RED MOUNTAIN UNDERGROUND GOLD PROJECT
VOLUME 2 | CHAPTER 1
PROJECT OVERVIEW

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1 PROJECT OVERVIEW

1.1 Introduction

IDM Mining Ltd. (IDM, the Proponent) proposes to develop and operate the Red Mountain Underground Gold Project (the Project), an underground gold mine in the Bitter Creek valley on a contiguous group of mineral tenures known collectively as the Red Mountain property, located approximately 18 kilometres (km) northeast of Stewart, British Columbia (BC). The Project will extract high-grade gold and silver ore to be processed on-site.

The Project is composed of two main areas of activity with interconnecting Access and Haul Roads: the Mine Site with an underground mine and dual portal access at the upper elevations of Red Mountain (1,950 metres above sea level [masl]) and Bromley Humps, situated in the Bitter Creek valley (500 masl), with a Process Plant and Tailings Management Facility (TMF).

This Project Overview describes how IDM proposes to construct, operate, and decommission the Project.

1.1.1 Proponent Information

1.1.1.1 Proponent

IDM Mining Ltd. (IDM) is a mineral exploration and development company listed on the Toronto Ventures Stock Exchange (TSX-V: IDM) with a registered office in Vancouver, BC. IDM, formerly known as Revolution Resources, underwent a name change and corporate restructuring in early 2014. IDM entered into an Option Agreement to acquire the Project from Seabridge Gold in 2014. The Red Mountain property is IDM's core asset.

IDM has been actively engaged in exploration of its Red Mountain since 2014. Since this time, IDM has expanded its program to include an exploration camp that operates with approximately 35 to 40 people involved in exploration, engineering, and environmental programs. Project advancement has also meant increased and more complex logistical support.

These programs are completed under various authorizations from the provincial Ministries of Energy and Mines and of Environment, and IDM has complied with all terms and conditions to date. In addition, IDM updates and submits management plans to the appropriate regulatory authorities and maintains internal operating procedures to improve safety and environmental protection. IDM has been transparent and forthcoming with all levels of government during all aspects of Project development and has developed a good relationship with community residents based on mutual respect and open communication.

IDM has an exemplary local employment, environmental protection, and safety record over the three years of work at the Red Mountain property. The Project site is inspected on a periodic basis by provincial and federal regulatory agencies. To date, no compliance orders have been issued by any provincial or federal regulatory agency and IDM has followed all terms and conditions.

IDM intends to build a mine with integrity: one that is safe, environmentally responsible, and beneficial to all parties involved. IDM intends to balance good stewardship in the protection of human health and the natural environment with the need for positive economic growth in northwestern BC.

1.1.1.2 Corporate Governance

IDM is governed by a board of directors with six members, including a chairman. The board of directors is responsible for governance and stewardship of the company. IDM is managed under the direction of:

- Rob McLeod, President and Chief Executive Officer
- Michael McPhie, Executive Chairman
- Susan Neale, Chief Financial Officer

IDM's head office is in Vancouver, BC.

Project Name:	**Red Mountain Underground Gold Project**
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1.1.1.3 Environmental Management System

An overview of IDM's Environmental Management System (EMS) is presented in Volume 5, Chapter 29. The EMS is the mechanism used to ensure that corporate policies will be implemented and respected for the Project. The EMS is based on the principle of continuous improvement and adaptive management: Plan – Do – Check – Correct – Report.

1.1.1.4 Occupational Health and Safety Policy

The people who work for IDM are key to our company's success, and we are committed to the health, safety, and well-being of our entire workforce. To achieve this commitment IDM has established the following health and safety policy.

IDM is committed to operating a safe and healthy working environment for all employees, representatives, consultants, contractors, and sub-contractors. Safety is IDM's number one priority. IDM's goal is to minimize all accidents and incidents to achieve a "Zero Harm" working environment and to create a culture of safety.

IDM's commitment to the health and safety of its employees, consultants, contractors, and sub-contractors will be achieved through the following actions. IDM will:

- Enforce a zero-tolerance drug and alcohol working environment.
- Comply with and abide by all applicable health and safety legislation and best practices, with legal compliance considered the minimum standard of business operation.
- Adhere to generally accepted industry safety standards.
- Support the development, implementation, and continuous improvement of health and safety programs, including emergency response and management plans, and provide all IDM employees, consultants, contractors, and sub-contractors with the information, training, and equipment they need to fully understand and implement these programs and plans and work safely.
- Identify and communicate the health and safety risks associated with our activities to IDM employees, consultants, contractors, and sub-contractors.
- Treat IDM employees, consultants, contractors, and sub-contractors with respect and integrity and require our representatives to show the same respect for one another. Improper conduct including harassment, discrimination, or horseplay will not be permitted.
- Foster a blame-free environment where all persons are able to report errors or near misses without fear of reprimand.
- Encourage IDM employees and representatives to be innovative and creative in integrating health and safety practices into IDM's business operations.

All IDM employees, as well as anyone acting on behalf of IDM, are responsible for acting in accordance with this policy, regardless of the jurisdiction in which they are working.

1.1.2 Guiding Principles

1.1.2.1 Application of the Precautionary Approach

The Precautionary Approach stipulates that lack of certainty regarding threats of environmental harm should not be used as an excuse for not acting to avert that threat. It also recognizes that delaying action until there is compelling evidence of harm will often mean that it is then too costly or impossible to avert the threat. The use of the Precautionary Approach promotes action to avert risks of serious or irreversible harm to the environment.

IDM integrates the application of the Precautionary Approach throughout the design of the Project. This approach forms the basis for Project design criteria, the effects assessment volumes of this Application for an Environmental Assessment Certificate / Environmental Impact Statement (Application/EIS), the alternatives assessment, and management practices.

IDM is fully committed to acting as a socially responsible steward of the environment throughout the lifetime of the Project. To this end, the Precautionary Approach will be integrated into decision making on all aspects of implementation.

In gathering data to achieve scientific consensus, IDM has conducted extensive research to establish baseline data and, where data is not yet available, incorporated examples from other similar, established operations. Extensive consultation with Aboriginal Groups, communities, and local stakeholders ensures that local knowledge will be fully evaluated and incorporated to support the goal of achieving scientific consensus.

Where there is uncertainty or some plausible risk, conservative approaches, together with a dynamic process of adaptive management, will be implemented. A flexible approach will be supported by the design of monitoring programs to address all areas of uncertainty, provide a process for mitigation, and to further support the ongoing collection of scientific data.

IDM promotes responsibility and accountability of managers, employees, and contractors to protect the environment and make environmental performance an essential part of the management/contractor review process as well as promoting the development and implementation of systems and technologies to reduce environmental risks.

The Project will contribute to the economic development of the region through the creation of private sector employment. Ongoing consultation, adaptive management, and the application of the Precautionary Approach in decision making is aimed at protecting the health of local populations as well as minimizing any effect of the Project on the environment and local ecosystems.

1.1.2.2 Sustainability

IDM also subscribes to the principles of sustainable development in mining. This is evidenced in IDM’s Environmental and Sustainability Policy, outlined below.

IDM is committed to conducting business in an environmentally and socially sustainable manner. IDM recognizes that our actions may directly or indirectly affect the ecological and human environments that IDM’s employees and neighbours depend on and enjoy. IDM’s goal is to achieve “Zero Harm” and ultimately a net positive contribution to ecological and human well-being.

IDM’s commitments to environmental protection and sustainable development will be achieved through the following actions. IDM will:

- Seek to minimize the potential adverse effects of IDM’s operations on the environment through the use of technology and ecologically conscious decision-making and best practices. This includes respectful consultation with Aboriginal Groups, local communities, government regulators, and stakeholders.
- Comply with and abide by all applicable environmental legislation and best practices, with legal compliance considered the minimum standard of business operation.
- Support the development, implementation, and continuous improvement of a comprehensive EMS and provide all IDM employees, consultants, contractors, and sub-contractors with the information, training, and equipment they need to fully understand and implement the EMS.
- Incorporate the principles of sustainable development into all levels of project planning, decision-making, and implementation.
- Choose environmentally preferable products and services as much as possible.
- Support initiatives that promote the long-term socio-economic, heritage, human health, and ecological well-being of the communities where IDM is active.

All IDM employees, as well as anyone acting on behalf of IDM, are responsible for acting in accordance with this policy, regardless of the jurisdiction in which they are working.

1.1.3 Analysis of Need and Purpose of the Project

The purpose of the Project is to mine and process ore and deliver gold and silver doré to world markets so there is an economic return on investment while protecting the environment and maximizing the socio-economic benefits to the region.

The need for this Project is as follows:

- To provide a return on investment to the IDM's shareholders;
- To provide additional employment and business opportunities for the local and regional communities around the Project;
- To supply gold and silver to the international marketplace. The reasonably foreseeable international demand for gold and silver has created market conditions that IDM believes are favourable for operating an underground gold mine; and
- To contribute to the development of infrastructure, skills training, employment, and business opportunities in BC. This will help build healthy communities and strengthen partnerships between IDM and stakeholders and institutions.

IDM believes in the economic viability and potential of the Project and that Project development will bring training and employment opportunities as well as increased investment in services to the people of the Stewart area and BC. The Feasibility Study, completed in July 2017, found that development of a significant portion of the Red Mountain resource provides strong economic returns at a high confidence level while complying with best practices of environmental and socio-economic sustainability.

The economic effects of the Project are a result of direct procurement and workforce employment. Using this data as input, the indirect and induced employment, personal income, Gross Domestic Product (GDP), and government revenue effects are predicted. Estimation of this information requires a detailed economic effects assessment, the results of which are included as part of the Application/EIS (Volume 5, Chapter 19).

The Project is predicted to result in employment, income, GDP, and government tax revenue benefits to the Stewart area, BC, and Canada. Table 1.1-1 is a summary of the direct and spinoff (indirect and induced) effects, as estimated by the economic model. As is evident, such project expenditures would be a significant boost to the local and regional economies.

Table 1.1-1: Input-output Interprovincial Model Summary Results

	Construction	Operation
Total GDP ($CDN million)	$81.2	$152.9
Total tax revenue ($CDN million)	$20.2	$36.6
Total direct employment (person years)	865	1,696

The Project is located near Stewart, BC, and access is proposed via one all-season road. IDM is open to negotiated use and access along the road corridor; however, at this time it will be considered a private road and closed to public use.

1.1.4 Regional Context

The Project is an advanced exploration gold project located in northwest BC, as shown in Figure 1.1-1, at approximately 55.896° to 56.054° north latitude and 129.665° to 129.802° west longitude.

The Project area is characterized by rugged, steep terrain with weather conditions typical of the northern coastal mountains, including significant snow accumulation, typically of more than 2 metres (m), in the winter. An existing access road extends for approximately 13 km along the Bitter Creek valley but stops approximately 7 km from the proposed Mine Site.

The Project falls within the Regional District of Kitimat-Stikine (RDKS). The closest community to the Project is Stewart, located approximately 18 km to the southwest of the Mine Site. Other communities in the northwest of the province, including Terrace and Smithers, are likely sources of workers, contractors, goods, and services.

The Project is located within the Nass Area and Nass Wildlife Area, as set out in Nisga'a Final Agreement (NFA). Pursuant to the NFA, Nisga'a Nation, as represented by the Nisga'a Lisims Government (NLG) has Treaty rights to the management and harvesting of fish, wildlife, and migratory birds within the Nass Area and Nass Wildlife Area. The Project is also within the asserted traditional territories of Tsetsaut Skii km Lax Ha (TSKLH) and Métis Nation BC (MNBC).

Refer to the Vegetation and Ecosystems Effects Assessment (Volume 3, Chapter 15) for a discussion of environmentally sensitive areas near the Project and for Terrain Ecosystem Mapping (TEM) and Predictive Ecosystem Mapping (PEM).

Figure 1.1-1: Project Location and Communities

1.1.5 History

Placer mining commenced in Bitter Creek at the base of Red Mountain at the turn of the century, but significant work on the current deposit began in 1988 when Wotan Resources Inc. staked claims in 1988 and optioned the property to Bond Gold Canada Inc. (Bond) in 1989. In that year, gold mineralization in the Marc and Brad zones were discovered by drilling. LAC Minerals Ltd. (LAC) acquired Bond in 1991. Surface drilling on the Marc, AV, and JW zones continued in 1991, 1992, 1993, and 1994. Underground exploration of the Marc zone was conducted in 1993 and 1994. In 1995, LAC was acquired by Barrick who subsequently optioned the property to Royal Oak Mines Ltd. (Royal Oak) in 1996. North American Minerals Inc. (NAMC) purchased the property from the receivership sale of Royal Oak in 2000. NAMC subsequently sold the property to Seabridge in 2002, who optioned the property to Banks Island Gold Ltd. (Banks). Banks terminated the option in 2013 and the property reverted to Seabridge. Seabridge subsequently optioned the property to IDM in 2014.

Table 1.1-2 provides a chronological summary of recent exploration efforts on Red Mountain.

Table 1.1-2: Red Mountain 1988 – 2016 Chronological Exploration Summary

Date Range	Exploration Activity Description
1988 – 1989	Staking of Red Mountain by Wotan Resources Inc.
1989	Red Mountain and Wotan properties optioned to Bond. Discovery of gold-silver mineralization by drilling in the Marc zone (3,623 m); airborne EM and magnetic survey.
1990	Exploration of Marc zone and adjacent area (11,615 m of drilling) by Bond.
1991	LAC acquired 100% of Bond. A 2,400 m drill program was completed on the Marc and AV Zones.
1992	Results of a 4,000 m drill program by LAC increased Red Mountain resources and indicated excellent potential for expansion.
1993	28,800 m of surface drilling defined the Marc, AV, and JW Zones and identification of the 141 Zone. An underground exploration adit allowed bulk sampling of the Marc zone. 8,600 m of underground drilling completed in the Marc zone.
1994	LAC completed a 350 m extension of the main decline, 30,000 m of underground drilling and 16,000 m of surface drilling.
1995	Red Mountain gold project acquired by Barrick following Barrick's take-over of LAC. No exploration work completed by Barrick.
1996	Royal Oak undertakes exploration to explore for additional reserves. Extended underground drift by 304 m and completed 26,966 m of surface and underground drilling.
2000	NAMC purchased the property and project assets from Price Waterhouse Coopers, conducts detailed relogging of existing drill core and constructs a geological model for resource estimation purposes and exploration modelling.
2002 – 2012	Seabridge purchases property, completes two Preliminary Assessment Studies (PEA)

Date Range	Exploration Activity Description
2012 – 2013	Banks options property, two surface drill holes completed, completes PEA study.
2014	IDM options property and drilled 12 diamond drill holes
2016	IDM drilled 11 surface diamond drill holes and 51 underground infill and resource expansion drill holes

Source: Arseneau Consulting Services (2017)

1.1.6 Mineral Tenure

IDM has, under an option agreement, the right to acquire 100% interest in the Red Mountain property, comprising 47 contiguous mining claims covering approximately 17,125 ha, currently owned 100% by Seabridge. The majority of all conditions of the agreement have been met and title to the property was transferred to IDM in May 2017. The remaining condition of the agreement will be satisfied by IDM when the Project goes into commercial production. All tenures are in good standing until May 9, 2023, and a description of the tenure type, size, and ownership of each property is listed in Table 1.1-3.

The mining leases have been surveyed by a registered Canadian land surveyor and do not require filing of annual assessment work; however, an annual fee must be paid to maintain the leases in good standing. The mining claims have been surveyed and are marked with pickets along claim boundaries and claim posts at the corners of the claims.

Annual reports have been delivered to Ministry of Energy and Mines and Ministry of Environment, per the terms and conditions of authorizations issued for work done on site to date (refer to Section 1.1.7 for a list of current authorizations and permits).

Figure 1.1-2 shows IDM's Project claim and lease map.

Table 1.1-3: Description of Mining Claims Associated with the Red Mountain Property

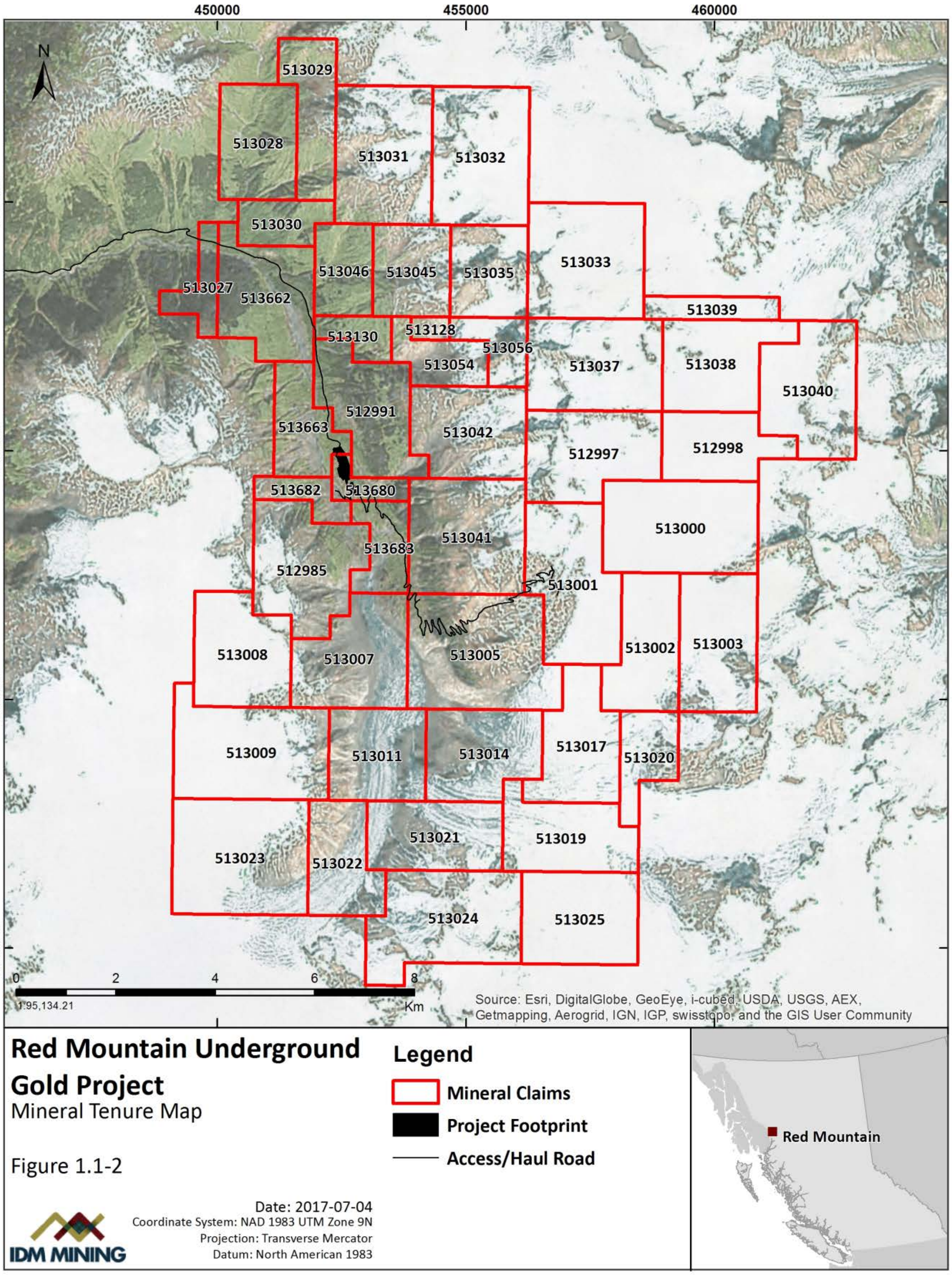
Tenure Number	Tenure Type	Size (Ha)	Ownership (%)
512997	Mineral	452.4	100
513001	Mineral	525.1	100
513028	Mineral	361.4	100
513040	Mineral	470.4	100
513046	Mineral	217	100
513054	Mineral	180.9	100
513662	Mineral	434	100
513002	Mineral	362.3	100
513024	Mineral	580.5	100

Tenure Number	Tenure Type	Size (Ha)	Ownership (%)
513045	Mineral	289.3	100
513130	Mineral	108.5	100
513007	Mineral	452.8	100
513017	Mineral	380.5	100
512985	Mineral	488.8	100
513005	Mineral	670.2	100
513014	Mineral	398.7	100
513019	Mineral	380.7	100
513031	Mineral	542.1	100
513032	Mineral	542.2	100
513033	Mineral	542.4	100
513038	Mineral	398	100
513009	Mineral	597.8	100
513021	Mineral	380.7	100
513056	Mineral	144.7	100
513022	Mineral	308.2	100
513023	Mineral	634.4	100
513680	Mineral	90.5	100
512998	Mineral	307.6	100
513027	Mineral	126.6	100
513029	Mineral	289.1	100
513030	Mineral	162.7	100
513682	Mineral	108.6	100
513000	Mineral	579.3	100
513025	Mineral	435.4	100
513035	Mineral	289.3	100
513037	Mineral	506.5	100
513663	Mineral	253.3	100
513683	Mineral	181	100
513011	Mineral	362.4	100
513008	Mineral	416.5	100
513020	Mineral	199.3	100
513003	Mineral	434.7	100

Tenure Number	Tenure Type	Size (Ha)	Ownership (%)
513039	Mineral	126.6	100
513128	Mineral	36.2	100
512991	Mineral	416.2	100
513041	Mineral	543.1	100
513042	Mineral	416.2	100
Total Hectares		17,125.2	

Source: JDS (2016)

Figure 1.1-2: Red Mountain Mineral Tenure Map



1.1.7 Current Exploration Activities

Advanced exploration and engineering activities are currently in progress at site on a seasonal basis. These include:

- Surface and underground drilling for resource delineation, exploration, and geotechnical data collection;
- Geophysics and area surveys for resource and engineering;
- Operation of an exploration camp and support services for the exploration program. IDM operates a 40-person self-contained exploration camp consisting of sleeping units, dry/kitchen/dining facilities, offices, and core processing facility. The existing underground mine portal is at the mountain top and serviced by a storage building used to store heavy equipment, a maintenance shop, and dedicated diesel generators. The exploration camp is operated on a seasonal basis; and
- Operation of the underground requires mine ventilation, dewatering, and qualified management to ensure a safe and environmentally responsible operation. Active mining has not been done since the decline was driven over 20 years ago.

Bulk goods and fuel are typically flown to site via helicopter. No roads currently access the site, but there are all-terrain vehicle (ATV) trails utilized for transportation between the camp and the existing mine portal.

These activities are conducted under permits, licenses, and authorizations as identified in Table 1.1-4. As Project development advances, it is anticipated that these activities will continue.

Table 1.1-4: Current Authorizations and Permits (as of January 19, 2017)

Permit	Expiry (year-mo-day)	Agency	Description
MX-1-933	2017-03-31	Ministry of Energy and Mines	Notice of Work and Reclamation Permit, camp, and surface drilling
MX-1-933	2021-03-31	Ministry of Energy and Mines	Permit Amendment, Multi-Year Area Based (MYAB) Permit including camp, surface drilling, trenches, and/or testpits
MX-1-933	Issued annually (annual notification required for re-issuance)	Ministry of Energy and Mines	Free Use Permit, for timber cutting up to 50 m^3/yr

Permit	Expiry (year-mo-day)	Agency	Description
MX-1-958	2021-03-31	Ministry of Energy and Mines	Notice of Work and Reclamation Permit, underground rehabilitation, drilling, and dewatering
Approval 108392	2017-09-29	Ministry of Environment	Authorization for discharge of mine water
Approval 108392	2017-09-29	Ministry of Environment	Authorization Amendment (increase in maximum authorized rate of discharge)

1.1.8 Project Layout and Major Components

The Project includes the Mine Site, Bromley Humps, and interconnecting roads, as shown in the Project Overview (Figure 1.1-3), Project Footprint – Mine Site (Figure 1.1-4), and Project Footprint – Bromley Humps (Figure 1.1-5).

Ore will be mined by underground methods from portals at the Mine Site, located in the Cirque (Alpine) area between the Cambria Icefield and the Bromley Glacier at elevations ranging between 1,500 and 2,000 masl (refer to Figure 1.1-4 for the Mine Site Project Footprint).

Major Project components include the Access Road, Haul Road, 138 kilovolt (kV) and 25 kV Powerlines, Mine Site infrastructure, and Bromley Humps infrastructure.

The following are the Project components to be located at the Mine Site:

- Upper and Lower Portals
- Ventilation Portal
- Laydown Areas
- Waste Rock Storage Area (WRSA)
- Ore Stockpiles (Upper and Lower Portal)
- Water Management Infrastructure, including:
  - Upper and Lower Portal dewatering systems
  - Portal Collection Pond
- Ancillary buildings and facilities, including:
  - 20,000 litre (L) Fuel tank (Lower Portal)
  - Site Offices (Upper and Lower Portal)
  - Maintenance Shops (Lower and Upper Portal)
  - Explosives Magazine

Existing infrastructure at the Mine Site near the Upper Portal includes an historical waste rock storage area, exploration portal (to be used as the Upper Portal for the Project), fuel tank, and generator enclosure.

During Project Operation, waste rock will be temporarily stored at the Mine Site in a designated storage area on surface (i.e., the WRSA) until ultimately backfilled into the mine workings (Figure 1.1-4). Ore will be trucked via connecting road to the Process Plant located in the Bitter Creek valley at Bromley Humps (refer to Figure 1.1-5 for the Bromley Humps layout).

The following are the major Project components to be located at Bromley Humps:

- Process Plant
- Run-of-Mine (ROM) Stockpile
- TMF and associated infrastructure, including:
  - TMF reclaim water management system
  - TMF surplus water management system
  - TMF non-contact water diversion ditch
  - North TMF Embankment Seepage Collection Pond
  - South TMF Embankment Seepage Collection Pond
- Water Treatment Plant
- Topsoil Stockpile (located next to the Access Road approximately ½ km north of the TMF)
- Ancillary buildings and facilities, including:
  - Fuel Tank
  - Administration Office / Mine Dry
  - Warehouse
  - Assay Lab
  - Waste Storage Area
  - Hazardous Materials Storage Area

Ore will be processed using conventional Carbon in Leach (CIL) recovery processes at the dedicated Process Plant at Bromley Humps. Tailings from the Process Plant will be stored in an adjacent TMF (Figure 1.1-5).

There are two Talus Quarries located in proximity to the Mine Site and an additional four borrow and quarry areas located along the Access and Haul Roads:

- Otter Creek Quarry;
- Roosevelt Borrow;
- Hartley Gulch Borrow; and
- Highway 37A Quarry.

The mine plan for the Project is an estimated six-year operating mine life based on currently delineated resources, with a total ore feed to the single Process Plant of nearly two million tonnes.

Continued exploration may extend the projected mine life.

Figure 1.1-3: Project Overview

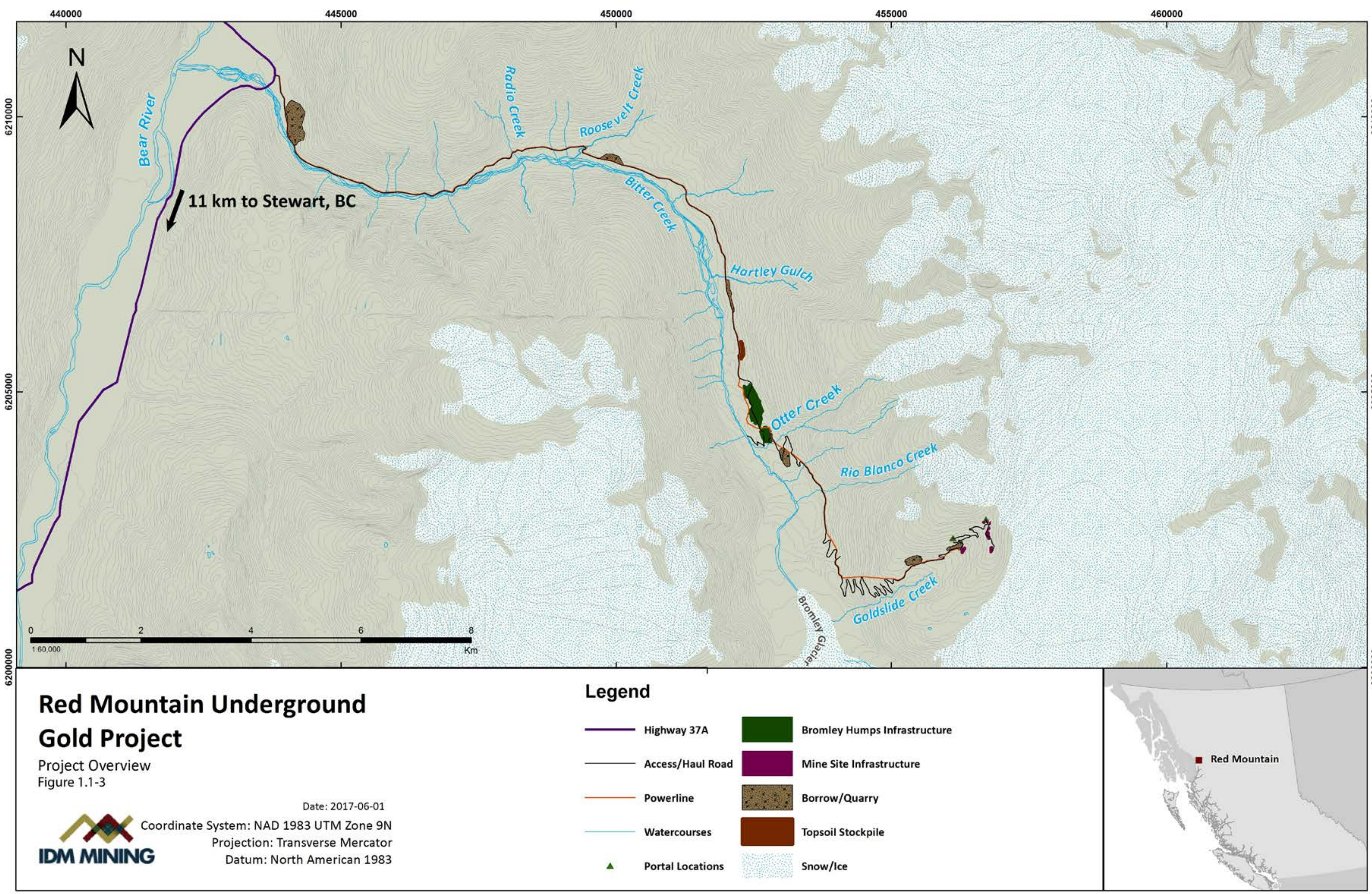


Figure 1.1-4: Project Footprint - Mine Site

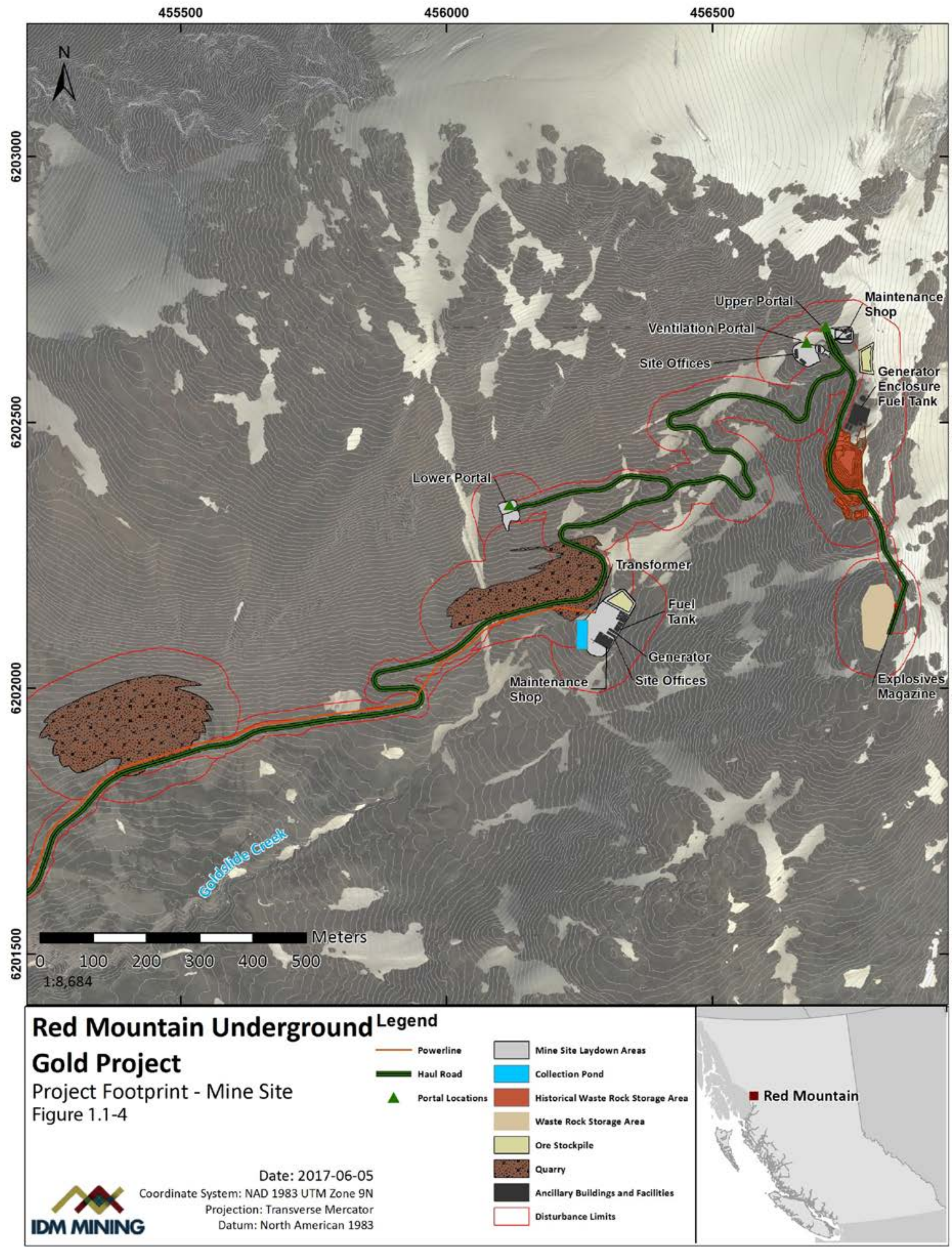
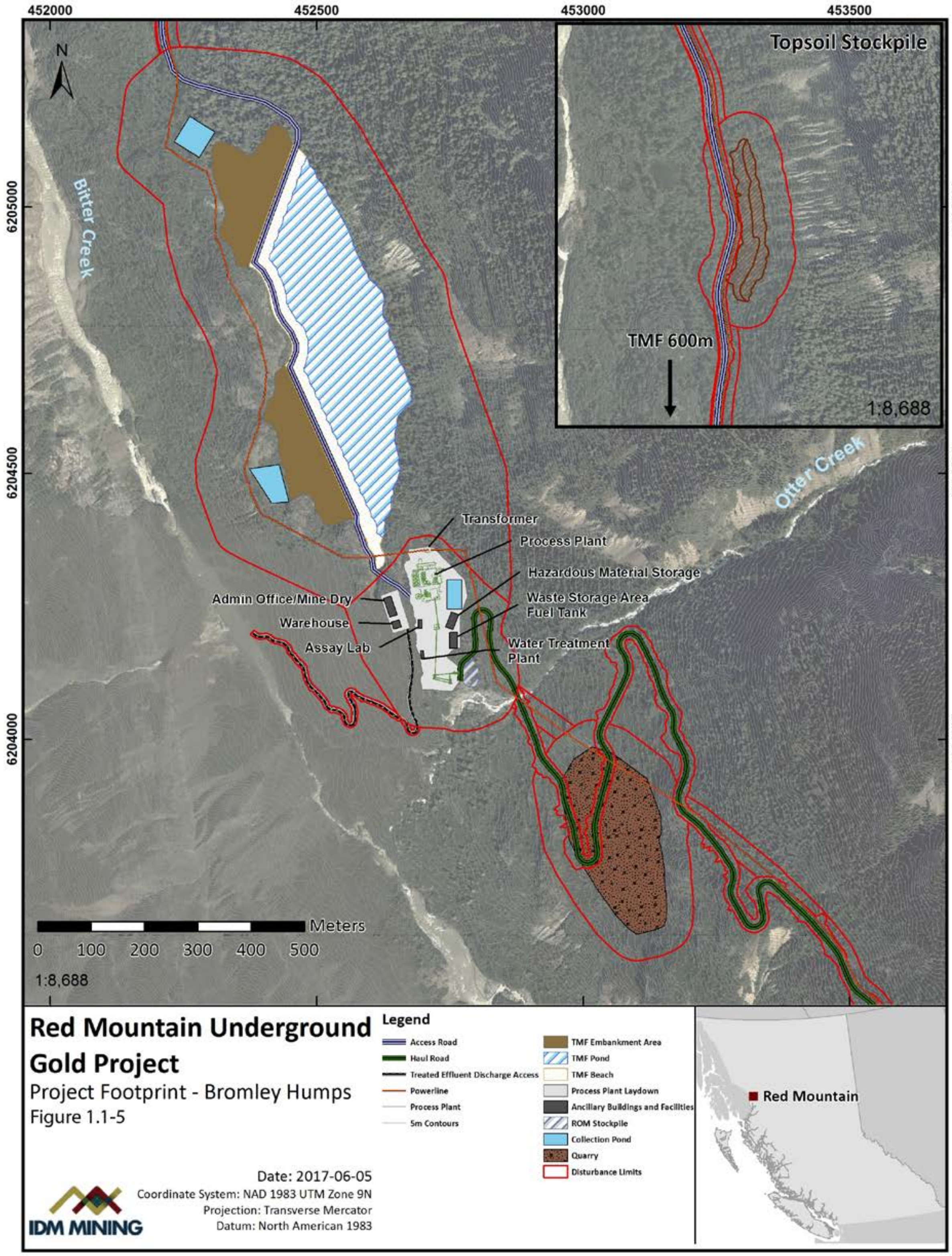


Figure 1.1-5: Project Footprint - Bromley Humps

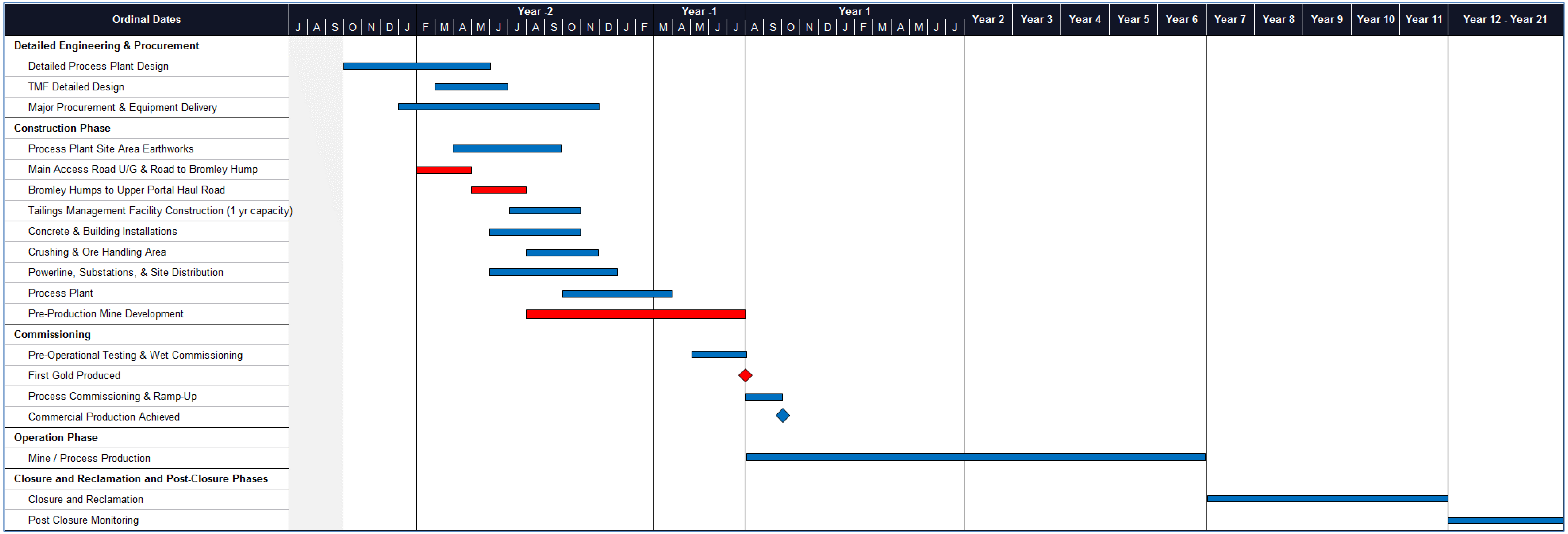


1.1.9 Project Phases

The life of the Project is approximately 22 years (including Closure and Reclamation and Post-Closure Phases). It is expected that the Construction Phase could begin as early as mid-2018, and will last approximately 18 months (Figure 1.1-6). The Operation Phase will continue for approximately 6 years, based on the mine plan proposed and current reserve base.

The mineral resources will ultimately be exhausted, whereupon the mine will enter a staged Closure and Reclamation Phase (up to five years). During the first season, immediately at the cessation of production, the mine, equipment, and infrastructure will be decommissioned. Mine backfill and reclamation of mine rock storage facilities will have been mostly completed during the Operation Phase; however the final grading and reclamation will be done at closure. Final reclamation of the TMF will be completed two years after cessation of mining. The Post-Closure Phase will consist mostly of site monitoring until the site is returned to a stable condition with no significant effect on the environment. Post-closure monitoring will be conducted for a period of approximately 10 years to ensure the area remains both chemically and physically stable. However, post-closure monitoring will carry on until closure objectives have been achieved.

Figure 1.1-6: Project Timeline



1.2 Project Setting and Design Considerations

1.2.1 Physical, Climate, and Hydrology Setting

The Project is located in rugged mountainous terrain with steep slopes and elevations ranging from between 500 and 2,700 masl. High peaks in close proximity to the Project include Otter Mountain at 2,700 masl and Bromley Peak at 2,300 masl. The Cambria Range and valley are heavily glaciated by the Bromley, Bear River, Kitsault, and Sutton Glaciers, and the Cambria Icefield dominates the area. At elevations greater than 600 masl, glacial ice persists year-round in the Bitter Creek valley and the treeline occurs at about 900 masl in elevation (Klohn 1994).

The region has undergone several stages of glaciation and local glaciers are currently in active retreat. Within the last century, the Bromley Glacier has retreated at an average rate of 45 metres per year with a total vertical thinning of approximately 300 m. As a result of the glaciation, exposed rock outcrops are well rounded with steep sides. Above 1,600 m elevation, the peaks have been modified by alpine glaciers and display sharp jagged crests. In general, the lower north and east facing slopes are steeper than south and west facing slopes, reflecting the general direction of glacial advance. The topographic map, dated 1927, of the Nass River Cassiar District (Nass River 103P, Edition 2) indicates that the Red Mountain Cirque was not glaciated at that time.

The region has cold weather and warm summers but no dry seasons. Climatic conditions at Red Mountain are dictated primarily by its altitude (i.e., 1,742 masl at the centre of the deposit) and proximity to the Pacific Ocean. Temperatures are moderated year-round by coastal influence; with more than four months with an average temperature of greater than 10°C, and an average temperature below 22°C in the hottest month (Peel, Finlayson, & McMahon, 2007). Precipitation is significant in all months, with October being the wettest. The area is characterized by significant snow accumulation in the winter (i.e., +2 m snow accumulation). Even at sea level, over one-third of the annual precipitation falls as snow. This proportion is greater at higher elevations, where snow may fall at almost any time of year.

Detailed baseline climate conditions are summarized in the Baseline Climate and Hydrology Report (Appendix 12-A). Key findings that support the design of water management infrastructure for the Project are the monthly and annual average precipitation values, provided in Table 1.2-1, and the estimates of Mean Annual Runoff (MAR). Runoff is defined as the total amount of water that is discharged from a watershed (i.e., balance between precipitation, snowmelt, evaporation, groundwater losses, and glacier discharges). Two runoff models were developed for areas with different glacier cover: watersheds with less than 10% glacial cover have a MAR of 1,584 millimetres per year (mm/yr) (i.e., Goldslide Creek) and watersheds with more than 10% glacial cover have a MAR of 2,981 mm/yr (i.e., Otter and Bitter creeks).

Table 1.2-1: Mean Monthly and Annual Precipitation at Red Mountain

Parameter	Monthly Average [mm]												Annual [mm/yr]
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Precipitation	219	137	121	90	72	66	77	121	212	293	226	214	1,847
SWE (1)	570	750	880	980	970	580	110	0	0	20	160	360	-
Actual Evapotranspiration	0	3	19	44	65	65	71	60	30	14	5	0	376

Source: Red Mountain Underground Gold Project – Baseline Climate and Hydrology Report (Appendix 12-A)
Note: SWE, Snow Water Equivalent

The proposed underground mine is in the Red Mountain cirque, a short, westerly-trending hanging valley above the Bitter Creek valley where Bitter Creek flows. Goldslide, Rio Blanco, and Otter Creeks are the three uppermost tributaries to Bitter Creek. All three tributaries are small alpine creeks characterized by very steep gradients and strong seasonal fluctuations in flow. Further details on these watercourses are provided below.

- Goldslide Creek drains the Red Mountain cirque, where the existing portal is located. The flow in Goldslide Creek is highest during freshet (typically in June) and is not influenced by glacial melt.

- Rio Blanco Creek drains the catchment where the Rio Blanco Snowfield is located into Bitter Creek downstream of the Goldslide/Bitter Creek confluence. The flow in Rio Blanco Creek is highest during freshet and flow appears to be glacially-influenced and dominated by snowmelt.

- Otter Creek drains into Bitter Creek downstream of the Rio Blanco/Bitter Creek confluence. The flow in Otter Creek is highest during freshet and flow appears to be glacially-influenced and dominated by snowmelt.

- Bitter Creek originates from the Bromley Glacier. It is a tributary to the Bear River, which flows into the Portland Canal near Stewart, BC.

1.2.2 Geology and Mineralization

1.2.2.1 Regional Geology

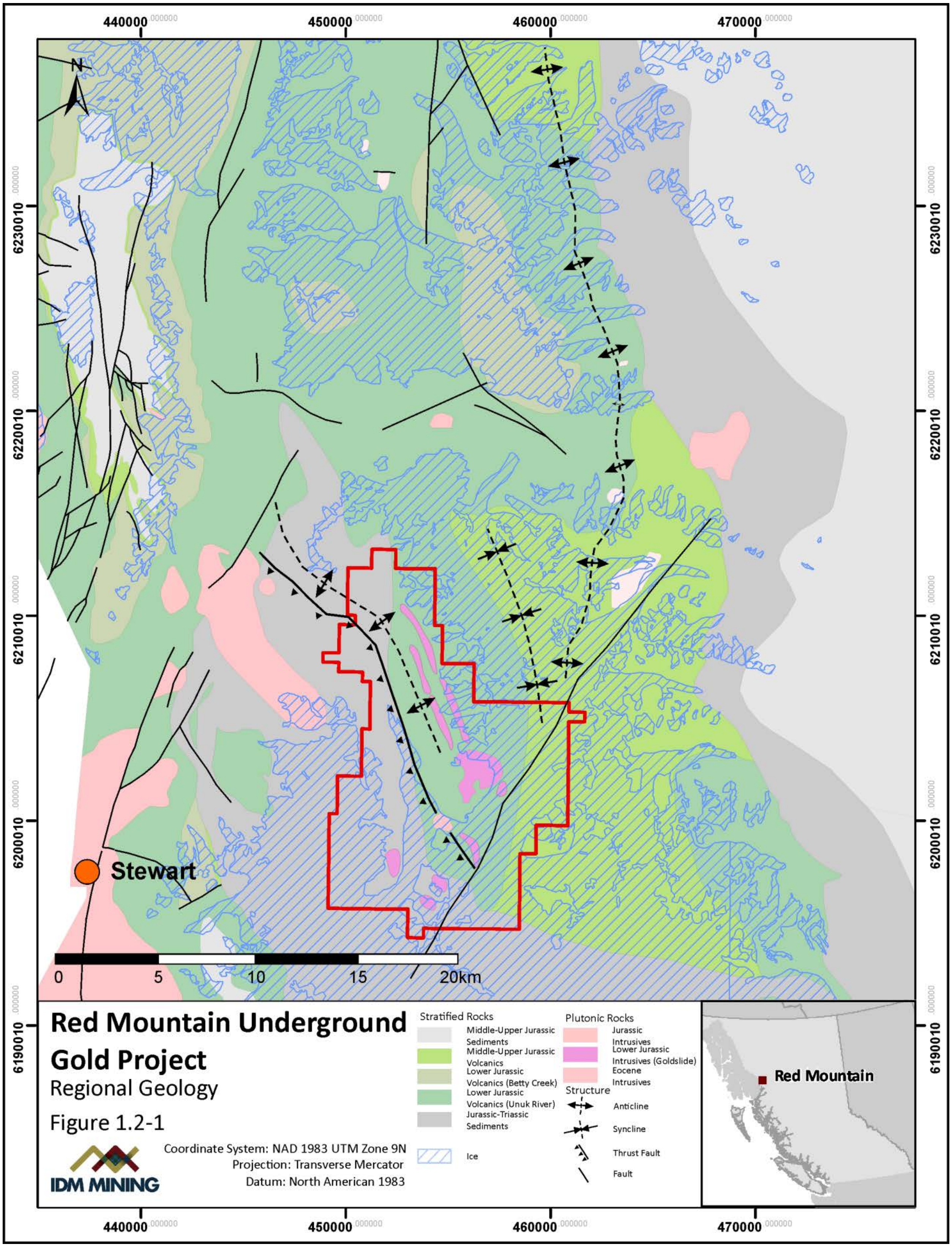
The regional geology of the Red Mountain area has been described by Greig et al (1994), Alldrick (1993), and Rhys et al. (1995). The following description is drawn from these sources.

The Red Mountain Gold Deposit is located in the Skeena Mining Division in northwest BC, near the western margin of the Stikine Terrane in the Intermontane Belt (Figure 1.2-1). There are three primary stratigraphic elements in Stikinia and all are present in the Stewart area: Middle and Upper Triassic clastic rocks of the Stuhini Group, Lower and Middle Jurassic volcanic and clastic rocks of the Hazelton Group, and Upper Jurassic sedimentary rocks of the Bowser Lake Group. Many primary textures are preserved in rocks from all of these groups, and mineralogy suggests that that the regional metamorphic grade is probably lower greenschist facies.

Intrusive rocks in the Red Mountain region range in age from Late Triassic to Eocene and form several suites. The Stikine plutonic suite is comprised of Late Triassic calc-alkaline intrusions that are coeval with the Stuhini Group rocks. Early to Middle Jurassic plutons are roughly coeval with the Hazelton Group rocks and have important economic implications for gold mineralization in the Stewart area, including the Red Mountain gold deposits. Intrusive rocks of this age are of variable composition (Rhys *et al.* 1995). Eocene intrusions of the Coast Plutonic Complex occur to the west and south of Red Mountain and are associated with high-grade silver-lead-zinc occurrences.

Structurally, Red Mountain lies along the western edge of a complex, northwest-southeast trending, doubly-plunging structural culmination, which was formed during the Cretaceous. At this time rocks of the Stuhini, Hazelton, and Bowser Lake groups were folded and/or faulted, with up to 40% shortening in a northeast-southwest direction (Greig, personal communication 2001). The Red Mountain deposits lie at the core of the Bitter Creek antiform, a northwest-southeast trending structure created during this deformation event (Greig 2000).

Figure 1.2-1: Regional Geology



1.2.2.2 Local Geology

The tectonic history of northwest BC in the Red Mountain area is described below.

200 million years ago (Ma) (Early Jurassic) – The Quesnelia and Slide Mountain terrains have already docked with ancestral North America. Stikinia is separated from continental North America by Cache Creek oceanic crust, which is being subducted at both under North America and the western edge of Stikinia. Another subduction zone exists on the eastern edge of Stikinia. Above this subduction zone the Red Mountain gold deposits are formed in an oceanic volcanic arc.

170 Ma (Middle Jurassic) – Stikinia has docked with North America. The Bowser Basin is has just formed and is getting initial basin fill from Cache Creek rocks in the east, which were placed on top of the Stikine terrain by back-thrusting during docking, and from Stikinia rocks in the west. A lack of intrusive rocks suggests there is no active subduction west of Stikinia at this time or that, if present, it is so far to the west that no influence is felt.

145 Ma (Early Cretaceous) – The Alexandria terrain docks and formation of the Skeena fold belt starts. This event folded the rocks of the Stuhini, Hazelton, and Bowser Lake groups.

65 Ma (End of Cretaceous) – Deformation of Stikine terrain rocks is complete, resulting in folded and doubly plunging structural culminations. The Red Mountain deposits have been rotated from a vertical (?) orientation to a westerly dipping, northerly plunging orientation in the eastern limb of the Bitter Creek antiform. Alexandria has been intruded by plutons of the Coast Plutonic Complex.

20 Ma (Miocene) – Extension along north-northwest and northeast trends forming large- and small-scale structures. Locally at Red Mountain can be equated to formation of the Rick Fault and other property scale faults, offsetting the mineralized zones.

1.2.2.3 Property Geology

1.2.2.3.1 Mine Site

Mine Site Geology is shown on Figure 1.2-2 and a schematic cross -ection of the Red Mountain property is provided on Figure 1.2-3. The oldest rocks, Middle to Upper Triassic mudstone, siltstone, and chert of the Stuhini group outcrops over about two thirds of the mapped area. The Triassic rocks grade upward into Lower Jurassic Hazelton Group clastic and volcaniclastic rocks, which outcrop in the northeastern portion of the map area. Rocks of both groups are folded about axes, which plunge towards 345° and dip steeply to the southwest. An approximate contact between rocks of the two groups also follows this trend and occurs along the projected trace of the Bitter Creek antiform, a structure that has been mapped by Greig et al (1994) to the northwest of the map area. Hazelton Group volcaniclastic rocks on the southwest limb of this structure have been eroded away.

Three phases of the Early Jurassic Goldslide intrusions are exposed in the map area. The Hillside porphyry, a fine to medium-grained hornblende and plagioclase porphyry, occurs near the summit of Red Mountain and along the ridge to the southeast of the summit. The medium to coarse-grained hornblende, biotite ± quartz Goldslide porphyry, is distinguishable from the Hillside porphyry by mineralogy and phenocryst size. It is exposed along the Goldslide Creek valley, extending from the surface expression of the Marc Zone to the southwest for two kilometres. Finally, sills of the Biotite porphyry intrude Upper Triassic sediments on the west side of Red Mountain. It is distinguished from the Hillside porphyry by the presence of biotite phenocrysts and from the Goldslide porphyry by the small size of hornblende and plagioclase phenocrysts (Rhys et al, 1995). Contact breccias and strongly disrupted bedding are common along the contacts of these intrusions, particularly in association with the Hillside porphyry. In addition, the Hillside porphyry contains rafts of the sedimentary rocks ranging in size from one or two metres to several tens of metres.

Recent work indicates that the three phases of intrusive porphyry have all originated from the same source, and as such represent an evolution in the magma, seen as an enrichment in elements such as sodium and minerals like quartz, which are common markers in the Goldslide phase.

A Tertiary intrusion, the McAdam point stock, is exposed in the Lost Valley area adjacent to the Bromley Glacier. It is a medium to coarse-grained biotite quartz monzonite dated to 45 Ma (Rhys et al. 1995). Rather than being one large intrusion, the Lost Valley stock appears to be a series of nested structures, with sharp contacts between coarse and fine phases of quartz monzonite observed in several locations. Ductile shear structures do indicate that regular emplacement took place in quick succession and that the entire intrusion cooled as a whole sometime in the Eocene or Oligocene. Several dykes of monzonite have been traced further to the south through the 'Lost Mountain' area, and suggest a continuation of the main body at depth, under a mantle of hornfelsed metasedimentary rocks.

Structural deformation at the property scale is consistent with the observations at the regional and tectonic scales. Folds have been mapped in the entire Triassic-Jurassic succession with north to northwest plunging axes and generally steeply dipping limbs. Fold traces can be complicated and difficult to trace, particularly near intrusive contacts (Rhys et al. 1995). The timing suggests that the folds are a manifestation of the Cretaceous Skeena fold belt deformation.

A series of north to south striking strike slip faults have been directly observed in Lost Valley, most notably where they truncate the andesitic / lamprophyre dykes, meaning that this movement is happening after the emplacement of the Lost Valley intrusion. These strike-slip faults can then be traced for several kilometers across the property, and occur as parallel structures spaced around 400 m apart. Sympathetic structures, such as riedel shears and normal and reverse faults, have been observed propagating from these faults, with some evidence that late stage mineralisation (unrelated to Red Mountain zones) tied these structural features.

Over all this brittle faulting has affected all rock units at Red Mountain. Rhys et al. (1995) recognised two phases of faulting: northeast striking, steeply northwesterly dipping faults, and north to northwest trending faults. Faults of the former group are those that offset the mineralized zones, such as the Rick Fault. The latter group are noted by Rhys et al. (1995) to have contain more gouge and have broader alteration envelopes than the former.

Figure 1.2-2: Mine Site Geology

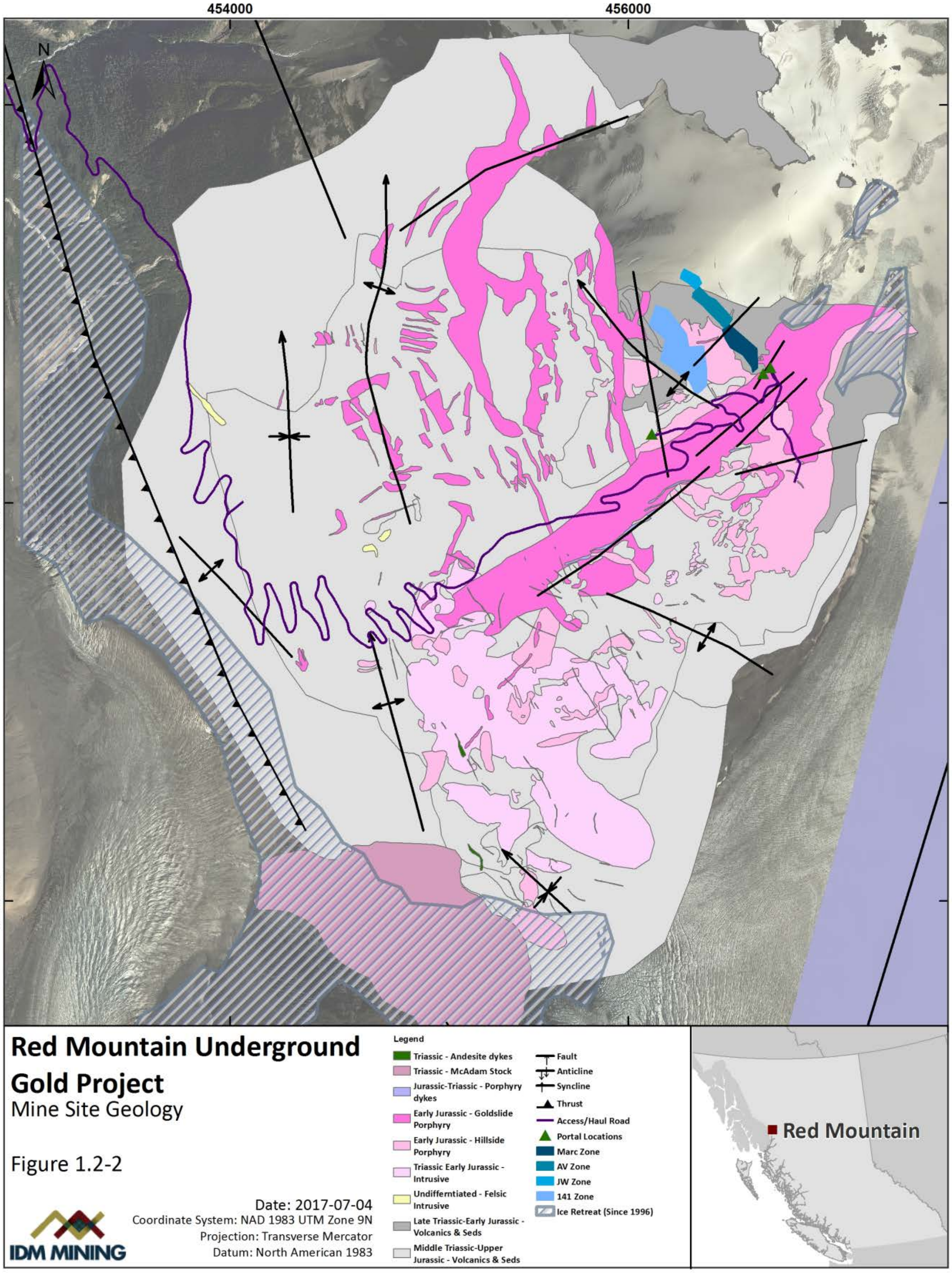
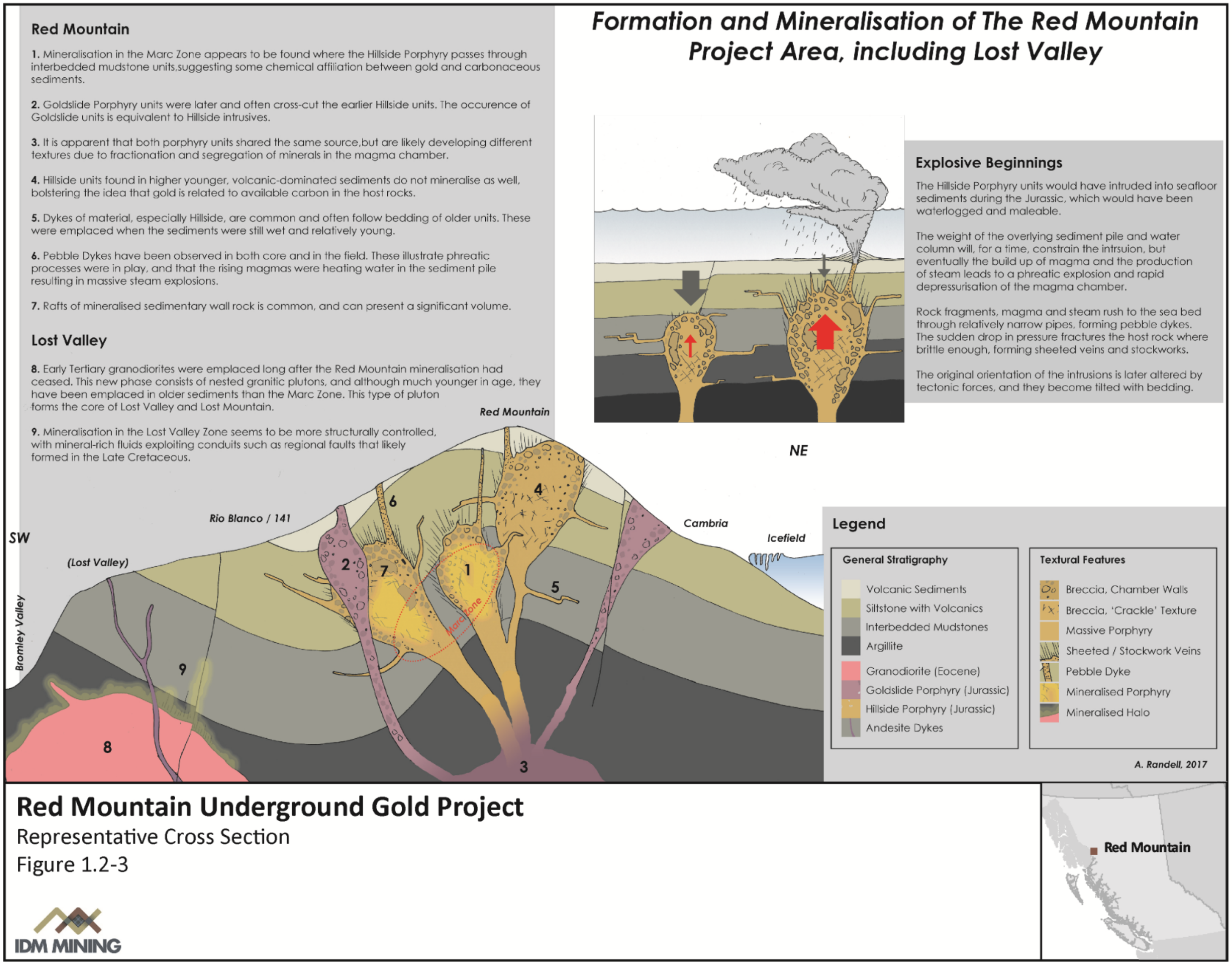


Figure 1.2-3 Schematic Cross-Section of the Red Mountain Property



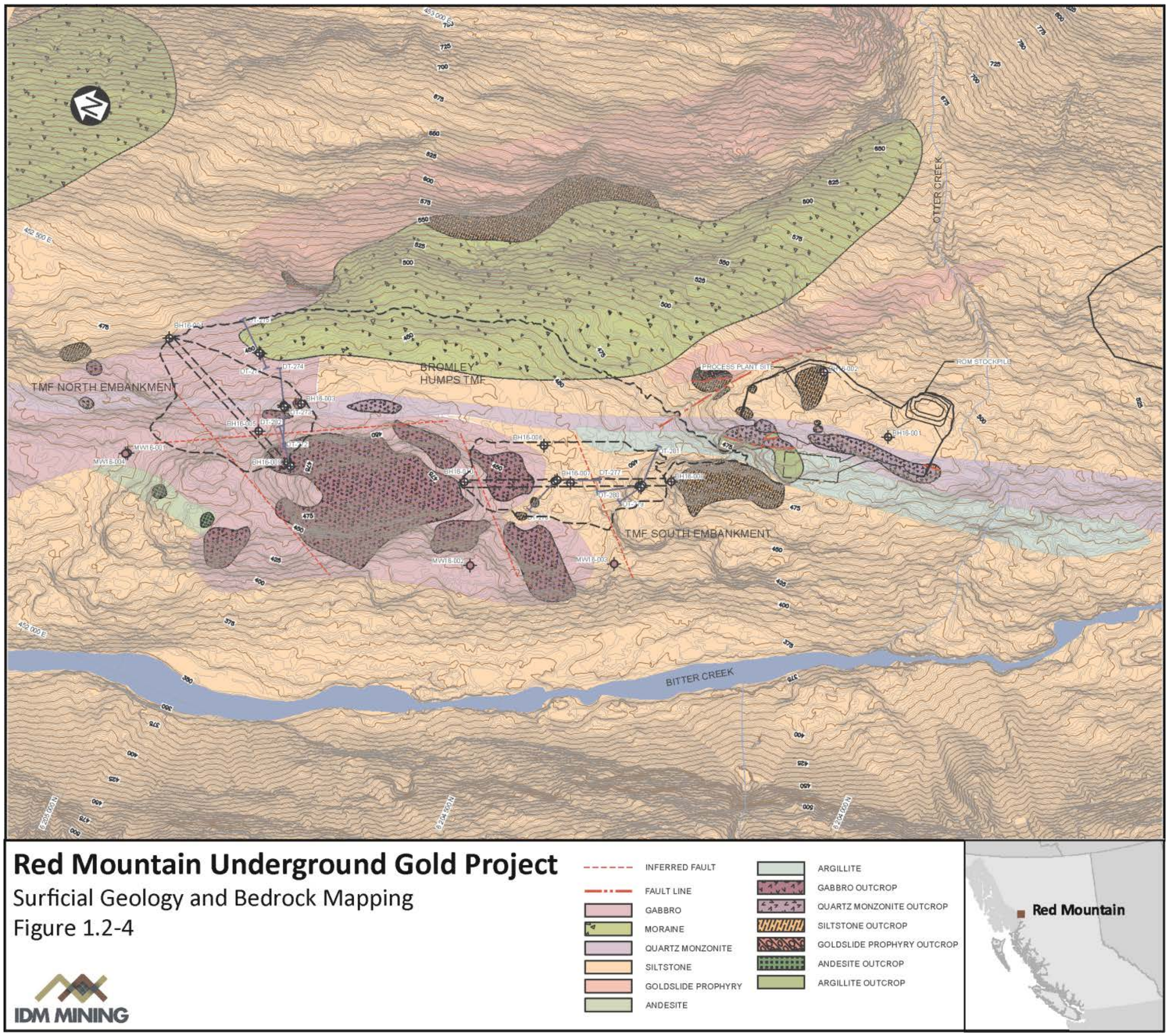
1.2.2.3.2 Bromley Humps

Surficial Geology

The regional surficial geology for Bromley Humps, as described by SNC (2017), is summarized below.

Surficial geology mapping by IDM and drilling from the 2016 site investigation (Geotechnical Site Investigation Report, Appendix 1-A) provides information on the local setting at Bromley Humps. Overburden cover is sparse and was generally thin where encountered during drilling, with thickness ranging from 0 to 6.8 m with an average thickness of 1.8 m (Appendix 1-A). The thickest overburden was intersected in lower lying areas above gently sloping bedrock near the centre of the valleys along the proposed embankments. The surficial geology is primarily comprised of bedrock outcrops, colluvium, and glacial moraine. The colluvium is generally described as a dense gravel to sandy gravel unit with a low fines content based on six samples (KP 2016). The glacial till is described as a sandy silt to well graded sand gravel with moderate fines content based on two samples (Appendix 1-A). Surficial geology mapping and interpretation completed by IDM in 2016 is presented on Figure 1.2-4 (obtained from the Bromley Humps Baseline Hydrogeology Report [Appendix 10-B]).

Figure 1.2-4: Surficial Geology and Bedrock Mapping



1.2.2.3.3 Bedrock Geology and Structures

Information about the local bedrock geology at Bromley Humps is based on the mapping of bedrock outcrops by IDM, a terrain assessment by SNC (2017), and drill core from site investigations in 1996 (Golder 1996) and 2016 (Appendix 1-A).

Bedrock outcrops mapped by IDM at Bromley Humps in the area of the TMF and Process Plant Site include siltstone, gabbro, and quartz monzonite. The mapped bedrock outcrops and interpreted lithology units at Bromley Humps by IDM are shown on Figure 1.2-4. IDM also identified four potential faults in the area of the TMF embankments with general orientation as follows:

- Subparallel to Bitter Creek intersecting the alignment of the TMF North Embankment. The mapping by IDM consists of one inferred fault at the left abutment, but there are likely additional sub-vertical features. A Digital Elevation Model (DEM) of the TMF area suggests this inferred fault identified by IDM potentially extends through the TMF area, following the unmapped channel. At least one other lineament intersecting the TMF North Embankment at the right abutment was identified from the DEM (Figure 2.5-2 in Appendix 10-B).

- Perpendicular to Bitter Creek with two inferred faults acting as boundaries to the gabbro intrusion between the TMF North and South Embankments (referred to as one of the Bromley Humps). One of these two faults intersects the TMF South Embankment at the right abutment. A third fault intersects the TMF South Embankment near the centreline.

As indicated, the TMF North and South Embankments are separated by a high relief gabbro intrusion, which is referred to as one of the Bromley Humps. The confinement of the Bromley Hump relative to the elongate structure of the adjacent faults suggests the Bromley Hump is likely to be less susceptible to erosion than the surrounding siltstone and/or faulted stratigraphy resulting in preferential erosion of the surrounding material relative to the gabbro intrusion during glacial periods.

The geology in the TMF area was characterized by Knight Piésold Ltd. (KP; Appendix 1-A) based on the drilling data from the 1996 and 2016 site investigations. Past deformation of the bedrock is evident in the drill core data, based on commonly described high fracture density, numerous broken, sheared and brecciated zones, and some slickensided joint faces.

Drilling for the TMF North Embankment mainly encountered gabbro, diorite, tuff, and goldslide porphyry suite rocks. The rock (excluding faulted zones) had an average Rock Quality Designation (RQD) and Rock Mass Rating (RMR) of 62% and 57%, respectively (Appendix 1-A). Appendix 1-A indicates the inferred fault intersecting the alignment near the left abutment was identified in two drill holes (BH16-009 and DT-282).

Bedrock in the area of the TMF South Embankment was generally comprised of gabbro and mafic and felsic dykes. Siltstone, mudstone greywacke, and conglomerate rocks were encountered at the left abutment and downslope of the embankment. The rock (excluding faulted zones) had an average RQD and RMR of 46% and 53%, respectively. The suspected fault intersecting the alignment near the right abutment was encountered in BH16-010. The second inferred fault intersecting the alignment of the TMF South Embankment was identified in DT-277 and DT-280 (Appendix 1-A).

Cross-sections along and perpendicular to both the alignments are presented in Appendix 1-A.

1.2.2.4 Significant Mineralized Zones

1.2.2.4.1 Mineralized Zones

The mineralized zones consist of crudely tabular, northwesterly trending, and moderately to steeply southwesterly dipping gold bearing iron sulphide stockworks. Pyrite is the predominant sulphide, however locally pyrrhotite is important. The stockworks zones are developed primarily within the Hillside porphyry and, to a lesser extent, in rafts of sedimentary and volcaniclastic rocks. Although locally anomalous gold values are present within the Goldslide porphyry, significant auriferous sulphide stockwork zones have not been located in this rock unit, which generally lies less than 100 m below mineralized zones.

The stockwork zones consist of pyrite microveins, coarse-grained pyrite veins, irregular coarse-grained pyrite masses, and breccia matrix pyrite hosted in a pale, strongly sericite, altered Hillside porphyry. Vein widths vary from 0.1 centimetres (cm) to approximately 80 cm, but widths of 1 to 3 cm are most common. The veins are variably spaced and average 2 to 10 per metre and generally comprise from 4% to 10% of any drill intersection. The veins are very often heavily fractured or brecciated with infillings of fibrous quartz and calcite. Orientations of veins in the stockworks are variable; however, sets with northwesterly trends and moderate to steep northeasterly and southwesterly dips have been identified in underground workings (Rhys *et al* 1995).

The pyrite veins typically carry gold grades ranging from about 3 grams per tonne (g/t) to greater than 100 g/t. Gold occurs in grains of native gold, electrum, petzite, and a variety of gold tellurides and sulphosalts (Barnett 1991). These mineral grains, which are typically 0.5 to 15 microns in size, occur along cracks in pyrite grains, within quartz and calcite filled fractures in pyrite veins, and, to a lesser extent, as inclusions within pyrite grains.

The stockwork zones are surrounded by more widespread zone of disseminated pyrite and pyrrhotite alteration. Each of these sulphides, which also occur as sparsely distributed stringers, comprise about 1.5 to 2.0% of the wall rocks to the stockwork zones. The most striking feature is that while disseminated pyrite occurs within the stockwork zones the disseminated pyrrhotite abruptly disappears, often over distances of less than a metre and at the edges of the bleached pyrite stockwork zones. Locally it does occur within the pyrite stockwork, but generally only in peripheral areas where bleaching and pyrite vein density is weak.

The stockwork zones are also partially surrounded by a halo of light-red-coloured sphalerite. It comprises 0.5 to 4.0% of the rock and generally is more abundant in the footwall portions of the zones. The relationship between this sphalerite and the gold bearing pyrite stockworks is unclear. Locally the sphalerite halo contains low-grade gold values (0.5 - 2.0 g/t gold); however, these areas also contain sparse pyrite or pyrrhotite veinlets that could easily explain the gold values. The lack of a consistent relationship between the stockwork zones, gold grades, and the distribution of sphalerite suggests that it is not necessarily related to the gold bearing system. A cross-cutting relationship between pyrite, pyrrhotite, and sphalerite mineralization was not observed during core re-logging in 2000.

1.2.2.5 Deposit Type

Several models have been presented for the formation of the Red Mountain gold deposits. Rhys et al (1995) concluded that the setting and style of mineralization is similar to that of many porphyry systems. This was based on data from deep drilling that indicated mineralization and alteration zoning common to traditional porphyry systems. Lang (2000) suggested that while the porphyry system zonation was present, the alteration and mineralization was more consistent with a later magmatic-hydrothermal system that overprinted the earlier vertical alteration pattern. A third scenario has been presented by Barclay (2000) in which fracture formation was due to extension caused by cooling in a high-level intrusion and sulphide-gold deposition was from a locally derived, volatile-rich exsolving fluid. In this case, both mineral deposition and extension were ongoing and evolving.

A synthesis of these models, in particular using elements of the models proposed by Lang and Barclay, appears to best fit with geological and mineralogical observations. A brief description of deposit formation models is provided below.

1. Intrusion of the Hillside porphyry into Stuhini and Hazelton Group strata. Large rafts of the host rocks are picked up by the intrusion.

2. The Hillside porphyry cools and contracts. The contraction causes the initial formation of a zone of extensional fractures. Pyrite deposited into these fractures starts from volatile fluids that are exsolving from the Hillside porphyry as it cools.

3. Ongoing cooling and extension with fracturing and brecciation of coarse-grained pyrite veins. Additional coarse-grained pyrite is deposited into open space. The gold telluride petzite is deposited as small inclusions in pyrite grains.

4. Intrusion of the Goldslide porphyry. The intrusion drives a pulse of hydrothermal fluids containing native gold, gold tellurides and sulphosalts into fractures in the coarse-grained pyrite veins where they are deposited.

5. Final infilling of remaining fractures in the coarse-grained pyrite veins with gold minerals, fibrous quartz, calcite, feldspar, and sericite.

The model proposes a plausible origin for the structures that host sulphide and gold mineralization, and puts forth a paragenetic sequence for mineral deposition that fits well with macroscopic and petrographic observations. The model also fits well with the random nature of a stockwork system and the variation in gold grades that are encountered over short distances in the diamond drill core.

1.2.3 Metal Leaching / Acid Rock Drainage

The following is a discussion of key results relating to metal leaching / acid rock drainage (ML/ARD) studies undertaken to date.

The operational components of ML/ARD management are outlined in the Material Handling and ML/ARD Management Plan (Volume 5, Chapter 29). The management plan outlines IDM's plan for managing ore, waste rock, rock quarries, borrow pits, construction aggregate, and construction materials associated with rock cuts and fills along Project roads, as it relates to the potential for the materials to leach metals and/or generate acidic conditions, resulting in adverse quality runoff reporting to local receiving waters.

1.2.3.1 Relevant ML / ARD Studies

For their report summarizing the geochemical characteristics of the ore, waste rock, and talus material, SRK (Geochemical Characterization of Waste, Ore and Talus, Appendix 1-B) reviewed geochemical tests initiated by MDAG (1996) and Frostad (1999) on 543 samples for acid-base accounting (ABA), paste pH, and trace element analyses.

Additionally, laboratory based humidity cell tests were conducted in 1993 on six waste rock samples, six ore samples, and one talus sample (MDAG 1996). Leachates were analyzed for pH and trace elements, among other parameters.

In the field, two field cribs containing approximately 20 tonnes of blasted rock were constructed in 1994. The first, HC-1, contains primarily Hillside Porphyry (igneous unit), and HC-2 contains 2/3 Mudstone (sedimentary unit) and 1/3 Hillside Porphyry. Leachate from cribs has been monitored periodically since 1995, and analyzed for pH and trace elements, among other parameters.

A separate report was developed by SRK (Appendix 1-L, Geochemical Characterization of Construction Materials) documenting the results of the geochemical characterization assessment for materials from potential rock cuts along the Access Road, rock in the Bromley Humps area that may be used as construction material for the TMF dam embankments, and surficial materials that may be used as general borrow sources for construction.

Samples for geochemical characterization were collected from 10 geotechnical drillholes in the Bromley Humps area, two within the footprint of the Process Plant and all others within the footprint of the proposed TMF. At the time of sampling, bedrock from both the TMF footprint and plant site areas were the proposed material for TMF dam construction; however, materials will now be sourced from the Plant Site and other borrow sources.

A geochemical sample set for the Access Road is comprised of surface rock samples collected in fall of 2016 and historic outcrop rock samples. Test pit samples from potential sources of surficial borrow material for road and TMF construction were also obtained in fall of 2016.

Static testing, including elemental analysis and acid base accounting, was completed on 26 samples from ten drillholes from within the TMF and Process Plant footprints, an additional 31 outcrop samples from the Access Road, and 5 samples from surficial borrow sources.

Lastly, SRK conducted a geochemical characterization program on metallurgical tailings from the AV, JW, and Marc zones of the deposit (Appendix 1-K, Geochemical Characterization of Metallurgical Tailings).

Results from each of the SRK studies mentioned above are summarized below.

1.2.3.2 Geochemical Characteristics

1.2.3.2.1 Ore and Waste Rock

According to information provided in Appendix 1-B, of the 543 samples analyzed for ARD potential, 53 were ore samples and 400 were waste rock samples (Table 1.2-2). All were classified as potentially acid generating (PAG) based on Neutralizing Potential / Acidic Potential (NP/AP) and Total Inorganic Carbon / Acidic Potential (TIC/AP) tests.

Data from two field cribs indicate that the upper bound of onset to acidity in mudstone (intermixed with some volcanic rock) is 20 years. This lag time is longer for volcanic rocks and may be shorter for unmixed mudstone samples.

When organized by lithology, 4 out of 53 ore samples are igneous (Hillside Porphyry), 45 are volcaniclastic (tuffs), 1 is from the fault zone, and the remainder are of unknown or composite lithology. During lab tests, three samples of bedded tuffs and mixed rock developed acidic pH over 30 to 55 weeks.

When organized by lithology, 36 out of 400 waste rock samples are igneous (Hillside Porphyry or Goldslide Porphyry), 269 are volcaniclastic (fragmented tuffs / bedded tuffs / contact breccia), 84 are sedimentary (mudstone), and the remainder are of unknown or composite lithology. Humidity cell tests show that waste rock samples remained pH neutral for the duration of the test, except for one fragmented tuff sample that was acidic for all cycles of the test.

With regards to metal leaching, manganese (Mn) leaching was observed at a rate of or greater than 0.4 milligrams per kilogram per week for both acidic and neutral samples of waste rock. Zinc (Zn) and cadmium (Cd) leaching is associated with the presence of sphalerite (Zn ore), although acidic samples showed higher release rates of both Zn and Cd irrespective of sphalerite content. Copper (Cu) leaching appears to be directly proportional to acidic conditions. Lead (Pb) leaching appears to be related to the presence of solid-phase lead content (likely, the mineral galena) in waste rock samples. Selenium leaching appears to be related to sulphide content.

Two ore samples show increased nickel (Ni) leaching under acidic conditions, although these results were within the range of analytical uncertainty.

One waste rock sample possibly shows increased nickel (Ni) leaching under acidic conditions, although these results were within the range of analytical uncertainty. Cobalt

(Co) leaching levels were highest for two waste rock cycles during initial acidic cycles after which they decreased to near or below detection limits.

In the field cribs, HC-2 showed increasing levels of cadmium, nickel, and zinc in the leachate since 2010 and increasing levels of cobalt and manganese since 2015. Trace element levels in HC-1 remain stable.

Geochemical properties appear to be consistent between the historic waste rock and newly generated waste rock.

Refer to Appendix 1-B for more details on the geochemical characteristics of waste rock, ore, and talus.

1.2.3.2.2 Talus Quarries

There are two talus quarries associated with the Project which are located in proximity to the Mine Site (Figure 1.1-4). Approximately 530,000 cubic metres (m^3) of material will be sourced from the two talus quarries near the Mine Site for use as backfill.

According to the information supplied in Appendix 1-B (and summarized in Table 1.2-2), of 543 samples analyzed for ARD potential, 90 were talus samples; 56% were classified as PAG, 26% as “Uncertain”, and 19% as NPAG according to TIC/AP tests. According to NP/AP tests, 24% were classified as PAG, 34% as “Uncertain”, and 41% as NPAG.

One third of fine fraction samples were already acidic when tested; additionally, it was found that talus fines are a source of acidity and soluble metals under both reducing and oxidizing conditions.

Acidic talus samples indicate cadmium, cobalt, copper, nickel, and zinc leaching.

Table 1.2-2: ARD Classifications According to Rock Type

Unit Name	Unit Code	Economic Classification	Total Number of Samples	Number of Samples		ARD Classification (% of samples)					
						Non-PAG[1]		Uncertain[2]		PAG[3]	
				NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP	NP/AP	TIC/AP
Hillside porphyry	Hlp	Waste Rock	29	29	7	0%	0%	3%	0%	97%	100%
	XHlp (fragmented)	Ore	4	4	0	0%	--	0%	--	100%	--
		Waste Rock	6	6	1	0%	0%	33%	0%	67%	100%
Goldslide porphyry	GOp	Waste Rock	1	1	0	0%	--	0%	--	100%	--
Mudstone, interbedded	MSI	Waste Rock	84	84	2	2%	0%	4%	0%	94%	100%
Tuffs, bedded (volcaniclastic)	TfB	Ore	8	8	4	25%	0%	13%	0%	63%	100%
		Waste Rock	23	23	13	4%	0%	9%	0%	87%	100%
Tuffs, fragmented (volcaniclastic)	xTF	Ore	37	37	8	0%	0%	11%	0%	89%	100%
		Waste Rock	225	225	15	1%	0%	12%	0%	87%	100%
Contact breccia	xTF-TfB	Waste Rock	21	21	0	0%	--	0%	--	100%	--
Fault zone	FZ	Ore	1	1	0	0%	--	0%	--	100%	--
Unknown/composite lithology	N/A	Ore	3	3	3	0%	0%	0%	0%	100%	100%
		Waste Rock	11	11	5	0%	0%	18%	0%	82%	100%
Talus	N/A	N/A	90	90	90	41%	19%	34%	26%	24%	56%
Total Number of Samples			543	543	148	32	3	79	25	432	120

Source: Appendix 1-B
Notes:
(1) Samples were classified as non-PAG if NP/AP or TIC/AP was greater than 3.
(2) Samples were classified as uncertain if NP/AP or TIC/AP was greater than 1 or less than 3.
(3) Samples were classified as PAG if NP/AP or TIC/AP was less than 1.
(4) AP calculated using sulphide sulphur for talus samples and total sulphur for waste rock and ore samples.

1.2.3.2.3 Tailings

SRK conducted a geochemical characterization program on metallurgical tailings from the AV, JW, and Marc zones of the deposit (Appendix 1-K). Tailings samples from all zones are classified as PAG. Because tailings will be rapidly deposited in the TMF and the exposure time of the tailings to atmospheric conditions will be on the order of weeks, ARD is not expected to develop during operations.

Elemental analysis indicates enrichment of silver, gold, arsenic, bismuth, cadmium, cobalt, copper, lead, sulphur, antimony, selenium, and zinc relative to ten times the crustal abundance for low- and high-calcium granite.

Humidity cell test work on the Marc zone tailings has been initiated. After 11 cycles, the leachate is neutral to alkaline and sulphate is starting to stabilize. Ongoing humidity cell test work will define the time frame to the onset of acidic conditions for the tailings and metal leaching, if present. Regardless of the outcome of these studies, the TMF has been designed using a conservative approach and assuming the tailings will be acid-generating.

1.2.3.2.4 Borrow Sites and Rock Cuts

As presented in Appendix 1-L and summarized in Table 1.2-3, the two main geological groups present in Bromley Humps are intrusive rocks (primarily gabrro) and the Hazelton Group sediments. Other units along the Access Road include the Coast Plutonic complex (monzonites) and the Hazelton Group volcanics, which are comprised of a mixture of sedimentary, volcanic, volcaniclastic, and intrusive rocks.

Table 1.2-3 summarizes the geological units that will be encountered by various components of the Project, along with a summary geochemical description of each geological unit, based on recent work by SRK (Appendix 1-L).

Table 1.2-3: Geological Units Present at Borrow Sources and Rock Cuts

Borrow Source / Excavation Area	Geological Units					
	Bromley Area Intrusives	Hazelton Group Sediments	Coast Plutonic Complex Monzonite	Hazelton Group Volcanics	Sand and Gravel	Mine Site Talus
Summary of Geochemical Characteristics	Not ARD; possible selenium ML	One-third ARD; possible ML	Not ML/ARD	Up to 50% PAG and ML	Not ML/ARD	ML/ARD
Process Plant Foundation	X	X				
Access Road Rock Cuts	X	X	X	X		
Hartley Gulch Borrow					X	
Otter Creek Quarry	X	X				
Highway 37A Quarry			X			

Borrow Source / Excavation Area	Geological Units					
	Bromley Area Intrusives	Hazelton Group Sediments	Coast Plutonic Complex Monzonite	Hazelton Group Volcanics	Sand and Gravel	Mine Site Talus
Roosevelt Creek Borrow					X	
Talus Quarries (2)						X

The intrusives in the Bromley Humps area and the monzonites of the Coast Plutonic complex were classified as non-PAG with a low potential for metal leaching. Approximately one-third of the Hazelton Group sediment and one-half of the Hazelton Group volcanic samples were PAG, with potential for metal leaching under acidic pH conditions. The Hazelton Group sediments also had some samples with anomalously high selenium levels indicating potential for selenium leaching at neutral pH.

Prior to construction, further geochemical analysis for ML/ARD potential will be undertaken for borrow sites, large cuts, and along the road alignment. If concerns are encountered, management strategies as outlined in the Materials Handling and ML/ARD Management Plan (Volume 5, Chapter 29) will be implemented. Management options include but are not limited to:

- Minimizing the use of PAG material for construction;
- Reducing cut and fill to the extent practicable;
- Optimizing cut and fill angles (i.e. minimizing exposed surfaces);
- Optimizing mass haul (i.e. management of material movement along the Access and Haul Roads); and
- Design adjustments, where possible, when PAG materials are encountered during construction.

1.2.4 Geotechnical and Hydrogeological Considerations

1.2.4.1 Geotechnical Assessments

In 2016, SRK conducted field investigations at the Mine Site to characterize the structural and rock mass conditions and undertook appropriate analysis of the data for use in underground mine and infrastructure design in support of feasibility level study (Underground Geotechnical Design, Appendix 1-E). The interpreted data was used to establish representative geotechnical domains, a three-dimensional structural model, undertake stability assessments, and conduct numerical stress modelling of the stope extraction sequence.

The structural geology study developed a three-dimensional structural model of brittle fault structures and defined structural domains for the geotechnical and hydrogeological design requirements. Three dominant and four subdominant structural orientations were identified. These orientations define the major structures at Red Mountain.

- **NE set:** The dominant fault set may dip to the SE or NW. The set includes the Rick Fault (R58) and Gaping Fault (R28). These faults are moderately to steeply dipping and characterised by significant strike slip offsets.
- **NNW set:** Faults correspond to the orientation of minor Goldslide porphyry dyke offshoots and regional fold axes. These faults are mostly dip slip reverse structures and are characterised by shear foliated faults. The structures are considered early, recording the NE-SW directed peak compressional deformation in the area
- **NNE set**: Steeply dipping structures. The trend is represented regionally by the Steward Valley, the Sutton Glacier, and the main axis of the Cambria Ice Sheet.

The regional stress orientation is interpreted to be an ENE to WSW compressive stress with the vertical stress being the minor stress.

A geotechnical core logging program was campaigned concurrently with the resource drilling program. Detailed geotechnical logging of the core from 11 drillholes (1,545 m) provided geotechnical parameters based on RMR_{90} (Laubscher, 1990) rock mass classification system. Point load rock strength testing was undertaken at approximately every 3 m during the geotechnical core logging. Core samples from the ore zone and surrounding host rock (hangingwall and footwall) were collected for laboratory strength testing. A total of 29 Unconfined Compressive Strength tests and 8 Triaxial Compression Strength tests were conducted. Additionally, one drillhole was surveyed using a downhole geophysical tool (acoustic televiewer) for the purpose of collecting orientation information of geological features downhole. A core photo geotechnical logging program was carried out on the resource geology holes to expand the geotechnical data coverage. Accessible areas of the existing underground excavations were mapped to supplement the rock mass and structural data collected through geotechnical core logging.

The geotechnical analysis of the Red Mountain deposit has confirmed suitability for longhole stoping with backfill and cut-and-fill/drift-and-fill mining methods. Four geotechnical domains were defined that will influence stable excavation dimensions, stope designs and ground support recommendations within the MARC, AV, and JW orebodies.

- **Green Domain:** This domain consists of “good” ground conditions that are suitable for open stoping. Recommended stope design is 10-15 m wide, 20-25 m long, with a 25 m sub-level spacing.
- **Yellow Domain:** Consists of a more blocky rock mass that is also suitable for open stoping. The stope design for Green Domain is still functional, but with increased levels of dilution expected.

- **Pink Domain:** Similar rock mass conditions as the Yellow Domain, but includes isolated zones of "poor" ground due to the intersection of brittle fault structures. Ground support and additional mining consideration is required to control stability and dilution.

- **Red Domain:** "Poor" ground condition that is only suitable for cut-and-fill or drift-and-fill mining methods.

Waste development underground is expected to be stable given the rock mass conditions and planned excavation dimensions. Ground support for the development excavations comprising combinations of tendons, wire mesh, cables, and shotcrete is based on the expected ground conditions and excavation life.

Also in 2016, KP completed the geotechnical work needed to support the feasibility mine design for the TMF and water management facilities. Details of the geotechnical investigation are presented in Appendix 1-A.

The geotechnical data collected in the TMF location during the 2016 geotechnical site investigation included the following:

- Geotechnical drilling and logging of 14 geotechnical drillholes in or near the TMF North Embankment, TMF South Embankment, and Process Plant sites. Drillholes ranged in depth from 30 m to 115 m and included sampling of both overburden and upper bedrock;

- Geotechnical logging of four historical drillholes in the Bromley Humps area; and

- Installation of four standpipe piezometers, four groundwater monitoring wells, and vibrating wire piezometers in six drillholes.

Geotechnical laboratory testing of soil and bedrock samples for moisture content determination, grain size analyses, specific gravity, and strength testing was conducted on select samples collected from the geotechnical drillholes.

Overburden at the TMF North Embankment varies in thickness from 0.5 to 6 m and is classified as a thin veneer of colluvium (approximately 0.5 to 2 m thick) underlain in some cases by glacial till or occasionally thicker colluvium deposits. Intact strength testing on samples from the TMF North Embankment area indicates generally strong to very strong rock with UCS test results ranging from 85 to 225 megapascales (MPa) and an average value of 150 MPa. The bedrock has a FAIR rock quality designation. Bedrock generally consists of low to moderate permeability Volcanic rocks with some Porphyry Intrusive units to the north of a fault zone that crosscuts the TMF North Embankment. An additional fault is interpreted to occur west and parallel to the TMF North Embankment.

Overburden at the TMF South Embankment varies in thickness from 0.6 to 5 m and is classified as a thin veneer of colluvium (approximately 0.5 to 2 m thick) underlain in some cases by glacial till or occasionally thicker colluvium deposits. Intact strength testing of samples from the TMF South Embankment area indicates generally strong to very strong rock with UCS test results ranging from 80 to 205 MPa and an average value of 120 MPa. The bedrock has a FAIR rock quality designation. Bedrock generally consists of low to moderate permeability Volcanic and Sedimentary rocks. Two faults were encountered that crosscut the TMF South Embankment.

Bedrock was encountered at or near to surface in the drillholes located in the vicinity of the Process Plant, with only a thin layer of topsoil present. Bedrock conditions are primarily characterized by Greywacke (Sedimentary unit) underlain by some Volcanic units (mafic and felsic dykes, gabbro, etc.) with a FAIR rock quality designation and approximately 60 MPa strength.

Results of the geotechnical stability assessment completed for the TMF embankments are provided in Appendix 1-D: Bromley Humps TMF Seepage and Stability Analysis.

The temporary WRSA and Topsoil Stockpile are considered to be relatively minor features; as such geotechnical stability assessments were not undertaken for these Project components.

1.2.4.2 Hydrogeological Setting

1.2.4.2.1 Regional Overview

The mountainous terrain associated with the Project area has a major influence on the groundwater flow system, causing steep hydraulic gradients that drive groundwater flow from higher to lower elevations. Available data for bedrock groundwater wells in highland areas indicate water tables within mountain bedrock are consistently close to the ground surface (Welch 2012). The water table is generally a subdued replica of topography, with depths to groundwater typically greater in the uplands relative to the valley bottoms.

The primary groundwater flow directions are from the mountain's summits to the Bitter Creek valley, and the secondary flow directions (i.e., localized shallow system) are towards the tributaries of Bitter Creek. The recharge occurs in the highlands in the form of snowmelt or rain infiltration and the discharges as baseflow or sub-stream flow in the Bitter Creek valley, and possibly in smaller order streams, gullies, breaks in slope, and geologic discontinuities. Considering the relatively steep topography, some flow systems may be perched and have localized seepage areas.

Groundwater is contained either in valley fill deposits or in the fractured rock. In valleys, groundwater fills the glacial and fluvial sandy gravely deposits associated with Bitter Creek, while on the mountain slopes, localized "shallow" groundwater flow system may be present through the relatively thin soil or overburden deposits composed of basal moraine, talus, and slopewash. Groundwater penetrates deep into bedrock through the fractures and joints. These fractured rock systems are expected to be irregularly distributed due to the variability of fractures (Parsons and Quinn 1994) and to be influenced by major structures or faults that act locally as preferential conduits, impermeable barriers, or both.

1.2.4.2.2 Summary of Completed Hydrogeological Investigations

Between 1990 and 2016, a number of technical hydrogeological field programs were carried out at the Mine Site in support of exploration and permitting (Red Mountain Underground Gold Project – Mine Area Hydrogeology [Appendix 10-A]). The field methods included borehole drilling and logging, installation and development of monitoring wells, hydraulic conductivity testing (packer tests and slug tests), measurements of groundwater levels, and measurements of inflow rates and pressure heads during dewatering events of the decline.

Hydrogeological baseline studies undertaken at Bromley Humps are summarized in Appendix 10-B (Bromley Humps Baseline Hydrogeology Report).

1.2.4.2.3 Mine Site Hydrogeology

Groundwater flow is controlled by topography, with gradients oriented from high elevations towards valleys. The groundwater table at the vicinity of the Red Mountain peak has an elevation of at least 1,875 masl. The groundwater table near Goldslide Creek, within the lower cirque area, is close to the ground surface, with an average elevation of approximately 1,425 masl.

Groundwater levels in the upper cirque and lower cirque show clearly the influence of freshet and a peak in the water table between June and August. Water levels in the existing decline range from an average elevation of 1,800 masl to 1,846 masl (near the Portal entrance), but have also dropped as low as 1,757 masl on at least one occasion (Pers. comm.; Rob McLeod, IDM, Sep 2016). During the rise in water levels following freshet, the average groundwater inflow rate is estimated at approximately 2,160 cubic metres per day (m^3/d).

Water levels and pumping rates were recorded during and after the dewatering events of May 1996, August 2000, and July 2016. Pumping rates were relatively low (i.e., less than 90 to 900 m^3/d) prior to the month of June or July, and then increased quickly to a peak around mid-August of 2,600 m^3/d for a “cold” year and 6,050 m^3/d for a “warm” year. Recharge from snowmelt of the Rio Blanco snowfield was interpreted to be the primary driver of the magnitude of inflow, hence a warm year leads to higher recharge and higher inflows.

The upper sections of Goldslide and Rio Blanco Creeks are likely ephemeral, perched above the water table, and fed primarily by glaciers, snowmelt, and/or runoff. It is assumed that the lower sections of the creeks, as well as Bitter Creek in the valley, are fed by groundwater all year round. During the low-flow season (i.e., the winter period), it is assumed that groundwater contributes to nearly 100% of the base flow. During spring, summer, and fall surface runoff and quick flow generated by the snowmelt and/or precipitation dominates.

1.2.4.2.4 Bromley Humps Hydrogeology

The groundwater table elevations in the TMF area range between 375 masl and 475 masl. The reported substantial changes in groundwater level over short distances are consistent with a groundwater flow regime influenced by structures. Therefore, structures are expected provide preferential groundwater seepage pathways away from the TMF.

Bromley Humps has no major aquifer, three types of potential minor aquifers (i.e., overburden, undifferentiated fractured bedrock, and high hydraulic conductivity (K) fractures or faults), and potentially low K structures that could act as aquitards.

Groundwater flow in Bromley Humps is driven by the relative elevation. Deep groundwater flows under the proposed TMF facility towards Bitter Creek. The deep groundwater system is recharged on the slopes above the proposed TMF site, as well as locally in the area of the proposed TMF.

Most groundwater bypassing or originating at the proposed TMF is expected to discharge into Bitter Creek. There may be also local discharges to local unmapped channel, to seeps or springs located in low the relief area to the northwest of the TMF, and to seeps or springs along the slope above Bitter Creek.

1.2.5 Terrain Stability and Geohazards

The following is a summary of terrain and geohazards for the Project Footprint Study Area (PFSA, as delineated in Appendix 9-A, Ecosystem, Vegetation, Terrain, and Soils Baseline Report), including the Access Road, Haul Road, TMF, and other Project infrastructure at Bromley Humps and the Mine Site, based on the information provided in Appendix 9-C (Terrain Stability Assessment for the Project Footprint Study Area) as well as 1:10,000 and 1:20,000 terrain stability, geohazard, and soil erosion potential mapping (provided in Appendix 9-A).

1.2.5.1 Terrain Overview

The Bitter Creek watershed has undergone multiple glaciations. Currently, the watershed is undergoing rapid glacial retreat from the Little Ice Age. Based on trimlines visible on the available imagery, the Bromley Creek glacier filled the Bitter Creek valley to about mid-slope during the peak of the Little Ice Age, and the surrounding Cambria Icefield likely covered the alpine. This interpretation is confirmed by vegetation distribution, where mature forests occupy mid slope positions while valley bottoms are occupied by young forests and pioneer vegetation. The glaciers deposited basal till and lateral moraine till across the landscape covering 23% of the PFSA (Appendix 9-A). In other areas, glaciers scoured the underlying bedrock so that presently 10% of the PFSA consists of bedrock outcrops.

At some point during deglaciation, a glacial lake formed in the Bitter Creek valley bottom depositing glaciolacustrine sediments. This may have occurred when valley bottom ice in the Bear Creek valley temporary blocked glacial melt flow from the Bitter Creek valley. Glaciolacustrine sediments are mapped beneath younger colluvial sediments in the Bitter Creek valley bottom between about a 3.5 km stretch centred on the mouth of Radio Creek (Figure 1.1-3). Although these sediments were not mapped at the ground surface, it is important to highlight their presence as they make unstable foundations, fail at low angles, and are highly erodible.

During retreat of the valley glacier, ice-marginal glaciofluvial terraces and colluvial fans formed. Currently these landforms exist as terraces along the lower valley sides where glaciofluvial sediments and glaciocolluvial fans form 4.3% and 5.0% of the PFSA, respectively. These sediments are often useful sources for aggregate.

Recently deglaciated terrain is associated with a higher frequency and magnitude of landslides (rapid mass movements) than areas that have been ice-free for millennia, due to debutressing of steep slopes and failure of poorly consolidated glacial sediments deposited on steep slopes (30% to 40%; Holm et al. 2004). Surficial materials moved by rapid mass movements, such as debris slides, debris flows, debris torrents, and rockfall, are classified as colluvium. Sediments moved by slow mass movement processes are classified as colluvium as well. Within the PFSA, this includes material deposited by bedrock slumps and sediments moved by solifluction and creeping ground ice in the alpine. Colluvium is the most extensive surficial material in the PFSA.

Fluvial sediments are mapped in the active floodplain and adjacent low-lying terraces of Bitter Creek and as fans on creeks with gentle gradients, such as Roosevelt Creek.

Although uncommon, ice is associated with the PFSA and with the margins of the Cambria Icefield. In this young landscape, organic sediments are rare.

1.2.5.2 Geohazards

Geohazards are mapped for the PFSA in Appendix 9-A, through polygon delineation of areas susceptible to landslides, slumps, rockfall, and snow avalanches. Table 1.2-4 provides a summary of this geohazard mapping, based on the following mass movement types.

- Initiation zone of **rapid mass movement processes** (downslope movement of debris derived from surficial material and/or bedrock), including debris slide, debris flow, debris flood, and rockfall). These geohazards are spread throughout the PFSA and tend to occur on slopes steeper than 60%;

- Initiation zone of **slow mass movement processes**, including bedrock slumps, solifluction, and ice/rock creep. Most of the polygons mapped with slow mass movement are located in the alpine area of Red Mountain and area associated with permafrost processes such as solifluction and larger lobate features created by creeping ground ice; and

- **Snow avalanche -** areas prone to snow avalanche often overlap areas associated with rapid mass movement.

Table 1.2-4: Summary of Geohazards and Snow Avalanches Mapped for the PFSA

Mass Movement Type	Geohazard Type	No. of Polygons	Percent of Polygons
Rapid Mass Movement	Rockfall	123	22.2
	Debris flow		
	Debris slide		
	Debris flood		
Slow Mass Movement	Bedrock Slump	39	7.0
	Solifluction		
	Rock/ground ice creep		
Snow Avalanche	Snow Avalanche	106	19.1

1.2.5.3 Terrain Stability

Terrain Stability maps for the PFSA, provided in Appendix 9-A, are covered by five terrain stability classes:

- Class I: Negligible
- Class II: Very Low
- Class III: Low
- Class IV: Moderate
- Class V: High

Polygons mapped as unstable (TS class V) contain slopes that show signs of terrain instability and include all polygons with initiation zones of rapid mass movement and slow mass movement geomorphological processes. Within the PFSA, 21.2% of the terrain is mapped as unstable.

Polygons that contain slopes greater than 50 to 60% and sloping terrain consisting of glaciolacustrine sediments that do not show signs of instability are classified as potentially unstable (TS class IV) and make up 12.9% of the PFSA. These polygons are scattered throughout the steeper slopes of the study area.

Terrain stability classes I, II, and III are applied to most terrain with slopes less than about 60%. The percent coverage of each of these three classes is 28.3%, 20.1%, and 16.6%, respectively. These polygons tend to occur along valley bottoms, terrace tops, the mouths of creeks, and on the hummocky terrain of the Bromley Humps.

1.2.5.4 Channel Change Detection

Bitter Creek presents a number of hazards to the proposed access road primarily via lateral erosion and flood events. Channel change detection has identified a number of locations where Bitter Creek is migrating towards the access road and actively eroding into the right bank.

Further studies into potential flood discharge, extent, and power will be undertaken during the detailed design phase, where the Access Road will be constructed at a similar elevation to the active floodplain, for example, near the confluence with Roosevelt Creek (Figure 1.1-3).

1.2.5.5 Mitigation

Appendix 9-C provides a section by section description of terrain characteristics, geohazard risk, as well as prescriptions and management strategies for addressing these risks for the entire Project footprint.

Additional studies will be undertaken during detailed design to identify areas where there is a moderate to high likelihood of slope failure following Project development. Specifically, terrain stability field assessments of those areas will be conducted by a qualified terrain specialist and designs will be adapted as required to address stability issues. Detailed geotechnical plans will be developed and implemented to avoid adverse effects on terrain. Follow-up monitoring will be undertaken in these areas to determine the effectiveness of mitigation. Mitigation will be used to reduce the risk of associated Project development in areas of potentially unstable terrain to an acceptable level. These strategies will reduce the risk in the following ways:

- Reduce the probability of the geohazard occurring;
- Reduce the geohazard magnitude (e.g., volume, peak discharge);
- Reduce the geohazard intensity (e.g., run-out distance, velocity, impact forces);
- Reduce the spatial probability of effect (likelihood that the geohazard will reach or affect the element at risk);
- Reduce the temporal probability of effect (likelihood of workers being present in the zone subject to the hazard); and
- Reduce the vulnerability (the degree of loss to a given element at risk within the area affected by the snow avalanche or landslide hazard).

Slope stabilization techniques, including terracing and bioengineering structures such as wattle fences and brush layers, will be used in areas with highly erodible soils and those areas with long and/or steep slopes. Erosion-control measures will include seeding of exposed soils with an erosion-control seed mix or hydro-seeding with a mix of seed, mulch, and a tackifier as soon as possible after soil surface disturbance. Where required, such as along water-diversion channels, soil-erosion control measures to be adopted and may include construction of channel-bank protection and the installation of erosion-control blanket. Silt fences will be used to contain sediments eroding off-site and to prevent them from entering waterways. To protect erodible channel banks, rock material, willow bundles, or gabions will be used, as required. Details are provided in the Erosion and Sediment Control Plan (Volume 5, Chapter 29).

Sections of the Access Road and Haul Road will be exposed to avalanche hazards. The exposed areas will be inspected by the Occupational Health and Safety and the Emergency Response Planning Committees to determine the associated risks. A road maintenance and avalanche management plan will be developed to reduce and manage the associated risks (see Volume 5, Emergency Response Plan and Health and Social Services Plan).

1.2.6 Biophysical Environment

A detailed characterization of the biophysical environment is presented in Volume 3, Chapters 9 to 18. The climate, soil conditions, and terrain form the prime design considerations for the viability of the Project.

Several considerations in Project design, operational safeguards, and contingency plans have been incorporated to mitigate potential effects. Highlights of the mitigation measures incorporated into the design include:

- Minimize Project footprint, thus minimizing the loss of habitat and reduction of habitat effectiveness.
- Contain the Project mining activities within the Bitter Creek watershed.
- Maintain riparian setback buffers for fish-bearing and non-fish-bearing watercourses.
- Maintain a buffer zone from important bird nesting areas.
- Select water sources such that water withdrawals that will minimize the potential for drawdown and effects to fish habitat and the aquatic environment.

Construction activities will utilize the existing Project infrastructure and footprint to the greatest extent practical to minimize land disturbance and improve the overall efficiency of construction activities. Where possible, permanent support infrastructure will be built at the onset of construction to be used during both the Construction and Operation Phases of the Project. In many instances, temporary infrastructure will be constructed or positioned for the duration of the Construction Phase only. This temporary infrastructure will be removed at the completion of the Construction Phase.

1.2.6.1 Ecosystem Integrity

Comprehensive baseline studies have been undertaken to characterize the various biophysical components of the Project. A range of mitigation measures have been identified that will enable IDM to minimize effects on the receiving environment. A summary of mitigation measures is presented in Volume 6, Chapter 31 of the Application/EIS.

Seven physical barriers to upstream fish migration are found on Bitter Creek, with the most downstream barrier between Otter Creek and Hartley Gulch. Four of these seven features represent falls that present vertical drops that are greater than approximately 1.5 m and in excess of resident species' ability to negotiate. The remaining three barriers are situated at the narrowest of the pinch-points in the bedrock margins and constrict flows to less than 3 m where water velocities and cascades are considered insurmountable to upstream migrants. In addition to the physical barriers, Bitter Creek generally has low habitat complexity and high turbidity persists from the headwaters at Bromley Glacier to the confluence with Bear River.

Effects to freshwater fish and fish habitat due to current and future activities include directly removing or altering fish habitat due to culvert installations and potentially affecting water quality or sediment quality. For the purposes of the *Fisheries Act* (1985), serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat. The main mitigation measure employed for serious harm to fish habitat will be avoidance. A range of specific and generally accepted techniques for sediment control, riparian care, site isolation, timing/sequencing, reclamation, and rehabilitation will be used to avoid serious harm, prevent the introduction of deleterious substances to watercourses, and to minimize adverse effects of disturbances to fish habitat. Effects associated with work in or around water will be minimized through adherence to Best Management Practices as outlined in IDM's current Site Water Management Plan (Volume 5, Chapter 29), Aquatic Effects Management and Response Plan (Volume 5, Chapter 29), Closure and Reclamation Summary (Volume 2, Chapter 5), and DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat.

The Project area has a broad range of wildlife species. IDM discourages any unnecessary disturbance to wildlife from its activities through the following measures:

- Prohibiting the feeding of wildlife and minimizing wildlife attractants (e.g., through implementation of a waste management plan that separates all waste at the source and ensures proper handling, storage and disposal);
- Prohibiting the harassment of or interference with all wildlife species. This includes chasing animals with any motorized vehicle;
- Prohibiting hunting in the Project Area by Project and contractor employees and consultants. The only exception may be individuals authorized to have registered company firearms for predator protection; and
- Recording of wildlife encounters in the wildlife log.

Information related to existing mountain goat trails and other terrestrial wildlife and mitigation measures adopted to minimize potential effects are presented in Wildlife and Wildlife Habitat Effects Assessment (Volume 3, Chapter 16) and the Wildlife Management Plan (Volume 5, Chapter 29).

In addition to these measures, IDM's EMS is presented in Volume 5, Chapter 29. The EMS and associated management framework defines the sequence of policy, planning, implementation, and operation, checking and corrective actions, and management review processes that must be established to ensure that the Project is executed in an environmentally acceptable manner and in a spirit of continuous improvement.

1.2.6.2 Conceptual Site Model

The Conceptual Site Model (CSM) provides a framework for identifying the types of receptors to be considered and the pathways by which these receptors may be exposed to Constituents of Potential Concern (COPCs) released by the Project. The CSM has been developed to visually represent the potential interactions between the proposed Project activities and the biophysical components of the environment, and in response to requests from NLG and regulators. The CSM is informed by the Screen Level Ecological Risk Assessment (SLEcoRA), which focuses on ecological receptors, and Human Health Risk Assessment (HHRA), which focuses on human receptors.

The CSM depicts the relationships between the following elements, which are necessary for a complete exposure pathway to occur in which human health may be impacted:

- Sources of contamination and COPCs;

- Contaminant release mechanisms and transport pathways;
- Exposure pathways and exposure mechanisms; and
- Exposed receptors.

1.2.6.2.1 Primary Sources of Contamination

Three primary sources of contamination are associated with the Project:

- Mining operations at the Mine Site will result in the excavation of tunnels, shafts, and portals, exposing ore deposits and producing waste rock;

- Ore processing at the Process Plant produces waste materials as a result of physical and chemical processes, including: crushing and grinding of ore material, thickening, pre-oxidation, cyanide leaching, electrowinning, cyanide destruction and tailings disposal (reagents include sodium cyanide, hydraulic chloric acid, caustic acid, copper sulphate, and sodium metabisulphate); and

- Roads constructed with material from local borrow pits and quarries.

1.2.6.2.2 Release Mechanisms, Transport Pathways and Secondary/Tertiary Sources of Contamination

Several primary mechanisms can release and transport COPCs, including:

- Leaching into groundwater from the primary source Mine Site, Ore Stockpiles (Upper and Lower Portal), ROM Stockpile, and the WRSA;

- Migration of water through bedrock fractures;

- Migration and free water movement and discharge to the ground surface via mine portals;

- TMF release to groundwater[1]; and

- Fugitive dust emissions from roads, stockpiles, above ground blasting during construction, and Process Plant emissions.

Secondary and tertiary sources of groundwater and surface water contamination are anticipated to be the result of:

- Weathering (physical and chemical) and leaching of exposed wall rock (i.e., intact bedrock surface) and waste rock (excavated and crushed rock as boulders, cobbles, etc.); and

- Interaction of water (i.e., groundwater and surface water) and oxygen (i.e., atmospheric air) with iron sulfide ore minerals in the waste rock and bedrock.

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[1] The TMF is fully lined; as a result, only very small amounts of groundwater seepage from the TMF are anticipated. During operations, any such seepage will be similar to process water chemistry

The anticipated drainage of these secondary sources carries concentrations of elements and base metals with the potential to impact downstream groundwater and surface waters.

Secondary and tertiary sources of air contamination are anticipated to be the result of:

- Wind erosion of dust from roads (fugitive dust precipitated by the driving of haul trucks on the roads);
- Wildland areas (as a result of natural weathering);
- Ore Stockpiles at the Mine Site, the ROM Stockpile, and the WRSA (due to the movement of materials to and from stockpiles); and
- Particulate and non-particulate Process Plant emissions.

Secondary and tertiary sources of soil contamination are anticipated to be a result of deposition of air particulate containing fugitive dust from the Project roads, ore material and waste rock.

Sources of sediment contamination are anticipated to be the result of soil erosion, deposition of air particulate, and precipitation of contamination in surface water.

The source of contamination in plants (tertiary source and exposure medium) is the soil impacted by the deposition of air particulate. The source of contamination in moose, hare and grouse (exposure media) is plants and to a lesser degree soil and surface water. The source of contamination in fish (exposure medium) is surface water.

1.2.6.2.3 Identification of COPCs

The concentration of constituents released to exposure media was measured or estimated. However, not all contaminants are released at loads that may result in concentrations in environmental media that may be harmful to human receptors. To identify which constituents may be harmful, the concentration of these constituents were compared to media-specific screening levels and background concentrations. Screening levels, in this case, can be considered to be safe concentrations or background concentrations.

A multi-step process is used to identify COPCs. This process involves the development of media-specific screening levels based on federal and provincial guidelines and standards, comparing data to these screening levels, and comparing data to background concentrations. Further details regarding this process are provided in the HHRA.

1.2.6.2.4 Exposure Pathways

The potential exposure pathways and routes to human populations at the LSA include:

- Inhalation of air;
- Incidental ingestion of and dermal contact with soil;
- Ingestion and dermal contact with surface water;
- Ingestion and dermal contact with groundwater;

- Incidental ingestion and dermal contact with sediment;
- Consumption of Country Foods mammals, birds, plants, and fish;
- Exposure to noise from Project activities; and
- Exposure to EMFs from power lines.

Further detail on and evaluation of each of the potential exposure pathways identified above is provided in the Human Health Risk Assessment (HHRA) Report, Appendix 22-A.

1.2.6.2.5 Conceptual Site Model

The CSM integrates potential sources of stressors, affected media (transport pathways), exposure routes, and potential receptors. Pictorial and Box-and-Line CSMs are shown in Figure 1.2-5 and Figure 1.2-6, respectively.

Figure 1.2-5: Pictorial Conceptual Site Model: Red Mountain Underground Gold Project

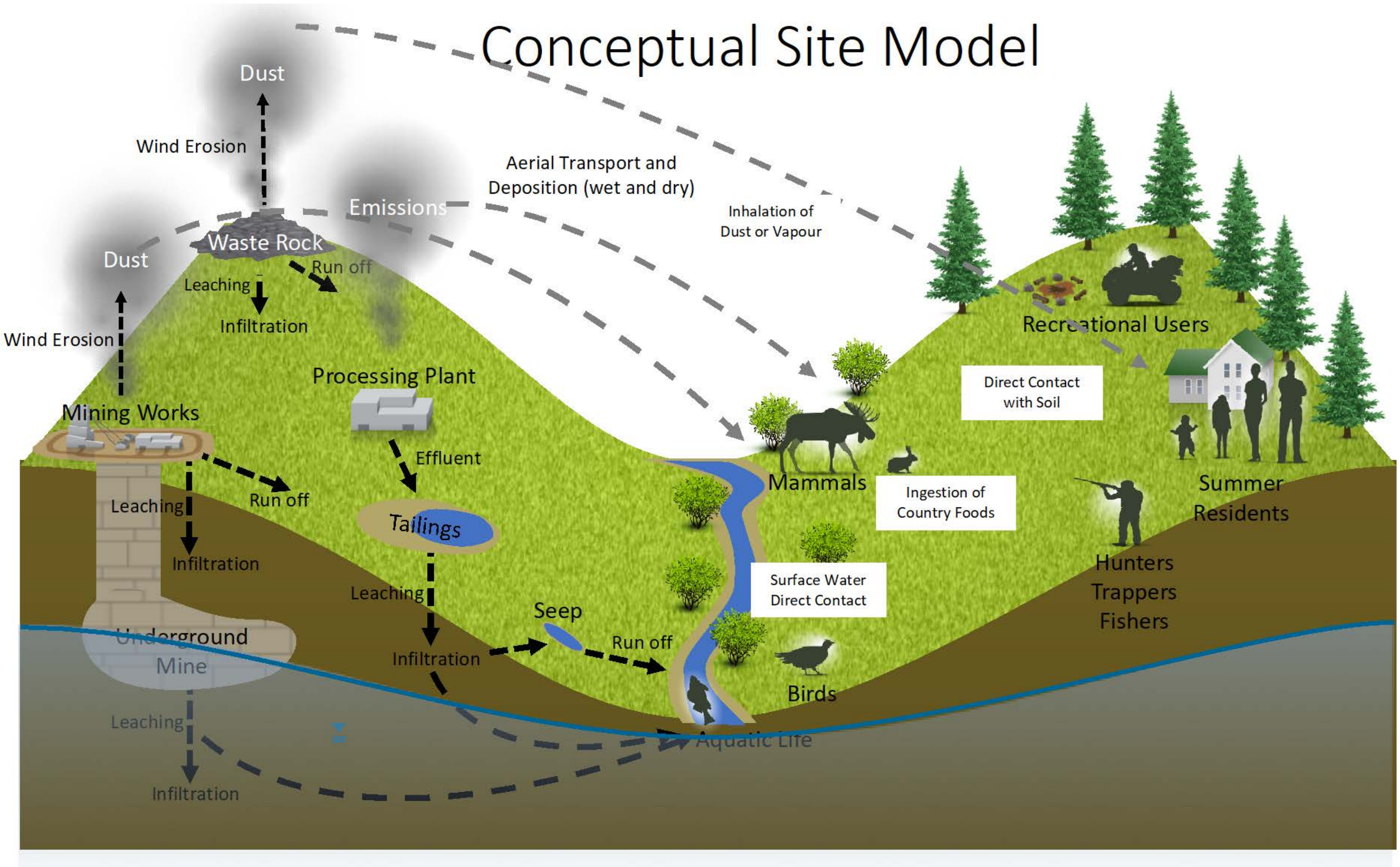
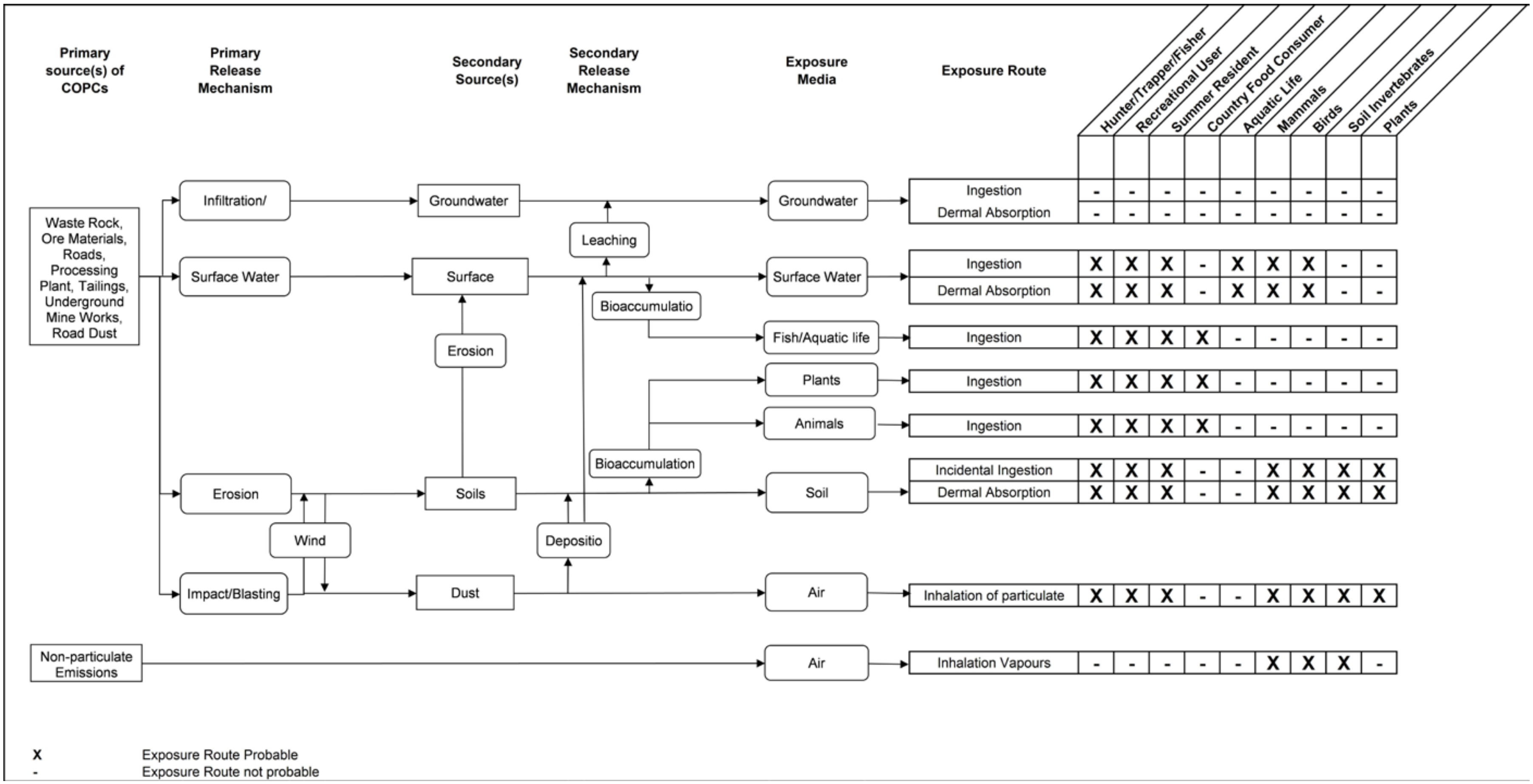


Figure 1.2-6: Box-and-Line Conceptual Site Model: Red Mountain Underground Gold Project



1.2.7 Heritage Resources

Heritage resources are resources that are important and protected by the *Heritage Conservation Act* (HCA, 1996) because of their historical, cultural, scientific, and educational value to communities, Aboriginal Groups, and the public. A heritage resource is defined as personal property that has heritage value to BC, a community, or an Aboriginal Group, regardless of whether it has been officially designated (Province of BC 1996) and may include archaeological resources, which are defined as "the physical remains of past human activity," (FLNRO 1998). Heritage resources may also include immaterial uses of the Project area for cultural or heritage activities.

The Bitter Creek valley is a remote wilderness area with steeply sloping terrain and an absence of old growth tree stands. The valley was, until very recently, covered with glacial ice and has also been exposed to previous human disturbances (mining, logging, powerline, and road construction) and natural disturbances of the soil (floods, landslides, and avalanches). An Archaeological Overview Assessment and a Preliminary Field Reconnaissance conducted in support of the Project found that there are no known archaeological, historical, paleontological, or architectural resources in the Project area and that the likelihood of discovering previously unidentified archaeological resources is low. In addition, IDM has not been made aware of any existing cultural resources in the valley.

It is unlikely, but not impossible, that Project construction may disturb previously unidentified archaeological, paleontological, cultural, or heritage resources. To mitigate this potential effect, a Chance Find Procedure has been developed for the Project. An Access Management Plan will also be developed to mitigate the potential effects of limited access on currently unidentified cultural and heritage resources.

1.2.8 Air Emissions

A discussion of potential Project contributions to atmospheric emissions, including emissions profile (type, rate, and source), is presented in the Air Quality Modelling Report (Appendix 7-A). Emissions from the following sources were identified:

Construction Phase:

- Unpaved roads
- Material handling
- Explosives
- Construction equipment and on-road vehicles

Operation Phase:

- Unpaved roads
- Material handling
- Operations equipment and on-road vehicles
- Process plant sources
- Ventilation portal

For each of the emission sources, where applicable, the air contaminants that were inventoried included the following Criteria Air Contaminants (CACs) and Greenhouse Gases (GHGs).

Criteria Air Contaminants:

- Carbon Monoxide (CO)
- Nitrogen Oxides (NOx)
- Sulphur Oxides (SOx)
- Total Suspended Particulate (TSP)
- Particulate matter less than 10 microns in diameter (PM_{10})
- Particulate matter less than 2.5 microns in diameters ($PM_{2.5}$)

Greenhouse Gases and Climate Forcers:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxides (N_2O)

Emissions of GHGs have been estimated on a CO_2 equivalent tonnes based on the 100-year time horizon (CO_2e_{100}) and the 20-year time period (CO_2e_{20}). The Global Warming Potentials (GWPs), shown in Table 1.2-5, were applied to determine CO_2 equivalent emissions for these two time horizons. For CH_4 and N_2O, the GWPs shown are based on the Fourth Assessment Report from the Intergovernmental Panel on Climate Change (IPCC)[2] and adopted by the BC Ministry of Environment.

Table 1.2-5: Global Warming Potentials

GHG	20-Year	100-Year
CH_4	72	25
N_2O	289	298

The Project will release greenhouse gas (GHG) emissions due to fuel combustion from vehicles and equipment. The total operational GHG emissions for the Project (provided in Appendix 7-A, Section 3) is well below the provincial threshold (10,000 tonnes per year of CO_2e) and federal threshold (50,000 tonnes per year of CO_2e) to report under both federal (Environment and Climate Change Canada's Greenhouse gas Reporting Program) and provincial (BC Greenhouse Gas Emission Reporting Regulation) reporting regulations. Major components of the Project, including the Process Plant and TMF, will be powered by electricity along with ancillary buildings and offices. Therefore, sources of GHG emissions

[2] IPCC, 2012, "IPCC Fourth Assessment Report (AR4) - Climate Change 2007: Working Group I: The Physical Science Basis". http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14

will emanate from equipment and vehicles during construction and operations, and diesel generators during construction; diesel generators during operations will be limited to emergency back-up use.

Given these sources, the relatively short operational life of the mine, and the use of BC Hydro electrical grid power for many of the energy-intensive mining processes, the Project, by design, considers limiting the release of GHG emissions in comparison to more energy-intensive mines that may rely on diesel power generation for some or all energy requirements.

The following table (Table 1.2-6) provides a comparison of the Project GHG emissions with other industrial facilities in BC, the provincial industrial total GHG emissions (of facilities above the reporting threshold), the province-wide total GHG emissions, and Canada-wide GHG emissions.

BC currently has two GHG reduction targets:

- By 2020 and for each subsequent calendar year, BC greenhouse gas emissions will be at least 33% less than the level of those emissions in 2007; and
- By 2050 and for each subsequent calendar year, BC greenhouse gas emissions will be at least 80% less than the level of those emissions in 2007.

Canada currently has a target to reduce GHGs by 30% below 2005 levels by the year 2030.

Table 1.2-6: Comparison of Project GHG Emissions with Top Industrial British Columbia Emitters, Province-Wide Emissions, and Canada-Wide Emissions

Provincial Rank	Company	Facility	Industry	Total GHG Emissions (tonnes of CO_2e	Percentage of Industry Reported GHGs in BC	Percentage of Province-Wide GHG Emissions	Percentage of Canada-Wide GHG Emissions
1	Spectra Energy Transmission	Transmission Mainline	486210 (Pipeline Transportation of Natural Gas)	1,165,211	6.01%	1.91%	0.16%
2	Spectra Energy Transmission	Fort Nelson Gas Plant	211113 (Conventional Oil and Gas Extraction)	1,020,085	5.26%	1.68%	0.14%
3	Canadian Natural Resources Limited	CNRL BC Aggregated Facilities (E <10,000 tCO2e each)	211113 (Conventional Oil and Gas Extraction)	931,782	4.80%	1.53%	0.13%
4	Lafarge Canada Inc.	Richmond Cement Plant	327310 (Cement Manufacturing)	796,982	4.11%	1.31%	0.11%
5	Lehigh Hanson Materials Ltd.	Delta Plant	327310 (Cement Manufacturing)	753,823	3.89%	1.24%	0.10%
6	Spectra Energy Transmission	Pine River Gas Plant	211113 (Conventional Oil and Gas Extraction)	741,618	3.82%	1.22%	0.10%
7	Powerex Corporation	Powerex EIO	221111 (Hydro-Electric Power Generation)	721,522	3.72%	1.18%	0.10%
8	Rio Tinto Alcan Inc.	Kitimat Works	331313 (Primary Production of Alumina and Aluminum)	522,819	2.69%	0.86%	0.07%
9	Spectra Energy Transmission	McMahon Cogen Plant	221112 (Fossil-Fuel Electric Power Generation)	510,864	2.63%	0.84%	0.07%
10	Chevron Canada Limited	Burnaby Refinery	324110 (Petroleum Refineries)	463,743	2.39%	0.76%	0.06%
11	Teck Coal Limited	Fording River Operations	212114 (Bituminous Coal Mining)	432,342	2.23%	0.71%	0.06%
12	Teck Metals Ltd.	Trail Operations	331410 (Non-Ferrous Metal (except Aluminum) Smelting and Refining)	411,694	2.12%	0.68%	0.06%
13	Teck Coal Limited	Elkview Operations	212114 (Bituminous Coal Mining)	389,951	2.01%	0.64%	0.05%
			Federal Reporting Threshold	50,000			
			Provincial Reporting Threshold	10,000			
Does not meet reporting threshold	**IDM Mining**	**Red Mountain Project**	**Proposed Underground Gold Mine**	**4,937**	**0.03%**	**0.0081%**	**0.0007%**
			Total Industry Reported GHGs in BC (2015[3])	19,400,000			
			BC Province-Wide Emissions (2015[4])	60,900,000			
			Canada-Wide Emissions (2015[2])	721,800,000			

[3] Consolidated BC Emission Report Summaries - http://www2.gov.bc.ca/gov/content/environment/climate-change/data/industrial-facility-ghg
[4] Source: Environment and Climate Change Canada (2017) National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada (www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1).

1.2.9 Existing and Planned Land Use

This section provides a summary of land ownership and land use in the vicinity of the Project. Refer to Volume 3, Chapter 19 (Economic Effects Assessment) and Volume 3, Chapter 20 (Social Effects Assessment) for the contemporary land and resource use and Current Use of Land and Resources for Traditional Purposes (CULRTP) effects assessments, respectively, including maps showing the location of other land uses discussed below. Chapters 25 (TSKLH), 26 (MNBC), and 27 (Nisga'a Nation) provide an assessment of the potential effects of the Project on Aboriginal and Treaty interests. Figures 6.12-1 and 6.12-2 in the Effects Assessment Methodology (Volume 3, Chapter 6) illustrate the past, present, and reasonably foreseeable land use activities near the Project area.

1.2.9.1 Land Ownership

The Project is located on provincial Crown land. There are no private land parcels within the Project area.

No federal lands are required or involved in the Project. Table 1.2-7 summarizes the distances from the proposed Project to the nearest federal lands.

Table 1.2-7: Proximity to Federal Lands

Federal Land Description	Distance from the Project
Gwaii Haanas National Park Reserve	380 km
Canadian Forces Base Comox	800 km
Qualicum National Wildlife Area	850 km

There are no Indian Reserves within the Project area. The nearest Indian Reserve is Gitanyow 3A, which is approximately 135 km from the Project.

No Aboriginal Groups have Aboriginal title in the Project area; the Project is within the Nass Area and Nass Wildlife Area, as set out in the NFA.

There are no local government zones or plans over the Project area.

1.2.9.2 Tenured Land Use

There are several overlapping tenures in the Project area. These are summarized in Table 1.2-8.

Table 1.2-8: Overlapping Tenure Holders

Tenure Holder	Tenure Type	Tenure Number
P.K. Contracting Co. Ltd.	Forest Tenure	A01497
Syntaris Power Corp.	Hydropower Licence	636485
Bridge Power Hydro Developments (formerly Northern Hydro Ltd.)	Hydropower Licence	636511
Seabridge Gold Inc.	Mineral Tenures	512985, 512991, 512997, 512998, 513000, 513001, 513002, 513003, 513005, 513007, 513008, 513009, 513011, 513014, 513017, 513019, 513020, 513022, 513023, 513024, 513025, 513027, 513028, 513029, 513030, 513031, 513032, 513035, 513037, 513040, 513041, 513042, 513045, 513046, 513054, 513056, 513128, 513130, 513662, 513663, 513682, 513683, 513680
Ian Alastair Logie	Mineral Tenures	250482, 250481, 250472
Teuton Resources Corp.	Mineral Tenures	513826, 1028305, 1028306, 1028307, 1030934
Randy John Marko	Mineral Tenure	1033757
Mountain Boy Minerals	Mineral Tenure	546600
Last Frontier Heliskiing Ltd.	Commercial Recreation Licence	SK910116
Bear Enterprises Ltd.	Commercial Recreation Licence	910352
Nisga'a Pacific Ventures	Guide Outfitter	601036
Fred Banerd	Trapline	TR614T101

Source: iMapBC (accessed 2016: http://www2.gov.bc.ca/gov/content/data/geographic-data-services/web-based-mapping/imapbc)

IDM is committed to open and honest communication with these stakeholders throughout the life of the Project. IDM's engagement efforts with these stakeholders are summarized in Chapter 28 (Public Consultation) and Appendix 28-A (Public Consultation Report).

Chapter 19 (Economic Effects Assessment) includes an assessment of the potential effects of the Project on tenured land uses under the VC Contemporary Land Use.

1.2.9.3 Non-Tenured Current Land Uses

Due to the lack of current access infrastructure, it is IDM's understanding that non-tenured land use and activities in the Bitter Creek valley are infrequent.

Stewart and the surrounding area have many recreation opportunities and unique attractions. Highway 37A, between Meziadin and Stewart, offers scenic sites of nearby mountains and glaciers; both Bear and Salmon glaciers can be viewed from roadside locations.

There are several hiking trails in and around Stewart that are maintained by community members. These trails provide accessible outdoor recreation opportunities for residents and tourists alike.

There are several lakes and rivers in the area for fishing, boating, and water skiing. Snowmobiling starts in November and can continue through to July. Snowmobiling events are held by the Stewart Bordertown Snowmobile Club. The area around Long Lake, 25 km north of Stewart, and Summit Lake, close to the old Granduc site, are two especially popular snowmobiling areas.

Clements Lake Recreation Area provides swimming, camping, canoeing, and hiking opportunities. It is located approximately 13 km from Stewart along Highway 37A, not far from the proposed turn off for the Project at the mouth of Bitter Creek. Clements Lake is the trailhead for a hiking trail that leads to Ore Mountain on the northern flank of the Bitter Creek valley. The trail is a difficult 4 km hike to a small alpine lake. According to local sources, the Project is unlikely to be visible other than from the summit of Ore Mountain (D. Green. Pers Comm. 2016) although this contradicts most maps and online sources that suggest the trail ends before Bitter Creek would come into view.

The Project is within the Nass Area and Nass Wildlife Area, as set out in the NFA, and Nisga'a Nation holds Treaty rights to manage and harvest fish, wildlife, and migratory birds within the Nass Area and Nass Wildlife Area. TSKLH and MNBC have also asserted Aboriginal rights over the Project area.

Volume 3, Chapter 20 (Social Effects Assessment) includes an assessment of the potential effects of the Project on non-tenured current land uses under the VCs Recreational Values and Current of Use Lands and Resources for Traditional Purposes. Volume 4, Chapters 26 (TSKLH), 27 (MNBC), and 28 (Nisga'a Nation) also provide an assessment of the Project's potential effects on Aboriginal and Treaty interests.

1.2.9.4 Provincial Land Use Plans and Land Use Designations

The Project is within the Nass South Sustainable Resource Management Plan (Nass South SRMP). The Nass South SRMP provides guidance on permitted land and resource use in the area and provides guidelines for timber operations. Guidelines for timber operations take into account cultural, environmental, and economic values to facilitate development potential of the land base by proactively reducing and/or preventing conflict on the ground, and to provide opportunities for sustainable economic development (FLNRO 2012a). The primary objectives of the Nass South SMRP are to foster and improve consultation and collaboration processes between the province, Nisga'a Nation, and Gitanyow First Nation, to enhance cooperation, and promote strategic and sustainable land use planning and resource development.

The Nass South SRMP provides management direction in seven areas: water, biodiversity, botanical forest products, wildlife, fisheries, cultural heritage resources, and timber. The SRMP summarizes the objectives for each of the seven areas; however, it does not prescribe how these objectives are to be achieved.

The Project is within the Nass Timber Supply Area, although it is IDM's understanding that there is very little merchantable timber in the Bitter Creek valley. There are Old Growth Management Areas in proximity to the Project; however these do not overlap with the anticipated footprint of Project components or activities.

1.2.9.5 Other Developments or Activities

Bridge Power Hydro Development Ltd. (Bridge Power) is proposing to develop a 15 to 20 megawatt (MW) run-of-river hydroelectric facility, the Bitter Creek Hydro Project, on Bitter Creek, immediately below the proposed location of the TMF and Process Plant (Bridge Power 2016). The Project would, should it proceed, operate from March through November, with an estimated life-of-project of 40 years. This project would require the re-establishment/upgrading of an access road and construction of a transmission line between Highway 37A and Otter Creek (Bromley Humps location for the Red Mountain Underground Gold Project), therefore there could be an opportunity for cost-sharing between Bridge Power and IDM for road and powerline construction and/or maintenance. There may also be an opportunity for power to be supplied to Bromley Humps and the Mine Site directly from the hydroelectric facility, should the project proceed. At the time of writing of this report, there does not appear to be a likelihood that this project would be proceeding along a similar time frame as that envisioned for Red Mountain. Given this, the opportunity for the two projects to benefit one another or occur on a similar development timeline is considered to be low.

1.3 Regulatory Framework

The Project is reviewable under both the provincial *BC Environmental Assessment Act* (2002) (BCEAA), administered by the BC Environmental Assessment Office (BC EAO), and the *Canadian Environmental Assessment Act, 2012* (CEAA 2012), administered by the Canadian Environmental Assessment Agency (the Agency). The development of the Project will require an Environmental Assessment Certificate (EAC), potentially issued by BC EAO following the completion of the Application Review stage of the provincial environmental assessment process. The Project also requires an environmental assessment decision from the Agency under CEAA 2012.

The Project will require multiple permits, including a provincial *Mines Act* (1996) permit and *Environmental Management Act* (2003) permit, which can only be issued after an EAC is obtained. Provincial permitting and licensing is expected to proceed following the completion of the environmental assessment pursuant to BCEAA. It is anticipated that all provincial permit applications for the Project will be coordinated through the BC Major Mines Projects Office of the BC Ministry of Forests, Lands, and Natural Resource Operations (FLNRO). IDM does not intend to request concurrent permitting, pursuant to the Concurrent Approval Regulation (BCEAA), but will apply for these permits using the synchronous permitting approach after receiving the EAC.

As the Project is within the Nass Area and the Nass Wildlife Area, the Project's environmental assessment is also subject to the requirements of Chapter 10, paragraphs 8(e) and 8(f) of the NFA.

Table 1.3-1 presents the principal provincial authorizations, licenses, and permits anticipated for Project construction and operations. The list is not intended to be comprehensive and as the environmental review continues, the list will be refined to reflect feedback from regulatory agencies throughout the permitting process.

Table 1.3-1: List of Anticipated Provincial Permits and Authorizations

Permits	Agency	Legislation	Description
Permit Approving the Work System and Reclamation Program (*Mines Act* Permit)	Ministry of Energy and Mines	Government of BC, *Mines Act* (1996)	Authorization to construct, operate, close/decommission and reclaim a mine.
Mining Lease	Ministry of Energy and Mines	Government of BC, *Mineral Tenure Act* (1996)	Authorization for the exploration or development of the mineral resource
Mining Right of Way Permit	Ministry of Energy and Mines	Government of BC, *Mining Right of Way Act* (1996)	Right of way access within Crown or private lands
Licence of Occupation and Statutory Right of way	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Land Act* (1996)	Authorization to occupy crown land for construction of freshwater pipeline
Temporary Use / Work Permits	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Land Act* (1996)	Temporary (short-term) use of Crown land portions for construction of fresh water pipeline
Investigative Use Permit	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Land Act* (1996)	

Permits	Agency	Legislation	Description
Occupant Licence to Cut – Mine Site	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Forest Act* (1996)	Authorization to harvest timber for site clearing
Liquid Effluent Discharge Permit	Ministry of Environment	Government of BC, *Environmental Management Act* (2003)	Authorization for discharge from any water storage facility or diversion structure
Air Emissions Discharge Permit	Ministry of Environment	Government of BC, *Environmental Management Act* (2003)	Authorization for air emissions discharge
Hazardous Waste Registration	Ministry of Environment	Government of BC, *Environmental Management Act* (2003) - Petroleum Storage and Distribution Facilities Storm Water Regulation	Authorization for temporary storage of hazardous waste
Explosives Storage and Use Permit	Ministry of Energy and Mines	Government of BC, *Mines Act* (1996)	Approval for surface and underground explosive storage and use
Section 9 Notification	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Water Sustainability Act* (2014)	Notifies MFLNRO of plans to conduct works not requiring approval or authorization (e.g. no diversion of water, can be completed within a short period of time, and will have minimal environmental or third party effects)
Section 9 Approval or Authorization for Changes In and About a Stream	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Water Sustainability Act* (2014)	Approval for changes in and about a stream that are of a complex nature
Section 8 Approval, Water Use License	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Water Sustainability Act* (2014)	Authorization to divert and use surface water
Construction Permit	Northern Health Authority	Government of BC, *Drinking Water Protection Act* (2001)	
Animal Salvage	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Wildlife Act* (1996)	Authorization to trap wildlife for research/scientific purposes, including salvage
Special Use Permit	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Forest Act* (1996)	Approval to build an access road and gravel pits on unencumbered crown land (non-tenure)

Permits	Agency	Legislation	Description
Occupant Licence to Cut – Access Road	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Forest Act* (1996)	Authorizes timber harvesting consistent with approved road upgrade and road design.
Occupant Licence to Cut – Powerline	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Forest Act* (1996)	Authorization for timber harvesting for construction of a powerline right-of-way
Licence of Occupation and Statutory Right of way	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Land Act* (1996)	Authorization to occupy crown land for powerline right-of-way
S.9 Approval or Authorization for Changes In and About a Stream	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Water Act* (1996)	Approval for changes in and about a stream that are of a complex nature
S.8 Authorization for Short Term Use of Water	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Water Act* (1996)	Authorization to divert and use surface water
Permit to connect a Powerline	BC Hydro	Government of BC, *Safety Standards Act* (2003) - Electrical Satefy Regulation	Approval of plans to connect a private powerline to the BC Hydro grid
Road Use Permit	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Forest Act* (1996)	Approval for the use of forest service roads
Industrial Access Permit	Ministry of Transportation and Infrastructure	Industrial Roads Act (1996)	Access improvements to Access Road
Highway Access Permit/Provincial Public Highway Permit Application	Ministry of Transportation and Infrastructure	Government of BC, *Transportation Act* (2004), *Motor Vehicle Act* (1996)	Approval for industrial access to Highway 37A; Access Road intersection with Highway 37A
Noxious Weed Control Permit	Ministry of Forests, Lands and Natural Resources	Government of BC, *Integrated Pest Management Act* (2003)	Recently disturbed lands within the Project area where invasive plants have vigorously established
Utility Permit	Ministry of Transportation and Infrastructure	Government of BC, *Transportation Act* (2004)	Approval to construct a utility (i.e. transmission line) within a highway ROW
Burning Reference Number	Ministry of Forests, Lands and Natural Resource Operations	Government of BC, *Wildfire Act* (2004)	Required for any category 3 open burn

A list of anticipated federal permits and authorizations is shown in Table 1.3-2. These will be addressed through the appropriate government agencies.

Table 1.3-2: List of Anticipated Federal Permits and Authorizations

Permits	Agency	Legislation	Approval Requirement
Explosives Factory Licence	Natural Resources Canada (NRCan)	Government of Canada, *Explosives Act* (1985)	Authorization for an explosives storage magazine, and for explosives manufacture/mixing
Radio Licences	Industry Canada	Government of Canada, *Radiocommunication Act* (1985)	Establish and operate radio frequencies and related infrastructure
Radio-isotope Licences	NRCan	Government of Canada, *Nuclear Safety and Control Act* (1997)	Authorization for nuclear devices such as slurry density flow meters

1.3.1 Changes to the Environment Resulting from a Federal Decision

Pursuant to Section 5(2) of CEAA 2012, a federal EA must evaluate changes to the environment that are directly linked or necessarily incidental to federal decisions as a result of the Project. None of the federal permits nor authorizations anticipated for the Project (as listed in Table 1.3-2) will result in changes to the environment. Table 1.3-2 also lists the specific Project component or activity for which a federal permit or authorization is required.

1.3.2 Changes Outside of Canada

No changes to areas outside of Canada are anticipated. This includes consideration of potential changes to water quality and quantity, air quality, and organic, inorganic, and living organisms. As stated in Chapters 7 (Air Quality), 10 (Hydrogeology), 11 (Groundwater Quality), 13 (Surface Water Quality), 15 (Vegetation and Ecosystems), 16 (Wildlife and Wildlife Habitat), 17 (Aquatic Resources), and 18 (Fish and Fish Habitat), no effects on these VCs are anticipated outside of Canada.

1.4 Future Development

1.4.1 Foreseeable Expansion of the Project

Exploration activities are ongoing and economic mineral resources have the potential to be expanded. The inclusion of additional reserves in the mine plan may extend the Operation Phase period of the mine life. Therefore, the Project Footprint includes the working of this potential future development (refer to Section 1.6.1.2 for a discussion on the Project Footprint).

The infrastructure is designed to enable ongoing use and expansion beyond the currently defined operating mine life.

1.4.2 Potential Development of Additional Ore Material

The Operation Phase of the Project may be extended, should the existing deposits be expanded upon or additional mineral deposits become economical for development.

The current environmental assessment focuses on mining activities within the Project Area. Should additional economic deposits be located within the current mine area or in the broader regional area that would increase the Project footprint beyond what is currently envisioned in this Application/EIS, IDM will consider the submission of an application for an amendment to its EAC and other relevant provincial or federal permits as necessary.

1.5 Economic Benefits

1.5.1 Project Economics

The following economic data are taken completed for the Project in July of 2017 (JDS 2017). Economic evaluation of the Project was performed to estimate the potential costs of the Project.

1.5.1.1 Capital Construction Costs

The total initial capital cost for the design, construction, and commissioning of the Project is estimated at $135.6 million (JDS 2017). This includes all direct, indirect, and Owner's costs, as well as contingency. A summary breakdown of the initial capital cost is provided in Table 1.5-1.

Table 1.5-1: Summary Breakdown of the Initial Capital Cost for the Design, Construction, and Commissioning of the Project

Project Activity / Component	Capital Cost ($ million)
Mining	11.3
Site Development	9.0
Mineral Processing	37.7
Tailings Management	7.2
Infrastructure	26.0
Project Indirect Costs	9.3
Engineering and Project Management	13.0
Owner Costs	9.1

Project Activity / Component	Capital Cost ($ million)
Contingency	12.6
Total	135.6

1.5.1.2 Operating Costs

A summary breakdown of mining life of mine (LOM), process LOM, site service, and General and Administrative operating costs is provided in Table 1.5-2.

Table 1.5-2: Summary Breakdown of Operating Costs

Project Activity / Component	Operating Cost ($ million)
Mining LOM Operating Costs: $141 Million	
Labour	56.4
Power & Fuel	8.2
Equipment Maintenance & Operating Consumables	76.6
Process LOM Operating Costs: $90 Million	
Labour	38.0
Power & Fuel	9.8
Equipment Maintenance & Operating Consumables	41.9
Site Services Operating: $20 Million	
Labour	4.5
Avalanche Control	5.1
Equipment Maintenance and Operating Consumables	10.7
General and Administrative Operating Costs: $22 Million	
Labour	14.6
G&A Items – Onsite	7.2
G&A Items - Offsite	0.4

1.5.1.3 Closure & Reclamation and Post-Closure Costs

Decommissioning, closure, abandonment, and reclamation costs are estimated at $13.6 million. With an estimated $3.8 million salvage value, the net closure and reclamation and post-closure cost is calculated as $9.8 million.

1.5.2 Government Revenues

The following information on estimated government revenues has been obtained from the BC Input-Output Model Report: Red Mountain (Appendix 19-A), which is based on information provided in the 2016 Preliminary Economic Assessment (PEA, JDS 2016) and as such should be considered conservative. Further details on how government revenues were estimated, as well as a statement of assumptions can be found in Appendix 19-A.

1.5.2.1 Construction

The total GDP effect in BC is estimated to be $81.2 million (direct, indirect, and induced) during the Construction Phase. The Project will bring revenues of approximately $10.0 million to the federal government, $ 9.4 million to the provincial and territorial governments across Canada, and 0.8 million to local government; this revenue will primarily come from personal income tax and sales tax. Total project expenditures for the Construction Phase are estimated at $143 million.

1.5.2.2 Operation

Total GDP effects in BC are estimated at $152.9 million over the six years of production. Total tax revenue during the Operation Phase is estimated at $36.6 million, consisting of $21.8 million in federal tax revenue, $13.4 million in provincial/territorial tax revenue, and $1.4 million in local government tax revenue over the life of the mine.

1.5.3 Employment

The following is a breakdown of direct employment to be created, by job category by Project phase, in number of person year (PY) jobs for construction and decommissioning and full-time equivalent (FTE) jobs for operations. Employment estimates have been obtained from Appendix 19-A. Further details on how employment was estimated, as well as a statement of assumptions can be found in Appendix 19-A.

All jobs are anticipated to be full-time or contract positions, with the exception of two nurses or paramedics that will be needed during construction and operations on an on-call basis. For all phases of the Project, IDM will seek to fill employment opportunities from local, provincial, and national resources, preferentially in that order and as the required technical capabilities are available. It is currently assumed, however, that personnel for all employment opportunities will be obtained within BC with minimal or no employees being engaged nationally or internationally.

1.5.3.1 Construction

During the Construction Phase, the Project is estimated to result in a total of 865 person-years of direct, indirect, and induced employment across BC. The maximum number of contract workers and employees on site during construction is estimated at 293 people. The

RDKS is estimated to benefit from a total of approximately 156 PY direct employment[5]; it is anticipated that the remainder of direct employment opportunities (234 PY) will be filled through workers hired within BC. Table 1.5-3 provides a summary breakdown of anticipated employment during the Construction Phase, by job category.

Table 1.5-3: Summary Breakdown of Anticipated Employment during the Construction Phase

Job Category	Percent of Total Employment (%)
Process Plant • Mill Staff • Mill Maintenance • Mill Technical Services	20
Underground Mining • Mining General • Mining Operations (Production) • Mining Operations (Services) • Mine Maintenance • Mining Technical Services	25
Surface & Infrastructure • Facilities Maintenance	2
Construction[1] • Construction Labour • Construction Management	48
G&A • General Management • Accounting • Human Resources • Community Relations • IT / OT Support • Health and Safety • Environmental • Logistics and Warehousing • Security • Health Support Services	5

Notes:
[1]Workforce requirements associated with the Construction job category (Construction Labour and Construction Management) will be provided by contractors.

[5] Employment estimates for the RDKS assumes 40% of the workforce to be supplied by regional workers.

1.5.3.2 Operation

During the Operation Phase of the Project it is expected that the total direct, indirect, and induced employment for BC will be an average of 283 jobs per year (1696 PY or 1884 FTEs over the six-year Operation Phase).

Direct employment is estimated to be an average of 194 FTE jobs per year, all of which it is assumed will be filled by people living in or relocating to communities within the RDKS.

In addition to the direct effect of the mine's operation on the regional economy, about 40% of the jobs, GDP, and employment in direct supplier industries are expected to be within the RDKS. On an annualized basis, it is estimated that 13 jobs would be supported in local industries directly supplying services used by the mine, with another 20 direct supplier industry jobs in other parts of the province. Further back in the supply chain, industry effects are expected to be largely outside the local area, as is the induced effect associated with spending by workers employed by the mine and its direct and indirect suppliers.

Table 1.5-4 provides a summary breakdown of anticipated direct employment during the Operation Phase, by job category.

Table 1.5-4: Summary Breakdown of Direct Employment during the Operation Phase

Job Category	Percent of Total Employment (%)
Process Plant • Mill Staff • Mill Maintenance • Mill Technical Services	25
Underground Mining • Mining General • Mining Operations (Production) • Mining Operations (Services) • Mine Maintenance • Mining Technical Services	60
Surface & Infrastructure • Facilities Maintenance	5
G&A • General Management • Accounting • Human Resources • Community Relations • IT / OT Support • Health and Safety	10

Job Category	Percent of Total Employment (%)
• Environmental • Logistics and Warehousing • Security • Health Support Services	

1.5.3.3 Closure and Reclamation

During the Closure and Reclamation Phase, the Project is estimated to result in a total of 22 person-years of direct, indirect, and induced jobs across BC. Closure and Reclamation jobs will primarily be contract positions lasting through the first two years of the Closure and Reclamation Phase. The RDKS is estimated to benefit from a total of approximately 9 PY direct employment[6]; it is anticipated that the remainder of direct employment opportunities (13 PY) will be filled through workers hired within BC.

Job categories associated with this phase will include:

- Equipment operators;
- Tradesmen;
- Supervisors;
- Health and Safety; and
- Labourers.

Further details regarding employment requirements during the Closure and Reclamation Phase, broken down by job category, will be available during the Operation Phase of the Project.

1.5.4 Employment Strategy

A Skills, Training, and Employment Plan (STEP) has been developed for the Project and is provided in Volume 5, Chapter 29. The purpose of the STEP is to enhance employment opportunities and benefits of the Project for residents of local communities and Nisga'a Nation. Training and employee retention will contribute to the success of the Project and help develop a skilled and experienced regional workforce that will be of benefit to future projects.

The STEP has three linked objectives:

- To maximize direct employment of workers from the District of Stewart, Nisga'a Nation, and other local communities;

[6] Employment estimates for the RDKS assumes 40% of the workforce to be supplied by regional workers.

- To develop opportunities for training of the regional workforce, provide on-the-job training, and support career advancement; and
- To minimize employee turnover through provision of career advancement and supportive employment conditions.

IDM is committed to maximizing employment of Nisga'a citizens and the local workforce. The hiring process will be open, merit-based, and competitive, however, within this context IDM will take a proactive stance for the hiring of local and Nisga'a Nation job-seekers. Recruitment will include early communication activities and development of employment policies and programs to encourage recruitment.

IDM will provide competitive compensation and benefit packages for all workers consistent with mining industry standards in BC. Employee benefits will include Health and Dental Care Plans, Employee and Family Assistance Program, and provisions for Professional Development.

During the Operation Phase, the goal is to encourage non-resident hires to relocate to Stewart on a full-time basis. IDM will work closely with the District of Stewart, service providers, and local businesses to ensure adequate housing, amenities, and recreational facilities are available to help attract and retain new workers to the community.

1.5.5 Labour income

Personal income effects (direct, indirect, and induced) are expected to total $133.1 million for BC with $98.6 million for the RDKS for life of mine.

Average wage, by major job category, for employees associated with construction and operations are provided in Table 1.5-5.

Table 1.5-5: Average Wage, by Major Job Category, for Construction and Operation Phase Employees

Job Category	Average Yearly Wage (Gross)[1]
Process Plant	$116,665
Underground Mining	$112,257
Surface and Infrastructure	$108,339
G&A	$118,737

Notes:
[1]Inclusive of overtime, vacation, holiday, CPP contributions, employment insurance, WCB insurance, and health insurance.

1.5.6 Contracting

The Project may depend on several contract services for the Construction and Operation Phases. For all phases of the Project, these services will be obtained from local, provincial, and national contractors, preferentially in that order and as the required technical capabilities are available. Contract services could include, but not be limited to:

- Construction Phase activities:
  - Road and Powerline construction;
  - Bulk earthworks;
  - Underground infrastructure work;
  - Surface infrastructure work; and
  - Engineering, procurement, and construction management.
- Operation Phase activities:
  - Logistics, transportation services, and fuel services;
  - Explosives product;
  - Expediting/mine resupply;
  - Communications;
  - Avalanche support;
  - Monitoring; and
  - External trainers on site to conduct specialty training, e.g., safety, conflict management, cultural awareness, etc.

Estimated values of supply of service contracts are provided in Table 1.5-6, by Project phase.

Table 1.5-6: Estimated Value of Supply of Services Contracts, by Phase

Phase	Estimated Value of Supply of Service Contracts
Construction	$100 Million
Operation	$163 Million[1]
Closure and Reclamation	$12 Million

Notes:
[1] Estimated assuming 60% of the total costs during the Operation Phase are associated with supply of service contracts (i.e. excluding labour).

IDM will require contractors to utilize reasonable local labour from qualified sources and provide on-the-job training program. The RDKS is estimated to benefit from approximately 20% of the value of supply of service contracts during the Construction, Operation, and Closure and Reclamation phases, with the remaining 60% being provided by companies within BC and 20% being outside of BC.

1.5.6.1 Local Purchasing Strategy

A Local Procurement Plan (LPP) has been developed for the Project and is provided in Volume 5, Chapter 29. Local procurement refers to Project spending on:

- The purchase of goods, such as consumables, supplies, and equipment;
- Services, such as consultants and contractors; and
- Expenses incurred during travel, such as car rentals, fuel, meals, and accommodation.

The objective of this LPP is to establish a fair and transparent process that will facilitate and encourage the participation of local businesses and contractors, especially during the construction and operation of the Project.

IDM will work with local governments, businesses, and others to identify appropriate criteria and requirements necessary to qualify as a “local” or “regional” supplier.

Local suppliers would be local businesses and contractors whose headquarters or primary area of operation is situated within the Project’s Local Procurement Area (LPA), including:

- District of Stewart;
- The Nisga’a Villages;
- Terrace; and
- Other communities within a 100-km radius of the Project, excluding communities in Alaska.

The Regional Procurement Area (RPA) would be defined as the area in northwest BC that is south of the BC-Yukon border, west and north of Prince George (inclusive of Prince George in its southeastern extent), and east of the Canada-USA border.

Proposed criteria to qualify as a local (or regional) business may include:

- A business or franchise wholly owned by a full-time or seasonal resident of a community located within the LPA or RPA;
- A joint-venture between another company and a resident of an LPA/RPA community;
- A business that owns or leases office space or employee accommodation space in an LPA/RPA community; or
- A supplier at least 51% owned by NLG, Nisga’a Pacific Ventures LP (NPV), a Nisga’a citizen, or any other Nisga’a Nation entity, whether or not they are headquartered in the Nass Valley, the LPA, or RPA.

IDM will track its performance and that of its primary contractors with respect to its use of local or regional suppliers.

1.5.7 Work Schedule, Transportation, and Housing

Production, maintenance, and technical personnel are currently planned to work 12-hour shifts on a four-day-on, four-day-off schedule. Construction and certain crews during the Operation Phase may work up to two-weeks-on, two-weeks-off schedule depending on prevailing requirements. The 4x4 schedule is a common schedule and will result in 2,190 scheduled hours of work per year, excluding vacation time. Crew changes will take place by via shuttle on a daily basis from Stewart to the site. The number of personnel required on-site will depend on the types and amounts of work being done.

A Stewart-based construction camp will be built to provide room and board for approximately 250 non-local workers. During the transition from construction to operations, IDM is evaluating phasing out the camp progressively to support the permanent relocation of all workers to Stewart. IDM's strategy is for all operational employees to reside in Stewart and it is evaluating various incentive-based alternatives; these will be reflected in future policies prior to construction. IDM will work with Nisga'a Nation to ensure the proposed housing and transportation strategy supports Nisga'a employees that reside within the surrounding communities.

1.5.8 Training and Benefit Program

IDM is committed to providing advancement and promotion opportunities to current employees, wherever reasonable, to attract, retain, and develop the calibre of employees necessary to optimize Operation Phase.

IDM will provide employees job-specific training and instruction as part of their employment. Comprehensive testing and training programs will be implemented to ensure the safety of all employees at the Mine Site.

IDM will provide for all its employees a comprehensive benefits plan coverage, which includes prescription, medical, dental, accidental death and dismemberment insurance, life insurance as well as an employee assistance program.

1.6 Construction Phase

Construction (Year -2 to Year -1) takes place over an approximately 18-month period. Most of the environmental protection measures are incorporated in the planning stage of the Project and will be implemented at the onset of construction activities and carry through for the life of the Project. This section presents an overview of the infrastructure to be advanced during Construction, which have a life-of-mine use. Information is presented as follows:

- Construction Overview (described in Section 1.6.1)
- Overview of the Project Footprint (described in Section 1.6.2);
- Construction and maintenance of the Access Road (described in Section 1.6.3); and

- Construction of infrastructure at the Mine Site and Bromley Humps, such as the Process Plant, TMF, Haul Road, water management facilities, laydown areas, and ancillary buildings and facilities (described in Section 1.6.4).

1.6.1 Construction Overview

Construction activities resulting in surface disturbance are expected to include clearing vegetation and removing topsoil, stockpiling overburden and topsoil, and constructing roads and infrastructure. Sediment and erosion control strategies will include limiting the disturbance areas to the minimum practicable extent, installing sediment controls prior to construction activities, progressively rehabilitating disturbed land, and constructing drainage controls to improve the stability of rehabilitated land. These measures are outlined in the Erosion and Sediment Control Plan (Volume 5, Chapter 29).

The first focus of Construction is to provide access to the Project and initiate delivery of equipment, materials, and supplies. The next focus is on constructing processing facilities, water and waste management infrastructure, support facilities, and the TMF.

1.6.1.1 Sequencing of Construction Activities

The Project sequencing is critical to the commercial production milestone and overall economic viability of the Project due to the seasonal effects on construction.

The main activities anticipated during construction are as follows:

- Clearing and grading for the upgrade and construction of the Access Road, Haul Road, and Powerline rights of way;
- Construction of watercourse crossings for the Access Road, Haul Road, and Powerline;
- Transportation of batched concrete to the site, to be used for the foundations of civil infrastructure;
- Blasting;
- Construction of drainage facilities for surface water;
- Installing structures for the Process Plant and ancillary facilities; and
- Environmental monitoring.

1.6.1.1.1 Site Access Road and Haul Road

The first construction activity scheduled is the Access Road, a critical-path activity which connects Bromley Humps to Highway 37A. The Access Road provides accessibility to Bromley Humps where a majority of the Project’s infrastructure is located, including the Process Plant, TMF, and water management facilities.

A Stewart-based construction camp will be built in parallel to the Access Road so that it is available for the construction crews once access is provided to Bromley Humps.

Following the completion of the Access Road, construction will commence on the Haul Road, connecting Bromley Humps to the Upper Portal. The Haul Road is another critical-path activity as it provides accessibility to the Mine Site where underground mine development will occur and the surrounding surface infrastructure will be constructed.

1.6.1.1.2 Bromley Humps Sequencing

Once access is constructed to Bromley Humps, clearing and grubbing will commence followed by topsoil stripping and stockpiling in the Topsoil Stockpile area (Figure 1.1-3). Sediment controls and temporary water management practices will be implemented as needed to mitigate the effects of construction disturbance.

Once all suitable topsoil has been removed, site civil works will commence, including the drilling, blasting, and excavation of the Process Plant pad, Seepage Collection Ponds, and TMF basin setbacks. Excavated material that meets material gradation and quality specifications will be used as bulk fill for the TMF structures. Quarries and borrow sites will be developed and material processing will commence to produce construction materials.

Borrow source material will be used to supplement the Process Plant pad excavation material for the TMF bulk fill material. Processed material will be used for transition and filter zone materials that will provide a bedding for the HDPE geomembrane liner installation. The HDPE liner will be installed within the entire basin area and will be terminated in an anchor trench around the perimeter of the TMF facility.

Following the excavation and preparation of the Process Plant pad, concrete slabs/footings will be constructed and construction will commence on the Process Plant, ancillary buildings, and facilities.

1.6.1.1.3 Mine Site Sequencing

In parallel to access being constructed to the Mine Site, mobile mining equipment will be transported to site and assembled such that underground development work can commence immediately upon the completion of the Haul Road. Approximately 1,100 m of total lateral development is planned to be mined during the Construction Phase. The development will consist of 400 m of Ramp to open deeper access to the Marc zone. Footwall and some crosscut development will establish the initial sub levels for longhole stopes. A second portal will be mined from the surface and connected to a 50 m vertical vent raise to complete a ventilation circuit prior to starting production mining. Pre-production waste will be stockpiled at surface and later back-filled.

In addition, the Explosives Magazine, Maintenance Shops, and stockpile pads will be constructed following the completion of the Haul Road.

1.6.1.2 Construction Equipment

A wide range of equipment will be required for various activities, such as site preparation, facilities construction, underground development, and road construction. Table 1.6-1 provides a list of anticipated equipment requirements during the Construction Phase.

Table 1.6-1: List of Equipment Anticipated to be Required during the Construction Phase

Equipment Description	Quantity
Excavators (CAT XQ1000, CAT XQ2000, CAT 345D)	3
Track Dozer – CAT D6T	2
Rubber Tire Loaders (CAT 966K)	1
40 tonne Articulated Trucks CAT 740	4
Vibrating Packer - Cat CS56	1
Bore / Drill Rigs (Top Percussion Drill - DX800)	2
Rough Terrain Forklifts (5 T Fork Lift Zoom-Boom - Terex GTH-5519)	1
Aerial Lifts (Genie S-65, Genie S85, Genie S-125, Genie ZX-135/70, Genie GS4069RT)	8
Mobile Cranes (RT60 – Tadano and RT100 – Tadano GR1000-XL2)	3
Tool Carrier – Cat 966K (c/w Attachments)	1
Tractor with Deck Trailer	2
Generator Sets	1
Air Compressors	1
Concrete Mixer Truck	2
Concrete Pump Truck	1
Supervisor Pickup – Ford F-350	1
Truck – Toyota PC	2
Freight Trucks	2

1.6.2 Project Footprint

The Project Footprint is the spatial area within which development of temporary and permanent infrastructure is expected to occur (Figure 1.1-3). The total Project Footprint is estimated at 147.2 ha, and includes five main features: 1) total cleared area for the Access Road and Powerline between Highway 37A junction and Bromley Humps (40.2 ha); 2) Bromley Humps, including the TMF and Process Plant (22.3 ha); 3) Haul Road and Powerline between Bromley Humps and the Mine Site (46.4 ha); 4) the Mine Site (2.5 ha); and Quarries and Borrow Sites (35.7 ha). Table 1.6-2 summarizes these footprint area estimates, as well as estimates of total disturbance area, which includes a disturbance buffer of up to

50 m surrounding the proposed infrastructure to accommodate for minor siting changes prior to the final design.

Table 1.6-2: Size and Footprint of Facilities

Project Component	Footprint (ha)	Disturbance Area (ha)
Access Road and Powerline between Hwy 37A junction and Bromley Humps	40.2	50.7
Bromley Humps	22.3	56.6
Haul Road and Powerline between Bromley Humps and the Mine Site	46.4	48.6
Mine Site	2.5	16.9
Quarries and Borrow Sites	35.7	73.8
Total	147.1	246.6

Since the Project design is at the feasibility phase, the actual footprint of these facilities may shift within the Project Footprint as further geotechnical investigations are undertaken and the design of the facilities is finalized. The Project Footprint makes allowance for potential relocation of certain facilities within its boundaries. Apart from freshwater, for the environmental effects assessment on other aspects (landform, vegetation, wildlife), it is assumed that the entire area of the Project Footprint is lost for the duration of the mine life. For freshwater aspects, the assessment focuses on the expected physical footprint of the facilities and their expected effects on the freshwater VCs.

1.6.3 Access Road

The Project will be accessed via an all-season road that follows the Bitter Creek valley. The Access Road follows a pre-existing resource road through the valley bottom for 14 km from Highway 37A along the north-northeast side of Bitter Creek to Bromley Humps. An additional 12.5 km Haul Road will be constructed to link the Process Plant at Bromley Humps to the Mine Site. The Haul Road is discussed further in Section 1.6.4.2.

Fish habitat assessments of watercourses along the proposed alignment were completed in summer 2016 by Northlink Consultants. There were four major crossings identified, two of which are classified as fish-bearing. There are 65 additional minor watercourses that have been identified as non-fish-bearing.

The road is planned to be a radio-assisted, single-lane gravel road with inter-visible turnouts. The road will be approximately 5 m wide and will include adequate drainage and cleared right-of-way space to accommodate the Powerline.

Road access will lessen the storage infrastructure required at the Project site and shift it to private vendors in Stewart or other supply hubs. Stewart will be the main supply hub to which freight can be delivered via Highway 37A or directly to the Stewart World Port.

Two distinct sections of road will be constructed for the Project: 1) upgrading pre-existing forest service road connecting Highway 37A to Bromley Humps (the Access Road) and 2) pioneering new access connecting Bromley Humps with the Mine Site (the Haul Road, discussed further in Section 1.6.4.2).

The road right-of-way will be cleared, grubbed, and stripped prior to construction. Trees will be cleared to a distance 3 m upslope of the road prism. Timber within the right-of-way is non-merchantable and will be piled and burned locally along the right-of-way. In areas of steep terrain where side-casting is not feasible, stripped soil will be end-hauled, either to the Topsoil Stockpile (material to be used for reclamation purposes) or to a spoil site (locations to be confirmed during detailed design) for storage.

Geohazard areas along with mitigation strategies to overcome these challenges, in the form of road upgrade prescriptions, construction management strategies, and cut-and-fill angles, have been identified in Appendix 9-C. Appendix 1-I (Feasibility Study Design Drawings) provides alignment details and plan and profile drawings for the Access Road and Haul Road. General design criteria for the Access Road are presented in Section 1.6.3.2.1.

1.6.3.1 Expected Use

A gate will be established at the entrance to the Access Road from Highway 37A. However, IDM acknowledges that once the Access Road is constructed, local hunters or other recreational users may attempt to use it for ease of access to the Bitter Creek valley. IDM's community communication efforts will emphasize the restricted status and safety aspects of using this road and the company will actively discourage the public from using the Access Road. The final Access Management Plan, discussed in Chapter 29, will be further developed in consultation with Nisga'a Nation, community members, and stakeholders to ensure appropriate access.

Freight and fuel will be transported from Stewart or other hubs to the Project via the Access Road beginning in Year -2. Freight and fuel quantities have been estimated for the life of the mine and are shown in Table 1.6-3.

Table 1.6-3: Expected Annual Freight and Fuel on the Access Road

	Freight (tonnes)	Fuel ('000 litres)
Year -2	2,900	1,000
Year -1	5,400	4,000
Year 1	11,700	1,700
Year 2	8,000	1,700
Year 3	8,800	1,800
Year 4	7,100	1,700
Year 5	4,000	1,500

	Freight (tonnes)	Fuel ('000 litres)
Year 6	3,800	1,500
Total LOM	51,700	14,900

The Access Road will be used year-round for the duration of the Project Life. The expected number of vehicles on the Access Road is presented in Table 1.6-4.

Table 1.6-4: Expected Annual Vehicle Traffic on the Access Road

Traffic Year	Freight/Fuel Loads	Personnel	Total Loads
Year -2	230	540	770
Year -1	650	1800	2,450
Year 1	740	1460	2,200
Year 2	570	1460	2,030
Year 3	620	1460	2,080
Year 4	530	1460	1,990
Year 5	360	1460	1,820
Year 6	340	1460	1,800
Total LOM	4,040	11,100	15,140

1.6.3.2 Design and Construction of the Access Road

The following provides a description of the design and construction of the Access Road. Refer to Appendix 1-I for plan and profile drawings of the Access Road and Haul Road. Refer to Appendix 9-C for further details regarding prescriptions and management strategies for mitigating geohazards along each section of the Access Road and Haul Road.

1.6.3.2.1 General Design Criteria

The Access Road is designed for a B-Train truck and trailer combination. It will be a gated single lane road with pullouts supporting two-way, radio-controlled traffic travelling at a maximum speed of 50 km/hr. In sections of the alignment where a 50 km/hr design speed is unfeasible due to topography, excessive earthworks, and increased cost, the design speed will be reduced to 30 km/hr. Speed limits will be imposed for site traffic and dusting is not expected to be problematic.

The design will include regular drainage culverts and road signs. Refer to Section 1.6.3.4 for further details regarding watercourse crossings.

The Access Road overall right-of-way is typically 25 m. In sections that encroach on Bitter Creek, the right-of-way is 10 m towards the creek and 15 m on the high side for a total of 25 m. The additional 5 m on the high side will accommodate the Powerline running to the Mine Site. Site-specific conditions may necessitate a wider right-of-way where cut and fill slopes extend beyond the typical right-of-way. In these locations, the right-of-way will increase 3 m beyond the typical toe of the fill or crest of the cut.

The specifications to meet these design speeds are summarized in Table 1.6-5 and have been obtained from the 2012 Standard Specifications for Highway Construction (BC Ministry of Transportation and Infrastructure 2011), BC Supplement to TAC Geometric Design Guide (BC Ministry of Transportation and Infrastructure 2007), Steep Grade Descent Calculator (Parker 2016), MFLNRO Engineering Manual (BC Ministry of Forests, Lands Resource Operations 2016), and Forest Road Engineering Guidebook (BC Ministry of Forests 2002).

Table 1.6-5: Design Specifications

Components	50 km/hr	30 km/hr
Maximum Road Grade	12%	18%
Tightest Vertical Curve	1% grade change over 12m (11m for crest curves)	1% grade change over 4m (3m for crest curves)
Minimum Curve Length	50 m	30 m
Minimum Stopping Sight Distance	135 m	65 m
Minimum Horizontal Curve Radius	80 m	35 m (16 m for switchbacks)
Minimum Cross Drain Culvert Diameter	600 mm	600 mm
Ditch Size	0.6 m deep with a 0.6 m wide base	0.6 m deep with a 0.6 m wide base
Road Width	5 m	5 m
Pullout Size	Additional 4 m width, 30 m long with a 7.5 m long taper at each end	Additional 4 m width, 30 m long with a 7.5 m long taper at each end

Construction of the road prism will require surficial material earthworks and ripping of rock where the road passes through near surface bedrock. The road subgrade will be tracked in lifts and the subgrade will then be surfaced with 15 to 30 cm (as specified in the design) of designated surfacing material. All material to be used for surfacing shall be at the discretion of the on-site engineer. To the extent practicable, only non-ARD/ML material will be used for backfill. Following placement and grading, the surfacing layer will be track packed. Unless otherwise specified in the design, all cut slope-and-fill slope angles will vary by material type (see Table 1.6-6).

Table 1.6-6: Permanent Cut Slope-and-Fill Slope Angles by Ground Type

Ground Type	Cut Slope Angle	Fill Slope Angle	Cut Expansion	Fill Expansion	Additional Detail
C1 – Silty sand rubble colluvium	70%	70%	.9	1	Angular rubble colluvium in a silty sand matrix. Deposits typically consist of a thin blanket to veneer overlying rock.
C2 - Sand and gravel rubble colluvium with cobbles	70%	70%	.9	1	Angular rubble colluvium in a sand and gravel matrix. Deposits typically consist of a blanket to veneer overlying rock with random cobbles or angular rock fragments throughout. Typically found below steep slopes with active head scarp or in active avalanche chute.
C3 – Blocky colluvium	100%	70%	1	1	Angular rock clasts with little to no fine-grained matrix. Derived from locally weathered bedrock, typically found in high elevation alpine locations.
T1 – Silty sand and gravel till	70%	70%	1	1	Silty sand and gravel ablation/morainal tills
T2 – Silt or clay based basal till	120%	70%	1.1	1	Silt or clay based basal till
LG – Glaciolacustrine silt and clay	50%	NA[1]	1	1	Glaciolacustrine silt and clay
SG – Sand and gravel some cobbles	70%	70%	.9	1	Sand and gravel fluvial deposits, typically rounded to subrounded.
FR – Fractured, weak rock	200%	70%	1.25	1	Weak, heavily fractured bedrock. Typically, weaker shale, siltstone, or volcanoclastic rock.
SR – Strong rock	400%	70%	1.4	1	Medium strong to very strong bedrock. Typically, competent granodiorite, gabbro, or quartz monzonite.
RF – Rock Fill	NA	85%	NA	NA	Placed rock fill, not into a fluvial environment
RF2 Rock Fill	NA	50%	NA	NA	Placed rock fill, into a fluvial environment

Notes:
[1] Excavated LG material will not be used as fill in the road prism

1.6.3.2.2 Drainage System

The Access Road has been designed to minimize sediment deposition and erosion. Many road components and construction techniques have been implemented to accomplish this. The most influential method is the roads drainage system. All road fills will be placed in lifts and the subgrade and surfacing material will be track packed to create a durable surface that limits rutting and pooling on the road. To ensure surface water is directed off the compacted road surface the road will be built with an appropriate crown.

Once water is directed off the road surface, ditches will move surface water from the cut slope and road surface towards offtake ditches and/or cross-drain culverts. Once at a cross-drain culvert or offtake ditch the water will be directed away from the road prism and watercourses onto undisturbed, vegetated ground. Where it is impractical to redirect ditch water away before entering a watercourse, armoured settling sumps will be constructed to reduce sediment delivery to the stream.

An Erosion and Sediment Control plan will be prepared with best management practices to guide construction (see Section 1.6.3.5).

1.6.3.2.3 Construction Types

Wherever possible, conventional cut-and-fill construction techniques will be implemented to minimize material movement. Cut-and-fill construction techniques are described below. In some locations, alternative construction techniques will be required. Alternative techniques will be utilized in sections where alignment constraints may require more cut material movement beyond what is desired with cut-and-fill construction or where ground conditions require additional fill to ensure a stable road prism.

Remaining construction techniques utilized along the proposed route follow the same principles as cut-and-fill with the exception being material movement. Aside from only moving material along the cross-section view of the road as with cut-and-fill construction, alignment constraints may generate material deficits and surpluses requiring material movement along the length of the road.

Re-conditioning Existing Road

The majority of the road alignment consists of upgrades to a previously existing resource road. The existing road is significantly overgrown with alder in most sections that will require clearing to open the right-of-way and that require re-grading, and re-surfacing. Other portions of the existing road are washed out and the road will need to be re-built in these locations with significant armouring of the fill slopes to protect the fills from additional erosion by Bitter Creek. All existing drainage structures will be inspected and assessed for blockage. If drainage structures are blocked, they will be cleared and reconditioned as required. If drainage structures are found to be in poor condition, they will be replaced as required.

Conventional Cut and Fill Construction

Following site preparation, the road prism will be constructed with a portion of the road's cross-section built in a cut, generating suitable subgrade fill material. That material is then moved to the fill portion of the roads cross-section, ideally generating zero surplus or excess material. The fill portion of the road will be placed on exposed mineral soil and compacted with the bucket of an excavator or tracked in lifts with a bulldozer until brought up to the designed subgrade elevation. The fill portion of the road will be placed on exposed mineral soil and compacted with the bucket of an excavator or tracked in lifts with a bulldozer until brought up to the designed subgrade elevation.

Full Bench End Haul Construction

Full bench end-haul construction is necessary in portions of the Access Road that will traverse areas with steep side slopes. In these sections, the entire road prism will be built on a full bench cut and generated material will be end hauled to a designated spoil site (locations to be specified during detailed design) or to another portion of the road to be used in its construction. In full bench end haul sections, no excavated material will be placed on the slope below the road.

Buttressed Cut Slopes

Buttressed cut slopes are used in cut areas where the cut bank is composed of weaker material that cannot maintain the slope required for the road design. A buttressed cut slope requires the excavation of the toe of the cut followed by placement of stable interlocking riprap material at the base of the cut to stabilize the toe and allow the cut slope to have a shallower angle which produces a stable configuration for the material being cut.

Stacked Rock Fills

Stacked rock fills are required in areas where the fill slope is required to be steeper than standard fill materials will allow. The toe of the fill section is excavated to competent mineral soil or bedrock and large riprap is selectively placed to create an interlocking fill slope. Road subgrade is then filled and compacted in lifts against the upper edge of the rock fill.

Bitter Creek Interference Areas

Standards and Best Practices for In-stream Works (BC Ministry of Water, Land and Air Protection 2004) will be employed for road fill work construction and riprap placement below the high-water mark, and will ideally occur during periods of low water levels in the creek (typically early spring before significant snow melt).In the event water levels or construction timing prevent works from being completed in the dry, work procedures will be altered to comply with the regulations outlined in the *Fisheries Act*. This may require consultation between the proponent and the Department of Fisheries and Oceans (DFO).

The proposed road alignment along the north-northeast bank of Bitter Creek follows an abandoned existing road at the toe of a steep hillside on the North side of Bitter Creek. To avoid destabilizing sensitive slopes, portions of the Access Road will encroach on the High Water Line (HWL) of Bitter Creek.

The right-of-way interference within riparian area totals 4.14 ha, which is 8.9% of the total Access Road. Total disturbed area within riparian zones is 3.63 ha, and total disturbed area within the Bitter Creek HWL is 1.14 ha. In these areas, the road will be designed to accommodate the 1:100-year flood event and to protect the infrastructure and prevent erosion. For details regarding Bitter Creek flows at specific return periods, refer to Appendix 12-A (Baseline Climate and Hydrology Report).

Blasting may occur to construct cuts in these sections of the access road. See Volume 5, Chapter 29 for best management practices for blasting near water.

Bitter Creek Re-alignment

One 150-m section of the access road requires re-alignment of Bitter Creek at the toe of a weak fractured bedrock face. The disturbed area is 0.5 ha of the total 1.14 ha disturbed within the Bitter Creek HWL.

Riprap fill will be placed into the creek with a 1.5 m high rock berm constructed on the upslope side. The surface will be finished with compacted granular surfacing. Riprap weirs extending from the toe of the fill slope will be constructed above the HWL to reduce excessive scouring at the toe of fill slope. The streambed will be excavated and re-graded along the south side to allow for creek realignment.

1.6.3.3 Access Tie-In and Staging Areas

Road construction activities will be accessed from Highway 37A. During construction, multiple small staging areas will be used. Staging areas will advance with road headings using pullouts, depleted borrow sites, spoil sites, and suitable previously cleared areas within the road right-of-way. No additional clearing or road construction activities are proposed to create specific staging areas. Staging areas will be used to store heavy equipment, materials, and tools. The materials stored at these sites will include culverts, geotextile, and bridge materials. Equipment will include excavators, bulldozers, gravel trucks, blasting equipment, surfacing equipment, crane trucks, water trucks, drum compactors, and graders.

1.6.3.3.1 Design Features to Facilitate Wildlife and Human Movement

The Access Road may impose a barrier to wildlife and human movement. Speed restrictions, policies giving all wildlife right-of-way on the roads, and reporting of wildlife will serve as wildlife protection measures.

1.6.3.4 Watercourse Crossings

Fish habitat assessments of watercourses along the proposed alignment were completed in summer 2016 by Northlink Consultants. There were four major crossings identified, two of which are classified as fish-bearing. There are 65 additional minor watercourses that have been identified as non-fish bearing.

Three types of stream crossings will be used for the access road:

- Culverts (non-fish-bearing);
- Clear-span bridges (larger spans, and-fish bearing); and
- Modified ford crossings.

All proposed structures are designed to:

- Meet a BCFS L-100 load rating;
- Accommodate B-Train truck-trailer configurations; and
- Safely accommodate creek flows estimated for a 100-year flood event.

The 100-year flood event was estimated for each crossing site using the rationale method (Thompson 2006), regional method (Riggs 1982), and cross-sectional manning equation (Arcement & Schneider 1989). Site observations, existing structures, and historic high-water evidence were also used to estimate peak flow.

Approaching the crossing site, ditch water will be redirected away from the stream by use of cross-drain culverts and off-take ditches. In-stream work on all streams is to be minimized and completed at times of low flow whenever possible.

1.6.3.4.1 Non-Fish Stream Culvert

Culverts at non-fish-bearing watercourse crossings (all crossings north of the most downstream barrier between Otter Creek and Hartley Gulch) will be skewed to match the horizontal alignment of the creek if possible. Where practical, culvert grades will match the slope of the ground at the crossing to ensure pipes are not perched at the outlet, reducing the likelihood of erosion and sediment deposition. At locations where culverts grades would exceed 5% if not perched, the culvert will be perched, set at 2% and a rock spill apron will be installed at the outlet to prevent erosion. Inlets and outlets will be armoured with 250-kg class riprap or riprap sized on site (MOTI 2011). Riprap at the inlet of the culvert will be arranged to train flow through the culverts. Minimum fill depths over culverts will vary by culvert diameter and will be specified by the culvert manufacturer.

1.6.3.4.2 Clear-Span Bridges

All bridges will be permanent single-span structures that provide clear-span access over undisturbed watercourses. The superstructure foundation will consist of compacted granular fill, pre-cast concrete ballast wall, and pre-cast spread footings with steel risers on geotextile wrapped leveling course. Construction methods will typically involve the following steps:

- Excavation of the abutments;
- Layout of the abutments;
- Placement of the spread footings and risers;
- Back-filling and compaction up to the bottom of ballast wall;
- Placement of riprap;
- Placement of the superstructure, ballast wall, and deck; and
- Backfill.

There will be no instream loss of Fish Habitat at watercourse crossings along the road because only two crossings, Roosevelt Creek and Hartley Gulch, are fish bearing and these will be crossed via clear-span bridges. No fish habitat loss is associated with clear-span bridges as there is no instream infrastructure required for this type of crossing.

1.6.3.4.3 Modified Ford Crossings

Modified ford crossings are used in locations where flows are expected to be high velocity, low volume, and with high debris potential. They are often used to cross watercourses that have constrained gully flows, avalanches, large debris potential, or unstable stream bank conditions.

The ford crossings will be constructed from large, keyed in riprap. Large riprap will be placed to train rainfall shutdown event flows through the heavy gauge steel pipe culverts and 100-year flows over the structure. There is also the potential to utilize articulated concrete mats as a road surface through the fords to minimize downtime following overtopping events.

The crossing is constructed using a pre-cast concrete wall anchored to competent material through a concrete footing using reinforced steel anchors on the upstream side. The downstream side is constructed of a Geosynthetic Reinforced Soil (GRS) fill retaining wall on top of a pre-cast footing anchored to bedrock using reinforced steel anchors. The structure is filled in compacted layers between woven geo-textile with the driving surface finished with shot rock. Riprap will be placed to train rainfall shutdown event flows through the heavy gauge steel pipe culverts and 100-year flows over the structure.

1.6.3.5 Erosion and Sediment Control

An Erosion and Sediment Control (ESC) Plan (see Volume 5, Chapter 29) will be in place prior to the start of construction. The plan provides the foundation on which site-specific erosion and sediment control activities will be implemented by the contractor at site. The ESC Plan is not intended to be a prescriptive document, as prescriptive measures are inappropriate prior to selecting a prime contractor. Also, a prescriptive document tends to work against typical construction methods and existing contractor construction plans. As a result, it does not address the processes responsible for erosion and sedimentation. The ESC Plan will be a comprehensive set of guidelines or best management practices and will provide the contractor and the qualified professionals assigned to the Project the flexibility to refine and apply the most appropriate erosion and sediment control measures based on the site-specific conditions encountered.

Upon construction contract award and prior to construction, the contractor’s work plans and specific ESC measures will be reviewed by the Project’s qualified environmental professional. These plans will describe the contractor’s construction methods and what type of and where specific ESC measures will be installed. It is assumed that there will be an aspect of “field fitting” with all the ESC measures to take into account individual site conditions. The ESC Plan will be used along with the final road and bridge crossing design in the upcoming permitting process for the Project.

1.6.3.6 Borrow Sources

There is a large quarry at approximately 1.5 km that will be utilized for road armouring, river fills, and final road surfacing (Figure 1.1-3). Refer to Section 1.6.4.6 for additional discussion of Quarry and Borrow Sources.

1.6.3.7 Spill Contingency and Emergency Response

The aspects of mitigating, responding to, and otherwise managing spill incidents occurring during transportation are detailed in the Spill Contingency Plan in Volume 5. It addresses spills, releases, or discharges of hydrocarbon or other contaminants to land, water, and snow. Depending on the type and quantity of the contaminant and relative locations of the spill, predetermined lines of response, plans of action, and roles and responsibilities are specified. Besides the customized spill response equipment, including the mobile unit, each vehicle will be outfitted with spill kits.

The basic steps are: source control; control free product; protect the environment; clean up; and relocation.

1.6.3.8 Access Road Maintenance

Once the Access Road is in operation, the labour crews will be scaled back for the purposes of performing road maintenance. Access road maintenance will take place daily by labour crews working 12-hour shifts, with the crew based at the Mine Site. The dayshift labour crew will consist of one equipment operator during the non-avalanche season and two equipment operators during the avalanche season. Additional contractor labour maybe used to supplement the mine’s labour crew as required during periods of heavy avalanche activity.

An Access Management Plan will be developed to reduce and manage geohazard risks (see Volume 5, Chapter 29).

1.6.3.9 Best Management Practices

Construction activities will be carried out in accordance with Standards and Best Practices for In-stream Works (WLAP 2004) and the Fish-stream Crossing Guidebook (FLNRO 2012b). Best Management Practices (BMPs) for the construction of crossing structures, blasting near fish-bearing waters, placement of riprap, fording equipment, and sediment and erosion control for cut-and-fill slopes are identified in the Project EMP (Volume 5, Chapter 29), specifically within the Access Management Plan and the Erosion and Sediment Control Plan.

To minimize the potential effects on fish and fish habitat, any work on the banks to place fill along the North bank of Bitter Creek and install bridges and culverts will ideally occur during periods of low water. To reduce the potential for erosion and sediment deposition in areas of cleared vegetation and cut-and-fill, appropriate crossing structures will be used and suitable erosion and sediment control BMPs will be implemented. Special care will be taken to stabilize slopes that have a potential for sediment generation.

Periods of low water will control when work in and around water will occur, however, if work must be completed outside of periods of low water, work procedures may need to be adjusted to ensure that work complies with the regulations outlined in the *Fisheries Act* and the Forest Planning and Practices Regulation (Government of British Columbia 2004).

1.6.3.10 Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) protocols will be put in place to help ensure all roadwork construction activities minimize any negative environmental effects, including any stream channel changes along the alignment as a result of road construction, to ensure construction activities are performed safely and to ensure the final roadway is safe to travel at the specified design speeds. To make certain these objectives are met, the following actions will be taken:

- Ahead of all construction activities, survey crews will field mark the designed road.
- During road construction, engineers/engineering designates will perform inspections of road construction techniques, monitor borrow and spoil sites, refresh survey markers, and ensure adherence to the design. Road construction inspections will be completed by the engineer/engineering designate at intervals determined to be acceptable by the engineer/engineering designate depending on the complexity of road sections and the competency of the road crews.
- During the construction of stream crossing structures, an engineer/engineering designate will be on site. They will ensure the designs are followed, appropriate construction techniques are utilized, and ensure all components are in an acceptable condition and meet specified standards when installed.

- During the construction of the roadway and stream crossing structures, the engineer/engineering designate will be responsible for coordinating site inspections/visits with all necessary additional experts (biologists, environmental monitors, geochemists, geocryologists, geotechs, etc.).

1.6.4 Mine Construction

Project infrastructure includes the following: temporary waste rock storage areas; ROM stockpile; Process Plant; maintenance and service buildings; explosives storage; TMF; laydown area including unheated and outdoor storage; substation; and administration and mine dry complex. The site layout is presented in Figure 1.1-3 to Figure 1.1-5. An overview of the characteristics of the infrastructure is presented in Table 1.6-7.

Table 1.6-7: Characteristics of the Infrastructure Constructed within the Project Footprint

Project Component	Characteristics
Project Footprint	147.2 ha
Haul Road	The Haul Road will be constructed using borrow material placed to a width of 5 m. Construction materials are from locally developed geochemically suitable borrows/rock quarries. The Haul Road will be constructed in accordance with mine haul road specifications, which require safety barricades. The Haul Road will be private and not for public use.
Quarry Sites and Borrow Area	Estimated aggregate required for construction: 459, 810 tonnes Number of rock quarries: 2 Number of borrow areas: 4 Only geochemically suitable rock quarries and borrow sources will be developed.
Water Supply for Construction Phase	Source: water management ponds, Bitter Creek, Otter Creek, and Goldslide Creek Quantity: 100 m^3/day (dust suppression, construction use, and domestic freshwater)
Fuel Storage	Fuel tank consists of double wall steel tanks at 100,000 L (Bromley Humps) and 20,000 L (two tanks at the Mine Site) capacity. Fuel delivered by tanker trucks from Stewart, BC.
Power Supply	9.5 MW
Explosives	For Construction: Ammonium Nitrate Fuel Oil (ANFO) at quantities of 1,000 kg/day to up to 10,000 kg/day or more. Blasting on a daily basis, at 3,000 – 5,000 m^3 / day. For Operations: Bulk storage area for emulsion: up to 10 tonnes. Explosive magazine containing 10 tonnes of packaged explosives and 100 cases of detonators temporarily stored on surface. Will be relocated underground starting in Year 2 and will provide explosives storage for up to seven days.
Laydown Areas	General laydown areas for material and supplies.

Project Component	Characteristics
Hazardous Materials and Waste Management (other than waste rock and tailings)	Waste Storage Area – adjacent to the Process Plant Hazardous Materials Storage: temporary storage area at Bromley Humps. Secure containers for hazardous materials, e.g., Process Plant reagents. Hazardous wastes disposal will occur offsite at an approved facility. Used tires and machinery: Remove hazardous waste from equipment not being salvaged.
Wastewater Treatment	Oily water treatment plant For light vehicle and mine maintenance shops – water treated and recycled within shop. Oil to be collected and drummed and removed from site as hazardous waste.
Buildings	Process Plant; Administration Office and Mine Dry; Assay Laboratory; Warehouse; Maintenance Shops; other Site Offices.
Overburden, Waste Rock Areas and ROM stockpile	Develop Topsoil Stockpile (estimated volume of 93,000 tonnes) near Bromley Humps in Year -1 Develop temporary Waste Rock Storage Area (up to 92,000 tonnes) starting in Year -1 Develop ROM Stockpile pad at Bromley Humps
Haul Road Water Crossings (Culvert/Bridge)	Up to 3 watercourse crossings will be needed and will be designed to minimize serious harm to fish. Crossings will consist of culverts and fords.

1.6.4.1 Construction of Water Management Facilities

1.6.4.1.1 Water Management during Construction

Construction activities are expected to elevate total suspended solids (TSS) in runoff. Specific surface water control elements and measures will be implemented to minimize erosion and prevent sediment discharge into surrounding areas. Surface water sediment mobilization and erosion will be managed throughout the site by:

- Installing sediment controls prior to construction activities;
- Limiting the disturbance to the minimum practical extent;
- Reducing water velocity across the ground, particularly on exposed surfaces and in areas where water concentrates;
- Progressively rehabilitating disturbed land and constructing drainage controls to improve the stability of rehabilitated land;
- Applying slope roughening to the surface in rehabilitation areas to promote infiltration;

- Protecting natural drainages and watercourses by constructing appropriate sediment control devices such as collection and diversion ditches, sediment traps, and sediment ponds. Temporary best management practices will also be employed as necessary;
- Restricting access to rehabilitated areas; and
- Constructing surface drainage controls to intercept surface runoff.

Subsurface water will be controlled using sump pits, wells, or removable pumping stations to draw down the natural water table and provide dry stable construction areas. Excavations will be kept stable and workable by pumping water collected in the excavation sump pits to sediment control devices, such as temporary holding ponds, sediment basins, or sediment filter bags where required. An adaptive management approach will be implemented that allows sediment and erosion control works to be field fit to suit conditions encountered during construction.

1.6.4.1.2 Construction of Water Management Infrastructure for Operations

The site water management systems for the Operation Phase will be designed and operated to meet the following objectives:

- Divert all non-contact water, as technically possible, around the Project footprint to Bitter Creek, Otter Creek, or Goldslide Creek, or their tributaries;
- Collect all contact water that does not meet TSS or other water quality objectives and direct it to collection ponds;
- Safely release water that meets TSS and water quality objectives; and
- Utilize groundwater dewatering systems to allow underground mining operations to progress safely.

Water management at the Mine Site, Bromley Humps, and for Quarries and Borrows along the Access Road are illustrated in Figure 1.6-1 to Figure 1.6-3.

Water will be managed with the objective of minimizing erosion in areas disturbed by mining activities and preventing the release of untreated contact water that could adversely affect the quality of receiving waters.

Contact and non-contact water are managed separately throughout the Project. Contact water is contained in collection ponds and the TMF, and is transferred through collection ditches and pipelines. Groundwater inflows from the underground mine are considered contact water as well. Non-contact water is diverted off-site through diversion ditches, berms, and culverts. General site drainage measures include collection and diversion structures that will be used throughout the Project site. Measures for road drainage consist of collection ditches, diversion ditches, and culverts that will be used alongside or through roads.

The design criteria for temporary and permanent general site drainage structures are:

- Temporary structure design flow event: Peak flow resulting from the 1-in-10 year, 24-hour rainfall event, or smaller with appropriate contingency measures; and
- Permanent structure design flow event: Peak flow resulting from the 1-in-200 year, 24-hour rainfall event, or smaller with appropriate contingency measures.

Guidelines for design and layout of drainage diversion and collection ditches are as follows:

- Ditches shall be designed as open channels to pass design flows without overtopping for the given design return period;
- Ditches shall be lined where needed to resist erosion;
- The minimum ditch slope shall be -0.5%, but preferably greater than -1%; and
- Ditches will include a minimum freeboard of 300 mm.

Where contact water has the potential to contain suspended solids, such as runoff from haul roads, drainage will be directed to silt fences or collection ponds for removal of suspended solids. This drainage may be released to the environment. A site drainage plan has been developed (refer to the Site Water Management Plan in Volume 5, Chapter 29).

During construction activities, where flows may directly or indirectly enter a waterbody, runoff water quality will comply with permitted discharge criteria.

Monitoring will consist of daily visual inspections during construction activity, spring freshet, and after significant rainfall events with sampling of runoff where turbidity is evident. Construction activities will be conducted in such a way as to minimize effects on surface drainage. Where construction activities necessitate temporary structures, IDM will undertake corrective measures to minimize effects on surface drainage. Guidelines for site development will be described in the Site Water Management Plan (Volume 5, Chapter 29), which will include master drainage plans for each site.

Refer to Section 1.7.12.2 for more information on collection and sediment ponds, including the North TMF Embankment Seepage Collection Pond, South TMF Embankment Seepage Collection Pond, Portal Collection Pond, and quarry / borrow sediment ponds.

No additional water storage facilities or sediment ponds are anticipated to be required.

Diversion and Collection Systems

Diversion ditches will be established around Bromley Humps and the Mine Site to route non-contact water to the natural catchment during the Operation Phase. Other possible areas that may require diversion systems to minimize contact water include buildings and site roads. Ditches will be constructed during the construction phase in Year -1.

Contact water will be collected and directed to the TMF (Bromley Humps) or the Portal Collection Pond (Mine Site).

Figure 1.6-1: Water Management – Mine Site

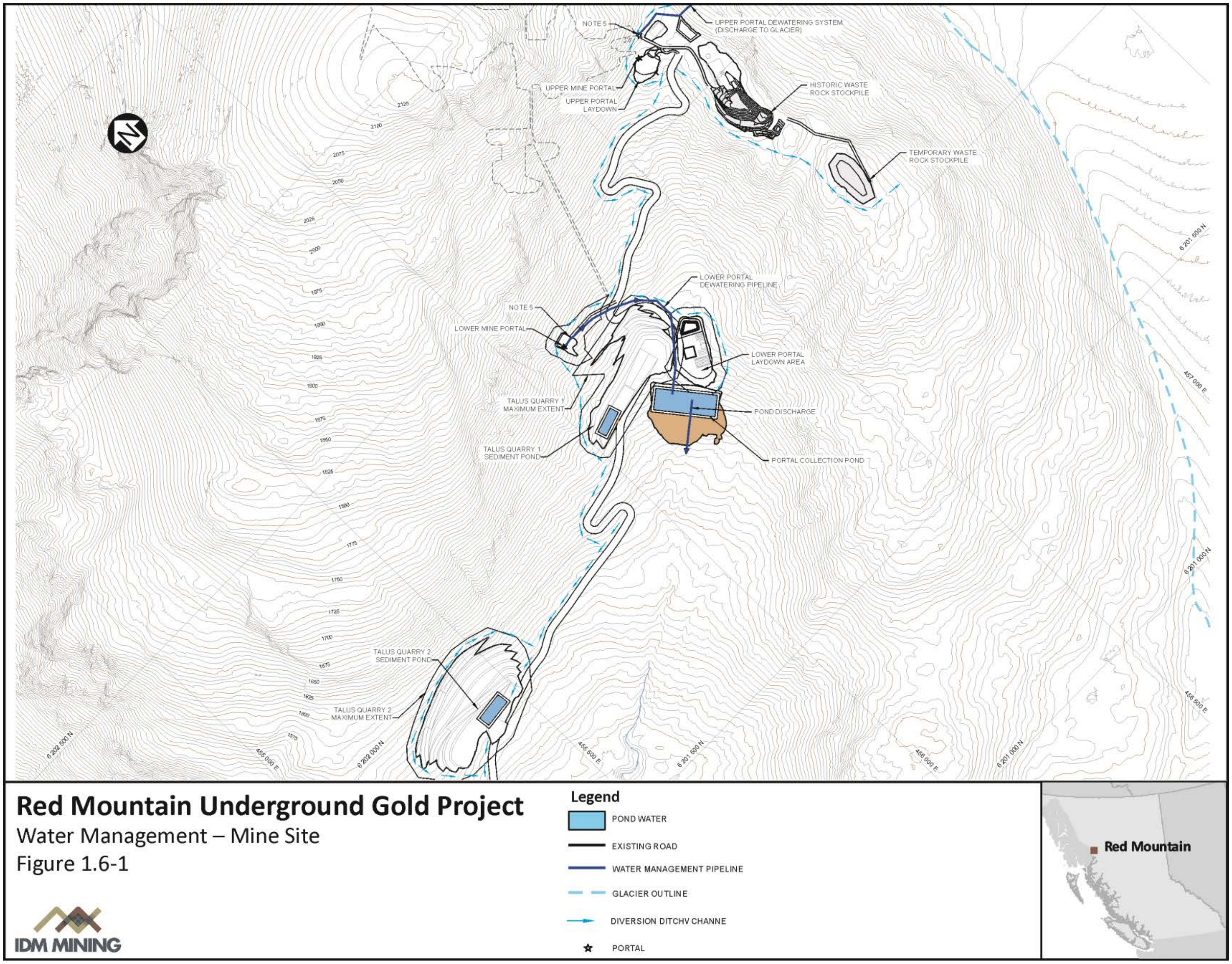


Figure 1.6-2: Water Management – Bromley Humps

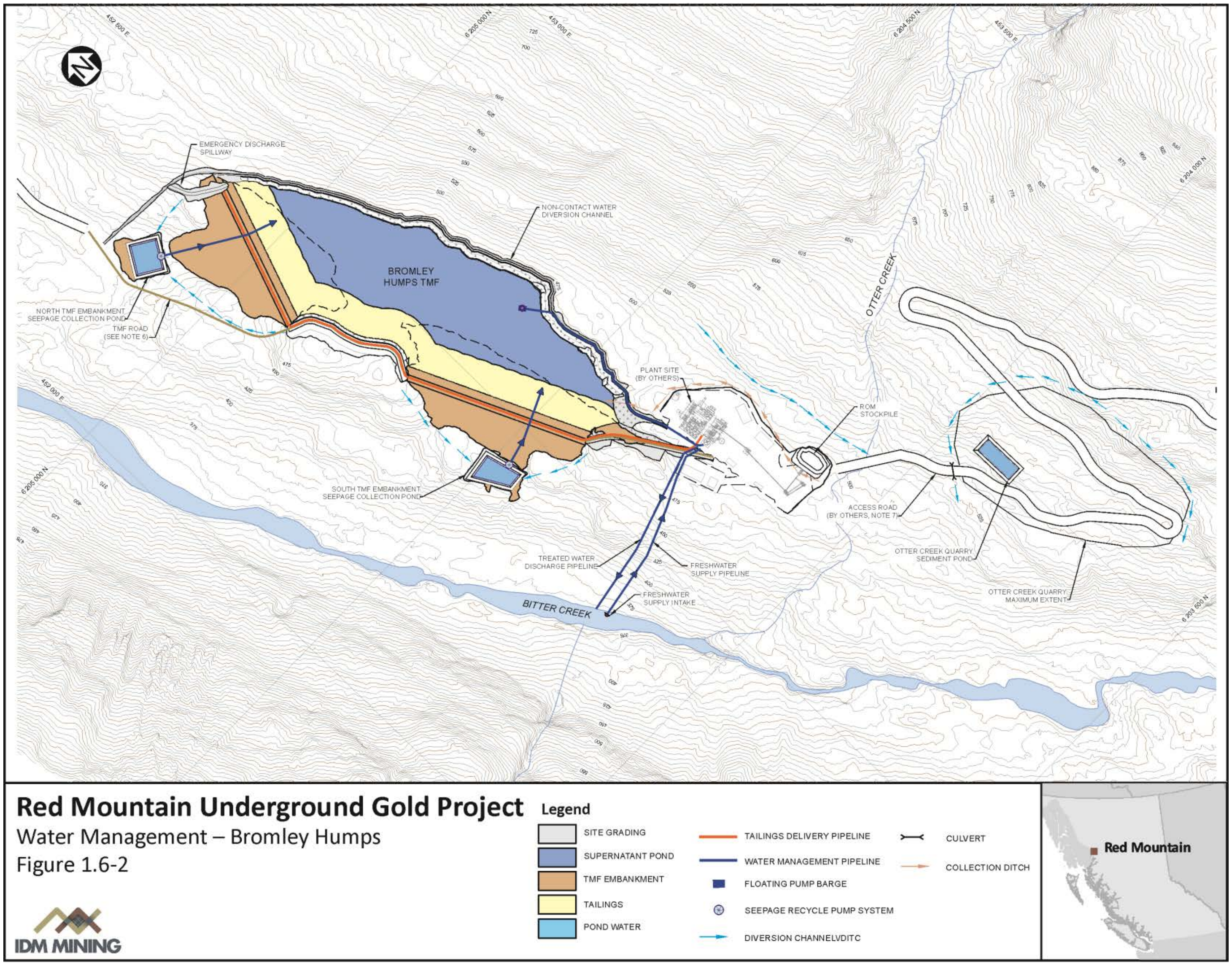
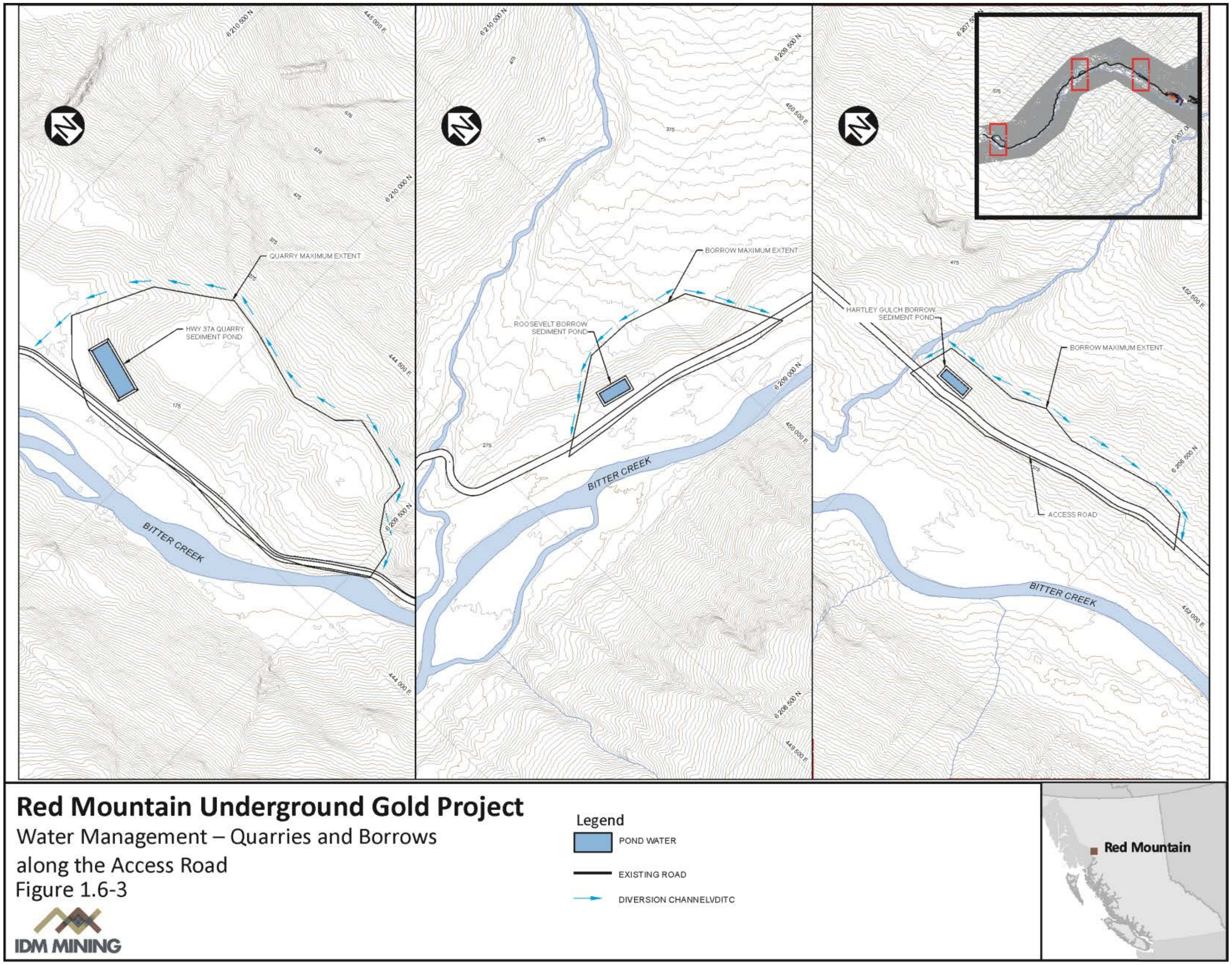


Figure 1.6-3: Water Management – Quarries and Borrows along the Access Road



Tailings Management Facility

The TMF area incorporates diversion ditches and Seepage Collection Ponds to control water that may potentially transport sediment downstream. All contact water ditches and collection ponds on site will be designed and sized to manage the 1-in-200-year 24-hr precipitation event (160 mm of rainfall). Non-contact water from the upstream catchment on the eastern side of the TMF will be diverted in a Non-Contact Water Diversion Channel. This channel will be designed and sized to manage the peak flow from the 1-in-5-year 24-hr precipitation event. A Process Water Tank located at the Process Plant will store reclaim water from the TMF for mill processing.

Seepage Collection Ponds will be constructed concurrent with the construction of the TMF embankment, and will form an integral part of water management during both Construction and Operation Phases, in and around the TMF.

Flood events will be managed through a combination of embankment freeboard (to contain an EDF event) and an Emergency Discharge Spillway designed to pass the Probable Maximum Flood (PMF) events, as discussed further in Section 1.6.4.14.

A water balance developed for the TMF has indicated that the TMF will operate in a net positive surplus throughout operations. Surplus supernatant pond water will be pumped to a Water Treatment Plant, located at the Process Plant, and discharged to the environment. Effluent will be monitored prior to discharge in accordance with the Site Water Management Plan (Volume 5, Chapter 29).

1.6.4.2 Water Use during Construction

1.6.4.2.1 Water Demand for Construction

For the Construction Phase, water consumption has been estimated based on industrial requirements (to support construction, industrial, or milling water uses). Dust suppression and construction use will be 50 m^3/day; and domestic freshwater needs (i.e., showers, sinks, toilets) will be in the range of 50 m^3/day.

During Construction, it is anticipated that the source of start-up water will be Bromley Humps catchment water. Water requirements for dust suppression and construction use will be sourced from water management ponds, Bitter Creek, Otter Creek, and Goldslide Creek. Domestic freshwater will be sourced from Otter Creek and Goldslide Creek.

Potable water for site personnel will initially be trucked to the site and stored in tanks located around the site, including the Administration Office, Maintenance Shops, Process Plant, and in several underground locations. Once the Water Treatment Plant has been constructed, however, potable water will be obtained from Bitter Creek. Further information on this, and on water consumption for the Operation Phase in general, is provided in Section 1.7.12.1

1.6.4.2.2 Drilling Activities

IDM will retain its existing permits, as discussed in Section 1.1.7, for ongoing exploration activities.

1.6.4.2.3 Water Uses in Maintenance Shops and Vehicle Washing

Water will be used in the heavy equipment and truck washing facilities. An oily water treatment system will be installed in the Maintenance Shops and to the greatest extent possible, treated oily wastewater will be recycled for reuse. During normal operations, make-up water will be required. However, upset conditions may occur which will require occasional discharge of excess water. The excess water will be released to the receiving environment, provided it meets the discharge water quality criteria as per effluent discharge permit requirements

Table 1.6-8: Water Use during Construction – Bromley Humps and Mine Site

Water Use	Volume (m^3/day)	Source
Dust suppression and construction use	50 m^3/day	Water management ponds, Bitter Creek, Otter Creek, Goldslide Creek
Domestic freshwater – (showers, sinks, toilets)	50 m^3/day	Otter Creek and Goldslide Creek

1.6.4.3 Haul Road

There is 12.5 km of Haul Road to be newly constructed from Bromley Humps to the Upper Portal and the Mine Site. The Haul Road follows the valley for a short distance before making numerous switch backs over steep terrain towards the portals.

Geohazard areas along with mitigation strategies to overcome these challenges, in the form of road upgrade prescriptions, construction management strategies, and cut-and-fill angles, have been identified in Appendix 9-C. Appendix 1-I (Feasibility Study Design Drawings) provides alignment details and plan and profile drawings for the Access Road and Haul Road.

1.6.4.3.1 Design Criteria

The proposed Haul Road is designed as a private, gated, single-lane road with pullouts supporting two-way, radio-controlled traffic travelling 30 km/hr. The road was designed for a Western Star 4900SB tandem truck paired with an SX3-Tri axle side dump trailer. The Haul Road will have a berm ¾ the height of the largest size haul truck tire to be used. The Haul Road is designed with a 25 m right-of-way in sections of the alignment where the Powerline will run parallel to the road and will be reduced to 20 m where the Powerline deviates from the road alignment. Site specific conditions may necessitate a wider right-of-way where cut-and-fill slopes extend beyond the typical right-of-way. In these locations, the right-of-way will increase 3 m beyond the typical toe of the fill or crest of the cut.

The specifications to meet the design speeds are summarized in Table 1.6-9 and were obtained from the 2012 Standard Specifications for Highway Construction (BC Ministry of Transportation and Infrastructure 2011), BC Supplement to TAC Geometric Design Guide (MOTI 2007), Steep Grade Descent Calculator (Parker 2016), FLNRO Engineering Manual (FLNRO 2016), Forest Road Engineering Guidebook (MOF 2002), and Guidelines for Mine Haul Road Design (Tannant & Regensburg 2001).

Table 1.6-9: Design Specifications

Components	Design Specification
Maximum Road Grade	18-23%[7]
Tightest Vertical Curve	1% grade change over 4 m (3 m for crest curves)
Minimum Curve Length	30 m
Minimum Stopping Sight Distance	65 m
Minimum Horizontal Curve Radius	35 m (16 m for switchbacks)
Minimum Cross-Drain Culvert Diameter	600 mm
Ditch Size	0.6 m deep with a 0.6 m wide base
Road Width	5 m
Pullout Size	Additional 4 m width, 30 m long with a 7.5 m long taper at each end
Shoulder Barrier (Haul Road Only)	0.9 m tall, with a top width of 0.5 m and fill slopes of 100%

Steep Grade Considerations

There are sections of the Haul Road between the Process Plant and the Lower Portal identified as requiring significant grades for short sections. These grades could be up to 23%. In these sections, terrain stability and other geohazards will be managed based on the prescriptions, construction management strategies, and cut-and-fill angles that have been identified in Appendix 9-C. In addition, trucks must:

- Not exceed speeds of 15 km/hr when descending grades between 5% and 17%;
- Not exceed speeds of 10 km/hr on grades of 18% and 23%;
- Limit payload to 36 tonnes;
- Make a mandatory stop at a designated location to cool brakes; and
- Ensure the road surface provides adequate traction in adverse weather.

[7] 18% from mill site to lower portal, 23% from lower portal to upper portal

In all sections with switchbacks, trucks must only travel at a maximum speed of 10 km/hr.

Cut and Fill Slope Angles

Refer to Section 1.6.3.2.1 for details regarding cut-and-fill slope angles.

1.6.4.3.2 Construction Types

Refer to Section 1.6.3.2.3 for details regarding construction types to be used in Haul Road construction.

1.6.4.3.3 Watercourse Crossings

Bridges and Culverts

Two types of stream crossings are being considered for the Haul Road:

- Culverts (non-fish-bearing); and
- Modified ford crossings.

All proposed structures are designed to:

- Meet a BCFS L-100 load rating;
- Suit a Western Star 4900SB tandem truck paired with a SX3-Tri axle side dump trailer; and
- Safely accommodate creek flows estimated for a 100-year flood event.

Refer to Section 1.6.3.4 for further details regarding water course crossing design considerations.

Typical Non-Fish Stream Culvert

For culvert crossing design criteria and details, refer to Section 1.6.3.4.1. In addition to the details noted in the access road description, the culvert crossings also require a berm as noted in Table 1.6-10.

Modified Ford Crossings

For modified ford crossing design criteria and details, refer to Section 1.6.3.4.3. In addition to the details noted in the access road description, the ford crossings also require a 0.9 m high H-pile post and W-beam guard rail on the downstream side of the structure in place of the pre-cast concrete guide barriers.

1.6.4.3.4 Public Access to Roads

IDM will develop an Access Management Plan to ensure that all roads within the Project area will be restricted to authorized users due to safety considerations. IDM will develop the

Access Management Plan in consultation with Aboriginal Groups and stakeholders to ensure that appropriate access is maintained whenever possible.

Visitors to the site will be asked to register their presence at the administration building. IDM's community communication will emphasize this requirement.

1.6.4.3.5 Sediment and Erosion Control

Refer to Section 1.6.3.5, Access Road Erosion and Sediment Control, for details that apply to the Haul Road erosion and sediment control plan.

1.6.4.4 Laydown Area and Material Storage

Laydown and material storage areas will be developed during the Construction Phase. Laydown areas, as shown on Figure 1.1-4 and Figure 1.1-5, will be required to store equipment, materials, and supplies for the construction of the site facilities. Laydown areas will be incorporated into the Process Plant and portal areas. Laydowns will be constructed from run of quarry rock sourced within the footprint of the Process Plant and portal areas. As per the road construction, a layer of graded surfacing material will be placed to provide a protective trafficking layer. The surface will be sloped to prevent pooling of water and runoff will be directed to contact water management ponds.

1.6.4.5 Overburden and Soil Stockpiles

Overburden and topsoil will be stockpiled along the Access Road, near Bromley Humps (refer to Topsoil Stockpile shown on Figure 1.1-3). Overburden and topsoil removal will occur during the preparation of mining and construction activities. The estimated stockpile volume is 45,000 m^3; all material will be placed in the stockpile location in Year -1. Refer to Table 1.6-10 for Topsoil Stockpile design criteria. The site overburden material and excavated material will either be handled as run-of-mine waste and stored accordingly, or segregated and used where possible in reclamation activities. Only geochemically suitable materials will be used for reclamation.

Table 1.6-10: Topsoil Stockpile Design Criteria

Waste Rock Storage Area Parameter	Value
Storage Volume	46,822 m^3
Tonnage	93,644 t
Top Elevation	408.5 m
Bottom Elevation	386 m
Average Foundation Angle	15 - 25°
Design Slope	1V:2H
Foundation Surface Area	14,300 m^2

Contact water will be managed through a system of diversion ditches and a sediment pond to ensure permitted discharge criteria is achieved prior to discharge to the receiving environment.

Refer to Landforms and Natural Landscapes Effects Assessment (Volume 3, Chapter 9) for a description of soil properties associated with the Topsoil Stockpile location.

1.6.4.6 Quarries / Borrow Pits

The locations of potential Project Quarries and Borrow Pits are shown on Figure 1.1-3. An estimated 1.15 million m^3 of quarry/borrow material, as well as material obtained from excavation associated with construction of the Process Plant foundation will be required primarily for road and TMF construction through the Construction and Operation Phases, as summarized for material source location in Table 1.6-11. An additional 530,000 m^3 of material will be sourced from the two talus quarries near the Mine Site, for use as backfill.

Table 1.6-11: Aggregate Quantities for Construction of the TMF, associated Water Management Infrastructure, and Roads, by Phase

Aggregate Source	Destination / Use	Quantity (m^3)		
		Construction	Operation	Closure and Reclamation
Process Plant Foundation Excavation	TMF Embankment Fill	160,000		
Hartley Gulch Borrow	TMF Filter/Drain Zones	60,000		40,000
Hartley Gulch Borrow	TMF water Management	3,000		285,000
Otter Creek Quarry	TMF Embankment Fill		850,000	
Hwy 37A Rock Quarry	Road	50,000		
Roosevelt Creek Borrow	Road	25,000		
	Total	298,000	850,000	325,000

Specific local borrow sites adjacent to the Access Road and Haul Road will provide the bulk of crushed rock and aggregate to build roads, laydown areas, provide concrete aggregate, and support other construction and maintenance activities. Where feasible, NPAG waste rock will be used for construction material.

Borrow sites have been identified for subgrade material, surfacing material, and riprap. Subgrade borrow sources are to be used to address a mass haul deficit for subgrade construction. Identified sources for subgrade borrow materials are suitable for subgrade construction and will not require any modification (sorting/crushing) beyond stripping of organics before developing the site.

Deficits are expected in areas where volume generated by conventional cut-and-fill construction is limited due to horizontal or vertical alignment constraints or cut-and-fill construction is undesirable and overlanding (fill only embankment) is required.

Multiple borrow sites were identified and sampled in the field. Refer to Sections 1.2.3.2.2 and 1.2.3.2.4 for details regarding ML/ARD studies undertaken for identified borrow sources. Minor borrow sites for access road construction will be opportunistically sourced along the alignment and will fall within the road right-of-way. There is a large quarry at approximately 1.5 km that will be utilized for road armouring, river fills, and final road surfacing. The granular borrow sites at Roosevelt and Hartley creeks are for TMF construction.

Prior to construction, borrow sites and large cuts will be geochemically assessed for ML/ARD potential. If concerns are encountered, management strategies as outlined in the Materials Handling and ML/ARD Management Plan (Volume 5, Chapter 29) will be implemented.

The identified borrow sites are classified as Quarries or Borrow Pits. Quarries are primarily composed of bedrock and will be established by working into the back wall of the borrow site (the excavation will start at the road edge and work into the slope as material is required, ensuring minimal disturbed area). Quarry construction will require the site to be cleared and stripped of organic and surficial materials (stripped organics are to be stored for later use in reclamation). Once the bedrock is exposed it will be blasted or ripped, then sorted (only if required), loaded, and hauled to the necessary location.

Borrow Pits primarily target organic-free, surficial materials that are to be excavated with an excavator, loader, or bulldozer. Like quarries, they will be stripped of the organic soil layer (stripped topsoil and organics are to be stored for later use in reclamation) before use and are to be established by working into the cut slope. Once the site has been stripped, the targeted material will be excavated and hauled to the required location.

Once use of the Borrow Pit has concluded, the cut slopes will be reduced to match the cut slope specifications applicable to the ground type at the site to provide long-term stability of the site

Contact water from all borrow sites will be directed to sediment ponds and further managed as necessary prior to discharge to ensure permitted requirements for meeting discharge water quality criteria are achieved.

1.6.4.7 Fuel Supply and Storage

1.6.4.7.1 Fuel Storage

Fuel storage is designed with capacity for 140,000 L of diesel. This will be delivered as needed from the town of Stewart and stored in an Enviro-Tank. Surface mobile equipment will fuel-up at the storage tank and fixed equipment would be supplied by the fuel and lube truck. The fuelling station will be equipped within a lined and bermed area to contain minor spills or leaks during refuelling. The liner (e.g., 40 mil High Density Polyethylene (HDPE) liner or equivalent) will be protected by aggregate bedding. Vehicles and mobile equipment will drive onto this bedding for refuelling. Fuel transfer is done by pumps.

The refuelling area will be provided with standard instrumentation and controls to monitor and safely manage the inventory in the tanks. Fuel storage areas and vehicles will be equipped with spill kits for emergency response. Each spill kit contains the appropriate type, size and quantity of equipment for the volume/type of product present in the storage.

1.6.4.7.2 Fuel Delivery and Consumption

Fuel supply during construction of the Project will be trucked from Stewart via the Access Road.

Storage size and fuel quantities, along with construction timing of the fuel storage and expected fuel consumption (peak), are presented in Table 1.6-12.

Table 1.6-12: Size of Fuel Storage and Expected Fuel Consumption

Site	Ultimate Storage Capacity	Construction Year -2 to Year -1	Operation Year 1 to Year 6	Peak Consumption
Bromley Humps	100,000 L enviro-tank	100,000 L enviro-tank	100,000 L enviro-tank	620,000 L / yr
Mine Site	Two 20,000 L enviro-tanks	Two 20,000 L enviro-tank	Two 20,000 L Enviro-tank	1,400,000 L / yr

Diesel will be used by motor vehicles and mining equipment on the site. Limited quantities of propane and gasoline will be used in maintenance facilities for smaller motorized equipment and machinery.

Project specific management strategies are outlined in the Fuel Management Plan (Volume 5, Chapter 29).

1.6.4.8 Explosives Use and Storage during Construction

Explosives will be used during construction of major infrastructure such as the Access Road and Haul Road.

Ammonium Nitrate Fuel Oil (ANFO) will be used during construction at quantities of 1,000 kg/day to up to 10,000 kg/day or more. Blasting is anticipated to occur on a daily basis, at 3,000 to 5,000 m^3/day average with larger quarry blasts occurring on a less frequent basis. Temporary explosives magazines will be stored at Bromley Humps as well as at various locations along the road during construction.

Explosive products will be stored on site in accordance with Natural Resources Canada regulations.

1.6.4.8.1 Explosive Handling and Transportation to Work Sites

The handling of explosives will be contracted out to a licenced operator. This operator will be responsible for obtaining licences and permits associated with the use, manufacture, and storage of explosives.

IDM and the Explosives Operator will adopt best management practices for blasting and the handling of explosives to avoid spillage and minimize explosives residue remaining after blasting, thereby lowering the potential for contamination.

Site-specific monitoring and management strategies are detailed in the Explosives Management Plan in Volume 5, Chapter 29.

1.6.4.9 Chemical and Hazardous Materials Other than Fuel and Explosives

A Hazardous Materials Management Plan (Volume 5, Chapter 29) will be developed to identify and monitor potentially hazardous materials.

A variety of supplies and materials classified as potentially hazardous will be required for the Project. A dedicated storage area (Hazardous Materials Storage) will be constructed for the temporary storage of hazardous materials. The hazardous materials to be handled may include:

- Petroleum products (gasoline, lubricants, hydraulic fluids, oil and solvents); and
- Process Plant reagents.

Refer to the Hazardous Materials Management Plan for a comprehensive list of hazardous materials anticipated to be used and stored on site.

Transportation, storage, use, and disposal will be considered for each stage of the Project life cycle and will be undertaken in accordance with the *Transportation of Dangerous Goods Act* (1992) and associated Regulation. Safety to the workers and the surrounding communities will determine each stage of materials handling.

1.6.4.10 Waste Management

The waste management infrastructure for the Project will be established at the onset of construction activities. The waste management infrastructure at Bromley Humps will consist of:

- A Waste Storage Area; and
- A Hazardous Materials Storage area.

1.6.4.10.1 Wastewater and Sewage

Sewage and grey water from the facilities will be removed by contractor for offsite disposal. No sewage or septic works are therefore required on site.

Water will be used in the heavy equipment and truck washing facilities. An oily water treatment system will be installed in the Maintenance Shops to the extent possible, and treated oily water will be recycled for reuse. The excess water will be released to the environment depending on water quality and operational needs, or pumped to the TMF as available.

1.6.4.10.2 Non-hazardous Solid Waste Management

Solid waste materials will be sorted at the source with material reused or recycled, when possible. A dedicated Waste Storage Area will be constructed to store the different types of solid wastes. Wastes will be transported offsite directly to an approved disposal area once sorted. This may include solid waste, contaminated soils or snow, and organic waste.

An inventory of the estimated types and quantities of waste that will be generated is presented in the Waste Management Plan (Volume 5). All construction waste will be backhauled from site to an approved disposal facility.

1.6.4.10.3 Hazardous Waste Management

Details regarding management of hazardous waste are provided in the Hazardous Materials Management Plan (Volume 5, Chapter 29).

A dedicated storage area (Hazardous Materials Storage) will be constructed for the temporary storage of hazardous materials and hazardous wastes. Typical hazardous wastes consist of:

- Waste batteries, oil, and solvents; and
- Empty petroleum and reagent drums, carboys, and pails.

Hazardous wastes will be stored at the Bromley Humps location and will be transported offsite to an approved disposal facility. All hazardous waste will be handled, stored and transported in accordance with the *Transportation of Dangerous Goods Act* and associated Regulation.

1.6.4.11 Communication Systems

To meet occupational health and safety requirements, environmental protection, and operational and logistics efficiency, communications will be needed between:

- Project - outside Project area (for example Project to Vancouver);
- Property – between sites (between Mine Site and Bromley Humps);
- Property – worksite (for example between administration building and drill location); and
- Property – access routes.

The primary basis for communication across the Project between the sites will be the phone system. Back-up communication will be available via satellite using hand-held satellite phones.

For on-site communication, hand-held VHF radios will be mandatory and communication will utilize a common frequency with separate discrete frequencies for specific work areas or groups. For example, these frequencies cover areas such as administration group channel and drilling group channel. Satellite phones and SPOT devices will also be used primarily by field personnel if the work area is outside the VHF radio range. Backup power sources and replacement batteries for all communications equipment will be available to provide continuous, uninterrupted operation either at fixed facilities or at temporary sites.

The Project will also have a site based computer network that is linked through a satellite dish and provides network communications to other network/email links within the company and externally. Wi-Fi communication access would be available around the infrastructure.

Communication between air to ground would be through dedicated radio units. Communication along the access road will be accommodated using the VHF radios and/or satellite phone network established as part of the on-site communication system.

1.6.4.12 Power Supply

The power supply will be installed during the Construction Phase of the Project and will remain in place for the life of the Project.

IDM envisions connecting the Project infrastructure to the BC Hydro electrical transmission system near Stewart, BC. Total average annual power consumption is estimated to be approximately 59 million kWh/a (6.8 MW on average), with a maximum capacity of 9.5 MW. It is planned that a 138 kV transmission line would run from the BC Hydro interconnection point, across Highway 37A, and then adjacent to the Access Road from Highway 37A to Bromley Humps. The Powerline will run mostly adjacent to the Access Road (Figure 1.1-3). A 25 kV line will run from Bromley Humps to the Mine Site, mainly within the Haul Road right-of-way. Step down transformers will be located at the Process Plant and Mine Site for local distribution. Both the 138 kV and 25 kV sections of the Powerline will be constructed using wooden power poles (combination of single, H-frame, and three pole dead-end configurations, depending on terrain and/or geohazards at any particular point along the Powerline route). The Powerline will span all watercourses that need to be crossed (i.e., no infrastructure located in stream or in riparian areas).

In the colder months, the underground mine will require heating of the intake air. The mine air heating system consists of two direct-fired propane heaters each with a rated capacity of 130 KCFM. The mine air heaters will be located outside of the mine portals.

1.6.4.13 Process Plant

The Process Plant will be constructed on a pad adjacent to the TMF. The Process Plant building will be a pre-engineered steel building with an approximate footprint of 54 m x 59 m. It will be supported on a concrete spread footing with concrete grade walls along its perimeter. The building floor will be a concrete slab-on-grade and will be sloped towards sumps for clean-up operation. Heavy equipment with dynamic loads housed in the mill building will be supported on a concrete foundation isolated from other building components. The following facilities will be located within the Process Plant building:

- Two-stage grinding;
- Carbon leaching;
- Reagents;
- Cyanide Destruction;
- Carbon Processing; and
- Refining.

A crushing plant will be located adjacent to the Process Plant building and will consist of three stages of crushing and screening. The crushing plant will be covered with a pre-engineered fabric structure on a concrete block foundation.

1.6.4.14 Construction of Tailings Management Facility

The objective of the TMF is to provide secure long-term storage of tailings and water. The TMF storage capacity is designed to store approximately 1.5 million cubic metres (Mm^3), assuming an initial dry density of 1.2 tonnes per cubic metre (t/m^3), and a final average density of 1.3 t/m^3.

A starter dam will be constructed and will provide approximately 12 months of tailings storage with an embankment raise during the first year of operations. The TMF embankments will be progressively raised during operations. The TMF (basin and upstream faces of the embankments) will be lined with a geomembrane to minimize the potential for seepage from the facility.

A system of collection ditches, ponds, and pumps/pipelines will collect runoff and seepage from the TMF. A foundation drain will be installed below the geomembrane liner and a basin underdrain will be installed above the geomembrane liner to promote consolidation of the tailings mass. Water collected from these systems will be recycled to the TMF and reclaimed to the mill.

The TMF has been designed to store runoff from an Environmental Design Flood (EDF) as per Canadian Dam Association Dam Safety Guidelines (CDA, 2013 & 2014). The EDF for the Bromley Humps TMF is equivalent to the runoff from a 1 in 50 year return period event with an event duration of one month. Flood volumes exceeding the EDF will be safely conveyed from the TMF through the use of an Emergency Discharge Spillway. The spillway will be designed for the PMF.

TMF location and footprint are shown on Figure 1.1-5. Geological (surficial and structural geology), geochemical, geotechnical, and hydrogeological characteristics of Bromley Humps (TMF location) are described in Sections 1.2.2, 1.2.3, 1.2.4.1, and 1.2.4.2, respectively, and in Appendices 1-A, 1-H, and 10-B.

Terrain stability and geohazard mapping for the entire Project footprint, including the TMF, is provided in Appendix 9-A. In addition, Appendix 9-C provides a section by section description of terrain characteristics, geohazard risk, as well as prescriptions and management strategies for addressing these risks for the Project footprint.

1.6.4.14.1 Site and Technology Selection

A tailings management alternatives assessment was completed for siting the TMF and for selection of the Best Available Technology (BAT). The tailings alternatives assessment is summarized in Chapter 4, Alternative Means of Undertaking the Project, and is based on information provided in Appendix 1-J, Tailings Best Available Technology (incl. Alternative Assessment).

The tailings BAT Assessment concluded that the use of thickened slurry tailings is preferred over other technology options, including conventional slurry tailings, ultra-thickened (paste) tailings, ultra-thickened cemented tailings, and filtered tailings, based on the following:

- The tailings deposition and water management strategy is simple relative to the other candidates.
- The process water is contained within the same facility and used for mill reclaim.
- No additional mill processes are required.
- There is a lower risk of operational problems (complications due to climactic conditions, etc.).
- There is a greater ability to maintain a degree of saturation within the tailings mass to reduce exposure of the tailings to oxidation and to limit ML/ARD generation potential.

Based on the TMF location alternatives analysis completed and described in Appendix 1-J, Bromley Humps was identified as the preferred site, as shown on Figure 1.1-5. This is the location that was carried forward during the PEA and optimized during this feasibility level assessment. This option is advantageous as a result of the following criteria:

- Geohazard risk, as well as favourable terrain and climatic conditions (snow accumulation, wind, etc.) and winter operations are expected to be safer and more reliable at a lower elevation than the previous PEA option (located at the Alpine area, near the Upper Portal).
- The location is clear from the Otter Creek avalanche path.
- There is potential for downstream expansion into additional cell.
- The location is advantageous from a construction and project execution standpoint.
- This location has lower capital, sustaining, and operating costs than other options.

1.6.4.14.2 General Description of the Tailing Facility Layout

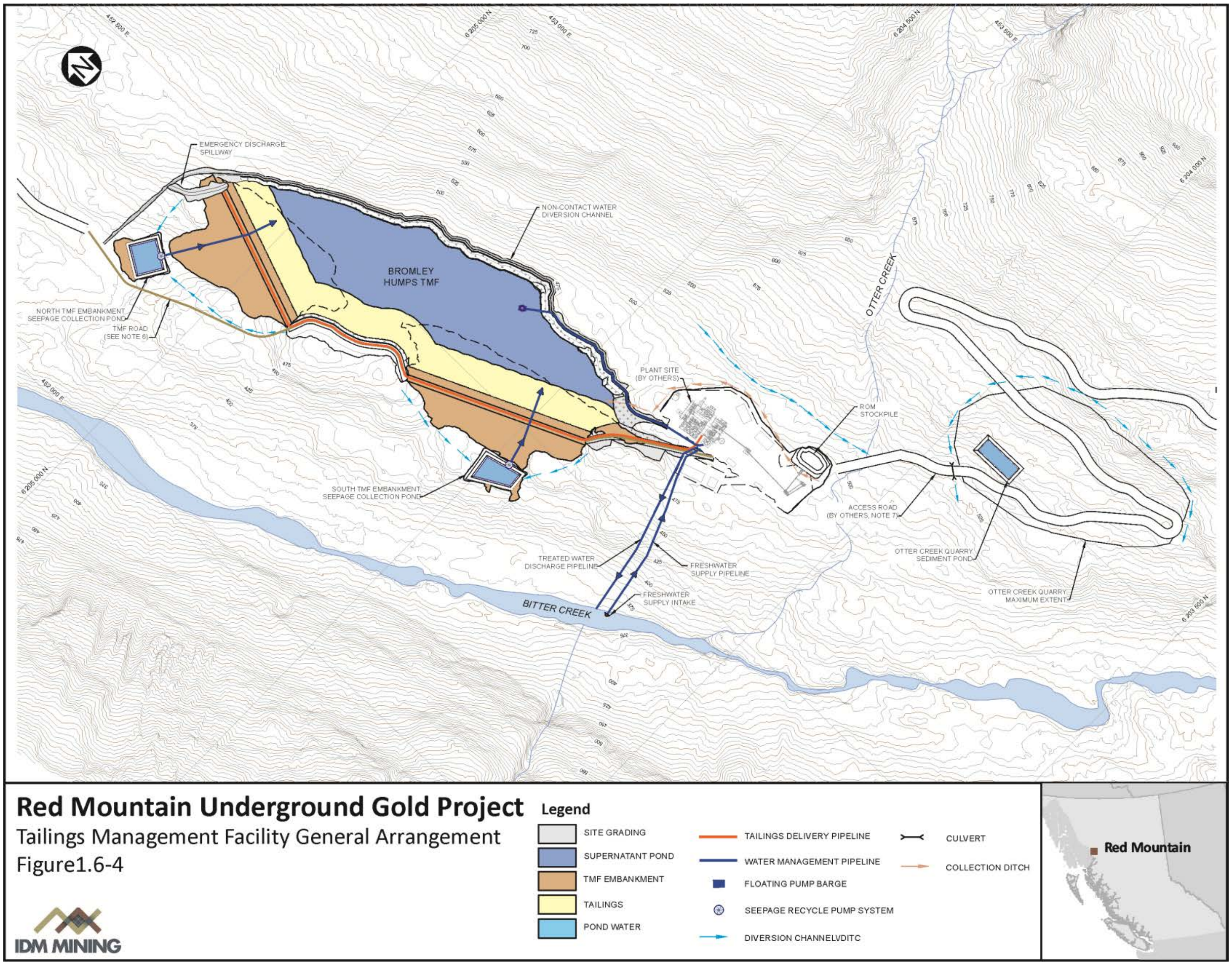
The TMF is situated at Bromley Humps, as shown on Figure 1.1-5. The TMF utilizes natural topographical containment provided by Bromley Humps and the slope to the east of the facility to minimize embankment construction requirements. The TMF has two rock/earthfill embankments: the North TMF Embankment and the South TMF Embankment.

- The north TMF embankment is a 275 m long embankment at its centreline, with a maximum height of 37 m, and is oriented in a southwest to northeast direction.
- The south TMF embankment is a 310 m long embankment at its centreline, with a maximum height of 26 m, and is oriented in a southeast to northwest direction.

The general arrangement of the TMF is presented in Figure 1.6-4, as well as in the Tailings Management Plan (Volume 5, Chapter 29); the Tailings Management Plan also presents the TMF embankment plan and section drawings.

The entire TMF basin will be lined with an HDPE geomembrane liner to control and significantly limit seepage from the facility.

Figure 1.6-4: Tailings Management Facility General Arrangement



1.6.4.14.3 Summary of Geotechnical Investigations

Information regarding geotechnical data collection in the TMF location is provided in Appendix 1-A.

1.6.4.14.4 Design Basis and Operating Criteria

Objectives

The principal objectives for the design of the TMF are to ensure protection of the regional groundwater and surface waters, both during Operation and in the long-term (Post-Closure), and to achieve effective reclamation at mine closure. The design of the TMF has considered the following requirements:

- Permanent, secure, and total confinement of all solid waste materials within an engineered disposal facility;
- Control, collection, and removal of free draining liquids from the tailings during the Operation Phase for recycling as process water to the maximum practical extent; and
- The inclusion of monitoring features for all aspects of the facility to ensure performance goals are achieved and design criteria and assumptions are met.

Summary of Design Basis and Operating Criteria

The following factors have been considered in the design of the TMF:

- Physical and chemical characteristics of the tailings material, including ML/ARD potential, as well as the potential for liquefaction;
- Hydrology and hydrogeology, including local climatic conditions and extreme weather events (including projections of increased extreme weather events because of global climate change);
- Foundation geology and geotechnical considerations, as well as seismic data and earthquake risk;
- Availability and characteristics of construction materials; and
- Topography of the TMF footprint and adjacent areas.

A discussion of the design and construction of water management facilities associated with the TMF can be found in Appendix 1-H: Tailings and Water Management Design Report, and is summarized above.

The TMF containment structure will be designed and constructed per stringent engineering standards (listed in Section 1.6.4.14.4). The long-term monitoring and inspection of containment structures for the TMF will be considered during the design and Construction

Phase. Appropriate instrumentation will be installed during construction to facilitate monitoring during the mine Operation and Closure and Reclamation Phases.

The TMF has been designed to provide secure and permanent storage of tailings solids and to optimize the management of water for reuse in the process. The design basis is summarized in Table 1.6-13.

Table 1.6-13: Design Basis for the Tailings Management Facility

Item	Design Criteria
Mine Production	• Total material milled = approximately 1.95 million tonnes (Mt) • Throughput = 1,000 tonnes per day (tpd) • 6 years
Tailings Property	• % solids = 50 % by weight • Average in-situ dry density of 1.2 t/m^3 in Year 1, consolidating to 1.3 t/m^3 by Year 6
Tailings Management Facility	• Geomembrane lined earth / rockfill embankment constructed using the downstream method of construction using borrow materials from a local borrow. • Starter dam sized to provide approximately 12 months of tailings storage. • Embankment constructed for approx. 6 years of tailings production plus Environmental Design Flood (EDF), freeboard, and process water • Embankments constructed at 2.5H:1V on the upstream embankment slope, and 2H:1V on the downstream embankment slope • Embankments constructed using downstream method of construction • Flood events exceeding the EDF will be safely conveyed from the facility through an emergency discharge spillway located in the TMF embankments • Basin and embankments covered with a geosynthetic system consisting of 100 mil HDPE geomembrane liner, between layers of 16 oz. non-woven geotextile. • Minimum 150 mm of liner bedding material (sand) beneath geosynthetic system • EDF of 1/ 50 yr return period precipitation with a duration of 1 month; approximately 615 mm • Minimum static factors of safety: − 1.5 – During Construction, Operation, and Closure and Reclamation Phases − 1.0 - Seismic (Pseudo-static loading conditions) − 1.2 – Seismic (Post-earthquake; full liquefaction of tailings)

1.6.4.14.5 Dam Hazard Classification

The following discussion in relation to TMF dam hazard classification is summarized from Appendix 1-D, Bromley Humps TMF Seepage and Stability Analysis.

The design, construction, operation and monitoring of dams, including tailings embankments, must be completed in accordance with appropriate provincial and federal regulations and industry best practices. The primary guidance documents in this regard are the following:

- Dam Safety Guidelines (CDA 2013) published by the Canadian Dam Safety Association (CDA);
- Technical Bulletin on Application of Dam Safety Guidelines to Mining Dams (CDA 2014);
- Health, Safety and Reclamation Code of British Columbia (BC MEM 2008, 2016a); and
- Part 10 Guidance Document (BC MEM 2016b).

A key component of the guidelines is classifying the dam in question into hazard categories (Dam Class), which establishes appropriate geotechnical and hydro-technical design criteria.

During the dam classification process, each of four hazard rating components (i.e., population at risk, loss of life, environmental and cultural values, and infrastructure and economics) is considered individually, and the overall dam hazard rating is defined by the component with the highest (i.e., most severe) rating. It is important to note that the hazard rating refers to the downstream consequences in the inundation zone of a dam breach.

Based on the analysis undertaken and summarized in Appendix 1-H, the highest hazard rating is defined by the Environmental and Cultural values category, which means the designated dam hazard rating for the TMF containment dam is “Very High”. Loss and/or deterioration of fish habitat is a real risk, although the diluted supernatant will not likely have an acutely toxic effect on fish in the Bitter Creek watershed. Furthermore, restoration and compensation is possible for the system if a tailings spill would affect Bitter Creek. For these reasons, the most appropriate classification with respect to Environmental and Cultural Values is “Very High”.

It should be noted that the TMF Seepage and Stability Analysis (Appendix 1-D) refers to the Dam Classification as “High”. This is due to the fact that it was completed prior to the Tailings Dam Breach Assessment (Appendix 23-A) where the results of the modeling increased the Dam Classification to “Very High”. The “Very High” Dam Classification was carried forward and incorporated into the Tailings and Water Management Design Report (Appendix 1-H), as is summarized in Section 4.3 of the Tailings and Water Management Design Report.

1.6.4.14.6 Seismicity

Based on the dam hazard classification of ”Very High”, the Canadian Dam Safety Guidelines (CDA 2013) recommend the seismic stability analysis be completed assuming the Peak Ground Acceleration (PGA) for a 1:2,475 year event. This event was selected as the design earthquake event for the Construction and Operation Phases, and results in a PGA of 0.064 g.

For the Passive Care Phase (i.e., long-term closure), the Earthquake Design Ground Motion (EDGM) for the TMF is required to be 1/2 between the 1:2,475 year and 1:10,000 year return period events. This results in a PGA of 0.092 g (Appendix 1-D).

The Earthquake Design Ground Motion (EDGM) for the Passive Care Phase (i.e., long-term closure) has been adopted as the Maximum Design Earthquake (MDE) for the life of the TMF, while the EDGM for the Construction and Operations Phases will be used as the Operating Basis Earthquake (OBE).

A design earthquake magnitude of 7.5 has been estimated for the MDE.

1.6.4.14.7 Foundation Conditions

The foundation conditions at the TMF were assessed based on the geological and geotechnical information presented in Appendix 1-A. Foundation conditions at the TMF embankments encountered an average thickness of overburden of approximately 1 to 2 m, with prevalent bedrock outcrops. Overburden is predominantly characterized by a layer of colluvium (well graded sandy gravel) overlain by a thin veneer (approximately 10 cm thick) of topsoil and organic material. Some thicker deposits of colluvium are underlain by deposits of glacial till. Overburden beneath the TMF embankment footprints will be excavated and the embankments constructed on bedrock.

1.6.4.14.8 TMF Embankments

The main design features of the TMF embankments are as follows:

- Starter dam sized to provide approximately 12 months of tailings storage with a dam crest elevation at 454 m;
- Progressive embankment raises throughout operations using downstream expansion methods;
- Geomembrane Liner on upstream face of dam and TMF Basin;
- Filter, transition, and bedding zones (Zones F and T) using processed material from borrow/quarry sources; and
- Shell zone material (Zone C) sourced from local quarried/borrow material.

1.6.4.14.9 Seepage Collection

Potential seepage will be collected through the TMF lining system, foundation drains, and a basin underdrain. The liner system will be anchored into the foundation and embankment, with the foundation drains constructed beneath the geomembrane to allow for dewatering of groundwater seeps. The basin underdrain will be installed above the geomembrane liner system to enhance consolidation of the tailings.

1.6.4.14.10 Water Management

A discussion of the design and construction of water management facilities associated with the TMF can be found in Section 1.6.4.14.

1.6.4.14.11 Tailings Distribution and Reclaim Systems

Tailings Distribution Strategy

Tailings will be pumped from the mill in one overland pipeline and discharged from the TMF embankments via offtake spigots selectively placed along the embankment crests.

The tailings piping system design is based on the following parameters:

- Daily milling rate of 1,000 tpd;
- Solids content of 50 % by weight;
- Tailings flow rate average of 42 tph; and
- Slurry density of 1.2 t/m^3 in Year 1, consolidating to 1.3 t/m^3 by Year 6.

Water Reclaim System

The water reclaim system performance objectives are as follows:

- To allow the collection and removal of process water; and
- To allow the collection and removal of precipitation and runoff.

Process water will be reclaimed from the facility at an estimated rate of 45 m^3/hr using a floating pump/barge and a single overland pipeline to the mill. Standby pumps will be available for use in the event of extreme precipitation events and in the case of pump failure.

1.6.4.14.12 TMF Dam Construction

A starter dam will be constructed using local borrow materials. It will provide approximately 12 months of tailings storage with an embankment raise during the first year of operations. The TMF embankments will be progressively raised during operations following the downstream method of construction. A total of four raises are proposed. Local quarry and borrow materials will be used to construct the expansions. Material quantities for the construction of the TMF are summarized in Table 1.6-11.

The TMF (basin and upstream faces of the embankments) will be lined with a geomembrane to minimize the potential for seepage from the facility.

Refer to the Tailings and Water Management Feasibility Design Report (Appendix 1-H) for more details regarding TMF Dam Construction.

1.6.4.15 Ancillary Buildings and Structures

1.6.4.15.1 Workers Accommodation

During construction, a Stewart-based construction camp will accommodate the expected maximum of 293 personnel required during the Construction Phase of the Project.

1.6.4.15.2 Ancillary Buildings and Facilities

The following is a summary of ancillary buildings and facilities that will be constructed at the Mine Site and Bromley Humps:

Bromley Humps

- Hazardous Materials Storage;
- Waste Storage Area;
- 100,000 L Fuel Tank;
- Administration Office and Mine Dry;
- Assay Lab; and
- Warehouse.

Mine Site

- Maintenance Shops (Upper and Lower Portals);
- Offices (Upper and Lower Portals);
- Explosives Magazine (near WRSA); and
- 20,000 L Fuel Tank (Lower Portal).

Existing facilities near the Upper Portal include the following:

- Fuel tank;
- Helipad; and
- Generator enclosure.

Skid-mounted trailers are planned for the Administration Office / Mine Dry and Mine Site Offices.

The Maintenance Shops will be single-bay, insulated fabric covered structures suitable for preventative maintenance services, basic repairs, and component replacement. More extensive repair work will be conducted offsite. Equipment will be washed underground.

The Warehouse will be located within proximity to the Administration Office / Mine Dry. The Warehouse will be a single-bay, uninsulated fabric covered structure.

There will be no concrete batch plant on site. Instead concrete will be batched at a facility in Stewart or other suitable location and shipped to the site.

1.7 Operation Phase

1.7.1 Overview of Operation Phase Activities

The Operation Phase of the Project (Year 1 to 6) focuses on the economic recovery of gold and delivery to market. Other activities during the Operation Phase will include ongoing exploration supported by the Project Infrastructure and ongoing progressive reclamation. Key activities during operations are outlined below:

- Grading and brushing as required to maintain road and Powerline rights-of-way;
- Mineral processing;
- TMF operation and ongoing reclamation;
- Ongoing use and maintenance as required for water management facilities (water diversions and Water Treatment Plant); and
- Environmental monitoring.

Operations will continue for approximately 6 years with the possibility of an extension of the Operation Phase depending on exploration success and metal prices; IDM recognizes that such an extension may require additional regulatory and/or permitting requirements, including consultation with Aboriginal Groups, community members, and stakeholders. Mine Site closure and reclamation would occur in the year post-cessation of operations for approximately five years, followed by post-closure monitoring. The anticipated Operation, Closure and Reclamation, and Post-Closure schedule is shown in Figure 1.1-6.

Further information on closure and reclamation is provided in Volume 2, Chapter 5: Closure and Reclamation.

1.7.2 Resources and Reserves

Mineral resource estimates were provided by Arseneau Consulting Services (ACS) and reported in the January 2017 Technical Report. Mineralized material has been categorized as a combination of Measured, Indicated, and Inferred resources in accordance with the criteria set out in the Canadian NI 43-101. The Measured, Indicated, and Inferred resources are summarized in Table 1.7-1. IDM's mineral tenures are shown on Figure 1.1-2.

Table 1.7-1: Red Mountain Underground Gold Project Resource Estimate (January 2017)

Zone	Class	Tonnage	Au (g/t)	Ag (g/t)	Au Ounces	Ag Ounces
	Measured					
Marc		682,000	10.62	38.33	232,800	840,500
AV		519,400	7.73	20.03	129,100	334,500
JW		44,600	10.11	13.21	14,500	19,000
	Total	1,246,000	9.4	29.8	376,400	1,194,000
	Indicated					
Marc		32,200	9.69	32.61	10,100	33,800
AV		236,300	9.07	19.25	68,900	146,300
JW		314,200	8.54	17.98	86,300	181,600
141		188,600	4.91	11.1	29,700	67,300
Marc FW		18,100	6.15	12.05	3,600	7,000
Marc Outliers		4,200	3.43	16.77	500	2,300
NK		10,700	5.58	7.57	1,900	2,600
JW Lower		24,300	8.15	26.58	6,400	20,800
Total		828,700	7.78	17.33	207,300	461,700
M & I Total		2,074,700	24.82	8.75	583,700	1,655,700
	Inferred					
Marc		4,500	10.43	43.35	1,500	6,200
AV		43,300	8.13	15.39	11,300	21,400
JW		111,700	6.78	7.39	24,400	26,500
141		15,100	4.67	4.69	2,300	2,300
Marc FW		12,600	5.12	6.38	2,100	2,600
Marc Outliers		7,300	6.54	27.36	1,500	6,400
NK		7,300	5.98	9.05	1,400	2,100
JW Lower		2,000	13.94	9.26	900	600

Zone	Class	Tonnage	Au (g/t)	Ag (g/t)	Au Ounces	Ag Ounces
AV Lower		42,500	5.55	6.05	7,600	8,300
132		78,700	4.73	11.51	12,000	29,100
	Total	324,700	6.21	10.11	64,800	105,500

Note:
Mineral resources were estimated in conformity with generally accepted CIM "Estimation of Mineral Resource and Mineral Reserve Best Practices" Guidelines. Mineral Resources are not Mineral Reserves and do not have demonstrated economic viability. The mineral resources may be affected by subsequent assessment of mining, environmental, processing, permitting, taxation, socio-economic and other factors.

Mineral reserves can only be estimated based on the results of an economic evaluation as part of a preliminary feasibility study or feasibility study. As such, no mineral reserves have been estimated by ACS. There is no certainty that all or any part of the mineral resources will be converted into a mineral reserve.

Inferred mineral resources have a great amount of uncertainty as to their existence and as to whether they can be mined legally or economically. It cannot be assumed that all or any part of the inferred mineral resources will ever be upgraded to a higher category. Mineral resources that are not mineral reserves have no demonstrated economic viability.

1.7.3 Mining

The main mining method at Red Mountain is longhole stoping. Longhole drilling is planned at a sub-level spacing of 15 m to 30 m. Stopes will be mucked by remote controlled Load Haul Dump (LHD) machines. Mineralized material is transported by LHDs to level remucks or directly to the muckpass. Muck will be loaded from the level remuck or muckpass into haul trucks and transported to the surface stockpile. Waste material will be dumped by truck into completed stopes as backfill. Production in longhole stoping zones will be mined in a bottom-up sequence in a primary to secondary fashion: primary stopes will be mined first, backfilled with cemented rock fill, then secondary stopes will be mined and backfilled with un-cemented run-of-mine waste.

Drift and fill mining will be used where the dip of the mineralized zone is too shallow for longhole stoping. Drift-and-fill mining will be completed in a bottom-up fashion from a main access drift. Backfill will be placed in each completed cut and tightly compacted by LHD.

1.7.3.1 Mining Sequence

The Project has been sized for a 1,000 tpd operation. The basic criteria used for the development of the mine schedule are:

- Maximize Internal Rate of Return (IRR);

- Maintain plant throughput at a net yearly production of 365,000 tonnes per annum (tpa) mineralized material;
- Maximize the Process Plant head grade in the early years of operations; and
- Underground mine operates 365 days per year.

Table 1.7-2 shows the underground production schedule.

Table 1.7-2: Mine Production Schedule

	Unit	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Mineable Tonnage	tonnes	3,000	322,000	366,000	366,000	366,000	366,000	158,000	1,946,000
Gold Grade	g/t	14.31	9.17	8.23	7.09	7.64	6.92	4.56	7.52
Silver Grade	g/t	50.55	31.96	30.11	17.23	17.72	16.87	13.95	21.89
Gold Ounces	koz	1	95	97	83	90	81	23	471
Silver Ounces	koz	5	331	354	203	208	198	71	1,370
Lateral Development	m	1,136	4,753	4,951	5,275	4,757	5,281	2,507	28,660
Vertical Development	m	46	106	182	322			56	712
Cemented Rock Fill (CRF)	kt	0	193	193	183	167	149	76	960
Waste Fill	kt	0	55	80	91	103	121	40	491

1.7.3.1.1 Cut-off grades

Cut-off grades were calculated using the parameters presented in Table 1.7-3.

Table 1.7-3: Cut-off Grade Calculation

Parameter	Unit	Value
Gold Price	US$/oz	1,200
Exchange Rate	C$:US$	0.78
Process Plant Recovery	%	89.3
TC/RC/Transport	$/oz Au	6.00
Payable Metal from Refinery	%	99
Royalties	% ($/oz Au)	3.50 (53.10)

Parameter	Unit	Value	
Operating Costs		Longhole ($/t)	Drift & Fill ($/t)
Production		65.00	85.00
Process		46.00	46.00
G&A		17.00	17.00
Total		128.00	148.00
Calculated Cut-off (g/t Au)		3.50	4.05
Cut-off Utilized (g/t Au)		3.55	4.10

Table 1.7-4: Mineral Reserves

Zone	Tonnes	Au (g/t)	Ag (g/t)
Marc	743,209	8.59	31.35
AV	769,719	6.94	17.14
JW	335,546	7.26	14.40
141	82,861	4.77	10.84
JW Outliers	14,945	5.85	25.44
Total	1,946,000	7.52	21.89

Source: JDS (2017)

Table 1.7-5: Mineral Reserves by Probable and Proven Categories

Category	Tonnes	Diluted Au Grade (g/t)	Diluted Ag Grade (g/t)
Proven	1,303,000	7.82	25.14
Probable	643,000	6.92	15.33
Total	1,946,000	7.52	21.89

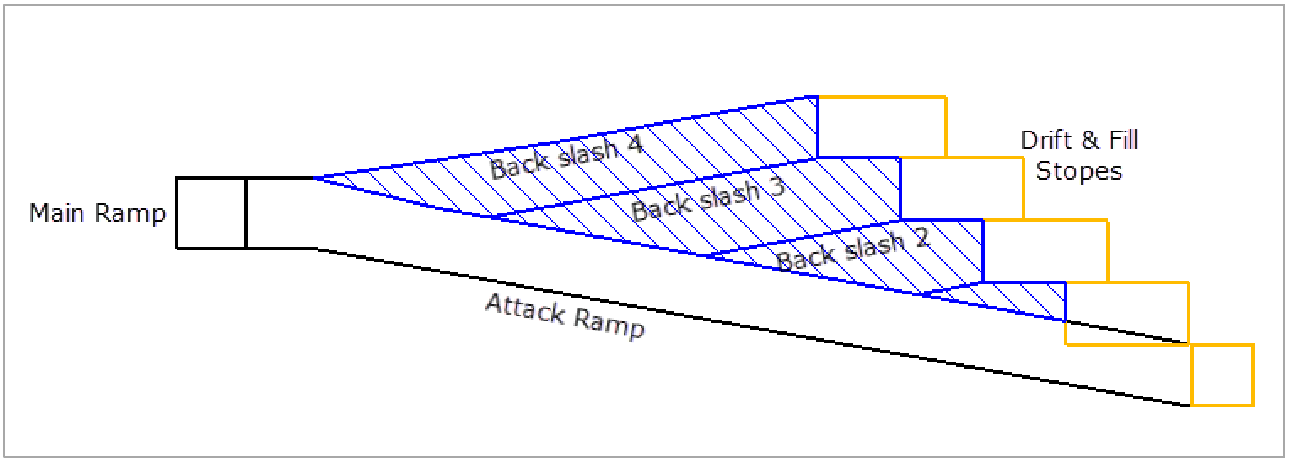
Source: JDS (2017)
Notes:
Estimates include Includes 2,924 tonnes of Inferred material at zero grade as dilution
Average external dilution grade of 3.4 g/t Au

Production in longhole stoping zones would be mined with a bottom-up sequence in a primary to primary fashion, whereby the stopes are only exposed to cemented rockfill on one side. This helps control geotechnical stresses. The final stope on the mining horizon is backfilled using un-cemented run-of-mine waste.

Drift and fill zones would be mined in a bottom-up fashion from a main access drift. From the main ramp, a drift would access the production area with a +/-18% attack ramp. Once the production drift would be mined out on that level, it would be backfilled and the access cross-cut would be slashed along the back and backfilled on the floor to allow access to the next level above, where the mining process would be repeated. In areas where the mineralization exceeds 4 m, the initial cut will be supported then the remaining ore will be slashed out. When the width exceeds 6 m, then a primary – secondary mining sequence is used in the drift and fill.

Figure 1.7-1 depicts the outlined drift and fill mining sequence.

Figure 1.7-1: C&F Stoping (Section View)



Each cut-and-fill lift will be mined out overhand using one and/or a combination of the following development stopes:

1. 4 m x 4 m square development;
2. 4 m x 4 m shanty back development;
3. Wall slashing (to a maximum span of 10 m); and
4. 4 m x 4 m primary/secondary stopes mined from a 4 m x 4 m footwall drift (where orebody exceeds 10 m width).

Figures 1.7-2 and 1.7-3 depict the example of the shanty back profile used in conjunction with wall slashing.

1.7.3.2 Underground Mining

The potentially mineable resource for Red Mountain is a product of multiple runs of the Vulcan Stope Optimizer© and manual design. Designing the final stopes was based on the applicable stope shapes, geological, geotechnical, and grade boundaries, ensuring the final stopes shapes meet cut-off criteria while maximizing the ore recovery.

Table 1.7-4 outlines the diluted, recoverable, mineable tonnage used for mine planning purposes. Any inferred resources included in the mine plan are assigned zero value. Table 1.7-5 shows the mineable resource by probable and proven categories.

Longhole stoping would contribute 64% of the mineable tonnage, 33% of the mineable tonnage comes from drift and fill mining, and the remaining 3% would come from cross-cut and access development.

Figure 1.7-2: Shanty Back Profile & Wall Slash

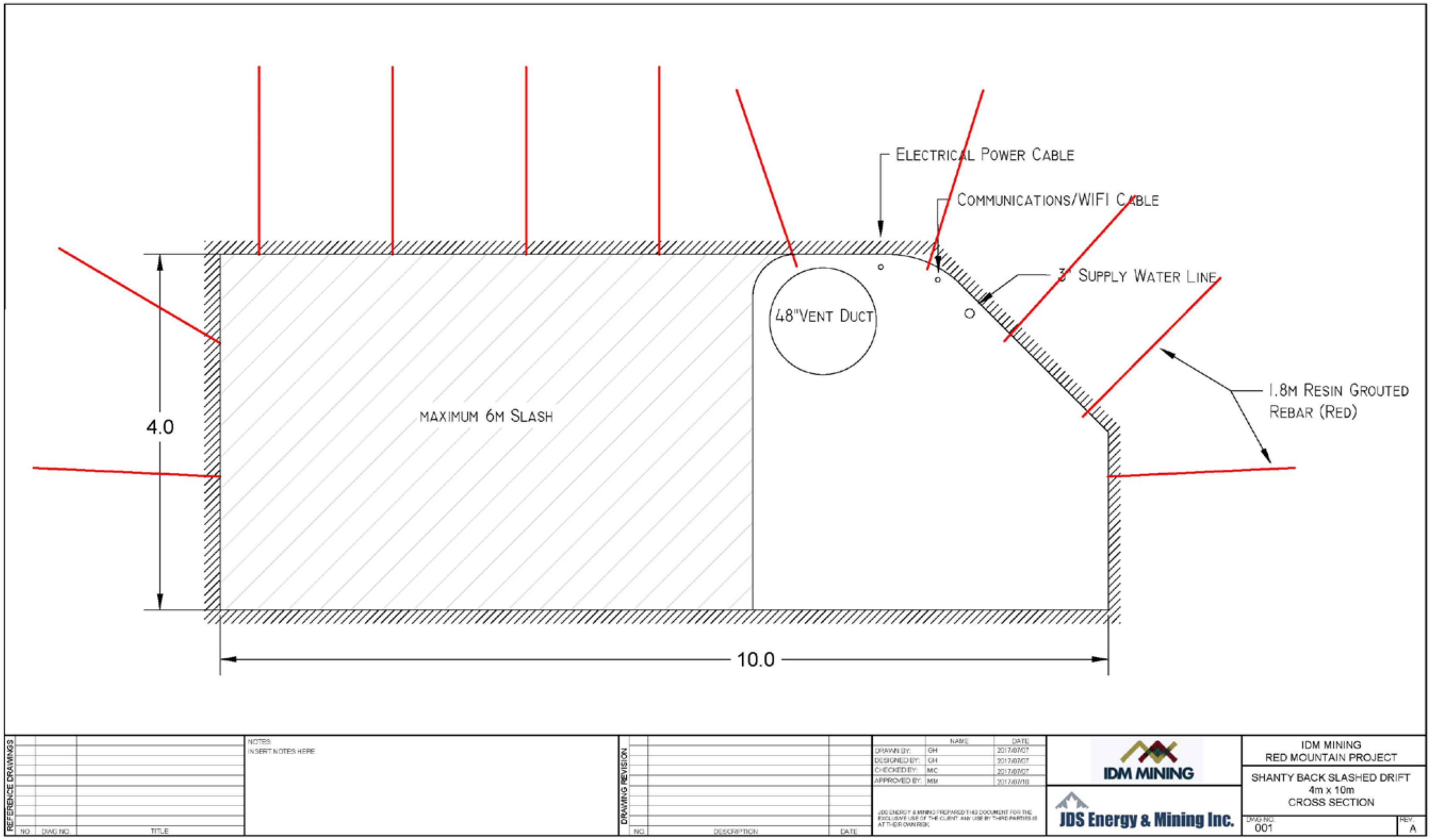
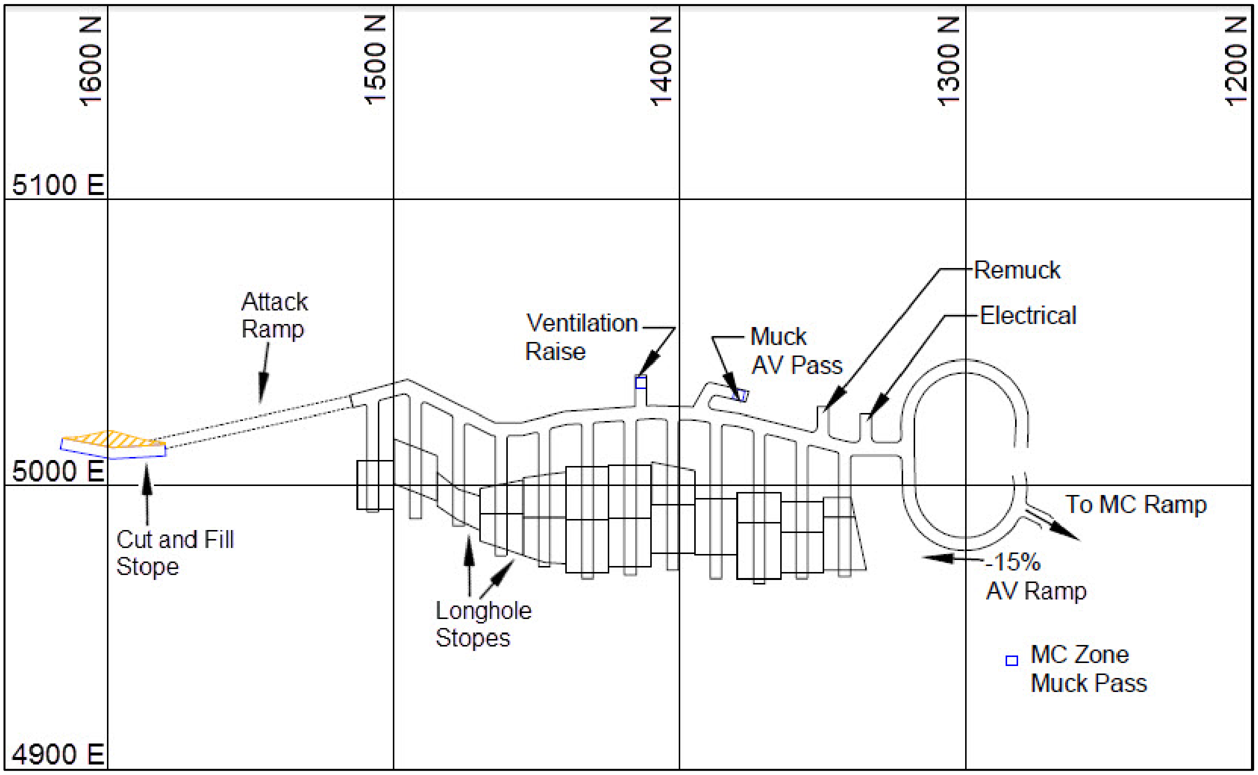


Figure 1.7-3: Level Plan



Cut-and-fill stopes will be filled with rock fill, with the exception of the primary stopes which will require CRF to allow mining of the adjacent secondary stopes.

Capital ramps, cross-cuts, footwall drives and other large headings will be developed by two-boom electric jumbo drills. Jumbos will be equipped with 4.88 m (16") drill steel and will advance an average 7.2 m/d per machine throughout the mine, which equates to approximately 1.5 rounds per day per machine. The smaller 4 m x 4 m headings will be drilled to 4.3 m per round.

Typical jumbo drill patterns for Red Mountain development and C&F mining are depicted in Figures 1.7-4 to 1.7-6.

Figure 1.7-4: 4.5 m x 4.5 m Ramp Profile

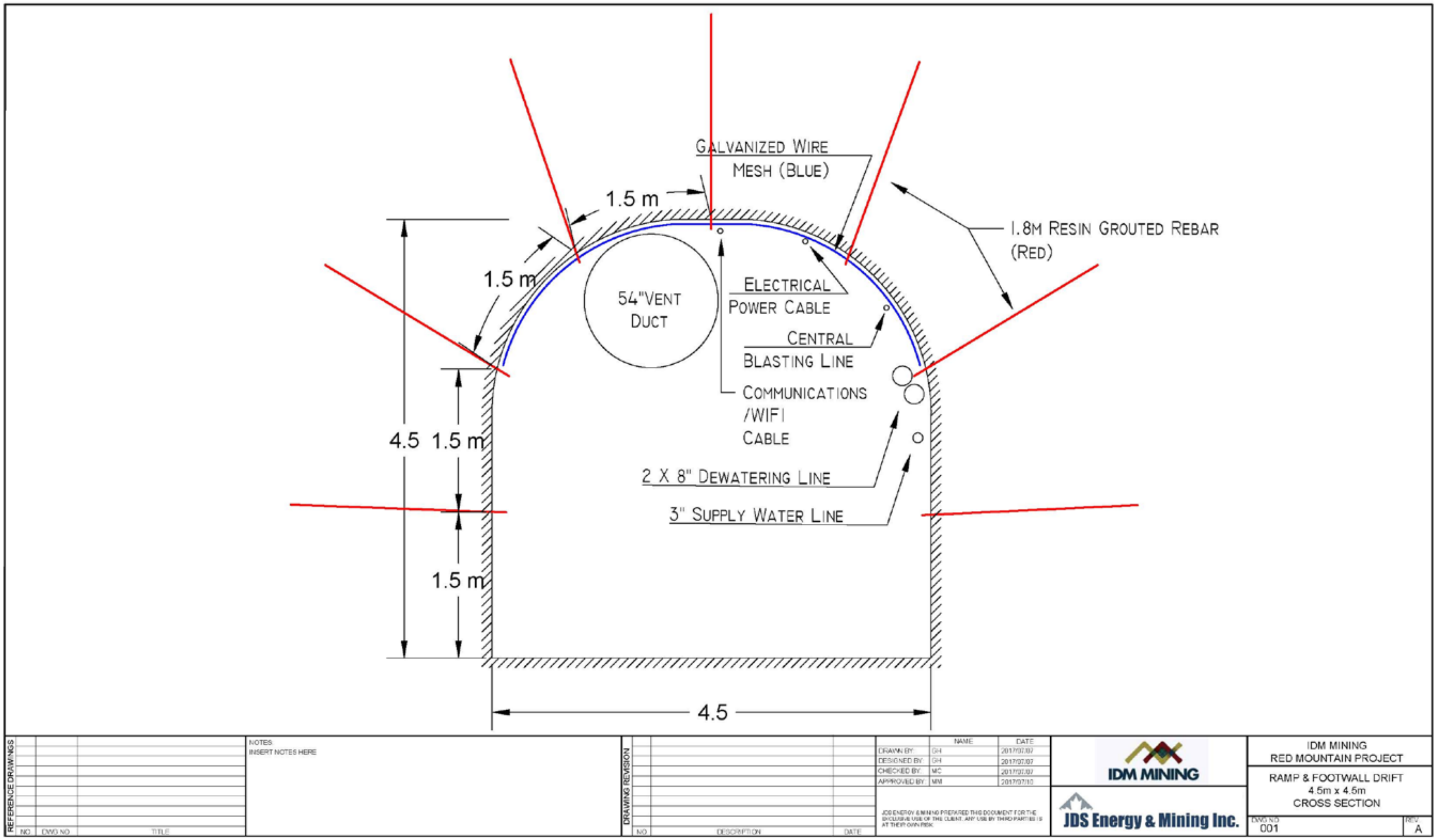


Figure 1.7-5: 4 m x 4 m Waste Drift Profile

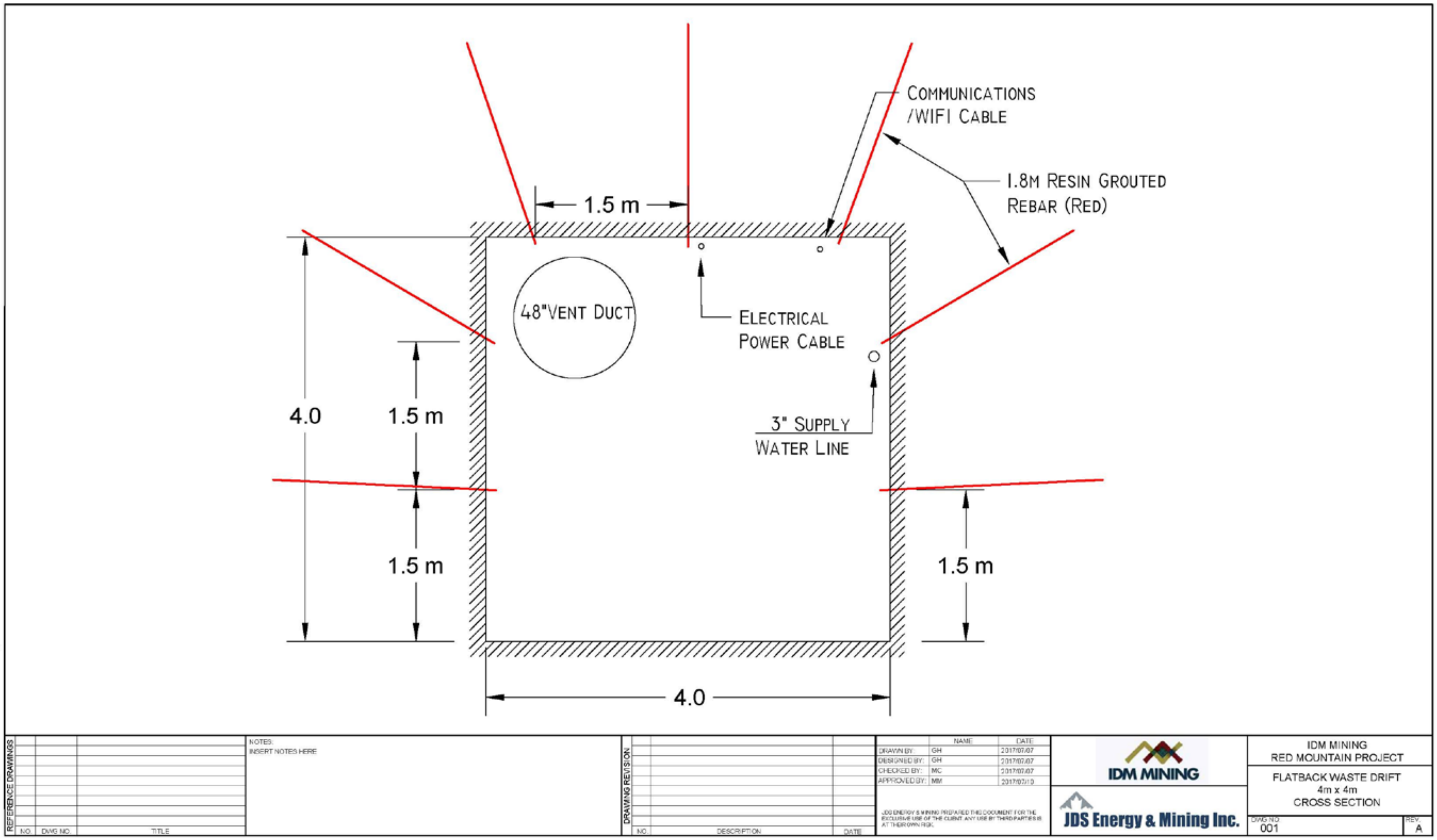
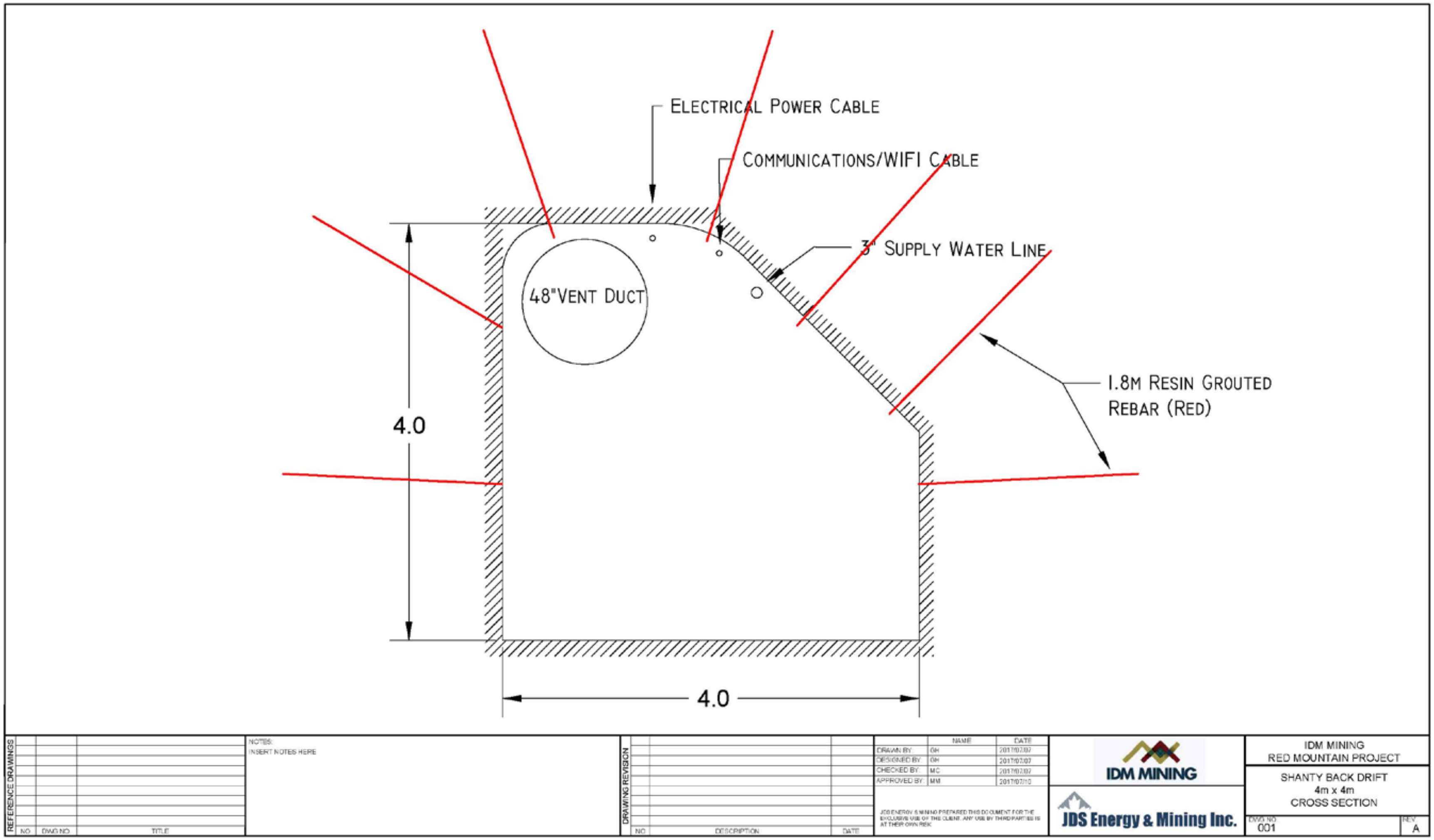


Figure 1.7-6: 4 m x 4 m Shanty Profile



Longhole drilling of mainly down holes with 89 mm diameter is planned at sublevel spacing of 15 m to 25 m. Some stoping would include drilling of upholes, being 20 m in length to ensure emulsion can be held in the hole.

Figure 1.7-7 depicts the planned production sequencing on an annual basis.

Mineral zones were sequenced to prioritize highest grade, lowest mine operating costs, and existing access development. As such, Marc zone would be targeted in the first year of production, followed by AV in the second production year. The remaining zones would commence production in Year 3.

Figure 1.7-7: Annual Production Sequencing

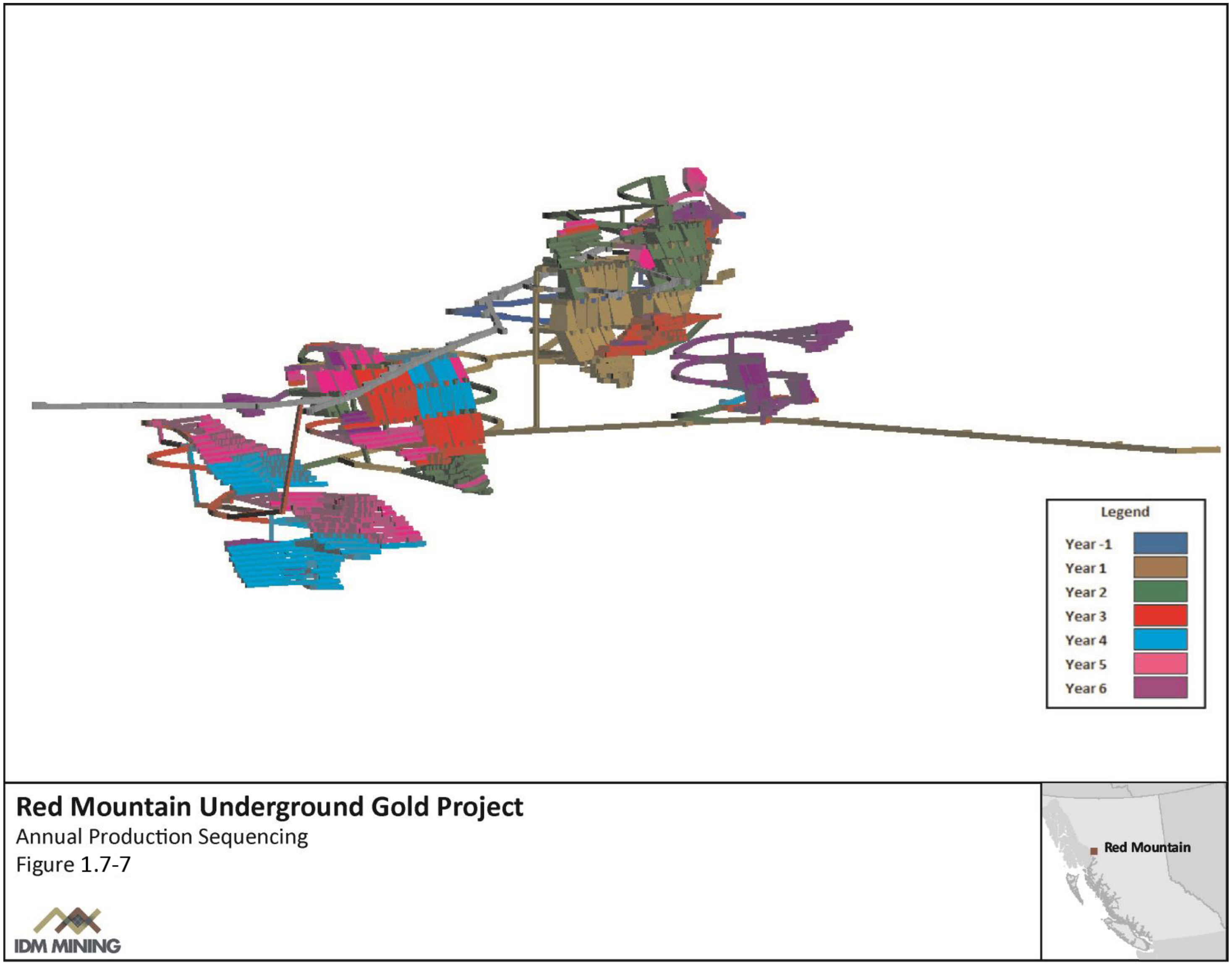
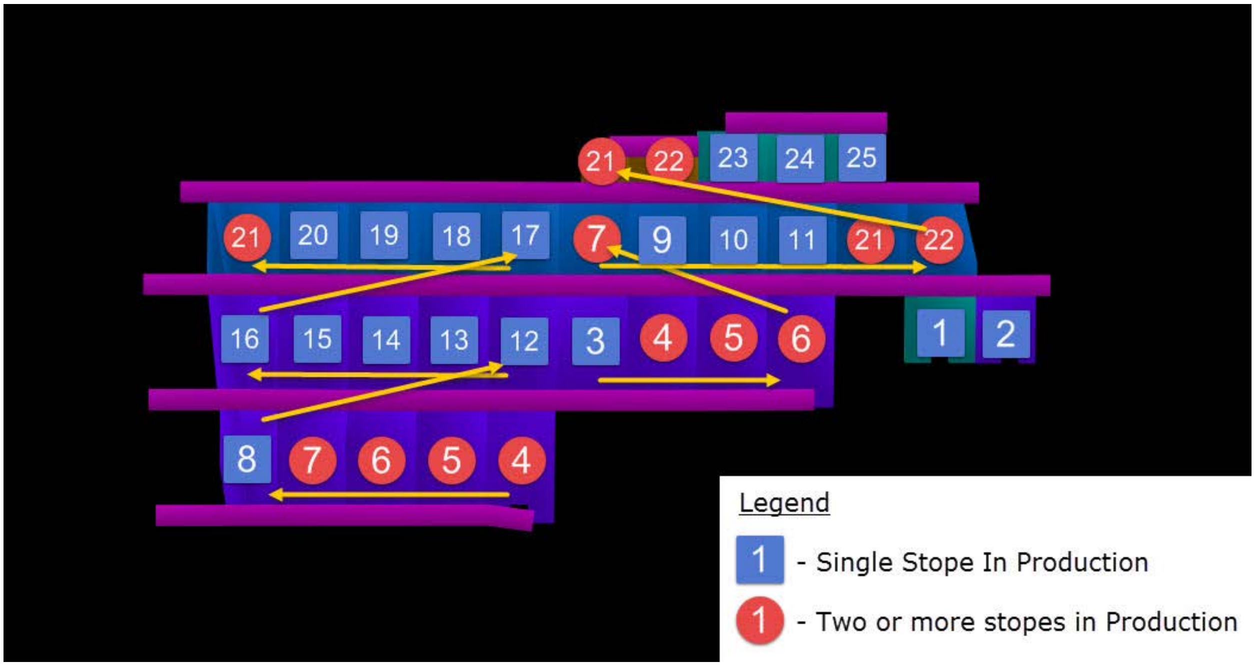


Table 1.7-8 depicts a typical stope sequence in the AV zone.

Figure 1.7-8: Typical Stope Sequencing



1.7.3.2.1 Access and Decline Infrastructure

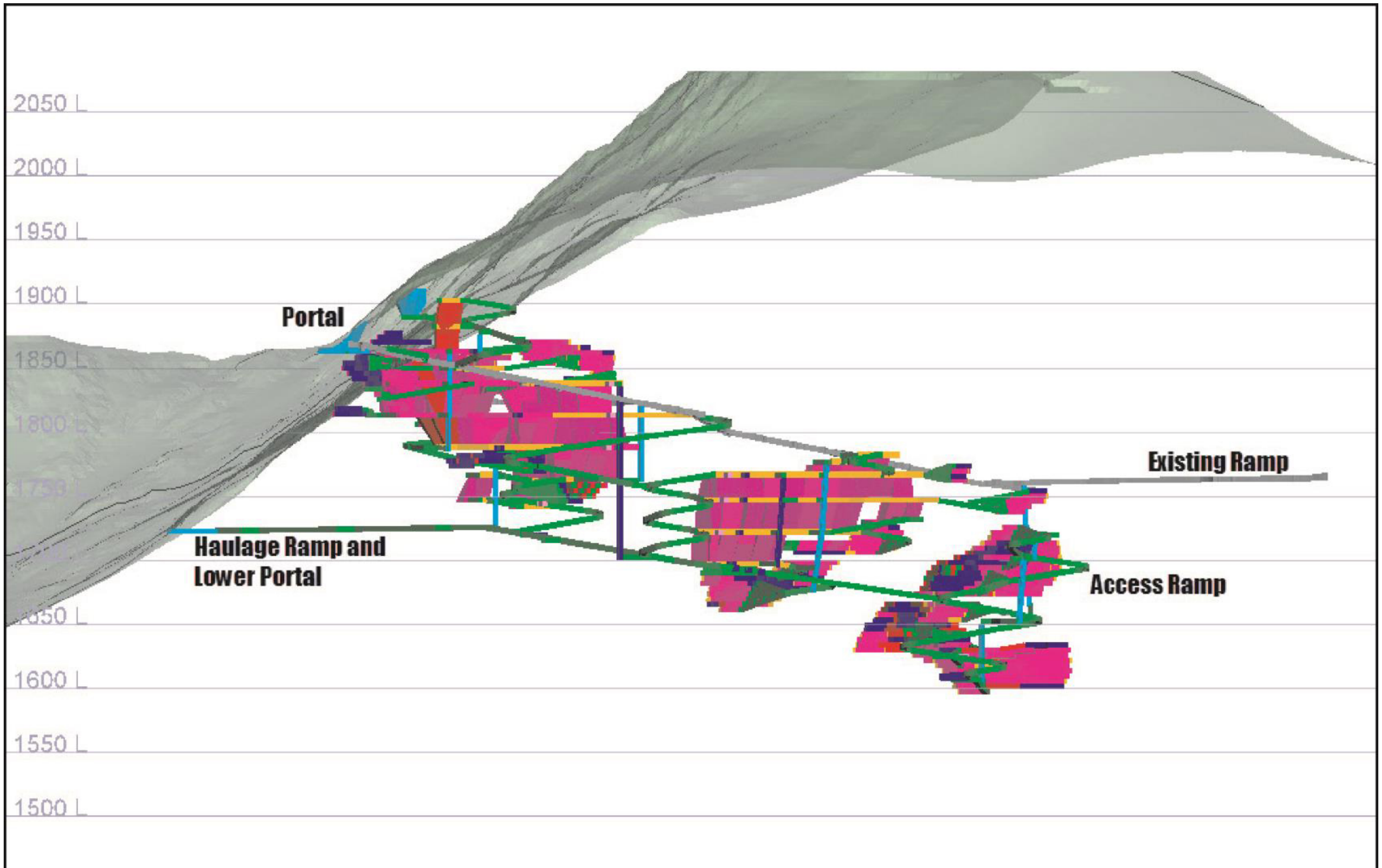
An exploration decline currently extends from a portal at 1,860 m elevation over the strike length at the top of the known resource. The existing decline is roughly 5 m wide by 4 m high and has been driven at a grade of -17%.

As the deposit is situated on a mountainside, there is an opportunity to establish a second portal at 1,720 m elevation and drive an incline towards the bottom of the mineable resource. The incline will be driven at +1% over 400 m to assist with dewatering. The lower portal will also provide a shorter haulage route to the Process Plant, allow gravity drainage of water, and to gravity feed broken material to an extraction level via muck pass.

An internal ramp system will be developed to provide access for mobile equipment for each of the three zones. 4.5 m by 4.5 m access ramps will be driven at a maximum grade of 15%. Mineralized zone development would be on a 4.0 m by 4.0 m profile.

Figure 1.7-9 depicts the mine access layout.

Figure 1.7-9: Mine Access

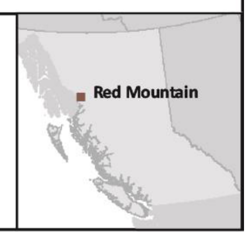


Red Mountain Underground Gold Project

Mine Access

Figure 1.7-9

IDM MINING



1.7.3.2.2 Backfilling

Backfill would consist of cemented rockfill (CRF) for primary stopes and unconsolidated waste rock for secondary stopes. All the development waste of 719,000 t would be used as mine backfill. The existing historical waste stockpile at the Upper Portal is estimated at 90,000 t and would also be consumed as backfill. No development waste would remain on surface at the end of the mine life. The remaining backfill deficit is planned to be sourced from the loose talus material surrounding the existing portal location.

CRF consists of waste rock mixed with cement slurry using a stationary CRF batch plant. The plant consists of an aggregate hopper/feeder, cement silo, and twin shaft CRF mixer. Mixed CRF is loaded into haul trucks and dumped into the empty stope.

Table 1.7-6 outlines the schedule for mine backfill placement.

Table 1.7-6: Backfill Schedule

Material	Units	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Waste Fill Placed Underground (UG)	m^3	0	41,000	93,000	90,000	78,000	79,000	49,000	429,000
CRF Placed UG	m^3	0	61,000	27,000	37,000	24,000	38,000	24,000	211,000
Total	m^3	0	102,000	120,000	128,000	102,000	117,000	72,000	640,000
Waste Material Balance									
Mined Waste to Backfill	kt	0	144	188	94	76	130	87	720
Waste from Temporary Storage to Backfill	kt	0	52	0	0	0	0	0	52
Waste from Historical Waste Dump to Backfill	kt	0	29	61	0	0	0	0	90
External "Rock" to Backfill	kt	0	0	10	182	144	124	70	530
Total Material placed Underground	kt	0	225	259	276	220	254	157	1,392

Source: JDS (2017)

1.7.3.2.3 Underground Mine Ventilation

Ventilation systems for the underground are designed to dilute and remove dust, diesel, emissions, and blasting fumes and maintain compliance with BC mine regulations. Ventilation networks were modelled using Ventsim® ventilation software for the underground mine. Industry standard friction factors and shock losses were included in the model to accurately simulate the ventilation system. Additional resistance for escape ladder ways was included in the modelling. The required pressures and flow rates were calculated and used for the selection of primary ventilation fans and estimation of power consumptions.

The main ventilation system must be capable of operating on blowing or exhaust duty and be equipped with a reversing switch, which normally will operate on exhaust. The airflow must be:

(a) At least 15 cubic metres per minute for each square metre (50 cfm for each square foot) of the working face area; and

(b) Where internal combustion engines are used underground, the total of the air flows specified on the engine permits.

Airflow requirements for the underground operation were compiled (Table 1.7-7) based on expected diesel emissions of the underground mining fleets. Where the engine model could not be sourced, a ventilation rate of 100 cubic feet per minute/horsepower (cfm/hp) was used.

Table 1.7-7: Ventilation Requirements

Equipment	Max. Qty	CANMET Ventilation (CFM)	Utilization (%)	Air Flow Required (cfm)
30t Haul Truck - Sandvik - TH430	4	21,100	100%	84,400
LHD - 6yd - Sandvik LH410	2	17,000	90%	30,600
2 Boom Jumbo - Sandvik DD321-40	2	9,200	10%	1,840
Bolter - Sandvik DS311	2	7,900	10%	960
Explosives Truck - EC3 Emulsion Charger	2	6,900	50%	6,900
Longhole Drill - Sandvik DL311	1	6,900	20%	1,380
Scissor Lift – Walden SLX5000	1	6,900	30%	2,070
Personnel Carrier - Maclean PC3	2	6,900	20%	2,760
Lube Service Truck - Maclean FL-3	1	6,900	30%	2,070
Boom Truck - Maclean BT-3	1	6,900	50%	3,450
Motor Grader - CAT12K	1	11,500	50%	5,750
Utility Vehicle - Etrac 1300	1	4,000	60%	2,400
Backhoe with Rockbreaker - JCB 3cx Compact	1	4,000	50%	2,000
Telehandler - JCB 535-140	1	6,000	50%	3,000
Mechanics Truck - Toyota MT	2	7,300	40%	5,840
Toyota PC	4	7,300	30%	8,760
Mobile Equipment Subtotal	28			164,200

Equipment	Max. Qty	CANMET Ventilation (CFM)	Utilization (%)	Air Flow Required (cfm)
Active Headings Allowance	10			43,600
Air Losses (5%)				14,300
Total Estimated Ventilation Requirements				224,200

The mine is designed to be ventilated using a primary fan installed in a bulkhead at the Upper Portal. The Ventilation Portal (adjacent to the Upper Portal) and Lower Portal would serve as exhausts. Fresh air will be directed from the existing portal via the mine ramps and ventilation raises.

A series of 3.0 m x 3.0 m ventilation raises would assist in the ventilation network, three of the raises serve as fresh air raises, the other two serving as level exhausts in the AV and Marc Zones. Auxiliary fans would circulate fresh air into active production areas, sized at 150 hp and 75 hp.

To provide adequate working conditions and prevent water from freezing underground, intake air will require heating for six months out of the year. The intake air will be heated to a temperature of +1.5°C. The heated air would be pulled into the heater drift by the main ventilation fan.

Heating calculations were based on modelled intake airflows and average monthly temperatures collected at the site weather station. It was estimated that 3.6M ft^3 of propane would be required throughout the year.

1.7.3.2.4 Underground Mine Dewatering

Groundwater inflows into the mine will vary throughout the year. Increased flow rates can be expected during summer snowmelt. As noted in Appendix 10-A, water levels and pumping rates were recorded during and after the dewatering events of May 1996, August 2000, and July 2016. Pumping rates were relatively low (i.e., less than 90 to 900 m^3/d) prior to the month of June or July, then increased quickly to a peak around mid-August of 2,600 m^3/d for a “cold” year and 6,050 m^3/d for a “warm” year.

Dewatering of the Upper Mine Portal will be achieved from start of operations to Year 1.5 via pumping with the discharge to the glacier east of the portal, outside of the Project area.

The Upper and Lower Mine Portals will be physically connected after Year 1.5 through to closure and therefore there will be no more surplus water from the Upper Mine Portal after Year 1.5. Dewatering of the Lower Mine Portal will be achieved by routing surplus water to the Portal Collection Pond and will be discharged to Goldslide Creek.

Mine dewatering must accommodate groundwater inflows, as well as inflows from drills and other equipment on all mining elevations. Old remuck bays would be converted to small sumps during access development. Small, portable 15 kW submersible pumps would be installed in these sumps and would discharge into steel pipes with 150 mm diameter. Mine water from Marc and AV zones would be drained through drain holes into the main drainage piping system. A permanent sump with 100 kW submersible pumps would be installed at the bottom of JW zone since it is below the Lower Portal elevation.

Mine dewatering will be achieved using a combination of submersible and horizontal pumps located throughout the working levels. The pumps will handle mine water via multiple lifts throughout the mine to minimize the pump size and power requirements.

For decline and production development, a face pump will be deployed to pump water to a nearby sump. This sump will transfer water via the raise system to sumps on higher elevations, in a staged configuration, for discharge to surface. Reticulation will be heat-traced, as required.

The dewatering monitoring program will be incorporated into the Site Water Management Plan (Volume 5, Chapter 29).

1.7.3.2.5 Ground Control and Surface Subsidence

The methods used to estimate the areal extent of any potential surface subsidence, the degree of expected subsidence, and potential effects on infrastructure and environment can be found in the Underground Geotechnical Design Report (Appendix 1-E) and is described in the Accidents and Malfunctions Chapter (Volume 3, Chapter 23). A risk analysis in relation to the underground workings identified four potential accidents/malfunctions associated with underground mine emergencies including roof fall. These were associated with potential effects to health and safety, production, cost, and reputation. The analysis did not identify any environmental effects. However, identified valued components (VCs) and intermediate components (ICs) may be indirectly affected by an underground collapse through subsidence of terrain above the mine. In the rare instance of a collapse, there is the potential for minor effects to surface water and groundwater flows, terrestrial ecosystems, and the subsequent changes to aquatic resources, fish and fish habitats, and wildlife and wildlife habitats. Appendix 1-F: Underground Geological Cross Section assesses the underlying geology of the Project, mine plan, and other site-specific conditions that support the rare likelihood assessment.

With regards to ground control and geotechnical management, waste development is expected to be stable given the rock mass conditions and planned excavation dimensions. Ground support for the development excavations comprising combinations of tendons, wire mesh, cables, and shotcrete is based on the expected ground conditions and excavation life.

A Site Water Management Plan (Volume 5, Chapter 29) will be developed for the underground workings as part of detailed design. This plan will include the following components:

- Description of the lithology, geological structure, and rock mass parameters;
- Mine design and controls;
- Ground support reinforcement design and standards;

- Ground monitoring systems;
- Seismic response management plan;
- Blasting considerations;
- Surface or groundwater management considerations;
- Risk management process;
- Personnel role descriptions and responsibilities according the SWMP; and
- Training requirements for mine personnel with regards to ground awareness.

1.7.3.3 Waste Rock Management

The temporary WRSA established adjacent to the Upper Portal will contain approximately 52,000 t of PAG waste rock. Although all mine waste rock will eventually be placed underground as backfill, scheduling may require some temporary surface storage. Additionally, there is also approximately 90,000 t of historic waste rock from the exploration phase of the Project located at the Upper Portal.

The temporary WRSA is expected to be depleted during the Operation Phase, as all development waste (approximately 719,000 t of waste rock) is planned to be re-handled into the underground stopes as backfill. No development waste will remain on surface at the end of the mine life.

Water that has come into contact with the temporary WRSA will be directed to the Cambria Icefield, similar to mine water that is temporarily discharged from the Upper Portal. A system of diversion ditches will be established at the Mine Site for diversion of non-contact water around major Project components, including the temporary WRSA.

1.7.3.3.1 Temporary Waste Rock Storage

Design criteria associated with the temporary WRSA are provided in Table 1.7-8. The foundation associated with the temporary WRSA is largely bedrock with minimal to no overburden or topsoil.

As noted above, the area will contain approximately 52,000 t of PAG waste rock. The temporary surface storage area is expected to be depleted within a year (by the end of Year 2) as all waste is planned to be re-handled into the underground stopes as backfill. Extensive geochemical studies and monitoring since 1993 of waste rock stored on surface have shown that the PAG rock is stable over the short to medium term and is not anticipated to generate acid, simplifying the management of this material during operations.

Table 1.7-8: Waste Rock Storage Area Design Criteria

Waste Rock Storage Area Parameter	Value
Storage Volume	25,000 m^3
Tonnage	52,000 t
Top Elevation	1,868 m

Waste Rock Storage Area Parameter	Value
Bottom Elevation	1,860 m
Average Foundation Angle	10 – 20°
Design Slope	38°
Foundation Surface Area	8,436 m^2

In Chapter 23, Accidents and Malfunctions, IDM has conducted a risk analysis based on a Failure Modes and Effects Analysis (FMEA) approach to evaluate the likelihood of a failure of permanent and temporary waste rock stockpiles and the potential consequences (effects) of that failure on selected VCs or ICs. Given the WRSA is a temporary and a relatively minor feature (8 m in height), is small compared to other mining projects, failure risk is considered to be unlikely.

With regards to instrumentation and monitoring, visual inspections of the WRSA will occur on a daily basis during the time temporary surface storage is required.

The temporary WRSA will be designed for geotechnical stability as per the “Interim Guidelines of the British Columbia Mine Waste Rock Pile Research Committee” (HSRMC 2017).

1.7.3.3.2 Waste Rock Production

The current mine production schedule produces approximately 750,000 t of waste rock, 100% of which is anticipated to be grouped as PAG. The waste rock development sequence is presented in Table 1.7-9.

Preliminary geochemical characterization of the mine waste rock was analyzed by SRK; results are presented in Section 1.2.3.2.1 and in Appendix 1-B.

Table 1.7-9: Waste Rock Development Sequence

Phase	Mine Year	Waste Rock Production (tonnes)
Construction	Year -1	52,000
Operation	Year 1	144,000
	Year 2	188,000
	Year 3	94,000
	Year 4	76,000

Phase	Mine Year	Waste Rock Production (tonnes)
	Year 5	130,000
	Year 6	87,000

1.7.3.3.3 Waste Rock Disposal

Any waste rock generated from mining activity including the existing historical waste rock pile will be placed underground as backfill. Section 1.7.3.2.2 provides further detail on backfill schedule.

Backfill will consist of cemented rock fill (CRF) for primary stopes and unconsolidated waste rock for secondary stopes. SRK (Appendix 1-B) recommended that the sedimentary waste rock be placed underground as cemented-paste backfill and that water levels in the mine (post-closure) be maintained in order to minimize waste rock interaction with air.

Geochemical study and monitoring have indicated that all mine rock will be potentially acid generating (Appendix 1-B). However, there is a long lag time to the onset of acidic conditions: more than 20 years.

1.7.3.4 Ore Handling, Stockpiling, and Crushing

For the first 1.5 years of mining during the Operation Phase, while the underground workings are being accessed through the Upper Portal, ore will be stockpiled outside of this portal (Figure 1.1-4). Following this period, an ore stockpile will be located outside active mining at the Lower Portal. The size of the ore stockpile outside of each portal will be about 3,000 to 5,000 t, representing two to three days of production.

Ore from the portal stockpiles at the Mine Site will be transported to the large ROM Stockpile located at Bromley Humps, adjacent the Process Plant (Figure 1.1-5). The ROM stockpile will provide sufficient storage so that processing can occur during periodic temporary winter shut-downs due to weather. There is no expected annual carry-over from the ROM stockpile, i.e., the stockpile will be exhausted annually.

There will be no separate storage or stockpiling of low grade ore (not applicable to this Project as all mined ore will be run through the Process Plant).

1.7.3.4.1 Ore Grade and Quantities

An estimated Process Plant feed is shown in Table 1.7-10. Refer to Table 1.7-2 for the mining production schedule.

Table 1.7-10: LOM Process Plant Feed Schedule

Underground Mine Schedule	Units	-1	1	2	3	4	5	6	Total
Resource Mined	kt	3	322	366	366	366	366	158	1,946
Au	g/t	14.31	9.17	8.23	7.09	7.64	6.92	4.56	7.52
Ag	g/t	50.55	31.96	30.11	17.23	17.72	16.87	13.95	21.89

1.7.3.4.2 Ore Crushing

Ore will be fed to the primary crusher by front-end loader.

Dust associated with the stockpiles is not expected to be significant. Crushing and screening during the Operation Phase will be conducted in an enclosed facility to prevent dust dispersion. Dust will be monitored at the sites and any required mitigation measures applied as planned dust monitoring and mitigation can be found in the Air Quality and Dust Management Plan (Volume 5, Chapter 29).

1.7.3.4.3 Physical and Chemical Stability of Mineralized Material

A brief overview of the physical, chemical property, ML/ARD characteristics of the ore is presented in Section 1.2.3 and the detailed ML/ARD characterization of the ore is presented in Appendix 1-B.

1.7.3.4.4 Runoff and Seepage Management

Contact runoff water from the Process Plant area and the ROM Stockpile will be routed toward the TMF via appropriate grading and collection ditching. Further information on site water management is provided in Sections 1.6.4.1 and 1.7.12.

1.7.4 Mining Equipment

1.7.4.1 Underground Equipment

Haulage requirements for LHDs and trucks were estimated for mineralized material, waste, and backfill. Mineralized material is hauled to a stockpile near the portal, where it is re-handled and loaded into surface haul trucks for transportation to the Process Plant.

A development crew with dedicated drill jumbo, LHDs, and bolter would drive the critical path development at Marc and the incline during pre-production. Some development equipment would be used for drift and fill mining later in the mine life, when the main access development is completed.

A twin-boom jumbo would be used for the mine development. Bolting would be performed with a bolting jumbo.

Two top hammer longhole drills were specified to allow for redundancy and efficient production drilling in two zones. Drain holes and electrical cable holes would also be completed with the longhole drills.

Over time, the equipment is planned to be rebuilt or replaced, as recommended by the manufacturers.

A summary of selected mobile equipment for the underground is shown in Table 1.7-11.

Table 1.7-11: Underground Production and Development Equipment List

Description	Maximum Required
30t Haul Truck - Sandvik - TH430	6
LHD - 7.5yd - Sandvik LH 514	2
2 Boom Jumbo - Sandvik DD321-40	1
Bolter - Sandvik DS311	1
Explosives Truck - AC3 Emulsion Charger	1
Longhole Drill - Sandvik DL311	2
Scissor Lift - Maclean SL-2	1
Shotcrete Sprayer - Maclean SS-2	1
Personnel Carrier - Maclean PC3	1
Lube Service Truck - Maclean FL-3	1
Boom Truck - Maclean BT-3	1
Transmixer - Maclean TM3	1
Motor Grader - CAT12K	1
Utility Vehicle - Etrac 1300	1
Backhoe with Rockbreaker - JCB 3cx Compact	1
Telehandler - JCB 535-140	1
Mechanics Truck - Toyota MT	1
Toyota PC	4

1.7.4.2 Support Equipment

A fleet of mobile site support equipment will be utilized during the Operation Phase. A list of site support equipment is provided in Table 1.7-12.

Table 1.7-12: Surface Equipment List

Description	Class	Quantity
Truck - Toyota PC	Light Vehicles	4
Sand Truck / Plow truck	Heavy Vehicles	1
Water Truck	Heavy Vehicles	1
46 Passenger Bus	Heavy Vehicles	1
Tool Carrier - Cat 966K (c/w Attachments)	Light Equipment	1
Skid Steer Loader (1Cu.M)	Light Equipment	1
3 T Forklift - Warehouse - CAT 2DP6000	Light Equipment	1
Grader - Cat 14M	Heavy Vehicles	1
Portable Diesel Light Plant	Support Equipment	1
Portable Diesel Heater	Support Equipment	2
Front end wheel Loader	Plant Equipment	1
30 t Ore Haulers	Ore Haul	4
Front end wheel Loader	Ore Haul	1

1.7.5 Power Supply and Fuel Supply / Storage

The power supply for the mine infrastructure and the locations of the fuel storage tank are discussed in Section 1.6.

High voltage power will be delivered to Bromley Humps at 138 kV and to the Mine Site at 25 kV and reduced to 4160 V at electrical sub-stations. All power will be three-phase.

For the underground mine, the major electrical power consumption will be from the following:

- Main and auxiliary ventilation fans;
- Drilling equipment; and
- Air compressors.

High voltage cable will enter the mine via the main declines and be distributed to electrical sub-stations located on sub-levels. All equipment and cables will be fully protected to prevent electrical hazards to personnel.

The mine power requirement was calculated by estimating the expected demand from the various major pieces of electric equipment used for the underground mine. Power usage considers the expected kW draw as well as the utilization of each piece of electric equipment.

1.7.6 Communications Systems

Site-wide communications design will incorporate proven, reliable, and state-of-the-art systems to ensure that personnel at the Mine Site have adequate voice, data, and other communication channels available. Several integrated systems will be provided for on- and offsite communication at the plant. A site local area network (LAN) will be provided to consolidate services into a single network infrastructure. Computers, cameras, telephones, and any Internet Protocol (IP) devices requiring connection to the corporate network will utilize the LAN. Further to the hardwired portion of the LAN, wireless access points will be placed in common areas such as the recreation hall, administration area, dining area, and construction office.

External communications via phone line will support a corporate network and voice telephony traffic between site locations and offsite. They will provide connections to the public telephone network and secure connections to the internet for office use.

Site communications will support mine and Process Plant production, security, monitoring, and corporate traffic across the site, including radio and telephone.

IDM will have local computer server, storage, and data backup capability in environmentally appropriate HVAC and UPS supported facilities. An information systems emergency response and business continuity plan will be developed to address information systems preparedness for Operation Phase in a subsequent phase of the Project.

The corporate network will provide wired and Wi-Fi connectivity between computing devices and servers to support corporate applications. The corporate network will support secure firewall connection for local production Process Plant and pit communications systems. Quality of Service connections will be implemented for offsite voice and data traffic via satellite communications.

The site will have a dedicated VHF radio system for surface communications. VHF radio coverage will extend underground via a leaky feeder radio antenna system. Underground Operation Phase will make use of dedicated emergency phones in refuges.

Communications along the road will be supported via operating procedures on a truck-to-truck simplex radio system. Emergency response and supervisory vehicles will be equipped with emergency backup satellite phones.

1.7.7 Explosives Storage during Operation

Bulk emulsion will be used as the major explosive for mine development and production.

1.7.7.1 Explosives Storage

It is anticipated that the quantity of emulsion stored onsite will be sufficient for seven days of production, approximately 10 tonnes.

Packaged explosives and explosive detonators will temporarily (for approximately one year) stored at a secure and monitored site approximately 600 m away from an inhabited building (Explosives Magazine, Figure 1.1-4), as per regulatory requirements. Explosives will be surrounded on three sides with earthen berms to prevent propagation and significantly reduce the separation distances from other parts of the operations.

Boosters and detonators will be separated per the Natural Resource Canada guidelines and stored in locked and barricaded sea-containers.

The Explosives Magazine will be relocated underground starting in Year 2 and will provide explosives storage for up to seven days. Day boxes will be used as temporary storage for daily consumption. Detonators and bulk explosives will be stored in separate facilities. Each magazine will be located in a bay off the decline. Access will be controlled by lockable gates. The magazines will be equipped with fire extinguishers, wooden shelves, and placed on a concrete floor.

1.7.8 Chemical and Hazardous Materials Other than Fuel and Explosives

A variety of supplies and materials classified as potentially hazardous will be required at the Project. The hazardous materials to be handled may include:

- Petroleum products (gasoline, lubricants, hydraulic fluids, oil and solvents); and
- Process reagents.

Designated areas for storage and handling of these materials will be included in the infrastructure developed at site.

1.7.9 Waste Management

Waste products other than mineral tailings will be sorted at the Process Plant prior to offsite removal. Solid waste (scrap steel, wood, etc.) will be collected in bins; empty chemical totes, lubricant drums, etc. will be collected and compacted. All industrial waste will be back-hauled offsite for disposal or recycling in an appropriate manner. Sewage and grey water from the Mine Dry and Maintenance Shops will be hauled to an appropriate facility near Stewart for disposal.

1.7.10 Milling Process Description

1.7.10.1 General

The results of the metallurgical test work, together with financial evaluation data, were used to select the recovery method for the Project and to develop metallurgical design criteria, which in turn were used to design the Process Plant.

The process design criteria and flowsheets were developed using both the metallurgical test work results and industrial design factors where applicable. The 2016 – 2017 metallurgical test program completed by Base Met Labs indicates that Project mineralization can be treated using three-stage crushing, two-stage grinding, Carbon in Leach (CIL), and acid waste, stripping, and electrowinning for the recovery of gold and silver doré.

The Process Plant will process material at a rate of 1,000 t/d with an average LOM head grade of 7.5 g/t gold and 21.9 g/t silver. Based on test work, the overall LOM metal recoveries are expected to be approximately 90.5% for gold and 85.2% for silver. The two-stage grinding circuit product size is targeted at approximately 80% passing (P_{80}) 25 micrometre (µm) before the precious metals are recovered in the CIL, stripping, and electrowinning circuits. After cyanide destruction, the tailings will be pumped to the TMF. The crushing circuit will operate at an availability of 75%, while the milling and leaching circuits will operate 24 hours per day, 365 days per year, at an availability of 92%.

To summarize, the plant will consist of the following unit operations:

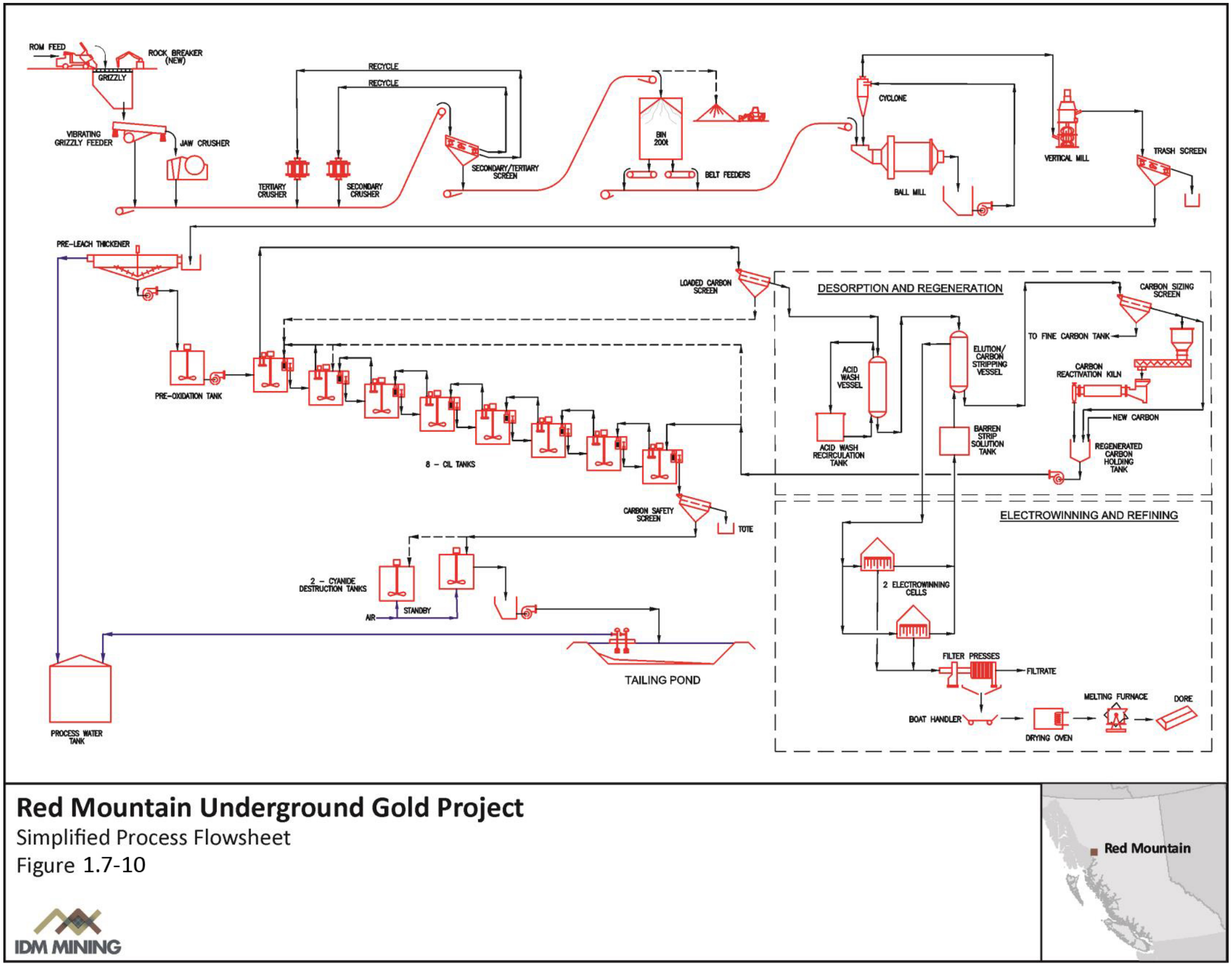
- **Primary Crushing** – A vibrating grizzly feeder and jaw crusher in open circuit, producing a final product P_{80} of 103 mm;
- **Secondary / Tertiary Crushing** – Two stages of cone crushing in closed circuit with a double deck vibrating screen, producing a final product P_{80} of 8.5 mm;
- **Crushed Material Storage Bin and Reclaim** – A 12-h live capacity bin (500 t) with two reclaim belt feeders feeding the Ball Mill Feed Conveyor;
- **Primary Grinding** – A ball mill in closed circuit with hydrocyclones, producing a transfer size T_{80} of 100 µm;
- **Secondary Grinding** – A vertical stirred mill in open circuit, producing a final product P_{80} of 25 µm;
- **Pre-leach Thickening** – A 17 m diameter high-rate thickener to achieve a 50% feed solids density for leaching;
- **Pre-oxidation** – An agitated tank sparged with oxygen to oxidize the slurry prior to leaching;
- **Cyanide Leaching and Carbon Adsorption** – Eight CIL tanks, giving 48 hours retention time to leach gold and silver into solution and adsorb the precious metals onto activated carbon;
- **Carbon Elution and Regeneration** – Acid wash of carbon to remove inorganic foulants, elution of carbon to produce a gold-rich solution, and thermal regeneration of carbon to remove organic foulants;
- **Gold and Silver Refining** – Precious metal electrowinning (sludge production), filtration, drying, and refining to produce gold and silver doré;

- **Cyanide Destruction** – Two agitated tanks to reduce the CNWAD (weak acid dissociable) concentration in the CIL tailings to less than 1 ppm with sodium metabisulphite for SO_2, air and copper sulphate; and
- **Final Tailings Disposal** – Centrifugal pumps to send slurry to the TMF and a barge reclaim system to pump reclaim water back to the process plant.

The simplified flowsheet of the milling process is presented in Figure 1.7-10.

Metallurgical test work to date suggests grinding to 25 µm will provide acceptable recoveries to maximize overall project economics.

Figure 1.7-10: Red Mountain Underground Gold Project Simplified Process Flowsheet



1.7.10.2 Process Plant Design Criteria

1.7.10.2.1 Process Design Criteria

The Process Design Criteria and Mass Balance detail the annual production capabilities, major mass flows and capacities, and availability for the process plant. Key process design criteria are summarized in Table 1.7-13.

Table 1.7-13: Process Design Criteria

Criteria	Unit	Nominal Value	Source
General			
Daily Throughput	t/d	1,000	2017 mine plan
Process Plant Availability	%	92	Industry standard
Process Plant Throughput	t/h	45.3	Engineering calculation
LOM Average Gold Grade	g/t	7.5	2017 mine plan
LOM Average Silver Grade	g/t	21.9	2017 mine plan
Overall Gold Recovery	%	90.5	2016-17 Base Met Labs Testwork Program BL0084 – Weighted average of zone recoveries and projected tonnages
Overall Silver Recovery	%	85.2	2016-17 Base Met Labs Testwork Program BL0084 - Weighted average of zone recoveries and projected tonnages
Crushing			
Availability/Utilization	%	75	Industry standard
Crushing Plant Throughput	t/h	55.6	Engineering calculation
Bond Crushing Work Index	kWh/t	11.1	2016-17 Base Met Labs Testwork Program BL0084 - Average of Marc, JW and AV variability samples
Number of Crushing Stages	-	3	Vendor Recommended – three stage crushing plant
Crushing System Product Size (P80)	mm	8.5	Estimated based on a final product aperture screen size of 10 mm
Fine Mill Feed Storage			
Bin Capacity (live)	t	500	Design consideration
Bin Capacity (live)	h	12	Engineering calculation

Criteria	Unit	Nominal Value	Source
Grinding			
Bond Ball Mill Work Index (overall)	kWh/t	20.1	2016-17 Base Met Labs Testwork Program BL0084 - Average of Marc, JW and AV variability samples
Primary Grinding Mill Type	-	Ball Mill	Industry standard for primary grinding to target transfer size
Mill Diameter	m	3.7	Vendor recommended
Mill Length	m	6.5	Vendor recommended
Installed Power	kW	1,194	Vendor recommended
Primary Grinding Transfer Size (T80)	µm	100	Engineering calculation
Secondary Grinding Mill Type	-	Vertical Stirred Mill	Selected to achieve fine grinding product size
Installed Power	kW	1,475	Vendor recommended
Final Product Size (P80)	µm	25	Based on results from 2016-17 Base Met Labs Testwork Program BL0084 and a trade-off study summarized in Section 13
Pre-Leach Thickening			
Thickener Loading Rate	t/h/m2	0.40	2016-17 Base Met Labs Testwork Program BL0084
Thickener Underflow Density	% w/w	50	Design consideration
CIL			
Pre-Oxidation	Y / N	Yes	2016-17 Base Metals Testwork Program BL0084 indicated improved extraction rates with pre-oxidation
Pre-Oxidation Retention Time	h	2	2016-17 Base Met Labs Testwork Program BL184
CIL Retention Time	h	48	2016-17 Base Met Labs Testwork Program BL0084
Number of CIL Tanks	#	8	Selected to ensure adequate carbon loading of gold and silver
Leach Slurry Flow Rate	m3/h	62.5	Mass balance calculation
Carbon Loading (Gold + Silver)	g / t of carbon	6,500	Design consideration and vendor recommended
Carbon Processing			
Carbon Handling Capacity	t/d	4	Engineering calculation
Overall Gold and Silver Production	oz/d	805	Engineering calculation

Criteria	Unit	Nominal Value	Source
Cyanide Destruction			
Discharge Solution, CNWAD	mg/L	<1.0	2016-17 Base Met Labs Testwork Program BL0084
Design Residence Time	h	1.5	2016-17 Base Met Labs Testwork Program BL0084
Number of Tanks	#	2	Selected to allow for one operating and one standby
SO2 Consumption – Marc Zone	g/t	2,447	2016-17 Base Met Labs Testwork Program BL0084
SO2 Consumption – AV / JW Zone	g/t	5,078	2016-17 Base Met Labs Testwork Program BL0084
CuSO4.5H2O Consumption	g/t	300	2016-17 Base Met Labs Testwork Program BL0084

Source: JDS (2017)

1.7.10.3 Crushing and Grinding

Material from the underground mining operations will feed a crushing plant that consists of three stages of crushing. The plant will process 56 tph of material, operate 18 hours per day, and produce a final product P_{80} of 8.5 mm.

1.7.10.3.1 Primary Crushing

Material will be stockpiled near the jaw crusher or direct dumped through a 500 mm static grizzly into a dump pocket. Stockpiled ROM material will be re-handled by a front-end loader and fed into the crusher. The material will discharge through a static grizzly into a 20-t live feed hopper. Oversize material from the static grizzly will be removed for later size reduction using a rock breaker.

A vibrating grizzly feeder will draw material from the dump pocket at a rate of 56 tph. The vibrating grizzly oversized material will discharge directly into the primary jaw crusher. The undersized material will bypass the crusher and feed directly into a 635 mm x 1,016 mm (25” x 40”) jaw crusher with an installed power of 90 kW. The undersized 75 mm minus material will bypass the crusher and feed directly onto the Screen Feed Conveyor. The primary crushing stage will produces a product P80 of approximately 103 mm at a crusher closed side setting (CSS) of 90 mm.

The Screen Feed Conveyor will collect crushed product from all three stages of crushing and feed a 1,829 mm x 6,096 mm (6’ x 20’) double-deck vibrating screen. The top deck will have an aperture size of 45 mm, and the +45 mm material will be conveyed to the secondary crusher. The bottom deck will have an aperture size of 10 mm, and the 45 mm minus material and +10 mm material will be conveyed to the tertiary crusher. The 10 mm minus final product, at an estimated P_{80} of 8.5 mm, will discharge onto the Bin Feed Conveyor and be transferred to the Crushed Material Storage Bin.

1.7.10.3.2 Secondary Crushing

Material from the Secondary Crusher Feed Conveyor will discharge into a Telsmith D 36" cone crusher with an installed power of 75 kW. The secondary crusher will reduce the material to a nominal product P_{80} of approximately 28 mm using a CSS of 25 mm. Crushed product will be transferred to the Screen Feed Conveyor and be circulated back to the double-deck screen.

1.7.10.3.3 Tertiary Crushing

Material from the Tertiary Crusher Feed Conveyor will discharge into a Telsmith SBS 38" cone crusher with an installed power of 132 kW. The tertiary crusher will reduce the material to a nominal product P_{80} of 9.8 mm with a CSS of 10 mm. Crushed product will be transferred to the Screen Feed Conveyor and be circulated back to the double-deck screen.

1.7.10.3.4 Crushed Material Storage

The double-deck screen undersize, with a final product size P_{80} of 8.5 mm, will be conveyed to the Crushed Material Storage Bin. The bin will provide 500 t, or 12 hours, of live storage capacity. If there is a planned crusher shut down, additional material will be crushed and stored adjacent to the bin. As the bin capacity is depleted, a front end loader will transfer the material onto the Bin Feed Conveyor. Two belt feeders under the bin will be installed with variable frequency drives (VFD) to control the reclaim rate feeding the primary ball mill. Each belt feeder will be capable of providing the total throughput of 45 tph to the plant.

1.7.10.3.5 Grinding

The grinding circuit will consist of a primary ball mill followed by a secondary vertical stirred mill. The ball mill will operate in closed circuit with a hydrocyclone cluster, while the stirred mill will operate in open circuit. The grinding circuit can process a nominal throughput of 45 t/h (fresh feed) and produce a final product P_{80} of 25 µm.

Reclaimed material from the Crushed Material Storage Bin will feed a 3.7 m diameter x 6.5 m long overflow ball mill via the Ball Mill Feed Conveyor. The mill will be installed with a 1,194 kW induction motor. A belt-scale on the feed conveyor will monitor feed rate and the reclaim belt feeder speed can be adjusted to ensure a constant feed to the mill. Water will be added to the ball mill to maintain the slurry charge in the mill at a constant density of 70%. Slurry will overflow from the ball mill to a trommel screen attached to the discharge end of the mill. The trommel screen oversize will discharge into a trash bin for removal from the system.

Slurry from the ball mill will flow into the cyclone feed pump box and be pumped up to a cluster of six (five operating / one standby) 250 mm hydrocyclones for size classification. The coarse underflow will flow by gravity back into the primary ball mill for additional grinding, while the fine overflow, at an approximate transfer T_{80} of 100 µm, will be pumped to the vertical stirred mill. The hydrocyclones have been designed for a 300% circulating load.

Cyclone overflow will feed a VXP 5000 vertical stirred mill operating with an installed power of 1,475 kW. The mill will use 3 mm ceramic grinding media for fine attrition grinding and will achieve a final product P_{80} of 25 µm.

1.7.10.4 Gold Recovery

1.7.10.4.1 Thickening

Stirred mill product will flow onto a 1.2 m x 2.4 m vibrating trash screen for removal of trash material. Oversize material will discharge into a trash bin, while screen undersize will flow by gravity to a 17 m diameter pre-leach thickener. Flocculant solution (anionic polyacrylamide) will be added to the thickener feed to promote the settling of fine solids. The high-rate thickener will thicken the slurry to 50% solids. The thickener underflow will be pumped to the CIL circuit, while the thickener overflow will flow by gravity into the process water tank to be used as make-up water in the grinding circuit.

1.7.10.4.2 Carbon-in-Leach (CIL)

Pre-leach thickener underflow will be pumped to a 6 m diameter x 6 m high pre-oxidation tank prior to leaching. Oxygen will be sparged into the bottom of the agitated tank and slurry will be conditioned for two hours to oxidize sulphide minerals. Based on metallurgical testing, this step will help reduce the consumption of dissolved oxygen during cyanidation, improving metallurgical recovery. It will also reduce NaCN consumption by preventing the formation of thiocyanate.

The slurry will then flow to the first of eight 8 m diameter x 10 m high CIL tanks. The CIL circuit is designed to provide 48 hours of retention time. Each tank includes an agitator, carbon transfer pump and interstage screen pumpcell. All leach tanks will be located outside and adjacent to the main process building.

As the slurry flows through the eight CIL tanks, precious metals will be leached into solution and the dissolved gold and silver will be adsorbed onto activated carbon. The average carbon concentration in the CIL circuit is expected to be approximately 30 g/L, with the concentration higher at 50 g/L in the first tank to maximize adsorption. As the slurry proceeds through the circuit, metal values in the solids and solution will progressively decrease. The carbon will be transferred counter-currently to the slurry flow to maximize precious metal recovery. Once per day, loaded carbon from the first CIL tank will be pumped to the loaded carbon screen where the slurry will be separated and the carbon transferred into the acid wash vessel. The separated slurry will then flow by gravity back into the first CIL tank.

Lime slurry will be added to the first and second leach tanks at a rate of up to 1.9 kg/t to maintain protective alkalinity at a design pH of 11.0, preventing the creation of hydrogen cyanide gas (HCN). Sodium cyanide solution will be added to the circuit at a rate of up to 1.77 kg/t, while oxygen is sparged in from the bottom of each tank. This will create the conditions needed for gold and silver to dissolve into solution and adsorb onto carbon.

The tailings stream from the last CIL tank will flow onto a 1.2 m x 2.4 m stationary safety screen to capture any carbon particles that may have escaped the CIL circuit. Captured carbon particles will be collected in bins and disposed. Safety screen undersize will then be pumped to the cyanide destruction circuit.

1.7.10.4.3 Carbon Processing

The carbon processing plant has been designed to accommodate 4 tpd of loaded carbon.

Acid Wash

Loaded carbon will be treated with hydrochloric acid solution in the acid wash tank to remove calcium deposits, magnesium, sodium salts, silica, and fine iron particles. Organic foulants, such as oils and fats, are unaffected by the acid and will be removed after the elution step by thermal reactivation in a kiln.

The carbon will first be rinsed with fresh water. Acid will then be pumped from the dilute acid tank to the acid wash vessel. Acid will be pumped upward through the acid wash vessel and overflow back to the dilute acid tank. The carbon will then be rinsed with fresh water to remove the acid and any mineral impurities.

A recessed impeller pump will transfer acid washed carbon from the acid wash vessel into the elution vessel. Carbon slurry will discharge directly into the top of the elution vessel. Under normal operation, only one elution will take place per day.

Carbon Stripping (Elution)

The carbon stripping (elution) process will utilize barren solution to strip the loaded carbon, creating a pregnant solution that will be pumped through the electrowinning cells before being circulated back to the Barren Solution Tank.

The strip vessel will be a carbon steel tank with a capacity to hold approximately 4 t of carbon. During the strip cycle, solution containing approximately 1% sodium hydroxide and 0.1% sodium cyanide, at a temperature of 140°C (284°F), will be circulated through the strip vessel at a pressure of 450 kPa (65 psi). Solution exiting the top of the vessel will be cooled below its boiling point by the heat recovery heat exchanger. Heat from the outgoing solution will be transferred to the incoming cold barren solution prior to passing through the solution heater. An electric boiler will be used as the primary heating source.

Carbon Regeneration

A recessed impeller pump will transfer the stripped carbon from the elution vessel to the Carbon Sizing Dewatering Screen. The 1.5-m diameter vibratory screen doubles as a dewatering screen and a carbon sizing screen where fine carbon particles will be removed. Oversize carbon from the screen will discharge by gravity into the regeneration kiln feed hopper. Screen undersize carbon, containing carbon fines and water, will drain by gravity into the carbon fines tank. Subsequently, the carbon fines will be filtered and collected into bags for disposal. A 250 kW horizontal electric kiln with residual heat dryer will be utilized to treat 4 t of carbon per day, equivalent to 100% regeneration of stripped carbon. The regenerated carbon from the kiln will flow by gravity into the carbon quench tank, cooled by fresh water and/or carbon fines water, and pumped back to the CIL circuit.

To compensate for carbon losses by attrition, fresh carbon will be added to the carbon attrition tank and mixed with fresh water to activate the carbon pores. The fresh carbon will then drain into the carbon quench tank and combine with the regenerated carbon coming from the kiln.

1.7.10.4.4 Electrowinning and Refining

Pregnant solution from the strip circuit will be pumped to the refinery for electrowinning, producing a gold and silver sludge. Pregnant solution will be pumped through two 3.54 m^3 electrowinning cells operating in parallel. Precious metals will plate on the pair of 33 stainless steel cathodes, while the barren solution will flow into the barren return tank and be pumped back to the barren solution tank for reuse. To prevent a build-up of impurities, a bleed of barrens solution will periodically be sent to the CIL circuit.

Gold and silver rich sludge will periodically be washed off the stainless steel cathodes into the electrowinning sludge tank using high pressure water. Once the tank is filled, the sludge will be drained, filtered, dried, mixed with fluxes, and smelted in a 125 kW induction furnace, producing gold and silver doré. This process will take place within a secure and supervised area, and the precious metal product will be stored in a vault until shipping off site.

1.7.10.5 Cyanide Destruction

The cyanide destruction circuit will consist of two 5 m diameter x 6 m high mechanically-agitated tanks, each with a capacity to handle the full slurry flow for the required residence time of 1.5 hours. Cyanide will be destroyed using the SO_2/air process. Treated slurry from the circuit will flow by gravity to a final tailings pump box and pumped to the TMF.

The cyanide destruction circuit will treat CIL tailings slurry, process spills from various contained areas, and process bleed streams.

Process air will be sparged from near the bottom of the tanks under the agitator impeller. Lime slurry will be added, if necessary, to maintain the optimum pH of 8.0 to 8.5 and copper sulphate ($CuSO_4$) will be added as a catalyst, maintaining a 73 mg/L concentration in solution. A sodium metabisulphite (SMBS) solution, at a rate of up to 5.1 kg/t, will be dosed into the system as the source of SO_2. This system has been designed to reduce the total cyanide concentration to less than a target of 1.0 mg/L Cyanide Weak Acid Dissociable (CNWAD) prior to transfer to the TMF.

1.7.10.6 Process Water Quality

A discussion of process water quality can be found in Section 1.7.12.3, Water Treatment.

1.7.10.7 Reagents

Reagents consumed within the Process Plant will be prepared on-site and distributed via the reagent handling systems. These reagents include: sodium cyanide (NaCN), lime, lead nitrate (Pb_2NO_3), hydrochloric acid (HCl), caustic soda (NaOH), copper sulphate ($CuSO_4$), sodium metabisulphite (SMBS), antiscalant, flocculant, and activated carbon. All reagent areas will be bermed with sump pumps that transfer spills to the final tailings pump box, with the exception of the flocculant. Flocculant spills will be returned back to the storage tank. The reagents will be mixed, stored, and delivered to the pre-leach thickener, CIL, acid wash, elution, and cyanide destruction circuits. Dosages will be controlled by flow meters and manual control valves. The capacity of the storage tanks will be sized to handle one day of production. The reagents will be delivered in dry form, with the exception of HCl and antiscalant, which are delivered as solutions.

Table 1.7-14 summarizes the reagents used in the plant and their estimated daily consumption rates. The table also includes other major process consumables.

Table 1.7-14: Reagents and Process Consumables

Description	Delivered Form	Quantity Stored On-Site	Usage
NaCN	1 tonne bags (dry)	30 t	1.6 t/d
Lime	2 tonne bags (dry)	30 t	1.6 t/d
Pb2NO3	50 kg bags (dry)	5 t	250 kg/d
HCl	208 L drums (36% liquid)	8 t	416 kg/d
NaOH	1 tonne bags (dry)	8 t	699 kg/d
CuSO4	1 tonne bags (dry)	6 t	300 kg/d
SMBS	1 tonne bags (dry)	30 t	4.2 t/d
Antiscalant	1 tonne tote (liquid) or 50 kg barrels	2 t	41 kg/d
Flocculant	25 kg bags (dry)	0.5 t	20 kg/d
Activated Carbon	50 kg bags (dry)	25 t	120 kg/d
Ball Mill Grinding Media – 75 mm chrome steel	1 tonne bags	25 t	1.2 t/d
Stirred Mill Grinding Media – 3 mm ceramic	500 kg bags	6 t	274 kg/d

Source: JDS (2017)

Emergency medical stations and emergency cyanide detoxification chemicals will be provided at the areas as well.

1.7.10.8 Air Supply

An instrument and plant air system with two 15,000 Nm^3/hr compressors and associated dryers, filters, and receivers will be provided and located in a compressor room inside the plant building. Two 30 kW blowers (one operating / one standby) will be used to provide sparged air for the cyanide destruction circuit.

Oxygen will be used in the CIL circuit and will be supplied by a contracted local vendor.

1.7.10.9 Process Plant Water Consumption

The following types of water will be used in the Process Plant:

Process Water – Overflow water from the pre-leach thickener will be used as process water. This water will have a low gold concentration and will be used predominantly in the grinding circuit to dilute slurry to the required densities.

Fresh Water – Fresh water for the process plant will be pumped from a fresh water supply, such as the local watercourse or an impoundment which may potentially be located adjacent to the process plant. Fresh water will be used as reagent make-up water, gland water, process make-up water, and cooling water services in the strip circuit boiler. The estimated fresh water consumption in the process plant will be 23 m^3/h.

Reclaim Water – Water reclaimed from the TMF will be used as dilution water in the grinding and cyanide destruction circuits. Based on the water balance and a settled tailings density of 70%, 32 m^3/h of water will be reclaimed from the TMF.

1.7.10.10 Process Plant Power Consumption

The Process Plant peak power consumption is expected to be in the order of 6 MW, which accounts for process from crushing and grinding through utilities.

1.7.10.11 Storage and Transportation of Final Product

Refined gold doré bars will be the final product. The gold bars will be stored in a secure section of the Process Plant and transported offsite via armoured truck on a weekly basis.

1.7.11 Tailing Management System

The PEA mine plan entails a six-year mine life with about 1.95 Mt of ore, processed at a rate of 1,000 tpd. Based on an assumed initial settled density of 1.2 t/m^3 and final settled density of 1.3 tonnes per cubic metre t/m^3, the required tailings storage capacity is in the order of 1.54 Mm^3. The tailings management system is designed for deposition of 2.0 Mt of tailings.

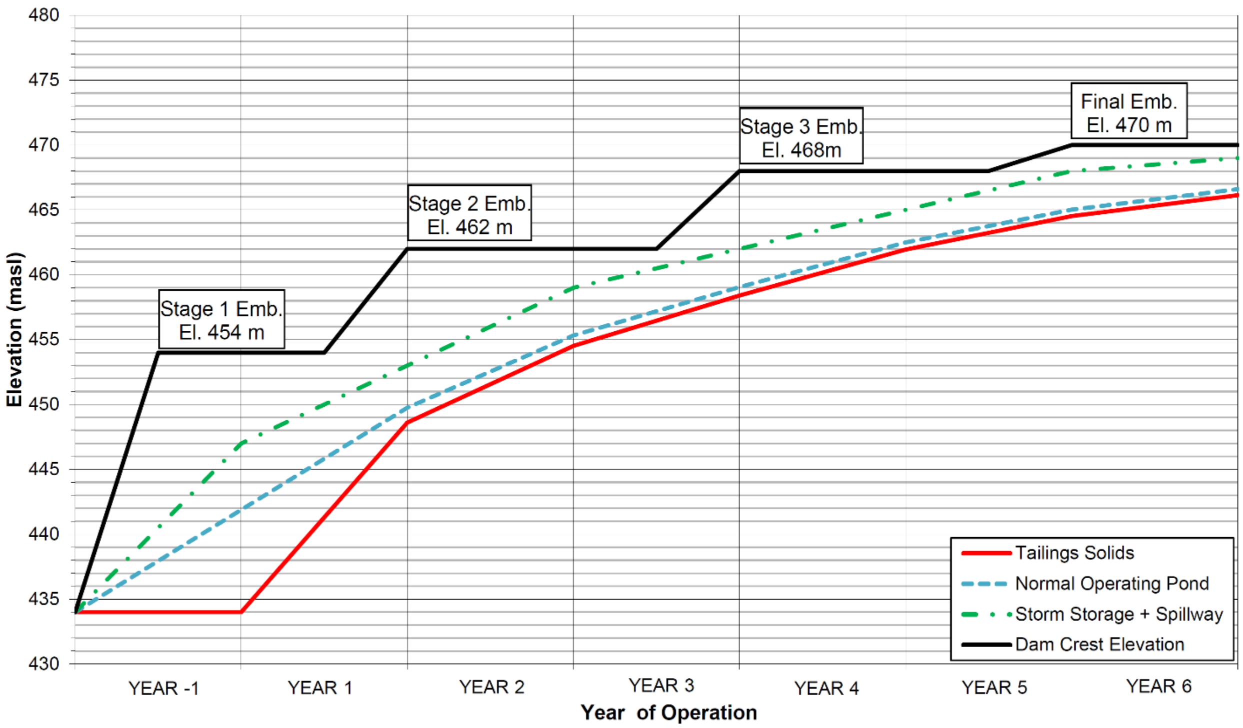
An initial starter dam will be constructed to contain the first year of tailings production and associated water management to minimize upfront capital expenditure. The dam will be raised over the mine life to increase the storage capacity and maintain operational freeboard.

The facility will have sufficient freeboard to manage contact water runoff, storm storage, and process water. Reclaimed water will be recirculated back to the Process Plant and used as process water. An allowance has also been included to account for the change in water storage requirements associated with the site water surplus. Surplus water will be released once it reaches a suitable quality.

The facility will be operated with an Emergency Discharge Spillway to convey large flood events (up to, and including, the PMF event) safely from the TMF.

The staged filling schedule is shown on Figure 1.7-11.

Figure 1.7-11: Filling Schedule



Source: Appendix 1-J

Geotechnical instrumentation will be installed in the tailings embankment and foundation during construction and over the life of the Project. Instrumentation will include vibrating wire piezometers installed in the foundation and embankment fill, in addition to inclinometers and survey monuments. Groundwater quality monitoring wells will also be required as part of the water monitoring program. The instrumentation will be monitored during the construction and operation of the TMF to assess performance and to identify any conditions different to those assumed during design and analysis. Amendments to the ongoing designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise.

1.7.11.1 Tailings Distribution Strategy

Tailings will be pumped from the mill in a single overland pipeline and discharged to the TMF from a series of spigoted off-takes located along the TMF embankment crests and perimeter road. The sandy coarse fraction of the tailings will settle rapidly after discharge and will accumulate close to the discharge points, forming a gentle beach. Finer tailings particles will travel farther and settle at a steeper slope adjacent to and beneath the supernatant pond. The tailings beaches will be developed with the intent to maximize storage volume and to control the location of the supernatant pond. Selective tailings deposition will be used to maintain the supernatant pond away from the embankment.

1.7.11.2 Seepage Control

Potential seepage from the TMF will be largely controlled by the geomembrane liner and tailings deposition methodology. Seepage that is intercepted in the embankment drainage zones and foundation drain system will be routed to the seepage collection and recycle ponds located at topographic low points at the downstream toe of each embankment. Water collected in ponds will be continuously monitored and pumped back into the TMF. Tailings bleed water and seepage collected in the basin underdrain system will be collected in a wet well sump and recycled to the TMF supernatant pond.

1.7.11.2.1 Lining System

The TMF impoundment is assumed to be fully lined with a geomembrane liner. The upstream face of the embankments and the impoundment will be lined with a lining system to minimize seepage leaving the facility. The liner system consists a 100 mg HDPE geomembrane sandwiched between layers of 16 oz. non-woven. The liner system will be placed on a fine-grained bedding layer to protect the liner. The liner system will need be appropriately anchored into the foundation and embankment as required.

1.7.11.2.2 Foundation Drains

Foundation drains will be constructed beneath the geomembrane to dewater any groundwater seeps and collect potential leakage through the geomembrane lining system. The Foundation Drains will also collect potential leakage through the geomembrane lining system. Water collected in the Foundation Drains will report to Seepage Collection Ponds and will be pumped back to the TMF. Flow rates and water quality in the foundation drains will be monitored.

1.7.11.2.3 Basin Underdrain

A basin underdrainage system will be placed above the geomembrane liner system to enhance consolidation of the tailings. Water collected in the underdrain system will be returned to the impoundment via a wet well pumping system.

1.7.11.3 Tailings Water Reclaim Circuit

The water reclaim system performance objectives are as follows:

- To allow the collection and removal of process water; and
- To allow the collection and removal of precipitation and runoff.

Water will be reclaimed from the tailings pond using a floating reclaim barge and a single overland pipeline to the process water tank. To float the barge and to provide adequate process water requirements at start-up, the TMF will first be partially filled with water from site runoff and precipitation. The reclaim water pipeline will extend from the barge to the

Process Plant. Additional pumps will be available for use in the event of extreme precipitation events, surplus water management, and in the case of pump failure.

1.7.11.4 Discharge

A water balance developed for the TMF has indicated that the TMF will operate in a net positive surplus throughout operations.

Surplus supernatant pond water will be pumped to the Water Treatment Plant and discharged to the environment. Anticipated rates of discharge, by year, are presented in the Tailings Management Plan (Volume 5, Chapter 29). The Site Water Management Plan (Volume 5, Chapter 29) describes the water management strategies as well as effluent monitoring that will be undertaken.

1.7.11.5 Consolidated Tailings Geochemistry

A description of tailings geochemistry can be found in Appendix 1-K, and is summarized in Section 1.2.3.2.3.

1.7.11.6 Monitoring of the Tailings Management Facility

Requirements to monitor, inspect and report on the performance of the TMF are outlined in the following guidance and legislation:

- Canadian Dam Safety Guidelines (CDA, 2013 and 2014) ;
- Health, Safety and Reclamation Code of British Columbia (BC MEM 2008, 2016); and
- Mining Association of Canada (MAC) tailings management guidelines (MAC, 2011a,b,c).

These guidance documents provide overlapping requirements for dam safety inspections and reviews and the development of an Operations, Maintenance, and Surveillance (OMS) Manual and an Emergency Preparedness and Response Plan (EPRP) specific to or inclusive of the TMF. The OMS Manual and EPRP will be prepared with the initial construction As-Built Report and will be revised annually in accordance with the Code (Section 6).

Geotechnical instrumentation will be installed in the TMF embankments and foundation during construction, and will be utilized during the Operation, Closure, and Post-Closure Phases of the Project. The instrumentation will be used to monitor and assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the ongoing designs and/or remediation work can be implemented to respond to the changed conditions, should the need arise. Key control and monitoring subject areas will include:

- Inspections of the TMF with regard to performance monitoring, instability indicators, stability monitoring, tailings deposition, water management and control, and quality of effluent;

- Construction controls, including the use of a construction management program;

- The adequacy of the water cover as dust control and to minimize ML/ARD generation from exposure of the tailings to the atmosphere;

- Quality assurance and quality control (QA/QC) measures for Operation Phase, monitoring, and inspections; and

- Post-closure requirements that will include annual inspection of the TMF and an ongoing evaluation of water quality, flow rates, and instrumentation records to confirm design assumptions for closure.

Monitoring and inspection requirements described in the Tailings Management Plan will be incorporated into the future OMS Manual. The OMS Manual will clearly document the procedures for operating, maintaining, monitoring, and inspecting the TMF, along with the roles and responsibilities of relevant staff. Inspections will include:

- Daily inspections by the Mine Supervisor;
- Weekly or after a major storm event or change by the TMF Qualified Person; and
- Annual dam safety inspections will be undertaken by the Engineer of Record (EoR).

1.7.11.6.1 Instrumentation

Geotechnical instrumentation will be provided during Project Construction, Operation, and Closure and Reclamation Phases to monitor the TMF and may include:

- Vibrating wire piezometers to measure pore water pressure in main dam and tailings;
- Pond level indicator in TMF supernatant pond;
- Inclinometers at the TMF embankments;
- Water management pond inflow weirs;
- Survey and surface movement monitoring monuments; and
- Flow monitoring for embankment and foundation drains.

1.7.12 Water Management

1.7.12.1 Water Use

Water will be required to support the industrial water requirements, Process Plant, TMF, ongoing exploration activities, road building, and other activities.

To the greatest extent possible, industrial and wash water will be collected, treated for suspended solids removal, and recycled.

Water will be sourced from the locations shown in Table 1.7-15. Water intakes will be designed in accordance with DFO guidelines for water intakes. These pumping station and water intakes will be established during the Construction Phase.

Potable water obtained from Bitter Creek will be treated and sourced from the same water line that is providing treated freshwater to the Process Plant. The water treatment technology is described further in Section 1.7.12.3.

Table 1.7-15: Operation Phase Water Use – Bromley Humps and Mine Site

Water Use	Volume	Source
Dust suppression along road alignment	70 m^3/day	Primarily contact water management ponds; secondarily Bitter Creek, Goldslide Creek, and Otter Creek
Potable water	7.5 m^3/day	Bitter Creek
Domestic freshwater – (showers, sinks, toilets)	50 m^3/day	Otter Creek and Goldslide Creek
Process Plant - startup water	110,000 m^3	TMF catchment
Process Plant - reclaim	45 m^3/hr	TMF
Process plant - glands and reagent use	14m^3/hr	Bitter Creek, with secondary source from contact water management pond and Otter Creek
Process Plant - water treatment capacity	62,000 m^3/month (estimated peak discharge from the TMF in Year 3)	TMF; treated water discharged to Bitter Creek and used for process freshwater
Mine Site - drill water	N/A	Sourced from and recirculated within the mine workings

1.7.12.2 Water Management

Detailed strategies regarding water management for the Project are provided in the Site Water Management Plan (Volume 5, Chapter 29).

The objective of water management during operations is to protect groundwater and surface water resources while meeting the Project water demands for mine waste management and providing water to the Process Plant to support processing.

The main sources of water contributing to water supply and site water management during the Operation Phase are described below.

1.7.12.2.1 Tailings Management Facility

Contact runoff water in the TMF area will be routed to the TMF via appropriate grading of the areas, or with pumping. The TMF has a geomembrane liner to minimize seepage, and seepage from the facility will be collected in sumps and pumped back to the TMF.

Collected runoff from the Process Plant area, ROM Stockpile, and seepage from the facility will be managed in the TMF prior to being used in the Process Plant for mill water requirements or being discharged if the volume is in surplus. Surplus water will be treated at the Water Treatment Plant, as detailed in Appendix 14-C, Water and Load Balance Model Report.

1.7.12.2.2 North TMF Embankment Seepage Collection Pond

The North TMF Embankment Seepage Collection Pond will be used to manage seepage and flows from TMF basin underdrain at the North TMF embankment. Surface runoff from the North TMF Embankment and a small local area will also be collected. Potential seepage from the TMF (through defects in the geomembrane) has been conservatively estimated at 32,000 m^3/year, and 40% (13,000 m^3/yr or 0.4 L/s) is assumed to report to the North TMF Embankment Seepage Collection pond. The seepage collection systems for the North TMF Embankment are assumed to be 80% efficient, with the remaining 20% assumed to be unrecoverable and therefore report to the downstream receiving environment. Seepage collection will be optimized during detailed design and may result in higher recovery efficiency.

1.7.12.2.3 South TMF Embankment Seepage Collection Pond

The South TMF Embankment Seepage Collection Pond will be used to manage seepage from the South TMF embankment. Surface runoff from the South TMF Embankment and a small local area will also be collected. Potential seepage from the TMF (through defects in the geomembrane) has been conservatively estimated at 32,000 m^3/year, and 60% (19,000 m^3/yr or 0.6 L/s) is assumed to report to the North TMF Embankment Seepage Collection pond. The seepage collection systems for the South TMF Embankment are assumed to be 80% efficient, with the remaining 20% assumed to be unrecoverable and therefore report to the downstream receiving environment. Seepage collection will be optimized during detailed design and may result in higher recovery efficiency.

1.7.12.2.4 Process Plant Site

Contact runoff water from the Process Plant area and the ROM Stockpile will be routed toward the TMF via appropriate grading and collection ditching.

1.7.12.2.5 TMF Diversion Ditch

Non-contact runoff upslope of the TMF pond will be diverted north of the Project to discharge to Bitter Creek. The ditch will convey up to a 1 in 5 year peak runoff with an extra 0.3 m of freeboard. In the event that inflows exceed the 5 m^3/s design capacity of the diversion ditch, excess water will spill over the ditch berm into the TMF. The storm storage criteria in the TMF (i.e., the EDF) has the capacity to manage this additional potential inflow from the diversion ditch during peak runoff events.

1.7.12.2.6 Existing Upper Mine Portal

Dewatering of the Upper Mine Portal will be achieved from start of operations to Year 1.5 via pumping with the discharge to the glacier east of the portal (Cambria Icefield), outside of the Project area.

The Upper and Lower Portals will be physically connected after Year 1.5 through to closure and therefore there will be no more surplus water from the Upper Mine Portal after Year 1.5.

Runoff from facilities adjacent to the Upper Mine Portal will be directed east to the nearby glacier via diversion ditches.

1.7.12.2.7 Lower Mine Portal

Dewatering of the Lower Mine Portal will be achieved by routing surplus water to the Portal Collection Pond and then discharging it to Goldslide Creek.

1.7.12.2.8 Portal Collection Pond

The Portal Collection Pond will collect pumped surplus water from the Lower Mine Portal, as well as runoff from the lower laydown area. The Portal Collection Pond is located near the lower laydown area, upslope from Goldslide Creek. Surplus water from the Portal Collection Pond will discharged to Goldslide Creek.

1.7.12.2.9 Talus Quarry Sediment Ponds

The Talus Quarry Sediment Ponds (TQSPs) will collect contact runoff from the Talus Quarry areas. Surface runoff will be routed to the sediment ponds via appropriate grading of the area or sumps and pumps. Surplus water from the TQSPs will discharge to Goldslide Creek.

1.7.12.2.10 Additional Quarry Sediment Ponds

In addition to the two Talus Quarries above, there are four additional borrow and quarry areas that will be used for source materials for the Project:

- Otter Creek Quarry;
- Roosevelt Borrow;
- Hartley Gulch Borrow; and
- Highway 37A Quarry.

Sediment ponds will collect contact runoff from each of the quarry areas. Surface runoff will be routed to the sediment ponds via appropriate grading of the area or sumps and pumps, and upslope non-contact runoff will be diverted around the quarry areas. Surplus water from the sediment ponds will discharge to Bitter Creek.

1.7.12.2.11 Site Water Balance

During the Operation Phase, the Process Plant will require a water load consisting of 45 m^3/hr of reclaim water and 14 m^3/hr of freshwater. While the majority of this water will be recycled water from the TMF, freshwater will be drawn from Bitter Creek. Preliminary water balance results indicate a water deficit will not be encountered as there will likely be a surplus of water collected if a lead time of at least six months is given between lining of the TMF and commencement of operations. Additionally, if operations begin after the freshet, a surplus of water in the TMF is expected.

Based on the estimated Process Plant capacity of 1,000 tpd, the constant losses of water are estimated as follows:

- Water trapped in consolidated tailings = 440 m^3/day (162,000 m^3/year); and
- Mine-life average water losses due to evaporation in the TMF supernatant pond = 60 m^3/day (22,000 m^3/year).

An additional important seasonal loss incurred is due to embankment seepage to the North and South TMF Embankment Seepage Collection Ponds, which is estimated at 0.5 m^3/day (180 m^3/year), with approximately 60% reporting to the South pond and the remainder to the North pond. It is assumed that 80% of this loss is successfully captured in the ponds, and 20% is lost to the environment. 100% of that captured is recycled to the TMF via a seepage recycle system.

The conceptual water balance for the Mine Site Year -2 to Year 1, Mine Site Year 2 to Year 6, Bromley Humps, and for Quarries and Borrows are presented in Figure 1.7-12 to Figure 1.7-15.

Water management figures for the Mine Site, Bromley Humps, and Quarries / Borrows along the road alignment, are presented in Figure 1.6-1 to Figure 1.6-3.

1.7.12.2.12 Underground Mine Dewatering

The underground operation will extend to approximate maximum depth of 1,900 m to 1,925 m from the surface and will have a peak ore production rate of approximately 365 kt/yr. Seepage water will be channeled to sumps and pumped to the surface for disposal. Based on information obtained from Appendix 10-A, an estimated 2,600 m^3/day (minimum in Year 6) to 3,800 m^3/d (maximum in Year 2) will need to be dewatered and discharged to the Cambria Icefield or Goldslide Creek (via the Portal Collection Pond).

Figure 1.7-12: Water Balance Schematic – Mine Site (Year -2 to Year 1)

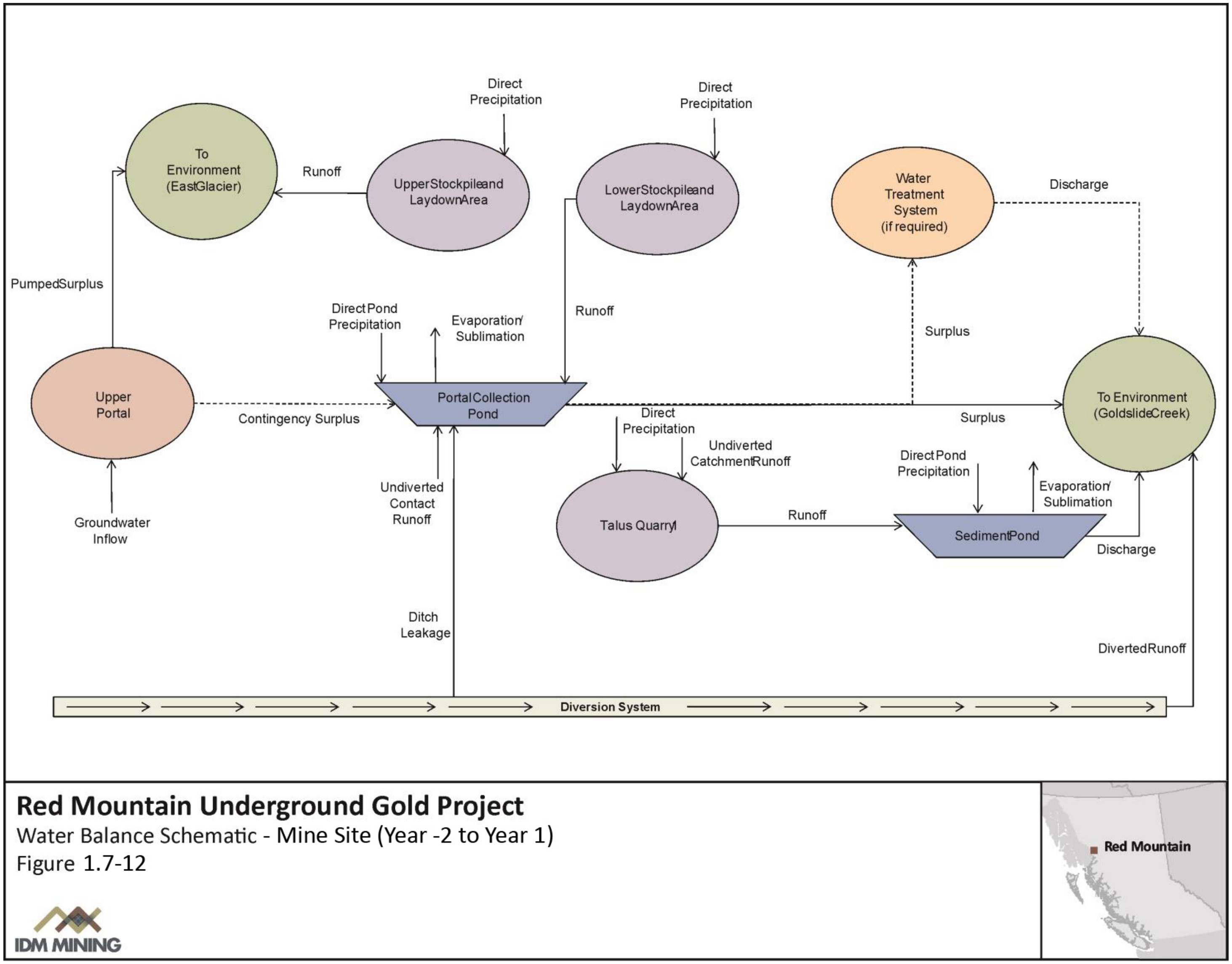
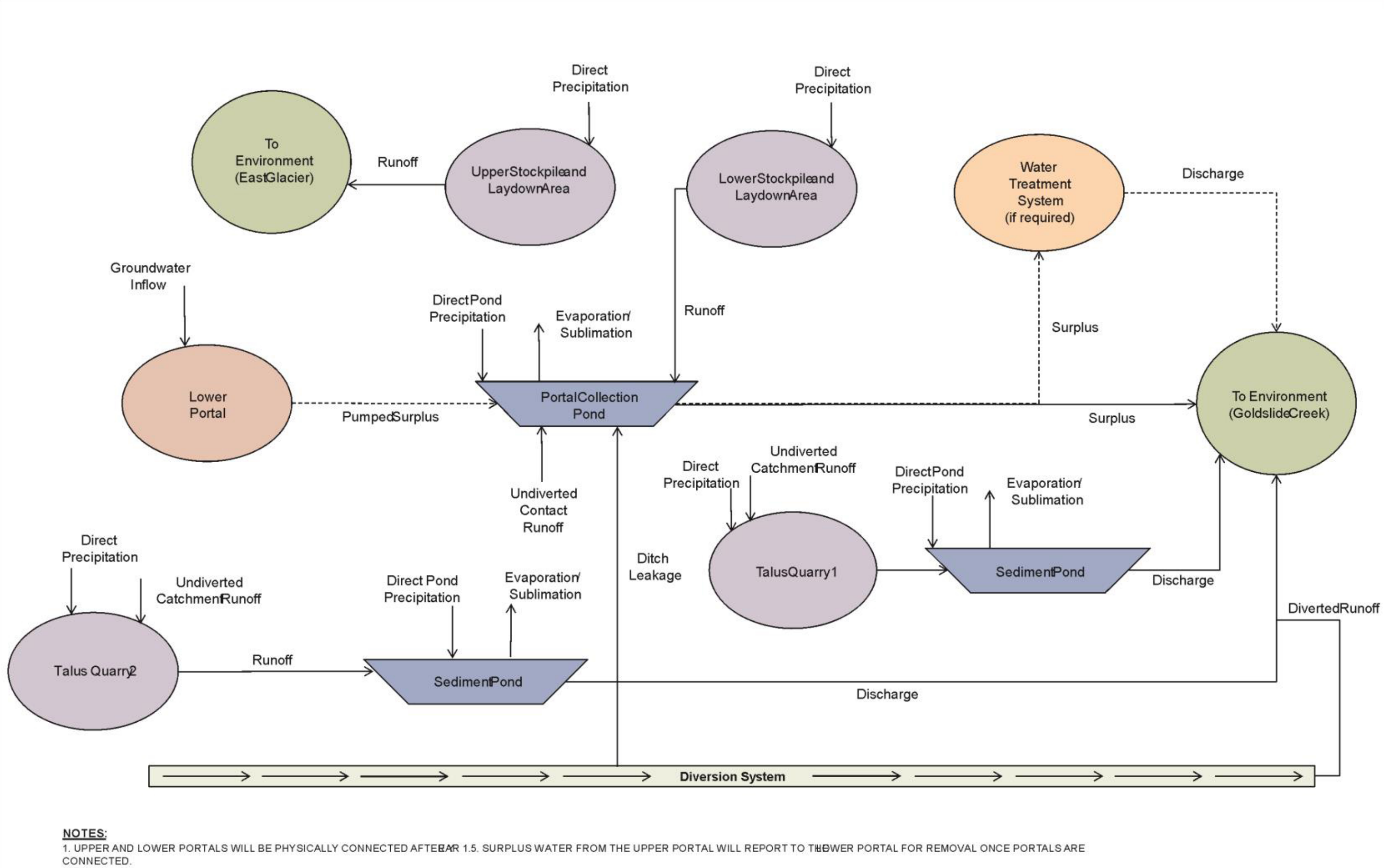


Figure 1.7-13: Water Balance Schematic – Mine Site (Year 2 to Year 6)



Red Mountain Underground Gold Project
Water Balance Schematic - Mine Site (Year 2 to Year 6)
Figure 1.7-13

IDM MINING

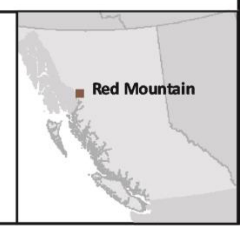
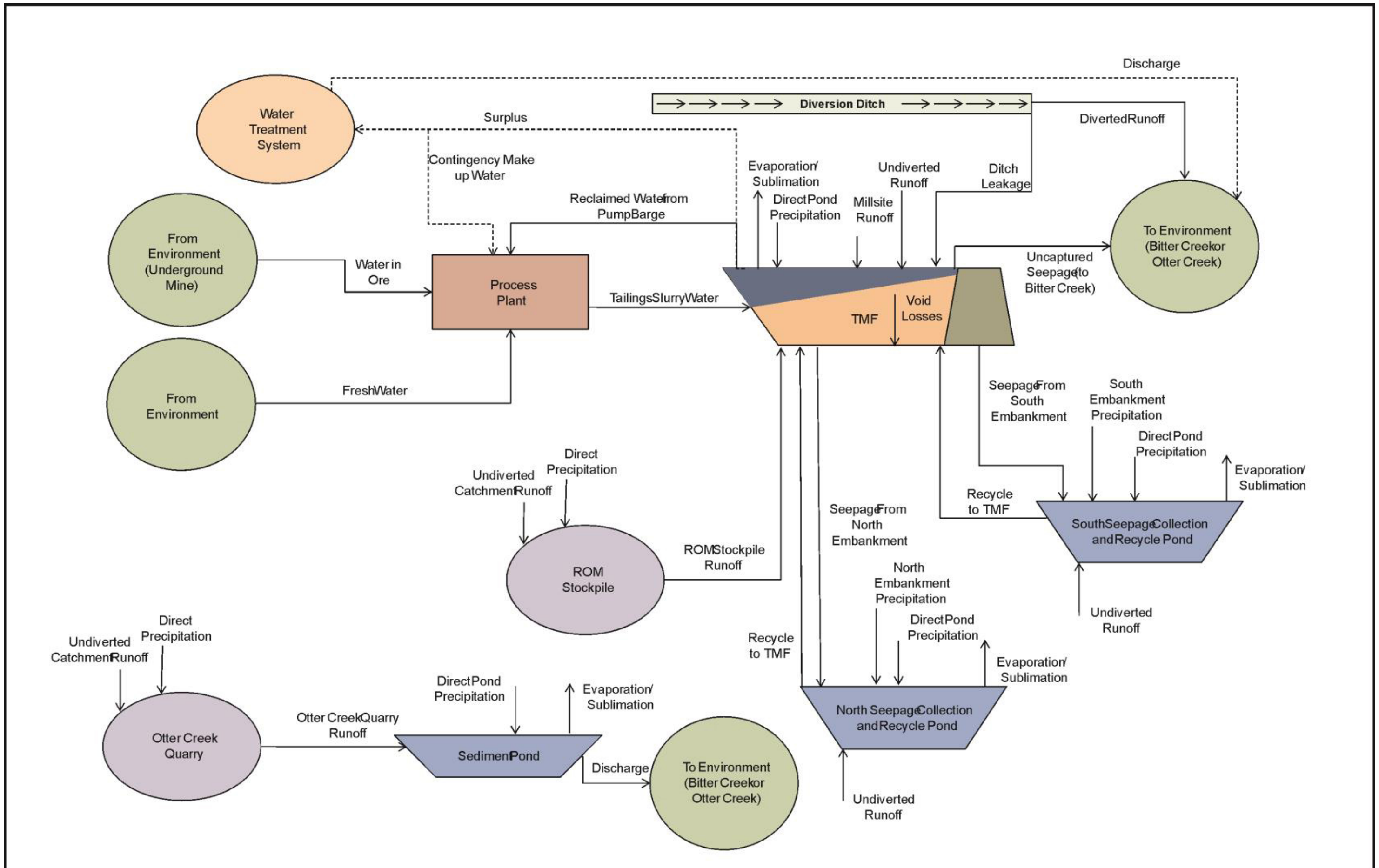


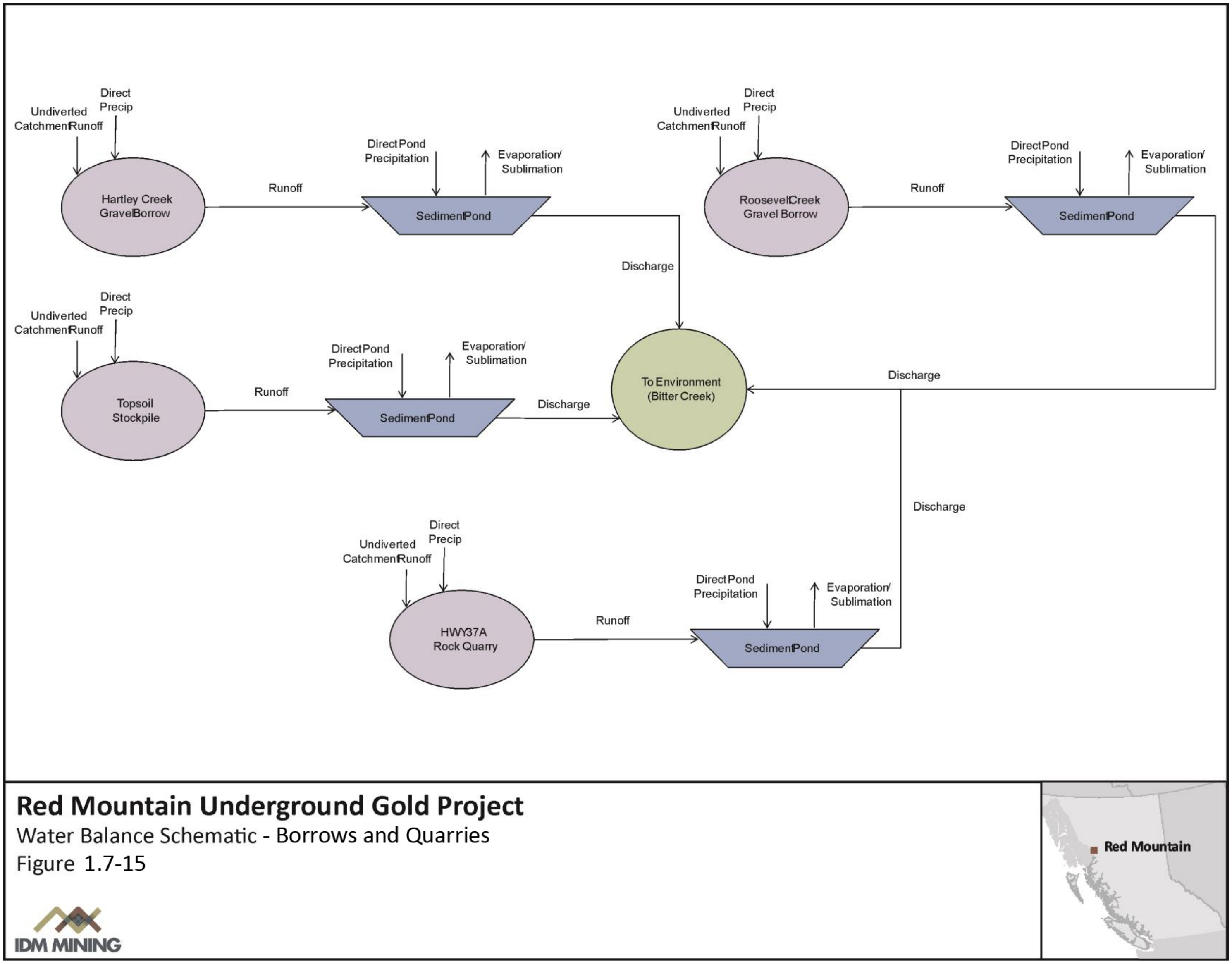
Figure 1.7-14: Water Balance Schematic – Bromley Humps



Red Mountain Underground Gold Project
Water Balance Schematic - Bromley Humps
Figure 1.7-14

IDM MINING

Figure 1.7-15: Water Balance Schematic – Borrows and Quarries



1.7.12.3 Water Treatment

A site-wide water quality prediction model was developed to determine mine water management and effluent treatment requirements for the Project (Water Quality Model Report, Appendix 14-C). The results of the water quality prediction model indicated that concentrations of ammonia, TSS, copper, and iron in the tailings pond water could exceed discharge concentration limits proposed for the Project. Therefore, excess water collected in the TMF will require treatment before it can be discharged to Bitter Creek. As is summarized in the Executive Summary of the Tailings and Water Management Design Report (Appendix 1-H), the TMF pond excess water will be discharged and treated over an eight-month period annually from March through October. During the months where there is no excess water, either a minor flow of water will have recirculated to maintain year round operations, or the water treatment plant will be decommissioned and recommissioned. A description of influent and effluent chemistry, flow, and the proposed treatment technology is provided in the following sections.

Refer to Appendix 1-H for a description of the drainage collection and conveyance systems for Bromley Humps and associated infrastructure.

1.7.12.3.1 Water Treatment Influent Flows and Chemistry

The Water Treatment Plant at Bromley Humps will treat surplus water from the TMF. The water balance for Bromley Humps (Appendix 1-H) estimates discharge rates from the TMF will peak in Year 3 at an estimated 62,000 m^3/month (estimated for the adjusted case which assumes wetter conditions as compared to the base case, as described in Appendix 1-H). Variations in the discharge rate are outlined in Appendix 1-H.

The TMF pond has limited dilution capacity, and process water makes up most of the water in the TMF. During the period when water is released from the TMF (during the first year of operations), process water in the pond varies seasonally and is approximately 60 to 100% of the volume that will be treated.

The design basis for the proposed water treatment system is based on results of the water balance and water quality model developed for the Project (Appendix 14-C).

The potential requirement to capture and treat mine contact water is driven by the concentrations of ammonia, TSS, copper, and iron predicted by the water quality model. Model predictions of water treatment plant influent water chemistry are summarized in Table 1.7-16.

Table 1.7-16: Design Basis for Red Mountain Water Treatment System

Parameter	Influent Concentration to Water Treatment System (mg/L)
Physical Parameters	
Conductivity (µS/cm)	10,400
pH	7.85
Anions and Nutrients	
Acidity (as $CaCO_3$)	20
Alkalinity, Total (as $CaCO_3$)	102
Ammonia, Total (as N)	122
Ammonia + Degradation Products (as N)	285
Bromide (Br)	1
Chloride (Cl)	23
Fluoride (F)	0.4
Nitrate (as N)	12
Nitrite (as N)	0.79
Sulfate (SO_4)	1,970
Cyanide	
Cyanide, Weak Acid Diss.	0.038
Cyanide, Total	0.89
Cyanate	381
Thiocyanate (SCN)	151
Dissolved Metals	
Aluminum (Al)-Dissolved	0.055
Antimony (Sb)-Dissolved	2.4
Arsenic (As)-Dissolved	0.014
Barium (Ba)-Dissolved	0.10
Beryllium (Be)-Dissolved	0.0005
Bismuth (Bi)-Dissolved	0.00025
Boron (B)-Dissolved	1.1
Cadmium (Cd)-Dissolved	0.0013
Calcium (Ca)-Dissolved	167
Cesium (Cs)-Dissolved	0.00023

Parameter	Influent Concentration to Water Treatment System (mg/L)
Chromium (Cr)-Dissolved	0.00075
Cobalt (Co)-Dissolved	0.084
Copper (Cu)-Dissolved	0.46
Iron (Fe)-Dissolved	0.78
Lead (Pb)-Dissolved	0.0019
Lithium (Li)-Dissolved	0.023
Magnesium (Mg)-Dissolved	12
Manganese (Mn)-Dissolved	0.23
Mercury (Hg)-Dissolved	0.00015
Molybdenum (Mo)-Dissolved	0.16
Nickel (Ni)-Dissolved	0.004
Phosphorus (P)-Dissolved	0.25
Potassium (K)-Dissolved	120
Rubidium (Rb)-Dissolved	0.026
Selenium (Se)-Dissolved	0.051
Silicon (Si)-Dissolved	1.8
Silver (Ag)-Dissolved	0.00093
Sodium (Na)-Dissolved	665
Strontium (Sr)-Dissolved	2.2
Tellurium (Te)-Dissolved	0.001
Thallium (Tl)-Dissolved	0.00013
Thorium (Th)-Dissolved	0.0005
Tin (Sn)-Dissolved	0.0005
Titanium (Ti)-Dissolved	0.0015
Tungsten (W)-Dissolved	0.0025
Uranium (U)-Dissolved	0.0024
Vanadium (V)-Dissolved	0.0025
Zinc (Zn)-Dissolved	0.085
Zirconium (Zr)-Dissolved	0.0003

The proposed water treatment process will also be effective at removing elevated concentrations of other dissolved metals. The water quality of the treatment influent was screened, and it was determined that most dissolved metal concentrations (excluding iron and copper) did not require treatment, and were at levels where treatment would not result in an appreciable reduction in concentrations. If higher concentrations of parameters and dissolved metals were observed, the treatment process would be effective at reducing concentrations of these metals and other parameters: Aluminum, Ammonia, Antimony, Arsenic, Cadmium, Cobalt, Copper, Cyanide, Dissolved Organic Carbon, Iron, Lead, Manganese, Mercury, Nickel, Nitrite, Silver, Tin, Total Suspended Solids, Uranium, and Zinc.

1.7.12.3.2 Treated Effluent Quality

Concentrations of TSS, ammonia, and copper in the TMF Pond are expected to exceed the Metal Mining Effluent Regulations (MMER) limits. Treatment is also required for iron to meet receiving water guidelines in Bitter Creek, which include BC MoE Water Quality Guidelines for Freshwater Aquatic Life (BC WQGs) and CCME.

A summary of the expected post-treatment concentrations of the parameters described above is provided in Table 1.7-17.

Table 1.7-17: Expected Post-Treatment Effluent Chemistry

Parameter	Post-Treatment Expected Concentration (mg/L)	Notes on Expected Effluent Concentration
Ammonia (as N)	5	MEND, 2014: typical precious metal sector treated effluent (average concentration)
Dissolved Iron	0.1	MEND, 2014: typical precious metal sector treated effluent (average concentration)
Dissolved Copper	0.03	Based on analog treated effluent of similar treatment plants and influent water chemistry
Total Suspended Solids	15	Required to meet MMER

The effluent from the water treatment facility will be treated to meet MMER guidelines and will be discharged to Bitter Creek.

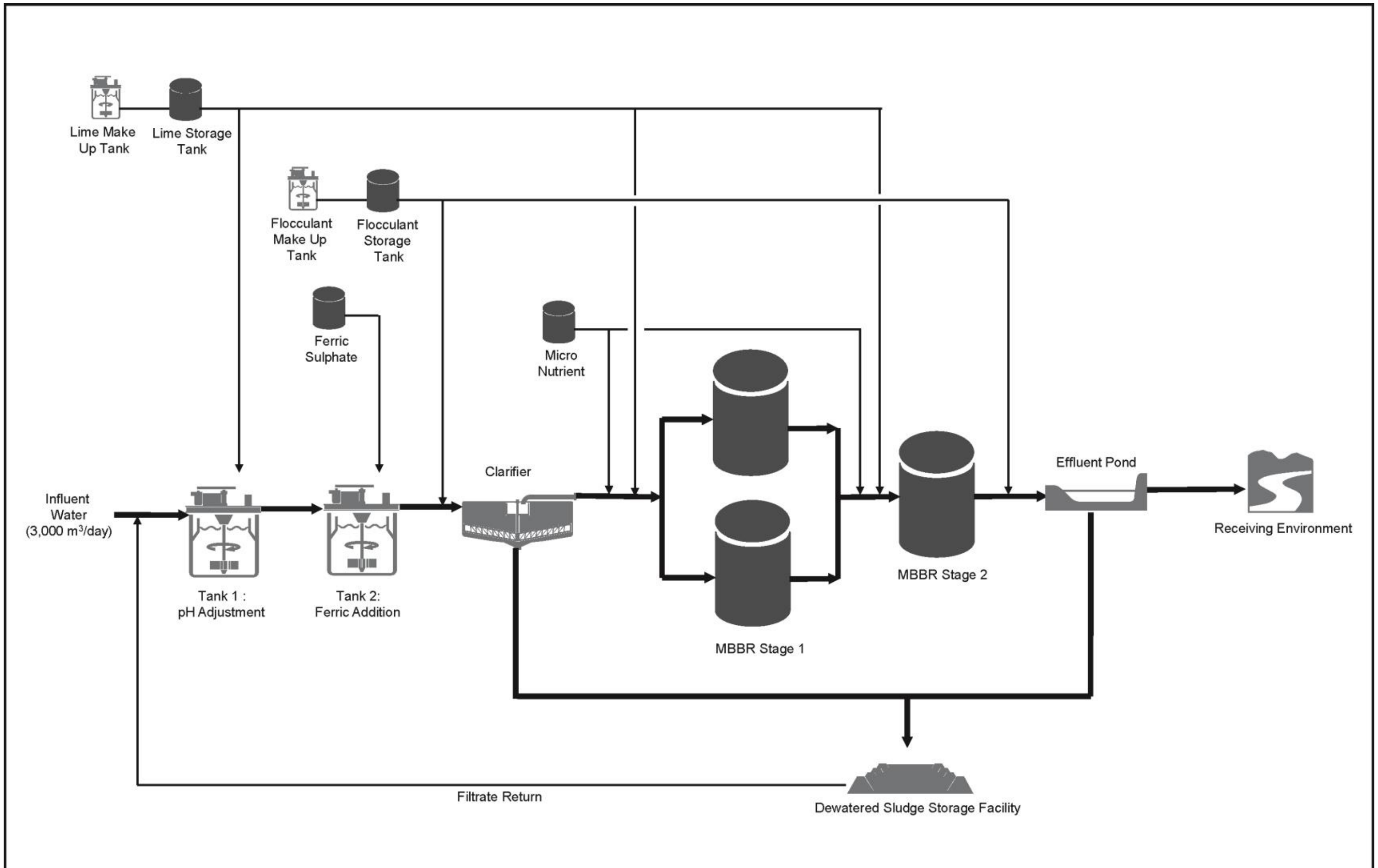
1.7.12.3.3 Treated Effluent Quality

The effluent from the water treatment facility will be treated to meet MMER Guidelines and will be discharged to Bitter Creek

The following is a description of the water treatment process proposed for the Project. Refer to Appendix 14-C (Appendix G of that report) for further information regarding process options that were considered for parameters of concern as well as the assessed performance of the selected option under a range of flow and climactic conditions.

Figure 1.7-16 shows a process flow diagram of the treatment system proposed for the Project.

Figure 1.7-16: Water Treatment System - Process Flow Diagram



Red Mountain Underground Gold Project
Water Treatment System - Process Flow Diagram
Figure 1.7-16

IDM MINING

TSS and Metals Treatment: Lime and Ferric Coagulation

The first stage of the proposed water treatment process is a lime treatment with ferric coagulation and clarification. For this treatment stage, the influent water will be pumped into a mix tank where hydrated lime ($Ca(OH)_2$) would be added to increase the influent water pH to 9.0. At a pH of 9.0, dissolved metals such as copper, cadmium, and iron precipitate as metal hydroxides solids. The tank will be agitated mechanically to ensure proper mixing. The lime dosing system will consist of a screw feeder, agitated make-up tank, transfer pump, storage tank, metering pump, and associated piping to the dosing location.

From the first mix tank, the water will flow to a second mix tank where ferric sulphate will be added. The addition of ferric sulphate serves the following purposes:

- Coagulation: ferric sulphate is a coagulant that binds precipitated metal hydroxides into larger particles; and

- Co-precipitation: the ferric added will form a ferric hydroxide precipitate ($Fe(OH)_3$) that acts as a media for adsorbing dissolved metals, including cadmium and arsenic.

The ferric sulphate reagent dosing system will consist of storage tanks, a metering pump assembly, and associated piping to the dosing location.

Following the ferric sulphate mix tank, the water will flow to a clarifier. Flocculant will be added to the clarifier influent pipe or clarifier center well. The addition of the flocculant will result in the formation of larger particles and will enhance the settling of the precipitated metal hydroxide solids. The proposed flocculant dosing system will consist of a screw feeder, agitated make-up tank, transfer pump, storage tank, metering pump, and associated piping to the injection location.

Flocculant reagents are used commonly in many different water treatment applications, both for drinking water and water released to aquatic environments. The Project's water treatment plant will use an anionic flocculant with low aquatic toxicity.

The precipitated metal solids will be collected as sludge in the clarifier. The sludge will be dewatered in exfiltration ponds to reduce the volume of treatment residuals that require disposal. Assuming that the sludge can be dewatered to a density of 30% solids, it is estimated that approximately 16 m^3 of sludge per month will be generated in the proposed treatment process. This sludge will mostly consist of ferric hydroxide and is expected to be non-hazardous. The dewatered sludge can either be mixed into the tailings or left in the exfiltration pond and covered.

The preliminary ferric co-precipitation tank sizing and clarifier sizing are summarized in Table 1.7-18.

Table 1.7-18: Preliminary Ferric Co-Precipitation Tank and Clarifier Sizing

Parameter	Value	Units
Design Flow	3,000	m^3/day
Estimated Annual Treatment Requirement	500,000	m^3/year
Lime Tank		
Number of Equivalent Standard Tanks	1.0	
Residence Time	10	minutes
Standard Tank Volume (each)	20.8	m^3
Height to Diameter Ratio	1.0	
Tank Diameter	3.0	m
Tank Wetted Height	3.0	m
Tank Headspace	0.5	m
Total Tank Height	3.5	m
Lime Dosing Rate	300	kg/day, dry lime
Lime Dosing Rate	2,000	L/day, 14% solution
Ferric Sulphate Mix Tank		
Number of Equivalent Standard Tanks	1.0	
Residence Time	5	minutes
Standard Tank Volume (Each)	10.4	m^3
Height to Diameter Ratio	1.0	
Tank Diameter	2.4	m
Tank Wetted Height	2.4	m
Tank Headspace	0.5	m
Total Tank Height	2.9	m
Ferric Sulphate Dosing Rate	215	kg/day, dry
Ferric Sulphate Dosing Rate	135	L/day, 40% solution

Parameter	Value	Units
Clarifier		
Rise Rate	1.0	m/hr
Clarifier Surface Area	125	m^2
Diameter	12.6	m
Flocculant Dosing Rate	6	kg/day, dry
Flocculant Dosing Rate	2,400	L/day, 0.25% solution

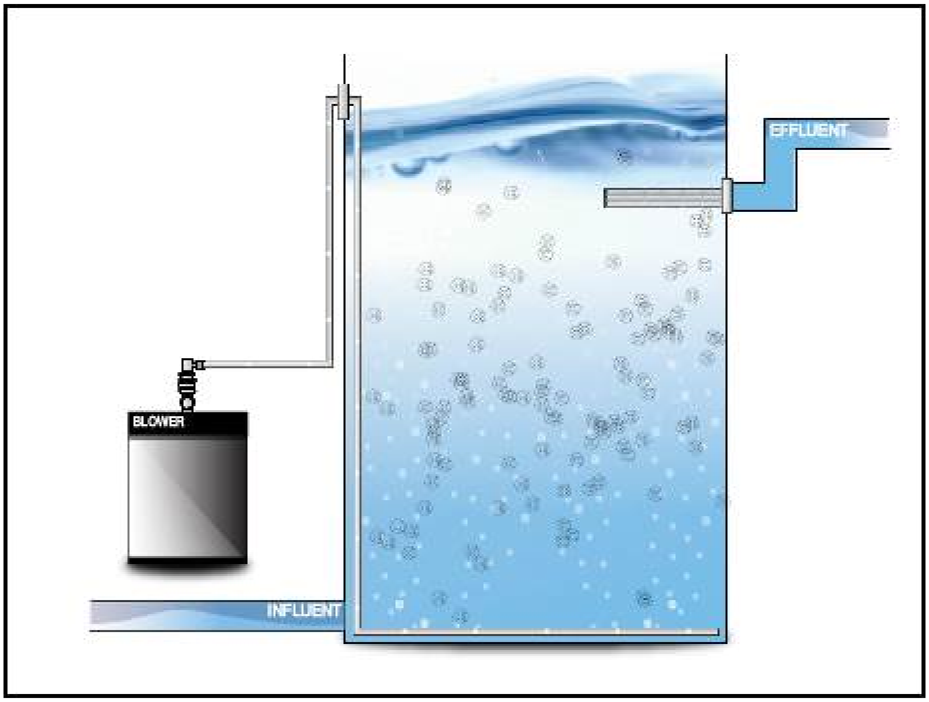
The clarifier supernatant will receive further treatment downstream in the moving bed bioreactor (MBBR) biological system, described below.

Ammonia Treatment: Moving Bed Bioreactor (MBBR)

The clarifier overflow will be pumped to the proposed MBBR process, which is an aerobic biological treatment system for removal of cyanide, cyanate, thiocyanate, and ammonia. The MBBR technology utilizes attached growth media that is circulated in an aerated reactor. Autotrophic microorganisms convert reduced ammonia species to nitrogen in a process known as nitrification. Air supplied to the MBBR by blowers and an air diffuser grid located on the bottom of the reactor vessel will keep the reactor aerated and will also mix the tank (Figure 1.7-17).

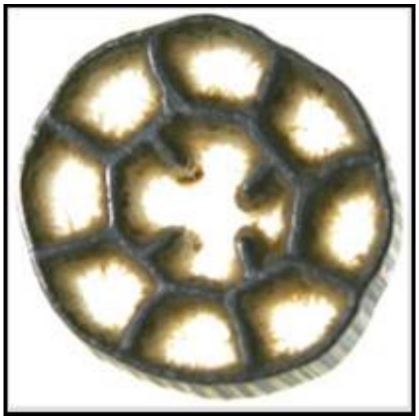
Suspended plastic biofilm carriers made from high density polyethylene is used as media to support the microbial growth (Figure 1.7-18). The media is available in different shapes and sized by generally measure about 1 cm in diameter. The pH of the reactors will be maintained at near neutral using lime. Micronutrients, such as phosphate, will be added as required. The micronutrients will be stored in a tote and dosed to the MBBR tanks via a metering pump.

Figure 1.7-17: Schematic of MBBR Configuration



Source: http://www.headworksinternational.com/biological-wastewater-treatment/MBBR.aspx

Figure 1.7-18: Example of Plastic Biofilm Carrier for MBBR



Source: http://www.headworksinternational.com/biological-wastewater-treatment/MBBR.aspx

To treat the ammonia loading anticipated for the Project, a two-stage MBBR system is proposed. The first stage would consist of two tanks operated in parallel, followed by a third tank in series. The MBBR media and tank preliminary sizing is summarized in Table 1.7-19.

Table 1.7-19: MBBR Media and Tank Preliminary Sizing

Parameter	Value	Units
MBBR Media		
Unit Media Area	700	m^2/m^3
Overall Performance	0.3	g/m^2/day @ 4°C
Design Feed Ammonia (as N) Loading	300	kg/day
Average Feed Ammonia (as N) Loading	0.3	g/m^2/day @ 4°C
Media Volume, Total	1429	m^3
Media Surface Area, Total	1,000,000	m^2
MBBR Tanks		
Number of Tanks	3	Two in parallel followed by one in series
Media Occupation	60%	% of total tank volume
Tank Volume (per tank)	794	m^3
Reactor Height:Diameter	1.0	
Tank Diameter	10	m
Tank Wetted Height	10	m
Tank Headspace	1	m
Total Tank Height	11	m
Lime Dosing Rate	3,300	kg/day, dry lime
Lime Dosing Rate	21,800	L/day, 14% solution
Monopotassium Phosphate Dosing Rate	85	kg/day, dry
Monopotassium Phosphate Dosing Rate	1,630	L/day, 5% solution
Flocculant Dosing Rate	3	kg/day, dry
Flocculant Dosing Rate	1,200	L/day, 0.25% solution

Effluent Pond or Clarifier

Following the second stage of the MBBR system, the treated effluent will be piped to an effluent pond prior or clarifier prior to discharge to the receiving environment. The effluent pipe from the MBBR system will be dosed with flocculant to enhance settling of the biomass generated from the MBBR system. The effluent pond or clarifier will serve as a final settling stage for removal of biomass.

From the effluent pond, the treated water will be discharged to the receiving environment.

1.7.12.3.4 Treatment Residuals Management

For the first stage of the proposed water treatment process (lime treatment with ferric coagulation and clarification), the precipitated metal solids will be collected as sludge in the clarifier. The sludge will be dewatered in exfiltration ponds to reduce the volume of treatment residuals that require disposal. Assuming that the sludge can be dewatered to a density of 30% solids, it is estimated that approximately 16 m^3 of sludge per month will be generated in the proposed treatment process. This sludge will mostly consist of ferric hydroxide and is expected to be non-hazardous. The dewatered sludge will be trucked off-site and disposed of in a registered hazardous waste facility.

The biological sludge is generated by conversion of ammonia (and other biodegradable material) to microbial biomass, which grows in a fixed film on the MBBR carrier media. A portion of the biomass will naturally slough from the fixed film and exit the system as suspended solids in the treated effluent. To estimate the generation of biomass sludge produced via biological treatment for ammonia, a conservative effluent biomass concentration of 20 mg/L was assumed. Chemically, the biomass consists of organic bacterial film and is non-hazardous. This sludge would be removed from the effluent pond and dewatered to reduce the volume of treatment residuals requiring disposal. Assuming a solids content of 20% by weight, the estimated sludge production is approximately 8 m^3/month. The biomass will be trucked off-site and disposed of in a registered hazardous waste facility. Sludge will be temporarily stored in sea-can containers within the enclosed water treatment plant footprint.

1.7.12.3.5 Capital and Operating Cost

Capital and operating costs have been provided by Integrated Sustainability for inclusion in the feasibility study for the Project, and are shown in Tables 1.7-20 and 1.7-21 (JDS 2017).

Table 1.7-20: Water Treatment Capital Cost Estimate

Capital Cost Estimate	
Labour	$1,233,025
Materials	$772,963
Equipment	$2,711,702
Contingency	$492,998
Total	**$5,496,903**

Table 1.7-21: Water Treatment Operating Cost Estimate

Operating Cost Estimate (/year)	
Maintenance	$99,000
Power	$531,778
Chemical Costs	$121,657
Lime Sludge Disposal	$539
MBBR Sludge Disposal	$3,963
Total	**$756,937**

1.7.12.3.6 Health and Safety

The proposed water treatment system uses unit operations and reagents that are standard for water treatment operations. The hazards associated with these reagents and reagent dosing systems are well understood and documented. Standard engineering safeguards, as well as comprehensive operator training, will be in place for the health and safety of all operators and personnel involved in the treatment system.

Throughout the design, commissioning, start-up, and ongoing operational phases, the water treatment system will be evaluated using hazards and operability analyses. Standard operating procedures and task training protocols will be developed and implemented to ensure that all operational procedures are consistently executed safely.

Emergency response procedures will be developed and integrated into the other site-wide emergency response protocols and systems for the Mine Site. All health and safety systems will be developed to meet or exceed the requirements outlined in the Health, Safety and Reclamation Code for Mines in BC.

1.7.12.3.7 Monitoring

Monitoring commitments and responsibilities related to water management are outlined in the Site Water Management Plan (Volume 5, Chapter 29).

1.7.13 Other Infrastructure Required for Operations

As discussed in Section 1.6, all ancillary buildings and facilities required for the operation will be erected during the Construction Phase of the Project. Refer to Section 1.6.4.15 for a description of these facilities.

1.8 Environmental Monitoring

IDM is committed to environmental monitoring through all phases of the Project. Monitoring will be undertaken for ensuring compliance with all regulatory requirements as well as for confirming the effectiveness of established mitigation and management measures. Adaptive management is incorporated into the Project EMS. Such a program is in place for adjusting management strategies, as required, based on monitoring results. Further details regarding environmental monitoring and follow-up programs can be found in Volume 5, Chapter 30.

1.9 Project Design Changes

IDM has elected to make changes to the Project design since originally proposed that, when considered altogether, minimize potential adverse environmental, social, economic, heritage, and health effects to Aboriginal people and the public. Table 1.9-1 provides a list of the key design changes and anticipated environmental and social benefits associated with these changes.

Table 1.9-1: Project Design Changes

Redesigned Project Component	Description	Benefit of Changes to the Environment	Benefit of Changes to Aboriginal Peoples	Benefit of Changes to the Public
Mining Schedule	The original mine production schedule was based on a seasonal schedule operating 9 months annually. The current mine production schedule is based on a year-round schedule operating 12 month annually.	Reduced temporary waste and ROM ore stockpiles, reducing overall Project footprint.	Year-round employment rather than seasonal employment opportunities.	Year-round employment rather than seasonal employment opportunities.
Lower Portal	The original lower portal location was designed at an elevation of 1,650 m. The current lower portal location is designed at an elevation of 1,720 m.	Reduced underground development distance.	No effect.	Current lower portal location reduces developmental costs and increases Project economics.
Power Transmission/Distribution	The original transmission design was a 34 kV line connecting Bromley Humps to the existing BC Hydro line off Highway 37A. The current transmission line design allows for a 138 kV line connecting Bromley Humps to the existing BC Hydro line off Highway 37A.	Reduced line loss with higher voltage line.	No effect.	No effect.
Employee Housing/Transportation	The original employee housing plan was for all personnel to be based out of Stewart during construction and operations. The current employee housing plan includes provisions for a construction camp based in Stewart for contract employees during Construction with a plan to transition all employees to Stewart during Operation.	No effect.	No effect.	The use of a construction camp will allow for a reduced effect on the Town of Stewart’s housing market during Construction and while being located in Stewart, it will provide direct and indirect opportunities to local businesses.

Redesigned Project Component	Description	Benefit of Changes to the Environment	Benefit of Changes to Aboriginal Peoples	Benefit of Changes to the Public
Ore Processing Method	The original mineral processing method was a Floatation, Re-Grind and Leaching (FRL) circuit. The current mineral processing method is a Carbon-in-Leach (CIL) circuit.	No effect.	No effect.	CIL circuit provides higher recoveries and increased Project economics.
Water Treatment	The original water quality prediction results did not indicate water treatment would be required. The current water quality prediction results indicate that water treatment will be required.	Increased discharge water quality. The results of the water quality prediction model indicated that concentrations of ammonia, TSS, copper, and iron in the tailings pond water could exceed discharge concentration limits proposed for the Project. Therefore, excess water collected in the tailings facility would require treatment before water can be discharged to Bitter Creek.	No effect.	No effect.

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