it has better technical considerations (gentler slopes and ease of water treatment), meets design criteria, and is less costly than Candidate 2.

3.5.5.4 Condemnation Assessment

Condemnation of resources in the LGO Stockpile footprint were investigated with drilling programs described in *Condemnation Report of the* Blackwater *Project* (Appendix 3-G). The results of condemnation drilling were reinterpreted for the Project optimizations (Appendix 3-G), which confirmed there are no economically viable mineralization beneath the LGO Stockpile.

3.5.5.5 Geotechnical Characterization

Geotechnical characterization of stockpile foundation was developed from an extensive geotechnical database, which incorporates geological and geotechnical data from the 2012, 2013, and 2019 to 2021 site investigations to support the stockpile design (KP 2013f, Appendix 3-D and 3-E). Drill locations are shown in Figure 3.1 in Appendix 3-N.

The deglaciation model map and the terrain and landform maps indicate that the surficial material at the LGO Stockpile footprint is predominantly glacial (ablation) till to the north and glacial (lodgement) till to the south at higher elevations. A historical sub-glacial meltwater corridor was identified at the northern end of the footprint where it is inferred that a northeast-east trending channelized glaciofluvial unit comprising undifferentiated sands and gravels may be present. Additional geotechnical investigations will be required during construction to evaluate the nature, extent, and significance of this deposit.

Information from 20 test pits, 12 geotechnical drillholes, and 6 condemnation drillholes completed at the vicinity of the LGO Stockpile were used to provide a preliminary assessment of the foundation conditions as follows:

- **Topsoil**: Thickness ranging from 0.1 to 0.2 m with an average of 0.2 m based on 20 test pits.
- **Glacial Deposits**: Glacial sequences identified range in thickness from 4.1 to 75.0 m with an average of 23.1 m. The deepest deposit was intercepted in GT13-47 located at the norther end of the footprint.
  - **Glacial Till** – Ablation till is present at surface with a range of thickness from 2.1 to 9.2 m. Lodgement and undifferentiated till occur below at depth with interval thickness ranging from 0.9 to 37 m and an average of 12.5 m.
  - **Glaciofluvial Deposits** – Surficial non-channelized glaciofluvial (kame) deposits with thickness ranging from 1.8 to 4.0 m and average of 2.6 m. Subsurface channelized glaciofluvial materials were identified at depth with interval thickness ranging from 2.4 to 8.4 m with the deepest unit (11.9 mbgs) at the northeast toe of footprint.
  - **Glaciolacustrine Units** – One major occurrence was intercepted from drillholes GT13-24 and GT13-47 with an average interval thickness of 4.9 m and a top elevation range from 1,422 to 1,420 masl. Three other minor localized units were also identified and categorized in the following top elevation groups: 1,469-1,468 masl, 1,409-1,408, and 1,395-1,394 masl.
- **Reworked Regolith**: This unit was intercepted in GT13-23 with a thickness of 7.2 m at depth of 16 mbgs and in GT13-24 with a thickness of 23.0 m at depth of 50.0 mbgs.
- **Completely Weathered Bedrock**: This unit was intercepted in GT13-14 with a thickness of 3.6 m at depth of 23.5 mbgs and in GT13-28 with a thickness of 2.1 m at depth of 9.5 mbgs.
- **Highly Weathered Bedrock:** This horizon was intercepted in drillholes (GT13-24 and GT13-47), and test pits (TP13-163 and TP13-164) located at the northern half of the footprint with an elevation ranging from 1,455 to 1,355 masl. This unit was also intercepted at the eastern part of the footprint in drillhole GT19-03 at an elevation of 1,468 masl.
- **Intact Bedrock:** This unit was intercepted north of footprint in drillhole GT13-14 with an elevation of 1,404 masl. This unit was also intercepted at the eastern part of the footprint in drillholes GT19-03, GT19-08, and GT19-10 with an elevation ranging from 1,469 to 1,459 masl. Several condemnation drillholes resulted in a bedrock horizon elevation range between 1,485 to 1,354 masl. The bedrock lithology is anticipated to be variable with areas of Andesite, Felsic Tuff, Volcaniclastics, and Sediments. The bedrock at the Stockpile areas is variable but can generally described as a strong to very strong rock with 'FAIR' RMR^{89} Rating. A healed fault zone was intercepted at GT13-14 from 46.9 to 48.5 mbgs which is characterized as a weak rock unit with 'POOR' RMR^{89} Rating.

Groundwater tables in the LGO Stockpile area were found close to surface based on recent monitoring data measured from available standpipe piezometers. Standpipe piezometers installed in bedrock from GT13-23, GT13-24, and GT19-03 show a groundwater level range from 1.6 mbgs to 4.5 mbgs and groundwater elevation range from 1,446 to 1,469 masl based on readings in October 2020. One monitoring well MW12-02D/S and two vibrating wire piezometers in GT19-04 installed in the surficial material indicates a groundwater level range from 0.2 to 3.4 mbgs and groundwater elevation range from 1,403 to 1,478 masl based on readings in October 2020.

3.5.5.6 Seismicity and Other Geohazards

Seismicity information is incorporated in the determination of the WSR and classification of the hazard rating. Details of the seismicity for the mine site are presented in Appendix 2-E.

The potential risk to the mine site to other geohazards are discussed in Section 2.3.4 Natural and Seismic Hazards Assessments. In general, the overall risk to landslides and mass wasting, snow avalanches, flooding, subsidence, seismic events, and volcanic events is low.

3.5.5.7 Stockpile Stability Rating and Hazard Classification

The stability for stockpiles has been assessed using the WSRHC system (Hawley & Cunning 2017) for comprehensive dump stability assessments. The WSRHC system requires evaluation of 22 key factors or attributes that are considered to affect stability. These factors are organized into seven groups. Numerical ratings are assigned to each factor, and the sum of these ratings defines the WSR.

The maximum possible WSR is 100, with a higher rating indicating a more stable configuration. The WSR values are subdivided into several WHCs. Waste dumps or stockpiles with a very high WSR rating (more than 80) are assigned to WHC I and are characterized as presenting a relatively very low potential for instability (i.e., a very low instability hazard). Conversely, waste dump or stockpiles with a very low WSR rating (less than 20) are assigned to WHC V and are characterized as presenting a relatively very high potential for instability (i.e., a very high instability hazard).

The LGO Stockpile has a WSR of 46.5 and assigned a WHC of III, a moderate instability hazard. Details of the analysis and results are presented in Section 3.4 Stability Rating and Hazard Classification of Appendix 3-N.

3.5.5.8 Stockpile Stability Assessment

Detailed slope stability analyses for the LGO Stockpile using two-dimensional limit equilibrium analysis software SLOPE/W (GeoStudio 2021) was conducted to evaluate the estimated FoS against rotational failure modes. The Morgenstern-Price method was used to estimate the FoS for all models.

Critical slope sections were modelled for the Year +3 and Year +18 (Ultimate) configurations of the LGO Stockpile against deep-seated global slip surfaces. The maximum OSA of the LGO Stockpile is 19 degrees. All modelling sections incorporate groundwater at surface since there is a shallow groundwater table at the site. Details of the analysis and results are presented in Section 4.0 Stockpile Stability Assessment of Appendix 3-N.

Acceptance Criteria

The minimum FoS targets for the LGO Stockpile based on the waste dump design guideline (Hawely & Cunning 2017), Part 10 of the Code (EMLI 2021) and the CDA Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (CDA 2019) are as follows:

- Short term Static: 1.3 – Modelled for Year +3 configuration;
- Long term Static: 1.5 – Modelled for Year +18 (Ultimate) configuration;
- Pseudo-static: 1.1 – Modelled for Year +18 (Ultimate) configuration; and
- Post-earthquake: 1.2 – Modelled for Year +18 (Ultimate) configuration.

Characterization of Stockpile Fill and Foundation Soils

Ore Geochemistry

LGO is classified as PAG with a relatively short lag time, and the stockpile is expected to generate acidic drainage with elevated metals until the ore is processed. Details of the geochemical properties of ore rock are presented in 2.4.1.3 Geochemical Characterization.

Material Parameters for the Stockpile Fill and Foundation Soils

The following material parameters for the stockpile and foundation soils were incorporated into the stability analyses (Table 3.5.5-1).

Table 3.5.5-1: Foundation and Stockpile Material Parameters

Material	Unit Weight (kN/m^3)	Internal Friction Angle (degree)	Cohesion (kPa)	Undrained Shear Strength Ratio	
				Peak	Residual
Foundation					
Glacial (Ablation) Till	23	32	0	-	-
Glacial (Lodgement) Till	23	35	0	-	-
Glaciofluvial	23	35	0	-	-
Glaciolacustrine Unit	21	31	0	-	0.2
Reworked Regolith	21	37	0	-	-
Completely Weathered Bedrock	19	-	-	0.67	0.22
Highly Weathered Bedrock	20	15	0	-	-
Stockpile					
HDPE Geomembrane Liner	20	15	0	-	-
Ore	20	Lower bound Leps (1970) function			

Seismicity

A value of 0.021 gravity (g) was used as the horizontal ground acceleration (Kh) for the pseudo-static analysis. The suggested Kh value is the PGA value for the 1/475-year MDE.

Stockpile Stability Results

Factors of safety for Year +3 and Year +18 (Ultimate) for the LGO Stockpile were computed against deep-seated global slip surfaces. All modelling sections incorporate groundwater at surface since there is a shallow groundwater table at the site. Section 1 showing a deep-seated slip surface for the ultimate LGO Stockpile configuration is presented in Figure 3.5-49. The stability results are summarized in Table 3.5.5-2.

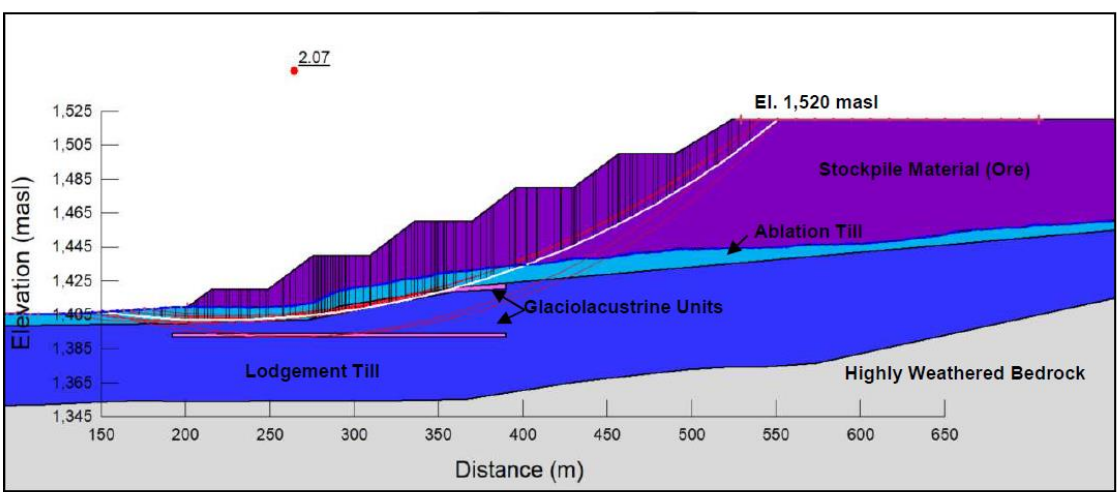


Figure 3.5-49: Low Grade Ore Stockpile Y+18 Deep Seated Failure Static Stability

Table 3.5.5-2: Low Grade Ore Stockpile Stability Results

Stage	Compartment	Section	Slope – Crest Elevation (masl)	Factor of Safety			Appendix 3-N Reference
				Static	Pseudo-static	Post-seismic	
Y+3	LGO Stockpile Pile A[5]	1	NW – 1,465	2.2	-	-	Figure C2.1 of Appendix C.2
	LGO Stockpile	2	NW – 1,500	2.6	-	-	Figure C2.2 of Appendix C.2
Target[1]				**>1.3**	**-**	**-**	
Y+18 Ultimate	LGO Stockpile	1	NW – 1,520	2.1	1.9	1.7	Figures C2.3 to C2.5 of Appendix C.2
		2	NW – 1,520	3.4	3.1	2.9	Figures C2.6 to C2.8 of Appendix C.2
Target[2,3]				**>1.5**	**>1.1**	**>1.2**	

Notes:
[1] *Minimum factors of safety for Year +3 static based on EMLI 2021.*
[2] *Minimum factors of safety for static and pseudo-static based on the requirements outlined in Hawely & Cunning 2017.*
[3] *Minimum factors of safety for post-seismic based on the requirements outlined in CDA 2019.*
[4] *Post-seismic case not applicable to underlying foundation soils.*
[5] *Compartment name in Appendix 3-C; Called "Sorted Higher – Grade Ore Stockpile" in Appendix 3-N.*

The stability analysis of the LGO Stockpile was evaluated and confirmed that the design meets the required FoS for the end of construction, static, long-term static, pseudo-static, and post-seismic loading conditions.

3.5.5.9 Planned Storage Capacity

The design capacity is 111.1 Mt with a 51.4 million loose cubic metres.

3.5.5.10 Design Standards

The LGO Stockpile will be built by bottom-up construction with six 20 m lifts. To support the storage capacities, Table 3.5.5-3 identifies the design standards.

Table 3.5.5-3: Low Grade Ore Stockpile Design Standards

Parameter	Value
Typical waste rock stockpile lift height (m)	20
Slope on each lift (degrees)	1.3H:1V
Overall slopes once berms and ramps are accounted	3H:1V

3.5.5.11 Construction

The Construction phase includes:

- site preparation;
- boulder rollout catchberms;
- access roads; and
- water management infrastructure.

Site Preparation

In order to ensure good ground contact between ore and geotechnically competent surficial materials, a number of steps are required during construction. *Mines Act* Permit M-246 (Early Works) authorizes logging of the LGO Stockpile foundation. In general, site preparation will include:

- Additional logging of ultimate footprint of the LGO Stockpile that is not included in *Mines Ac*t Permit M-246.
- Stripping, salvaging and stockpiling of mineral soils and organics in accordance with the Soil Management Pan (Appendix 9-B).
- Inspection of the final foundation footprint by a qualified geotechnical engineer prior to material placement. Any unsuitable materials will be removed from the footprint areas prior to liner system construction and placement of ore at the stockpile.

Boulder Rollout Catchberms

Prior to placement of each stockpile lift, a rollout catch berm will be constructed along the toe of the lift and will be constructed from run-of mine waste.

Access Road Construction

Detailed drawings of access road cut and fill designs are presented in Section 7 Mine Haul Road Designs of Appendix 3-C.

Water Management Structures

The water management design for the LGO Stockpile includes a liner system across the footprint area of the stockpile, foundation drains and a series of diversion and collection channels to manage runoff and seepage. The design intent is to divert non-contact water around the facility to natural drainages that flow to the WMP and to collect contact water at the LGO Collection Pond. Contact water will then be pumped to the process plant for lime neutralization (see Appendix 3-F) before being discharged along with tailings to the TSF. The LGO Stockpile will be developed progressively as mining progresses. Details of the water management system for the LGO Stockpile are presented in the Stockpiles Geotechnical and Water Management Design Report in Appendix 3-N.

The detailed design of LGO Stockpile water management system was completed for the initial development area, which allows for LGO stockpiling through approximately Year +3, depending on LGO mining rates during early operations. Further design will be required to accommodate the final extent of the stockpile in the later stages of mining, which will be informed by conditions encountered during development of the initial works described in this report and by completing additional site investigation work thereafter, if required.

Non-contact water will be collected in diversion channels upstream of the LGO Stockpile and conveyed around the facility to the east and west using a combination of constructed channels and existing drainage channels.

Contact water will be collected and conveyed via collection channels and foundation drains (located below the glacial till liner) to the LGO Collection Pond at the downstream toe of the LGO Stockpile. Groundwater (springs) discharging to the foundation drains will also be collected and conveyed to the LGO Collection Pond. Contact water collected in the LGO Collection Pond is expected to be acidic due to the PAG nature of the LGO. High-density polyethylene (HDPE) geomembrane liner will be used in areas where flows are concentrated or ponding is expected, such as the collection channels and pond.

A compacted glacial till (Zone S) liner is utilized below the stockpile itself to limit the potential for lost seepage and to enhance contact water collection where limited ponding is expected.

The LGO Collection Pond will manage seepage and storm water inflows and will utilize a pumping system to convey the recovered flows to the process plant. The pond will be maintained in a dewatered condition to the maximum practical extent to limit the potential for discharge of untreated water to the WMP during severe storms.

Details of the water management system for the LGO Stockpile are presented Section 5.0 of the Stockpiles Geotechnical and Water Management Design Report in Appendix 3-N.

Design Criteria

Design criteria were developed for the LGO Stockpile and associated water management infrastructure to facilitate the preparation of designs. The water management systems will be constructed during Year -1 prior to ore stockpiling. It is anticipated the LGO Collection Pond will be drained and decommissioned, and the embankment breached and reclaimed during the active mine closure period, once the LGO has been processed and footprint area reclaimed.

The design criteria for the contact water management structures is the 1-in-200-year, 24-hour return storm event. The non-contact water diversion channels have been sized to pass the 1-in-10-year, 24-hour storm with 300 mm of freeboard and the 1-in-200-year, 24-hour storm event with no freeboard.
The design floods were estimated using the return period peak flow results presented in Appendix 2-B.

Diversion and Collection Channels

Non-contact water diversion channels are located along the southern edge of the facility to divert stormwater around the facility. The channels include erosion protection for the underlying in-situ foundation materials during storm events. The east non-contact diversion channel has a gravity towards the east via a culvert under the primary mine haul road. The west non-contact diversion channel has a gravity discharge to the mine area creek, which flows towards the WMP. The non-contact diversion channels will be relocated as the LGO Stockpile footprint expands.

Contact water collection channels will convey runoff and seepage from the LGO Stockpile to the LGO Collection Pond. The channels will be lined with HDPE geomembrane or impermeable material equivalent to minimize seepage. The design includes two key contact diversion channels, one located along the western and northern edge of the facility and a second located along the eastern edge of the facility.

The design parameters for non-contact and contact water channels are presented in Table 3.5.5-4. Figure 3.5-50 presents the layout of the water management system. Details for design parameters are presented in Appendix 3-N.

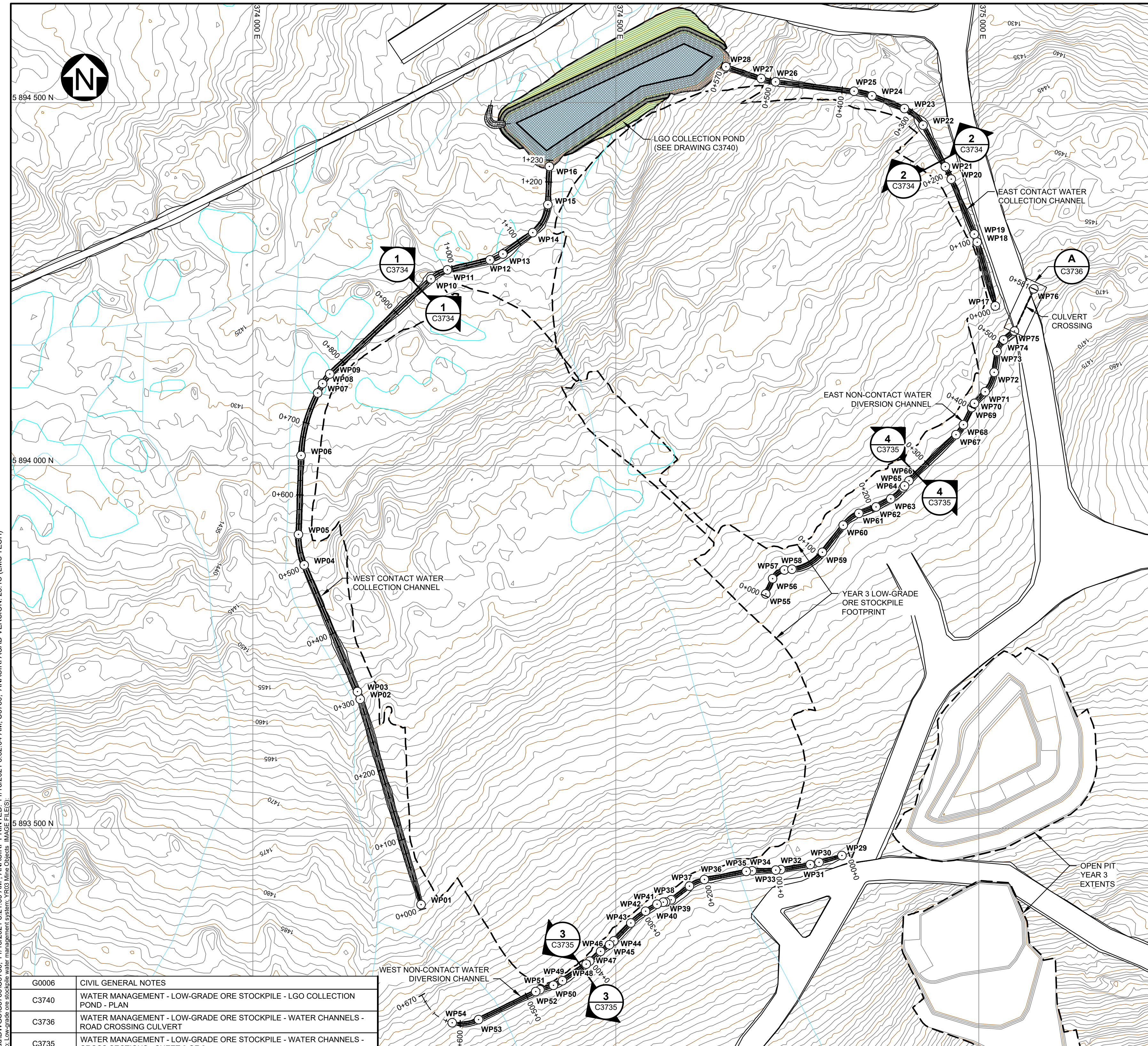
LGO Collection Pond

The LGO Collection Pond will be formed using cut and fill techniques to form the storage basin of the pond and will use the natural topography, where practical. The primary outlet will be a pump and pipeline to the process plant lime neutralization circuit. The secondary outlet is an emergency spillway which discharges to the mine area creek, which flows towards the WMP.

The LGO Collection Pond will be constructed downslope of the LGO Stockpile area to manage runoff and seepage from the contributing areas. The LGO Collection Pond will be constructed in Year -1 prior to ore stockpiling. Potential seepage through the till liner and groundwater recharge will be collected in the foundation drains and conveyed to the LGO Collection Pond.

Table 3.5.5-4: Low Grade Ore Stockpile Diversion Channels Design Parameters

Structure	Section	Design Life	Catchment Area (ha)	Side Slopes	Width (mm)	Depth (mm)	Flow Rate (m^3/s)	Velocity (m/s)	Ave. Gradient (m/m)	Erosion Protection
Non-contact water diversion channels	West	Y-1 to Y+3	10.9	2H:1V	1,000	800	0.5	2.0	0.005	Riprap Bedding
	East		10.6					2.3	0.005	Riprap D_{50} 150 mm
Contact water collection channels	West	Y-1 to Closure	67.2	2H:1V	1,500	1,000	3.4	3.3	0.05	HDPE Geomembrane Liner
	East		9.3				1.2	2.5	0.08	HDPE Geomembrane Liner



PLAN

WATER MANAGEMENT SYSTEM

SCALE A

CONTACT WATER WEST CHANNEL WORK POINTS

POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP01	374231.8	5893394.9	1478.6
WP02	374147.9	5893677.8	1454.2
WP03	374144.2	5893688.3	1453.3
WP04	374070.6	5893862.6	1440.3
WP05	374062.8	5893904.9	1437.8
WP06	374066.5	5894013.5	1431.8
WP07	374089.3	5894099.8	1427.9
WP08	374096.1	5894112.7	1427.3
WP09	374106.1	5894125.8	1426.6
WP10	374245.4	5894257.0	1421.4
WP11	374268.2	5894269.3	1420.1
WP12	374326.7	5894283.1	1418.8
WP13	374344.4	5894291.2	1418.6
WP14	374385.7	5894320.8	1417.8
WP15	374406.5	5894359.4	1414.9
WP16	374408.5	5894411.9	1411.6

CONTACT WATER EAST CHANNEL WORK POINTS

POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP17	375023.0	5894219.5	1460.6
WP18	374997.9	5894307.4	1453.1
WP19	374994.0	5894318.6	1452.3
WP20	374962.2	5894394.4	1444.6
WP21	374954.1	5894411.6	1443.3
WP22	374923.4	5894468.8	1436.1
WP23	374897.6	5894491.8	1432.0
WP24	374852.9	5894509.3	1430.8
WP25	374828.3	5894515.5	1430.2
WP26	374720.2	5894528.6	1420.8
WP27	374700.3	5894533.1	1417.8
WP28	374652.0	5894549.3	1412.9

NON-CONTACT WATER WEST CHANNEL WORK POINTS

POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP29	374811.7	5893462.5	1503.0
WP30	374780.2	5893452.9	1501.2
WP31	374767.9	5893450.0	1501.2
WP32	374727.5	5893443.0	1501.0
WP33	374720.4	5893442.3	1500.9
WP34	374688.0	5893441.4	1500.8
WP35	374679.8	5893440.5	1500.7
WP36	374622.1	5893429.4	1500.4
WP37	374601.5	5893420.2	1500.3
WP38	374576.5	5893401.5	1500.2
WP39	374568.7	5893398.5	1500.1
WP40	374565.6	5893398.3	1500.1
WP41	374556.8	5893395.4	1500.0
WP42	374541.0	5893385.7	1500.0
WP43	374520.9	5893369.5	1499.8
WP44	374497.3	5893344.8	1499.7
WP45	374491.4	5893339.6	1499.6
WP46	374479.1	5893330.2	1499.5
WP47	374464.3	5893316.8	1499.4
WP48	374459.3	5893312.8	1499.4
WP49	374426.5	5893290.0	1499.2
WP50	374414.0	5893283.7	1499.1
WP51	374395.7	5893277.4	1499.0
WP52	374389.7	5893275.0	1499.0
WP53	374311.1	5893236.3	1498.6
WP54	374274.8	5893232.0	1498.4

NON-CONTACT WATER EAST CHANNEL WORK POINTS

POINT NO.	EASTING	NORTHING	ELEVATION (m)
WP55	374706.8	5893822.8	1468.3
WP56	374716.0	5893844.0	1467.1
WP57	374732.4	5893855.9	1467.0
WP58	374742.9	5893857.0	1466.9
WP59	374784.6	5893880.2	1466.7
WP60	374813.3	5893917.6	1466.5
WP61	374835.1	5893933.8	1466.3
WP62	374858.5	5893942.8	1466.2
WP63	374878.9	5893953.8	1466.1
WP64	374896.2	5893969.2	1466.0
WP65	374898.0	5893971.8	1465.9
WP66	374904.0	5893978.8	1465.9
WP67	374968.9	5894042.4	1465.4
WP68	374978.9	5894056.1	1465.4
WP69	374990.4	5894079.7	1465.2
WP70	374994.3	5894085.5	1465.2
WP71	375008.9	5894101.6	1465.1
WP72	375021.3	5894128.2	1464.9
WP73	375025.3	5894156.9	1464.8
WP74	375034.3	5894172.9	1464.7
WP75	375049.3	5894185.1	1466.0
WP76	375076.0	5894243.2	1463.5

LEGEND:

- MINE WATER
- FILL AREAS
- CUT AREAS
- WP01 WORK POINT

NOTES:

1. FOR GENERAL NOTES SEE DWG. G0006.
2. FOR CONTACT WATER CHANNEL PROFILES SEE DWG. C3732.
3. FOR NON-CONTACT WATER CHANNEL PROFILES SEE DWG. C3733.

DETAILED DESIGN
NOT FOR CONSTRUCTION

SCALE A: 60 30 0 100 200 300 m

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BLACKWATER GOLD PROJECT

WATER MANAGEMENT
LOW-GRADE ORE STOCKPILE
PLAN
YEAR -1

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C3730	0

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
G0006	CIVIL GENERAL NOTES
C3740	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - LGO COLLECTION POND - PLAN
C3736	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - WATER CHANNELS - ROAD CROSSING CULVERT
C3735	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - WATER CHANNELS - CROSS SECTIONS - SHEET 2 OF 2
C3734	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - WATER CHANNELS - CROSS SECTIONS - SHEET 1 OF 2
C3733	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - NON-CONTACT WATER CHANNELS - PROFILES
C3732	WATER MANAGEMENT - LOW-GRADE ORE STOCKPILE - CONTACT WATER CHANNELS - PROFILES

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	16NOV'21	ISSUED FOR PERMITTING	KAB	ABN/RAF		

SAVED: M:\1\01\00457\33\A\Acad\DWGS\C3730\C3730, 11/16/2021 8:21:00 AM, ANASIRI PRINTED: 11/16/2021 8:32:04 AM, C3730, ANASIRI ACAD VERSION: 23.1S (LMS TECH)
XREF FILE(S): Topo 1m contours; Hydro; Low-grade ore stockpile water management system; VR03 Mine Objects; IMAGE FILE(S):

Figure 3.5-50: Low Grade Ore Stockpile Water Management Structures

Source: Knight Piésold Consulting (2021l; Appendix 3-N).

The LGO Collection Pond was designed with a crest elevation of 1,411 masl. The base elevation is at an average of approximately 1,405 masl. The natural ground elevation at the downstream toe of the pond is at approximately 1,400 masl resulting in a maximum embankment height of approximately 11 m. The design includes external slopes graded at 2.5H:1V and internal slopes graded at 3H:1V. The full containment footprint will be lined with HDPE geomembrane liner. The total water storage capacity of the pond at the invert level of the spillway (i.e., 1,410 masl) is 73,000 m^3. The LGO Collection Pond was designed to contain continuous seepage and runoff from events up to the 1-in-200-year, 24-hour storm assuming it is maintained dewatered to the maximum practicable extent. Larger storm inflows in excess of the 1-in-200-year, 24-hour return period storm event will be managed by an emergency spillway constructed in the northwestern corner of the pond that discharges into the adjacent natural creek. Stability analysis for the contact water pond embankments is detailed in Section 5.6.4 Stability in Appendix 3-N.

The stored water volume will be managed via a combination of pumping and gravity flow systems to maintain dam safety. The pumping systems will provide the primary control of water level on a day-to-day basis. The system includes a shore mounted pump with sufficient capacity to allow the drawdown of the contact water pump in approximately 10 days.

Water collected in the LGO Collection Pond will be pumped up to the lime neutralization circuit at the process plant. The pumping system will consist of one operating shore-mounted end-suction centrifugal pump, and one uninstalled spare unit, providing a total design head of 70 m at a flowrate of 97 L/s. The system will be controlled via a level control float system, or equivalent, and will operate for the life of the mine. The pipeline will consist of ND 300 mm DR17 HDPE pipe. The pumping system and pipeline was designed for the initial configuration described above, and additional design work may be required for future configurations.

The pumps will be located on the crest of the LGO Collection Pond at an elevation of approximately 1,411 masl. The pumps will draw water through the suction hose with an intake elevation of 1,405.5 masl which is equal to the minimum operating water level of the pond. There is approximately 0.5 m dead storage depth within the pond to prevent suction of sediment from pond bottom. All system components, including pumps, pipe, valves, fittings, and instrumentation, will be equipped with weather protection in the form of insulation and heat tracing or weatherproof enclosures, except for free-draining sections of the pipeline, which do not require weather protection.

The parameters for the LGO Collection Pond and associated water management structures for the LGO Stockpile are presented in Table 3.5.5-5. Additional design details are presented in Appendix 3-N.

Liner System Design

The LGO liner system will incorporate two types of low permeability liners, including compacted glacial till and HDPE geomembrane, which will limit seepage entering the groundwater by providing physical separation and promoting drainage to the contact water collection channels. The footprint area will be graded to promote drainage within the stockpile to the contact water collection channels and LGO Collection Pond to reduce infiltration/stormwater ponding. Runoff from the LGO Stockpile will be the highest during initial development of the stockpile, when there is minimal attenuation through the LGO and portions of the stockpile footprint are exposed.

The liner system for the LGO stockpile will comprise a 1.0 m thick, compacted earthen glacial till liner across the stockpile footprint area constructed using locally available glacial till material. The till liner material will meet the Zone S material specifications (see Section 3.5.3.8) producing a relatively low permeability subgrade comprised of gravels, sands, silts, and clays. Alternative lining methodologies may be evaluated following additional geotechnical investigations prior to and during construction, which will be performed to verify that ground conditions are consistent with design assumptions. The till liner will be graded to convey surface runoff to the collection channels.

Table 3.5.5-5: Low Grade Ore Stockpile Contact Water Pond and Support Structures Design Parameters

Structure	Parameters	Value
Contact water pond	Capacity (m^3)	73,000
	Freeboard (mm)	500
	Crest elevation (masl)	1,411
	Embankment height (m)	11
	Crest width (m)	5
	Dead storage depth (m)	0.5
Spillways	Peak design flow (m^3/s)	3.5
	Freeboard (mm)	500
	Base width of trapezoid channel (mm)	5,000
	Depth (mm)	1,000
	Minimum grade (%)	1
Pumping and pipeline system	Pumping rate (L/s)	97
	Pump total design head (m)	70

An HDPE liner will be installed where water ponding or concentrated flows are expected. Generally, the HDPE will be installed within the contact water collection channels and at the LGO Collection Pond. The HDPE liner is designed with a 1,000 mm overlap with the till liner to minimize water loss as flows are conveyed from the stockpile foundation into the collection channels.

The foundation drains will be constructed at topographic low points using engineered fill material underneath the till liner. The foundation drains will be located to collect potential seepage through the till liner and limit development of groundwater pressures below the liner. The foundation drains are designed to be wrapped in geotextile to reduce the potential for fines from the till liner (Zone S) migrating into the coarser-grained foundation drain materials. The foundation drains will convey the collected water to the contact water channels and hence to the LGO Collection Pond.

3.5.5.12 Operation

The stockpile and reclaim schedules for the LGO Stockpile and LGO Stockpile Pile A compartments are presented in Table 3.5.5-6. Details of the development of the LGO Stockpile including plan views and cross-sections are provided in Section 6 Low Grade Ore Stockpile Designs and Section 8.3 LGO Stockpile End-of-period of Appendix 3-C.

Stockpile and Reclaim Schedules

Low Grade Ore Stockpile Pile A

Higher grade ore will be directed to LGO Stockpile Pile A starting in Year -1 and to the end of Year +5. Delivery tonnages will vary from 1.9 to 2.7 Mtpa over from Year +1 to Year +5. LGO Stockpile Pile A will store 11.5 Mt until the end of Year +9. Thereafter, this ore will be reclaimed until depletion at the end of Year +15.

An initial lift will be developed in Year -1 starting at 1,430 masl (Figure 3.5-51) with subsequent lifts at 1,420, 1,440, 1,460, 1480, and 1,500 masl. The LGO Stockpile Pile A will exist as a separate compartment until at least Year +8 (Figure 3.5-52). By Year +13, the LGO Stockpile will be expanded and combined with the LGO Stockpile Pile A into single contiguous pile (Figure 3.5-53).

Table 3.5.5-6: Low Grade Ore Stocking and Reclaim Schedule

Year	Directed to LGO Stockpile Pile A (Mt)	Cumulative to LGO Stockpile Pile A (Mt)	Directed to LGO Stockpile (Mt)	Cumulative to LGO Stockpile (Mt)	Reclaimed from LGO Stockpile Pile A (Mt)	Reclaimed from LGO Stockpile (Mt)	Reclaim from LGO Stockpile per Annum (Mt)
LoM	11.5	0.0	113.8	125.3	11.5	113.8	125.3
Year -2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Year -1	0.1	0.1	0.4	0.4	0.0	0.0	0.0
Year +1	2.0	2.1	4.4	4.7	0.0	0.0	0.0
Year +2	2.5	4.5	5.7	10.5	0.0	0.0	0.0
Year +3	1.9	6.4	5.2	15.6	0.0	0.0	0.0
Year +4	2.3	8.8	6.5	22.2	0.0	0.0	0.0
Year +5	2.7	11.5	7.4	29.6	0.0	0.0	0.0
Year +6	0.0	11.5	7.5	37.1	0.0	0.0	0.0
Year +7	0.0	11.5	9.1	46.1	0.0	0.0	0.0
Year +8	0.0	11.5	13.5	59.6	0.0	0.0	0.0
Year +9	0.0	11.5	15.5	75.1	0.0	0.0	0.0
Year +10	0.0	9.5	13.2	88.2	2.0	0.0	2.0
Year +11	0.0	9.5	4.4	92.7	0.0	0.0	0.0
Year +12	0.0	9.5	3.7	96.3	0.0	0.0	0.0
Year +13	0.0	4.5	2.2	98.5	5.0	0.0	5.0
Year +14	0.0	0.5	3.4	101.9	4.0	0.0	4.0
Year +15	0.0	0.0	5.3	106.7	1.0	0.0	1.0
Year +16	0.0	0.0	4.4	111.1	0.0	0.0	0.0
Year +17	0.0	0.0	2.2	105.3	0.0	8.0	8.0
Year +18	0.0	0.0	0.0	87.5	0.0	17.8	17.8
Year +19	0.0	0.0	0.0	67.5	0.0	20.0	20.0
Year +20	0.0	0.0	0.0	47.5	0.0	20.0	20.0
Year +21	0.0	0.0	0.0	27.5	0.0	20.0	20.0
Year +22	0.0	0.0	0.0	7.5	0.0	20.0	20.0
Year +23	0.0	0.0	0.0	0.0	0.0	7.5	7.5

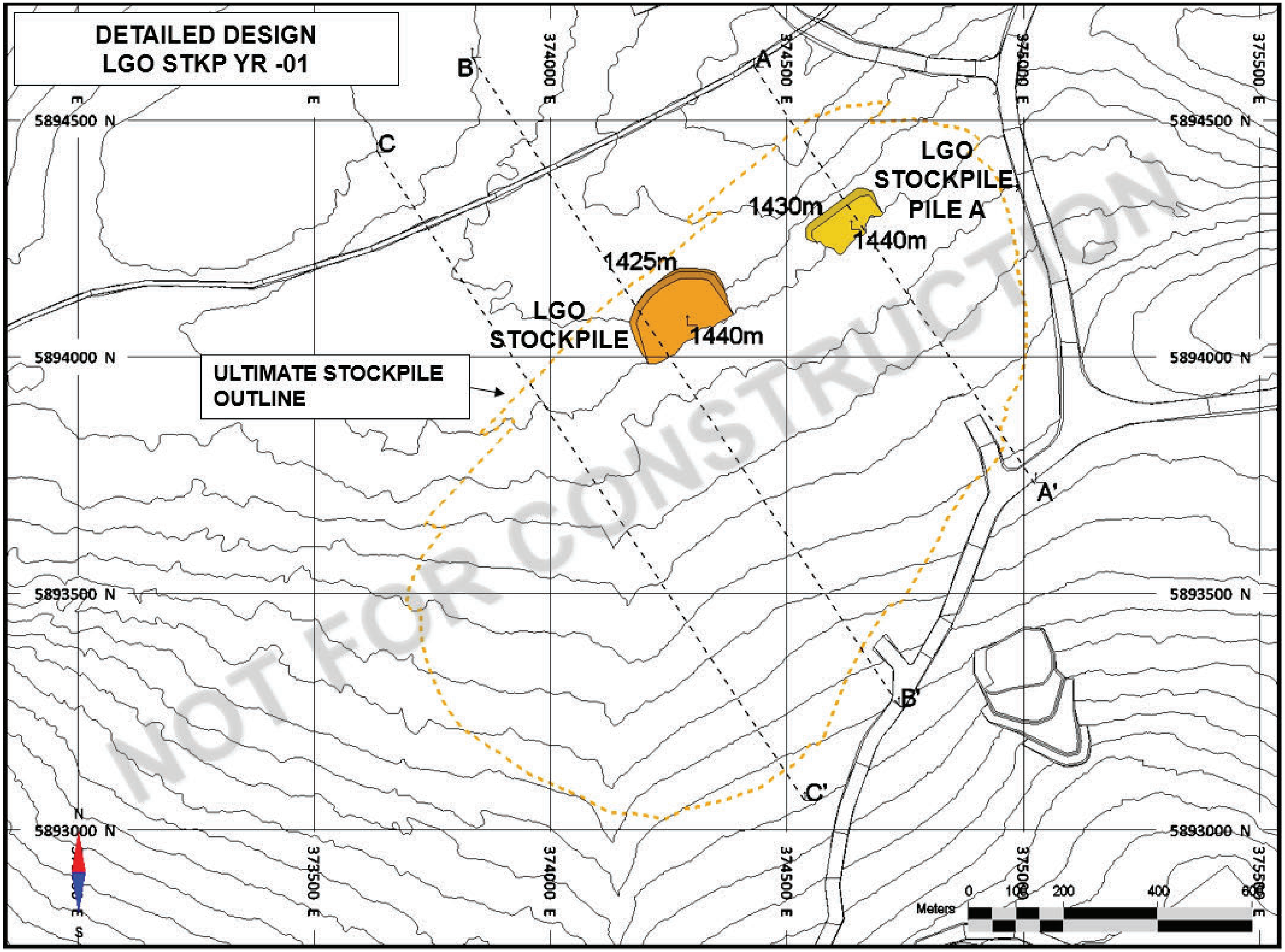


Figure 3.5-51: Plan View of Low Grade Ore Stockpile Year -1

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

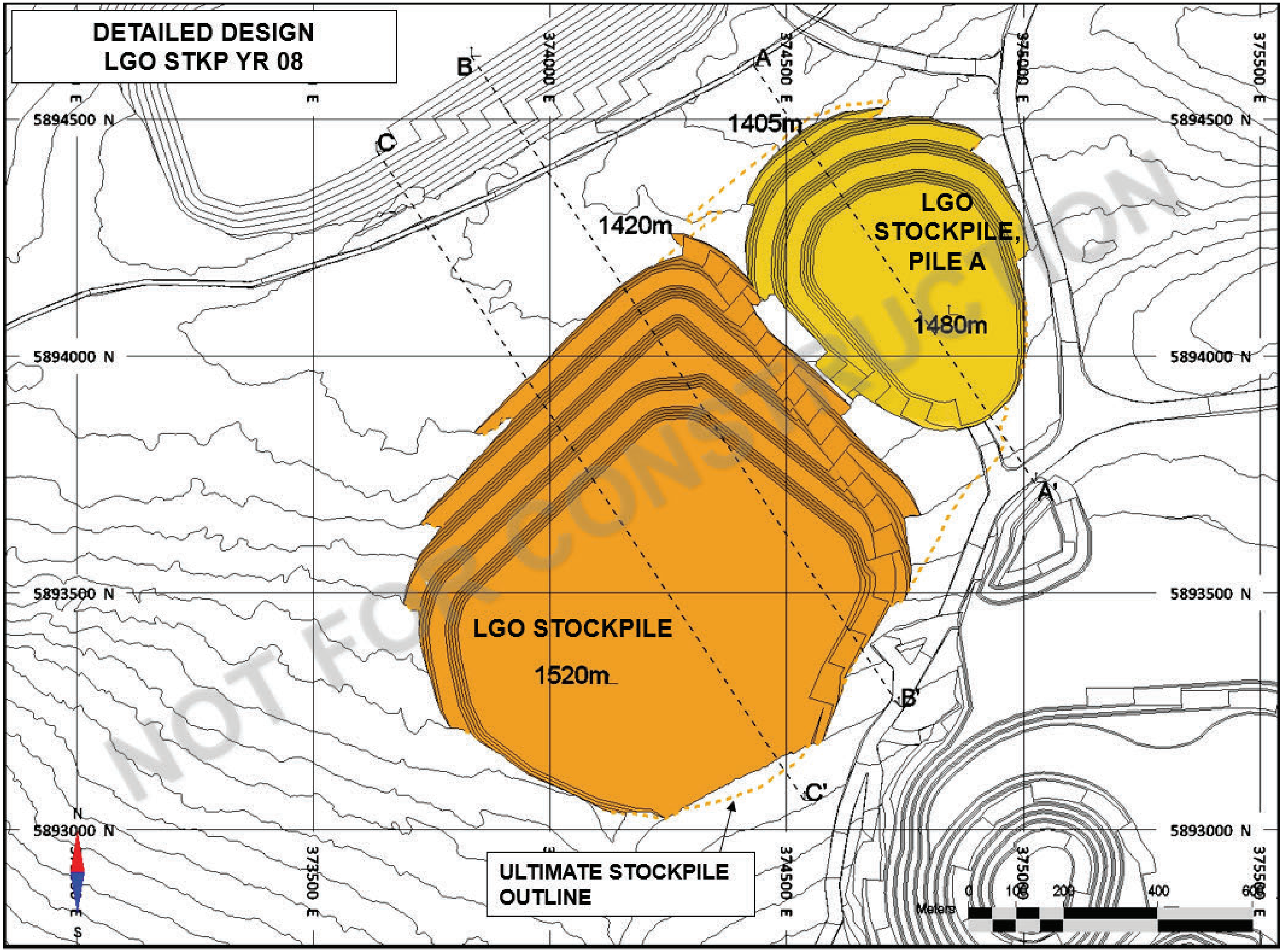


Figure 3.5-52: Plan View of Low Grade Ore Stockpile Year +8

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

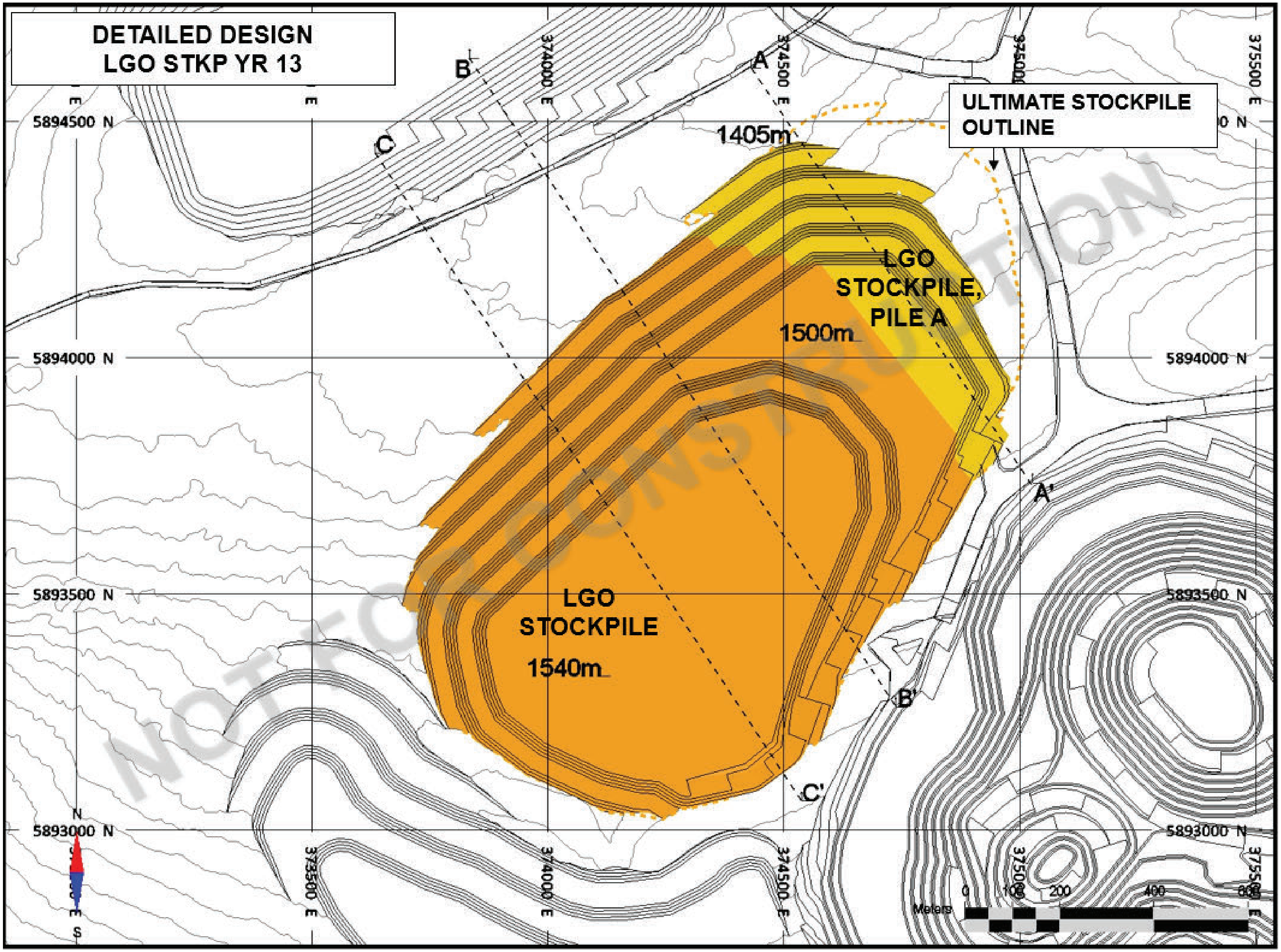


Figure 3.5-53: Plan View of Low Grade Ore Stockpile Year +13

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

Low Grade Ore Stockpile

Lower grade ore will be directed to LGO Stockpile also starting in Year -1 and to the end of Year +17 with the completion of mining operations at the Open Pit. Delivery tonnages will vary from 12.2 to 15.5 Mtpa. At the peak, LGO Stockpile will store 111.1 Mt of low grade ore in Year +16. Thereafter, this ore will be reclaimed until the end of Year +23.

An initial lift will be developed in Year -1 starting at 1,425 masl (Figure 3.5-51) with subsequent lifts at 1,420, 1,440, 1,460, 1,480, 1,500, and 1,520 masl. The maximum build will be in Year +16. LGO Stockpile will be depleted by Year +23 (Figure 3.5-54).

3.5.5.13 Monitoring

Stockpile monitoring will include visual inspection and instrumentation as deemed required. A detailed monitoring and management plan will be developed prior to active stockpiling operations, which will employ appropriate status and monitoring sign off sheets. The plan will include preliminary locations, installation schedules, monitoring frequency, and initial threshold response criteria for all proposed instrumentation. The monitoring plan will be updated periodically as required.

3.5.5.14 Closure and Post-closure

Ore from the stockpile will be depleted by the end of Year +23 and the foundation of the LGO Stockpile will be exposed and be at the same level as it was prior to stockpiling ore (Figure 3.5-54). Closure activities will start in Year +24 with reclamation in Year +25.

At the Closure phase, the following activities will be undertaken:

- Removal all equipment, debris, signage, culverts, power lines, etc. will be removed;
- HDPE geomembrane liner will be removed and disposed of appropriately;
- Till liner will be ripped and removed and deposited in the Pit Lake or the TSF C Pond;
- Surface recontoured to facilitate drainage and to support topsoil placement;
- Non-contact and contact water management systems will be decommissioned;
- Revegetation in accordance with the end land use objectives; and
- Monitoring and reporting of reclamation success, as required.

Details of closure and reclamation of the ore stockpile are presented in Section 4.7.5 Low Grade Ore Stockpile.

3.5.6 Water Management Structures

3.5.6.1 General Description

The principal design objectives for the water management structures for the Project are to manage surface water during mine operations and active closure. Surface water is to be managed in a manner that allows for the beneficial use of the water to support mine operations and to divert flows not needed to the downstream receiving environment. The design of the water management structures has taken into consideration the following requirements:

- Temporary and secure storage of fresh water within the mine site area in engineered water storage facilities.
- Limit accumulation of surplus water within the TSF to the maximum practicable extent.

- Control, collect, and divert non-contact surface water flows not needed for mine operations.
- Control and collect contact surface water prior to use/release.
- Controlled release of surface water flows to Davidson Creek downstream of the mine meeting IFN to reduce the potential environmental impacts of the project to the extent reasonably practicable.
- The inclusion of monitoring features to confirm performance goals are achieved and design criteria and assumptions are met.
- Staged development of the facilities over the life of the Project as the disturbed mine site areas change.

Water management plans were developed by identifying the size and position of the planned mine site facilities and establishing estimated catchment area boundaries based on the mine site development concept. Drainage from the majority of the mine area flows by gravity into the TSF, following natural topographical drainages mapped for the project; which simplifies water management, spill control, and mine closure. Mine-affected runoff within the project area will be captured and recycled for use as process water. Surplus water not required to support mine operations will be sampled and analyzed, comparing to applicable water quality criteria and, if compliant, will be used to augment flow in lower Davidson Creek.

The specific water management structures and systems described in this section are listed below.

- Freshwater diversion systems, including:
  - Central Diversion System (Year -1, relocated in Year +6), and
  - Northern Diversion System (Year +6);
- Water management pond (WMP);
- Freshwater reservoir (FWR); and
- Freshwater supply system (FWSS).

A simplified general arrangement of water management and diversion structures is provided in Figure 3.5-55.

Collection and diversion systems that drain specific features such as the Open Pit dewatering system (Section 3.5.1.9 Open Pit Water Management) are included in the descriptions of those sections. Similarly, water management of the TSF during construction and operations is included in Section 3.5.3 Tailings Storage Facility and Associated Infrastructure. Water treatment after closure of the Open Pit and Closure and Post-closure phases of the mine site will be discussed in Chapter 4 Closure and Reclamation and Chapter 5 Modelling, Mitigation and Discharges. Appendix 9-E includes the Mine Site Water and Discharge Monitoring and Management Plan.

Design reports of the water management and diversion structures can be found in:

- Water Management Structures Detailed Design Report (KP 2021k) – Appendix 3-O;
- Tailings Storage Facility - Life of Mine Design Report (KP 2021i) – Appendix 3-K; and
- Fresh Water Supply System Design Report (KP 2021m) – Appendix 3-P.

3.5.6.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction, operation, decommissioning/ closure, and reclamation of the water management and diversion structures. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

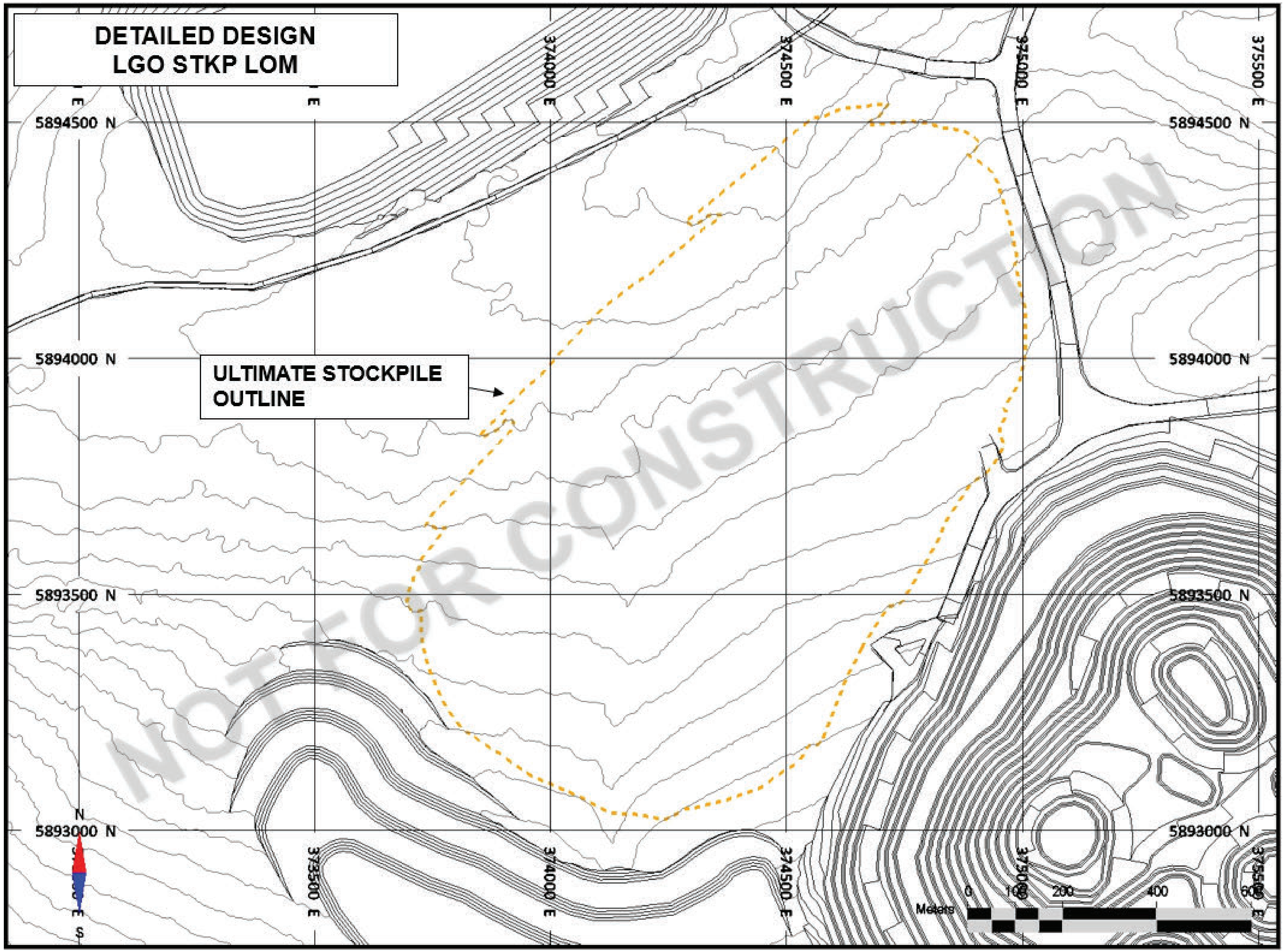


Figure 3.5-54: Plan View of Low Grade Ore Stockpile after Year +23 in the Closure Phase

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

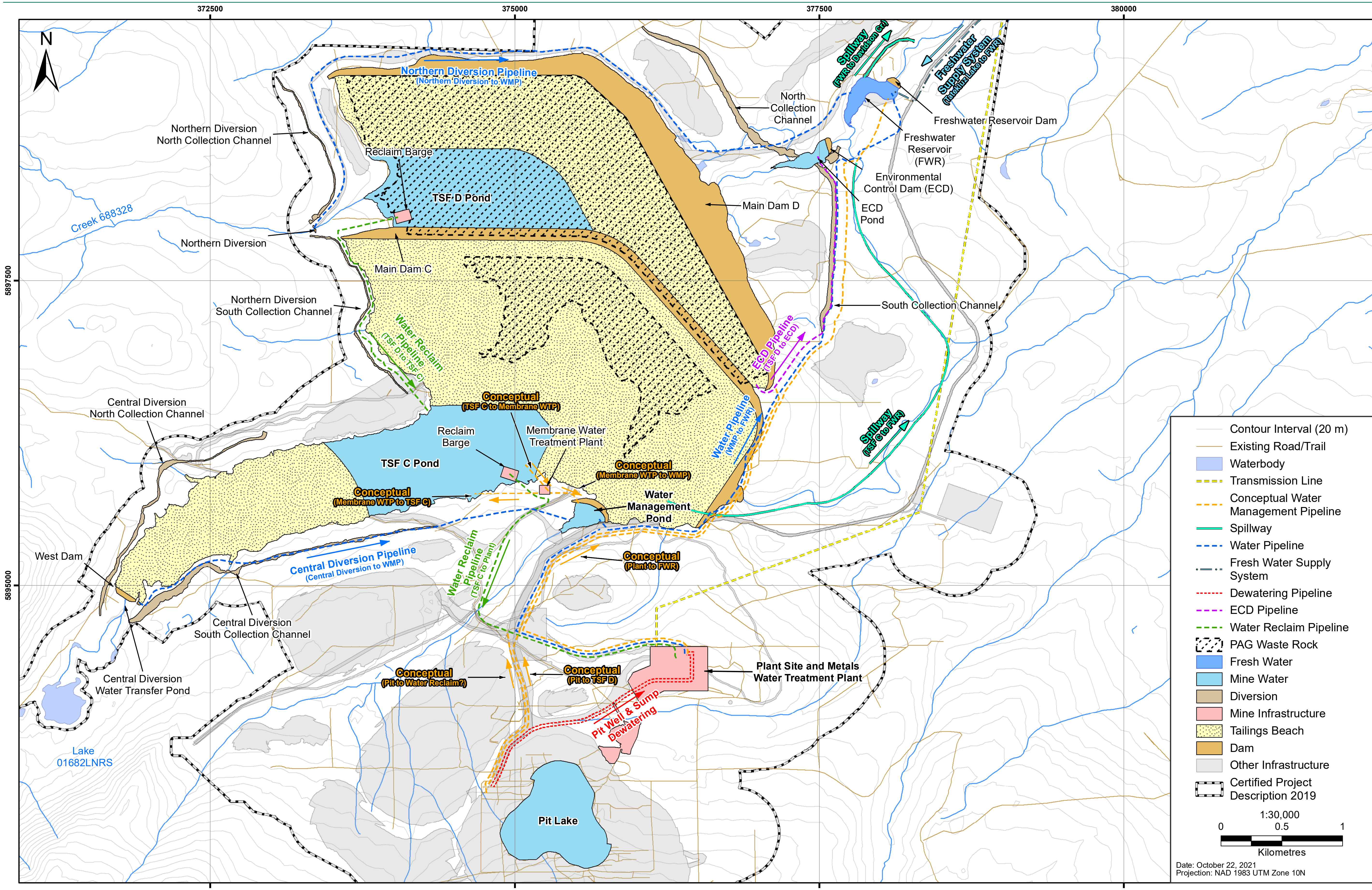


Figure 3.5-55: Simplified General Arrangement of Water Management and Diversion Structures

Regulatory Framework

Regulatory requirements include:

- BC *Water Sustainability Act*, *Water Sustainability Regulation, Groundwater Protection Regulation,* and *Dam Safety Regulation;*
- *Fisheries Act* and *Authorizations Concerning Fish and Fish Habitat Protection Regulations;*
- Part 10.5 Operations; Section 10.5.3 Annual Dam Safety Inspection – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.5 Operations; Section 10.5.4 Dam Safety Reviews – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021);
- Part 10.6 Mine Closure; Section 10.6.6 Impoundments – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10.7 Reclamation Standards; Section 10.7.12 Watercourses – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance is as follows:

- Dam Safety Guidelines, 2007 (CDA 2007);
- Draft Technical Bulletin: Mining Dams – Application of 2007 Dam Safety Guidelines to Mining Dams (CDA 2013);
- Technical Guidance 7: Assessing the Design, Size and Operation of Sediment Ponds Used in Mining (BC ENV 2015);
- A User Guide for Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining (BC ENV 2016);
- Part 3 Mine Plan; Section 3.5.6 Water Management Structures – JAIR (BC EMPR & BC ENV 2019a);
- Part 4 Reclamation and Closure Plan; Section 4.6 Groundwater Well Decommissioning – JAIR (BC EMPR & BC ENV 2019a); and
- Part 4 Reclamation and Closure Plan; Section 4.7.5 Watercourse Reclamation Prescriptions – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Past reports and other documentation is as follows:

- Blackwater Gold – Fresh Water Supply Options Trade-off Study (KP 2012);
- Blackwater Gold Project Geotechnical Characterization Report (KP 2013e);
- Blackwater Gold Project Mine Waste and Water Management Design Report (KP 2014);
- Blackwater Gold Project Construction Sediment and Erosion Control Plan (KP 2013e);
- Section 12.2.1 Construction and Operations Management Plan; Subsection 12.2.1.18.4.18.1 Mine Water Management Plan (Application//EIS, New Gold 2015);
- Section 2.6.6 Conceptual Reclamation Plan; Subsection 2.6.6.2.2.1.10 Watercourse Reclamation (Application/EIS, New Gold 2015);

- Section 2.6.6 Conceptual Reclamation Plan; Subsection 2.6.6.2.5. Freshwater Supply System (Application/EIS, New Gold 2015);
- Water Management Structures Detailed Design Report (KP 2021k) – Appendix 3-O;
- Tailings Storage Facility – Life of Mine Design Report (KP 2021i) – Appendix 3-K;
- Fresh Water Supply System Design Report (KP 2021m) – Appendix 3-P; and
- Fresh Water Reservoir Dam Breach Assessment (KP 2021n) – Appendix 3-Q.

EAC Conditions

EAC conditions related to the design, construction, operation, closure, and reclamation of the TSF include:

- Condition 11 (Care and Maintenance Plan) – requires the development and implementation of a plan that covers care and maintenance periods for both definite and indefinite time frames, including measures to monitor, manage, and avoid build-up of water surplus;
- Condition 13 (Construction Environmental Management Plan) – includes measures to manage sediment and erosion control;
- Condition 33 (Mine Waste and Water Management Plan) – requires the development and implementation of a plan to manage mine waste and water that is protective of the receiving environment; and
- Condition 35 (Tailings Dam Safety Transparency Plan) – requires identification and description of reports, reviews, inspections and meetings pertaining to dam safety and requires preparation of annual report related to dam safety.

The Care and Maintenance Plan and Construction Environmental Management Plan must be developed in consultation with EMLI, ENV, Ministry of Forests, Lands, Natural Resource Operations and Rural Development and Aboriginal Groups. The other two plans referenced above must be developed in consultation with EMLI, ENV, and Aboriginal Groups.

3.5.6.3 Central Diversion System

The Central Diversion System will be constructed to divert freshwater around the TSF to the downstream receiving environment or to water transfer points where the captured flows can be pumped to the WMP. The WMP will provide freshwater to support ore processing. Water not needed to support mine operations will be discharged from the WMP to the FWR and used to mitigate flow reductions in lower Davidson Creek.

The design of the Central Diversion System is separated into two phases, as the system will need to be re-located in approximately Year +6 due to the expanding footprint of the TSF. The mine years associated with the two phases are:

- Phase 1: Year -1 to Year +6
- Phase 2: Year +7 to end of Post-closure

The primary components of the Phase 1 Central Diversion System are summarized in Table 3.5.6-1 along with their design objectives.

Table 3.5.6-1: Central Diversion System Phase 1 – System Components and Design Objectives for Non-contact Water

Diversion System	Design Objective
North Diversion Channel	Divert water around the TSF and release to Creek 668328, which ultimately flows to Davidson Creek downstream of TSF C. The North Diversion Channel will be relocated in approximately Year 2.
North Collection Channel	Route water around TSF C to the Central Water Transfer Pond
South Collection Channel	
Minor Diversions	Divert water towards a natural pond where flows will be pumped to the WMP until approximately Year 2
Central Water Transfer Pond	Temporarily store captured water to facilitate pump submergence and conveyance to the WMP
Central Diversion Pipeline	Route water from the Central Water Transfer Pond to the WMP using a pump and pipeline system

Phase 1 Collection and Diversion Channels

Three channels will be constructed for the Phase 1 Central Diversion System:

- The North and South Collection Channels will be constructed in Year -1 and operate until the end of Year +6. The collection channels will route water to the Central Diversion System Water Transfer Pond.
- The North Diversion Channel will be constructed in Year -1 and will then be relocated further north at the end of Year +1 to accommodate the growing TSF footprint. The re-located channel will then be in place until the end of Year +6. General Arrangements of the Central Diversion System in Year -1 and Year +2 showing the relocated North Diversion Channel) are provided in Figures 3.5-56 and 3.5-57.

The design life of the Phase 1 channels is less than 10 years. As such, the channels are sized to route the 1-in-10-year flood with a minimum of 300 mm of freeboard and have capacity to pass the 1-in-200-year flood at bank full conditions.

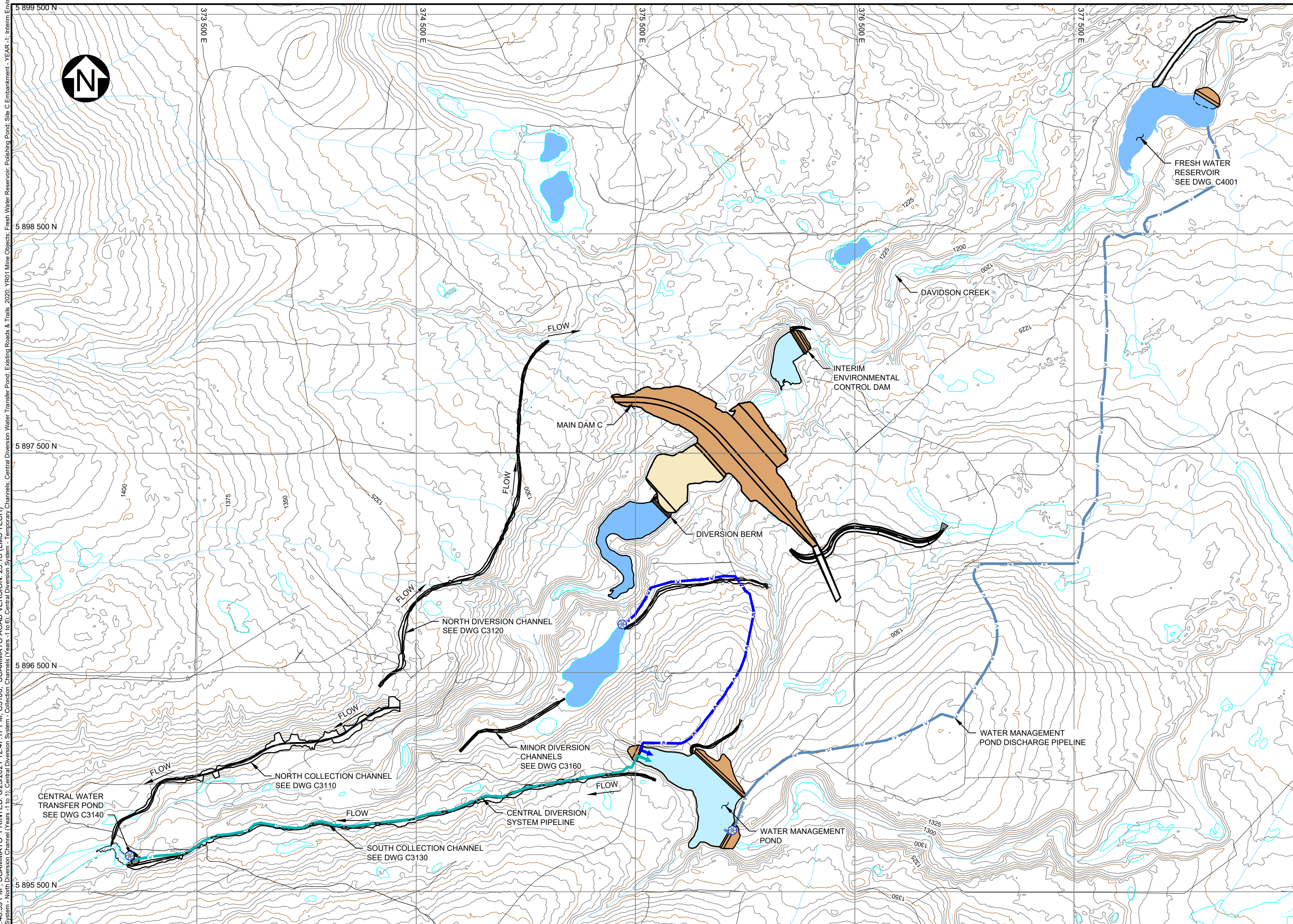
Minor Diversions

Two minor diversions will be constructed in Year -1 south of the TSF, and will be operated until the end of Year +1. These diversions will route water towards a natural pond which will be repurposed for water collection such that the collected water can be pumped to the WMP. The channels are designed to pass the 1-in-10-year flood with a minimum of 300 mm of freeboard.

Phase 1 Central Water Transfer Pond

The Phase 1 Central Water Transfer Pond will be constructed upstream of the TSF within the Davidson Creek Watershed and has a total contributing catchment area of approximately 8.6 km^2. The pond is expected to be in place until the end of Year +6 and will receive inflows from Davidson Creek and the North and South Collection Channels. The pond is also designed to manage the 1-in-200-year flood, consistent with the EDF of the Main Dam C.

Water from the pond will be pumped to the WMP using the Central Diversion Pipeline System, which has a design flow of 300 L/s. The design flow was selected to minimize spill into the TSF to the extent practical and the selected flow rate corresponds to the 92nd percentile flow contributing to the Central Diversion System Water Transfer Pond.



LEGEND:

- TAILINGS BEACH
- MINE WATER
- FRESH WATER
- EMBANKMENT FILL
- PAG WASTE ROCK
- EXISTING ACCESS TRAILS
- CENTRAL WATER DIVERSION PIPELINE
- WATER MANAGEMENT POND DISCHARGE SYSTEM PIPELINE
- TEMPORARY DIVERSION SYSTEM PIPELINE

NOTES:

1. FOR GENERAL NOTES SEE DWG. G0006.
2. FOR DIVERSION PIPING SYSTEMS GENERAL ARRANGEMENT SEE DWG. M3050.
3. TSF C GENERAL ARRANGEMENT FOR YEAR -1 IS SHOWN. C1000 DRAWING SERIES FOR DETAILS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE A 200 100 0 200 400 600 800 1000 m

PLAN
SCALE A

REFERENCE DRAWINGS

DRG. NO.	DESCRIPTION
M3050	WATER MANAGEMENT - DIVERSION PIPING SYSTEMS - GENERAL ARRANGEMENT YEAR -1
G0006	CIVIL GENERAL NOTES
C4001	FRESH WATER RESERVOIR - EMBANKMENT AND RESERVOIR - GENERAL ARRANGEMENT
C3160	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - MINOR DIVERSION DITCHES
C3140	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - WATER TRANSFER POND
C3130	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - SOUTH COLLECTION CHANNEL - PLAN AND PROFILE
C3120	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH DIVERSION CHANNEL - PLAN AND PROFILE
C3110	WATER MANAGEMENT - CENTRAL DIVERSION SYSTEM - NORTH COLLECTION CHANNEL - PLAN AND PROFILE

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
A	25JUN'21	ISSUED FOR CLIENT REVIEW	MJB1	RMM	-	-

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BW GOLD LTD.

BLACKWATER GOLD PROJECT

WATER MANAGEMENT
DIVERSION SYSTEMS
GENERAL ARRANGEMENT
YEAR -1

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C3100	A

Figure 3.5-56: Central Diversion System General Arrangement Year -1

Source: Knight Piésold Consulting (2021).

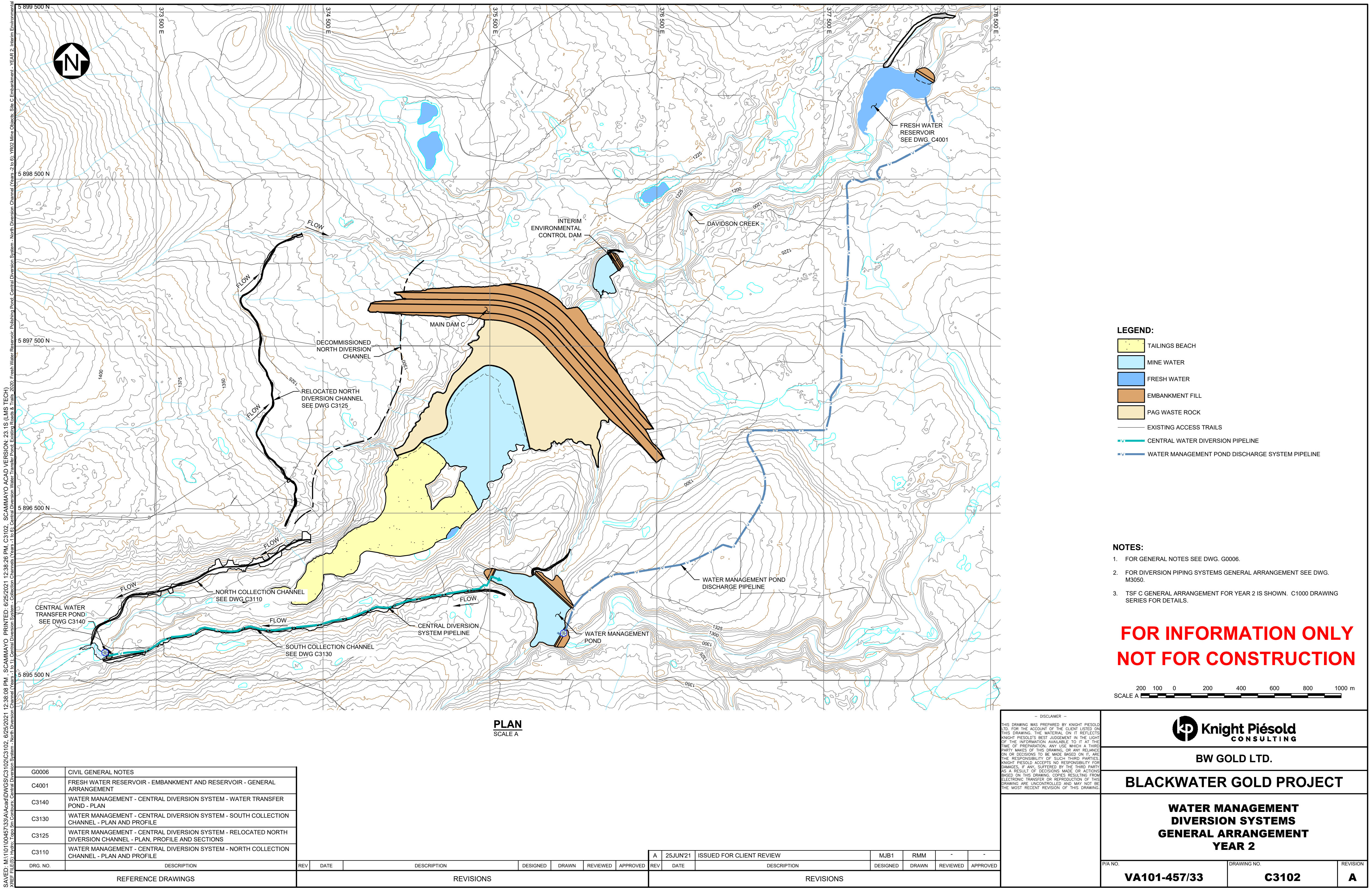


Figure 3.5-57: Central Diversion System General Arrangement Year +2

Source: Knight Piésold Consulting (2021).

Water will be impounded by a weir structure that will be constructed using a combination of fill and concrete lock blocks. The weir will have a crest elevation of 1,300 masl, with a total height of 2 m and crest length of 38 m. In total, the Phase 1 Central Water Transfer Pond will impound a volume of around 2,500 m^3 at the crest.

Phase 1 Central Diversion Pipeline

Water collected in the Central Water Transfer Pond will be pumped to the WMP. This system will consist of two shore-mounted end centrifugal pumps with suction hoses. The pipeline is specified as ND 500 mm DR17 HDPE and ND 300 mm DR21 HDPE. The system is weather protected including both insulation and heat tracing at the pump station and in pipeline segments which are not free draining. This includes cold weather protection of the flanges, fittings, valves and instrumentation.

The pump station will be designed to contain two operating and one uninstalled spare pump to provide a flow of 300 L/s. The pump station will be installed on the pump pad adjacent to the lock block weir. The pump pad is specified as minimum 11 m x 20 m in dimension to provide sufficient space for the pumps in weather enclosures, the associated pipes and fittings as well as for vehicle access. The pump pad will be at elevation 1,300.75 masl to provide sufficient freeboard above the maximum water level in the Central Water Transfer Pond. Both suction hoses will draw water at elevation 1,299 masl which will provide ground clearance to prevent suction of sediment from the riverbed as well as clearance to the surface to prevent cavitation in the pump. The system will be installed during the pre-production phase and will be operated until the end of Year +6. The system will be operated with a level control float system or equivalent.

The primary components of the Phase 2 Central Diversion System are summarized in Table 3.5.6-2 along with their design objectives.

Table 3.5.6.2: Central Diversion System Phase 2 – System Components and Design Objectives

Diversion System	Design Objective
North Collection Channel	Route water around the TSF to the Central Water Transfer Pond
South Collection Channel	
Central Water Transfer Pond	Capture water such that it can be pumped to the WMP
Central Diversion Pipeline	Route water from the Water Transfer Pond to the WMP using a pump and pipeline system

Phase 2 North and South Collection Channels

After the end of Year +6, the Central Diversion System will be relocated upstream to accommodate the growing footprint of TSF C approximately coincident with construction of the West Dam of TSF C. Two collection channels will be constructed at the end of Year +6 which will route water around the TSF to the Phase 2 Central Water Transfer Pond.

The design life of the Phase 2 channels is approximately 16 years, as it is anticipated that the channels will be decommissioned during the Closure phase. The channels are sized to pass the 1-in-200-year flood with a minimum of 300 mm of freeboard.

Phase 2 Central Water Transfer Pond

The Phase 2 Central Water Transfer Pond will be created by impounding water upstream of TSF West Dam and has a total contributing catchment area of approximately 5.5 km^2. The pond is expected to be in place starting in Year +7 and will remain in place through Closure and into Post-closure. The pond will receive inflows from the headwaters of Davidson Creek and the Phase 2 North and South Collection Channels.

Phase 2 Central Diversion Pipeline System

Water from the pond will be pumped to the WMP using the Phase 2 Central Diversion Pipeline System. The pump and pipeline have a design flow of 300 L/s and inflows that exceed the design flow will be routed to the TSF. The design flow is consistent with the design flow of the Phase 1 pump and pipeline system and corresponds to the 96th percentile flow contributing to the Phase 2 Water Transfer Pond.

Water collected in the Central Water Transfer Pond will be pumped up to the WMP. This system will consist of two shore mounted end centrifugal pumps with suction hoses. The pipeline is expected to be of similar specifications to the Phase 1 system. The system will b weather protected including both insulation and heat tracing at the pump station and in pipeline segments which are not free draining. This includes cold weather protection of the flanges, fittings, valves and instrumentation.

A pump station will be designed to contain two operating and one uninstalled standby pump to provide a flow of 300 L/s. The pump station will be installed on the pump pad located on the river right bank adjacent to the West Dam. The pump pad will be at elevation 1,345 masl while both suction lines will draw water at elevation 1,340 masl. The system will be installed in Year +7 and will be operated through closure and post closure.

3.5.6.4 Northern Diversion System

The primary function of the Northern Diversion System is to divert freshwater around the TSF and provide water to the FWR through a gravity pipeline system.

The North Diversion System will be constructed at the end of Year +6, coinciding with the construction of the Phase 2 Central Diversion System and the TSF West Dam. The primary components of the North Diversion System are summarized in Table 3.5.6-3 along with their design objectives.

Table 3.5.6-3: Northern Diversion System Components and Design Objectives

Diversion System	Design Objective
North Collection Channel	Intercept freshwater prior to reaching TSF D and convey to the Northern Water Transfer Pond
South Collection Channel (from Central Diversion System)	
Northern Water Transfer Pond and Intake Structure	Capture water such that it can be conveyed to the FWR
Northern Diversion Pipeline	Route water from the Northern Water Transfer Pond to the FWR using a gravity pipeline system

Collection Channels

The design life of the collection channels is approximately 16 years and the channels are sized to pass the 1-in-200-year flood with a minimum of 300 mm of freeboard. Trapezoidal channels with 2.5H:1V side slopes were selected for the collection channels.

Northern Water Transfer Pond

The Northern Water Transfer Pond will be constructed upstream of the TSF within the Creek 668328 watershed and has a total contributing catchment area of approximately 9.8 km^2.

The pond has an expected design life of 16 years and will receive inflows from the undisturbed area upstream, and the North and South Collection Channels. The pond is also designed to manage the 1-in-200-year flood, estimated to be 4.8 m^3/s.

Water from the pond will flow to the FWR using the Northern Diversion Pipeline. The pipeline has a design flow of 300 L/s. The design flow corresponds to the 91st percentile flow contributing to the Phase 2 Water Transfer Pond (i.e., the capacity of the pipeline system will be exceeded roughly 9% of the time) although the total spilled flow will be much less than 9% of the annual flow.

Water will be impounded by an embankment structure, constructed using a combination of earth fill material and concrete. The embankment will have a crest elevation of the wingwalls of 1,350 masl, with a total height of 3.5 m. In total, the Northern Water Transfer Pond will impound a volume of around 4,000 m^3 when the water level is at the crest.

Northern Diversion Pipeline

The Northern Diversion Pipeline conveys collected water from the Northern Water Transfer Pond to the FWR through a gravity pipeline. The intake to the Northern Diversion Pipeline is set at 1,347 masl and will be cast directly into the concrete intake weir. The pipeline is specified as a single ND 550 mm HDPE DR17 and ND 350 mm HDPE DR17 with a design flow capacity of 300 L/s. The pipeline alignment routes around the perimeter of the Main Dam D footprint and delivers the diverted water to the FWR. The pipeline alignment is sufficiently graded to a minimum slope of 0.5% to prevent flat areas or pipeline segments where water can pool. The system will discharge at an elevation below the normal operating pond level of the FWR. This system will be operated by a gate valve at the intake structure. The system will be constructed at the end of Year +6, concurrent with the construction of the Northern Water Transfer Pond and associated collection channels.

3.5.6.5 Water Management Pond and Discharge Pipeline

The WMP will be constructed downslope of the Open Pit and stockpiles area and within the ultimate footprint of TSF C to manage runoff from contributing areas and water pumped from collection points. The WMP's main objective is to provide fresh make-up water to support ore processing. Surplus water not needed to support mine operations will be sampled and analyzed, comparing to applicable water quality criteria and, if compliant, will be used to augment flow in lower Davidson Creek.

The WMP will be formed using natural topography enclosed by construction of three geomembrane-lined earthfill berms on the West, North, and East sides of the pond. Each berm is designed with a crest elevation of 1,325 masl, with the pond basin invert at an average elevation of 1,308 masl. The basin and berms will be fully geomembrane-lined up to 1,324.5 masl providing a total water storage capacity of 825,000 m^3 at this elevation.

The berms will be constructed from locally borrowed earthfill materials meeting the Zone C material specification. The upstream and downstream slopes were specified as 3H:1V for all three berms. The specified minimum crest width is 12 m, which includes an allowance for an access road running between two safety berms and a 300 mm thick wearing course. The West Berm is designed with a 16 m crest width to accommodate the reclaim water pipeline corridor.

The WMP stored water volume will be managed via pumping systems and two secondary outflow mechanisms designed to maintain dam safety. The pumping systems will provide the primary control of water level within the WMP on a day-to-day basis. A culvert at the West Berm will provide supplemental outflow capacity to the TSF supernatant pond during periods of elevated runoff, such as during freshet. Larger storm inflows up to the 1-in-200-year, 24-hour return period storm event will be managed by an emergency spillway constructed along the left abutment of the North Berm.

The hydraulic design criteria for these outlets are as follows:

- Convey the mean freshet inflows for a 50-year return period wet year using the culvert without activating the emergency spillway.
- Convey up to the 1-in-200-year, 24-hour return period flow via the emergency spillway, assuming that the culvert is blocked during the event.
- The WMP water elevation is assumed to be at each respective outlet invert when the return period event begins. No pumped outflows are relied on to manage inflows during the design storm events.

A 30 m long, 1,300 mm ID Type corrugated steel pipe (CSP) culvert is sized to manage a constant inflow of 0.98 m^3/s, which includes the pumped inflow from the Central Diversion System and the average freshet inflows expected during a 1-in-50 year wet spring. The invert elevation of the culvert specified as 1,322.75 masl and the minimum culvert slope is 1%. The culvert will be bedded in engineered fill.

The design inflow for the emergency spillway is 5.76 m^3/s, which includes runoff from the Mine Area Creek catchment, resulting from the 1-in-200-year, 24-hour storm as well as a constant inflow of 0.28 m^3/s (1,000 m^3/h) pumped to the WMP from the Central Diversion System.

The primary function of the WMP Discharge System will be to convey water from the WMP to the FWR beginning in late Year -2 or early Year -1 once the WMP Discharge System is operational. The system comprises three pumps arranged in parallel at the WMP East Berm. The pumps will be contained weather protected and each capable of providing approximately 40 m of total dynamic head (TDH) and flowrates of 940 m^3/h for a total system flowrate of approximately 2,819 m^3/h. Water pumped from WMP will be monitored using a flow meter installed downstream of the pumps. The pumps will be controlled by a floating level control system in the WMP and equipped with variable frequency drives to balance the total system TDH from the individual units. One uninstalled pump will be available along with all the necessary control, check, drainage, and isolation valves.

The pipeline will consist of a combination of ND 300 mm DR 21 HDPE, ND 750 mm DR 21 HDPE, and ND 500 mm DR 9 HDPE. The pipeline corridor grade is optimized to minimize high or low sections which results in gravity-flow conveyance to the FWR after initial lifting from the pump system. The system is weather protected including both insulation and heat tracing at the pump station and in pipeline segments that are not free draining.

The pipeline will discharge into the FWR at approximately elevation 1,155 masl, which is below the normal operating level of the FWR. The WMP discharge pipeline will be installed during the pre-production phase to allow diversion of flows around the TSF construction area, if required, and will be operated until the end of Year +12.

3.5.6.6 Freshwater Reservoir

The FWR will be constructed downstream of the TSF and the associated seepage collection works. The purpose of the FWR is to maintain a suitable source of fresh water to provide flows to lower Davidson Creek as required to reduce the potential environmental impacts of the project and to support mine operations when required. The FWR will receive inflows from several sources as follows:

- Direct precipitation on the FWR and runoff from contributing catchments;
- Diverted flows from undisturbed areas upgradient of the TSF that will be conveyed around the TSF to the FWR;
- Mine contact water suitable for release to the downstream receiving environment; and
- Fresh water from Tatelkuz Lake supplied by the FWSS in later phases of mine operations.

The FWR will be formed as an in-creek reservoir using natural topography enclosed by construction of an earthfill berm on the northeast side of the reservoir. The FWR embankment is designed with a crest elevation of 1,167.5 masl, and the base elevation at the highest section of the embankment is approximately 1,153.0 masl. Davidson Creek is incised in the vicinity of the reservoir, and the natural ground elevation is typically greater than 1,170 masl adjacent to the reservoir. The maximum embankment height is approximately 15.5 m, and most of the embankment is over 10 m high except locally at the abutments. The specified embankment crest width is 14 m, which includes an allowance for an access road running between two safety berms. The embankment will be approximately 125 m in length and will impound a total volume of around 370,000 m^3 from its foundation level to the spillway invert elevation.

The detailed design of the FWR presented in the Water Management Structures Detailed Design Report (KP 2021k) included as Appendix 3-O and pertinent details are summarized below. The design report in Appendix 3-O includes the details related to the dam site characterization, seepage assessment, stability analyses, and recommendations for confirmatory investigations to be completed concomitantly with construction.

The following are specific design features of the FWR:

- Water retaining zoned earthfill embankment;
- HDPE geomembrane liner on the upstream face of the embankment and select areas of the reservoir;
- An embankment downstream toe buttress;
- Low level outlet pipes;
- A surface level outlet pipe;
- Temperature and flow control chamber;
- Foundation drain blanket;
- FWSS connection pipeline;
- Overflow spillway and stilling basin; and
- Geotechnical instrumentation and flow monitoring devices.

The Canadian Dam Association Dam Safety Guidelines (CDA 2019) and Part 10 of the Code were used to determine the dam hazard classification and suggested minimum target levels for some design criteria, such as the IDF and EDGM for the FWR. The dam hazard classification for the FWR was determined to be SIGNIFICANT. The EDGM and IDF target levels adopted for the design basis of the FWR were based on the 1-in-1,000-year return period events. The methodology and basis of the hazard classification is summarized in the design report (Appendix 3-O).

The peak flow for the IDF for the 1-in-1,000-year return period event was estimated using the pre disturbance catchment area. The catchment area of the FWR will be reduced substantially during the operational phase of the mine due to construction of the TSF, which will progressively reduce the contributing catchment area and peak flow associated with the 1-in-1,000-year return period event. The spillway was designed to utilize the natural topography above the left bank of Davidson Creek downstream of the embankment dam. The spillway inlet is located approximately 200 m upstream from the embankment crest with an invert elevation of 1,166 m, and the spillway outlet is at Davidson Creek approximately 350 m downstream from the toe of the dam.

The design criteria related to minimum flow releases from the FWR was defined by the IFN in Davidson Creek. The basis for and magnitude of these flows (IFN) are described by Palmer Environmental (Palmer 2021). The target IFN flows were developed to limit the potential environmental impacts of the project by providing flows supportive of rainbow trout (*Oncorhynchus mykiss*) and Kokanee salmon (*Oncorhynchus nerka*) populations within Davidson Creek. The discharge requirements vary throughout the year from 0.12 m^3/s in the fall to a maximum 0.56 m^3/s for approximately 7 weeks in May and June.

Water temperature objectives were also considered to reduce the potential environmental impacts of the project. The design objective for the FWR is to release water into Davidson Creek at temperatures consistent with historical baseline conditions to the extent reasonably practicable.

The two sets of FWR outlet works (a surface level outlet and low level outlet) consist of three identical pipes, each sized to individually provide the largest IFN of 0.56 m^3/s, for a combined total of 1.68 m^3/s. The low level outlet contains a set of identical twin pipes for redundancy, higher flow flushing capacity and ease of maintenance. The surface level outlet will contain one pipe with ability to provide the maximum IFN without the use of the low level pipes. The design objectives of the two outlets are:

- The IFN can be met at all times of year, with two outlet pipes out of service.
- Water can be drawn at the surface of the FWR or at depth in the FWR to adjust to seasonal temperature targets.
- Higher flushing flows or IFNs can be accommodated if the IFNs change in the future.

The low level pipes will be fitted with a concrete headwall while the surface level pipe will inlet in a concrete box. The upstream end of the pipes will be open and fitted with hydraulically controlled gates, valves, and trash racks to prevent reservoir debris from migrating into the pipes. The trash racks and headwall will provide protection against the ingress of organic debris and native materials from the right bank where the pipe is located. Each pipe will be fitted with a vent pipe which outlets to the embankment crest.

Steel pipes will be utilized on the upstream side of the profile. The surface level pipe will travel down the upstream face of the dam and join with the low level outlet pipes. At the upstream toe, the three pipes will be encased in concrete and constructed on the right abutment on native materials and engineered fill. The concrete will be backfilled with Zone S material, with 100 mm or greater particles removed, placed where the concrete interfaces with the seal zone embankment fill materials. Concrete seepage collars will be used to control seepage around the concrete encasement. In the materials down station of the upstream seal, the concrete encasement will end. The pipes will transition to HDPE and will be encased in appropriately graded transition zone material throughout the remainder of the embankment to reduce the risk of a seepage path developing along the alignment

Once through the embankment, the three pipes will feed into the Temperature and Flow Control Chamber, which will provide further flow regulation. Each pipe will be fitted with a main valve and a maintenance valve with the ability to regulate flows according to water surface levels and IFN requirements. An ultrasonic flow meter will be installed on the pipes upstream of the outlet valves to accurately measure flows for compliance reporting requirements. A smaller diameter u-shaped fitting will be installed to allow flow to circumvent the final valve to allow for each outlet pipe to run full even in low flow situations.

The Temperature and Flow Control Chamber will include an offtake for future connection to the FWSS. The FWSS will convey flow from nearby Tatelkuz Lake in later phases of mine operations to provide additional make-up water to the FWR or to supplement discharge to Davidson Creek directly from the end of pipe when flows diverted from the upstream catchment are not sufficient or are needed to supply the mine operations. Details of the FWSS design are presented in the following section (Section 3.5.6.7).

Water from the reservoir released through the outlets will be monitored using ultrasonic flow meters installed at each of the discharge outlets, as discussed above. In addition, an in-stream flow monitoring station downstream of the FWR within Davidson Creek may be required as a back-up station to confirm the IFN release, should the flowmeters require maintenance or in the event that they are damaged. Baseline monitoring station H2B is located in Davidson Creek between the FWR pipe outlets and the

FWR spillway outlet. Monitoring at H2B and a spillway monitoring device could be used in combination to determine the total flow from the FWR. If additional precision is required, a more permanent structure such as a weir could be installed in place of hydrometric station H2B or further downstream below where the FWR spillway re-enters Davidson Creek, so that the contributing flow includes the overflow spillway and water released through the FWR pipe outlets.

Geotechnical instrumentation will be installed along one plane through the FWR. The geotechnical instrumentation will comprise vibrating wire piezometers, slope inclinometers, and survey prisms, and will be installed in the foundations, embankment fill, and on the embankment crests. The instrumentation systems will include some degree of overlap and redundancy to enable verification of problems that may be detected.

In addition to flow monitoring and geotechnical instrumentation for the dam, water level monitoring within the reservoir is also required to inform the operation of the outlets and storage availability. Water levels will be monitored using a pressure transducer with an appropriate depth range.

Monitoring instrumentation will incorporate an automated data acquisition system so that the data can be accessed in real time, as required. An OMS Manual will be prepared following initial construction and prior to commissioning of the FWR, WMP, and Central Diversion System to provide comprehensive operating instructions and monitoring frequencies for the instrumentation. The OMS manual will include threshold conditions in the form of quantitative performance objectives and associated trigger action response plans (TARPs). The OMS Manual will be updated regularly during mine operations as the water management systems, monitoring infrastructure, and surveillance protocols evolve.

3.5.6.7 Freshwater Supply System

General Description

The principal design objective for the FWSS is to provide additional freshwater, drawn from Tatelkuz Lake and released at the FWR, as needed to supplement the water available for release to Davidson Creek or to provide make-up water to the mine when required. The design of the FWSS has taken into consideration the following requirements:

- Layout of the system components contained within the EAC Certified Project Description boundary;
- Sufficient capacity to convey the currently recommended IFN for Davidson Creek as a minimum;
- Consideration for potential future adjustments to flow requirements if monitoring and adaptive management requires adjustment to flow provisions;
- Provide variable and controlled flow from Tatelkuz Lake and allow optimized use of both the FWR and the FWSS to meet IFN and temperature objectives;
- Tatelkuz Lake FWSS intake will be located at a depth that will produce temperatures appropriate for Davidson Creek;
- Limit environmental impacts of the FWSS itself, particularly at the Tatelkuz Lake intake site by minimizing the physical footprint of the intake structure on the shoreline of Tatelkuz Lake and using appropriate screens on the intake pipes;
- Include monitoring features to confirm performance goals are achieved and design criteria and assumptions are met; and
- The FWSS must be able to operate year-round.

The FWSS will include the following components:

- access roads;
- transmission to the intake structure and pumpstation at Tatelkuz Lake and booster pump station(s);
- Tatelkuz Lake intake and pumpstation (outside the proposed *Mines Act* permit boundary);
- freshwater supply pipeline;
- booster pump station(s); and
- connections to the FWR outlet works (described in Section 3.5.6.6).

The FWR is included as a part of this Application. The volume of diverted water to be impounded in the reservoir will be submitted under a water license application. The components outside of the proposed *Mines Act* permit boundary including most of the utility corridor, Tatelkuz Lake works and the volume of water diverted will be applied for under another water licence and a licence of occupation. All components are described in this section.

FWSS components are presented in Figure 3.5-58. The design details for the FWSS (KP 2021m) are included in Appendix 3-P.

Design Considerations for the Freshwater Supply System

The design criteria related to minimum flow releases from the combined FWR was defined by the IFN in Davidson Creek. The IFN values were used to inform the selection of the design basis flow rate for the FWSS. The IFN values vary throughout the year. The design IFN are shown in Table 3.5.6-4. A design flow rate of 0.67m^3/s (2,400 m^3/h) was selected for consistency with the Application/EIS (New Gold 2015). This amount is expected to be the maximum flow governing the design. It corresponds to 20% more than the maximum IFN demand of 0.56 m^3/s.

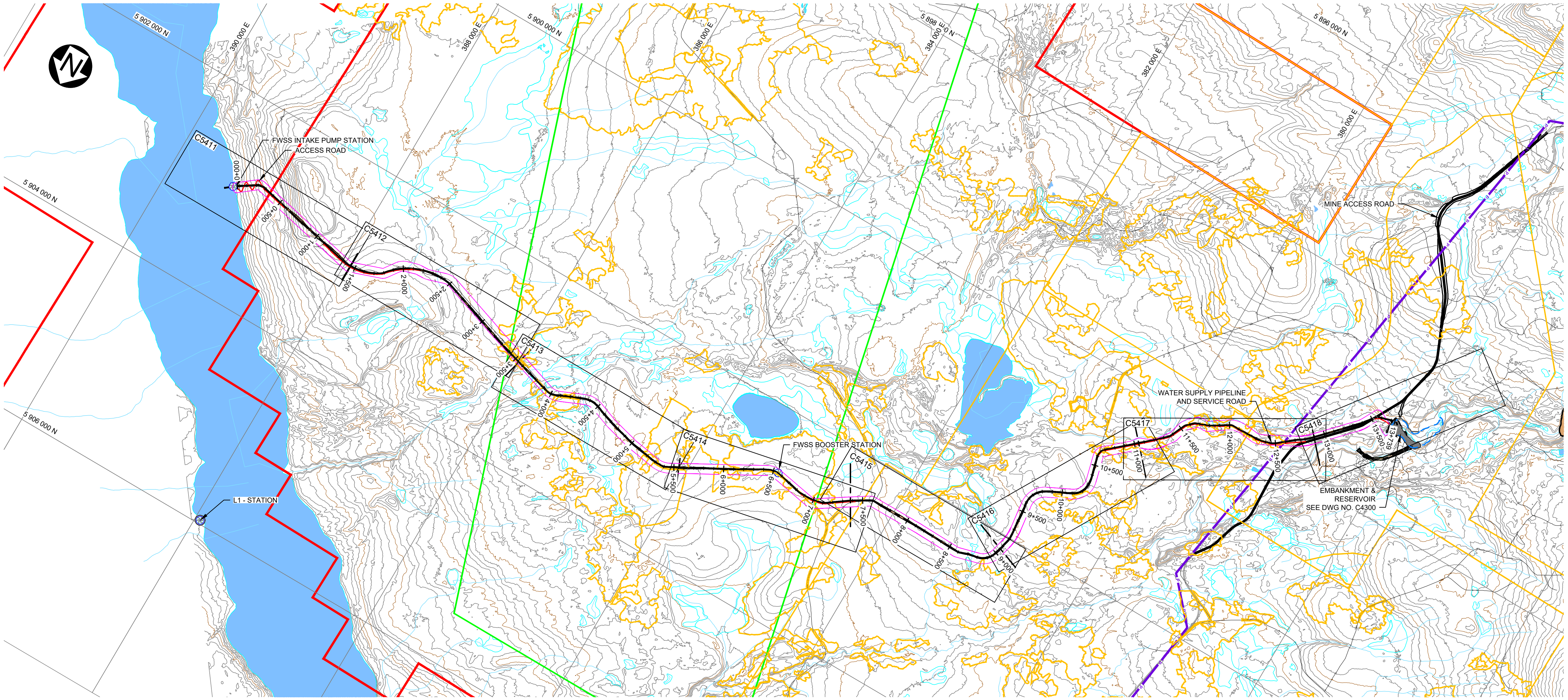
Table 3.5.6-4: Mine Site and Instream Flow Needs Freshwater Requirements[1]

Period	Selected Design IFN (m^3/s)	Days
January 1 – April 15	0.08	105-106
April 16 – May 10	0.15	25
May 11 – May 15	0.56	5
May 16 – June 30	0.56	46
July 1 – July 15	0.30	15
July 16 – August 31	0.15	47
September 1 – November 30	0.12	91
December 1 – December 31	0.08	31

[1] *Blackwater Fisheries Offsetting Plan – Instream Flow Needs for Davidson Creek (Palmer 2021).*

Tatelkuz Lake Intake and Pump Station

An intake structure and onshore pump station will be built on the shoreline of Tatelkuz Lake. The location was determined after a trade-off study (KP 2012) determined that Tatelkuz Lake is the best source for freshwater. Subsequent consultations with Indigenous nations and local stakeholders identified a previously clear-cut area on the western shoreline as a suitable location for the intake structure and onshore pumphouse.



PLAN
SCALE A

C5418	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 8 OF 8)
C5417	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 7 OF 8)
C5416	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 6 OF 8)
C5415	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 5 OF 8)
C5414	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 4 OF 8)
C5413	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 3 OF 8)
C5412	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 2 OF 8)
C5411	FRESH WATER SUPPLY SYSTEM - WATER CONVEYANCE - PLAN & PROFILE (SHEET 1 OF 8)
C4300	FRESH WATER RESERVOIR - EMBANKMENT - PLAN
G0006	CIVIL GENERAL NOTES
M5050	FRESH WATER SUPPLY SYSTEM - PIPELINE - PLAN AND PROFILE
DRG. NO.	DESCRIPTION

REFERENCE DRAWINGS

LEGEND:

- PUMP STATION
- MINE ACCESS ROAD
- TRANSMISSION LINE
- EXISTING ACCESS TRAILS
- PROPERTY BOUNDARY
- CERTIFIED PROJECT DESCRIPTION BOUNDARY
- FOREST TENURES
- SUNFIELD ENERGY INVESTIGATIVE LICENSE
- FWSS PIPELINE ACCESS ROAD

NOTES:

1. FOR GENERAL NOTES SEE DWG. G0006.
2. REFER TO DRAWING M5050 FOR PIPELINE SPECIFICATIONS.

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION

SCALE A 400 200 0 400 800 1200 1600 2000 m

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	04NOV'21	ISSUED FOR PERMITTING	BXF	BRS		

REVISIONS

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BLACKWATER GOLD PROJECT

FRESH WATER SUPPLY SYSTEM
WATER CONVEYANCE
GENERAL ARRANGEMENT

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C5410	0

SAVED: M:\1\01\00457\33\A\Acad\DWGS\C5410\C5410, 11/5/2021 1:56:31 PM , ELEE PRINTED: 11/5/2021 2:05:17 PM, C5410, ELEE ACAD VERSION: 23.1S (LMS TECH)
XREF FILE(S): Hydro; Topo 5m Contours; Site C Embankment - YEAR 23; YR23 Mine Objects; Mine Access Road; Fresh Water Reservoir; PropertyBoundary; Site D Embankment and PAG in Stages; CPD Polygons; Existing Roads & Trails_2020; 762MM_DIA_FWSS_PIPELINE-P; Fresh Water Reservoir_Berm_Spillway; IMAGE FILE(S):

Figure 3.5-58: Freshwater Supply System

Source: Knight Piésold Consulting (2021m; Appendix 3-P).

The FWSS will draw water from Tatelkuz Lake through two pipes, each approximately 110 m long and equipped with cylindrical screens at the intake end of the pipes. The pipes will passively convey water from the lake to the concrete wet well. The upstream end of the screened intake pipes will be located at a depth that allows for water to be drawn from the lake hypolimnion as frequently as practicable. There will be two sections of intake pipe, both constructed of ND 900 mm DR17 HDPE. The first section of pipe will be anchored on the lake bottom as required to keep it in place. The second section of pipe will be installed underground through the lake bank (between the lake and wet-well) and constructed either via horizontal drilling or jacking, or other means deemed appropriate upon collection and review of additional geotechnical data. This configuration makes it possible to limit the depth of the pumpstation wet-well while allowing the intake to draw water from a greater depth, more easily achieving water intake from the hypolimnion. Two pipes, as opposed to one, allows for redundancy and for maintenance/modifications to take place as required.

The wet-well will be constructed as a cast-in-place concrete structure and will serve to provide a basin from which the pumps can draw water to be delivered to the FWR. The wet-well will be rectangular in shape with a minimum internal elevation of 922 masl and will rise to the pump house floor at elevation of approximately 931 masl. The boundary of the extents of excavation required for construction of the well will be set back from the high-water level extents. The high and low water levels are expected to be 928.8 masl and 926.8 masl, respectively.

The intake pumpstation will initially be outfitted with three vertical turbine pumps: two operating, and one on standby. The pumps were designed to provide a total maximum flowrate of 0.67 m^3/s (2,400 m^3/h) to meet the design flowrates. The pumps will be housed inside a prefabricated steel structure and will draw water from the wet-well chamber. Each pump will provide the required total design head at a maximum flowrate of 335 L/s (1,150 m^3/h) to meet the total design flowrate of 670 L/s. Each of the pumps will be equipped with a variable frequency drive and motor to allow for controlled start-up and shutdown, as well as to accommodate variable flow demand.

Figure 3.5-59 presents a plan and section view of the intake structure and pump station. A general arrangement of the FWR is provided in Figure 3.5-60.

Utility Corridor

To convey freshwater from Tatelkuz Lake to the FWR, a 13.9 km long pipeline will be constructed from the pumphouse to the FWR. The elevation gain from 926 masl to highest point above the FWR at 1,170 masl represents a 244 m gain. To achieve this elevation gain, a booster station(s) will be required. A utility corridor will house a 6 m wide secondary mine site access road (Section 3.5.8 Mine Service and Haul Road) originating from the MAR, and a 25 kV transmission line originating from the PDC. Booster stations will placed along the access road.

The booster station will comprise a structural steel skid complete with a building equipped with all necessary access, insulation, heating, ventilation, and lighting. The skid will contain the pumps, piping, and valves in one room, and the electrical infrastructure in a separate room. The pumps will be equipped with variable frequency drives and will be fed directly from the main FWSS pipeline.

Pipeline

The pipeline/water conveyance will be comprised of 5 sections: a higher pressure section immediately upstream of the pumphouse, transitioning to a lower pressure as the pipeline gains elevation, then again after the booster station the pipeline is at higher pressure transitioning a second time to a lower pressure, a final outfall section will descend to either the FWR or Davidson Creek.

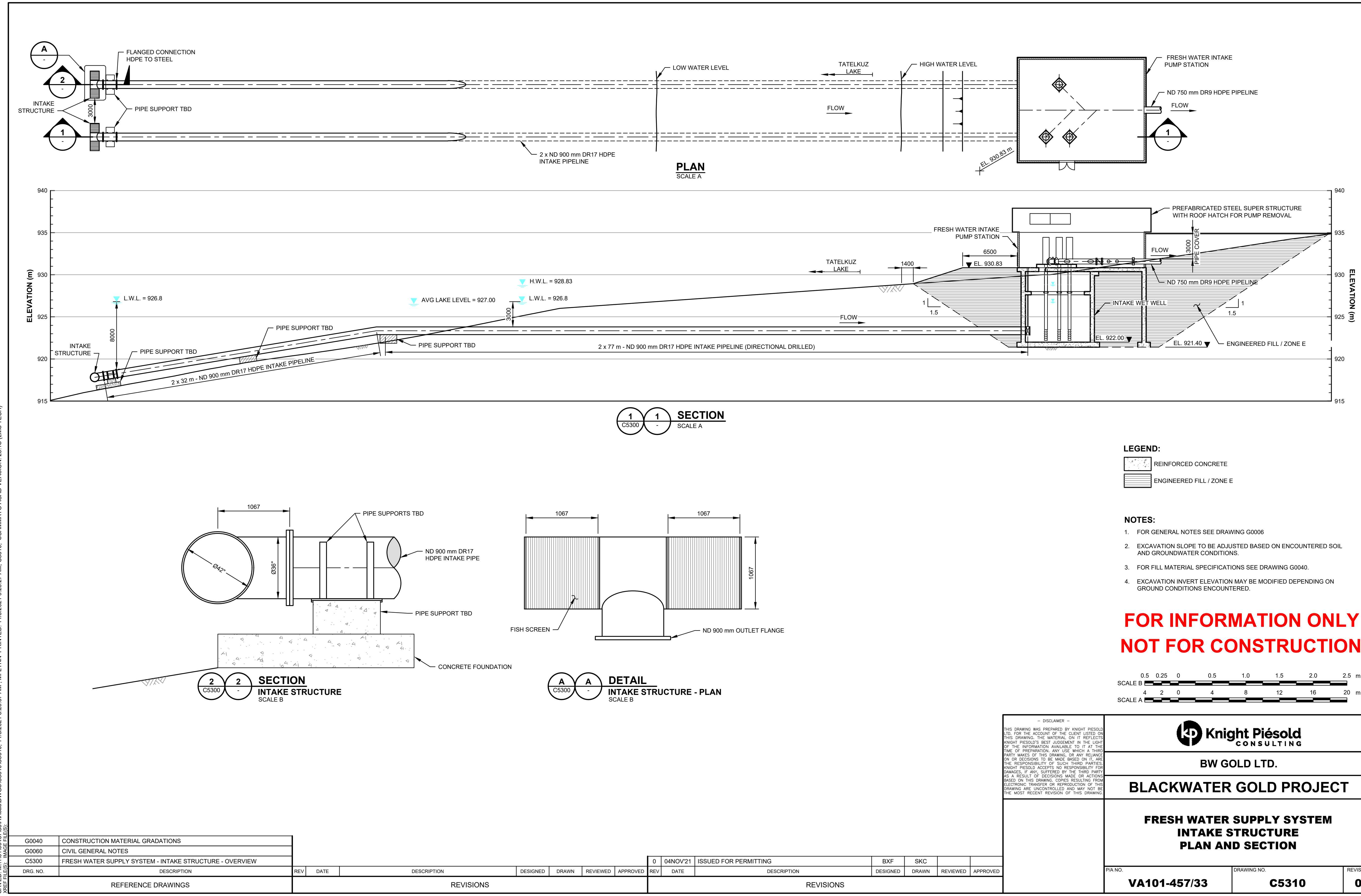
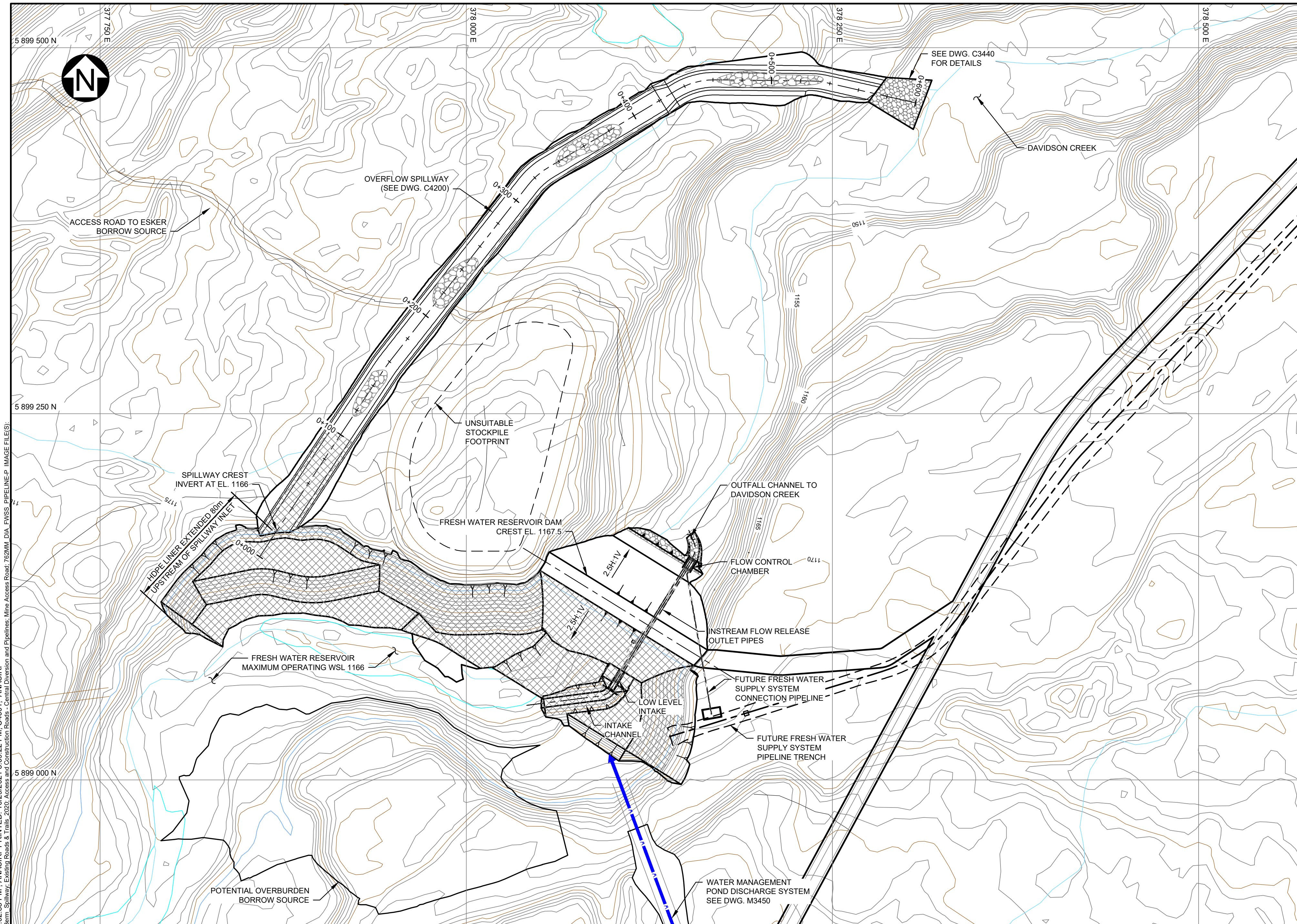


Figure 3.5-59: Tatelkuz Lake Intake Structure and Pump Station

Source: Knight Piésold Consulting (2021m; Appendix 3-P).



PLAN
SCALE A

LEGEND:

- HDPE LINER
- RIPRAP
- CONSTRUCTION ROAD
- ACCESS ROAD
- WATER DIVERSION PIPELINE
- EXISTING ACCESS TRAILS

NOTES:

1. FOR GENERAL NOTES SEE DRAWING G0006.
2. FOR FRESH WATER RESERVOIR INSTRUMENTATION SEE DRAWING C1506.

DETAILED DESIGN
NOT FOR CONSTRUCTION

SCALE A 30 15 0 50 100 150 m

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BLACKWATER GOLD PROJECT

FRESH WATER RESERVOIR
EMBANKMENT AND RESERVOIR
GENERAL ARRANGEMENT

P/A NO.	DRAWING NO.	REVISION
VA101-457/33	C4001	0

DRG. NO.	DESCRIPTION
M3450	WATER MANAGEMENT POND - DISCHARGE SYSTEM - PIPELINE - PLAN AND PROFILE
C4200	FRESH WATER RESERVOIR - OVERFLOW SPILLWAY - PLAN AND PROFILE
C1506	TSF - STAGE 1 INSTRUMENTATION - SECTIONS (SHEET 2 OF 3)
C1440	TSF - CULVERT AND STILLING BASIN - TYPICAL SECTIONS AND DETAILS
G0006	CIVIL GENERAL NOTES

REFERENCE DRAWINGS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED

REVISIONS

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	REVIEWED	APPROVED
0	29OCT'21	ISSUED FOR PERMITTING	CBN	ELG/ABN		

REVISIONS

SAVED: M:\1\01\00457\33\A\Acad\DWGS\C4001\C4001, 10/29/2021 3:02:38 PM, ANASIRI PRINTED: 10/29/2021 3:09:22 PM, C4001, ANASIRI
XREF FILE(S): Topo 1m Contours; Hydro; TrimRoads_UTM10; Fresh Water Reservoir_Berm_Spillway; Existing Roads & Trails_2020; Access and Construction Roads - Central Diversion and Pipelines; Mine Access Road; 762MM_DIA_FWSS_PIPELINE-P IMAGE FILE(S):

Figure 3.5-60: Freshwater Reservoir General Arrangement

Source: Knight Piésold Consulting (2021).

3.5.7 Topsoil Stockpiles

3.5.7.1 General Description

During the LoM, reclamation materials (i.e., topsoil with subsoil, organic soil) will be salvaged and stored for use in progressive or final reclamation. The total estimated volume of potentially salvageable soil is 5.45 Mm^3. Seven soil stockpile locations have been identified at various locations throughout the mine site. The total area for these topsoil stockpiles is estimated to be 10 ha (Figure 3.5-61). Other topsoil placement includes windrowed areas for salvaged soils alongside roads and other linear corridors and smaller stockpiles adjacent to small clearings or for short-term temporary storage. During construction, other locations based on site suitability and feasible haul costs may be identified and proposed to be utilized. A number of factors will determine the deposition of the salvaged soil at stockpiles including: distance from source and location of final distribution for reclamation, types of materials, and access to transportation routes.

3.5.7.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction, operation, closure, and reclamation of the topsoil stockpiles. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements include:

- Part 6.10.1 Dumps, Roads and Ramps - Manager Responsibility – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10.1.3 Application - (d) Mine Plan (vi) dumps etc. – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

- Part 3 Mine Plan; Section 3.5.7 Ore, Overburden, Soil, and Construction Stockpiles – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Key reports and other documentation is as follows:

- Soil Management Plan (IEG 2021) – Appendix 9-B;
- Blackwater Gold Project – Open Pit and Stockpile Design Report (MMTS 2021) – Appendix 3-C; and
- Blackwater Gold Project – Stockpiles Geotechnical and Water Management Design Report (KP 2021l) – Appendix 3-N.

EAC Conditions

There are no EAC conditions related to the design, construction and operation of topsoil stockpiles.

3.5.7.3 Planned Storage Capacity

The planned topsoil storage capacity is 7.89 Mm^3 distributed amongst seven stockpiles (Table 3.5.7-1). Plan and section views of the topsoil stockpiles are presented in Appendix 3-C.

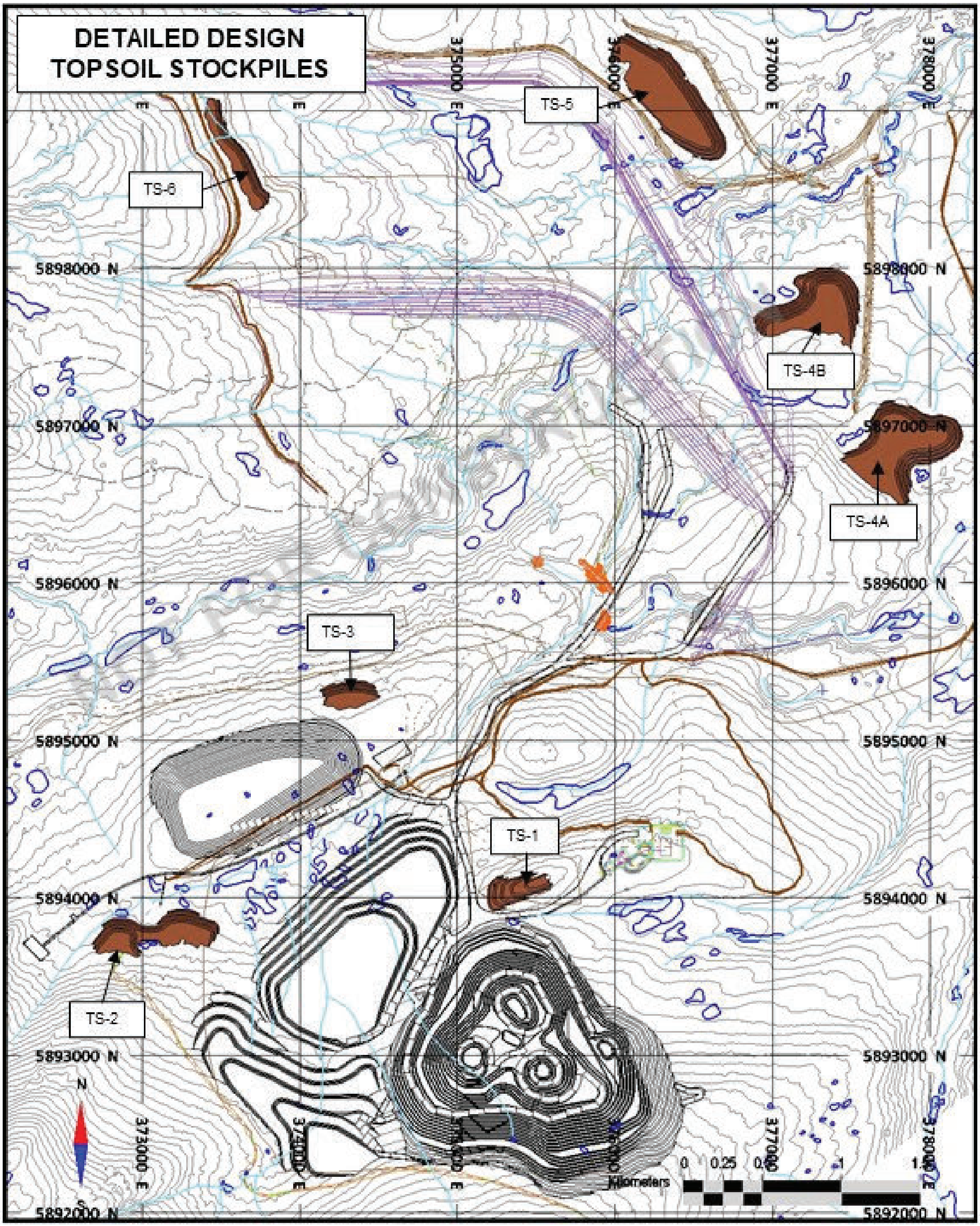


Figure 3.5-61: Simplified General Arrangement of Topsoil Stockpiles

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

Table 3.5.7-1: Topsoil Stockpiles Parameters

Topsoil Stockpile	Available Capacity (Mm^3)	Foundation Angle (degrees)	Base Elevation (masl)	Final Elevation (masl)	Source of Soils
TS1	0.13	4	1,485	1,510	Additional capacity for mine infrastructure area, if required
TS2	0.73	5	1,440	1,470	Lower Waste Stockpile, LGO Stockpile, Open Pit, Explosives Storage Facility, Plant Site, Ready Line and Bulk Storage area
TS3	0.20	6	1,390	1,405	Additional capacity for mine infrastructure area, if required
TS4A	2.57	2	1,255	1,275	Main Dam D and TSF D, if required
TS4B	2.01	5	1,230	1,250	Main Dam C, TSF C, and FWR
TS5	2.02	3	1,225	1,245	Main Dam D and TSF D
TS6	0.23	5	1,325	1,340	Main Dam D and Northern Diversion System
Total	**7.89**				

3.5.7.4 Design Standards

Stockpile Layout Criteria

Table 3.5.7-2 summarizes the layout criteria that influenced the design of the topsoil stockpiles.

Table 3.5.7-2: Topsoil Stockpile Design Standards

Parameter	Value
Lift heights (m)	5
Maximum number of lifts	4
Slope for each lift	3H:1V
Overall slopes including 10 m wide berm	5H:1V

Stockpile Stability

The stability rating for topsoil stockpiles was assessed using the waste dump and stockpile stability rating and hazard classification system (Hawley & Cunning 2017) for comprehensive dump stability assessments. The WSR and classification system requires evaluation of 22 key factors or attributes that are considered to affect stability. These factors are organized into seven groups. Numerical ratings are assigned to each factor, and the sum of these ratings defines the WSR.

The worst-case values from all the topsoil stockpiles for each factor were used to determine a conservative rating for all the topsoil stockpiles for the purpose of selecting a hazard classification. The topsoil stockpiles had a WSR of 62.5 and assigned a WHC of II, a low instability hazard.

Slope stability analyses were completed for topsoil stockpiles TS-1, TS-2, TS-3, TS-4B, and TS-5 using the two-dimensional limit equilibrium analysis software SLOPE/W (GeoStudio 2021). The estimated factor of safety (FoS) against rotational failure modes was determined for static and seismic loading conditions.

The Morgenstern-Price method was used to estimate the FoS for all models. Factors of safety were computed for topsoil stockpiles considering deep-seated global slip surfaces. The stability and sensitivity analyses confirmed that the designs meet the required FoS for all loading conditions.

Additional details related to the above analyses and results are presented in Appendix 3-N.

Water Management

The water management design for the topsoil stockpiles includes a series of water collection and diversion channels as well as one sediment control pond per stockpile. The intent is to divert non-contact surface runoff around the stockpile facilities to natural water courses. The topsoil stockpile collection channels will be constructed along the stockpile peripheries to collect and convey the contact-water surface runoff to the sediment control ponds. The sediment control ponds are sized to safely manage storm event runoff while allowing for adequate suspended sediment settling time prior to release to the downstream environment. The water management components have been designed for the ultimate stockpile configurations and are to be installed prior to the start of topsoil fill placement in each stockpile.

The following are specific design features of the topsoil stockpile water management components:

- cut/fill erosion protection-lined earthfill collection and diversion channels;
- contact water sediment control ponds;
- primary outflow culverts; and
- emergency spillways.

Design criteria were developed for the topsoil stockpile water management features as the basis for designs. The water management systems will be constructed at each stockpile prior to the start of fill placement at that particular stockpile. Considerations used in the development of the water management designs, design details and design drawings are included in the Stockpiles Geotechnical and Water Management Design Report (KP 2021l) in Appendix 3-N.

The design of topsoil stockpile water management features for stockpiles TS-1, TS-2, TS-3, TS-4B and TS-5 was completed. The design of water management measures and geotechnical analyses for two additional topsoil stockpiles (TS-4A and TS-6) will be completed when they are required during mine operations and were excluded from the detailed design report.

3.5.7.5 Construction and Maintenance

Soil stockpiles will be bottom up construction. The surface area of stockpiles should be maximized to maintain higher levels of biological activity. Stockpiles will be managed to prevent loss of soils through erosion and colonisation by non-native vegetation. This may include; sediment and erosion control measures on the surface and stockpile perimeter and a certified weed-free vegetative cover. Clearly marked signage will identify the stockpile for reclamation management at time of mine closure, and to ensure stockpiles are not used for any other purpose but reclamation during LoM.

Details for the management and monitoring of salvageable soils are presented in the Soil Management Plan (Appendix 9-B) and the Construction Environmental Management Plan (Appendix 9-C).

A preliminary evaluation of the topsoil stockpile locations and designs was conducted (KP 2021l). The assessment considered proximity to the TSF and associated facilities, stockpile capacity, and other logistical/technical factors. It is generally assumed that the topsoil stockpiles would be developed progressively on an as needed basis to limit the need for these additional water management facilities to the extent practicable. The topsoil stockpile evaluation concluded that the TS-2 and TS-4B locations are the preferred topsoil stockpiles to construct first. Other facilities will be developed progressively on an as-needed basis.

3.5.7.6 Closure

Stockpiled soils will be used for progressive and final reclamation of the mine site. A sufficient base of salvaged soils will be left (0.5 to 1.0 m) to support reclamation of the topsoil stockpiles when they are depleted.

3.5.8 Mine Service and Haul Roads

3.5.8.1 General Description

Mines Act Permit M-246 (Early Works) authorizes mine service roads, and ex-pit mine haul roads. The road network for the mine site will develop as the Project progresses. The key road developments will be the expansion of the TSF in Year +6 with the construction of the Main Dam D, the West Dam and eastward expansion of the Open Pit, and the roads to stockpiles (Figure 3.5-62). Traffic controls for the mine site road network are presented in Mine Site Traffic Control Plan (Appendix 9-L).

Major mine service roads include:

- Explosives Storage Facility Service Road – no change under this Application;
- Central Mine Site Service Road – new road developed under this Application;
- East Plant Site Service Road – new road developed under this Application;
- West Plant Site Service Road – new road developed under this Application;
- TSF Service Road – new road developed under this Application;
- Borrow and Preparation Area Service Road – rerouting and extension of this road under this Application;
- Northern Diversion Road – new road developed under this Application; and
- Operations Camp Access Road – no change under this Application.

Haul roads include:

- Ex-pit haul roads (Section 3.5.8.9); and
- In-pit haul roads (Section 3.5.8.9).

Aside from these roads, short access roads will be built temporarily as required to support development and operation of facilities. Temporary access will also be built to support construction of infrastructure.

3.5.8.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction, operation, closure, and reclamation of mine service and haul roads. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements are set out in Part 6 Mine Design and Procedures; Section 6.9 Mine Haul Road Design – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

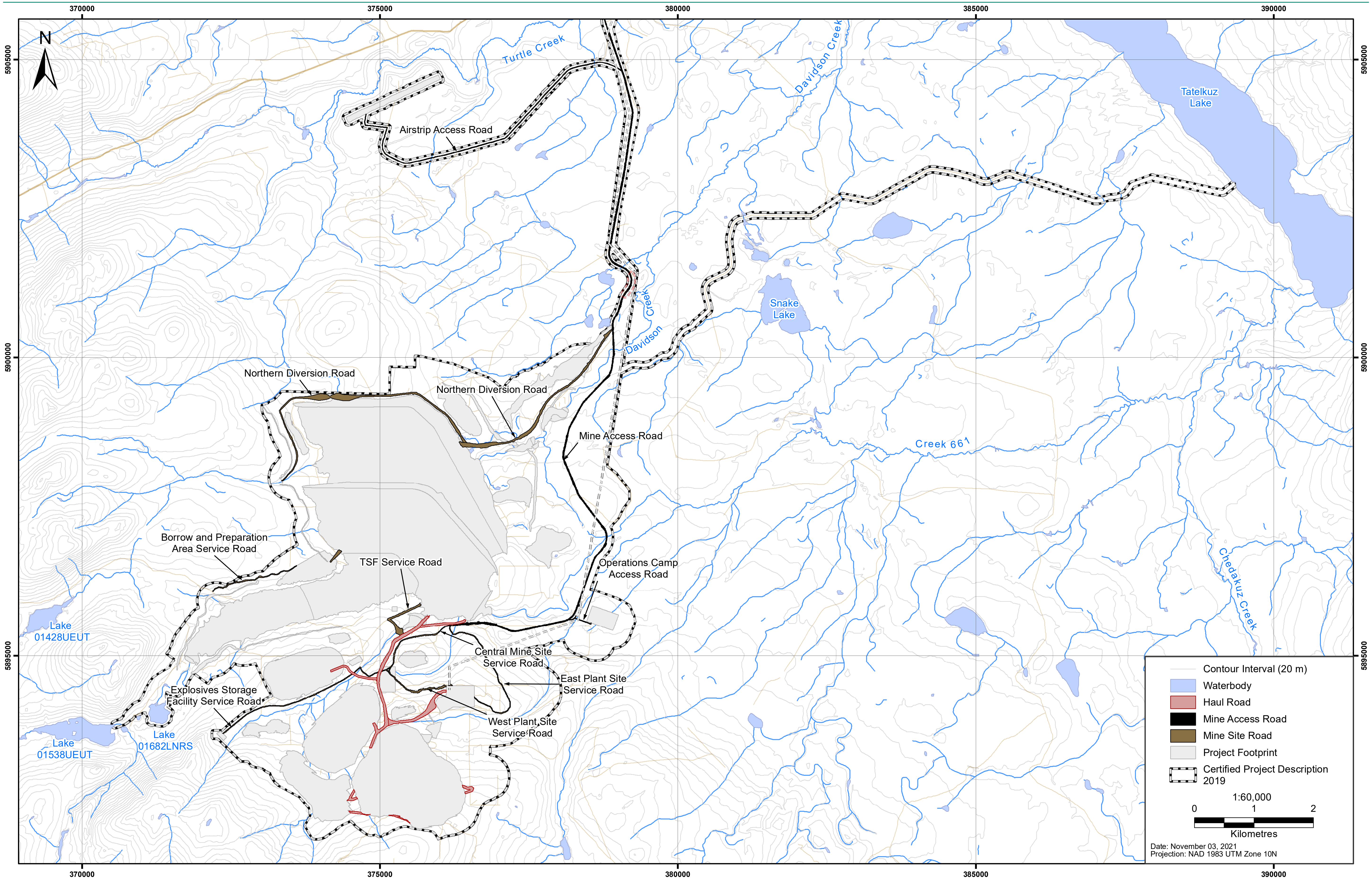


Figure 3.5-62: Simplified General Arrangement of Roads Year +18

Technical Guidance

Technical guidance includes:

- Forest Road Engineering Guidebook 2nd Ed. (MoF 2002); and
- Part 3 Mine Plan; Section 3.5.8 Mine Access and Mine Haulage Roads – JAIR (BC EMPR & BC ENV 2019).

Key Reports and Other Documents

Key reports and other documents include:

- Blackwater Gold Project Geotechnical Characterization Report (KP 2013e);
- Blackwater Gold Project Mine Access Road – Special Use Permit Application (Artemis 2020b);
- Blackwater Gold Project 2019 Geotechnical Site Investigation Data Report (KP 2021b) – Appendix 3-D;
- Blackwater Gold Project 2020 - 2021 Geotechnical Site Investigation Data Report (KP 2021c) – Appendix 3-E;
- Blackwater Gold Project Seismic Hazard Assessment (KP 2021g) – Appendix 2-E;
- Blackwater Gold Project – Open Pit and Stockpile Design Report (MMTS 2021) – Appendix 3-C;
- Condemnation Report of the Blackwater Project (Baker & Popelka 2021) – Appendix 3-G;
- Blackwater Gold Project Early Works Joint *Mines Act* / *Environmental Management Act* Permits Application (Artemis 2021); and
- Section 6 Roadworks in Civil Design Criteria. Appendix 3 Design Criteria of the Blackwater Gold Project - Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F.

EAC Conditions

EAC conditions relevant to mine service and haul roads includes:

- Condition 22 (Caribou Mitigation and Monitoring Plan) – requires the existing Exploration Access Road (from its origin at the Kluskus-Ootsa FSR to the mine site) and the Mount Davidson Exploration Road to decommissioned and reclaimed in a manner that supports the reestablishment of caribou habitat.

The Caribou Mitigation and Monitoring Plan must be developed in consultation FLNRORD, EMLI, ENV, ECCC, and Aboriginal Groups.

3.5.8.3 Condemnation Assessment

Condemnation of resources for the road footprints were investigated with drilling programs described in Appendix 3-G. The road network is distributed across condemnation assessment areas; stockpile, Plant Site, TSF, and camp areas (Figure 2 of Appendix 3-G). No economically viable mineralization is anticipated to be beneath the roads constructed in these areas. If new information in the future requires, road alignments can be modified.

3.5.8.4 Geotechnical Characterization

The geotechnical characteristics of these roads are covered by site investigations in 2012, 2013, 2019, 2020, and 2021 (KP 2013e; Appendices 3-D and 3-E).

3.5.8.5 Seismicity and Other Geohazards

Potential risks to the mine site associated with natural and seismic hazards are discussed in Section 2.3.4 Natural and Seismic Hazards Assessments and Appendix 2-E. In general, the overall risk to landslides and mass wasting, snow avalanches, flooding, subsidence, seismic events, and volcanic events is low.

3.5.8.6 Mine Access Roads

Exploration Access Road

Mines Act Permit M-246 authorizes upgrading the existing Exploration Access Road to allow for transport of construction machinery and materials to the mine site (Figure 3.5-63). As per Condition 22, the existing Exploration Access Road will be decommissioned as soon as the MAR becomes operational. After closure, the southern sections of the Exploration Access Road will be connected to the Northern Diversion Road. It will continue to be used to access areas north of the TSF.

Mine Access Road

The MAR is authorized by Special Use Permit SP0001 (Table 1.4-1 in Chapter 1). The road surface running width to the boundary of the mine site is 5 m wide, single lane with pullouts, and has a design maximum speed limit of 50 km/h. The MAR crosses three bridges within the mine site; Davidson Creek crossing with a 18.3 m steel concrete composite on pre-cast spread footing, and two crossings of the Creek 661 tributaries with a 14.0 m slab girder bridge on pre-cast spread footing, and a 12.0 m slab girder bridge on pre-cast spread footing.

3.5.8.7 Road Construction

When construction is required, roads will be pioneered by dozers as a balanced cut/fill accesses with a collector ditch and soil salvage temporarily windrowed up-slope locally. Material for surfacing will be sourced from borrow areas when available; otherwise, suitably sized NAG waste rock from the Construction Borrow pits will be used. Rock outcrops will be avoided is possible, however; if roads need to be built through rock outcrops, drilling and blasting may be required ahead of road construction. During the pre-development stage, road construction will be guided by the Surface Erosion Prevention and Sediment Control Plan (Appendix 9-A).

The typical cross drain will be a CSP with a minimum diameter of 600 millimetres. The ground in this area is relatively dry and the topography of the terrain is favorable to drain the water away from the road prism. Cross drains will be used to minimize the distance that water in the ditch travels before being dissipated away from the road prism. Typical locations for culvert placement will be, but not limited to, the following:

- At top of step gradient;
- In seepage zone;
- At natural drainage pattern disruption; and
- At low point in the road profile where the existing ground topography does not allow the water to dissipate away from the road prism.

Damaged culverts will be replaced and new culverts installed where required.

Roadside ditches will be flat-bottom channels with the invert a minimum depth of 300 mm below the sub-base and a minimum width of 1,000 mm. Rip-rap and sediment control devices will be incorporated in the design where required. Hydro seeding will be used to protect erodible fills.

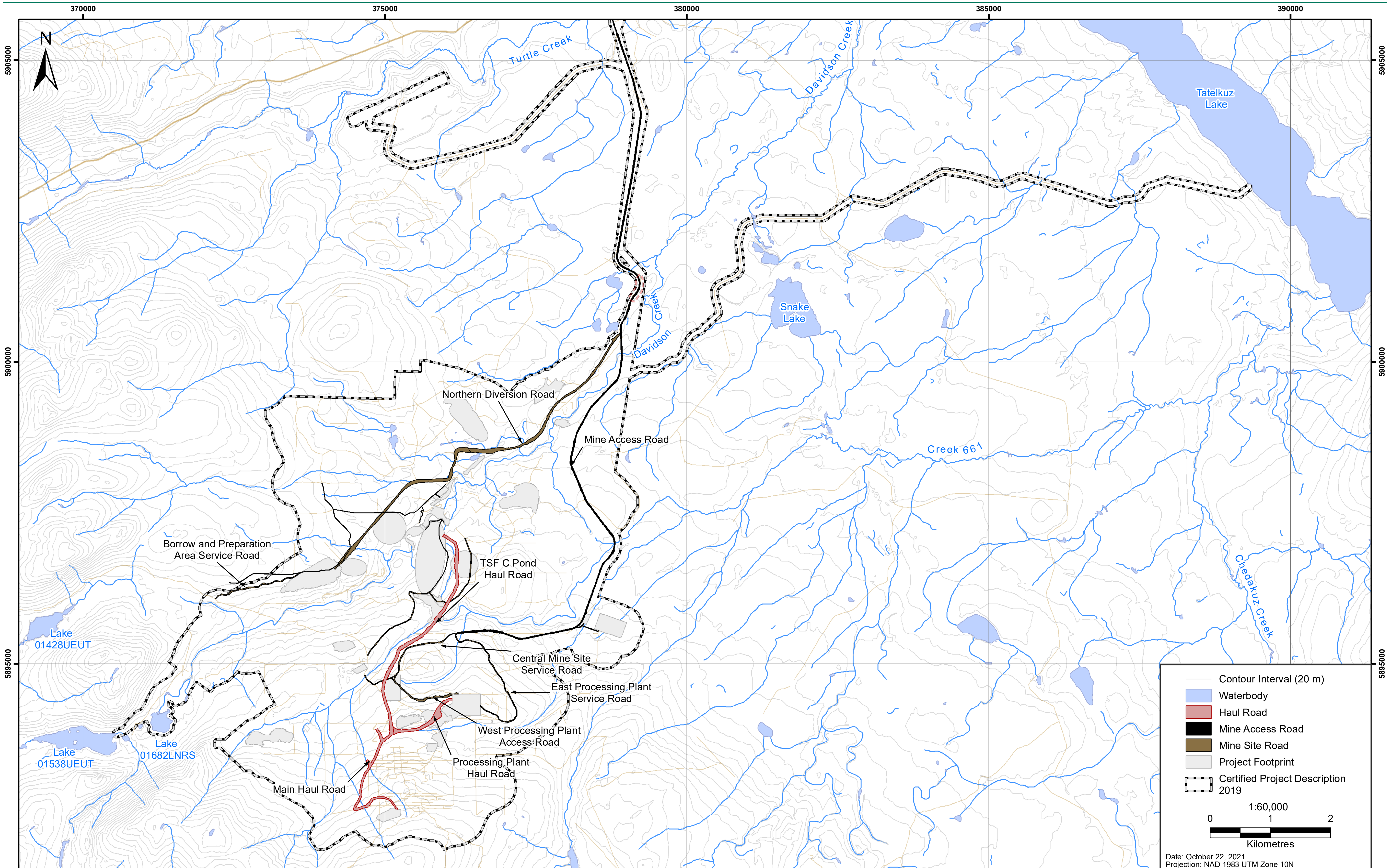


Figure 3.5-63: Simplified General Arrangement of Roads Early Works

The anticipated completion of the major mine site road network is Year +6 with the accessing of the facilities associated with the construction and operation of the Main Dam D and the associated downstream facilities.

3.5.8.8 Mine Service Roads

Mine service roads provide access between the mine site facilities construction and operations. The mine service roads will retain the running surface of 5 m width for this Application. The maximum gradient for mine service roads will be 10% with a maximum designated speed limit of 50 km/h.

Mine service road design parameters are presented in Table 3.5.8-1. Road bed thickness and materials are presented in Table 3.5.8-2.

Table 3.5.8-1: Mine Service Road Design Parameters

Parameter	Value
Minimum Width of Travelled Surface (m)	5
Minimum Shoulder Width (m)	1
Ditch Allowance, if ditches required (m wide x m deep)	1.5 x 0.5
Design Loading	ASSHTO H20
Crown Slope (degrees)	2
Minimum Surface Course Thickness (mm)	100
Vertical Curves	L = 11 x A; where A = algebraic difference in adjoining grades

Table 3.5.8-2: Mine Service Road Roadbed Thickness and Materials

			Material	
Road	Surfacing (mm)	Base[2] (mm)	Surfacing	Base
Primary Roads Service Roads	150	450	25 mm minus crushed rock	100 mm minus crushed rock
Secondary Service Roads	150	300	25 mm minus crushed rock	100 mm minus crushed rock
Haul Roads	200	500	50 mm minus crushed rock	200 mm minus shot rock

Notes:

[1] *To be confirmed by geotechnical analysis at the design stage.*

[2] *If over rock, can reduce thickness by 100 mm.*

3.5.8.9 Mine Haul Roads

Ex-Pit Haul Roads

Mines Act Permit M-246 (Early Works) authorizes constructing mine service roads, and ex-pit mine haul roads, during Construction and Operations, the road network were will be expanded to incorporate the development of the Open Pit. The ex-pit haul roads will be built on relatively gently sloping terrain. Ex-pit roads will have a maximum grade of 10%. Table 3.5.8-3 summarizes the design parameters of the ex-pit mine haul roads. A typical section of ex-pit haul roads is presented in Figure 3.5-64.

The Code require runaway lanes spaced as required for all roads over 5% grade. These are not shown in the feasibility level design but will be included in operational planning.

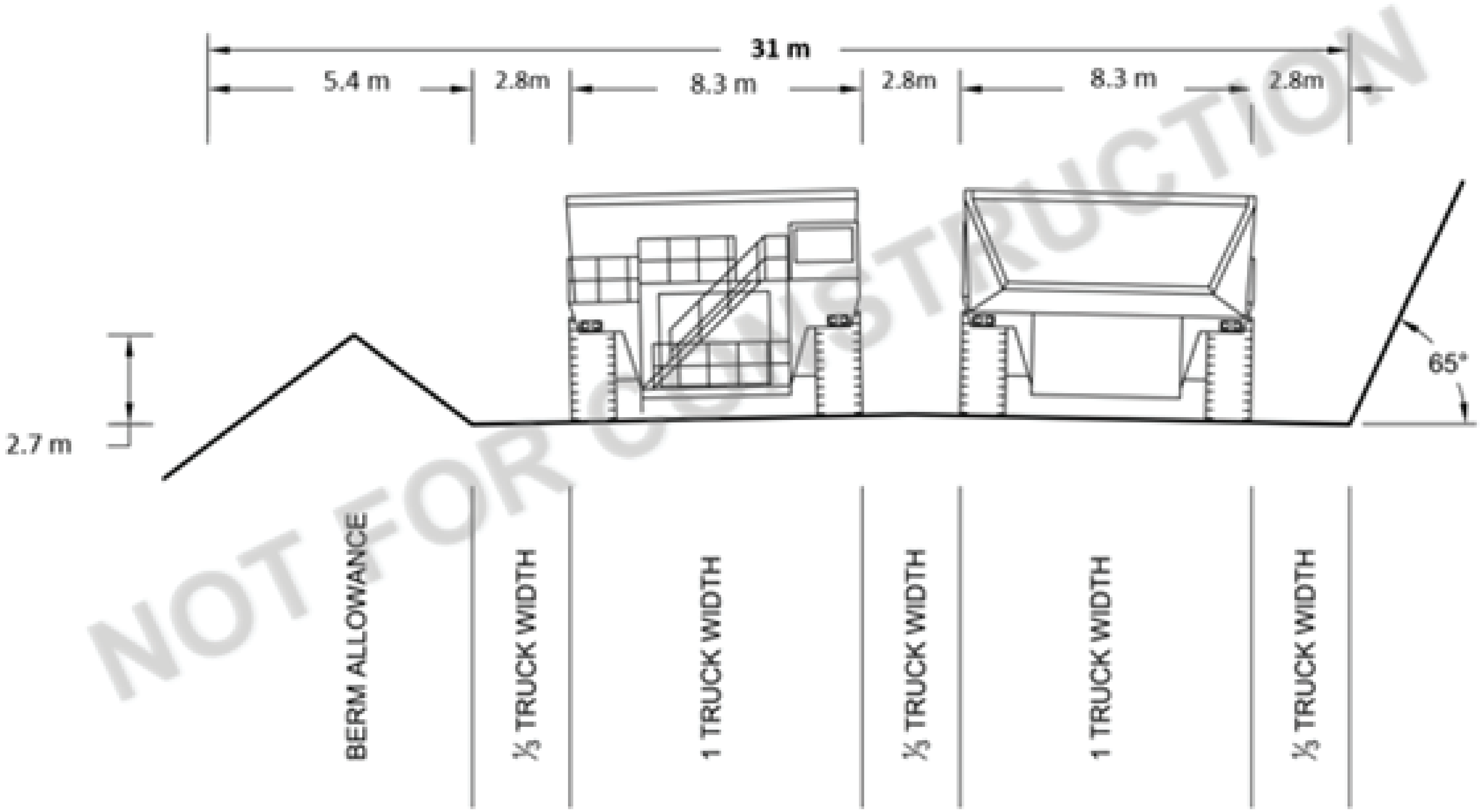


Figure 3.5-64: Typical Section of Ex-Pit Haul Road

Table 3.5.8-3: Ex-Pit Haul Road Design Parameters

Parameter	Value
Operating width of max. vehicle – 230 t payload (m)	8.3
Two-way haul (ex-pit) – 3 times maximum truck width + berms + ditching (m)	36
Cut slopes (degrees)	45
Fill slopes (degrees)	37
Berm Height (m) – ¾ the height of the largest tire	2.7
Ditch Allowance, if ditches required (m wide x m deep)	3 x 1

Although the requirements of haul truck fleet are the primary consideration in haul road design, they are capable of being used by all light and heavy equipment in operation at the mine site. Where alternate routes exist, light vehicles are directed to avoid interaction with the mining fleet (Appendix 9-L). Pullouts will be designed into haul roads to support safe passing of vehicles and accommodation of roadside breakdowns and servicing.

Details of in pit road design are presented in Section 7 Mine Haul Road Designs in Appendix 3-C.

The ex-pit haul road network is built as required to access pit phases. The haul road runs from the pit exit:

1. West to the Upper Waste Stockpile,
2. Northwest to the LGO Stockpile;
3. Northeast to access the crushing area,
4. North and west to the Lower Waste Stockpile; and
5. North branch to access the PAG stockpile, upper lifts of TSF C and TSF D.

The ex-pit access haul roads are presented in Figure 3.5-65. Access to specific Open Pit phases are presented in Section 3.5.6.1 Phased Development.

In-Pit Haul Roads

Two-way in-pit haul roads will have a travel width of not less than 3.0 times the width of the widest haulage vehicle. The narrower roads are planned for the first five pit phases, as smaller haul trucks (191 t payload) are planned to operate in those phases, and the wider roads are planned for the final three phases with larger haul trucks (230 t payload). For single lane traffic a travel width of not less than 2.0 times the width of the widest haulage vehicle used on the road (only used on bottom two pit benches, for temporary low traffic access). Table 3.5.8-4 presents the design criteria of the in-pit haul roads.

Table 3.5.8-4: In-Pit Haul Road Design Parameters

Parameter	Hauler Class	
	230 t Payload	190 t Payload
Hauler width (m)	8.3	7.65
Hauler tire height (m)	3.6	3.42
Berm height (3/4 * tire height) (m)	2.7	2.6
Berm width (1.5:1 slope) (m)	5.4	5.1
Two way traffic haul road width (m)	31	29
One way traffic haul road width (m)	22	21

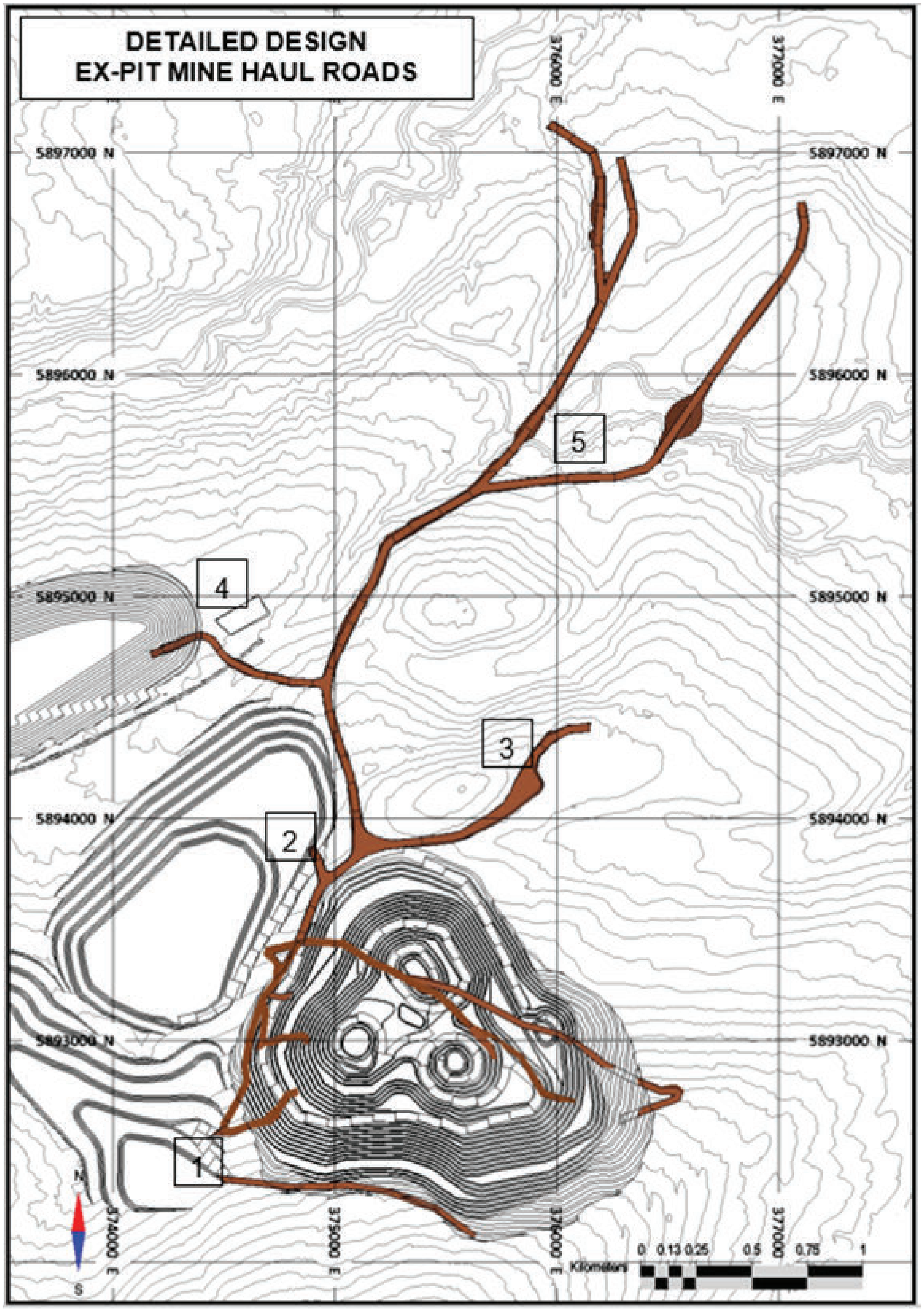


Figure 3.5-65: Ex-Pit Haul Road Access to Open Pit

Source: Moose Mountain Technical Services (2021; Appendix 3-C).

Shoulder barriers are 3/4 of the height of the largest tire on haul vehicles wherever there is a drop-off greater than 3 m. The shoulder barriers are additional to the travel width on the overall road width allowance and are designed at 1.5H:1V. There is anticipated adequate water drainage at the edge of the road between the crowned surface and lateral embankments such as highwalls or the shoulder barriers. In practice, excavated ditches in haul roads quickly get filled in by road grading; and when maintained as open ditches can create a hazard if haul trucks or light vehicles catch a wheel in them.

In-pit haul road grades will be limited to a maximum of 10%, except for the bottom two benches of the pit, where grades will be increased to 12%. Access ramps are not designed for the last two benches of the pit bottom, on the assumption that the bottom ramp segment will be removed using retreat mining.

Details of in-pit road design are presented in Section 4.1 In-Pit Haul Road Design Parameters in Appendix 3-C.

A typical section of in-pit haul roads is presented in Figure 3.5-66.

3.5.8.10 Stream Crossings

Based on the preliminary alignment of roads, there may be eight stream crossings for the mine site. The design of the stream crossings will be determined after the final alignment of roads and the design of site-specific crossings.

3.5.9 Power Supply and Distribution

3.5.9.1 General Description

There is no grid-connected power in the vicinity of the mine site. Power during construction will be provided by diesel generators located at the exploration camp. By the end of Year -1, a 230 kV overhead pole line from the Glenannan substation will be routed to the mine site, which will become the main power supply for the LoM (Figure 3.1-5). The transmission line will enter the mine site generally parallel to the MAR, occupying a 30 m wide, cleared right-of way. The transmission line will be routed to the main substation in the Plant Site footprint (Figure 3.5-67). From there power will be distributed by the main substation throughout the mine site (Figure 3.5-68). During operations, this system will be backed up with diesel generators for emergencies.

The key power supply and distribution infrastructure that support mining operations include:

- Transmission line from the Glenannan substation[9];
- Main substation – Section 3.5.9.4;
- On-site power distribution – Section 3.5.9.4; and
- Standby/emergency power – Section 3.5.9.4.

3.5.9.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for power supply and distribution. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

[9] The transmission line from BC Hydro's Glenannan Substation to the mine site is off-site infrastructure will be addressed in a separate permit application.

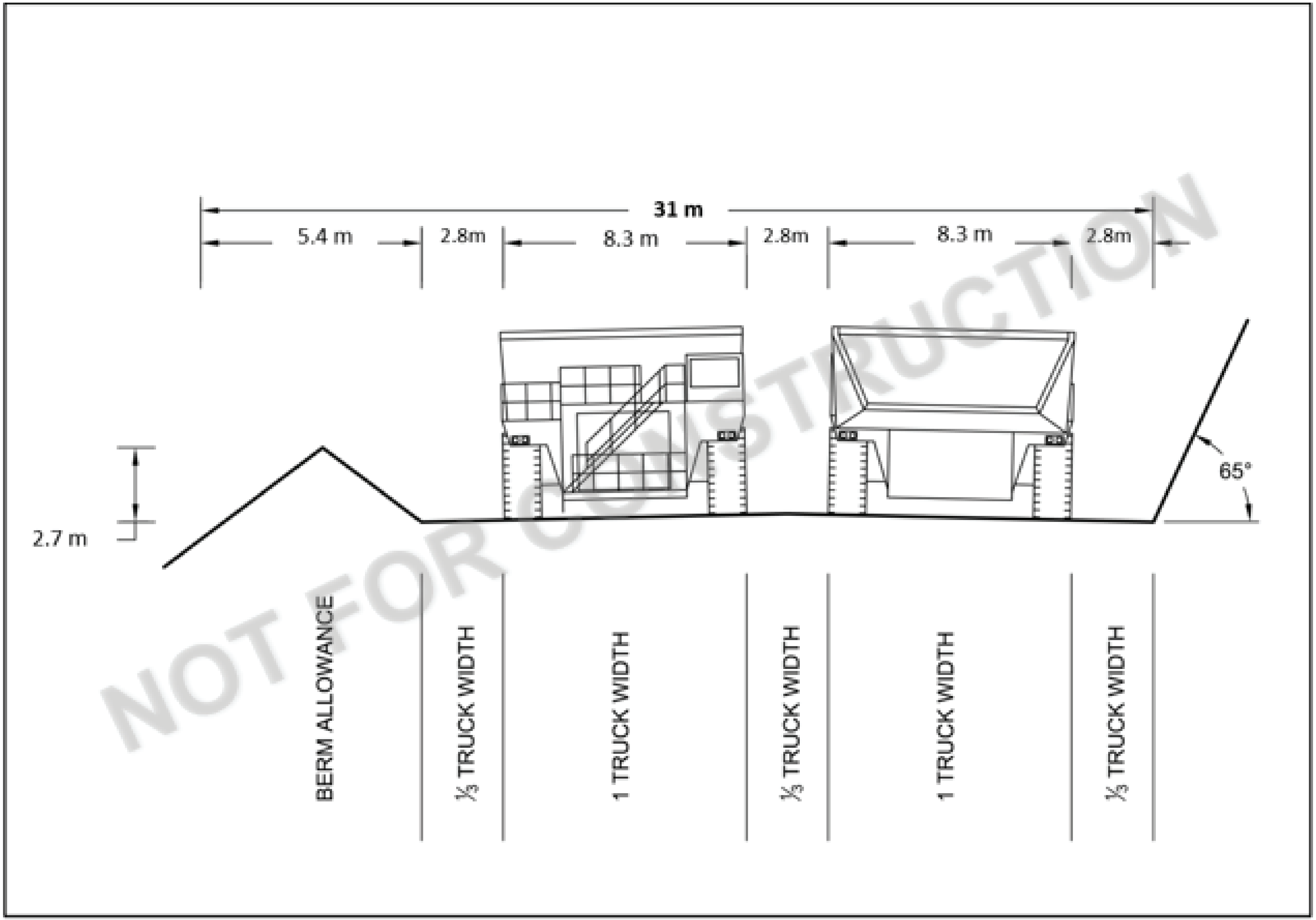


Figure 3.5-66: Typical Section of In-Pit Haul Road

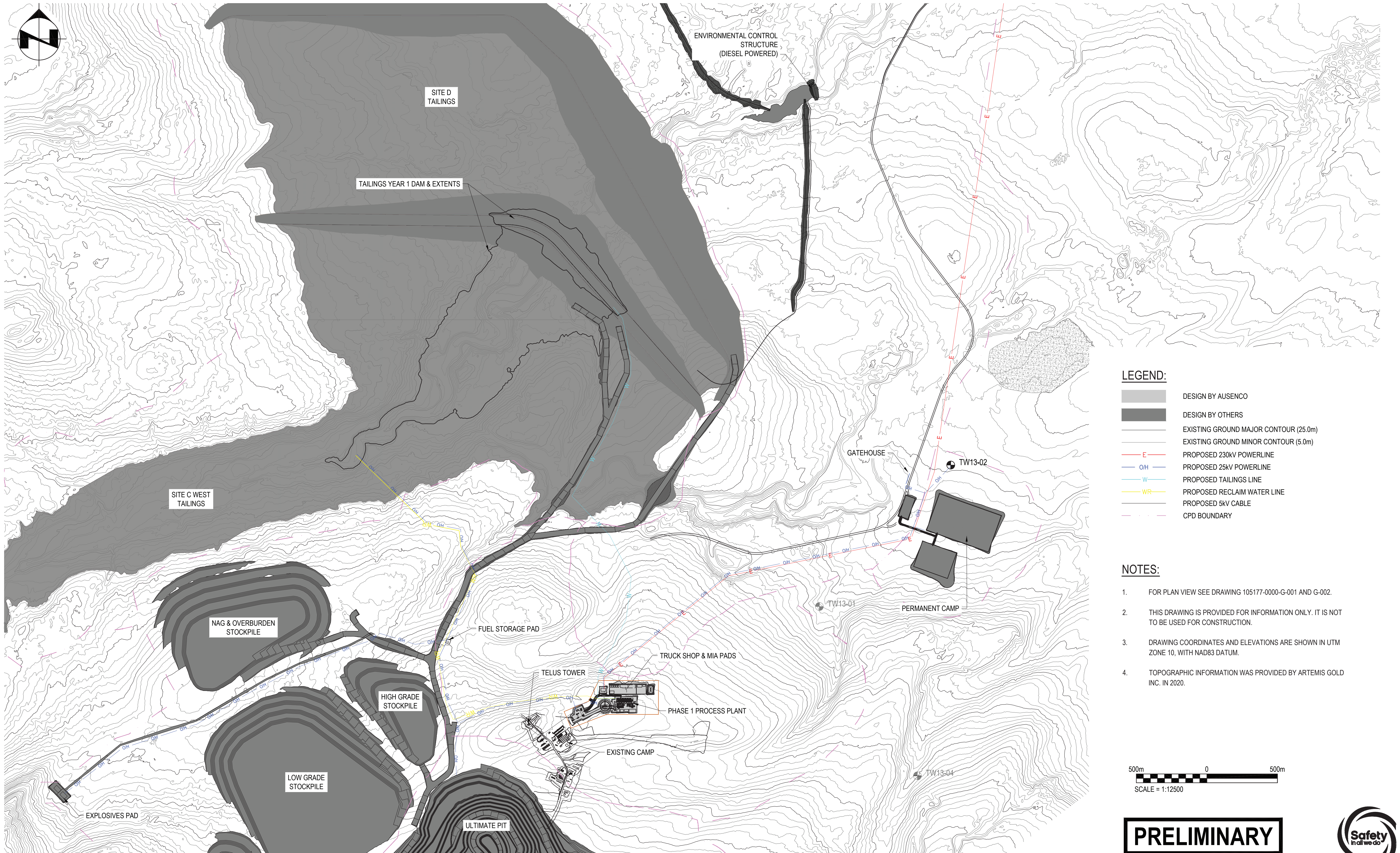


Figure 3.5-67: Distribution of Power within Mine Site

Source: Ausenco (2021).

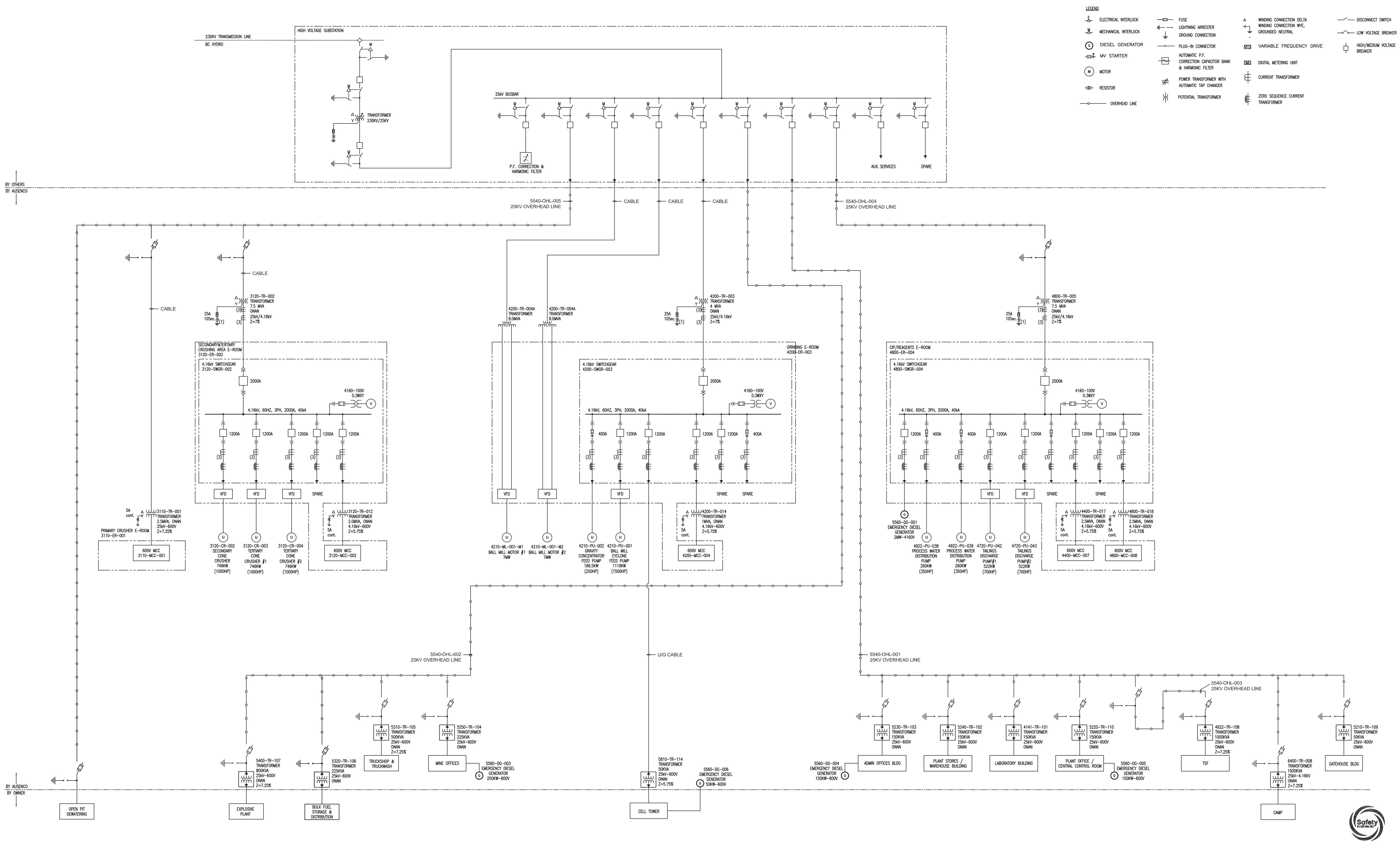


Figure 3.5-68: Simplified Schematic of Power Distribution throughout Mine Site

Source: Source: Ausenco (2021).

Regulatory Framework

Regulatory requirements are set out in:

- Part 5 Electrical Power System – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021); and
- Part 10.1.3 Application (d) Mine Plan (i) power transmission lines – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

- Part 3 Mine Plan; Section 3.5.9 Power Supply and Distribution Infrastructure – JAIR (BC EMPR & BC ENV 2019).

Key Reports and Other Documents

Key reports and other documents include:

- Blackwater Gold Project 2020-2021 Site Investigation Report (KP 2021c) – Appendix 3-E;
- Blackwater Gold Project Plant Site Foundation Assessment (KP 2021f) – Appendix 3-H;
- Appendix 3: Civil Design Criteria. Design Criteria of the Blackwater Gold Project - Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F;
- Appendix 3: Electrical Design Criteria. Design Criteria of the Blackwater Gold Project - Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F; and
- Appendix 6: Single Line Diagram - Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F.

EAC Conditions

There are no EAC conditions related to the design, construction, operation, decommissioning/closure, and reclamation of the mine site[10] power supply and distribution.

3.5.9.3 Design Criteria

Details of the electrical design criteria are presented in Appendix 3 Design Criteria: Electrical Design Criteria of Appendix 3-F. This appendix details the following design criteria for the following sections.

- Power Supply Sources and Distribution – Sections 5 to 7;
- Control Power – Section 8;
- Substations and Electrical Rooms – Section 9;
- Transformers and Overhead Lines – Sections 10 and 11;
- Switchgear and Motor Control Centres – Sections 12 to15;
- Enclosures and Cables – Sections 16 to 18;
- Lighting and Small Power – Section 19;
- Batteries and Uninterruptible Power Supply (UPS) – Sections 20 and 21; and
- Grounding, Lightning and Corrosion Protection – Section 22.

[10] A number of EA Conditions relate to the transmission line from BC Hydro's Glenannan Substation to the mine site. These conditions will be addressed in a separate application for the transmission line.

3.5.9.4 Facility Descriptions

Transmission Line from BC Hydro's Glenannan Substation

Electrical power to the mine site will be provided by a 230 kV transmission line from BC Hydro's Glenannan Substation. The portion of the transmission line within the Mine Site is part of this Application and involves the right-of-way clearing and construction of the transmission line from the point of entry to the mine site to the terminal mine site substation.

The transmission line splits from the Kluskus – Ootsa FSR and heads due southwest towards the operations camp then makes a turn west and parallels the MAR and eventually turns south to the main substation (Figure 3.5-67). The 230 kV transmission line will pass over the MAR at two locations as well as the West Plant Site Access Road. It will cross Davidson Creek and number of tributaries for Creek 661. The overall length of the 230 kV alignment within the mine site is 8.6 km. The RoW will be 30 m.

Main Substation

Geotechnical and Foundation Characterization

The main substation is part of the Plant Site. The geotechnical characteristics of the Plant Site are described in Section 3.5.2.4, Geotechnical Characterization with details in Appendix 3-E. The foundation characteristics are described as part of the overall Plant Site in Appendix 3-H.

Facility Description

The transmission line will terminate at the main substation which located within the Plant Site footprint (Figures 3.5-18 and 3.5-68). The main substation location is based on minimizing cabling costs and losses as the processing plant has the greatest energy demands. The main substation will consist of single power transformer (schematic presented in Figure 3.5-68).

The substation will have incoming circuit breakers, motorized isolating disconnect switches, power transformers, switchgear, and protective equipment for the transformation of power from the transmission voltage level of 230 kV to the site distribution / utilization level of 25 kV.

On-Site Power Distribution

The transformer secondaries will be connected to the main substation for power distribution around the mine site. Power will be distributed to the mine facilities by 25 kV, three-phase, 60 Hz through radial feeders originating at the main substation and routed around the site in cable and tray and on overhead power lines (schematic presented in Figure 3.5-68).

Cables will distribute power to the Grinding E–room. An underground cable services the cell tower. Overhead lines will distribute power to these areas:

- Crusher lines and Open Pit services;
- Explosives storage facility, Ready Line Bulk Fuel Storage, truck shop and wash/mine office;
- Operations camp, potable water supply system, security gatehouse, FWSS;
- TSF and water reclaim system; and
- Processing plant facilities.

The nominal voltages for distribution are:

- 25 kV ± (TBC by the Utility) %, 3 phase, 3 wire;

- 7.6 kV ± 5%, 3 phase, 3 wire, resistance grounded neutral;
- 4.16 kV ± 5%, 3 phase, 3 wire, resistance grounded neutral; and
- 600 V ± 5%, 3 phase, 3 wire, resistance grounded neutral.

Details of step-down transformers at each service point are presented in Figure 3.5-68.

Cables

Cables in the Processing Plant area for 600 V distribution system will be rated as 1,000 V, Teck90, TRXLPE, aluminum interlocked armour, stranded copper conductor cable, with a minus 40°C black PVC jacket that meets the standard criteria for FT4 classification and that will pass the CSA C22.2 No. 0.3-201 Test Methods for Electrical Wires and Cables, paragraph 4.11.4 “Vertical Flame Test”.

Buried cables will be either laid directly in the ground or run in heavy duty, PVC conduit bedded in sand. The cables to be buried will be suitably rated for the purpose. Depth of cover over underground wiring shall be in accordance with the Canadian Electrical Code. All underground conduit or duct installations shall include a bare copper ground wire that is installed in parallel with the conduit or duct route and interconnected to the ground grid at each end of the route.

Overhead Lines

The 25 kV overhead lines will be in accordance with CSA C22.3 No. 1-15. Open wire circuits will employ Alloy Conductors with Steel Reinforcing conductor throughout. Where required by Scope ADSS Fibre optic cable will be installed along with the power conductors for the purpose of communication. Where insulated conductors are required, Aerial bundled conductors will be used. Overhead lines will not be installed through plant areas and the use of overhead lines around service areas will be limited where practicable. Overhead lines will not be installed across haul roads.

Transformers

Distribution transformers will be ONAN/ONAF type, complete with de-energised tap changer at the HV side capable of ±5% voltage regulation in ±2 steps. Power distribution transformers housed within E-Rooms will be dry type. The transformers for the remote buildings / loads will be pole mount type up to 300 kVA and pad mount type for ratings above 300 kVA.

The dry type transformers will be vacuum pressure impregnated type, ANN Indoors, 115°C temperature rise. Dry type transformers rated 500 kVA and larger will have the following wired to the transformer control cabinet:

- Temperature monitoring device; and
- Anti-condensation space heaters.

Oil-filled transformers (for ratings 500 kVA and above) will be supplied with the following fittings:

- Top and bottom filter valves;
- Gas and sudden pressure relay (Buchholz);
- Dial type thermometer;
- Skids;
- Lifting and jacking lugs; and
- Oil sampling valve.

The electrical system will be coordinated to minimize power interruption on operation of the power system protective relay.

A 25 kV overhead pole line running from the main substation will have service drops for Open Pit dewatering, TSF reclaim water supply and booster station, Membrane WTP, Ready Line and Bulk Fuel Storage area, and cell tower. A second overhead pole line running from the main substation will have service drops for water wells, FWSS, operation camp, and security gatehouse. All other mine power will be supplied using pole-mounted transformers to step the voltage down from 25 kV to stepdown voltages.

Standby/Emergency Power

Emergency power will be available from a standby power station rated to provide the maximum power required in the event of a utility power failure. One 600 V, 2 MW, standby emergency generator set will be connected to the CIL/Reagents E-room 600 V Motor Control Centre to supply emergency power to critical loads as identified in the mechanical equipment list (schematic Figure 3.5-68). The emergency power loads will be controlled through the process control system, which will stagger starts and automatically start and stop loads to keep process tanks properly agitated and to run equipment such as lubrication pumps on the large mills. Uninterruptible power supplies (UPS) will be used to provide backup power to critical control systems. The UPS equipment will be sized to permit operations to shut down and back up the computer and control systems to facilitate start-up on restoration of normal (utility) power.

Smaller 600 V diesel generators are connected to each of the following buildings:

- Plant office / central control room;
- Administration offices;
- Mine offices; and
- Cell tower.

Emergency battery power packs will supply backup power to the fire alarm system and emergency egress lighting fixtures. Emergency power through portable diesel generators will also be available at the airstrip, potable water supply, and fire fighting water supply.

3.5.9.5 Roles and Responsibilities

Prior to the energizing of the mine site through additional generators or the transmission line, the following procedures will be undertaken in accordance with the Code (EMLI 2021):

> ***5.1.1 Application of Electrical Rules Codes and Standards***
>
> *Unless modified by this code, all electrical equipment shall be installed, maintained and operated in accordance with CSA Standard M421 Use of Electricity in Mines, in conjunction with the Canadian Electrical Code, as amended from time to time.*
>
> ***5.1.2 Electrical Work***
>
> *Installation, alteration and maintenance work performed under section 5.1.1 shall only be performed by, or under the supervision of, a certified person.*
>
> ***5.2.1 Notices and Information All Mines***
>
> *(1) The manager shall develop a plan, approved by a registered electrical engineer, for the use of electrical energy at any mine, and the plan shall be forwarded to the chief inspector prior to the introduction of electricity at the mine. A plan shall also be required for any increases in capacity of an existing installation by more than 500 kva. (2) The plan referred to in subsection (1) shall show the areas at the mine where the electrical energy is to be transmitted and used, including schematic drawings.*

3.5.10 Explosives Storage Facility

3.5.10.1 General Description

The explosives storage facility will be located west of the main mine site area, roughly 2 km away from any significant structures to meet regulatory guidelines for safety clearances (Figure 3.5-69). The approximate area of 1.05 ha (150 x 70 m; Figure 3.5-70). A full-service explosives contractor will provide blasting support, the main explosives plant and storage, mobile processing units, loading personnel, and other support. Blasting within the Open Pit is planned from Year -2 until the last year of mining of the pit in Year +18. No other blasting requirements are anticipated for the mine site.

The blasting and explosives activities and infrastructure that support mining operations include:

- Explosives storage facilities – Section 3.5.10.3;
- Type and quantities of explosives on-site – Section 3.5.10.4; and
- Explosives residuals – Section 3.5.10.5.

Discussion of the blasting and explosives consumption is presented in Section 3.5.1.10 Drilling and Blasting. The explosives storage facility described in this section will be authorized under the F05-01: Division 1 Factory License or Satellite Site Certificate Application (Natural Resources Canada 2021) submitted May 2021.

3.5.10.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, construction and operation of the explosives storage facility. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

Regulatory Framework

Regulatory requirements include:

- *Explosives Regulations*;
- *Occupation Health and Safety Regulation*, Part 21 – Blasting Operations;
- G05-01: Guidelines for Bulk Explosives Facilities Minimum Requirements (Natural Resources Canada 2014); and
- Part 8 Explosives – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance is as follows:

- Technical Guidance 9: Guidance for Preparing Nitrogen Management Plans for Mines using Ammonium Nitrate Fuel Oil Products for Blasting (BC ENV 2018a); and
- Part 3 Mine Plan; Section 3.5.5 Waste Rock Dumps – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documents

- Blackwater Bulk Explosives Reload / Manufacturing Facility (Orica 2015) – Appendix 3-S; and
- Blackwater Gold Project ML/ARD Management Plan (Lorax 2021) – Appendix 9-D.

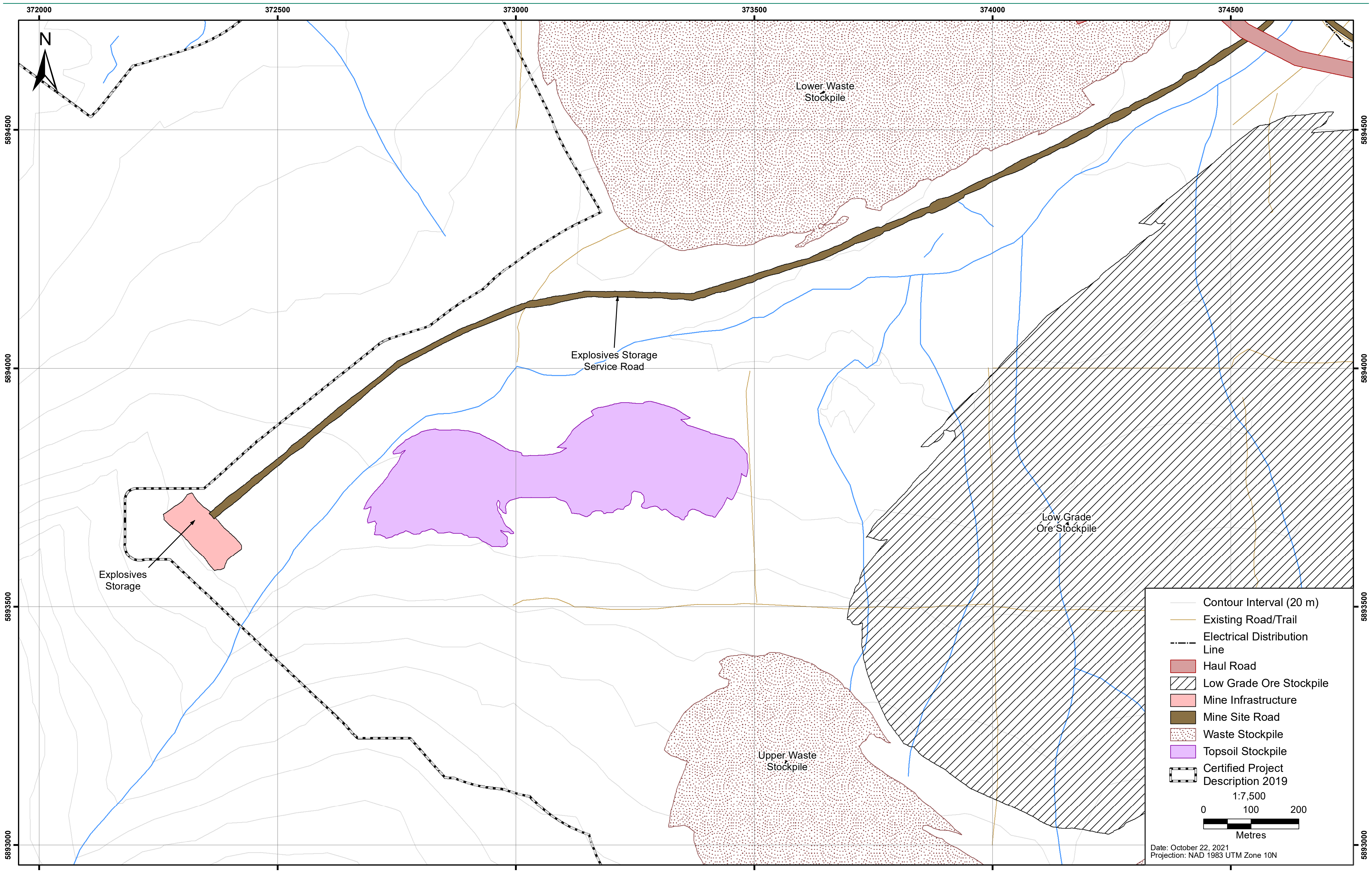


Figure 3.5-69: Explosives Storage Facility Location

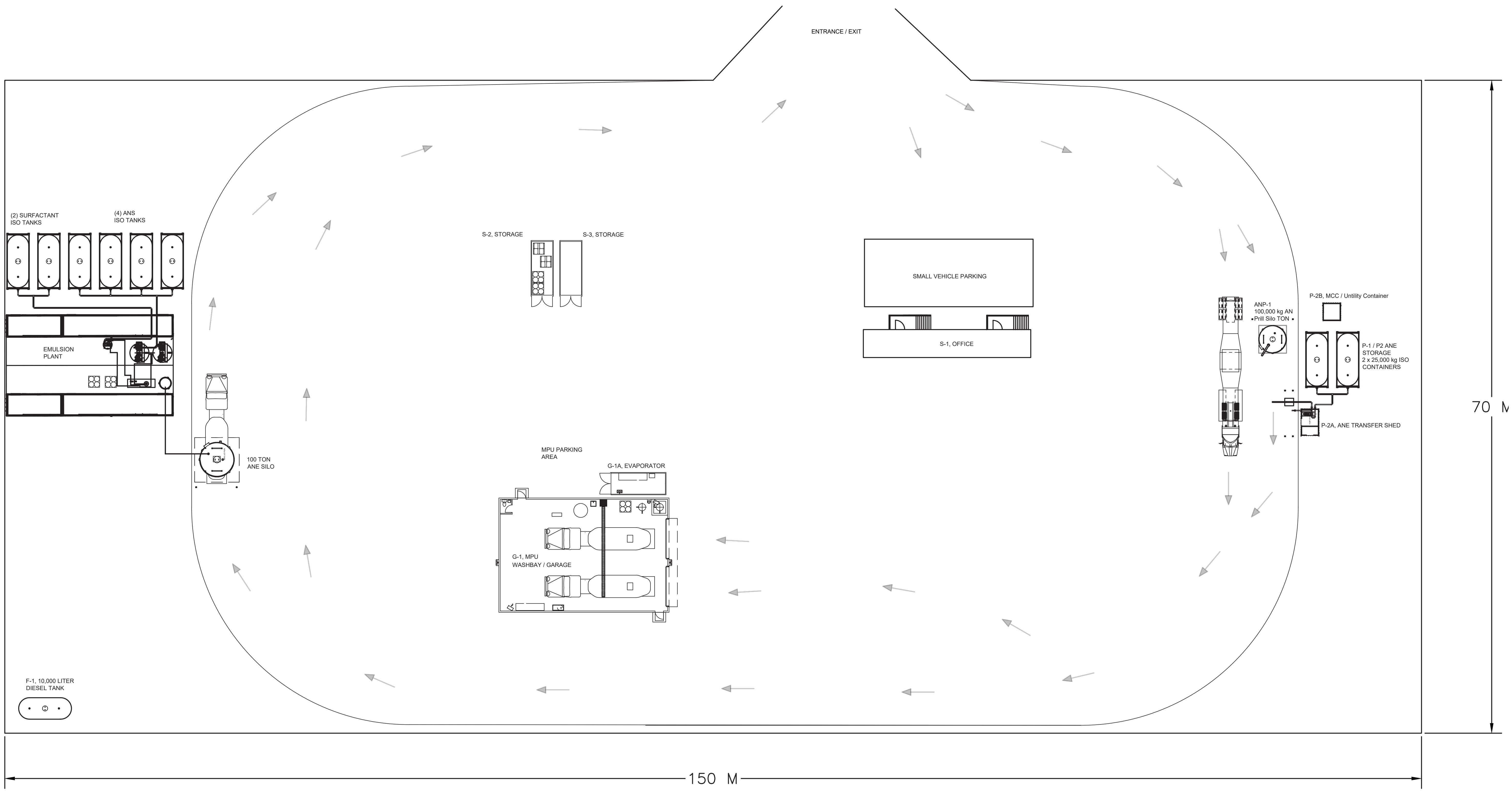


Figure 3.5-70: Plan View of the Explosives Storage Facility

Source: Orica (2021; Appendix 3-S).

EAC Conditions

There are no EAC conditions related to the explosives storage facility.

3.5.10.3 Geotechnical Characterization

The geotechnical characteristics beneath the ancillary facility footprints are covered by site investigations presented in KP (2013e) and Appendices 3-D and 3-E.

3.5.10.4 Explosives Storage Facility

The facility will constructed in two phases to support the level of mining in each phase. Phase I will support mining from Year -2 to the end of Year +5 during this period the amount of material mined will be less than 27.5 Mt per annum. Phase II will support mining from Year +6 to the end of Year +18 during this period the amount of material mined will peak at 84.0 Mt per annum.

Phase I

Mobile Processing Unit Washbay/Garage Complex (G-1)

The complex will be a 19 m x 12 m pre-engineered, steel building, erected on a concrete pad. This complex has two areas. The washbay/decontamination area will be used for the decontamination of the mobile process units (MPUs) and other equipment associated with operation of the explosives storage facility. The garage area will be used for the maintenance of the MPUs and other equipment. Two MPUs can be parked outside the complex while one can be parked inside of the complex. Heating will be by 30 kw Ruffneck heaters. All electricals will be CEMA/NEMA 4X.

Washbay/Decontamination Area

The washbay/decontamination area will be used to wash and decontaminate MPUs and contain residues and contaminants. The high-pressure hot water used for decontamination will be supplied via the site electric powered pressure washer, which will be located inside the evaporator building (G-1A) when not in use. The floor will be sloped towards a deep trench drain that leads into a sump, located on the west side of this area. The resultant effluent will then be transferred via an air driven diaphragm pump to a holding tank located inside the evaporator building (G-1A). A truck access door will be located on the east side measuring. A one-man door will located in the northwest corner and will be signed with exit signs/ panic hardware.

An explosives samples cabinet will be located along the west gable wall. This cabinet will be used for the storage of cup samples obtained during the loading process and will be labelled with a Hazard Class 1.5D placard and locked when not attended.

The gasser solution preparation area will be located in the northeast corner of this area. A 340 L plastic tank will be used to blend sodium nitrite/water/glycol into gasser solution. The tank will be located within an environmental bund, 1.0 m x 0.3 m concrete wall, to provide containment of the gasser solution mix tank. Metered glycol will be transferred from the glycol barrels/cubes using an air actuated drum pump into the gasser tank. Pressurized hot water will be metered into the gasser tank and controlled by a hand actuated valve. Sodium nitrite will be manually added from bags, which will be stored in the raw materials container (S-3). The two ingredients will be blended by an electric, totally enclosed fan-cooled motor/ agitator. The resultant blend is transferred into the MPU gasser tanks via an air driven diaphragm pump.

Located along the north wall will be a 340 L plastic tank used to blend a water/glycol mix for product lubrication while pumping via a MPU. Metered glycol will be transferred from glycol barrels/cubes from an air actuated drum pump into the tank. Pressurized water will be metered into the tank and controlled by a hand-actuated valve. The two ingredients will be blended by an electric totally enclosed fan- cooled motor/agitator. The resultant blend is transferred into the process vehicle water tank via an air driven diaphragm pump.

Located along the north wall will be an area to store 205 L barrels of glycol and/or 1,000 L glycol cubes for the water lubrication and gasser solution make up. The metered glycol will be transferred from glycol barrels/cubes into either the gasser solution-mixing tank or the lubrication tank via an air actuated drum pump. Also located on the west wall will be an 8,100 L plastic tank used to store process and sanitary water. Water will be delivered to this tank via an on-site mine tanker and on-board pump system. Water will be distributed via a 3 HP electric totally enclosed fan cooled motor/pump assembly and pressure will be maintained via a pressure tank and CEMA NEMA 4x pressure switch.

Located on the north wall will be a 4,100 L plastic tank used to store potable water for personnel use. Water will be delivered to this tank via a certified potable water hauler and on-board pump system. Water will be distributed via a 1 HP totally enclosed fan cooled motor/pump assembly and pressure will be maintained via a pressure tank and CEMA NEMA 4x pressure switch.

The water closet area will be located in the northwest corner of this area. Wastewater will flow into 2 x 3,400 L in-ground holding tanks which will include a high-level monitoring system. The sewage holding tanks will be periodically emptied by an off-site pumping contractor. A self-contained eye wash station will be located on the north wall of this area.

Garage Area

The garage area will be located on the south side of the complex. This area will have one maintenance bay. The area will be equipped with an air compressor to power air tools for maintenance on contaminated equipment. The area includes an air-operated parts washer. One truck access door will be located on the east side measuring 4.26 m x 4.57 m. A one-man door will be located in the southeast corner and will be equipped with exit signs/panic hardware.

All electrical tools will be stored in closed cabinets and are used only when there are no explosives contained within this area. Lubricants, oils, greases etc. for daily equipment maintenance will be located in the center and along the walls of this area. Hot work will be to be performed in this area. Prior to any hot work activity being performed, an individual and specific work permit will be completed. The work permit will cover the requirement to ensure mobile processing unit washbay/garage complex (G1) is free of explosives residue, oxidizers and flammable chemicals prior to the commencement of the hot work. A gas monitoring system will be located in this area to continually monitor air quality. The maintenance garage ventilation fan/louver will interlocked with the detector and will be activated automatically.

Evaporator Room (G-1A)

The evaporator room will be located in a 2.43 m x 6.1 m sea can placed north of the mobile processing unit washbay/garage complex (G-1). This room will contain the site evaporator system which will be used to remove excess water from the wash water. A one-man door will located in the on the southwest side of this container, as well double sea container doors are located on the west side All exits will be signed with exit signs/panic hardware. Heating will be by one 30 kw Ruffneck heater. All electricals will be CEMA/NEMA 4X.

The evaporation process will start with the transfer of the wash water from the wash bay sump via a diaphragm pump to a 2,270 L holding tank. This wastewater will then be transferred via a diaphragm pump to the evaporator, a 454 L stainless steel tank. A 0.33 HP totally enclosed fan cooled motor will agitate the solution to accelerate the evaporation process. An evaporator exhaust fan will be located on the south side to facilitate the removal of the water vapor. The resultant solids will removed via a port located at the bottom of the tank and then destroyed by placing on loaded boreholes in the Open Pit. Heat to the evaporator will provided via an electric glycol heater.

Facility Office (S1)

The facility office will be a double door, ATCO office trailer located to the northeast of the mobile processing unit washbay/garage complex (G-1). This area will be used for the site administration and employee welfare. Heating in this area is performed via electric baseboard heaters. Parking for small vehicles will be provided adjacent north of the facility office.

Raw Materials Containers (S2 and S3)

Facility raw materials will be stored in two 2.43 m x 6.1 m sea containers located north of the mobile processing unit washbay/garage complex (G-1) and east of the facility office (S1). Double doors will located at the south end of the sea containers. The two containers allows for segregation of incompatible materials. S2 will be used for general storage and the storage of glycol drums/cubes. S3 will be used for general storage and the storage of sodium nitrite. All electricals will be CEMA/NEMA 1X.

Ammonium Nitrate Prill Silo (ANP-1)

Ammonium nitrate (AN) prill will be transferred from pneumatic highway trailers into a 25 Te mild steel storage silo. Subsequent transfer from the silo to MPUs will be via gravity feed. Electrics consist of exterior lights and silo vibrators. All electricals will be CEMA/NEMA 4X.

Ammonium Nitrate Emulsion Storage Containers (P-1/P-2)

AN emulsion will be stored in two portable ISO containers each with a 25 Te capacity. Each silo will be placed on a concrete pad. Heating will be provided via a closed water/glycol circulation from the motor control centre/utility building (P-2B). AN will be transferred from the highway tanker into ISO containers and from ISO containers in MPUs via an electrically operated 3″ Bowie pump. Waste products including contaminated rags collected from drip trays will be bagged and disposed of as a hazardous waste (Waste (Refuse and Emissions) Management Plan in Appendix 9-N).

Ammonium Nitrate Emulsion Transfer Shed (P-2A)

The AN emulsion transfer shed will be a 2.4 m x 2.5 m sea can which will store transfer/operating equipment, hoses, drip trays, etc. The shed will contain an electrical control panel for the operation of a 3″ Bowie pump. An explosives samples cabinet will store cup samples obtained during the loading process. The cabinet will be labelled with a Hazard Class1.5D placard and locked when not attended. Electrical feed will be underground from the motor control centre/utility container (P-2B). All electricals will be CEMA/NEMA 4X.

Motor Control Centre/Utility Container (P-2B)

The MCC /utility container will be a 2.4 m x 6 m sea container. It will house a 600 V Rheem Ruud electric glycol/water heater and a Grundfos circulation pump for heating the AN emulsion storage containers (P-1/P-2). The heating system's water/glycol level will be monitored via a combination pressure/ temperature gauge located within container. This gauge will be checked on a regular basis (weekly), to ensure water/glycol line integrity. Electricals in this container will be CEMA/NEMA 1.

Explosive Magazine (M1)

Packaged explosives will be stored in a Type IV magazine meeting the CAN/BNQ 2910-500/2015 Explosives - Magazines for Industrial Explosives standard. The magazine will be mounded towards the AN emulsion/AN prill storage and transfer areas. There will be no electrical systems in the magazine. The Protexplo I-button system will be installed and in operation. Each inspection will be logged via an electronic recording devise (eye button technology). Records of the magazine inspections will be held electronically.

Detonator magazine (D1)

Detonators will be stored in a 2.4 m x 3.65 m x 2.1 m, Type IV magazine meeting the CAN/BNQ 2910-500/2015 Explosives - Magazines for Industrial Explosives standard. The magazine will be mounded towards the AN emulsion/AN prill storage and transfer areas. There will be no electrical systems in the magazine. The Protexplo I-button system will be installed and in operation. Each inspection will be logged via an electronic recording device (eye button technology). Records of the magazine inspections will be held electronically.

Diesel Fuel Storage Tank (F1)

A 10,000 litre tank will provide diesel fuel for the facility and vehicles.

Site Security System

Facility access will be controlled by a gate equipped with a match-lighter collection box gate and warning sign “EXPLOSIVES”. The plant area will be secured by a chain-link fence and gate. The facility will be staffed by four people and can support four visitors at any one time. Rules relating to site safety will be in force at the site. These will be reviewed with employees and contractors during the site orientation. For visitors, these rules will be covered during their site induction. Sign off in both cases will be required. Fire protection will be via portable fire extinguishers.

Site Power

Initial power to the explosives storage facility will be provided by a 150 kw diesel powered generator located greater than 25 m from the all potentially reactive site facilities including: mobile processing unit washbay/garage complex (G-1), AN prill silo (ANP-1), AN emulsion storage containers (P-1/P-2), and the MPU parking area. With the connection to the main transmission line and the development of the overhead powerlines, a take-off from the eastbound 25 kV overhead powerline through a 600 V transformer will be used to provide power to the facility.

Power will be distributed to the MCC /utility container (P-2B) then to the MPU washbay/garage complex (G-1), evaporator room (G-1A), facility office (S1), raw materials containers (S2 and S3), AN nitrate prill silo (ANP-1), AN emulsion storage containers (P-1/P-2), and AN emulsion transfer shed (P-2A).

All electrical supply cables exiting the generator and transformer, and leading to buildings will be located underground.

Phase II

In Phase II, the explosives storage facility will be expanded to include the following facilities:

- Surfactant storage tanks;
- AN solution tanks;
- AN emulsion silo; and
- AN emulsion manufacturing facility.

Phase II will be developed to the west side of the explosives storage facility (Figure 3.5.10-2). The layout in Figure 3.5-70 is preliminary but shows sufficient area for expansion. Details and layout of Phase II will be provided prior to increase in throughput.

3.5.10.5 Type and Quantities of Explosives On-Site

In Phase I, the following types and amounts of explosives will be stored at the explosives storage facility (Table 3.5.10-1).

Table 3.5.10-1: Types and Amounts of Explosives Stored in Phase I

Location/Facility	Materials	Quantity
Total Site	AN emulsion	50,000 kg
	AN prill	100,000 kg
	Package explosives	20,000 kg
	Detonators	10,000 units
MPU Washbay/Garage Complex (G-1), one MPU	Type E.1/PE-1	250 kg or less Heel@
Raw Materials Container (S2)	Glycol	2,000 kg
AN Prill Silo (ANP-1)	AN prill	100,000 kg
AN Emulsion Storage Containers (P-1/P-2)	AN emulsion Type E.1/PE-1	50,000 kg
AN Emulsion Transfer Shed (P-2A)	Type E.1/PE-1	250 kg or less AHeel@;
MPU parking area; 2 units	Type E.1/PE-1	250 kg or less AHeel@ per vehicle
Explosives Magazine (M-1)	Package explosives Type E.1/PE-1	20,000 kg
Detonator Magazine (D-1)	Detonators Type I/PE-1 & 4	10,000 units

3.5.10.6 Blasting Residuals

Blasting will be undertaken at the frequency and duration established by the Mine Manager in consultation with the Environmental Manager. The blasting schedule will be set out in advance and will take into account moisture conditions in the blast location. The type and volume of explosives used will be recorded, and the expected rate of loss, and predicted peak and plateau nitrite concentrations from Open Pit dewatering will be noted.

The following measures will be undertaken to prevent the production of undetonated or detonated blast residuals:

- Scheduling blasting to avoid blasting during wet conditions;
- Varying the blasting formulation according to moisture conditions with a higher ratio of emulsion to ANFO used in wetter conditions; and
- Using hole liners and dewatering of drill holes and rock faces prior to setting charges.

Blasting residues will be confined to the Open Pit where residuals are left on pit walls, and largely removed with the OVB, waste rock (PAG and NAG), and ore. Drainage from handling and storage facilities for these materials will be considered contact. The Open Pit will need to be dewatered throughout its operational life. Dewatering and treatment of Open Pit water is discussed in Section 3.5.1.7, Open Pit Water Management. The source term details for the blast residuals on pit walls, OVB, waste rock and ore are presented in Appendix 9-D.

Blasting management will be adaptive with processes in place to review and revise the management of blasting activities. In general, these will include:

- Explosive use and Open Pit water management plans will be regularly reviewed and revised, as appropriate, to maintain source effective source control. Revisions will be based on operational objectives, performance criteria, regulatory requirements, water quality monitoring data, and any other relevant data (e.g., pit dewatering requirements and blasting schedule).
- Operational changes that affect Open Pit development will be flagged and evaluated for nitrite impacts before, during and after implementation.
- Performance monitoring is conducted and data are promptly provided to and evaluated by the individuals responsible for managing the blasting operations.
- Mitigation measures are implemented and evaluated for effectiveness, and necessary corrective actions are identified to correct undesired effects.

A detailed blasting plan will be developed prior to construction of the Open Pit in Year -2. At that time, nitrogen management measures will be developed based on the detailed blasting plan to minimize the potential release of the nitrogen into the Open Pit and contact waters and rock.

3.5.11 Ancillary Facilities

3.5.11.1 General Description

Ancillary facilities to support mining operations include:

- camp facilities;
- truck shop and wash/mine office;
- contractor laydown areas;
- concrete batch plant;
- Ready Line and Bulk Fuel Storage area;
- waste management facilities;
- mobile and supporting mine equipment;
- security;
- communications; and
- helipad.

Figure 3.5-71 presents the ancillary structures for Blackwater.

3.5.11.2 Regulatory Framework and Technical Guidance

This section identifies the regulatory framework for the design, closure and reclamation of ancillary facilities. Technical guidance documents, key reports, and relevant EAC conditions are also identified.

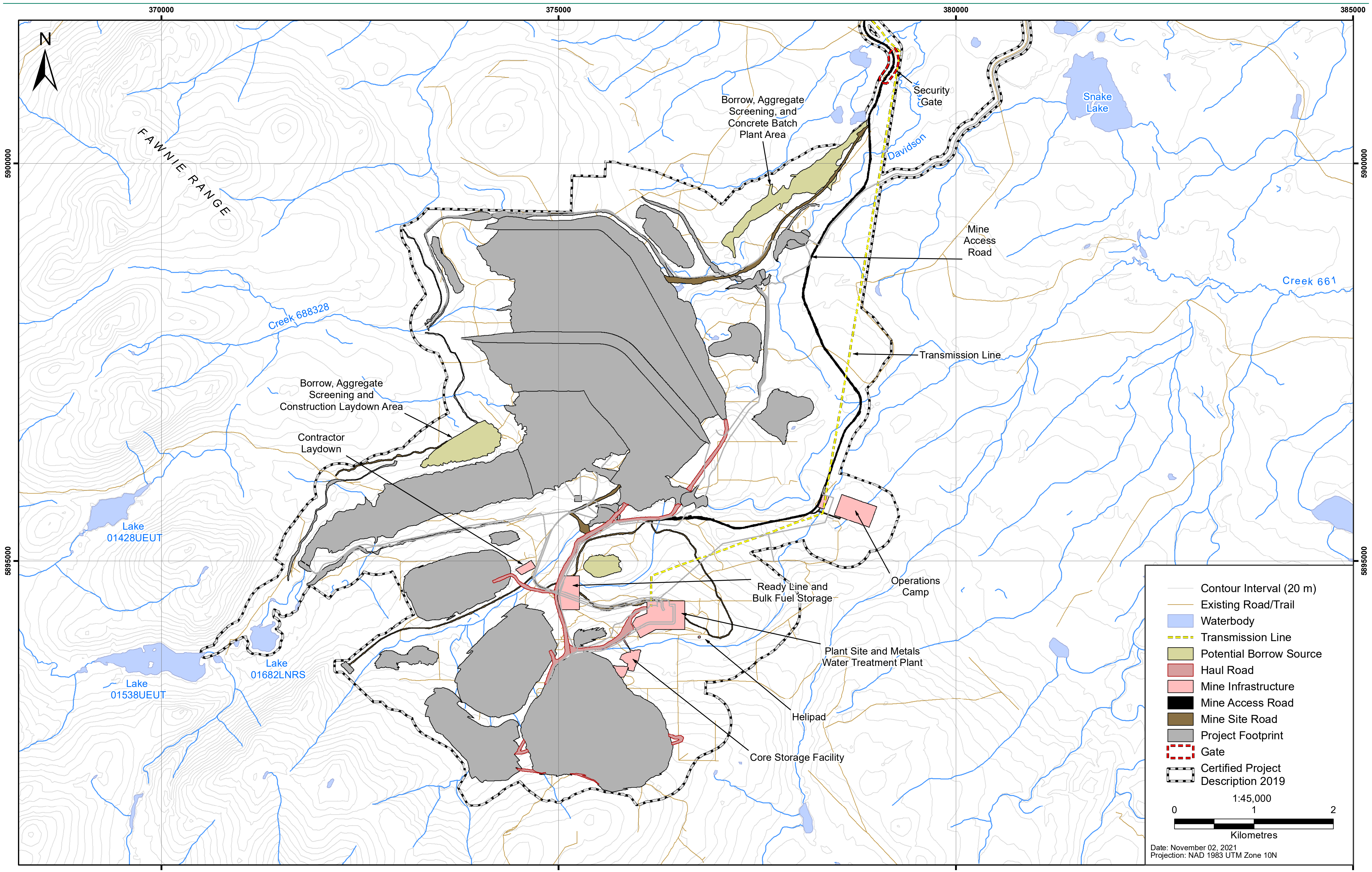


Figure 3.5-71: Simplified General Arrangement of Ancillary Facilities (Year +13)

Regulatory Framework

Regulatory requirements include:

- BC Building Code 2018 (Government of BC 2018a);
- BC Fire Code 2018 (Government of BC 2018b);
- BC Fire Plumbing Code 2018 (Government of BC 2018c); and
- Part 4.1 Buildings - General; Sections 4.1.1, 4.1.3 to 4.1.11 – Health, Safety and Reclamation Code for Mines in British Columbia (EMLI 2021).

Technical Guidance

Technical guidance is as follows:

- A Field Guide to Fuel Handling, Transportation, and Storage (BC MWLAP 2002);
- *B.C. Guidelines for Industrial Camps Regulation* (BC MoH 2017);
- Fact Sheet Industrial Camps: Waste Authorizations and Best Practices. Ver. 1.1. (BC ENV 2018b);
- Part 3 Mine Plan; Section 3.5.11 Ancillary Facilities and Infrastructure – JAIR (BC EMPR & BC ENV 2019a); and
- Part 4 Reclamation and Closure Plan; Section 4.7.1 Infrastructure and Equipment – JAIR (BC EMPR & BC ENV 2019a).

Key Reports and Other Documentation

Key reports and other documentation are as follows:

- Blackwater Gold Project Seismic Hazard Assessment (KP 2021g) – Appendix 2-E;
- Building Specifications for Royal Camp Services – 38 Man Executive Dormitory – Skidded (Northgate Industries Ltd. 2013) – Appendix 3-T;
- Condemnation Report of the Blackwater Project (Baker & Popelka 2021) – Appendix 3-G;
- Artemis Blackwater Mine – Mill, Truckshop, and Admin Area Wastewater Treatment and Disposal Design (WSP 2021) – Appendix 3-I;
- Blackwater Gold ALLNORTH Scope of Supply Fuel and DEF[11] System (Fireball Equipment 2021) – Appendix 3-R;
- Instrumentation and Communications Design Criteria (AMEC 2013); and
- Ausenco Permitting Report (Ausenco 2021) – Appendix 3-F.

EAC Conditions

There are no specific EAC conditions related to the design, construction, operation, decommissioning/ closure, and reclamation of ancillary facilities.

[11] DEF = Diesel Exhaust Fluid. Diesel Exhaust Fluid is a mixture of 32.5% urea and 67.5% deionized water and freezes at -11ºC.

3.5.11.3 Seismicity and Geohazards

Potential risks to ancillary facilities associated with natural and seismic hazards are discussed in Section 2.3.4 Natural and Seismic Hazards Assessments. In general, the overall risk to ancillary facilities from landslides and mass wasting, snow avalanches, flooding, forest fires, subsidence, and volcanic events is very low (KP 2013c and Appendix 2-E). In BC, a low seismic region is classified as Sa (0.2) $\leq$ 0.70 (BC Ministry of Municipal Affairs and Housing 2018); hence, the mine site is well below the threshold for a low seismic region. Ancillary facilities will follow or exceed the BC Building Code 2018 seismic guidelines.

3.5.11.4 Geotechnical Characterization

The foundation elevation for the truck shop and administrative building is 1,413 and 1,408 masl, respectively. The truck shop and administrative building will be located to the west of the Plant Site area on a separate ridgeline. Seven test pits (TP12-035, TP12-036, TP12-037, TP12-143, TP13-279, TP13-304, and TP13-305) and one sonic drillhole (GT12-34) were completed within the vicinity of the truck shop and administrative building area.

Descriptions of the material types and near surface foundation conditions at this site are outlined below:

- Topsoil thickness was found to vary from 0.1 to 0.3 m.
- The temporary laydown areas have a thicker sequence of topsoil which was in the order of 1 to 1.5 m.
- Test pits encountered silt and sand (ML-SM) or silty sand and gravel (SM-GM).
- Drillhole GT12-34 encountered silty sand (SM) to 38 m depth, overlying silty sandy gravel (SM-GM), silt (ML), clay and silt (ML-CL) and sandy gravelly silt (SM-GM) to 76 m depth.
- Drillhole GT12-34 intersected intact bedrock at a depth of 76 m depth, corresponding to an elevation of 1,343 m.

The results of the site investigation program were used to provide estimates of factored bearing resistance and settlements, relevant geotechnical parameters and factors affecting foundation design (KP 2013b).

3.5.11.5 Condemnation Assessment

Condemnation of resources for the footprints ancillary facilities were investigated with drilling programs described in the *Geotechnical Characterization Report* (KP 2013e). The results of condemnation drilling were reinterpreted for the recent Project optimizations (Appendix 3-G). The results of the reinterpretation for the areas of the mine site covered in the condemnation assessment (Figure 2 of Appendix 3-G) also includes the ancillary facilities (Table 3.5.11-1). No economically viable mineralization is anticipated to be beneath the ancillary facilities constructed in these areas.

Table 3.5.11-1: Condemnation Assessment Coverage of Ancillary Facilities

Condemnation Assessment Area	Ancillary Structure
Plant Site Area	Truck Shop/Mine Dry/Office
	Wastewater Treatment Plant
	Ready Line and Bulk Fuel Storage
Camp Area	Camp Facilities
	Wastewater Treatment Plant and Infiltration Basin
Stockpile Area	Contractor Laydown Area
TSF Area	TSF Contractor Laydown Area

3.5.11.6 Foundation Preparation

The clearing of trees covering the ancillary facilities is authorized under *Mines Act* Permit M-246 (Early Works). For this Application, the remaining vegetation will be cleared, and the ground grubbed and levelled. Suitable soils for salvage will excavated to 300 mm and stockpiled (Section 3.5.7 Topsoil Stockpiles). A gravel surface over fill will be placed over the levelled site. The composition and thickness will depend on the sub-base of the levelled site (Table 3.5.11-1). As a guide, the in-situ soil subgrade material should be scarified and moisture conditioned, if necessary, and compacted to a minimum 95% Standard Proctor Maximum Dry Density (SPMDD). Each layer of additional granular material should be compacted to 95% SPMDD. Moisture contents for materials shall be ±2% of optimum moisture content. Compacted fill material should be placed in loose lifts no thicker than 300 mm.

Details of grading and finishing are provided in Appendix 3 Civil Design Criteria of Appendix 3-F. Additional footings and concrete pads may be also be put in place depending on the design requirements of the buildings and geotechnical site investigations.

A perimeter drainage will be placed around each site. Perimeter ditches will be flat bottom with the invert a minimum depth of 300 mm below the sub-base and a minimum width of 1,000 mm. Drains and conveyances will be placed within the site depending on the pattern of water discharge and shedding from structures and will be designed to prevent pooling of water, surface run-off, or damage to the site surfaces. On-site drainage will be conveyed to the perimeter drainage. Sediment traps will be placed between perimeter drainages and their discharge off-site. Contact waters will be discharged to the TSF ponds while non-contact waters will be discharged to the Northern, Southern, or Central Diversion water conveyance structures and eventually to Davidson Creek.

3.5.11.7 Camp Facilities

Two camps will support the Project; the current exploration camp and newly constructed operations camp (Figure 3.5-71). This Application seeks approval to construct and operate the operations camp (through LoM). The exploration camp is permitted and no further modifications are anticipated.

Mines Act Permit M-246 authorizes the use of the 250-person exploration camp. The early Construction phase of this Application also makes use of this camp. The exploration camp facilities will be moved to the pad south of the operations camp after construction completion of the operations camp. The existing sewage discharge field will however remain and be used to discharge treated sewage from the operations camp.

During Year -2, the operations camp pad which is adjacent to the MAR will be cleared of remaining vegetation, grubbed and levelled (Figure 3.5-72). The operations camp pad will be 275 m x 465 m. Section 3.5.11.6 further describes the foundation preparation.

Initially, the operations camp will be built to have a capacity of 266 beds. The accommodations will be modular, pre-fabricated structures. There will be seven dormitory units distributed along a central corridor with a core service unit with shared facilities. Each dormitory unit will have 38 beds. Each room in the dormitory will be 10′ 11″ x 10′ 11″ and “Executive” style such that each room has its own en-suite facility. The core service unit will have an administrative office, dining area, kitchen, laundry facilities, and gym/ recreational area. The camp will house construction workers and management personnel. Through the end of the Construction phase the operations camp is expected to have a capacity of up to 516 beds with the balance of the beds coming from the exploration camp. The operations camp once fully expanded (during Phase 2 and 3 of the Project) will have a capacity of up to 532 beds.

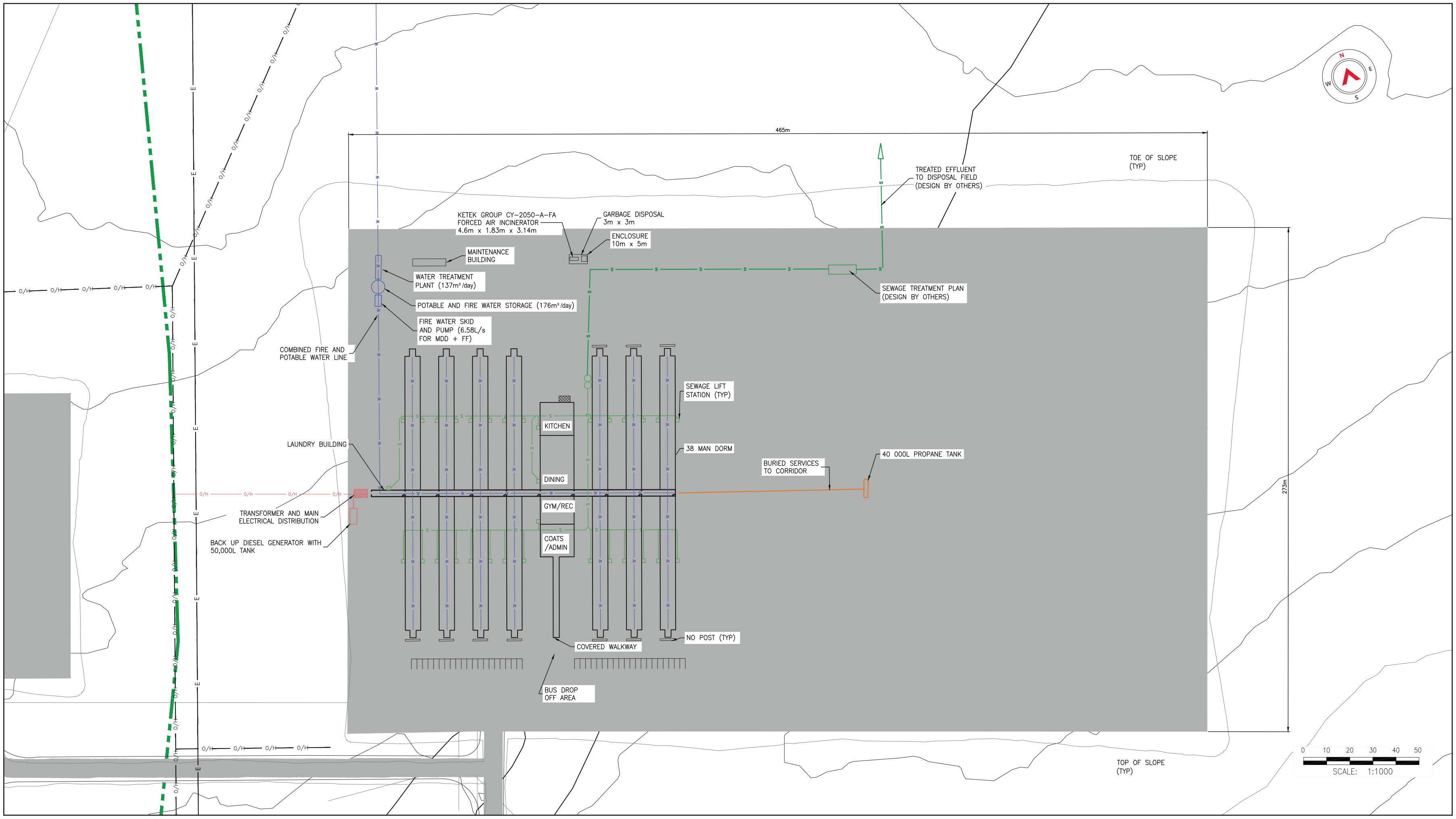


Figure 3.5-72: Detailed Plan for the Operations Camp

Source: Allnorth (2021; Appendix 3-R).

Buildings will be equipped with skids and will be placed on a level gravel surface to minimize damage to soils and to control drainage under and around buildings. The modules will be elevated above grade with a minimum 1 m of clear crawl space below. The crawlspace will be fully enclosed with skirting and have personnel access at various points throughout for the connection of services such as plumbing. All crawl space plumbing will be designed and installed with heat tracing and/or sufficient insulation to prevent the pipes from freezing.

The camps will be heated with propane-fired, forced-air furnaces and electrical baseboard heaters. A single air conditioner unit will be attached to each furnace and be distributed through the same floor vents. Each dormitory unit will have eight propane heated hot water tanks. Fire protection is provided by fire extinguishers. Camps will be equipped with smoke and CO_2 detectors, and pull alarm stations.

Electricity will be supplied by the main power distribution system or, in the event of a service disruption, backup generators. A 25 kV overhead line to a 4.16 kV transformer will be routed to the Main Electrical Distribution centre. A diesel fueled 750 kW back-up generator will provide emergency services and be serviced by a 50,000 L tank with secondary containment. A 40,000 L tank will supply propane for heating, the kitchen, hot water, and incinerator. The northwest corner of operations camp pad will have the waste transfer area (Waste (Refuse and Emissions) Management Plan in Appendix 9-N) and maintenance. A potable WTP, potable water storage, and fire water skid and pump will be located in the northeast corner of the operations camp pad with the fire and potable water line conveyed in the same line as the dormitory units. A wastewater treatment plant will be located on the center north edge of the operations camp pad and will discharge treated effluent to an infiltration basin (Section 3.5.11.12 Waste Management Facilities).

Building specifications for the modular camp facilities are provided in Appendix 3-T.

3.5.11.8 Truck Shop and Wash/Mine Office

Haul and mine service vehicles will be washed and maintained on-site at facilities north of the Plant Site (Figure 3.5-71). The pad to the north of the Processing Plant will have the following:

- Truck shop and wash complex
- Truck tire change building;
- Truck ready line; and
- Mine management/administration building.

The truck shop/wash complex will be four bays north of the stockpile pad (Figure 3.5-73). Three bays will be sized for the 230 t haul trucks. Each bay will have an overhead crane with a 12 t capacity. The overhead crane hook height shall provide sufficient clearance to accommodate the largest heavy haul trucks with the dump body in the raised position. The heavy equipment shops shall be separated from the welding bays to reduce welding fumes and smoke by a relocate-able steel wall. The eastern area in the complex is a warehouse to store consumables and maintenance parts for vehicles.

The wash bay will be located to the west of the service bays and will be used to clean heavy mine equipment prior to service, inspection and repair (Figure 3.5-73). The wash bay is intended to handle a single 230 t haul truck as well as all heavy support equipment. The drive thru wash bay will include a fabric building with a concrete floor and roll-up doors of sufficient height to accommodate haul trucks. The area surrounding the wash bay shall have drainage to minimize ice buildup. Water cannons and steam washers shall be located on both sides of the vehicles. The wash water and contaminants from the wash bay will flow towards the concrete sump along with rocks and sediments. The sump shall be fitted with a sump pump for feeding the water recycling loop. The slurry will be pumped to the clarifiers through a screen to separate the liquid from solids. The liquid oil/water suspension from the clarifier overflow shall be separated using an oil/water separator after which the separated water is pumped to the wash water tank for storage and recycled usage. Water from the tank will flow back to the wash cannons in a closed circuit. Sediment (underflow solids) will collect in reclaim pits accessible by roll-up doors by loader or bobcats. Oil from the separator will be placed in a steel drums and disposed of offsite as a hazardous waste (Waste (Refuse and Emissions) Management Plan – Appendix 9-N).

For safety, the wash bay shall be equipped for restricted personnel access via locking doors and a visual notification system actuated from outside the wash bay so the operator inside can be notified if necessary.

The truck tire change building is south of the truck shop/wash complex and will house the air compressors and hydraulic lifts.

The truck ready line will be located to the south of the truck shop/wash. A second truck ready line is located at the Ready Line and Bulk Storage area.

The east part of the pad will house the mine office (Figure 3.5-73). The mine office will have dry rooms, and separated change areas with lockers and washrooms. The office complex will have individual offices, workstations, break-out rooms, office and records storage spaces, and a lunch area. The building will be supported by a cast-in-place concrete spread footings.

For both the truck shop facilities and the mine office, HVAC services will be by stand-alone electric units with heating provided by propane heaters. Secured propane tanks will be located on the far eastern end of the truck pad.

3.5.11.9 Contractor Laydown Areas

Mines Act Permit M-246 (Early Works) authorised clearing at the north end of the Lower Waste Stockpile Mine Haul Road, which will be used as a contractor laydown area during construction (Figure 3.5-71). This laydown area will be 6.3 ha. The surface over fill will be gravel with perimeter and cross drainage.

A second laydown area will be located on the north side of the TSF (Figure 3.5-71). This laydown area will be 29.6 ha. This area will service TSF construction and accommodate a trailer office and facilities. The TSF construction offices will support up to 75 people. This area will be powered by a take-off from the 25 kV overhead line. Potable water will be trucked in and stored on site. Sewage will settled within a septic tank and sewage effluent will be disposed of to a septic field. Septage will be trucked offsite for appropriate disposal. Details for the handling of sewage are provided in Section 3.5.11.12 Waste Management Facilities.

3.5.11.10 Concrete Batch Plant

The borrow source, aggregate screening, and concrete batch plant area is located downstream of the Main Dam D on the north side of Davidson Creek (Figure 3.5-71). This area will support a single concrete batch plant. The high volume plant (~100 m^3/h) will operate during concrete construction. The batch plant will be winterized and located adjacent to the crushed aggregate storage area. This facility will operational for the LoM.

3.5.11.11 Ready Line and Bulk Fuel Storage

The Ready Line and Bulk Fuel Storage area will be located at the intersection of the West Processing Plant Access Road and TSF haul road (Figure 3.5-71). The location was chosen to minimize the travel distance for vehicle service and tow distances, in case of emergencies.

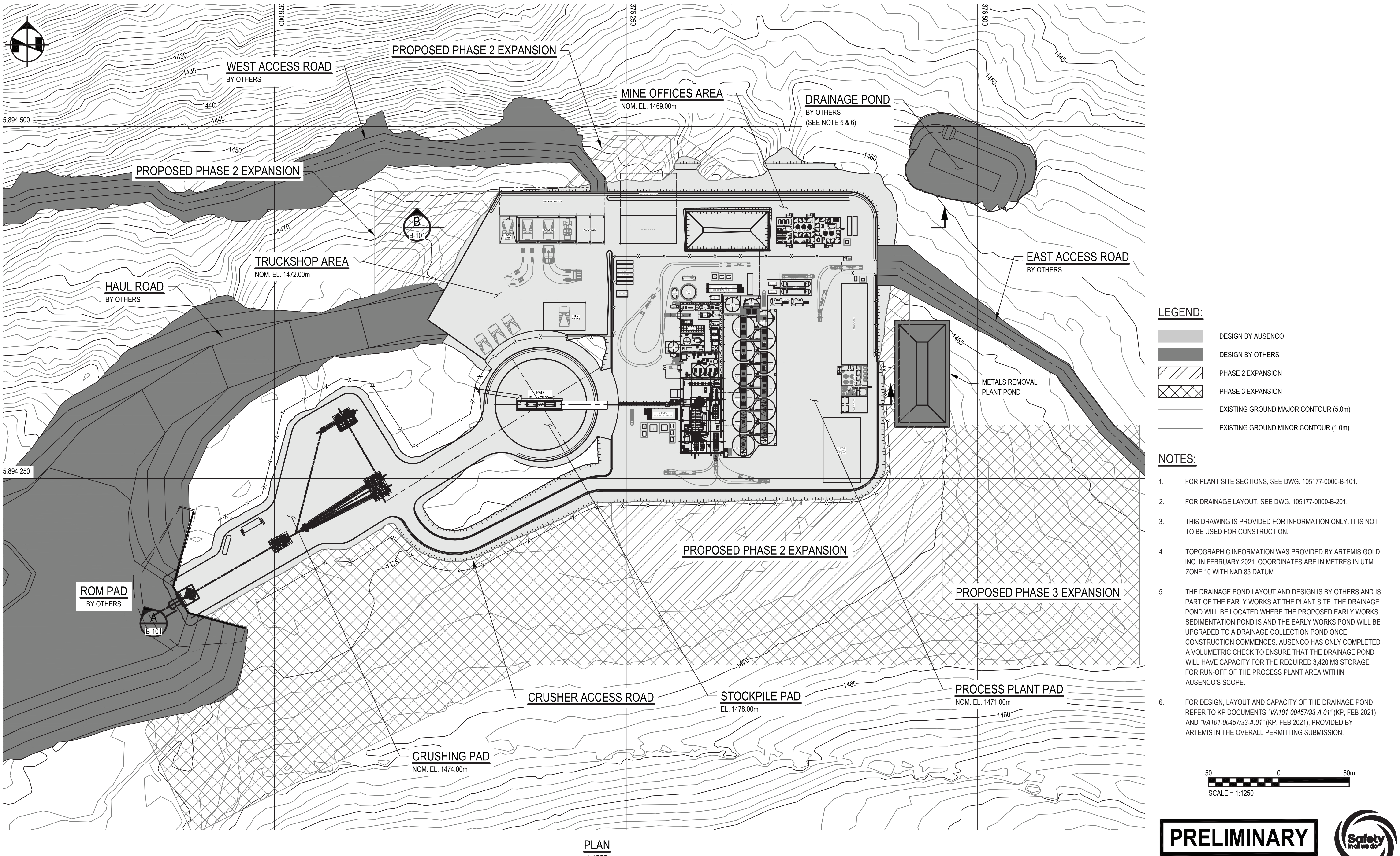


Figure 3.5-73: Layout for the Truck Shop Facilities and Mine Office

Source: Ausenco (2021; Appendix 3-F).

The Ready Line and Bulk Fuel Storage area will include:

- Fuels receiving and dispensing pumphouse;
- Fuel offloading;
- Fuel storage;
- Fuel dispensing;
- Diesel exhaust fluid (DEF) system;
- Oil and lube station; and
- Fuel/lube trucks.

The full build-out plan for the Ready Line and Bulk Fuel Storage area is presented in Figure 3.5-74. This section provides a summary of the facility. Further details of the facilities are provided in Appendix 3-R. The Fuel Management and Spill Control Plan provides procedures for handling, transport, storage of fuels, and the emergency response to a spill (Appendix 9-L).

Fuels Receiving and Dispensing Pumphouse

A sea can will house the fuel receiving and dispensing pumps and controls (Figure 3.5-75). The Ready Line and Bulk Fuel Storage area will be powered by a 25 kV overhead line from the main substation. Power will be transformed to 600 V prior to routing the E-room within the sea can. Power will be distributed through the main power distribution panel from this E-room. All wiring will supported through the chase ways or conduits inside the sea can. The control panels and motor starters for variable frequency drives will be wall mounted and sealed for protection from leaks and spills. The piping between the fuels receiving and dispensing pumphouse and the remote dispense skids will be insulated and heat traced using self-regulated heat tracing.

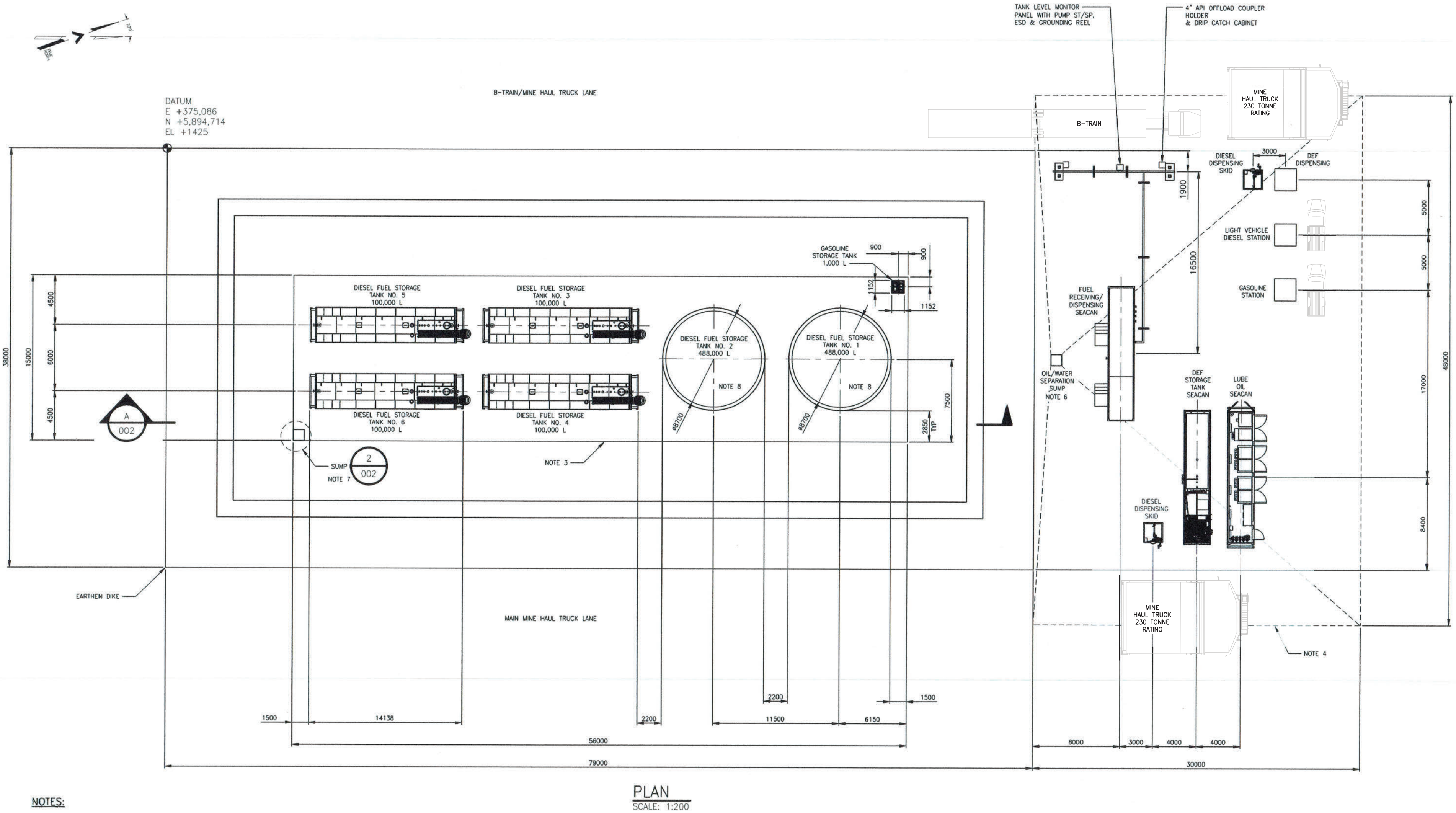
The sea can will be insulated, heated, ventilated and lit with LED lights for servicing. A seal welded steel spill containment pan with cleanout will allow for maintenance and containment of minor spills. This spill pan will include separate high and high level switches to trigger an emergency shut-down if triggered. Operators access the equipment through man doors.

Fuel Offloading

Fuel will be delivered by large tanker trucks to the main storage tanks at the bulk fuel storage facility, which will be able to accommodate western style b-trains with a total capacity 65,000 L (Figure 3.5-75).

For offloading fuel, a duel hose manifold and API[12] couplers will be used so delivery drivers never have to use truck hoses or pump. A suction style transfer system will be utilized so that the fuel from the delivery truck is drawn under vacuum such that if a leak occurs within this assembly, air will be drawn into the system rather than a pressurized release of fuel. The standard bulk fuel transfer connection on mobile tanks will be a 4″ API receiver (Photo 3.5-1). This will allow for a drybreak connection that includes a poppet and valve, leaving minimal chance for drips on the ground. The API coupler will be stored in a drip cabinet with drain.

[12] API = American Petroleum Institute



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
2. ALL COORDINATES AND ELEVATIONS ARE IN METERS UNLESS OTHERWISE NOTED.
3. MINIMUM CONTAINMENT AREA VOLUME IS 860m³.
4. BURIED 60MIL HDPE LINER.
5. FIREFIGHTING ACCESS TO STORAGE TANKS WILL BE PROVIDED.
6. OIL/WATER SEPARATION SUMP SHALL BE DESIGNED IN ACCORDANCE WITH B.C. Reg. 321/2004.
7. SUMP TO BE PUMPED TO OIL/WATER SEPARATOR WHEN FREE OF HYDROCARBON.
8. 488,000L DIESEL FUEL STORAGE TANKS TO BE EQUIPPED WITH LEAK DETECTION SUMPS. TANKS ARE PARTIALLY SHOP FABRICATED TO MINIMIZE FIELD WELDING.

Figure 3.5-74: Plan for the Ready Line and Bulk Fuel Storage Facility

Source: Allnorth (2021; Appendix 3-R).

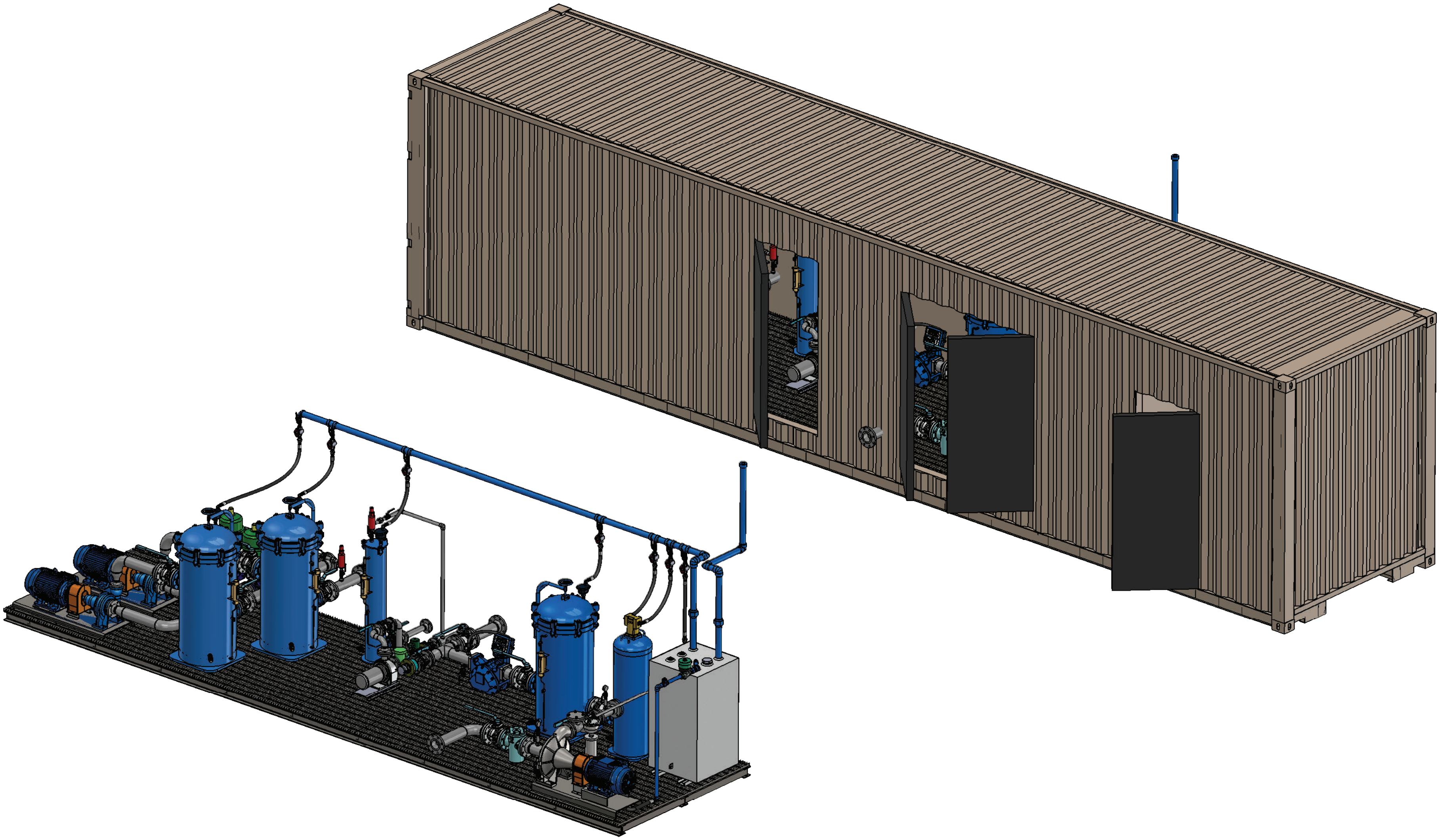


Figure 3.5-75: Typical Layout for Fuel Receiving and Dispensing Sea Can Pumphouse

Source: Allnorth (2021; Appendix 3-R).

Photo 3.5-1: Four inch API coupler for fuel offloading.

The fuels receiving and dispensing instrumentation and controls sea can (see above section) houses the offloading pump and supporting components. Air elimination, fuel release and back-flow protection systems will be supported in the fuel offloading system. There will be an emergency fill point downstream of the meter assembly with a ball valve spec blind. This will only be used when the offloading assembly is being serviced. In this case, the delivery truck onboard pump will deliver the fuel into the tanks.

Fuel Storage

Diesel will be the primary fuel stored at the facility. Low-sulphur diesel will be used when it is available. Standard temperature diesel will be used during the summer months, and standard winter-grade diesel during the winter months, because the winter design low temperatures are above the clouding temperature of the winter grade fuel.

At full build-out (Figure 3.5-74), the facility will include:

- 1 x 488,000 L vertical cylindrical aboveground diesel fuel storage tanks;
- 4 x 100,000 L horizontal aboveground diesel fuel storage tanks; and
- 1x 1,000 L gasoline storage tank.

Tank capacity will be designed to meet surface and mining fleet requirements for up to five days and in the event of weather related delays in fuel delivery. Over the LoM, storage capacity will be monitored and adjusted, accordingly.

The fuel storage area will be surrounded by a 1.8 m high x 11.5 m wide bund with a 3H:1V slope on the inside and a 2.5H:1V slope on the outside (Figure 3.5-76) [13]. The bund and the fuel storage area will be lined with a buried geotextile and 60 mil high density polyethylene (HDPE) liner. The geotextile and liner will be keyed into the construction of the bund to prevent “creep” over time and to effectively seal the fuel storage area in case of a spill.

[13] Note the Typical Leak Detection Sump shown in Figure 3.5-76 is still being considered and may not be included in this Project.

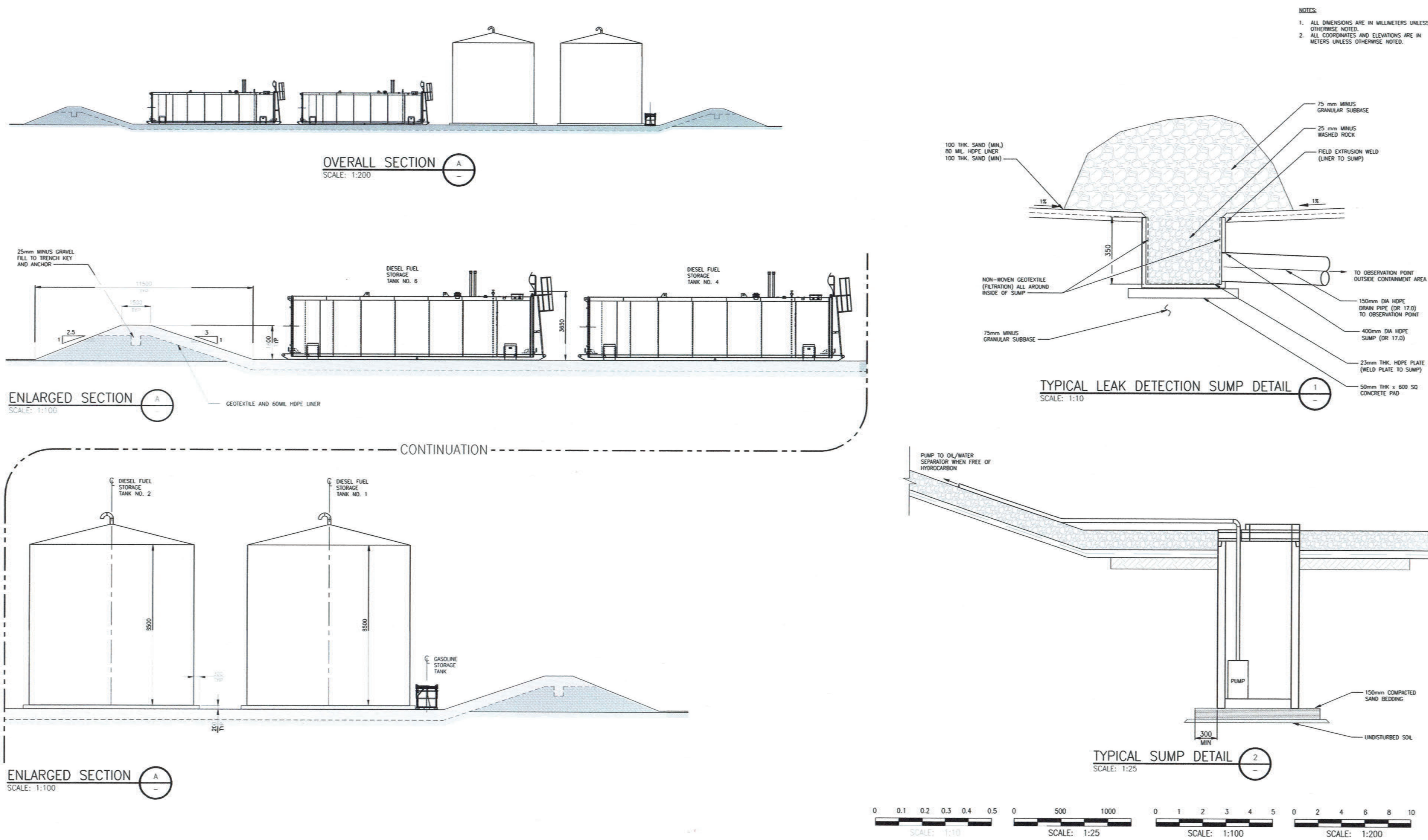


Figure 3.5-76: Sectional Plans for the Fuel Storage Area

Source: Allnorth (2021; Appendix 3-R).

To recover contaminated surface water in the fuel storage area, a sump will be placed at a low point. Separated water from the sump well will be pumped to an oil/water separator and recycled to site drainage via the TSF, if free from hydrocarbons (Figure 3.5-76).

Storage tank construction and operation will follow the Project phases to support the increase in mining operations and mine fleet. The anticipated full build-out of the facility will be completed in Year +10.

A sectional view of the fuel storage area is presented in Figure 3.5-76.

Fuel Dispensing

A number of fuel dispensing areas will be located on the haul lane along the westside of the facility, the haul lane on the eastside of the facility, and the supporting lane on the northside of the facility (Figure 3.5-74).

Haul Lanes

Each haul lane dispensing unit will have two skids; high flow and medium flow skids. Each skid will be serviced by a dispensing pump and filter assemblies located in the fuel receiving and dispensing pumphouse. The pumps will have a positive displacement with a 30 hp motor and variable frequency drives, allowing for different dispensing speeds. The filter vessel will be the same as the receiving filter.

Each skid includes an integral drip tray with clean out to capture any minor drips. Each nozzle will have a holder with drip containment with a drain. The drain line will include a ball valve and outlet at bucket height to collect any excessive buildup of fluid within the nozzle holder. A start/stop panel will be installed on the skid for controlling the pumps and valves. The panel will also have an emergency shutdown button and meter totalizer head.

Supporting Lane

The supporting lane will have two skids (Figure 3.5-74). One skid will be a light vehicle diesel station, and the other will be a gasoline station.

The low flow diesel system will service the light diesel station with a separate 2″ nozzle suction line from the tanks to prevent over pressuring and/or overflowing the system. The low flow pump will be a 2″ centrifugal pump with 2 hp motor located within the fuel receiving and dispensing pumphouse. Final delivery will be with a standard ¾″ splash nozzle.

Diesel Exhaust Fluid (DEF) System

For large diesel vehicles, the lean burning of diesel, i.e. high ratio of air-to-fuel (overstoichiometric ratio) ensures the full combustion of soot and prevents exhausting unburnt fuel into the atmosphere. However, high ratio of air-to-fuel can potentially lead to the generation of nitrous oxides. To prevent the release of nitrous oxides, large diesel vehicles will be fitted with selective catalyst reduction (SCR) catalyst systems. An SCR catalyst treats the diesel exhaust with a solution of urea and deionized water (diesel exhaust fluid [DEF]) and coverts the nitrous oxides to water and nitrogen which are then released into the atmosphere through the exhaust. In large diesel vehicles, DEF from a separate tank is injected into the exhaust pipeline.

The Ready Line and Bulk Fuel Storage area will have a stand-alone DEF storage and pumphouse housed within a sea can (Figures 3.5-74 and 3.5-77). This system is designed to fill large vehicles as well as large diesel support equipment.

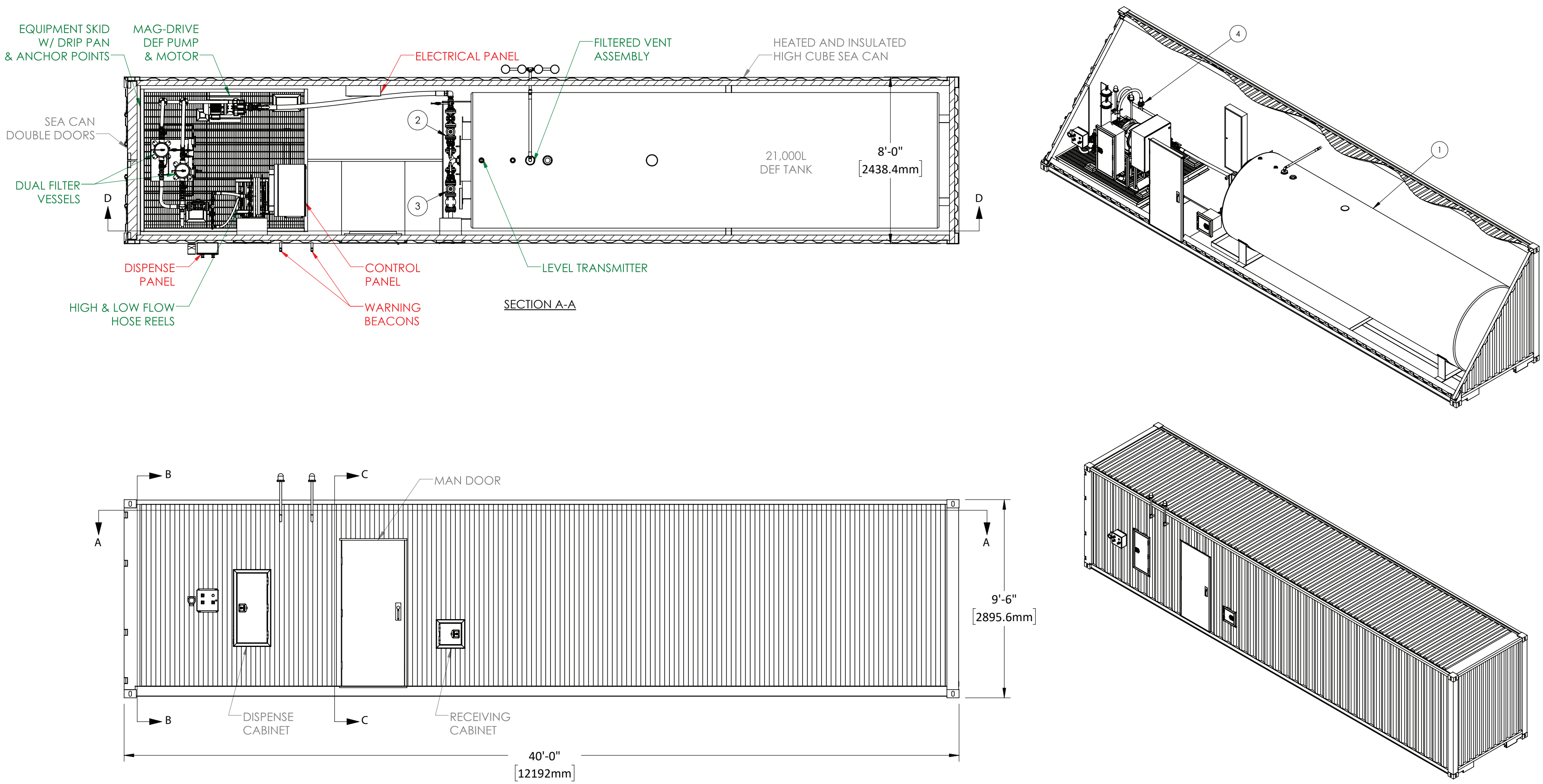


Figure 3.5-77: Diesel Exhaust Fluid Facility

Source: Allnorth (2021; Appendix 3-R).

DEF will be delivered by tanker trucks to the DEF storage tank. The offloading system will include a dripless coupler in a heated cabinet with check valve, isolation valve and normally closed solenoid valve. The on-board pumps of the delivery truck will be used deliver the DEF to the storage tank.

The DEF storage tank will be a 24,000 L double walled stainless steel tank built to ULC - 601. The tank will be vented to provide a safe worker environment and to prevent DEF vapours from damaging equipment.

DEF dispensing facilities will be paired with the diesel dispensing facilities allowing for the filling of diesel and DEF at one stop. One DEF dispensing facility will be paired with the diesel dispensing facility on the westside haul lane. The DEF dispensing facility will be in a heated cabinet and installed on the dispense skid at the westside haul and northside supporting lane intersection. The piping between the DEF seacan and the remote dispensing cabinet will be insulated and heat traced using self-regulated heat tracing.

The other DEF dispensing facility will be housed in the DEF sea can and will be located on next to the diesel dispensing facility on the eastside haul lane.

Both facilities will have high and low flow DEF hoses. High flow DEF hose reel is to bottom fill haul truck tanks with a 1″ Hartmann nozzle. This system will have non-pressure shut-off equipment to be installed on the DEF tank. A low flow DEF hose reel will be connected to a splash fill light support equipment.

The DEF storage, pumps, and controls will be housed in a 40′ high-cube sea can that is insulated, heated, ventilated and lit with LED lights for servicing. The sea can includes a seal welded steel spill containment pan with clean-out for minor spills during maintenance. This spill pan will have separate high level switches to trigger an emergency shut-down, if triggered. Operators access the equipment through man doors.

Oil and Lube Station

An oil and lube facility will be located next the DEF sea can (Figure 3.5-74). This facility will store lubricants and oils for light maintenance on the Ready Line and to supply diesel fuel/lube trucks for remote servicing. The sea can will be insulated, heated, ventilated and lit with LED lights for servicing. The sea can will include a seal welded steel spill containment pan with clean-out for minor spills during maintenance. Multiple double doors along its side will allow ready access to the storage compartments.

Fuel/ Lube Trucks

To support the remote fueling, lubing and maintenance of heavy vehicles on the mine site, a fleet of fuel/ lube truck(s) will be operated over the LoM. At a minimum, these vehicles will have the following features:

- Onboard diesel storage tank;
- Oil storage tank;
- Coolant storage tank;
- Independent dispensing system for each tank;
- Air compressor; and
- Roadside safety and traffic management equipment.

The number of fuel/lube truck(s) will be based on demand during the LoM.

3.5.11.12 Waste Management Facilities

Sewage Treatment and Disposal

Domestic wastewater will be produced from five locations on the mine site:

- Exploration camp;
- Operations camp;
- TSF contractor area;
- Explosives storage facility; and
- Plant Site.

The exploration camp domestic wastewater treatment and disposal is already permitted, under the *Municipal Wastewater Regulation*, and has operated since 2012. A new domestic wastewater treatment and disposal facility will be constructed in association with the operations camp. A separate application will be submitted to seek authorization for this system under the *Municipal Wastewater Regulation* registration and Northern Health (Table 1.4-2). Sewage treatment and collection from the TSF Contractor Area, and Explosive Area is planned to be discharged to either the Plant Site system or to the system associated with the operations camp.

The remainder of this section will focus on sewage treatment facilities at the Plant Site.

Plant Site

This Application includes domestic wastewater discharge from the Plant Site, which will be generated from facilities at the processing plant, truck shop and wash, and mine dry/office, including kitchen, washroom, showering, and laundry. The facilities at the Plant Site will be built during Year -2 and Year -1 of the Construction phase with facilities generating domestic wastewater by the start of Year +1. Domestic wastewater from the Plant Site will be treated and directed to the TSF C Pond via the tailings line.

Details of the Plant Site sewage treatment are provided in Appendix 3-I with effluent discharge discussed in Section 5.7 Domestic Water/Sewage Treatment.

Wastewater Process System

Mechanical Treatment Plant

A mechanical treatment plant will used to treat wastewater from the Plant Site. Wastewater will be collected via gravity and treated using a moving bed biofilm reactor (MBBR) followed by dissolved aeration flotation (DAF). Key features of the MMBR and DAF are described in Appendix 3-U. The DAF will remove suspended solids from MBBR effluent to ensure biochemical oxygen demand (BOD)5 and total suspended solids (TSS) meet discharge criteria. The effluent will undergo ultraviolet treatment before discharging to the TSF. The majority of the coagulant and flocculent will stay in the sludge phase and will not be discharged to the TSF.

The plant will be delivered preassembled by the manufacturer and installed in prefabricated containers. The entire treatment plant will be delivered as a compact, pre-wired and piped unit for rapid plug and play installation on a concrete pad. The equipment skid will be installed alongside the tank and is also pre-wired and plumbed. The use of remote I/O modules and coiled connectorized cables nearly eliminates field wiring costs between the two modules. Pre-designed pipe sections and fittings will minimize piping work between the tank and equipment skid.

The process configuration is provided in Figure 3.5-78.

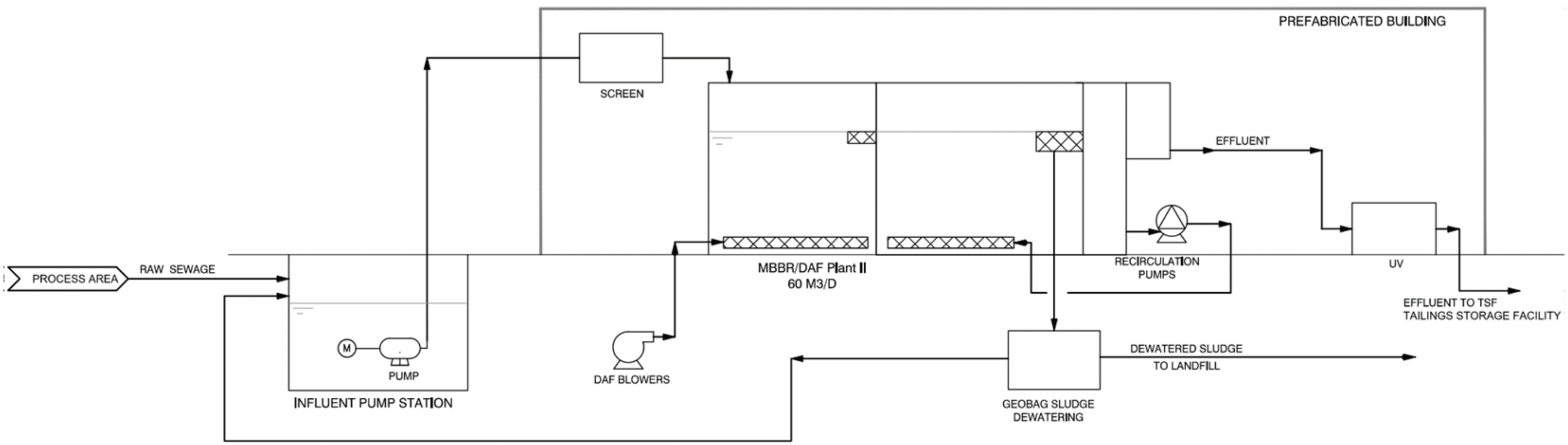


Figure 3.5-78: Plant Site Wastewater Process Flow Diagram

Source: WSP (2021; Appendix 3-I).

The plant is designed for peak dry weather flow which is about 4 times of average daily flow. The MBBR is robust process that requires few control measures or operating support to maintain high quality effluent under variable flow and loading conditions.

Sludge Dewatering

Sludge dewatering will be done via a dewatering bag system, which is a simple and easy to operate system. No motorized equipment is required for this system which eliminates downtime in the event that any part of the system failed. Figure 3.5-79 shows the configuration of the dewatering bag system.

The dewatering bag system will use reusable geotextile bags that are hung on aluminium frames. When sludge is introduced to the bags with polymer, the filtrate seeps out almost immediately. The filtrate seepage becomes slower after a short time and sludge becomes denser inside the bag. More sludge can be added into the bags when more space on top part of the bag becomes available to increase the utilization rate of the bags. Once the sludge is dewatered to about 12 to 15% in the bags, the bags will be moved off the frame using a forklift and the dewatered sludge will be dumped to a truck for hauling away to an approved disposal facility. The filtrate from the dewatering (geotextile) bags will be collected and pumped back to the tray and piped back to the influent lift station to be treated in the MBBR/DAF system. The disposal interval will depend on the capacity of the dumpster into which the dewatered sludge will be stored prior to disposal.

Monitoring

Monitoring related to the discharge to the TSF is described in the Mine Site Water and Discharge Monitoring and Management Plan in Appendix 9-E.

Waste Management

Waste generated over the LoM will include food and other putrescible; combustible (non putrescible); non-combustible; recyclable; and hazardous. The Waste (Refuse and Emissions) Management Plan (Appendix 9-N) provides procedures for collection, handling, and disposal of wastes.

BW Gold is permitted to operate a diesel-fuel fired, double chamber incinerator (*Environmental Management Act* Authorization #106530). The Authorization allows a maximum discharge rate of 110 m^3/minute and maximum waste feed of 1.1 tonnes/day. Authorized waste for incineration include putrescible camp waste, paper, cardboard and lumber scraps that cannot be recycled.

BW Gold is considering future permitting and design/construction of an inert material landfill. The landfill would be used for the disposal of inert, non-combustible waste only, including but not limited to non recyclable plastics, cement, sand, used construction materials, and excess packaging such as cardboard and polystyrene foam.

Industrial Waste

Combustible (non-putrescible) wastes such as clean, untreated wood waste will be incinerated or burned through strictly controlled open burning (assuming permits are obtained and conditions are favourable) consistent with provincial authorizations. Pallets will be stockpiled and reused wherever possible. Pallets that cannot be reused will incinerated or burned through strictly controlled open burning (assuming permits are obtained and conditions are favourable). Non-combustible solid wastes are those that cannot readily burn and those that are not suitably disposed of through burning (e.g., conveyor belts and tires). These materials will be stored in designated and marked areas/bins located throughout the site. Wastes such as scrap metal, and unsalvageable equipment will be sorted in steel recycle bins for either on-site reuse or off-site recycling/disposal.

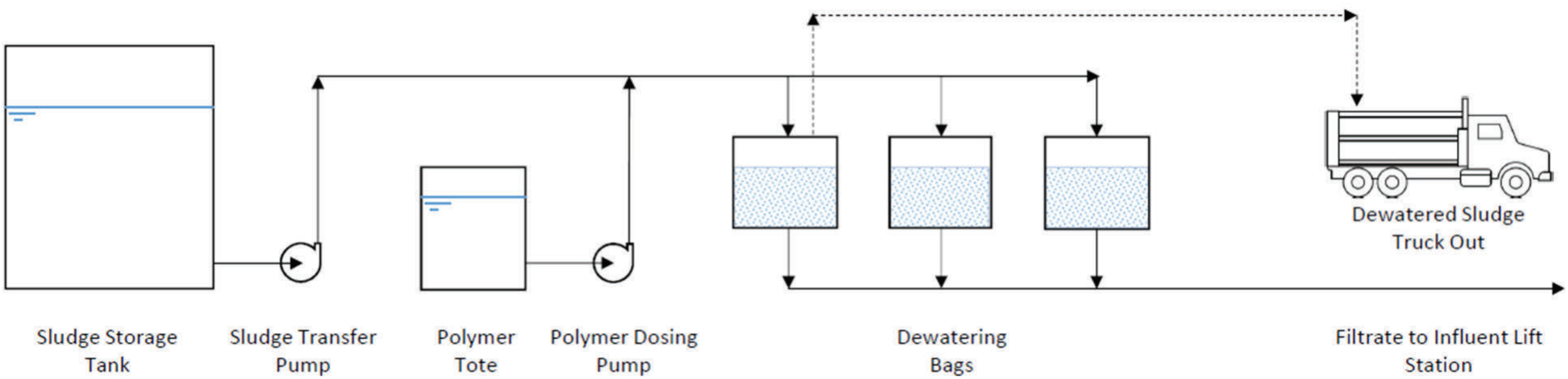


Figure 3.5-79: Dewatering Bag System Flow Diagram

Source: WSP (2021; Appendix 3-I).

Bulk wastes that cannot be recycled, or incinerated will be hauled to an approved off-site landfill. This waste may consist of treated wood, rubber, non-recyclable scrap metal and machinery parts (cleaned of any petroleum residues), building construction debris, and plastic.

Domestic Waste

Domestic (kitchen) wastes will be treated similarly in all mine phases. Domestic wastes will be incinerated daily or periodically, subject to Authorization #106530. Plastics will be separated at source where possible and not incinerated to minimize dioxin and furan emissions and to ensure compliance with the Canada Wide Standard for dioxins/furans. Ash disposal will be in accordance with Authorization #106530.

Food, food-covered packaging, and other combustible (non-recyclable) office wastes will be collected and stored in sealed, wildlife-resistant containers.

Hazardous Waste

Hazardous wastes will include waste oil, oily waste (e.g., contaminated soils, pads, absorbent mats, rags, Personal Protective Equipment [PPE]), waste paints, solvents, and batteries (nickel cadmium, lead acid, and lithium).

Hazardous and non-hazardous wastes will be stored separately, and will be segregated according to classifications in the *Hazardous Waste Regulation*. All chemical and materials including wastes will be handled and stored according to compatibility. Segregation will ensure both that there is no contact between hazardous materials, and that sufficient storage space between containers will be maintained for safe access and handling. Hazardous wastes and flammable hazardous wastes will be stored separately in appropriately covered containers prior to transport by licensed carrier for appropriate disposal. All hazardous wastes will be transported off-site by licensed transporters and to designated disposal facilities.

3.5.11.13 Mobile and Supporting Mine Equipment

Table 3.5.11-2 provides a list of the supporting mine fleet. The in-pit mine fleet is described in Section 3.5.1.9 In-Pit Equipment and Power. The mine fleet will be adjusted depending of construction and operation requirements.

Table 3.5.11-2: Mining Support Equipment

Unit	Function
Motor Grader (5.5 m blade)	Haul road/service road maintenance
Motor Grader (4.9 m blade)	Haul road/service road maintenance
Water/Gravel Truck	Haul road/service road maintenance
Track Dozer (450 kW)	Stockpile maintenance
Track Dozer (325 kW)	Shovel support, snow clearing, site prep, construction
Wheel Loader (19 m^3)	Shovel support, snow clearing, site prep, construction
Wheel Loader (7 m^3)	Shovel support, snow clearing, site prep, construction
Hydraulic Excavator (4.5 m^3)	Ore cleaning, prep for ore loading
Hydraulic Excavator (3.0 m^3)	Ditching, construction
Fuel and Lube Truck	Fuel/lube support
Shuttle Bus (15 passenger)	Staff transportation
Pickup Trucks (1/4 ton)	Staff transportation

Unit	Function
Lighting Plants	Construction and maintenance support
On-Highway Dump Truck	Utility material movement
Flatbed Picker Truck and Lowboy Trailer	Material transport, pump crew support
Emergency Response Vehicle	Mine safety and first aid
Maintenance Trucks	Mobile maintenance and tool transport
Mobile Crane (30 t capacity)	Mobile material handling
Mobile Crane (150 t capacity)	Mobile construction material handling
Articulated Truck (40 t capacity)	Mobile construction material handling
Float Trailer (55 t capacity)	Equipment transport
Forklift	Maintenance support
Cable Reeler (WL, 10 t capacity)	Shovel and drill support
Scissor Lift	Maintenance support
Compressors	Maintenance support
Welding Machines	Maintenance support
Forklifts	Maintenance Support
Mobile Manlift	Maintenance support
Skid Steer Loader	Maintenance support
Telehandler	Maintenance support

3.5.11.14 Security

The security gatehouse will be constructed at approximately km 11.6 of the MAR, located within the mine site. The building will be of modular construction and consist of three modules, each 3 m wide x 9 m long x 3 m high, supported on cast-in-place concrete spread footings on a gravel surface over fill will placed over the levelled site. There will be two offices, a training/orientation room, a coffee station, a PPE storage room, drug and alcohol testing room, and a unisex washroom. The checkpoint will be staffed by security personnel 24 hours/day, 7 days/week and only authorized personnel will be granted entry to the mine site.

3.5.11.15 Communications

The site-wide communications system will be based on a fibre optic backbone connected to the following systems:

- Information Technology network (VoIP telephone and local area network);
- Control system network;
- Security network;
- Closed circuit television network; and
- Fire alarm network.

TELUS currently provides telecommunications service from an existing microwave tower at the Project site. At present, a 3G (third generation) wireless communication system with full cellular or data service is available on site. The system will be updated as required during the LoM.

Data service will be brought to site at a later date via a permanent fibre optic cable running along the transmission line starting in Year -1. The in-plant communications system will then transition to the fibre optic cable as the primary communication connection; the cell tower system will be retained for secondary backup.

3.5.11.16 Helipad

A helipad will be constructed east of the Plant Site along the east processing plant service road (Figure 3.5-71). The helipad will operated from Year -1 to approximately Year +45 and will be used for rapid access to and from the Property including for emergency purposes. The helipad will be decommissioned after the Closure phase. The pad will be concrete and follow the *Canadian Aviation Regulations* Standard 325 Heliports. Final construction design will be done in consultation with helicopter companies and/or air safety experts.

3.6 References

Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.

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