OCEANAGOLD
Haile Operation

Appendix A

Detailed Project Description

for Proposed Haile Gold Mine Expansion

(Revision 2)

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List of Acronyms

amsl	above mean sea level
Applicant, the	Haile Gold Mine, Inc.
bmsl	below mean sea level
CIL	carbon in leach
CoG	cut-off grade
CPS	Coastal Plains Sands
CWTP	Contact Water Treatment Plant
cy	cubic yard(s)
CN	cyanide
EAP	Emergency Action Plan
FWSA	Fresh Water Storage Area

FWSD	Fresh Water Storage Dam
gpm	gallons per minute
HDPE	high-density polyethylene
kton	kiloton(s)
kV	kilovolt
Haile	Haile Gold Mine, Inc.
HCO_3	bicarbonate
LCRS	leak collection and recovery system
mil	a mil is one one-thousandth of an inch
MW	megawatt(s)
m	meter
Mt	million tons
NH_4	ammonium
North Fork	North Fork of Haile Gold Mine Creek
NPDES	National Pollutant Discharge Elimination System
OCN-	cyanate
opt	ounces per ton
OSA	overburden storage area
PAG	potentially acid-generating
PMP	probable maximum precipitation
ppm	parts per million
Project	Haile 2018 Mine Expansion Plan
rec oz/t	recoverable troy ounce per ton
SCDHEC	South Carolina Department of Health and Environmental Control
TSF	Tailings Storage Facility
US 601	US Highway 601
UV	ultraviolet
WAD	weak acid dissociable

PROPOSED HAILE GOLD MINE PROJECT DESCRIPTION

This document describes the Haile Mine Expansion Plan (the proposed Project) in detail, including the ore mining and processing operations that would recover gold and silver[1] by excavating pits and underground deposits, storing excavated soils and overburden, processing the ore, managing surface water and ground water during operations, reclaiming the site at the end of operations, and monitoring site conditions post-mining. The components of the proposed Project are summarized in Section 3, "Overview of the Proposed Project," and each component is discussed in detail in the sections that follow. Imperial units of measure are used throughout this Project Description narrative. Metric conversions are provided in the attached Conversion Chart in Appendix A at the end of the document.

1. SITE DESCRIPTION

The proposed Project is located 3 miles northeast of the Town of Kershaw in southern Lancaster County, South Carolina (Figure A-1). Lancaster County lies in the north-central part of the state. The Haile Gold Mine is approximately 17 miles southeast of the City of Lancaster, the county seat, which is approximately 30 miles south of Charlotte, North Carolina.

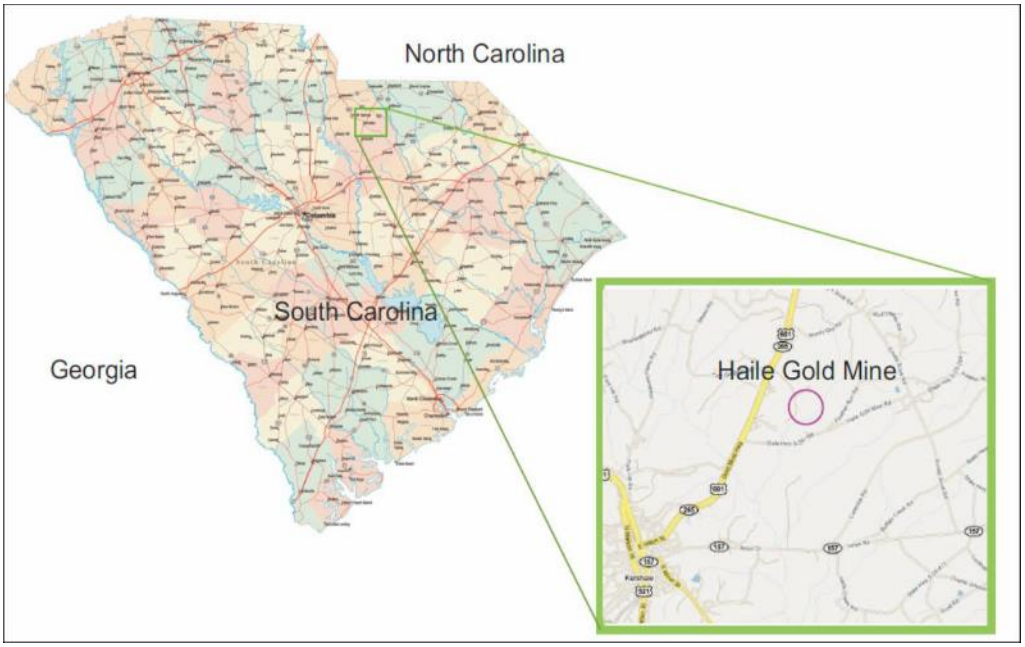

Figure A-1 Vicinity Map of the Proposed Project
Source: State-Maps.org and Google Maps, 2014

Figure A-2 shows the Site for the proposed Project area in greater detail, including the Project Boundary within which mine activity would occur. It also shows the location of specific elements of the currently permitted mining activity and local roads. US Highway 601 (US 601) runs along the west side of the main portion of the Project area; the proposed Tailings Storage Facility (TSF) is located west of US 601 at the north end of the Project area.

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[1] Although approximately 50 percent more silver than gold is extracted from the Haile Gold Mine by volume, Haile Gold Mine is considered a gold mine because the value of the gold exceeds the value of the silver at a general ratio of 50:1 (or more). Thus, the gold reserve is what makes Haile Gold Mine a valuable ore body to mine. For convenience, the supplemental environmental impact statement (SEIS) refers to ore extraction and processing in terms of gold production.

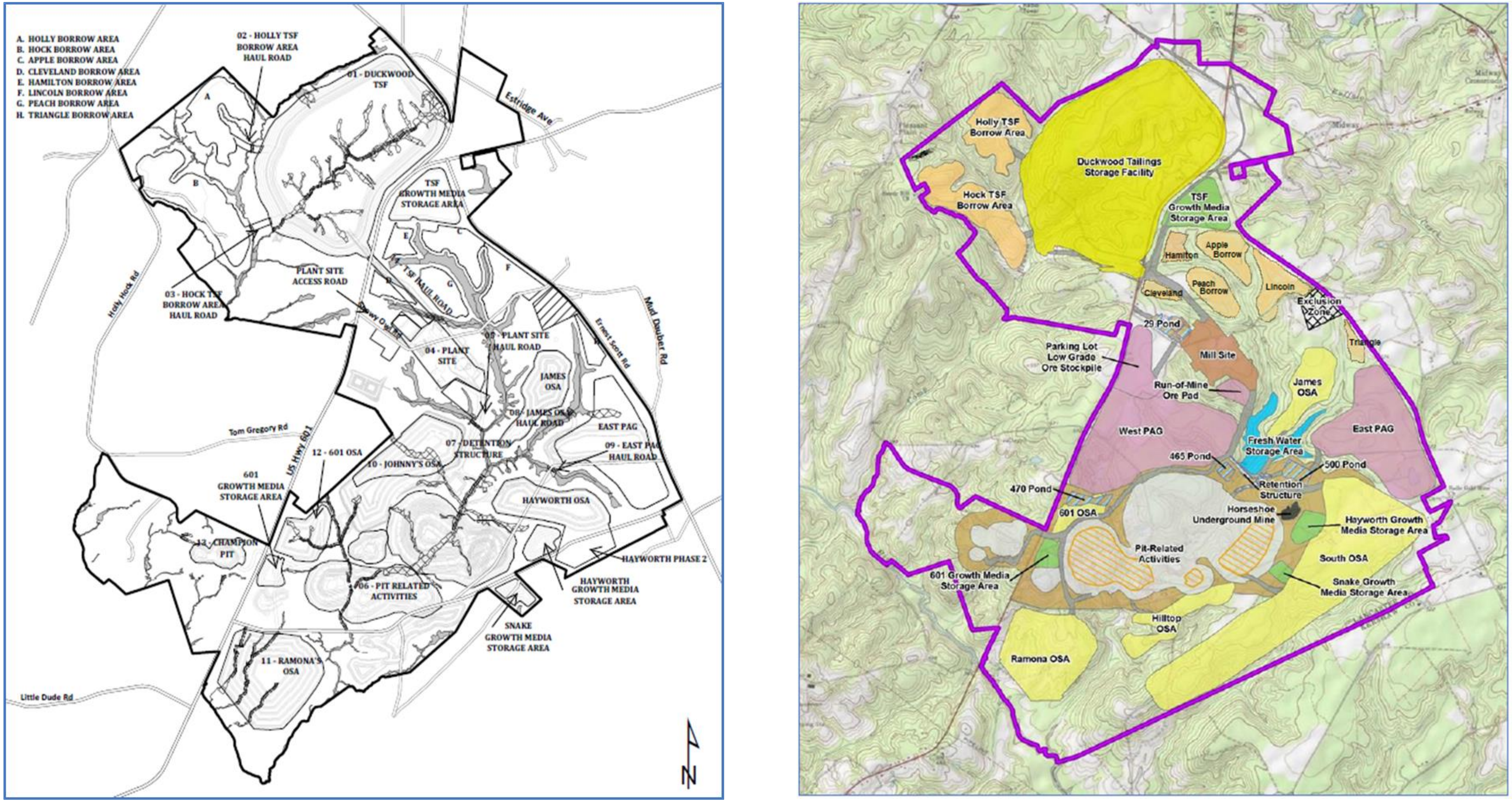

Figure A-2 **Currently Approved Mine Plan and Proposed Mine Plan**
Source: Haile 2018

Haile initiated its current mining activities in 2015 pursuant to permits issued in 2014. The timeline for the Haile Project is shown in Appendix B. Haile currently is mining in Mill Zone Pit, Snake Pit, Red Hill Pit and starting mining activities in Haile Pit and Ledbetter Pit. Overburden has been placed, depending on its acid generating potential, into Johnny's Potentially Acid Generating (JPAG) or East PAG Storage Areas, or into one of three non-PAG (green) overburden storage areas (OSAs) - Ramona OSA, Hayworth OSA, or James OSA. Growth media has been placed in 601 Growth Media Storage Area (GMSA), TSF GMSA, and Hayworth GMSA. The Mill Processing Plant (Mill) is operating and approaching permitted capacity at 3.3 million tons / year through the crusher and grinding circuits. Gold doré bars are being poured, and tailings material is being deposited in the Tailing Storage Facility (TSF).

The purpose of this Expansion Plan is to:

- Increase the mine pit shell from $950 to $1,150/troy ounce. This expands the volume of gold-bearing ore that previously would have been uneconomical to mine.
- Perform underground mining operations at Horseshoe Deposit.
- Optimize Mill operations by removing several operational bottlenecks, which increases capacity from approximately 9,100 tons / day to approximately 14,400 tons/day (from about 3.3 M tons / year to 5.1 M tons / year).
- Expand the Project Boundary to include adjacent properties which will increase total acreage within the Project Boundary by about 832 acres from about 4,552 acres to about 5,384 acres. See Figure A-3 for a comparison of the currently permitted Project Boundary and the proposed new Project Boundary.
- Increase TSF storage (with HDPE liner and underdrain collection system) from approximately 40 million tons to approximately 72 million tons by adding additional lifts to the existing TSF.
- Increase above ground Potentially Acid Generating (PAG) storage (with HDPE liner and contact water collection system) from approximately 100.1 million tons to approximately 150.1 million tons by expanding the existing JPAG facility (now called "West PAG");
- Increase above ground green OSAs from approximately 147.5 million tons to approximately 207.0 million tons primarily by adding a large green OSA facility along the southern border – South OSA.
- Expand Contact Water Treatment Plant (CWTP) average capacity from approximately 1,200 gallons per minute (gpm) to approximately 2,400 gpm; and
- Increase primary contact water storage capacity at the 19 Pond (which services the CWTP) from approximately 19 million gallons to approximately 39 million gallons.

As a result of the proposed expansion of mine and process operations, Haile will:

- Increase current employment from approximately 400 to over 650 people at the peak of open pit and underground mining.
- Extend mine life from about 14 years to over 16 years.
- Expand its Project Boundary by less than 20%, as illustrated in Figure A-3.

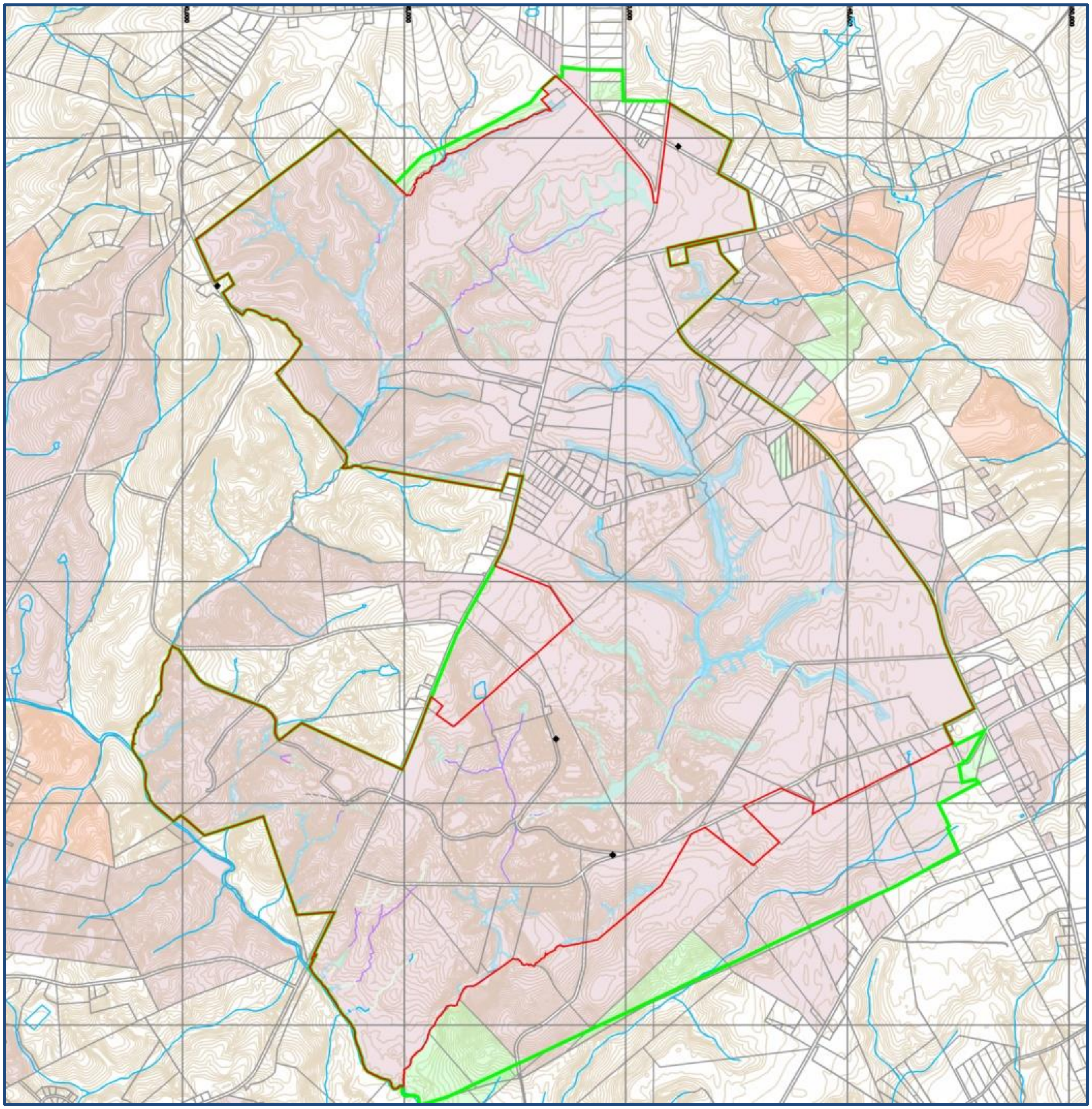

Figure A-3 Project Boundary - Original Boundary (2014) – Red, Proposed New Boundary (2018) – Green)

Source: Haile 2018

2. MINERALIZED ORE TO BE MINED

Haile's most recent Feasibility Study has identified additional gold-bearing minerals that could be economically recovered within the Project area (SRK NI 43-101 Technical Report (August 2017)). These gold-bearing minerals are known as ***reserves***[2]. Use of the term reserves is limited to ore bodies that have

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[2] Declaration of a reserve is governed by public disclosure requirements applicable in the United States and Canada. See U.S. Securities and Exchange Commission *Industry Guide 7* (August 13, 1992); Canadian Institute of Mining, Metallurgy, and Petroleum *Definition of Standards for Mineral Resources and Reserves* (December 11, 2005).

been subjected to a thorough analysis of extensive exploratory drilling results and a comprehensive evaluation of technical and economic feasibility based on mining industry investment standards. The plan for mining a defined reserve (the expected pit locations and the depths and pace of mining) is called the mine plan and is set out initially in a feasibility study. Areas that may contain gold-bearing minerals, but that have not been subjected to rigorous subsurface evaluation and feasibility analysis, may be considered ***resources*** and are differentiated from reserves. Resources are not considered for inclusion in a mine plan unless further studies convert the resources into reserves. The term mineralization refers to rock that contains, or is likely to contain, gold. Mineralization or mineralized strata can occur in both reserves and resources, as well as outside of them, as these terms simply indicate the potential for the rock strata to contain precious minerals.

Haile used $950 / troy ounce as the cut-off price to determine economic feasibility in the 2014 EIS. This established the blocks of ore material that would be economical to mine and this led to the original Mine Plan that Haile permitted in 2014. However, the price of gold has been consistently above $950 for the past ten years, as shown in Figure A-4; therefore, the new Mine Plan is based on $1,150 / troy ounce. This results in the Mine Plan's inclusion of some additional reserves shown in Table A-1.

Figure A-4 Gold Price (US$ / troy oz)
Source: www.macrotrends.net, August 2020

Table A-1: Open Pit and Underground Mine Plan

Mining Type	2014 EIS		2018 Plan	
	Ore Processed (Mt)	Au Contained (M troy oz)	Ore Processed (Mt)	Au Contained (M troy oz)
Open Pit	40	2.00	63.1[1]	3.02[2]
Underground	---		3.4	0.44
Subtotal	**40**	**2.00**	**66.5**	**3.46**

Source: Haile, 2014 and 2018 Mine Plans

Notes:

[1] The TSF proposed for the Haile 2018 Mine Expansion Plan is designed to hold 72.0 M tons of tailings (about 5.5 M tons more than this tailings tonnage figure) to account for discrepancies in bed densification and to allow for needed operational flexibility.

[2] Haile mined 0.15 million troy ounces of this open pit reserve by the end of 2017, and an additional amount in 2018 to be determined via reconciliation of its operations after the close of the calendar year.

The mine plan identifies the pits where the reserves will be mined. Figure A-5 shows the location and naming convention for each open pit. Haile proposes to mine the pits in the following order (see Section A.4, "Project Sequence" for more details):

- Mill Zone Pit Phase 1 (P1)
- Snake Pit Phase 1 and 2 (P1 and P2)
- Red Hill Pit (P1)
- Mill Zone Pit Phase 2 (P2) (includes previously designated Small Pit)
- Haile Pit (P1)
- Horseshoe Underground and Snake Pit Phase 3 (Portal_P1)
- Ledbetter Pit – Phase 1 through 4 (P1 – P4)
- Champion Pit Phase 1 and 2 (P1 and P2)

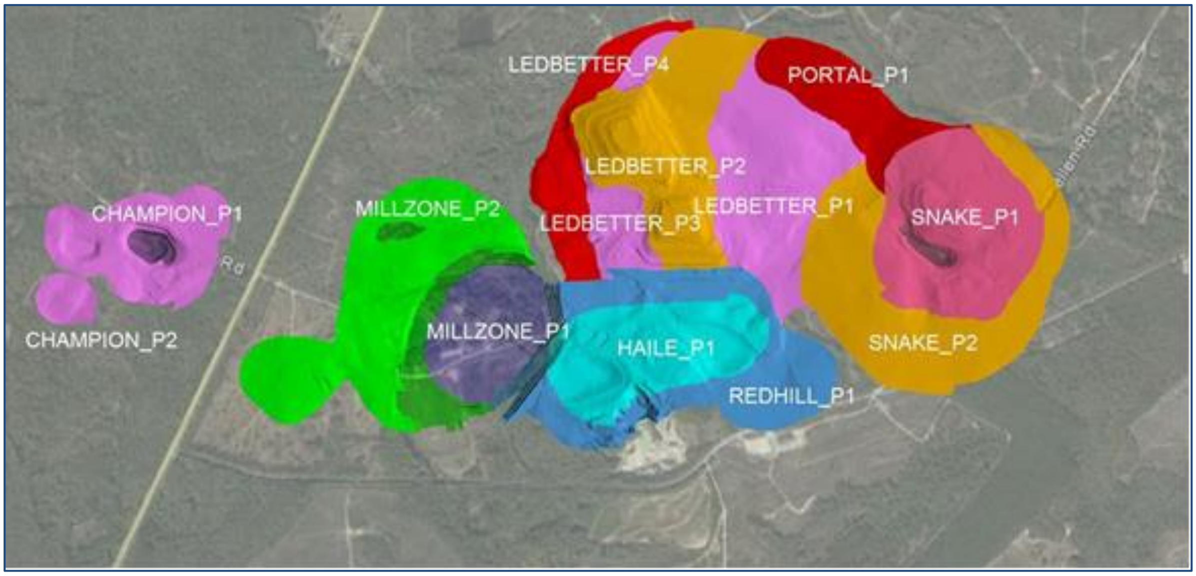

Figure A-5 **Open Pit Names and Locations**
Source: Haile 2018

Figure A-6 depicts a side view of the reserves, with the open pits identified and the expected zone of mining indicated as the reserve ore. Horseshoe is a reserve that Haile proposes to recover via an underground mine that it will construct from a decline in the sidewall of Snake Pit Phase 2. The cross-section is a view from the surface to depths of more than 2,000 feet. HGM16 refers to the block model name that was used in the August 2017 Feasibility Study. Pits are shown in gray while modeled gold bearing mineralized ore blocks are shown in gold.

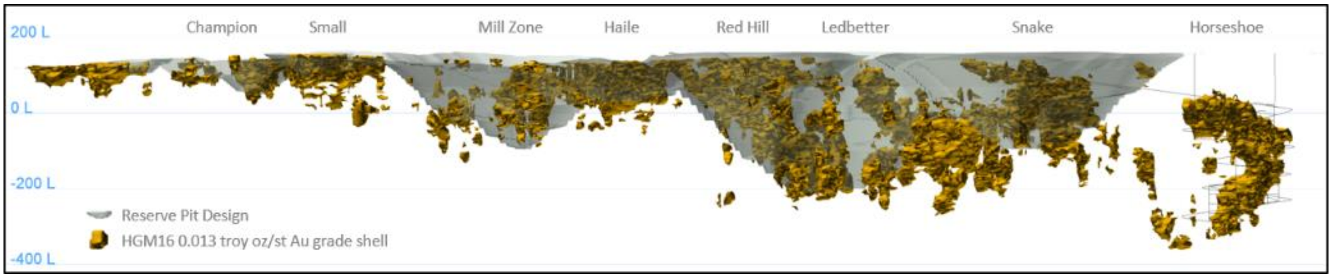

Figure A-6 Cross Section of Mineralized Ore
Source: Haile 2018

3. OVERVIEW OF THE PROPOSED PROJECT

This section provides an overview of the proposed Project. Development and operations of the gold mine will take place over an approximately 16-year period (2017 to 2032). Haile officially began its processing operations in 2017. Thus, Haile's operations currently are in Mine Year 3 (2020) of the 16-year expansion plan that Haile now seeks to permit. Unlike Haile's Project Description used for the USACE's 2014 FEIS, ROD, and 404 Permit, this Project Description refers to calendar years, rather than mine years, in an effort to minimize confusion. Since Haile's ability to pursue its expanded mine plan depends on when a Supplemental EIS (SEIS), ROD, and Amended 404 Permit are issued, all references to calendar years are an approximation based on the assumption that Haile will receive its permitting in late 2020. Fourteen (14) years are spent actively mining, and a final 2 years are spent processing low grade ore that has already been mined while reclaiming pits and OSAs that were not concurrently reclaimed during active mining.

The major elements are shown in Figure A-7, a plan view of the Project area representing all facilities over the life of the mine, and in Figure A-8, an aerial view of the pit shapes in 2031 without the backfilling. The proposed Project includes the following major components:

1. Open pits and associated haul roads where gold reserves are mined.
2. OSAs for storage of surface soils and overburden removed from the pits to expose the gold reserves, including four Growth Media Storage Areas (GMSAs), four Green OSAs (counting the portion of Hayworth OSA that becomes incorporated into South OSA as one Green OSA) and two PAG facilities (counting JPAG that becomes incorporated into West PAG as one PAG facility), and associated haul roads.
3. A Mill for processing the ore and refining the gold. The Mill Site also includes the CWTP, materials storage, administrative offices, a truck shop, a warehouse, and ancillary facilities.
4. A TSF for permanent storage of tailings (a byproduct of the ore recovery process), a slurry pipeline to transport the tailings from the Mill to the TSF (and to transport reclaimed process water from the TSF to the Mill), an access road, and borrow areas used to construct the individual TSF lifts).
5. A Fresh Water Storage Dam (FWSD) on Haile Gold Mine Creek to (i) protect the open pits from flooding in extreme weather and (ii) establish a Fresh Water Storage Area (FWSA) for non-contact water required for operational makeup needs.
6. Diversion of upper Haile Gold Mine Creek into pipes during mining operations that carry a minimum base flow around the open pits to lower Haile Gold Mine Creek.

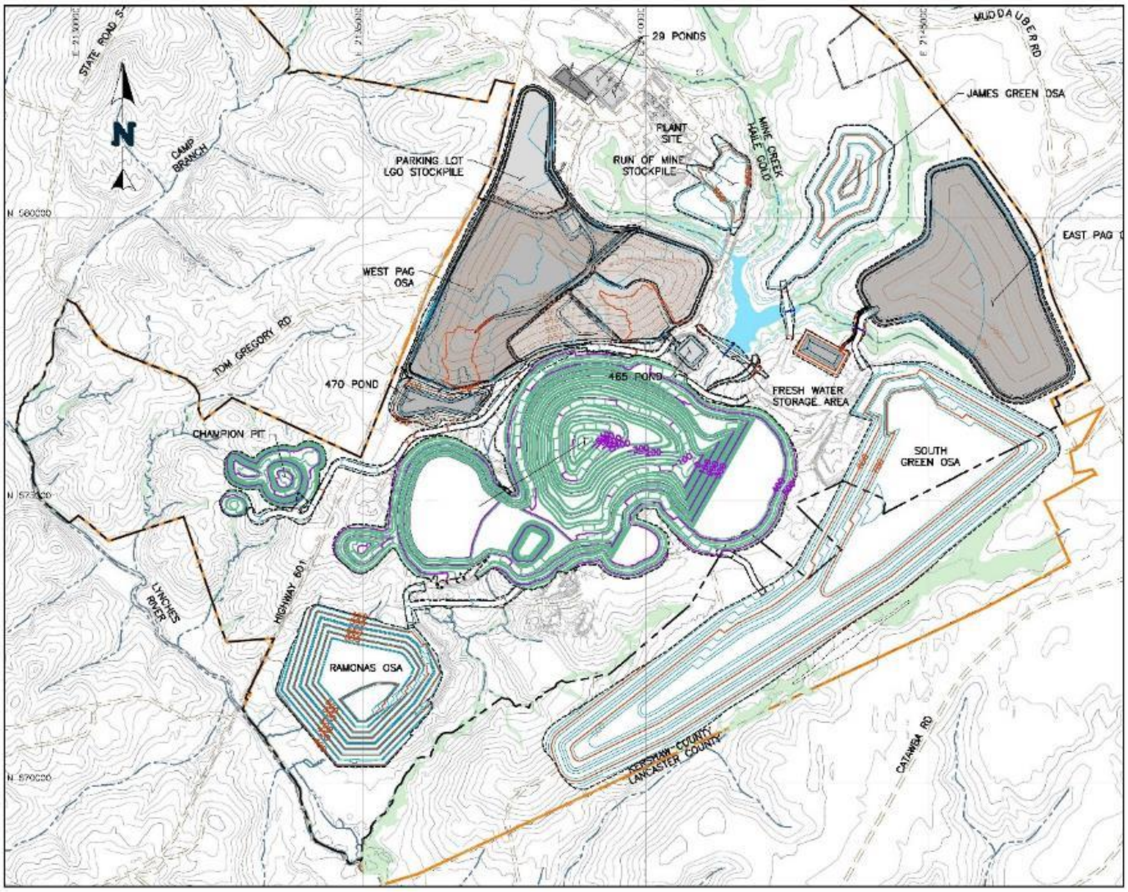

Figure A-7 Project – Plan View of the Project Area
Source: Haile 2018.

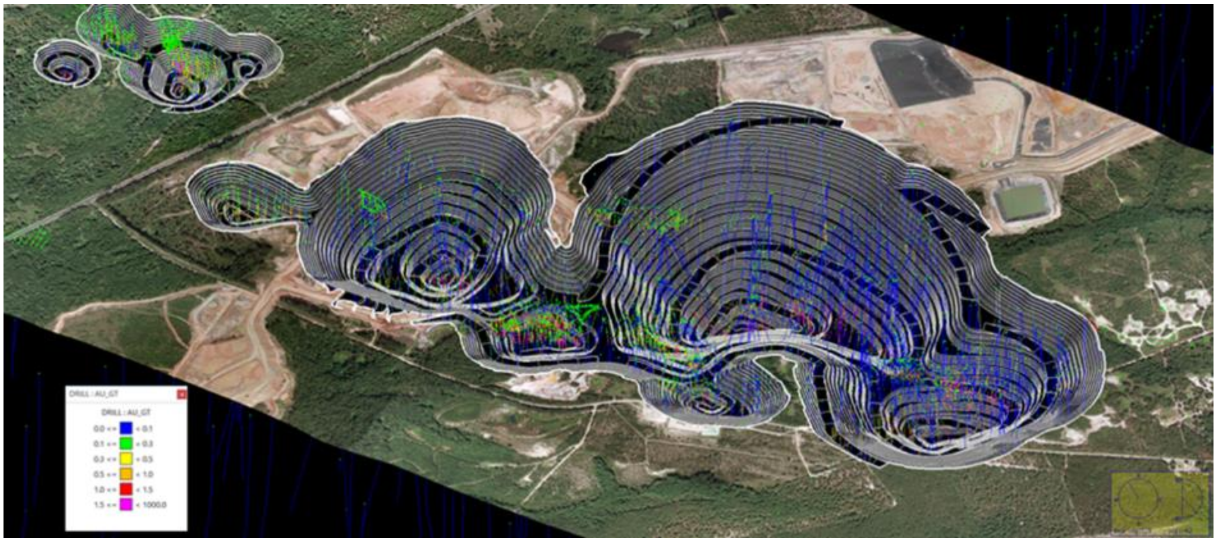

Figure A-8 Simulated Aerial View of Haile Gold Mine Open Pit Operations (2031)
Source: Haile 2018.

The area disturbed by each of the Project elements is shown in Table A-2. Project elements would disturb approximately 4,080 acres of the Project area.

Table A-2 Project Footprint by Major Component

Mine Component	Approximate Area (acres)
Mine pits, pit-related activities, and haul roads	1,248
OSAs, GMSAs, and haul roads	1,590
Mill, associated ore storage and support facilities, and haul roads	185
TSF and associated haul road and slurry pipeline	632
Material borrow Areas and associated haul roads	385
FWSA (at 470 ft amsl operating level) including FWSD	15
Site access road and US Highway 601 overpasses	5
Total estimated footprint (of 5,384 acres in the Project area)	**4,060**

Source: Haile 2020.

A few notable aspects of the Project design and operations include:

a. Haile has carefully planned this expansion to avoid and minimize impacts where practicable to do so and will propose mitigation for unavoidable impacts. In addition, proposed reclamation activities include restoration of on-site streams.

b. Water used in the Project area is managed to maximize recycling and reuse:

  - Process water within the Mill and TSF is managed in a closed-loop system (and never discharged to surface waterbodies or groundwater) that continuously reclaims water from Mill operations and the TSF for process use. Once make-up water from other sources (such as groundwater depressurization or contact water collected from PAG facilities or open pits) is introduced into the process system, it never leaves the process loop.
  - The CWTP treats contact water (e.g., water collected in open pits or at PAG facilities), and the discharged effluent is released subject to National Pollutant Discharge Elimination System (NPDES) standards.
  - Only treated water, surface water, or water from the depressurization wells is discharged.

c. In addition to crushing methods, the Mill would use a sodium cyanide chemical extraction process in tanks to refine gold from the ore. Chemicals and reagents (chemicals and solutions used in the processing system) are stored and used within containment structures to protect against their release to the environment. Cyanide is present only in the closed-loop process water used at the Mill. Under normal operating conditions, flow from the Mill is pumped to the TSF through the Cyanide Destruct process to ensure that the effluent leaving the Mill is less than or equal to 50 parts per million (ppm) weak acid dissociable (WAD) cyanide so as to ensure that the level of WAD cyanide in the TSF Reclaim Pond remains below 30 ppm all times (so as to avoid posing a risk to birds and other wildlife that may come in contact with water stored there). In addition, ultraviolet (UV) sunlight and air would naturally decompose cyanide and cyanide complexes to further decrease cyanide levels in the TSF Reclaim Pond, as well.

d. Reclamation occurs concurrently with active mining. Concurrent reclamation includes backfilling and re-grading. Mine pits fill with water to become pit lakes; Ledbetter Reservoir and the Champion and

Champion Southwest Reservoirs. Concurrent and post- mining reclamation include grading and revegetation of the Green OSAs, PAG facilities (including HDPE-lined and saprolite cover), borrow areas, and TSF (including HDPE-lined cover). Ongoing maintenance and monitoring of site conditions would continue following completion of reclamation.

4. PROJECT SEQUENCE

The mine is developed and operated over a 16-year lifespan, 14 years of active mining, and 2 years of continued ore processing after mining is completed. Some facilities are reclaimed concurrently with ongoing mining (concurrent reclamation), and final site reclamation would occur after mining and processing of ore ceases.

The total planned footprint for the seven pits is approximately 1,248 acres (including the infrastructure necessary to support mining of the pits, such as haul roads, utility lines, pumping wells, temporary laydown areas, and stormwater management infrastructure). See Table A-3 for the surface area disturbance associated with each pit. During concurrent reclamation (while other pits are being mined), Mill Zone, Snake, Haile, and Red Hill Pits will be backfilled. Backfilling is the process of refilling the open pit with the material called overburden (material not sent for processing at the Mill) that is removed from pits being actively mined. (Refer to Section A.6, “Overburden Storage Areas” for details, including a description of which types of overburden can be used as pit backfill.)

Table A-3 Proposed Pit Surface Area and Depth

Open Pit	Approximate Surface Area Disturbance (acres)	Approximate Final Pit Floor Elevation (ft.)
Mill Zone Pit - Phase 1	60.0	30 AMSL*
Snake Pit - Phase 1 and 2	88.1	20 BMSL
Red Hill Pit - Phase 1	47.5	95 AMSL
Mill Zone Pit - Phase 2*	63.0	115 BMSL
Haile Pit - Phase 1	42.5	160 AMSL
Snake Pit - Phase 3	57.3	300 BMSL
Ledbetter Pit - Phase 1 through 4	163.46	690 BMSL
Mill Zone Pit - Phase 2*	65.2	310 BMSL
Champion Pit - Phase 1 and 2	41.2	145 BMSL

* Notes:

Previously designated Small Pit (27.6 acres), is now included in Mill Zone Pit – Phase 2.
AMSL – Above Mean Sea Level BMSL – Below Mean Sea Level

The individual mine pits will remain inter-connected to form Ledbetter Reservoir which will be managed during the reclamation period for acidity. Ledbetter Reservoir is expected to take approximately 57 to 58 years to fill[3]. (Refer to Section A.11, “Site Reclamation” for additional information.)

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[3] For Pit Lakes, “full” refers to 95 percent full because these pit lakes are filled with groundwater and stormwater.

Production at Haile Gold Mine consists of the phased mining of multiple open pits to supply the Mill with ore at a planned rate of approximately 14,400 tons per day, 365 days per year. In general, two to three pits are mined simultaneously. At least one pit is in the overburden stripping phase where overburden is removed, and at least one other pit is mined for ore and overburden. This approach would maintain a constant supply of ore to the Mill.

4.1. Mining Schedule

During mining, high grade ore is sent to the Mill while low grade ore is stockpiled at PAG facilities – i.e., either the Ledbetter Low-Grade Stockpile or the Parking Lot Low-Grade Stockpile for later use. (Ultimately the Parking Lot Low-Grade Stockpile will merge with the West PAG facility.) Some low-grade ore is processed concurrently with higher grade ore during mining, but much of the low-grade ore will be processed during post-mining production. Reclamation will commence concurrently with mine operations. Each part of mining includes activities and steps that proceed in a sequence, and some activities will occur concurrently at different locations on site. The order of mining is designed to maintain the steady supply of ore to the Mill and to ensure concurrent reclamation in areas where mining is completed.

Table A-4 illustrates the development of the individual open pits; life of Horseshoe underground mine; loading of the overburden stockpiles; and initiation of concurrent reclamation. Stripping, mining, pit backfilling, and reclamation are specific stages that occur during the Project. The Project is proposed to last 16 years, 14 years of active mining (and some concurrent reclamation) and 2 years of processing low grade ore from stockpiles after mining has ended (along with additional reclamation). Overall site reclamation activities, water treatment, and monitoring and maintenance will continue after mining and ore processing has ended. Haile Gold Mine will require maintenance and monitoring at the end of mining and processing operations, as required by the South Carolina Department of Health and Environmental Control (SCDHEC). This will include monitoring surface water and groundwater for at least 10 years following the period when the pit lakes are filled and the TSF and PAG Cells are capped and drained down. During this post-mining period, Haile expects also to perform periodic maintenance of drainage and treatment systems. (Refer to Section A.11, “Site Reclamation” for details.)

Table A-4 Proposed General Mining Schedule

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total (M Tons)
Material Extracted from Open Pit and Underground	**Open Pit**															
	Mill Zone Phase 1	⬛	⬛	⬛	-	-	-	-	-	-	-	-	-	-	-	**31.80**
	Snake Pit Phase 1	⬛	⬛	⬛	-	-	-	-	-	-	-	-	-	-	-	**18.30**
	Snake Pit Phase 2	⬛	⬛	⬛	-	-	-	-	-	-	-	-	-	-	-	**25.30**
	Red Hill	-	⬛	⬛	⬛	-	-	-	-	-	-	-	-	-	-	**31.90**
	Ledbetter Stockpile Pit	-	-	⬛	⬛	-	-	-	-	-	-	-	-	-	-	**8.00**
	Mill Zone Phase 2	-	-	-	⬛	⬛	⬛	⬛	-	-	-	-	-	-	-	**51.30**
	Haile Pit	-	-	-	⬛	⬛	⬛	-	-	-	-	-	-	-	-	**22.10**
	Snake Pit Phase 3	-	-	-	⬛	⬛	⬛	⬛	-	-	-	-	-	-	-	**66.30**
	Ledbetter Phase 1	-	-	-	-	-	⬛	⬛	⬛	-	-	-	-	-	-	**63.70**
	Ledbetter Phase 2	-	-	-	-	-	⬛	⬛	⬛	⬛	⬛	⬛	-	-	-	**84.50**
	Ledbetter Phase 3	-	-	-	-	-	-	-	⬛	⬛	⬛	⬛	⬛	-	-	**75.60**
	Ledbetter Phase 4	-	-	-	-	-	-	-	-	-	⬛	⬛	⬛	⬛	⬛	**92.60**
	Champion Phase 1	-	-	-	-	-	-	-	-	-	-	-	⬛	⬛	-	**14.80**
	Champion Phase 2	-	-	-	-	-	-	-	-	-	-	-	-	⬛	-	**1.00**
	Underground															
	Horseshoe UG - Ore	-	-	-	-	⬛	⬛	⬛	⬛	⬛	⬛	-	-	-	-	**3.40**
	Horseshoe UG - Waste	-	-	-	⬛	⬛	⬛	⬛	⬛	⬛	⬛	-	-	-	-	**0.60**
															Total Extracted from Mine	**591.20**
Material Placed in an OSA, PAG Dump, or Backfilled	**Dump**															
	TSF	-	-	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	-	-	-	**41.70**
	Ramona	🟩	🟩	🟩	🟩	🟩	-	-	🟩	🟩	🟩	🟩	-	-	-	**57.60**
	Hayworth 1 and 2	🟩	🟩	🟩	-	-	-	-	-	-	-	-	-	-	-	**31.00**
	James	🟩	🟩	🟩	-	-	-	-	-	-	-	-	-	-	-	**14.70**
	South	-	-	-	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	**103.90**
	Mill Zone 1 In-Pit	-	🟨	🟨	-	-	-	🟨	◩	-	-	-	-	-	-	**20.70**
	Haile In-Pit	-	-	-	-	-	🟨	🟨	🟨	◩	-	-	-	-	-	**13.90**
	Red Hill In-Pit	-	-	-	-	-	-	🟨	🟨	◩	-	-	-	-	-	**18.90**
	Snake In-Pit	-	-	-	-	-	-	-	🟨	🟨	🟨	🟨	🟨	◩	-	**37.80**
	Mill Zone 2 In-Pit	-	-	-	-	-	-	-	🟨	🟨	🟨	🟨	🟨	🟨	◩	**35.40**
	JPAG (to be inc. into West PAG)	▨	▨	🟥	🟥	🟥		-	-	-	-	-	-	-	-	**21.30**
	West PAG	-	-	-	🟥	▨	▨	▨	▨	▨	▨	▨	▨	🟥	🟥	**75.40**
	East PAG	-	-	▨	▨	▨	▨	▨	🟥	🟥	🟥	🟥	🟥	-	-	**53.80**
															Total Overburden	**526.10**
	Surface Ore															
	Stockpiled Low-Grade	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	**11.70**
	High Grade to Mill	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	**53.40**
															Total Ore	**65.10**
	Process Plant															
	Process Mill	**Gold Extraction**														
	Water Treatment Plant	**Contact Water Treatment**														

🟩	◩	🟨	▨	🟥	🟧	▦
Green Overburden	Combination Yellow / Green	Yellow Overburden	Combination Yellow / Red	Red Overburden	Low Grade Ore	High Grade Ore

Notes:

1. Because Haile is constructing the 3rd TSF lift in 2021 instead of 2023 and less green overburden is available from pit development at that time, Haile will be using 14.9M tons from its Borrow Areas for construction of that TSF lift, bringing the total green overburden used for TSF development down from 56.6M tons to 41.7M tons.
2. Haile has competed further geotechnical study of Ramona OSA that supports its ability to use its full capacity permitted during the FEIS, so Haile has increased its storage from 39.9M tons to 57.6M tons.
3. Haile is eliminating at least one lift from the top of South OSA to provide room for a bulldozer and two haul trucks to safely manuever during completion of its final lift(s), reducing its total capacity (including Hayworth OSA from 152.4M tons to 134.9M tons.
4. Due to the accelerated development of Mill Zone 2, Haile is able to increase its total backfill in all pits by 13.2M tons up to 126.7M tons.

Source: Haile 2018

4.2. Work Schedule and Personnel

Estimated numbers of personnel needed to operate surface and underground operations; maintain mining and mill equipment; and operate Mill facilities during the life of the Project are shown in Table A-5. These estimates are based on keeping the Mill continuously supplied with ore for the 16 years that ore is processed. Shifts may vary over the life of the mine, but operations for the mine and the Mill will occur 24 hours per day, 365 days per year. Administrative personnel will work during the day shift. Table A-5 lists the estimated number of people by job class that are employed currently; at the peak of production in approximately 2024; at the end of the mine life in approximately 2031; and during post-mine life at Mine Years 17–19, 20–29, 30–40, 41–50, and 51-60.

Table A-5 Project Personnel Estimates for Selected Years

Job Type	Number of Personnel							
	Current	2024 (Peak)	2031	Mine Years 17–19	Mine Years 20–29	Mine Years 30–40	Mine Years 41–50	Mine Years 51–60
Contract	65	80	0	50	2	2	2	2
Mine*	165	378	85	3	2	0	0	0
Process	83	106	90	2	1	0	0	0
Administrative	50	53	45	4	2	1	1	1
Total	**373**	**617**	**220**	**59**	**7**	**3**	**3**	**3**

Source: Haile (2018).
- Mine numbers are for underground and open pit combined.

5. MINING METHODS AND FACILITIES

5.1. Open Pit Development

Gold is produced from ore located at various depths within the designated mining pits. The gold mineralized bedrock is overlain by growth media (including topsoil) that is removed and stored in GMSAs for later reuse. Sand, clay, and heavily weathered bedrock (which together are called “overburden”) are removed and stored. Generally, this material can be excavated without blasting and is removed using hydraulic shovels, excavators and / or wheel loaders and placed into haul trucks. It is transported to other mined out pits for backfill, to Green OSAs or to the PAG storage facilities. Green overburden may also be used for construction of the TSF lifts. Overburden generally is moved only once.

Pit development follows engineering plans that optimize the size and shape of the pit to obtain the most ore and to minimize the amount of overburden that must be removed, considering operational safety and logistics. Mining within the pits progresses in levels - called benches where mining proceeds to a depth then expands the size of a bench and incorporates room to safely operate mining equipment and allow for access roads. Each bench of the mine pit is measured as an elevation. As the mine grows deeper, the benches resemble large steps. The height of each mining bench is approximately 33 feet. The strength of the rock in the pit determines how steep the pit walls can be and still protect workers and equipment from wall instability.

Figure A-9 shows Mill Zone Pit with catch benches along the pit highwall and a truck hauling rock up the haul road. Figure A-10 is an example of a blast hole drill, and Figure A-11 is a typical blast pattern.

Blast holes are drilled approximately 14 feet apart in a blast pattern of typically 50 and 200 holes (Haile 2018). The blast propagation is in a timed sequence to optimize rock fragmentation, minimize low-frequency vibrations, minimize fly rock, and protect the high wall from damage. The size of each blast, and the amount of explosive used in an individual blast, may vary depending on the rock characteristics and the geometry of the available room on a bench. Once an individual blast pattern has been drilled and the explosives are loaded, the pattern is blasted to fragment the rock for subsequent excavation.

Figure A-9 Mill Zone Open-Pit Mine

Notes: A Haul Truck is hauling ore up the access road on the left. Benches are visible along the pit wall in the background, and a blasting pattern has been drilled on the level surface at the base of the pit.

Source: Haile 2018

Figure A-10 **Blast Hole Drill**
Source: Haile 2018.

Figure A-11 **Drill Holes in a Blast Pattern**
Source: Haile 2018.

5.2. Mining Equipment

Hydraulic shovels, excavators, and wheel loaders are used to remove blasted material. Figure A-12 shows a hydraulic excavator loading a haul truck, and Figure A-13 shows a wheel loader in the center. The loading equipment has a typical bucket capacity of approximately 15 cubic yards (cy) and will run on diesel fuel for 24 hours per day. The loading equipment excavates material from the pits and loads it into haul trucks for transport to the Mill, to OSAs, to pits for backfilling, or to GMSAs. The hydraulic shovel was selected for working in poor ground conditions that may impede the ability of a wheel loader to work efficiently. Wheel loaders were selected as they are highly mobile and can quickly move from one working area to another. A hydraulic excavator was selected for the ability to mine the deposit in a more selective manner. Wheel loaders excavate material in the pits and re-handle material in GMSAs and ore stockpiles, as well as in some OSAs.

Haulage equipment consists of 150-ton and 200-ton capacity, off-road haul trucks (shown in Figure A-12). Articulated trucks are used where conditions warrant, such as in poor ground conditions. These trucks are smaller and have a capacity of approximately 25–40 tons. Equipment also is required to build and maintain pits, OSAs, haul roads, and GMSAs and to perform concurrent reclamation. The equipment used for support operations would consist of small loaders, small mining trucks, track dozers equipped with rippers, rubber-tire dozers, motor graders, water trucks, and hydraulic excavators. A track dozer, wheel loader, and motor grader are shown in Figures A-12, A-13 and A-14, respectively. A water truck is used for dust control is shown in Figure A-15. Figure A-16 is a dozer with GPS controls for earthwork orientation, an articulated truck, and an excavator used in project and construction work.

Figure A-12 Hydraulic Excavator, Dozer, and Haul Truck
Source: Haile 2018.

Figure A-13 Example of a Track Dozer (left and in background), Wheel Loader (center), and Motor Grader (far right)

Source: Haile 2015.

Figure A-14 Motor Grader

Source: Haile 2018.

Figure A-15 Water Truck for Dust Control
Source: Haile 2018.

Figure A-16 Dozer with GPS Controls (Foreground), Articulated Trucks and Excavator (Background)
Source: Haile 2016.

Mining equipment is selected to provide efficient operations within the pit design parameters. A schedule of required mine equipment is shown in Table A-6. During years of peak mining activity, major equipment requirements are 27 haul trucks, five blast hole drills, and four track dozers, as well as the smaller support equipment mentioned above. As mining decreases after 2028, the size of the haul truck fleet is reduced, and the total number of units gradually decline. After 2031, excavation equipment no longer is needed.

Table A-6 Major Mining Equipment

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Excavator Cat 6020	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Excavator Cat 6030	-	2	1	0	0	0	0	0	0	0	0	0	0	0	0
Kamatsu Shovel Excavator	1	1	2	2	2	2	2	2	2	2	2	2	1	1	-
Loader Cat 992 / 993	2	2	3	3	3	3	3	3	3	3	3	3	2	2	5
Trucks 773 (60 ton)	8	8	6	6	6	6	6	5	6	5	5	5	6	6	4
Trucks 777 (100 ton)	12	12	10	8	6	4	4	4	4	4	4	4	4	2	2
Trucks 785 (150 ton)	8	6	6	6	6	4	4	4	4	4	4	3	2	0	0
Trucks 730E (200 ton)	6	10	16	19	19	21	21	21	21	21	21	21	18	12	0
Ore Drill - Cat 5150C	2	4	4	4	4	4	4	4	4	4	4	3	3	1	2
Waste Drill - Cat MD6290	4	4	4	3	4	4	4	4	4	4	4	4	4	3	3
Dozers (D6 – D10)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Motor Grader	1	1	3	3	4	4	4	4	4	4	4	4	2	2	1
Fuel Truck	1	1	2	2	3	3	3	3	3	3	3	3	2	2	1
Water Truck	3	3	3	3	3	3	3	3	3	3	3	3	3	2	1

Source: Haile 2020

5.3. Earth-Moving, Geosynthetics, and Pipeline Construction Equipment

During construction of the TSF lifts and PAG Cells, major earthworks, geosynthetic installation, and pipe works construction will take place. General activities for construction include the following:

- Installation of temporary erosion and sediment control features;
- Clearing, grubbing and removal of the growth media material and transporting it to the GMSA for later use at the TSF lifts and PAG Cells;
- Excavation of stormwater diversion channels, sediment detention channels, and basins;
- Excavation of construction material and equipment storage areas, haul and service access roads, and pipeline corridors as well as placement of safety berms;
- Rough grading and foundation preparation for the TSF lifts, PAG Cells, and related ponds;
- Excavation of groundwater drains and placement of drainpipe and drainage aggregate for the TSF lifts and PAG Cells;
- Transport and placement of soil materials, and moisture conditioning and compaction of the low-permeable soil liner material for the TSF lifts, PAG Cells, and related ponds;
- Transport and placement of soil materials, and moisture conditioning and compaction of the TSF embankment materials;
- Placement of geomembrane liner beneath the TSF, PAG Cells, and related process water and contact water containment ponds.
- Transport and placement of soil materials for the drainage aggregate and geosynthetic liner protective layer for the TSF lifts and PAG Cells; and
- Final grading.

The earthworks equipment fleet required will consist of scraper, track-type tractors, and hydraulic excavators to excavate various materials. Wheel loaders would load the growth media, low-permeability soil liner, and embankment material into haul trucks that transport materials to respective GMSAs, the TSF lifts, and PAG Cells.

5.4. Access, Roads, and Highway Crossings

5.4.1. Main Entrance at US Highway 601

Currently, the main access to Haile Gold Mine is on Snowy Owl Road which intersects with US 601 approximately 3 miles north of the Town of Kershaw. See Figure A-17 below. At the main entrance, Haile has added a left-hand turn lane on US 601 heading south to alleviate traffic flow on US 601 in immediate vicinity. This access point is improved to include the Guard House where Security personnel sign in all trucks and light vehicles, thereby controlling entrance to the mine. Snowy Owl Road has been improved with duel lanes to accommodate increased traffic flow by mine personnel. Once on site, Security Officers direct visitors to their appropriate destination.

Figure A-17 Main Entrance at Snowy Owl Road and US Highway 601
Source: Haile 2018.

5.4.2. Tailings Storage Facility Overpass on US Highway 601

The TSF is accessed via haul road from the Mill Site. The design of this road is very similar to the mine haul roads because it is used to haul TSF construction materials from the mine to the TSF. The more common use, however, is for the daily trips by light vehicles from the Mill Site to the TSF. To avoid disrupting traffic flow along US 601, an overpass is constructed over US 601 (See Figures A-18 and A-19) and capable of supporting a fully loaded 150-ton and 200-ton class haul trucks. This overpass is designed for one-way traffic. There is a section dedicated to carrying the tailings delivery and the tailings reclaim water pipelines. A concrete barrier separates the pipe corridor from the vehicle traffic lanes.

In 2027, during the construction of TSF, US 601 will be realigned, north of the overpass. Highway 601 will be straightened and there will be 90-degree intersections for Highway 265, Earnest Scott Road and Duckwood Road.

Figure A-18 Tailings Storage Facility Overpass on US Highway 601
Source: Haile 2018.

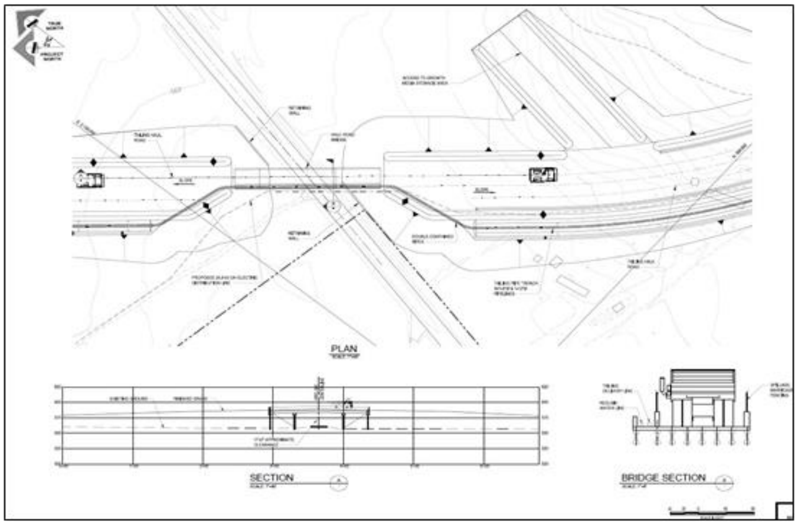

Figure A-19 General Layout of US Highway 601 Overpass
Source: Haile 2016.

5.4.3. Champion Pit Overpass on US Highway 601

Mining of Champion Pit is scheduled to begin in approximately 2029. Champion Pit is on the west side of US 601, making it necessary to haul the ore to the east side of the road. To avoid disrupting traffic on US 601, Haile would install an overpass of similar design as the TSF overpass to cross US 601 at the intersection of US 601 and the Champion Pit haul road.

5.4.4. Mine Haul Roads

Haul roads are used throughout the mine to connect various facilities. Light vehicles, haul trucks, and other mobile mine equipment will use the haul roads to get to and from various facilities for appropriate work. The primary use of the haul roads is for haul trucks to deliver ore and overburden to the appropriate destinations. Roads are constructed from each active pit to the Mill Site and appropriate OSA or PAG Cells. Left-hand traffic is used on all mine haul roads. These haul roads are constructed from mined overburden, and fugitive dust is controlled with water trucks. Haul roads are approximately 110 feet wide, including safety berms and drainage ditches. The maximum haul road design gradient is 10 percent. Figure A-20 illustrates a typical mine haul road cross section (in metric).

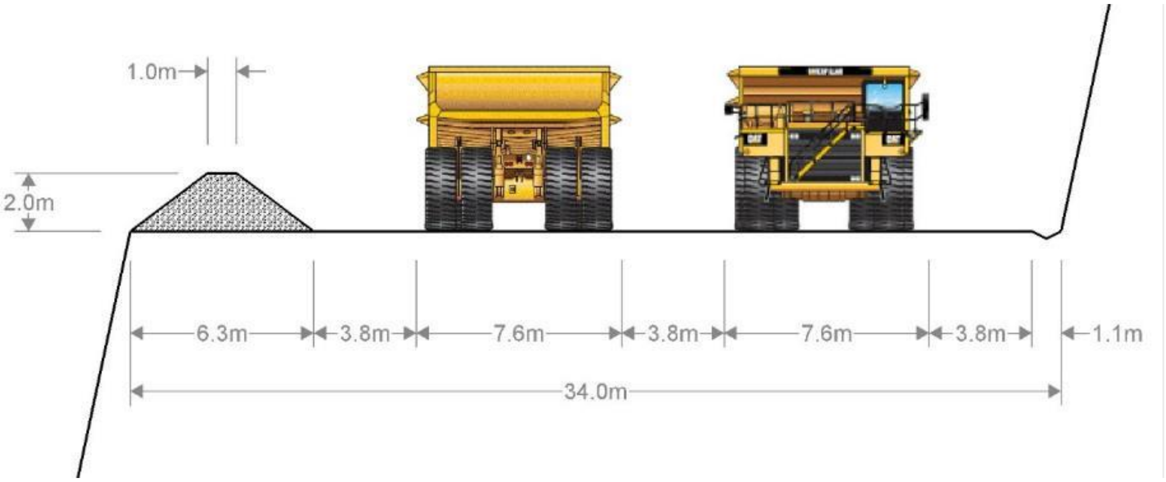

Figure A-20 Typical Mine Haul Road Cross Section (Metric)
Source: Haile 2018.

In addition, several service roads are dirt or gravel, typically 15 to 30 ft. wide for light vehicles, and primarily used by process operators and maintenance personnel to move about the mine site. One such service road follows the utility corridor from the Mill Site to the Mill Zone Pit area. Similar service roads are used by light vehicles to access other areas of the mine for operations and maintenance.

Within the Mill Site, only a few small travel ways exist for light vehicles and delivery trucks. These travel ways generally follow each side of the Mill. One segment of the service road would branch off and go to the warehouse, truck shop building, and the fuel station. Figure A-21 illustrates a typical mine service road cross section.

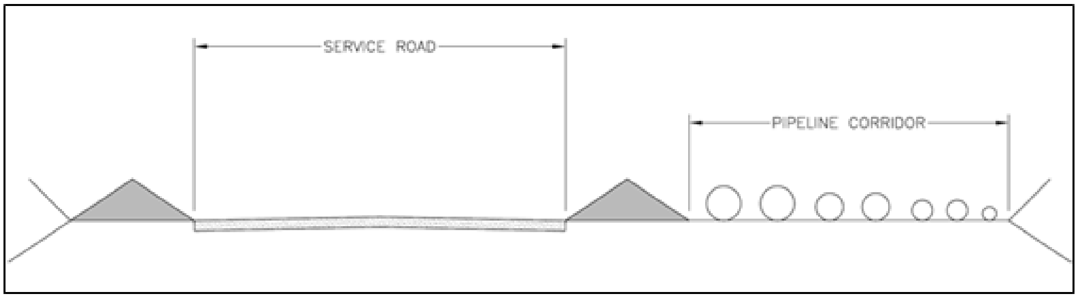

Figure A-21 Typical Mine Service Road Cross Section
Source: Haile 2017.

Figure A-22 shows the accumulation of mine roads that is developed over the course of the mine. The location of mine haul or service roads will change over the course of the mine life as the focal point of the mining work changes. Note that Figure A-22 does not depict mine roads related to pit operations where pit development eventually would consume the haul road.

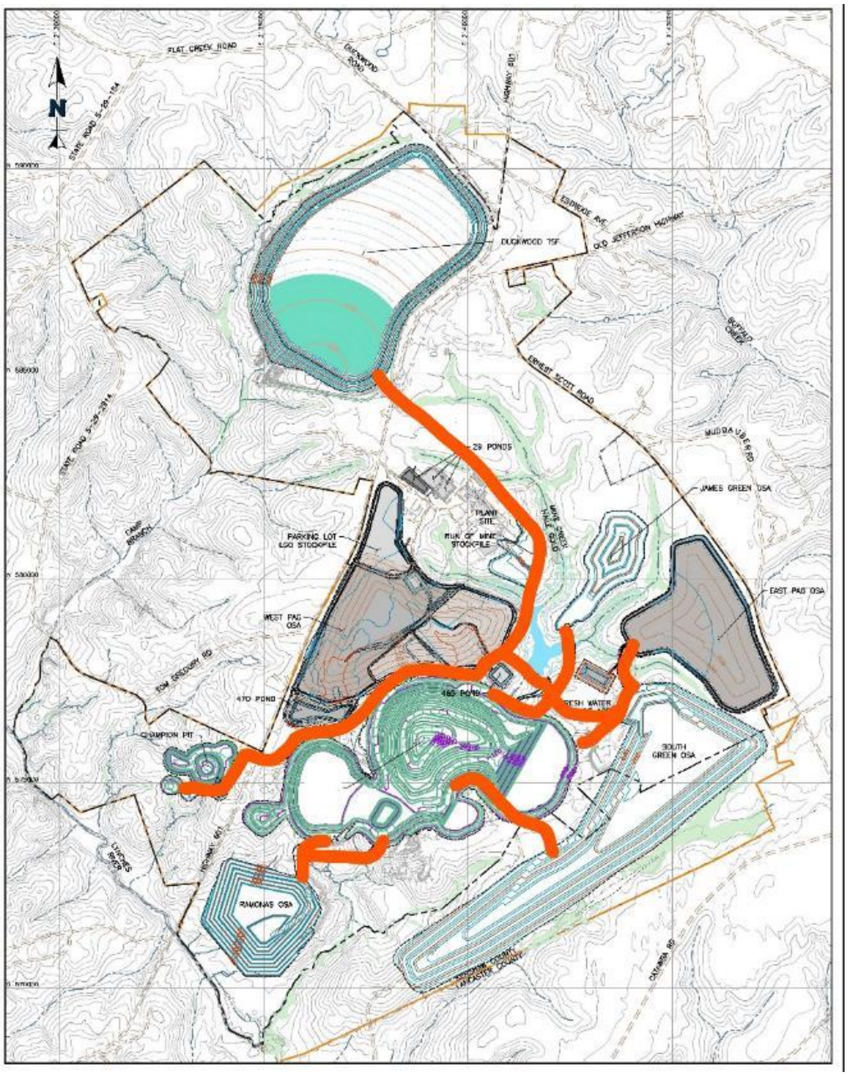

Figure A-22 General Location of Mine Haul Roads
Source: Haile 2018.

5.4.5. Road Construction

Haul roads are constructed with overburden materials placed and maintained by mine personnel and equipment. The gravel (wear surface) used on the haul roads is generated by an on-site mobile crushing plant located near the active mine pit. Construction material is predominately dike material located within each of the mine pits and crushed green overburden material.

6. OVERBURDEN STORAGE AND GROWTH MEDIA STORAGE AREAS

Prior to the start of mining, the growth media is removed from the pit areas, PAG Cells, and TSF and stored in designated storage areas called "growth media storage areas" (GMSAs) for later use in constructing/stabilizing and later reclaiming storage sites (OSAs, PAG Cells, TSF and all Borrow Areas). The growth media is stored in four growth media storage areas – TSF GMSA, 601 GMSA, Snake GMSA and Hayworth GMSA.

Once growth media has been removed from the pit areas, overburden is removed. The overburden classification summary is shown in Table A-7.

Table A-7 Overburden Classification Summary

Overburden Classification	Classification	(M tons)	(%)
Overburden Storage Areas	Green	207.2	39.4
Potentially Acid Generating (PAG) Storage	Yellow / Red	150.5	28.6
Backfilled In-Pit	Yellow / Green	126.7	24.1
Tailing Storage Facility	Green	41.7	7.9
Total Overburden Material		**526.1**	**100.0**

Source: Haile

Overburden mined in the pits is classified as potentially acid-generating (PAG) or not potentially acid-generating (non-PAG or "Green") overburden, depending on the amount of acid-generating minerals that occur in the rock.[4] Overburden is tested and classified during ore control sampling (with a sample of the drill cuttings from each blast hole assayed for sulfur and gold) into the following categories based on its acid-generating potential:

- PAG (Red Class) – Net Neutralization Potential (NNP) < -31.25 kg/t as $CaCO_3$
- Moderate PAG (Yellow Class) – Total S greater than 0.2 % or NNP < 0 and NNP ≥ -31.25 kg/t as $CaCO_3$
- Non-PAG (Green Class) – Total S less than 0.2 % and NNP > 0 kg/t as $CaCO_3$

The material classified as Red Class overburden is stored exclusively within a facility that is lined with a high-density polyethylene (HDPE) liner. The Yellow Class overburden is stored on a lined facility or may be used for backfilling pits (see Section A.11, "Backfilled Pits" for details). The other four OSAs (601, Ramona, Hayworth / South, and James) receive Green Class overburden. OSAs are constructed and managed as the open pits are developed (see Section A.4, "Project Sequence" for details).

Table A-8 compares the types and amounts of material that is stored in each OSA, and the estimated final capacity of each OSA under the currently permitted mine plan to the proposed mine expansion plan. Low-grade stockpile volume will fluctuate over the life of mine.

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[4] Acid-generating potential refers to a material's potential to generate acid and produce acid rock drainage. Acid rock drainage is produced by the oxidation of sulfide minerals, chiefly iron pyrite or iron disulfide (FeS2). Ferrous iron can be further oxidized, producing additional acidity. This is a natural chemical reaction when minerals are exposed to air and water that produces acidity and dissolves metals in water; however, it can impair water quality. Acid rock drainage can mobilize and transport the heavy meals that occur in metal deposits. Acid mine drainage is the outflow of water from mines, underground workings, waste rock, and tailings after sulfide minerals have been exposed to air and water, oxidizing metal sulfides (often pyrite, which is iron-sulfide) within the surrounding rock and overburden.

Table A-8 Overburden Comparison Bridge from 2014 EIS to 2018 SEIS

	EIS (2014)				SEIS (2018)			
Overburden Storage Area	**Potential Acid Generation Class**	**Planned Loading (M Tons)**	**Base Foot Print (acres)**	**Notes**	**Potential Acid Generation Class**	**Planned Loading (M Tons)**	**Base Foot Print (acres)**	**Notes**
JPAG	Yellow / Red	46.3	159	1				1
West PAG	--	--	--		Yellow / Red	96.7	370	
East PAG	--	--	--		Yellow / Red	53.8	145	
601 OSA	Green	7.2	42		Green	2.2	42	5
Ramona	Green	57.8	150		Green	57.6	150	
Hayworth	Green	21.3	86					
Hilltop	Green	12.6	63		--	--	--	2
James	Green	17.8	66		Green	14.7	66	
Robert	Green	14.8	81		--	--	--	3
South	--	--	--		Green	134.9	442	4
Pit Backfill	Yellow / Green	66.7	N/A		Yellow / Green	126.7	N/A	6
TSF Growth Media	Green	3.3	56		Green	3.3	56	9
601 Growth Media	Green	1.2	15		Green	1.2	15	9
Snake Growth Media	Green	1.0	13		Green	1.0	13	9
Hayworth Growth Media	Green	1.5	19		Green	1.5	19	9
TSF	Green	--	N/A	7	Green	41.7	153	7/8
Total		251.5	750			535.3	1,590	

Notes:

1. JPAG is being consumed into West PAG.
2. Hilltop OSA is eliminated.
3. Robert OSA is converted into East PAG.
4. Hayworth OSA is consumed into South OSA in 2020.
5. 2.2 M tons of Green overburden has been placed on 601 OSA. This OSA will be partially mined during Mill Zone Phase 2, therefore no additional material has been planned for this facility.
6. Pit Backfill has no additional footprint other than the individual Mine Pits.
7. Last two TSF lifts will be green material generated from active mine pits.
8. Disturbance Area is only for the extended TSF footprint.
9. GMSAs are not accounted for in TOTAL line as material will be re-handled onto OSAs and is already accounted for in those tonnages.

Source: Haile 2018.

Any water that encounters the Red and Yellow Class overburden material in the PAG Cells is managed as contact water, meaning that it is water that has come in contact with PAG material and cannot be discharged to surface waters without treatment. PAG Cells are constructed with an 80-mil (a mil is one one-thousandth of an inch) HDPE geomembrane liner underlain with low- permeability soils to contain and route seepage and runoff waters to collection ponds (465, 470 and 525 Collection Ponds are on the West PAG and 500 Pond is on East PAG) for water treatment. The proposed 470 Pond would replace 469 Pond identified in the currently permitted mine plan, and the 525 Pond is a new addition to the north end of West PAG.

Seepage is water that may collect within the stored material and seep to the collection system above the HDPE liner. Runoff is rainwater that may land on the stored material and run off the surface. Collection channels built within the HDPE-lined facility, surrounding the PAG Cells divert untreated surface runoff and seepage from the PAG to HDPE-lined collection ponds that have been sized to capture the 100-year 24-hour precipitation event. The 100-year 24-hour precipitation event is defined by the American Meteorological Society as, “the storm precipitation that has a 1 percent chance of being equaled or exceeded in a 24-hour duration during a given year” (AMS 1959). The 100-year 24-hour event for the Project site is calculated as 8.59 inches. This contact stormwater runoff and seepage is used in the Mill or treated at the Contact Water Treatment Plant (CWTP) (see Section A.10, “Surface Water Management” for details). Contact water is not released to the environment without treatment.

Groundwater is routed under the PAG Cells to avoid contact via collection pipes installed below the HDPE and low-permeability soil liner. Groundwater is routed to a tributary of Haile Gold Mine Creek. See Figure A-23 for a typical cross section of the (1) HDPE / lower permeability soil liner and underdrain collection system and (2) of the groundwater drain piping placed below the HDPE and low-permeability soil liner.

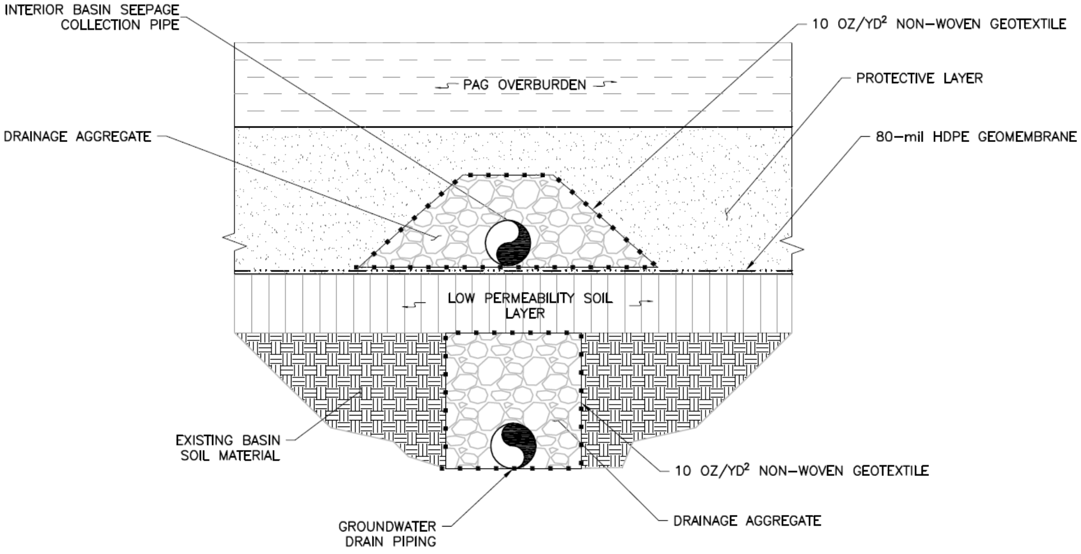

Figure A-23 Cross Section of PAG Groundwater Drain and Seepage Collection System
Source: Haile 2018.

Green Class OSA’s are developed with 3:1 side slopes. Channels to collect stormwater and sediment are constructed around the footprint of each OSA (see the example provided in Figure A-24) with such runoff managed as non-contact storm water.

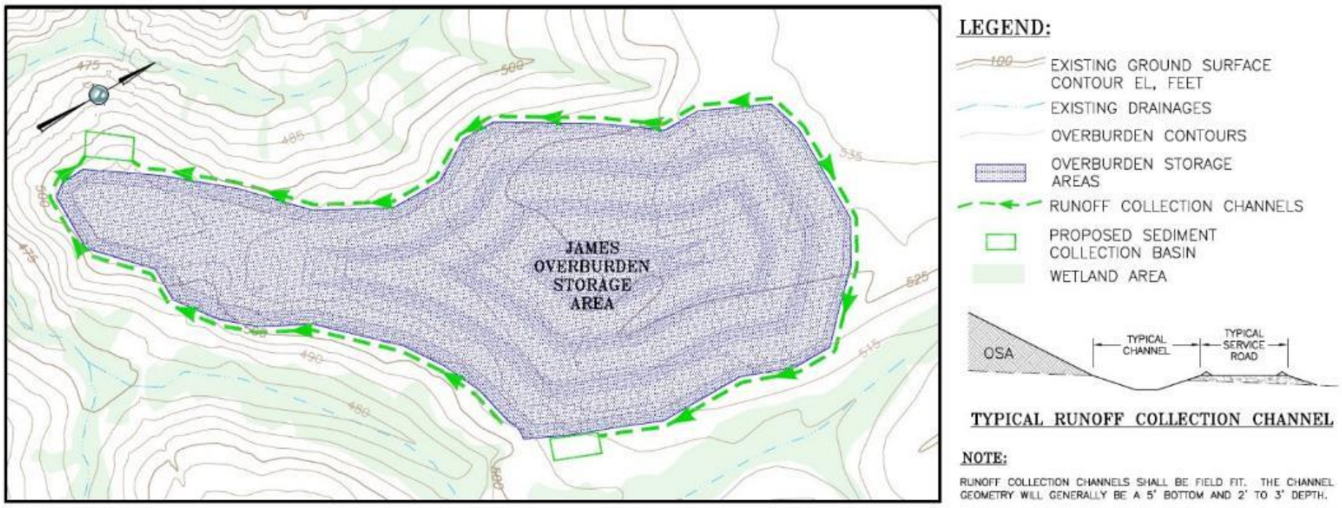

Figure A-24 Example of a Green Overburden Storage Area with Runoff Collection Channels and Sediment Collection Basins

Source: Haile 2018

Sediment control structures are constructed at the outfall of the stormwater runoff control channels for each facility. After the sediment settles out, water retained within the ponds is discharged to an adjacent drainage, consistent with Haile's NPDES General Permit for Stormwater Discharges Associated with Industrial Activities (Except Construction) regulated by the SCDHEC, Bureau of Water, Stormwater Permitting Section (Haile's Industrial General Permit). The sediment also is managed in accordance these standards.

7. UNDERGROUND MINING AT HORSESHOE DEPOSIT

The Project is currently being mined as an open pit mine; however, economic mineralization extends below and outside of the pit extents in an underground mine deposit referred to as Horseshoe. The upper portion of the Horseshoe mineralization is wider and localized in planar zones that strike NE-SW, but dip at 40º to 45º NW. The lower zone is localized in deformed zones within the meta-sediment parallel to the meta-volcanic contact. This zone strikes NE-SW and dips vertically. Figure A-25 shows the Horseshoe upper and lower mineralized zones.

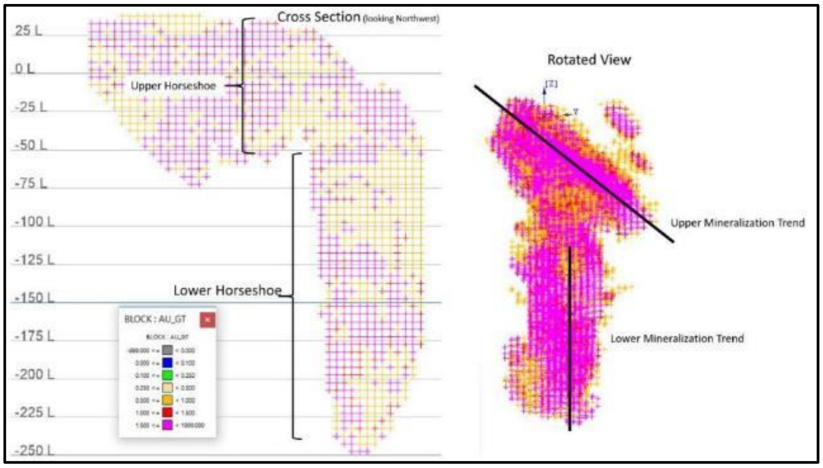

Figure A-25 Horseshoe Deposit Upper and Lower Mineralized Zones (Metric)
Source: Haile 2017.

Based on the orientation, depth, and geotechnical characteristics of the mineralization, a transverse sublevel open stoping method (long hole) has been selected. The stopes will be 50 ft. wide, and stope length will vary based on mineralization grade and geotechnical considerations. A spacing of 80 ft. between levels is used. Cemented Rock Fill (CRF) will be used to backfill 75% of stopes and non-cemented waste rock will be used in the remaining stopes. The CRF will have sufficient strength to allow for mining adjacent to backfilled stopes. Figure A-26 shows the Horseshoe Exploration Drill Pattern, and Figure A-27 shows the Horseshoe Underground Block Model and Mineralization Extents.

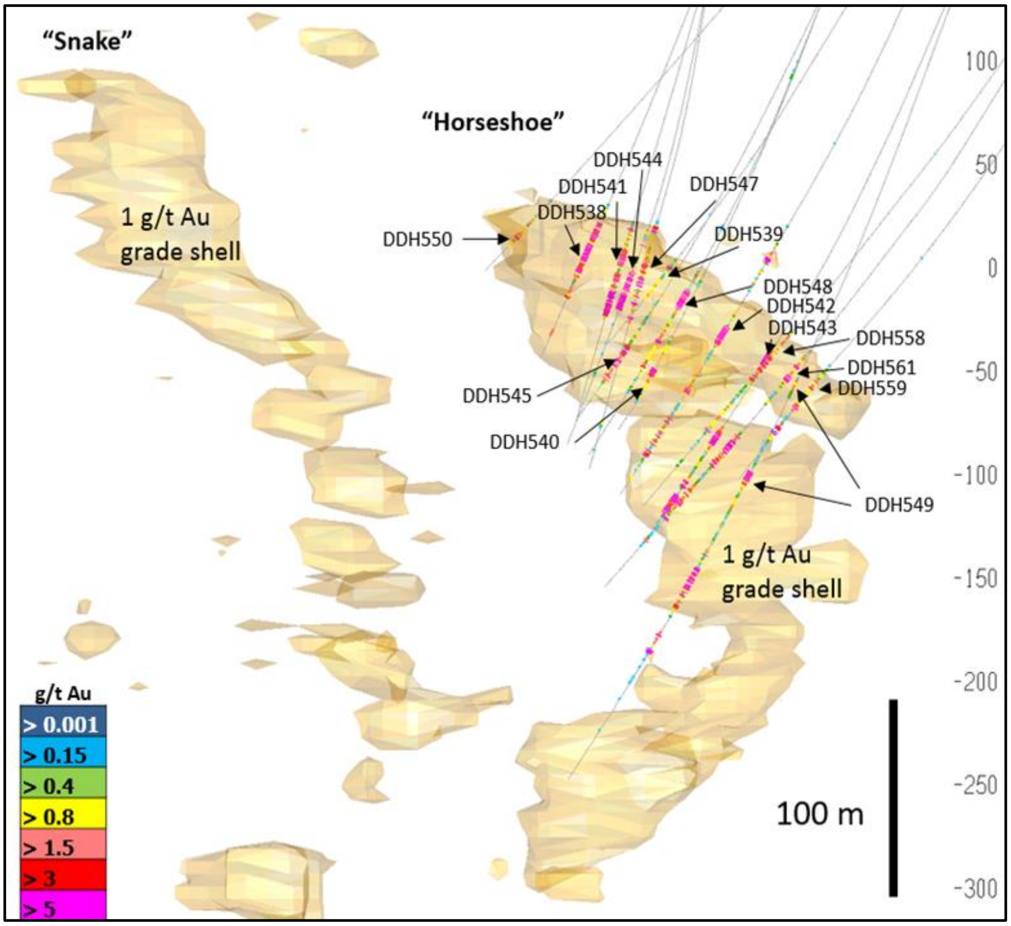

Figure A-26 Horseshoe Exploration Drill Pattern (view to NW in meters)

Source: Haile 2018.

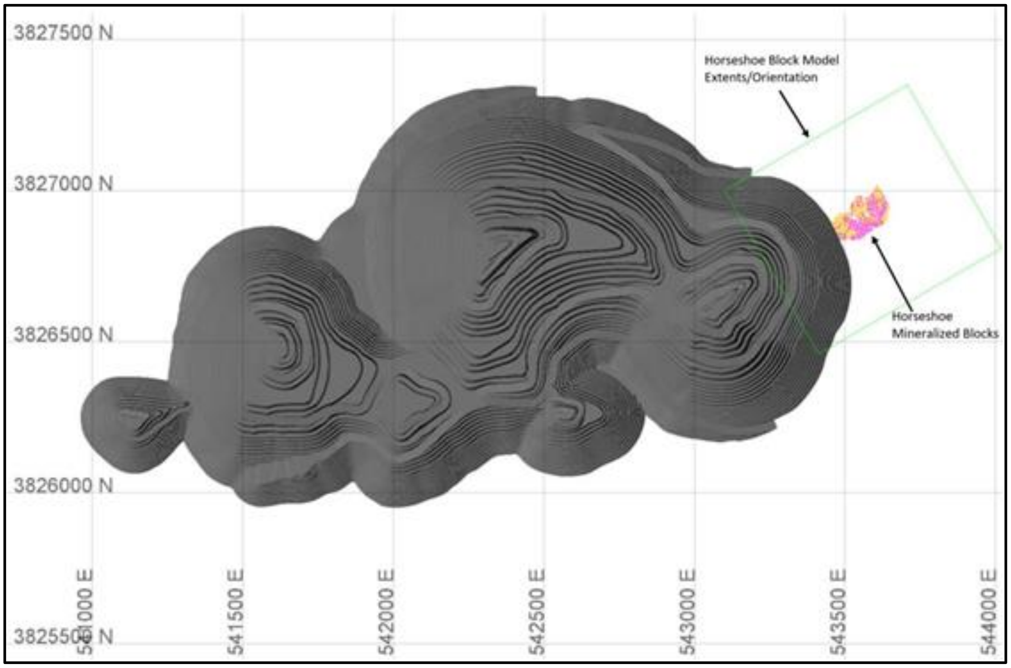

Figure A-27 Horseshoe Underground Block Model and Mineralization Extents
Source: Haile 2017.

7.1. Mine Design

Stope optimization results were used as a basis for the underground mine design. The top of the Horseshoe mineralization is approximately 450 ft. below surface and extends to a depth of approximately 1,315 ft. below surface.

7.1.1. Stope Design

Stope optimizer shapes were used as a basis for the design work. Stope centerlines were generated, and both top and bottom stope accesses are designed, as mucking will occur from the lower access, and drilling/backfilling will occur from the upper access. Stope accesses are expected to be in waste until they intercept the stoping block, but grade control will be used to determine the exact ore/waste boundary during mining.

A typical level in the upper zone is made up of approximately ten stopes across, while the lower zone has approximately five stopes across. The length of stopes is limited by geotechnical stability, and often several stope cuts are taken as shown in Figure A-28. Backfilling will be an integral part of the mining cycle as there is a limited quantity of stopes available on each level. Where possible stope cuts were aligned to minimize the requirement for CRF.

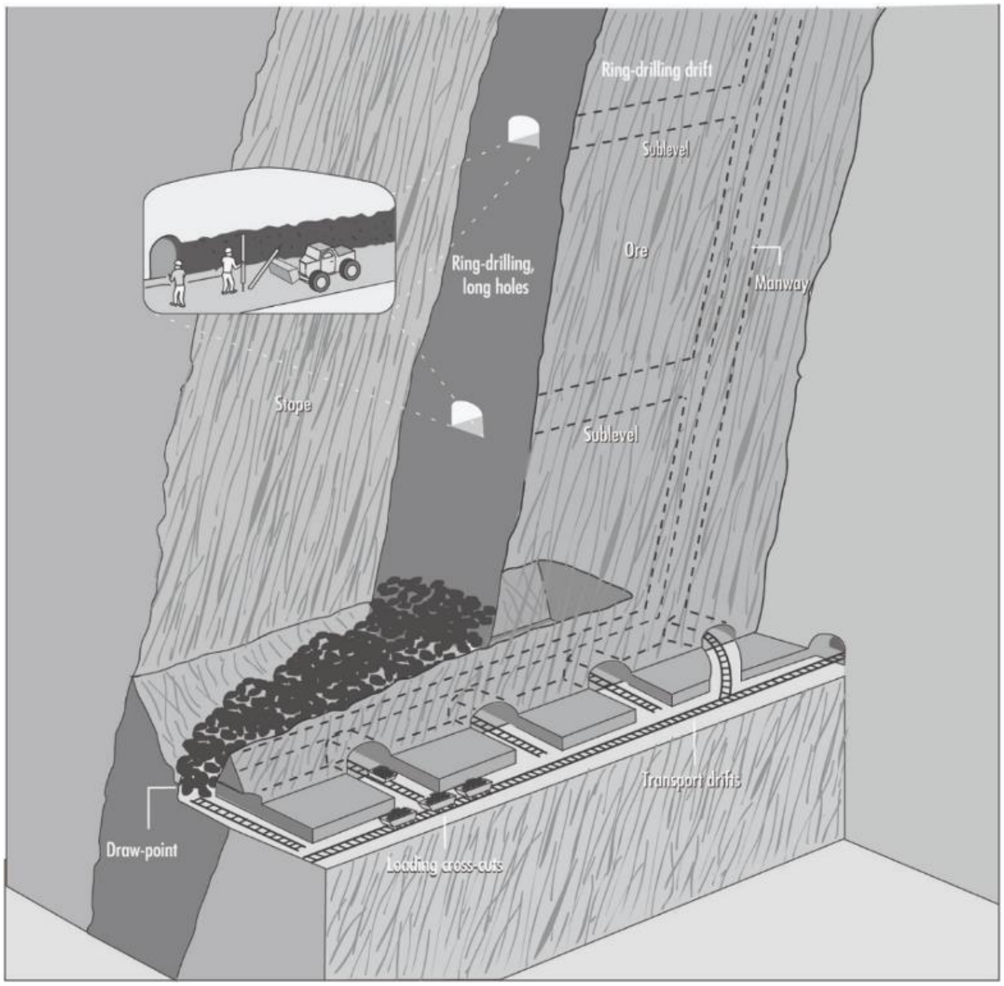

Figure A-28 Transverse Sublevel Open Stoping Mining Method (with long holes)
Source: US Bureau of Mines

Figure A-29 shows a cross section of the stopes.

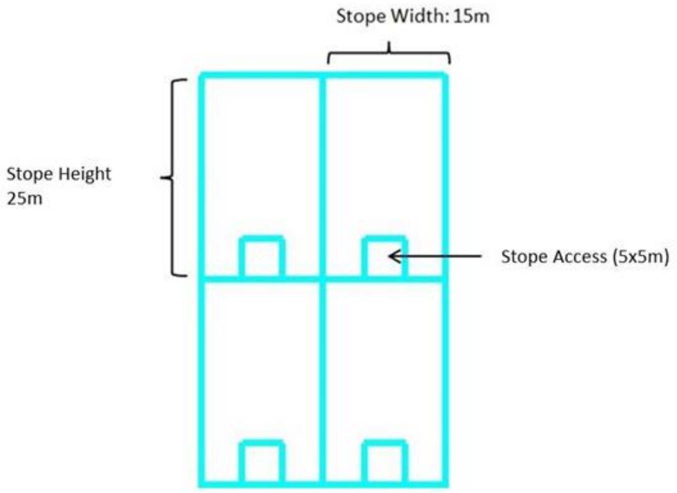

Figure A-29 Stope Cross Section (Metric)
Source: SRK 2017.

Stopes are developed using a slot. Separate slot triangulations were not constructed for each stope, but the slot tonnage of each stope is separated out, and a slot activity is used for scheduling.

The underground mine is accessed via a decline from the surface. The decline portal is located on an open pit bench approximately 260 ft. below the natural surface as shown in Figure A-30 and Figure A-31.

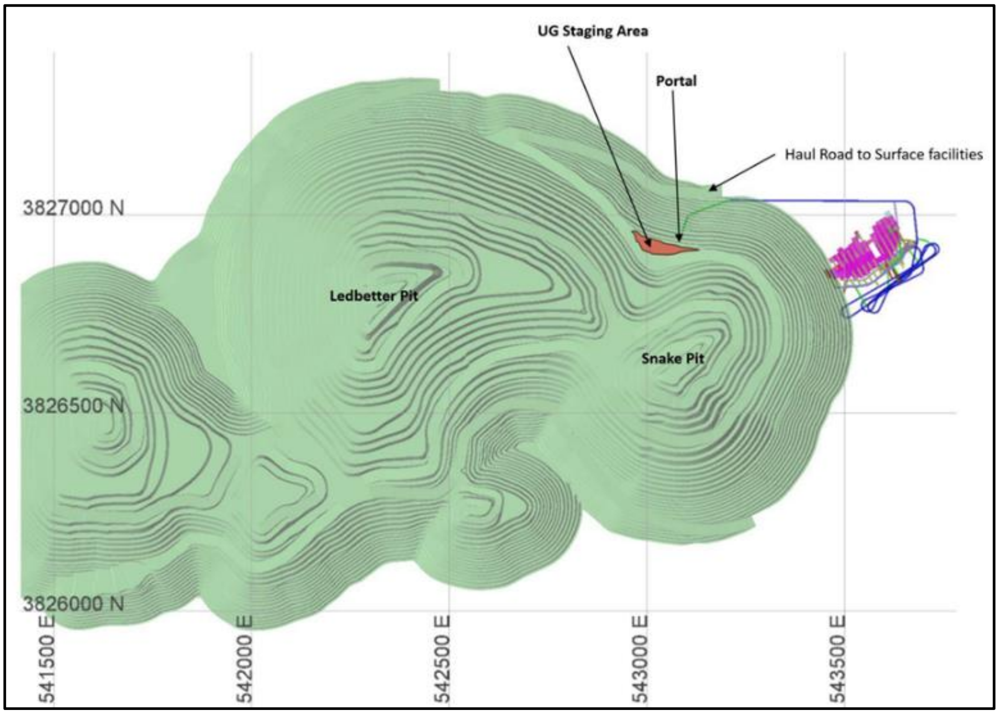

Figure A-30 Portal Location
Source: SRK 2017

Figure A-31 Typical Underground Portal with Articulated Truck
Source: OceanaGold – Waihi Operation

The stope accesses are connected to a level access located in the footwall in waste material. The level accesses are offset a minimum of 80 ft. from the stopes. The level accesses connect to the inter-level ramp system which is in the footwall and is offset approximately 250 ft. from the stopes. On the southwest end of each level access there is a connection to a fresh air intake raise and on the northeast end the level access connects to an exhaust air raise. Figure A-32 shows a typical level section.

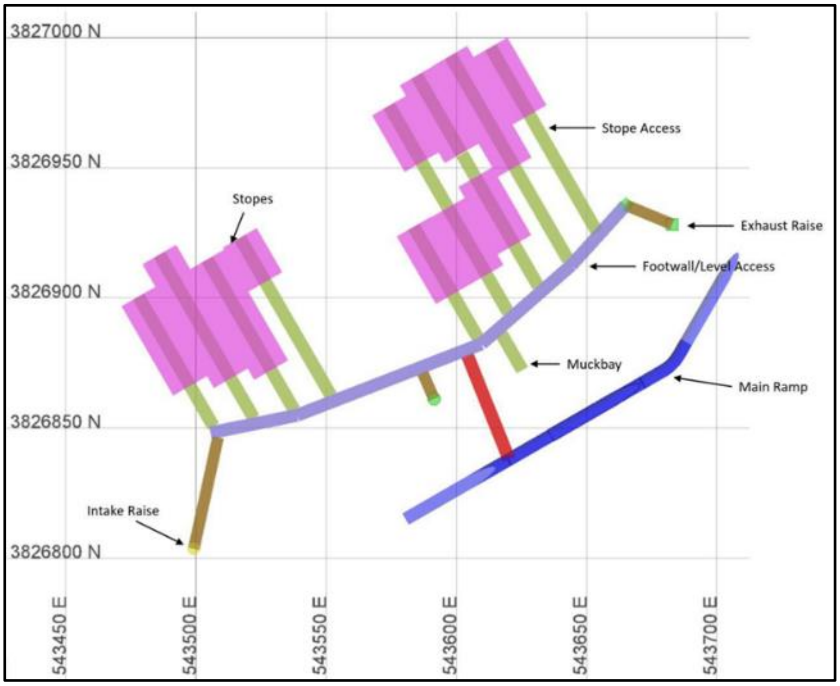

Figure A-32 **Typical Level Section**
Source: SRK 2017.

An additional development allowance was used for main ramps and level accesses to account for detail currently not in the design. Where possible, muck bays are re-used to minimize additional development. All planned maintenance will be on the surface, and underground shop facilities are not included in the design. The CRF facilities are also located on the surface and no additional infrastructure is required underground.

Where possible accesses/ramps are in the metavolcanics and away from known dikes. Where ramps must cross a fault/dike, the crossing is designed perpendicular to the structure to minimize the length of development through these structures. Figure A-33 shows the completed mine design colored by activity type and gold mineralization blocks, respectively.

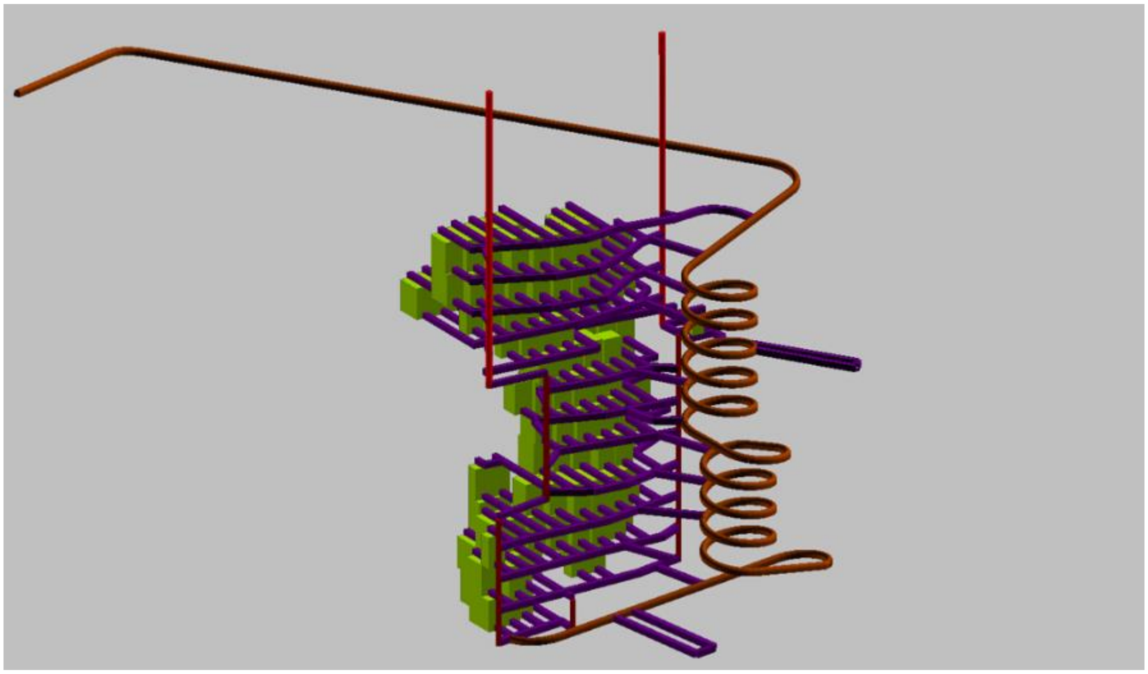

Figure A-33 Horseshoe Completed Mine Design (and looking North)

Note: The vertical ventilation shafts shown here have been replaced with horizontal drifts into Snake Pit (See Figure A-40)
Source: SRK

Table A-9 summarizes the Horseshoe mine design by activity type.

Table A-9 Horseshoe Mine Design Summary – by Activity Type

General Summary	(M tons)
Ore Tons	3.44
Waste Tons	0.64
Total Tons Moved	4.08

Ore Summary	(M tons)
Development Ore	0.307
Stope Slot Development	0.970
Stope Production	2.157

Horizontal Development Summary	(ft.)
Main Ramp Length	9,334 ft.
Footwall Access Length	6,752 ft.
Stope Access Drift Length in Ore	12,985 ft.
Stope Access Drift Length in Waste	8,093 ft.
Ventilation Drift Length	1,844 ft.
Total Development Length	**39,009 ft.**

Vertical Development Summary	(ft.)
Raise bore Length	1,570 ft.

Source: SRK

Waste material within the design was characterized geochemically based on the block model. All rock characterized as Red PAG had sufficient grade to be considered ore. Only Green and Yellow Overburden are generated as summarized in Table A-10.

Table A-10 Horseshoe Mine Design Geochemistry Summary

Geochemical Breakout	(M tons)
Green Overburden	0.53
Yellow Overburden	0.12
Total Waste	**0.64**

Source: SRK

7.1.2. Main Ramp Development (long-term development openings)

The main ramp is 16.5 ft. wide by 18.0 ft. high with an arched back. The drill pattern provides for 62 charged blast holes and five uncharged relief holes. Blasting will be a bulk emulsion explosive like the explosive used in open pit operations.

Loading will be performed with a 14-ton load-haul-dump unit (LHD) (See Figure A-34) that will transport blasted rock to muck bays. Units were selected for excellent load, maneuver and dump times. Rock in the muck bay will be loaded into trucks and hauled to the surface.

Figure A-34 Typical Load-Haul-Dump (LHD) Unit

Source: Caterpillar

Ground support will be installed concurrently with each stage. This includes mobilization and setup, scaling, bolting/meshing/shot creating as required, and demobilization. Cable bolts will be installed at intersections. Utility installation includes piping lines, ventilation tube, electrical cable, messenger cable, and leaky feeder. Piping, ventilation and electrical utilities will be installed at the end of every other round.

7.1.3. Level Access Drifts (medium-term development openings)

The level access drifts will be 16.5 ft. wide by 16.5 ft. high. They will be developed with a twin-boom jumbo drilling 1.6 in. diameter blast holes and 4 in relief holes. The anticipated drill pattern provides for 63 charged blast holes and five uncharged relief holes. Loading will be performed with a LHD that will transport blasted rock to muck bays that will be located, on average, 250 ft. from the advancing face.

7.1.4. Stope Development Drifts (short-term development openings)

The stope development drifts will also be 16.4 ft. wide by 16.4 ft. high. Productivity parameters for drilling, blasting, mucking, ground support, and utilities are the same as for the level access drifts.

7.1.5. Slots – Stope Development

After top and bottom stope development drifts are established, a slot will be developed at the far end of the stope. The slot consists of a conventionally blasted drop raise and 28 fan-drilled holes that will be slashed into the void that is created by the drop raise. The fan drilled holes are created by a Down-the-Hole (DTH) drilling unit as shown in Figure A-35. Including the fan-drilled holes, the overall dimensions of the slot will be 49.2 ft. wide by 19.7 ft. long by 82 ft. high.

Figure A-35 Typical Down-the-Hole (DTH) Drilling Unit
Source: Atlas Copco

All blast hole drilling for the slot will be at a diameter of 4.5 in. using a DTH drill. It is anticipated that a total of 50 holes will be required for the slot (22 holes for the drop raise and 28 holes for slashing). The slot will be removed in a series of four blasts using a bulk emulsion product. The first two blasts will remove the bottom 46 ft. of the drop raise. The third blast will remove the remaining six meters at the top of the drop raise along with 14 of the fan-drilled slash holes on one side of the drop raise. The fourth and final blast will remove the remaining fan-drilled slash holes on the opposite side of the drop raise.

Slot ore will be mucked with an LHD that will transport blasted ore to muck bays that will be located, on average, 328 ft. from the stope. Ore that is placed in a muck bay will be loaded into trucks and hauled to the surface.

7.1.6. Stoping

Stopes will be 80 ft. high by 50 ft. wide and will have varying lengths based on the mineralization. Blast holes will be 4.5 inch in diameter. Stope blasting will be performed in a series of three-ring blasts, the number of which will be a dictated by the length of the stope. Each three-ring blast will have a total of 39 charged holes (13 holes per ring). A bulk emulsion product will be used.

Stope ore will be mucked with an LHD that will transport blasted ore to muck bays that will be located, on average, 325 ft. from the stope. Ore that is placed in a muck bay will be loaded into trucks and hauled to the surface.

7.1.7. Main Ventilation Openings – Raise Bored Raises

Raise boring and blind sinking will be used for the main ventilation openings. The one blind sink and two raise bored raises will each have a diameter of 16 ft. and will have the following lengths.

- Exhaust raise from Level 1 to the surface: 1,835 ft.
- Intake raise from Level 5 to the surface: 2,105 ft.
- Intake raise between Level 12 and Level 5: 455 ft.

7.1.8. Ventilation Connections Between Levels – Drop Raises

Conventional drop raising will be used to establish ventilation connections between level access drifts. The ventilation connections will be 15 ft. wide by 15 ft. long by 65 ft. high.

All blast hole drilling for the ventilation connections will be at a diameter of 4.5 inch using a DTH drill. A total of 22 holes will be required for the drop raise (16 charged blast holes and 6 uncharged relief holes). The drop raise will be removed in a series of three blasts using a bulk emulsion product. The first two blasts will remove the bottom 45ft. of the drop raise. The third and final blast will remove the remaining 25 ft. at the top of the drop raise.

7.1.9. Mine Production Schedule

The Horseshoe schedule is based on mining operations occurring 365 days/year, 7 days/week, with two 12-hour shifts each day. Figure A-36 shows the mine production schedule by year.

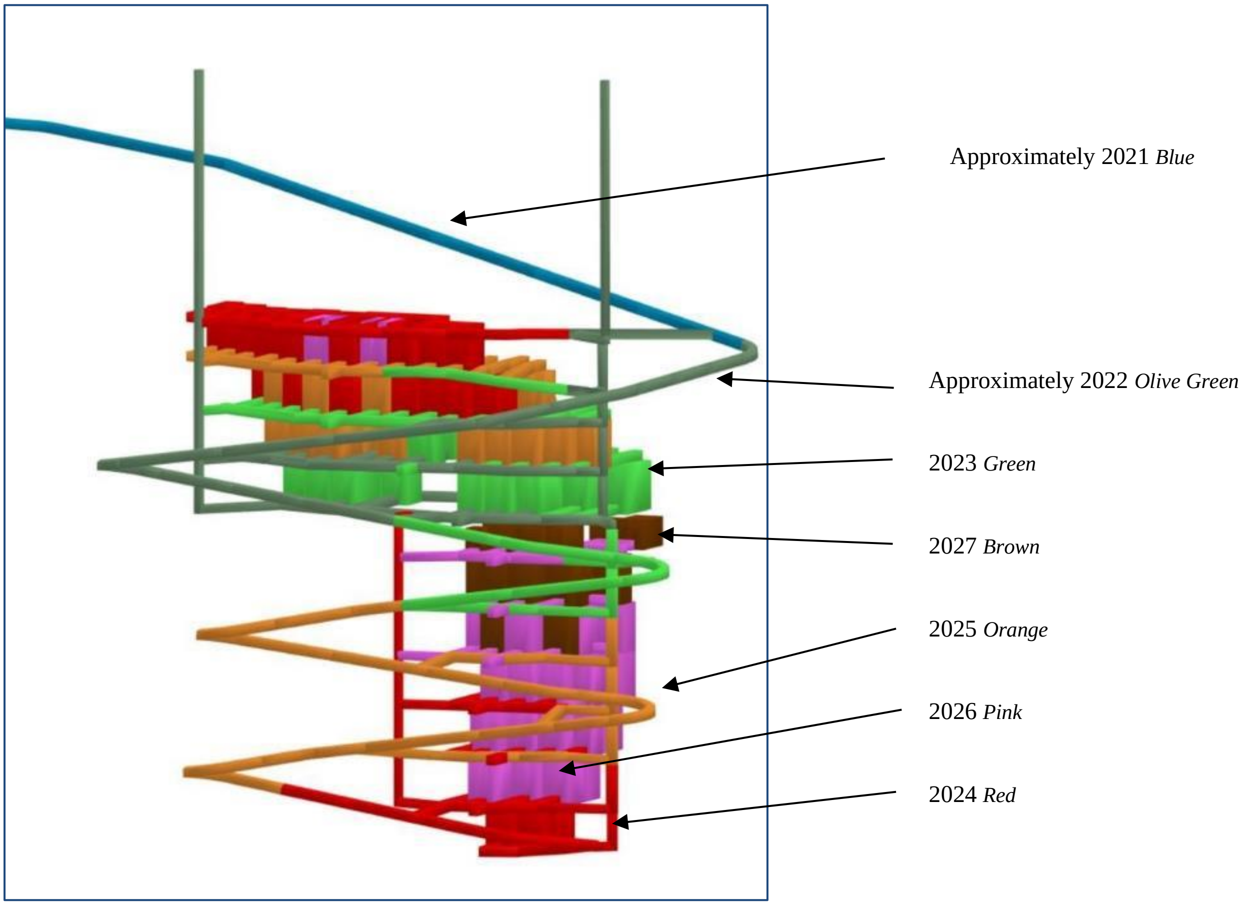

Figure A-36 Mine Production Schedule Colored by Year
Source: SRK

Level naming nomenclature is shown in Figure A-37. Elevations for level are shown in Table A-11.

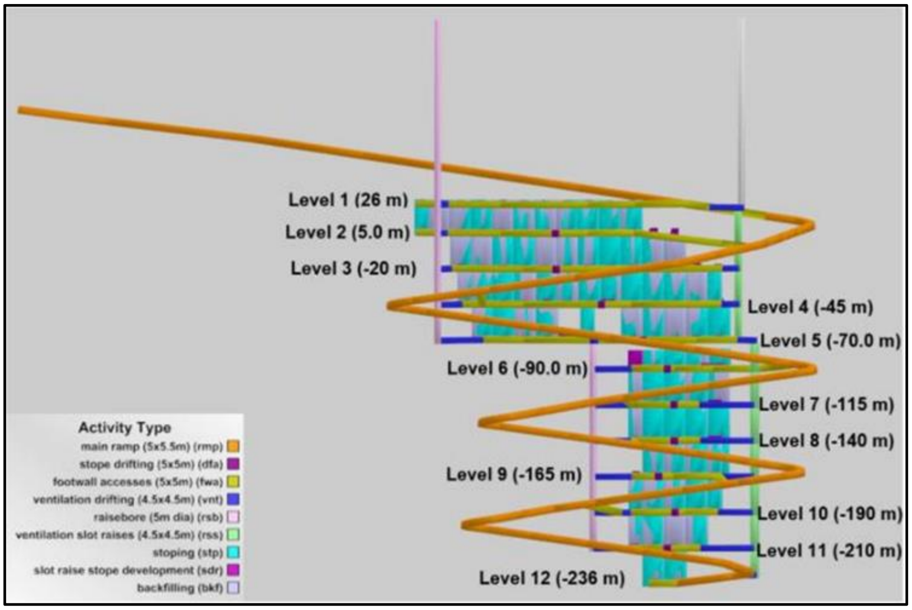

Figure A-37 Level Nomenclature (Metric)
Source: SRK

Table A-11 Horseshoe Mine Level Summary

Level	Elevation amsl / bmsl (ft.)
Surface	540
Portal	477
Level 1	85
Level 2	16
Level 3	-66
Level 4	-148
Level 5	-230
Level 6	-295
Level 7	-377
Level 8	-459
Level 9	-541
Level10	-623
Level 11	-689
Level 12	-774

Source: SRK

7.2. Mine Access

The upper portion of the 16.5 ft. wide by 16.5 ft. high access decline is expected to be in weathered rock and therefore will require an increased level of ground support. After the decline has passed through the weathered rock, a less intensive level of ground support will be required. The decline is designed at a maximum gradient of 14%. A turning radius of 80 ft. is suitable for the underground haul trucks contemplated for the operation.

The portal for the access decline will be located on an open pit bench approximately 265 ft. below the natural surface, thereby eliminating the need to develop the access decline through saprolite. The portal construction will consist of scaling and bolting/screening and application of shotcrete as necessary to support and create a safe surface above the mine portal. A structurally sound corrugated pipe style liner with supports as necessary will be constructed for the first 200 ft. of portal or as dictated by the rock conditions. Ventilation, power, water discharge, supply water, and communications will be installed at the portal and carried down the decline to support the development operation. An all-weather gravel surface will be established at the portal and portal bench area, and drainage will be maintained away from the portal entrance to minimize water entering the portal and decline from the bench area.

Secondary egress will be via 20 ft. diameter raise bored ventilation raises equipped with emergency hoisting.

7.2.1. Stoping

Stopes will be mined using the sublevel open-stoping method. Individual stope blocks are designed to be 50 ft. wide by up to 100 feet long and will have a transverse orientation. Levels are spaced 75 feet apart, and each stope block will have a top and bottom access.

Stopes will be drilled downward from the top access using 4.5” diameter holes. (Stope slots will be drilled with a DTH drill, and stope production rings will be drilled with a top hammer drill.) A bottom up, primary/secondary extraction sequence will be followed. Primary stopes will be backfilled with CRF, and secondary stopes will be backfilled with overburden from the underground and open pit operations.

Stope extraction will occur in two steps. During the first step, a slot will be mined at the far end the stope using a drop raise and 28 fan-drilled slash holes. The slot is required to create sufficient void space for the remainder of the stope to be blasted. During the second step, production rings will be blasted three rows at a time (13 blast holes per ring) until the stope is completely extracted. The number of three-row blasts in each stope will depend on the length of the stope. All blasting will be performed with bulk emulsion.

Ore will be remotely mucked from the bottom stope access using a 14-ton LHD. Cable bolts will be installed at the stope brow to ensure stability. The LHD will transport the ore to a muck bay to maximize the efficiency of the stope mucking operations. A second LHD and a fleet of 40-ton haul trucks will be used to transport ore from the muck bays to the surface. Multiple muck bays will be used on each level to avoid interference between the stope loader and the haul trucks.

At the surface, the haul trucks will dump onto an ore stockpile and will then travel to an adjacently located backfill plant to be loaded with CRF. After being loaded, the haul trucks will return to the underground mine and will dump the CRF into a muck bay near the top of an empty primary stope. After dumping the load of CRF at the muck bay, the haul truck will return to the producing level to once again be loaded with ore. A 7-ton LHD will be used to transport the CRF from the muck bay to a dumping point at the top access of the empty stope.

7.2.2. Truck Haulage

The mine plan assumes that 14-t LHDs will load 40-t haul trucks from muck bays that will be strategically located throughout the development workings.

7.3. Backfilling

The mine will utilize CRF in the primary stopes and either rock fill or low strength CRF in the secondary stopes. CRF will be generated in a surface plant located at the underground storage yard that includes a 160 t/hr portable crushing/screen plant that will create two specification grade aggregate piles and an oversize pile. The specification grade aggregate will be transported to the CRF plant by a front-end loader where it will be loaded into one of two hoppers, a large aggregate (4 inch to 3/16-inch) hopper or fine aggregate (3/16-inch minus) hopper, that will in turn batch feed into a mixer that combines specified quantities of cement, water, and aggregate to create the required high strength CRF (4% cement on a dry basis). A conveyor moves the CRF mixture to a bin that stores the CRF for loading of the underground trucks. The CRF plant has a capacity of 100 yards^3/hr with a batch mixer, cement silo with screw conveyor and weigh hopper, water weigh hopper, and two loss-in-weight aggregate bins. The 40-t underground haul truck pulls under the bin after dumping its ore on the stockpile and loads the CRF. Once loaded, the truck hauls the CRF underground to an open stope where backfilling is taking place. The truck dumps the load either directly into the stope or in a staging area where an LHD hauls the CRF to the stope for placement. Figure A-38 shows the CRF Backfill Plant cross-section.

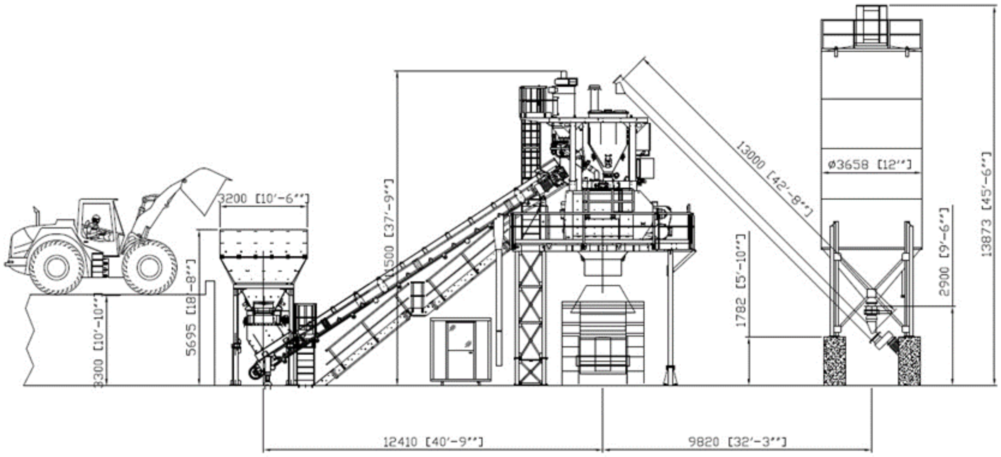

Figure A-38 CRF Backfill Plant Cross-Section
Source: SIMEM, 2017

The cement will be provided by a local manufacturer that will truck the cement in 25-t tanker transports to the site at the rate of approximately two trucks per week.

7.3.1. Waste Rock

Waste rock from the underground will be used as non-cemented fill in secondary stopes when possible. If a secondary stope is not available at the time the waste is mined, it will be hauled to the surface and placed in the UG stockpiling area where it will subsequently be either hauled via open pit trucks to the appropriate waste rock stockpile or used to make CRF. The UG stockpile is located internally to Snake Pit. The waste rock is hauled to the surface prior to stopes being developed.

7.3.2. Grade Control

The characterization of ore versus waste and further geochemical waste classification will be completed through diamond core drilling of the stope accesses prior to mining. Once the footwall level access is established, horizontal drill holes will be drilled 10 ft. beyond the planned length of the stope access. The core will be logged, sampled and analyzed to provide grade control and geochemical waste classification information. Geologic and block models will be updated with this information, and ore/waste grade boundaries will be pre-determined prior to mining the stope accesses. Areas considered to be waste will be characterized geochemically to determine which OSA the material should be sent to. Geochemical sampling techniques for the underground mine will follow existing open pit sampling techniques. Initially, all stope accesses will be drilled and sampled to ensure adequate definition for each stope. As knowledge of the deposit is gained, there may be an opportunity to increase the spacing of the drill holes.

7.4. Ventilation

A ventilation system has been designed to support the development and production activities for the underground mine. The total life-of-mine analysis includes predicted distribution of airflow and pressure. The analysis is broken down into five phases, extending from the initial startup of construction activities to the completion of the decline and all associated levels and raises.

7.4.1. Input Parameters

The location of the mine is in a very temperate area with the average low temperature in January of 29.7°F (average high 53.2°F), and an average high temperature in July of 90.1°F (average low 67.6°F). Combined with the shallow depth and apparent lack of geothermal activity, temperature stress related issues will be minimal.

No harmful strata gases are expected to be encountered at this site. No crushers or fixed ore/waste conveyances (continuous acute dust sources) are currently designed underground. Strategies for controlling dust while loading and hauling ore/waste are an important operational consideration. The configuration of the system as an exhausting ventilation system, which minimizes the blast clearance time/possibility of exposure to blast-generated gases by maintaining the ramp clear of blasting fumes.

Airway dimensions are as per the mine design, with the main ramp being 16.5 ft. x 18 ft. and the raises to surface at 16.5 ft. diameter. Oval equivalent duct of 5.5 ft. equivalent was modeled for the main decline developments. Model friction factors, resistances, shock losses, etc. were used based on available data and standard best practice.

7.4.2. Airflow Requirements

Airflow for individual pieces of equipment in the mine will need to meet (1) the requirements of CFR57.5067, which refers to the nameplate dilution values determined by MSHA/NIOSH testing or (2) the EPA requirements. Overall, the total airflow requirement for the mine is approximately 7,700 ft^3/s. A total volume of 1,836 ft^3/s is required for a one haul truck and one LHD configuration. A volume of 2,966 ft^3/s is required to operate two haul trucks and an HD in the same development heading.

7.4.3. Auxiliary Ventilation Systems

The decline development auxiliary ventilation system is sized for the simultaneous operation of one truck and one LHD. The decline auxiliary ventilation system will consist of:

- One, two, or three fans operating in series that can be added as the length of the development increases. A single fan will be able to be used until the length (resistance) of the duct increases to a point where the airflow delivered to the face is impacted, at which time the second fan should be added and so forth.
- The single 5.4 ft. oval equivalent duct can be used to develop the initial decline. In the immediate development face area, a length of supplemental duct can be attached to the main duct to provide ventilation directly at the face during blasting and during loading. The supplemental duct is advanced with the face and is not left incorporated within the long-term duct installation.

For the stope auxiliary ventilation system, auxiliary fans were selected to provide the air flow required for development or production in a stope. A maximum duct length was assumed for this specification for a forcing auxiliary system. If a haul truck will enter the stope access during the backfill cycle, a second duct system will be installed to be more than sufficient for a single haul truck. Up to four stopes were assumed to be active at once: either in development, production, or backfilling. Each stope will require two auxiliary fan/duct systems, with one fan/duct system moved up from the mucking level to the backfill level after each stope completes production.

7.4.4. Ventilation Model

Model work was completed using 5 stages. Stage 1 is the initial development of the decline and exhaust raise. As the decline continues onto the first level, the duct will extend with the development up to the 2,400 ft. length of ducting required to ventilate the raise boring of the exhaust raise, as shown in Figure A-39.

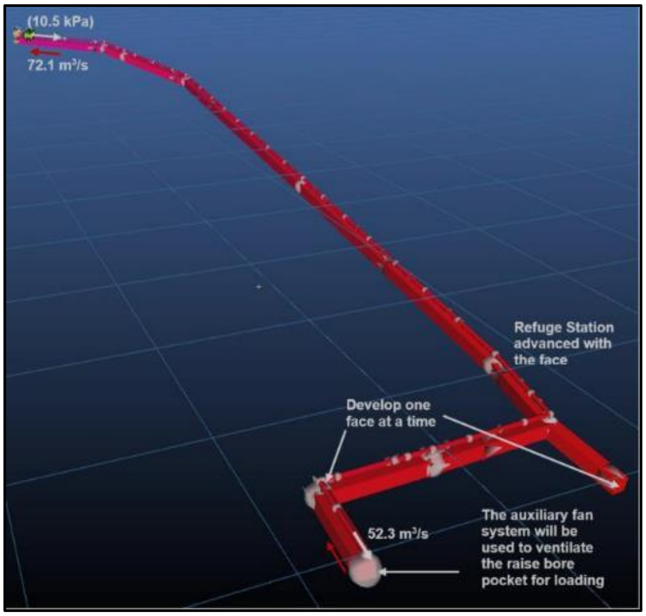

Figure A-39 Stage 1 Airflow Distribution
Source: SRK

The auxiliary fan system operates at 42.2 inches of water and uses two auxiliary fans in series and a third fan in series hung in the decline downstream of the two fans. The two-fan system (See Section 8.6) will be positioned outside of the portal. As development of the decline progresses, the ducting will be extended to the new face as needed, and the third fan will be added as airflow demands increase. An initial quantity of air enters the ducting and is delivered to the raise bore pocket. This quantity should be sufficient to support one truck and one LHD as the decline and initial raise access are developed.

Stage 2 includes further development of the decline, level development along this section of decline, and the eventual addition of the intake raise. The fan to be installed at the top of the exhaust raise should operate at the entirety of Stage 2. This will establish the initial flow-through ventilation in the mine.

The decline development is highly dependent on the continued development of levels. Each level connects into the exhaust raise via slot raises. Once a lower level is properly connected into the exhaust system, a regulator is placed on the exhaust access airway of the level above it. This method will effectively draw more airflow deeper into the mine, through the new level and out to the exhaust slot raise. The availability of flow-through airflow farther down the decline will allow the auxiliary fan system and ducting to advance down ramp, closer to the working face. This “leapfrogging” process shortens the necessary ducting length and utilizes fan power more efficiently.

The development in Stage 2 will progress to develop levels 1, 2, and 3 from their decline accesses to the exhaust airways. Level 5 is developed from its decline access to the bottom of the planned intake raise.

Stage 3 includes finishing construction on the intake raise, further development of levels, and decline advancement. Upon the completion of the intake raise at the end of Stage 2, the overall mine airflow can be increased. This stage also includes the large-scale development and production of the stopes between Levels 4 and 5.

Stage 4 is the development of the lower portion of Haile leading up to the boring of the internal raise. This stage includes the construction of the main decline, portions of the lower levels, and the exhaust slot raises. The lower mine levels constructed during this stage will be connected into the exhaust airway via slot raises. Regulators will be used to distribute the airflow between the levels. Stage 4 concludes with the auxiliary system ventilating the starting point of the raise bore for the development of the internal intake raise.

Stage 5 will commission internal intake raise, completion of the planned levels, and beginning of full-scale production from the lower block. The internal intake raise will carry air from the intake raise connected to surface. The airflow distribution is shown in Figure A-40.

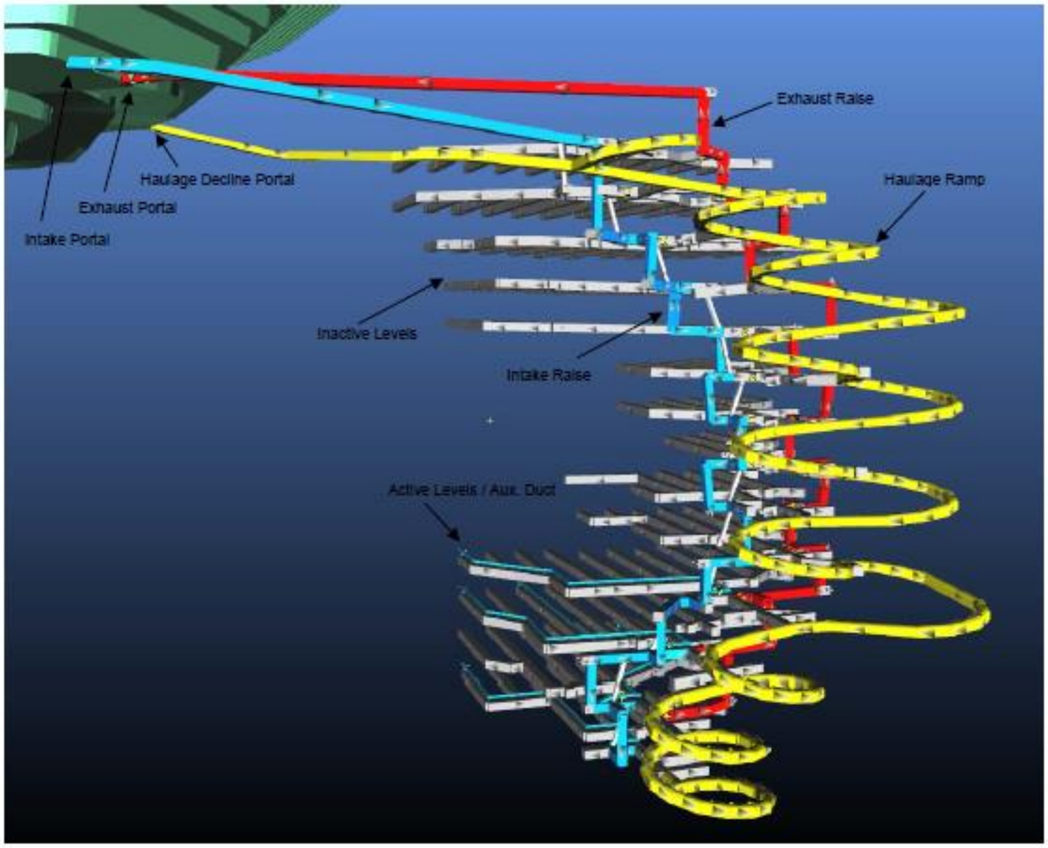

Figure A-40 Airflow Distribution

Note: Fresh Air shown in Blue and Exhaust Air shown in Red.

Source: SRK

In Stage 5, most of the mine's upper levels and stopes have been mined out and the mine airflow is directed to the lower portion of the mine with the use of ventilation controls. Stage 5 overall airflow quantity will enter the mine at the intake raise to surface and a quantity of air will enter the mine through the main portal. The maximum air velocity in the ramp will occur just beyond the portal.

7.5. Mine Services

7.5.1. Dewatering

The Horseshoe Underground will have a dewatering system that has a 1,000 gpm capacity but will typically operate at approximately 600 gpm. The larger peak inflows are expected to be encountered in the decline near surface. The weathered metavolcanics in this area have an enhanced permeability as compared to the other units. Once through the weathered zone, lower amounts of water are anticipated.

The system is built in phases as the mine develops and consists of a portable development system and permanent level pump stations that will be constructed as the mine production levels are constructed. The system will pump from the underground workings through steel and SDR11 8-inch HDPE pipes to 465 Pond where the water will be pumped through an existing system to the Contact Water Treatment Plant (CWTP).

The portable development system will be used from the portal. Once the permanent pump system is completed and piping out through the vent hole is completed, the portable system will be removed from the decline and utilized for the development decline. A second permanent pump station will be established on the -240 m level that will pump to the surface for discharge to Pond 465.

Surface dewatering will be ongoing during the time of underground production and a surface dewatering well is anticipated to be located near the main decline to minimize water encountered during development through the weathered zone.

7.5.2. Electrical

The mine electrical system will be supplied from the existing power line from the main substation at the Mill through the 24.9kV power line that feeds 465 Pond. The line will be further developed to the underground yard and eventually to the ventilation raise to feed the mine.

Initially power will come from the underground yard through a feeder cable to the portable mine substation located at the portal location that will provide power for the portal fans used during development, mine pump system, mine equipment used for driving the access decline, and auxiliary power for miscellaneous equipment required during development of the mine. Power will be carried down the decline in power cables suspended in the back to portable subs that will step the power down to feed the mobile equipment and pumps.

Once the mine ventilation hole is established, a new 13.8 kV overhead line from the underground storage yard will be extended to the vent hole and a main power feed will be run down the vent raise to feed the mine through a distribution system at 13.8kV to portable substations that feed the various mine ventilation, mobile, fixed, and pumping equipment.

The underground mine connected load including all equipment at full capacity is approximately 6 MW. The Life of Mine average usage is 1.2 million kWhr per month with an average operating load of 2.4 MW.

7.5.3. Mobile Equipment

The Mobile Equipment required for underground operation is shown in Table A-12.

Table A-12 Mobile Equipment in Operation, by Year

Type of Equipment	Diesel (kW)	Electric (kW)	2021	2022	2023	2024	2025	2026	2027	Max
DTH	119	119		1	1	1	1	1	1	1
TH Drill	110	119		1	1	1	1	1	1	1
Explosives Charger (large)	158		1	1	1	1	1	1	1	1
LHD's (14T)	256		1	1	2	2	2	2	2	2
Jumbos	119		1	2	2	2	2	2	2	2
Explosive Chargers (small)		200		1	1	1	1	1	1	1
Bolters	70	70	1	2	2	2	2	2	2	2
Scissor Lifts	127		1	1	1	1	1	1	1	1
Trucks (40T)	405		1	2	5	5	5	5	5	5
Cable Bolter	120		-	1	1	1	1	1	1	1
LHD (7T)	150	63	1	2	2	2	2	2	2	2
Boom Truck	127		1	1	1	1	1	1	1	1
Lube Truck	127		1	1	1	1	1	1	1	1
Fuel Truck	127		1	1	1	1	1	1	1	1
Flat Bed (for explosives chargers)	170		1	2	2	2	2	2	2	2
Shotcrete Sprayer Truck	170		1	1	1	1	1	1	1	1
Trans-mixer Truck	170		1	1	1	1	1	1	1	1
Telehandler	106		1	1	1	1	1	1	1	1
Skid Steer	73		1	1	1	1	1	1	1	1
Personnel Carriers (4 person)	19		2	4	4	4	4	4	4	4
Personnel Carrier (16 person)	127			2	2	2	2	2	2	2
Underground Core Drill		55		1	1	1	1	1	1	1
Grader	114			1	1	1	1	1	1	1

Source: SRK

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8. ORE PROCESSING METHODS AND FACILITIES

This section generally describes how the ore is processed to remove the gold. Ore is sent to the Mill, where it goes through a process of physical size reduction and chemical separation to extract the precious metals. The Mill Site is located on a 185-acre portion of the mine (See Figure A-41) that includes the Mill and ancillary support facilities, such as reagent storage and mixing, CWTP, water storage tanks, containment systems, 39 Pond, fuel storage (diesel fuel and gasoline), mine and mill maintenance shops, truck wash, warehouse, administrative offices, and parking. Figure A-42 shows the constructed Process Mill flow sheet and its support facilities. The Mill Site includes stormwater and sediment management features.

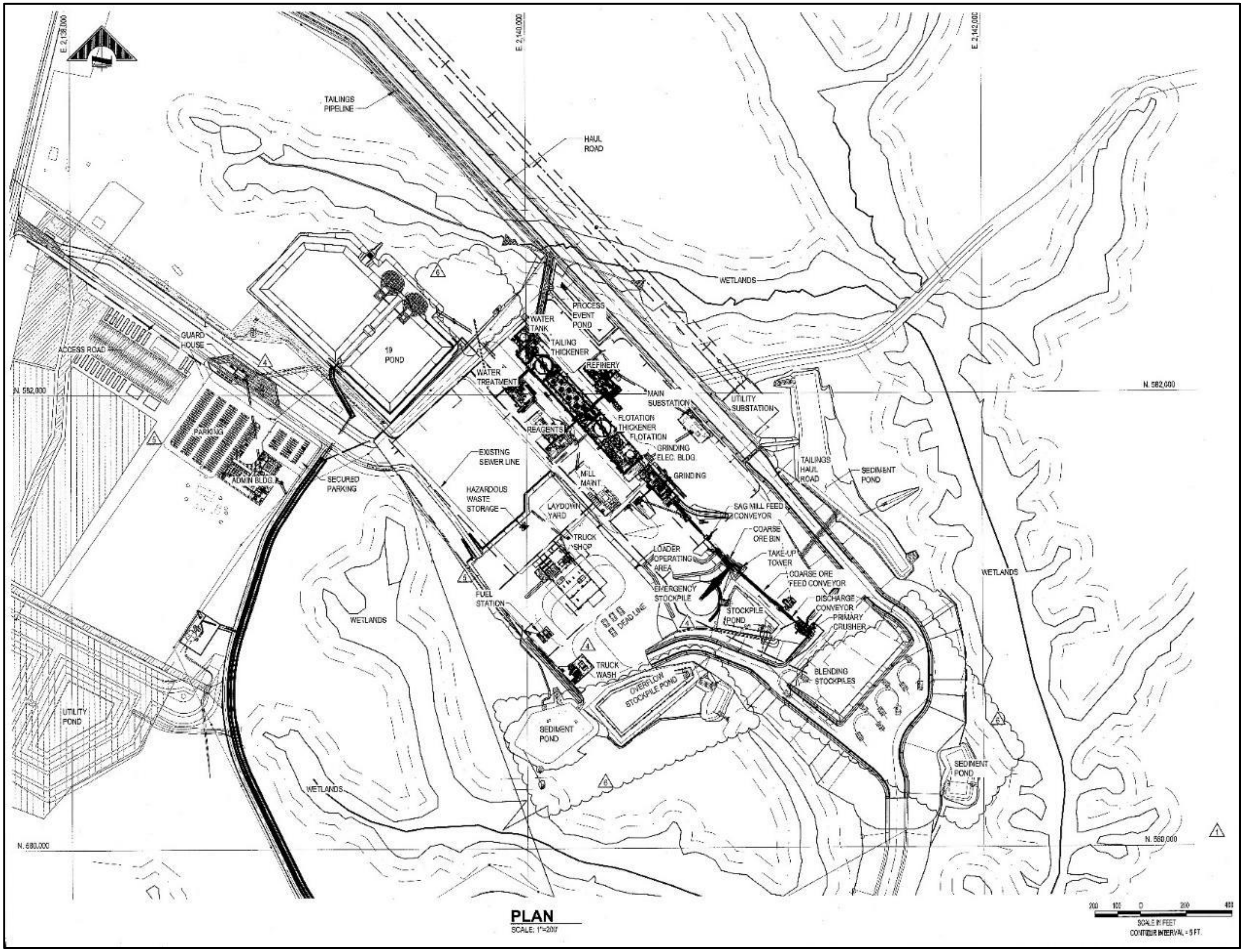

Figure A-41 As-Built Mill Site General Arrangement
Source: Haile 2017.

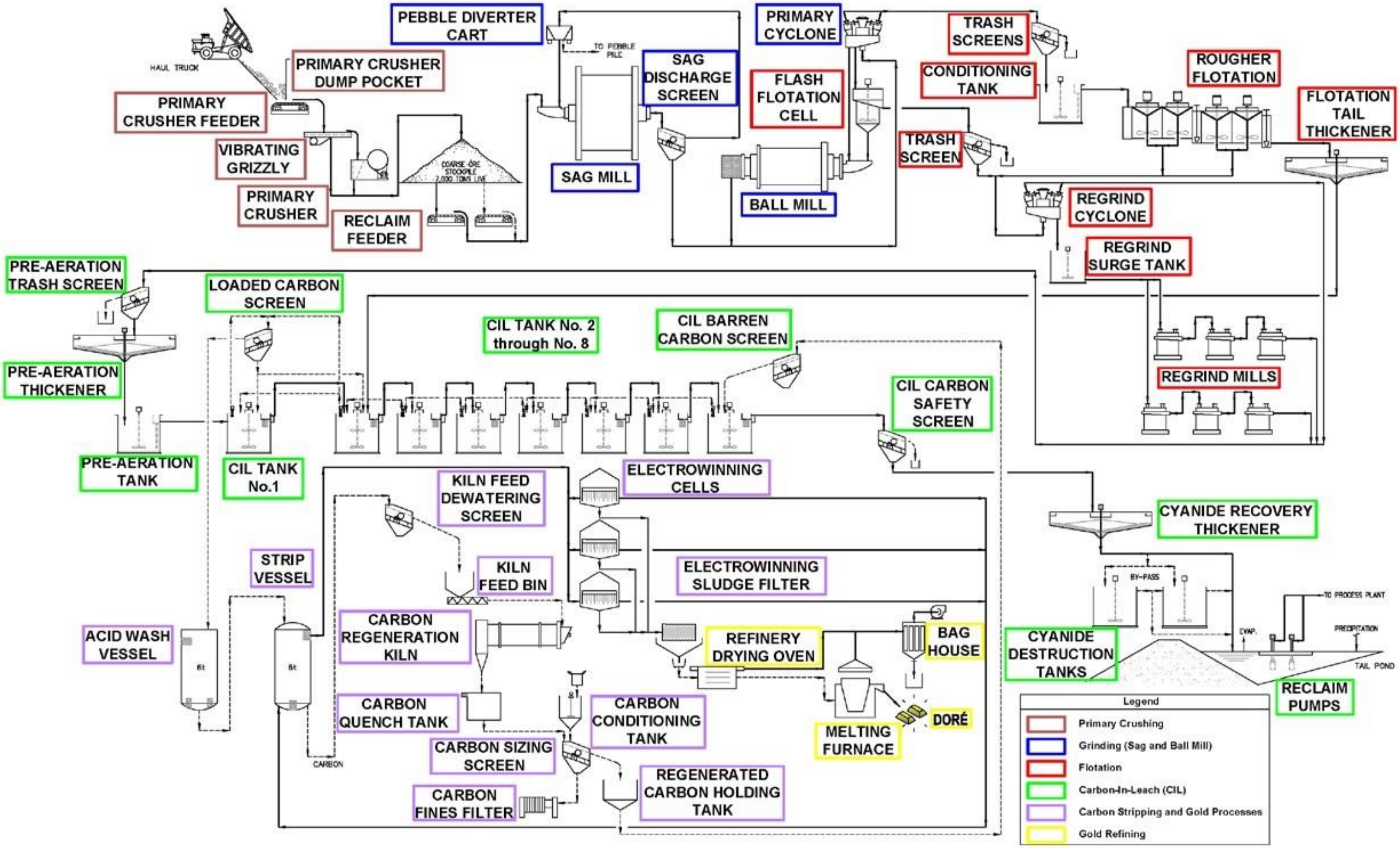

Figure A-42 As-Built Mill Process Flow Sheet
Source: M3 Engineering & Technology 2017.

The following steps summarize the process for extracting the gold from the ore (colors refer to those shown in the figure):

- Primary Crushing (brown) – The ore is crushed to less than 6 inches by the primary crusher (See Figure A-43) and then stacked on the Emergency Stockpile (Figure A-44) or direct fed into the grinding circuit.

- Grinding (SAG and Ball Mill) (blue) – The less than 6-inch rock is ground in water to the size of a fine powder, approximately 74 microns in size, or about the grain size of table salt. The mixture of particles and water is called *slurry*, and the process from this point on is in slurry form. The SAG and Ball Mills are shown in Figure A-45.

- Flotation (red) – The slurry from grinding is treated with chemicals to enable the gold-bearing minerals to float to the top of the flotation machines (flash flotation cell and rougher flotation) and concentrate as a froth. The froth would flow downstream as a slurry concentrate for further processing in the regrind circuit (described next). The ore that does not float in this process is called flotation tailing, and these tailings are pumped to the carbon-in-leach (CIL) circuit described below.

- Regrind (red) – The slurry concentrate of gold-bearing minerals from flotation is ground further to approximately 13 microns in size, about the grain size of talcum powder, in the six regrind mills shown in Figure A-46.

- Carbon in Leach (green) – The CIL process takes place in eight tanks. The reground concentrate slurry is oxidized with air in the pre-aeration tank prior to being treated with sodium cyanide in CIL Tank No. 1. Dissolved gold is adsorbed onto activated carbon. The discharge from CIL Tank No. 1 flows by gravity to CIL Tank No. 2, where it combines with the flotation tailing. The combined streams are treated with sodium cyanide, and the dissolved gold is adsorbed onto activated carbon in CIL Tanks Nos. 2 through 8. The discharge from CIL Tank No. 8 is thickened, and most of the sodium cyanide is returned to the concentrate treatment stage. The remaining flow is pumped to the TSF through the cyanide destruction process, where cyanide is destroyed using a sulfur dioxide and air (INCO) process.

- Carbon Stripping and Gold Processing (purple) – The gold-bearing activated carbon is treated with chemicals to strip the gold from the carbon into solution (called “pregnant solution”). The gold is removed from the pregnant solution in the electro-winning cells. In the cells, a gold-bearing “sludge” forms on the electro-winning cathodes. The sludge is washed off the cathodes and dried in an oven. After the gold is removed from the carbon, the carbon is thermally reactivated by heating in a kiln to remove impurities. After reactivation, the carbon is returned to the CIL circuit for reuse.

- Gold Refining and Processing (yellow) – The gold-bearing sludge is smelted to separate the gold from the waste material, poured into a mold, and cooled to form a doré bar that is a mixture of gold and silver.

Figure A-43 Run-of Mine Pad and Crushing Circuit
Source: Haile 2018.

Figure A-44 Emergency Stockpile
Source: Haile 2018.

Figure A-45 Grinding Circuit – SAG Mill and Ball Mill

Source: Haile 2018.

Figure A-46 Flotation and Ultrafine Grinding Circuit
Source: Haile 2018.

The key additions to optimize the Mill process, shown in Figure A-47, include the following:

- Pebble crushing installation on existing SAG mill scats recycle (See Figure A-48)
- Additional scavenger Flotation cells to maximize reaction times (See Figure A-49),
- Tertiary (whole ore) grinding using a vertical ball ISA mill (See Figure A-50, left and A-51),
- Primary regrinding stage using a vertical ball Tower mill (See Figure A-50, right),
- Additional acid wash and strip vessels in the Elution circuit (See Figure A-52), and
- Additional reaction tank in Cyanide Destruct circuit (See Section 8.1).

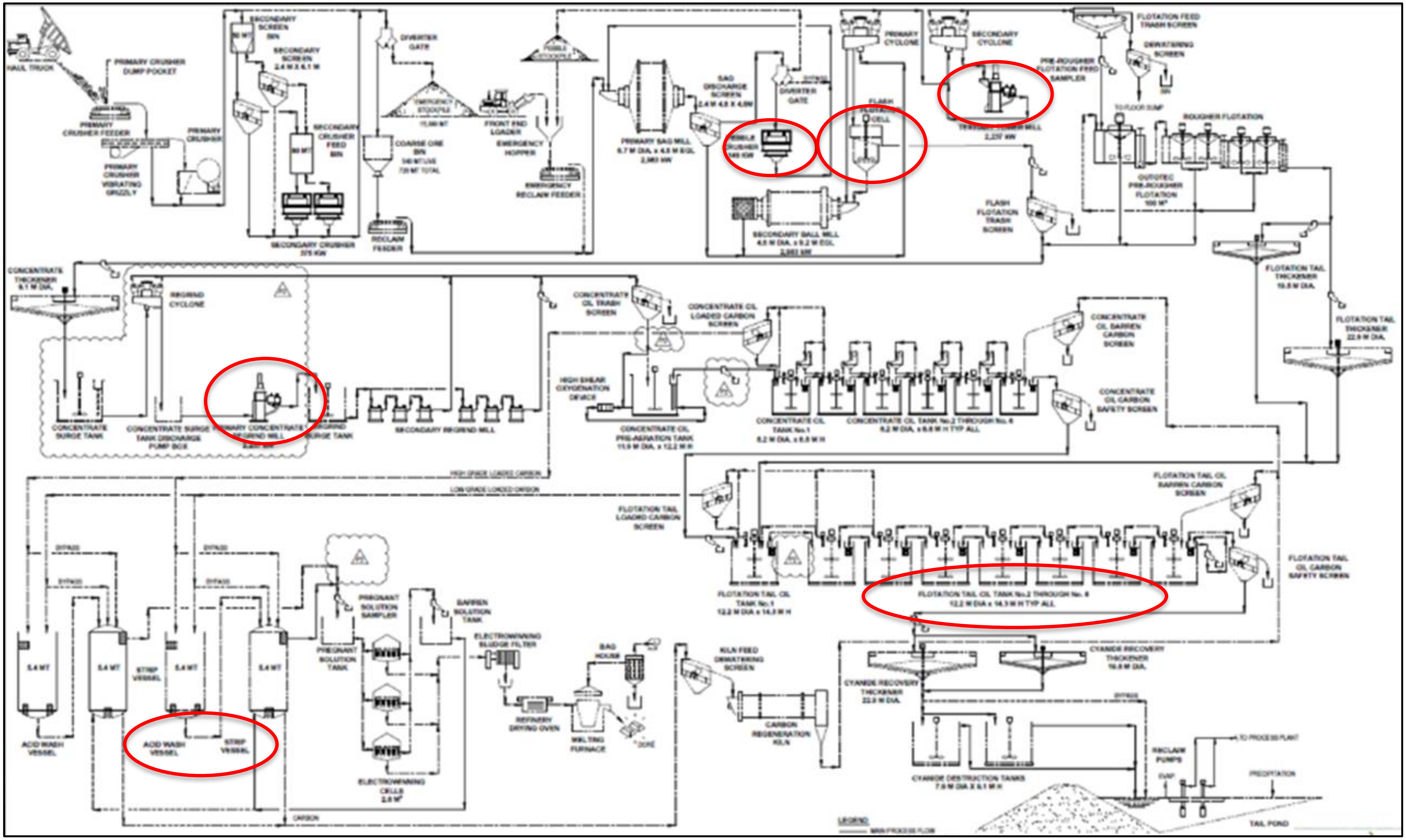

Figure A-47 Optimized Mill Process Flow Sheet (selected additions are circled)

Source: M3 Engineering 2017.

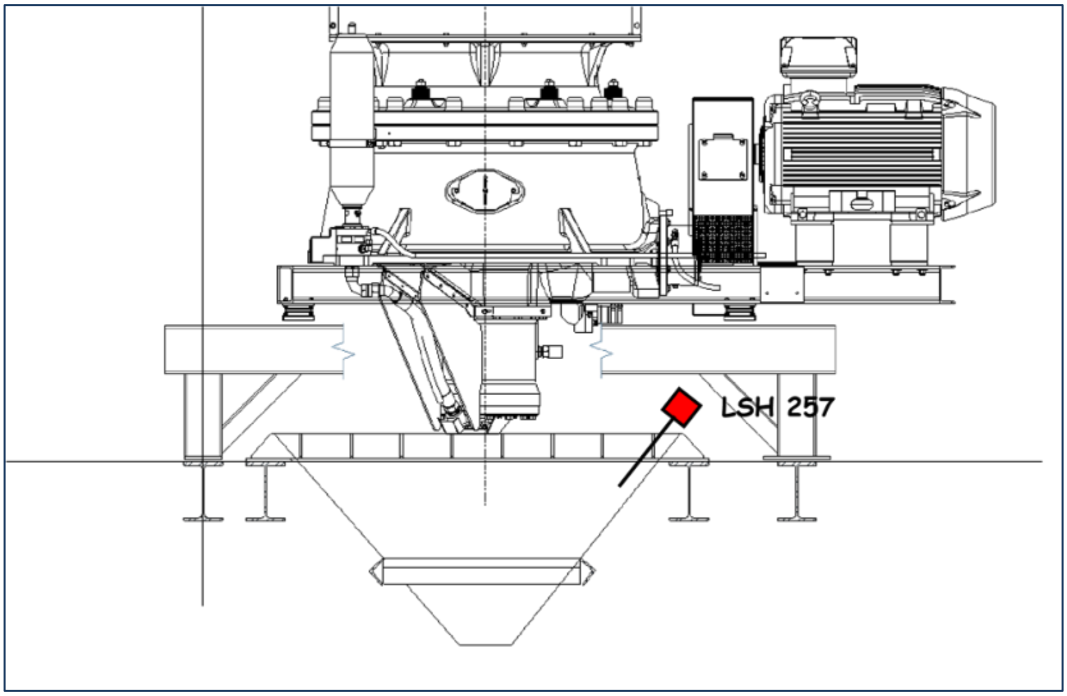

Figure A-48 Pebble Crusher
Source: East Group 2018.

Figure A-49 Flotation Cell
Source: Outotec 2018.

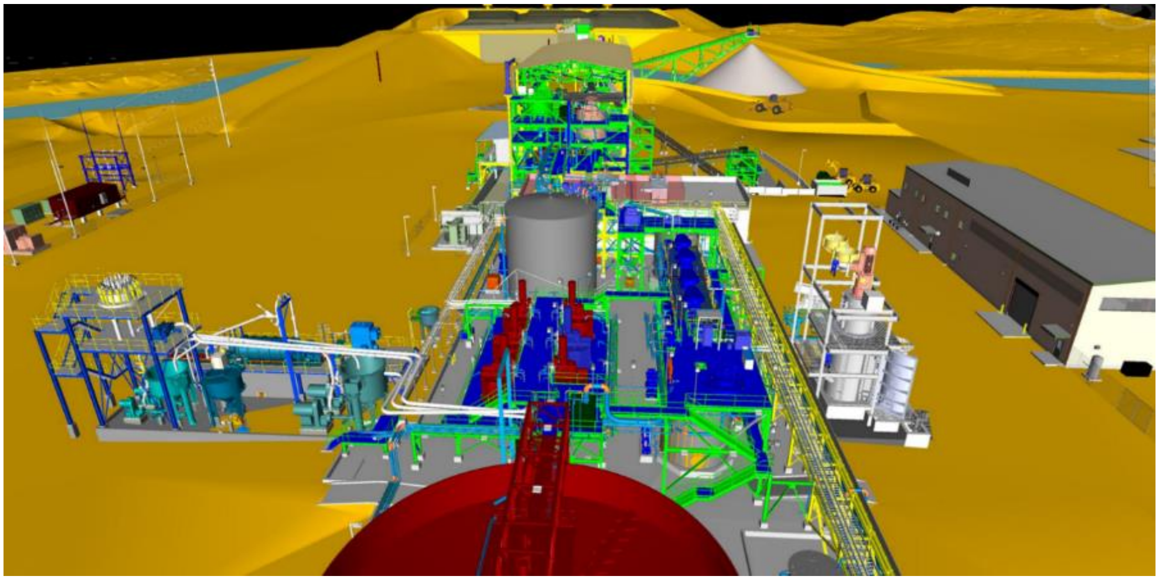

Figure A-50 Location of ISA Mill (left) and Tower Mill (right)
Source: Ausenco 2018.

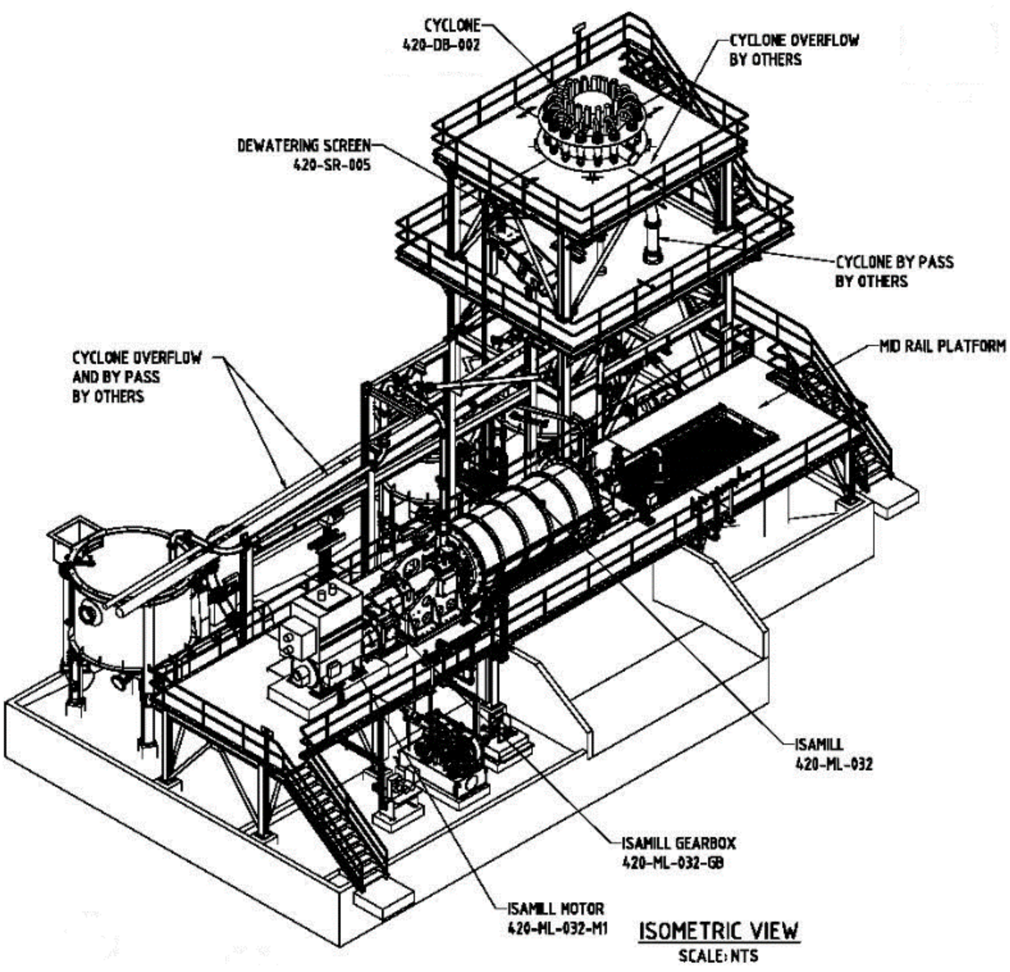

Figure A-51 Isometric View of the ISA Mill
Source: IsaMill 2018.

Figure A-52 Elution Circuit – Acid Wash, Barren Tank, and Carbon Regeneration Rotary Kiln
Source: Haile 2018.

The particle size distribution through each reduction operation is shown in Table A-13.

Table A-13 Approximate Particle Size Distribution by Operation

Operation	Particle Size (P_{80})
Run of Mine Ore	24 inches
Through Crusher	6 inches
Through SAG Mill	2.25 inches
Through Ball Mill	85 microns
Through Tower Mill	47 microns
Through ISA Mill	13 microns

8.1. Sodium Cyanide Use and Recovery

Sodium cyanide is used only in tanks and in the following manner within the closed-loop system for the Mill process water. Sodium cyanide is transported to site in an ISO Container (See Figure A-53), liquefied in the container, and then transferred to the storage tanks. It is pumped to the CIL tanks and mixed with the activated carbon in the concentrate and flotation tailing treatment stages. (Prior to those stages, the slurry is aerated to oxidize the ore, which reduces the amount of sodium cyanide required to extract the gold.) In addition to sodium cyanide and activated carbon, lead nitrate and lime are added in the concentrate and flotation tailing treatment stages in various amounts to enhance gold recovery and maintain the pH to ensure protective alkalinity. The Carbon-In-Leach (CIL) process takes place in eight tanks. Slurry advances from tank to tank by gravity, and all discharge from the last tank reports to the carbon screen. Because the particles of activated carbon with the adsorbed gold are larger than the slurry mixture, they are retained in the tanks by screens while the waste slurry passes through from tank to tank and finally out of the circuit.

Figure A-53 Sodium Cyanide Transfer Station
Source: Haile 2018.

The slurry is pumped to the TSF through the cyanide destruction circuit (if needed to keep WAD cyanide levels in the slurry below 50 ppm), where cyanide is destroyed using a sulfur dioxide and air (INCO) process.

In the cyanide destruction tanks, WAD cyanide is oxidized to form cyanate (OCN-). The process uses sulfur dioxide and air at a slightly alkaline pH in the presence of soluble copper to oxidize the cyanide. Through this process, the cyanate quickly decomposes in water to ammonium (NH4) and bicarbonate (HCO3) ions that are stable. This process was developed in the 1980s and is currently in use at over 30 mine sites worldwide. Ammonium bisulfite is the source of sulfur dioxide, and air is the source of oxygen. Copper sulfate is added as a catalyst and lime is added to control pH.

Discharge from the cyanide destruction tanks is pumped to the TSF with the tailing slurry. In the TSF, UV sunlight and air naturally decompose cyanide and cyanide complexes to further decrease cyanide levels. Figure A-54 shows the Tails Thickener and Cyanide Destruct Circuit.

Figure A-54 Tails Thickener and Cyanide Destruct Circuit
Source: Haile 2018.

8.2. Process Water Supply

Water for the Mill process is obtained from the sources shown in Figure A-55. These sources include:

- Water reclaimed from the TSF tailing slurry;
- Groundwater pumped to depressurize the areas adjacent to the mining pits (see Section A.10.2.3, “Depressurization Water Management” for details) or other non-contact water sources stored in the FWSA;
- Contact water pumped from the pit sumps, underground mine, and PAG Cells; and
- Moisture retained within the ore.

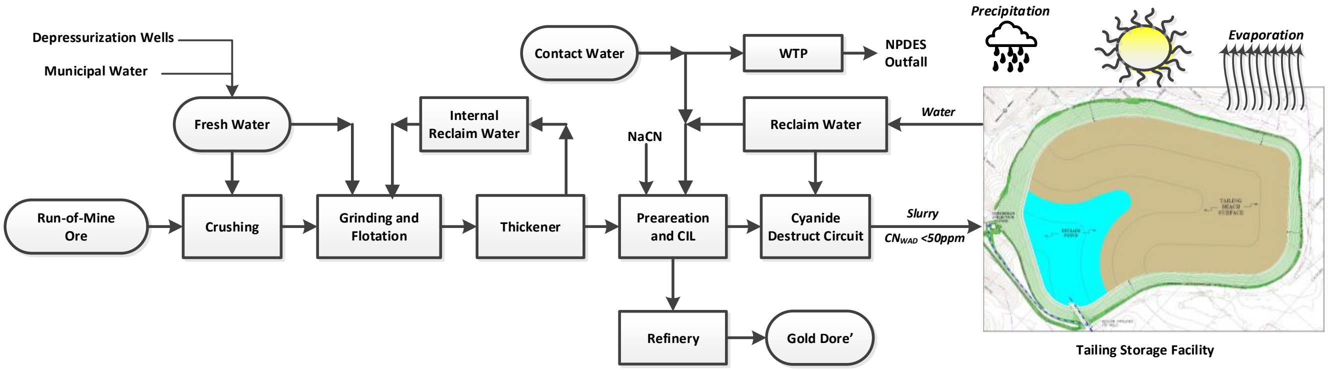

Figure A-55 Process Water Supply
Source: Haile 2013 (updated 2018).

If necessary, Haile can use municipal water as makeup for the Mill, though water balance model results suggest that Haile can meet process water needs through a mix of reclaim water from the TSF; internal reclaim water extracted from the thickeners; contact water; and direct use of non-contact water. Town of Kershaw can also supply water from a new 250,000-gallon tank on Highway 601, at the edge of city limits. The Town of Kershaw has committed a water volume of 640 gallons per minute, as needed, if it poses no encumbrance to the community. This new tank was funded by Haile and state commerce for this specific purpose.

The TSF Reclaim water (reclaimed in the closed-loop process) is the primary source of water for the Mill. The water level in the TSF changes seasonally and in dry or wet periods. The use of non-contact at the Mill increases only when the volume of TSF reclaim water decreases. The amount of water supplied from TSF reclaim is expected to range from approximately 800 to 1,575 gallons per minute (gpm). The range of values is a product of the amount of free water that may be stored in the TSF prior to a drought. The ratio of TSF reclaim water to non-contact water varies based on the available TSF reclaim water. During typical conditions, reclaim is expected to range from approximately 1,200 gpm to 1,575 gpm. Only during severe drought conditions is reclaim expected to drop to the 800 gpm range.

Contact water is derived from runoff and seepage from PAG material, precipitation falling into the pits, and water from underground mine operations. During an extreme dry condition with no precipitation, when the underground mine is not yet operational, little to no contact water is generated; therefore, it cannot be counted on to meet Mill demands. During average and wet conditions, sufficient water is available in the TSF to meet the full reclaim demand of 1,575 gpm, and contact water is not brought to the Mill in these situations. Contact water is brought to the Mill only when minimal amounts of free water exist in the TSF and precipitation occurs (but in limited amounts). Given this atypical condition, the volume of water in the TSF would not be sufficient to meet the full 1,575 gpm reclaim. Contact water or additional non-contact water would then be brought into the Mill to supplement TSF reclaim.

8.3. TSF Reclaim Water

TSF reclaim water is reused in the Mill process. The reclaim water cycles between the Mill and the HDPE-lined TSF in a closed loop, which prevents the Mill process water from being discharged into the environment. As described above, the concentration of WAD cyanide is reduced below 50 ppm prior to being pumped to the TSF, in accordance with the International Cyanide Management Code. Once the slurry reaches the TSF, ultraviolet (UV) sunlight and air naturally further decompose carbon and nitrogen bonds which complexes to further decrease total cyanide levels in the TSF Reclaim Pond.

Given average precipitation conditions, a maximum of approximately 350 acre-feet of reclaimed water is stored in the TSF. If a prolonged period of extreme precipitation were to occur (a 95th-percentile wet cycle), water storage in the TSF is expected to approach approximately 700 acre-feet. In all cases, the TSF is designed to store rainfall associated with the probable maximum precipitation (PMP) event while maintaining an additional 4 feet of freeboard. The American Meteorological Society defines a PMP event as “the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin at a particular time of year” (AMS 1959). The PMP storm for the Haile Gold Mine site is calculated as 48 inches for a 72-hour event. Freeboard is a function of the facility design and is calculated to provide a factor of safety greater than that for which the facility is designed.

At the end of the production phase of the mine, Haile’s NPDES permit will be modified to include a treatment system for this process water. This new process water treatment system will treat underdrainage from the TSF until it is capped and sufficiently drained down such that the flows have diminished to a level where the outflow can be treated in a passive treatment system.

8.4. Reagents

Reagents are chemicals or solutions used in gold ore processing to produce a desired reaction. Reagents that would require handling, mixing, and distribution systems are listed in Table A-14.

Table A-14 Reagents Used in Ore Processing

Reagent	Use	Maximum On-Site Storage Capacity[a]
Aero 404 (l)	AERO 404 (or an equivalent flotation promoter) is added to the SAG mill and flotation stage to enhance flotation recovery of gold and gold-bearing sulfide minerals.	26 tons 6,070 gallons (total) One tank @ 6,070 gallons
Ammonium bisulfite (ABS) (l)	Ammonium bisulfite is used in the sodium cyanide destruction circuit. Ammonium bisulfite is added to the sodium cyanide destruction tanks as the primary source of sulfur dioxide (SO2), which is used to oxidize free sodium cyanide and weak acid dissociable (WAD) metal sodium cyanide complexes (SO_2/air process).	30 tons 6,365 gallons (total) One tank @ 6,365 gallons
Antiscalant (l)	Antiscalant is added to the barren strip solution, reclaim water, and internal reclaim water tanks to prevent scaling in pipelines and tanks.	25 tons 7,950 gallons (total) Three tanks @ 2,650 gallons (each)
Caustic soda (sodium hydroxide) (NaOH) (l)	Caustic soda solution is used to neutralize acidic solutions after acid washing in the carbon strip stage. Caustic soda can be added to the sodium cyanide mix tank for pH control, if needed.	31 tons 5,265 gallons (total) One tank @ 5,265 gallons
Copper sulfate ($CuSO_4$) (s)	Copper sulfate is delivered dry and stored in bags until mixed with water in a distribution tank. Copper sulfate is added to the sodium cyanide destruction tanks to provide copper ions as a catalyst for the sodium cyanide destruction process.	6 tons dry on pallets plus One mix tank @ 6,390 gallons and one distribution tank @ 6,360 gallons
Flocculant (s)	Flocculant is delivered dry and stored in bags until mixed with water in three separate distribution tanks. Flocculant is added during the slurry thickening process to promote solids settling.	26 tons dry on pallets plus 13,800 gallons mixed – two tanks @ 5,750 gallons and one tank @ 2,300 gallons
Flux (s)	Flux is added in the gold refining stage to remove contaminants from the precious metals. Flux is added in solid form.	3 tons
Frother (MIBC) (l)	Frother is added at the flotation stage to enable flotation of gold-bearing sulfide minerals.	25 tons - 7,500 gallons (total) One tank @ 7,500 gallons
Hydrochloric acid (HCl) (l)	Hydrochloric acid is used in the carbon strip stage to acid wash carbon.	25 tons 5,100 gallons (total) One tank @ 5,100 gallons
Lead nitrate (PbNO3) (s)	Lead nitrate is delivered dry and stored in bags until mixed with water in a distribution tank. Lead nitrate is added in the pre-aeration stage to enhance leaching.	6 tons dry on pallets One mix and distribution tank @ 1,550 gallons

Reagent	Use	Maximum On-Site Storage Capacity[a]
Potassium amyl xanthate (PAX) (s)	PAX (flotation collector) is delivered dry and stored in bags until mixed with water in a distribution tank. PAX is added to the grinding and flotation stages to facilitate flotation of gold-bearing sulfide minerals.	30 tons on pallets plus One 5,140-gallon mixing tank and one distribution tank at 5,485 gallons
Quicklime (pebble lime) (CaO) (l) and (s)	Milk-of-lime slurry (MOL) is produced by hydrating pebble quicklime. MOL is used to control pH in various parts of the process. MOL is distributed to the concentrate treatment stage (pre-aeration), CIL tank Nos. 1 and 2, thickeners, and the sodium cyanide destruction circuit.	One silo at 100 tons dry One mixing and distribution tank @ 24,000 gallons
Sodium cyanide (NaCN) (l)	Sodium cyanide solution is added to the ore in the leach circuit to recover gold and silver. Sodium cyanide solution also is used to promote removal of gold and silver from the carbon in the carbon strip stage.	46 tons 51,000 gallons (total) Two tanks @ 25,500 gallons (each)
Metalsorb (l)	Metalsorb (or an equivalent chelating agent) is used to abate mercury production by complexing mercury to form a stable organic sulfide precipitate.	2.6 tons 560 gallons (total) Two tote bins @ 280 gallons (each)

Notes:

(l) = liquid (s) = solid

[a] Actual volumes stored on site may be less than full storage capacities based on factors such as replenishment order points, market conditions, vendor logistics, Mill throughput, reagent availability, delivery options, and process optimization. Metric conversions are available upon request.

[b] Antiscalant is a vendor-supplied package.

Source: Haile 2018.

The dry reagents are stored under cover and then mixed in reagent mixing tanks and transferred to distribution tanks for process use. Figure A-56 shows the Reagents Storage Facility.

The reagent building is a steel-framed structure with metal roofing. In general, the building is open, but metal siding is installed where necessary to keep reagents dry. The floor is slab on-grade concrete, with concrete containment walls to capture spills and any precipitation that enters the sides of the structure. Reagents that are not compatible to be stored together are kept in separate containment areas within the reagent storage area.

Figure A-56 Reagents Building
Source: Haile 2018.

8.5. Spill Containment

The ore processing facilities, chemical storage areas, and fuel storage areas are designed with the capacity to contain spills or leaks, with the volume to hold a 100-year, 24-hour storm event, assuming it would occur in conjunction with a spill or leak. Each area is built on a concrete floor with cast-in-place concrete walls. The floor area and wall heights are designed to capture any spills, and the floors slope toward a collection sump for cleanup and return of the spill to the process stream for which it is best suited. The floor area and walls are designed to capture 110 percent of the largest vessel (or container) in that process area plus stormwater (for the 100-year, 24-hour storm event) if it is open to the sky. If a spill is greater than the facility's containment capacity, it is captured and flows into the Process Event Pond (explained below). Table A-15 summarizes the proposed containment systems and volumes for components of the Mill and Mill Site.

Three of the containment areas are interconnected – Flotation to Pre-Aeration Thickener; Tail Thickener to CIL; and Cyanide Recovery Thickener to Cyanide Destruct. These areas are separated by a stem wall with a slot, so water can pass in either direction. This feature is based on efficiency in design and allows for the low probability that there will not be multiple tanks fail at the same time.

Table A-15 As-Built Containment Systems

Containment Area	Indoor / Outdoor	Containment System	Containment Volume	Sump Pumps to
Primary crusher	Outdoor	Concrete pad with stem walls	100-year, 24-hour storm event	Stockpile Collection Pond
Grinding (SAG and Ball mill) building	Covered	Concrete pad with stem walls	110% of largest vessel	Grinding circuit

Containment Area	Indoor / Outdoor	Containment System	Containment Volume	Sump Pumps to
Flotation and regrind	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event.	Flotation circuit
Pre-aeration thickener	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event.	Pre-aeration thickener
Flotation tail thickener	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event.	Flotation tail thickener
Carbon-in-leach (CIL) area	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event.	CIL circuit
Cyanide recovery thickener/cyanide destruction	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event.	Cyanide destruction
Reagent mixing area	Covered	Concrete pad with stem walls	110% of largest vessel in each containment area + 100-year, 24-hour storm event	Cyanide destruction
Reagent storage area	Outdoor	Concrete pad with stem walls	110% of largest vessel in each containment area + 100-year, 24-hour storm event	CIL circuit
Reclaim water pad	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event	Reclaim water tank
Tailings line	Outdoor	Lined trench and pond	110% of the entire pipeline volume + 100-year, 24-hour storm event	Process Event Pond
Truck shop tank farm	Outdoor	Double-walled tanks	Tanks are double-walled on a concrete pad foundation	No sump in this area; any spills is remediated at the point of spill.
Carbon acid wash	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event	Carbon acid wash
Carbon strip	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100-year, 24-hour storm event	Carbon strip
Carbon regeneration	Outdoor	Concrete pad with stem walls	110% of largest vessel + 100 Year/ 24-hour storm event	Carbon regeneration

Containment Area	Indoor / Outdoor	Containment System	Containment Volume	Sump Pumps to
Refinery	Indoor	Concrete pad with stem walls	110% of largest vessel	Refinery
Fuel storage	Outdoor	Double-walled tanks	Tanks are double walled on concrete foundations	No sump in this area; any spills are remediated at the point of spill.

Source: M3 Engineering & Technology 2017.

In the event of a spill that exceeds a facility's containment capacity, the overflow drains to the adjacent Process Event Pond (See Figure A-57), which is designed to act as a failsafe in case individual containment systems have insufficient capacity. The Process Event Pond is designed to capture quantities of spilled solution or slurry that may exceed the main process containment facilities, tailing slurry pipeline contents, or reclaim water line contents. It is constructed on the north end of the processing facilities, adjacent to the refinery.

Figure A-57 Process Events Pond
Source: Haile 2018.

The Process Event Pond is an approximately 1.5-million-gallon-capacity HDPE-lined pond to handle overflow events. Should multiple spill events occur in the processing area, any material that would not fit within the containment area would flow to the HDPE-lined Process Event Pond via a pipeline that would flow by gravity to the Process Event Pond. The tailings slurry and process water pipelines (described below) are designed to have double containment, involving either a pipeline within a pipeline or a pipeline within a lined containment structure or trench. Should a failure of the tailings or process water pipelines occur, or a prolonged unplanned power outage occur, the material from the pipelines would drain to the Process Event Pond.

Once the failures have been repaired, or power restored, material in the Process Event Pond is returned to the cyanide recovery thickener or applicable area for processing. Water from a spill or incident that contacts processing reagents is suitable for use in the closed-loop system, which includes use of process water from the TSF.

In addition to the containment systems identified for the Mill, the following support facilities also would have spill control measures: the truck shop, fuel storage locations, hazardous waste storage building, and electrical substation. Chemical storage and containment are designed to avoid mixing chemicals that interact negatively.

8.6. Air Point Sources

The summary of air discharge and point sources placed into the Haile operation are shown in Table A-16. These are monitored quarterly for visible emissions and were measured during initial compliance testing. Stack testing and calculations were performed in accordance with initial performance test requirements of the New Source Performance Standards (NSPS) 40 CFR Part 60 Subpart LL and the National Emissions Standards for Hazardous Air Pollutants (NESHAP) 40 CFR Part 63 Subpart EEEEEEE. The NSPS standards apply to ore processing equipment and impose limits on particulate matter (PM) and visible emissions.

Table A-16 Air Point Sources

Source Identification	Engineering ID	Description	
PT-1	100-CR-001	Primary Crusher including Load-In/Load-Out	
PT-2	150-BN-001	Crusher Conveyor Transfer to Stockpile Feed Conveyor	
PT-3	150-CV-003	Stockpile Feed Conveyor Transfer to Coarse Ore Stockpile	
PT-2A	150-CV-002	Crusher Conveyor Transfer to Coarse Ore Bin	
PT-3A	200-HP-001	Emergency Hopper Load-In	
PT-4	300-CV-002	Conveyor Transfer to SAG Mill	
PT-5a	500-KN-001	Carbon Regeneration Kiln	Kiln Exhaust (Wet Scrubber)
			Natural Gas Combustion
PT-5b	500-WS-002	EW Cells, Pregnant and Barren Tanks (Wet Scrubber)	
PT-6	500-DC-001	Electric Melting Furnace - Refinery (Baghouse)	
PT-7	800-FL-001	Reagent Area Lime Silo Bin Vent Filter (75 ton capacity silo)	
PT-7a	800-PK-010	Reagent Area Lime Slaker	
PT-8	700-GE-001	1,500 kW Diesel Emergency Generator	
PT-9	NA	Trailer Mounted Lighting Systems (10 kW each)	
PT-15	NA	335 hp Diesel Fired Sump Pump Engine	
PT-16	500-HT-001	Natural Gas Fired Thermal Fluid Heater	
PT-17	650-PP-022	Fire Water Pump Engine (149 hp)	

Source Identification	Engineering ID	Description
PT-18	050-CR-002	Portable Crushing Operation
T-1	450-TK-001 through 008	Carbon-in-Leach Tanks (8 total) and Cyanide Recovery Thickener
T-2	800-TK-015	Hydrochloric Acid (30%) Storage Tank
T-3	800-TK-007	Sulfuric Acid (93%) Storage Tank
T-5	800-TK-010	Potassium Amyl Xanthate Storage Tank
TK-001	960-TK-001	Diesel Off-Road Fuel Storage Tank
TK-002	960-TK-002	Diesel Off-Road Fuel Storage Tank
TK-003	960-TK-003	Diesel Off-Road Fuel Storage Tank
TK-004	960-TK-004	Diesel Off-Road Fuel Storage Tank

Additional point sources that have been modelled and permitted as part of 2014 Air Permit 1460-0070-CA include the following equipment. Note that this equipment has not been installed.

Source Identification	Engineering ID	Description
PT-10	950-TK-001	150-ton Overburden Lime Silo
PT-11	950-TK-002	58.5 tpd Lime Drop to Truck Bed

There are two ventilation fans planned for the underground portals as shown in Figure A-58.

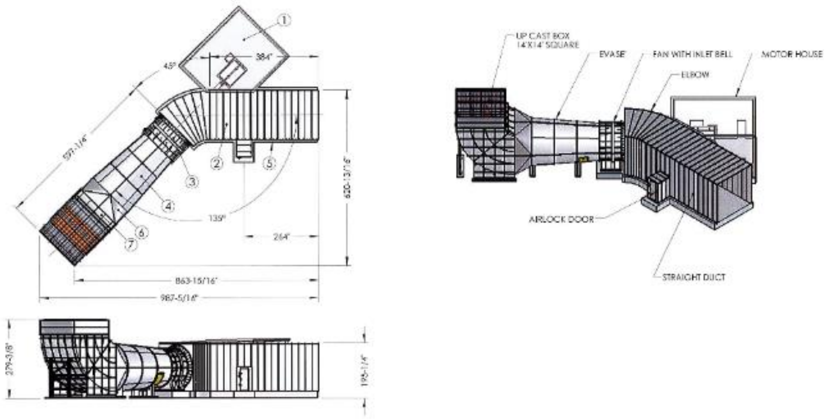

Figure A-58 Portal Ventilation Fans
Source: SRK 2017.

8.7. Electrical Power

The Haile Gold Mine straddles the boundary between the Duke Energy-franchised electric service territory and that of Lynches River Rural Electric Cooperative. Haile has entered into an agreement with Duke Energy to supply Haile's power, and Lynches River (and its engineering and construction partner, Central

Electric Power Cooperative) have constructed a new 69 kilovolt (kV) overhead power line and a 69 kV/24.9 kV substation to serve the mine.

Central Electric has an existing 69 kV power line, known as the Heath Springs to Flat Bush transmission line that runs in an east-west direction north of Project site. The new connecting 69 kV line of approximately 4.5 miles is constructed to run from near the intersection of this line and Duckwood Road north of US Highway 903 to a substation on the Haile Gold Mine property (see Figure A-59). Most of the new line at the Mill Site is within or alongside of the existing Duckwood Road and US 601 utility right-of-way.

Figure A-59 Lynches River 69 kV Substation

Source: Haile 2018.

After the mine is permanently closed, the line and substation may be available to serve other customers. If other potential customers ask for service from the line and substation while the mine is operating, Haile would consider such requests, provided there is no degradation to the quality of power delivered to the mine (specifically the CWTP).

The peak electrical load for the Haile Gold Mine is approximately 14 megawatts (MW), and the typical operating load is from 11 to 12 MW. Power is distributed throughout the site via underground duct banks as well as by a series of 24.9 kV overhead lines.

8.8. Natural Gas

Natural gas is brought to the Project via a buried pipeline connecting to the Lancaster County Natural Gas Authority near US 601 to supply process requirements such as heating the carbon stripping solution, reactivating carbon, and comfort heating requirements. Figure A-60 shows the natural gas pipeline connection for the Project.

Figure A-60 Natural Gas Line at Highway 601
Source: Haile 2018.

8.9. Potable Water

The Haile Gold Mine currently obtains potable water from the Lancaster County Water and Sewer District. The Project is connected to the Town of Kershaw municipal water system.

8.10. Fire Protection Water

The Haile Gold Mine uses water from the mine depressurization wells for fire protection water. If fire trucks are called to the site, they can connect to one of the fire hydrants located around the Guard House, Administration Building, Warehouse, Mill Maintenance, Mine Maintenance, or from the Mill itself. The Town of Kershaw can also supply fire protection water from an existing 250,000-gallon storage tank near the Kershaw Correctional Institution or the new 250,000-gallon tank on Highway 601 at the edge of city limits.

8.11. Sewage

The Haile Gold Mine is connected to the Town of Kershaw municipal waste water treatment facility. There is a network of lift stations near the Mine Maintenance Building and the Administration Building that remain intact through the life of mine.

9. DUCKWOOD TAILINGS STORAGE FACILITY (TSF)

Once the ore is processed to remove the gold, the resulting slurry of pulverized rock and process water, known as tailings (approximately 55 percent solids and 45 percent liquids by weight), is piped to the TSF located across US 601 at the north end of the Project area. The TSF is designed for permanent storage of all tailings produced during operations of the Mill.

9.1. General Layout

The TSF is currently permitted to cover an area of approximately 524 acres (including the TSF, the TSF Underdrain Collection Pond that holds the seepage captured beneath the tailings but above the liner, the perimeter service road, diversion channels, and sediment control basins) located in the upper portion of Camp Branch Creek. Under the proposed mine expansion plan, the area covered by the TSF (and ancillary facilities) would increase to 687 acres. The TSF is constructed in stages with storage to contain the current life-of- mine total tons of tailings. Each stage allows for storage of an operating reclaim water pond plus a PMP event with 4 feet of freeboard above the maximum water elevation. The much smaller volume TSF Underdrain Collection Pond would have a freeboard of 2 feet. Benches along the interior embankment are constructed for placement of the tailings distribution pipelines.

The TSF is currently bounded by the Project Boundary on the northeast and northwest, Duckwood Road on the east, US 601 on the southeast, and the existing surface drainages on the south and west. To construct the TSF, Haile will need to move Duckwood Road and US 601. Existing topography in the area slopes toward the southwest at an average gradient of approximately 1 percent, with an overall maximum elevation change across the site of approximately 100 ft.

9.2. Stages of Construction

The TSF was previously permitted as a four-stage facility to an elevation of 630’ AMSL to safely contain up to 40 million tons of tailings. The revised design is a five-stage construction to an elevation of 670’ AMSL as described below:

Stage A:	The constructed and operational starter embankment as presented in the original permitted design and is now renamed Stage A.
Stage B:	Combines the original Stages II and III for a 25 foot raise up to elevation 600.
Stage C:	Raises the embankment by 30 feet to elevation 630. Per the FEIS, this was ultimate facility. Up to this point, the original runoff collection channels, underdrain collection pond and highway overpass can be used.
Stage D:	Raises the facility 20 feet to elevation 650. As the TSF footprint will exceed the original area for this raise, the following will be required to be in place by the time of the embankment raise:

- ▪ Realign portions of the following local roads and highways:
  - ✓ US Highway 601
  - ✓ Duckwood Road
  - ✓ Old Jefferson Highway
  - ✓ Estridge Avenue
  - ✓ Install “T” intersections at Earnest Scott Road / Highway 265.
  - ✓ Crossbow Lane
- ▪ New haul truck overpass over the realigned US601.
- ▪ Reconstruct all perimeter runoff collection channels.
- ▪ Relocate and construct a new channel for upper Camp Branch Creek.
- ▪ Remove existing stormwater sediment collection basin and the current TSF underdrain collection pond.
- ▪ Reconstruct perimeter stormwater sediment collection basins.

- Repurposing the existing stormwater sediment collection basin into the new TSF underdrain collection pond.
- Reshape the Existing TSF Growth Media Stockpile.
- Relocate the TSF Perimeter Fence
- Relocate the Hilton Archaeological Site

Stage E: Final raise to elevation 670.

A tailings density of 80 pounds per cubic foot was used to estimate the storage capacities for the facility.

The TSF embankment is constructed to higher elevations by increasing the height and width of the embankment. Figure A-61 shows the Layout of the TSF, and Figure A-62 illustrates a section of the TSF embankment at each stage of construction. The final embankment configuration would allow for a total storage capacity of approximately 72 million tons to account for variables in the production tailings densities. An aerial view of the current TSF is shown in Figure A-63.

The construction materials for each stage of the TSF will come from green material internal to the mine pits. Stages and surface area acreage is shown in Table A-17.

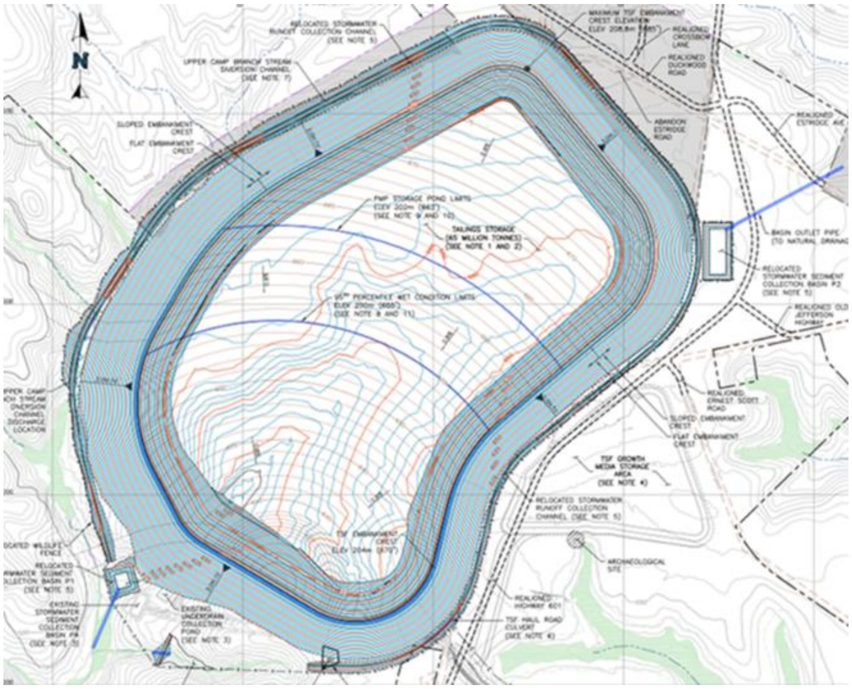

Figure A-61 Layout of the Tailings Storage Facility
Source: NewFields 2018.

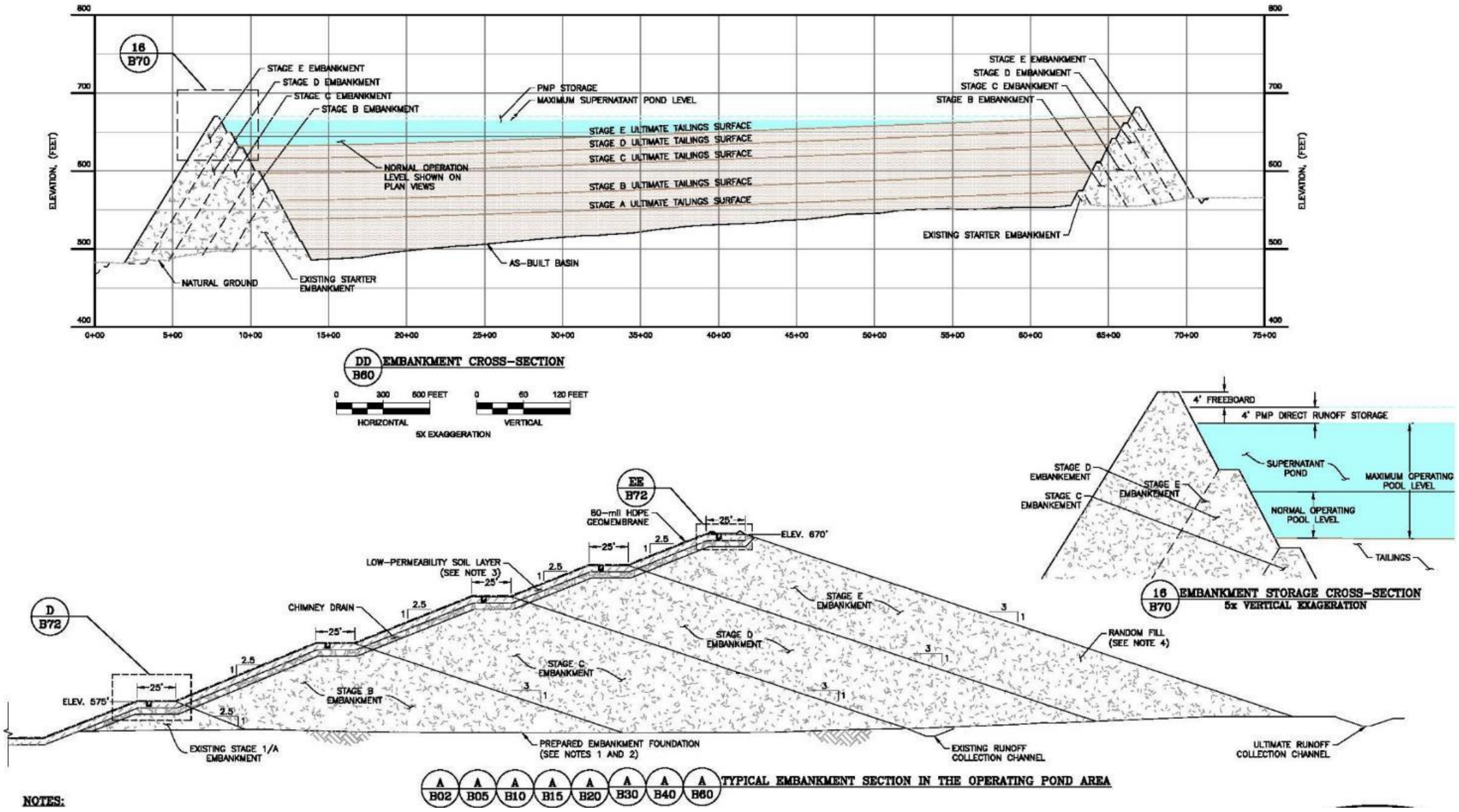

Figure A-62 Cross Section of the Tailings Storage Facility Embankment Showing the Stages of Construction

Source: NewFields 2018.

Figure A-63 Aerial View of TSF

Source: Haile 2018.

Table A-17 Stages and Acreages of the Tailings Storage Facility

Phase	Planned Construction (complete by date)	Maximum Tailings Surface Area (acres)	Lined Surface Area (acres)	Basin and Embankment Footprint (acres)	Volume of Material for Each Lift (M yd^3)
Stage A	Completed	198	320	353	In-place
Stage B	2020	219	326	377	3.478
Stage C	2021	303	337	417	7.526
Stage D	2028	338	356	498	8.225
Stage E	2031	350	356	537	10.748

Source: NewFields 2018.

9.3. Design Components

The Duckwood TSF includes the following primary design components:

- **Zero Discharge** – the TSF is designed as a zero-discharge facility. In addition to the anticipated tailings storage requirements, the facility is designed to contain the PMP storm event and an additional 4 feet of freeboard during operation. Water drained from the tailings slurry at the TSF is the primary source of water used for the Mill, in a closed-loop process. If TSF water volumes are high (e.g., after a storm event), all stormwater is used at the Mill, reducing the need for using fresh make-up water at the Mill. All water is used in the closed-loop cycle and is not released into the environment.

- **Zoned Earth Fill Embankment** – The TSF is designed as a zoned, well-compacted earth fill material embankment. The TSF is constructed in stages during the life of the mine. The zoned features of the TSF embankment consist of distinct parts or zones of dissimilar soil or rock materials. Majority of the TSF is built using a shell zone of random fill material on the exterior, downstream side of the embankment using Coastal Plains Sand (CPS), saprolite or bedrock. Interior, upstream to the random fill is the chimney drain zone. The chimney drain is constructed of CPS and is designed to control any unlikely seepage from the Tailings Reclaim Pond and preserve the integrity of the downstream random fill zone. Upstream of the chimney drain is the compacted low-permeability soil layer zone.

  This low-permeability soil layer is constructed of saprolite from the mine overburden. The purpose of the low-permeability soil layer is:

  1. To act as a suitable layer for placement of the 60-mil HDPE geomembrane under-liner; and
  2. To act as a secondary liner to control any seepage through defects in the HDPE geomembrane liner and prevent the tailings from migration into the chimney drain.

  Chimney drains and low-permeability soil layer zones consist of selected, fine-grained materials designed to meet the geotechnical specifications for particle size and other engineering parameters, such as the gradation of particle size and plasticity to ensure against segregation and clogging, and basic filter and permeability criteria for each of the two zone materials.

- **Toe Drain –** As part of the ultimate TSF embankment construction, a toe drain is constructed along the perimeter of the toe of the TSF footprint. The toe drain construction would consist of a ditch-type flow conduit of perforated pipe wrapped in a non-woven geotextile, backfilled with drainage aggregate, and covered with fill. The purpose of the toe drain is to ensure that (1) any seepage from precipitation within the exterior embankment slope is controlled; and (2) erosion of the embankment toe is reduced and routed safely into the sediment control channels and basins at locations around the TSF perimeter.

- **Basin –** The TSF basin is fully lined with a 60-mil HDPE geomembrane underlain by 12 inches of a compacted low-permeability soil liner. Above the geomembrane liner, a network of perforated pipe and 18 inches of a drainage layer material is built to collect and route underdrainage from the tailings to a central collection point. The basin is graded to promote gravity flow to the downstream TSF Underdrain Collection Pond.

- **TSF Underdrain Collection Pond –** An HDPE geomembrane double-lined pond with a leak collection and recovery system (LCRS) is constructed downstream of the embankment toe, at the southwest corner of the facility, for collection of underdrainage flows from the basin through a concrete-encased series of outlet pipes. See Figure A-64 for a cross-section view of the TSF ground water and seepage collection system, which feeds the TSF Underdrain Collection Pond. The TSF Underdrain Collection Pond is pumped back into the TSF Reclaim Pond for return to the Mill for reuse as process water.

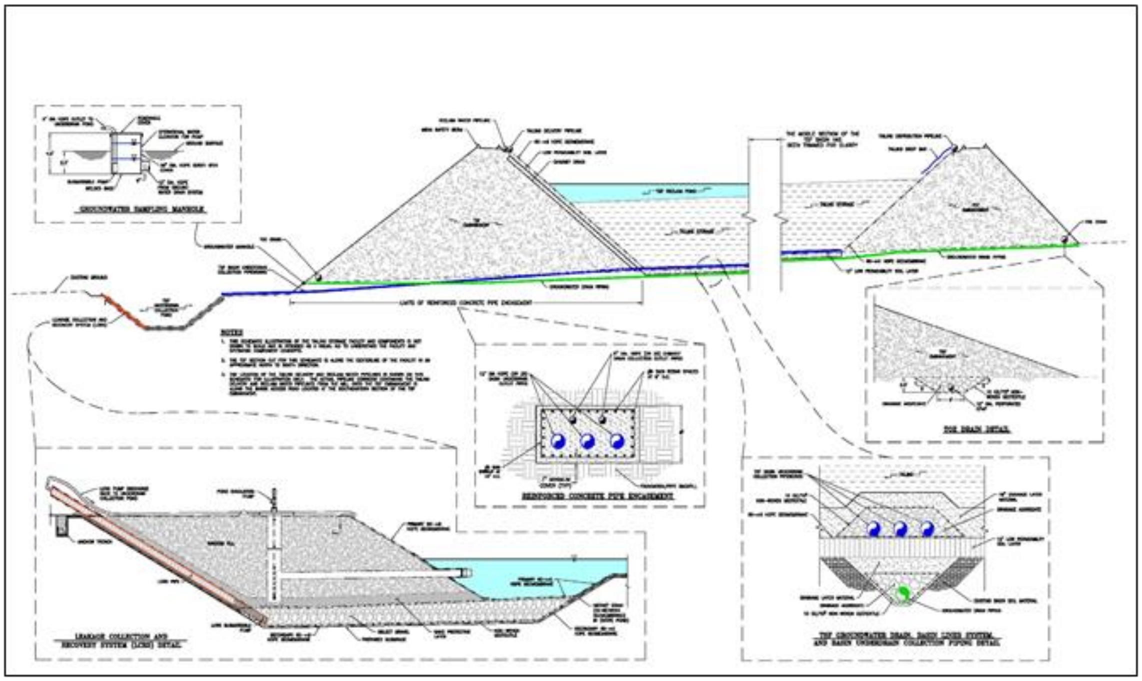

Figure A-64 Cross Section of TSF Groundwater Drain and Seepage Collection System
Source: Haile 2013a.

- **Leakage Collection and Recovery Systems –** A LCRS is constructed as part of the TSF Underdrain Collection Pond. The purpose of the LCRS is to provide a method to collect seepage in the unlikely event that leakage should develop within the pond through the primary HDPE liner. Seepage is collected and removed from a low point located above the secondary HDPE liner. The LCRS design is shown in Figure A-65.

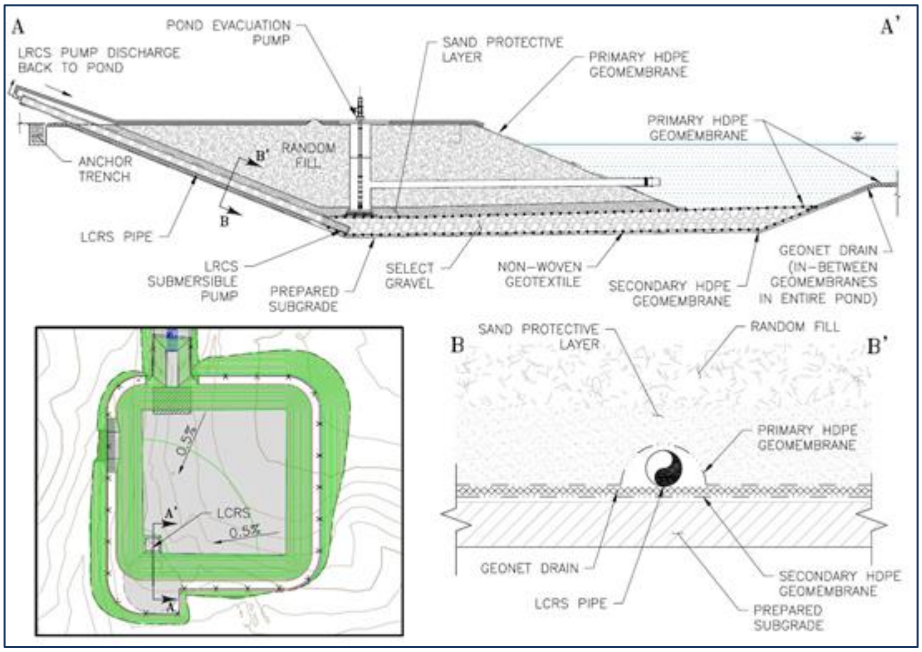

Figure A-65 Typical Leak Collection and Recovery System Design
Source: Haile 2013

- **Pipeline Corridor and Tailing Distribution System –** Benches along the interior embankment are constructed for placement of the tailings slurry distribution pipeline. Rotational distribution of tailings slurry is from the perimeter of the upper northwest, west, and upper northeast reaches of the facility through a series of drop bars. The reclaim and tailings slurry delivery pipe is included in the haul road corridor.

Tailings from the Mill is pumped in a pipeline system that minimizes the potential of an accidental spill to the distribution system along the interior crest perimeter of the TSF embankment. The tailings distribution system is operated as a rotational tailings distribution system to control the reclaim water pond position and to promote tailings beach development within the TSF.

Banks of tailings drop bars (distribution pipes or spigots) are operated rotationally using mainline valves to control a specific group of drop bars (8 to 10) spaced around the TSF perimeter. The individual drop bars are connected to the main distribution pipeline with holes drilled in the top of each drop bar. When a bank of drop bars is actuated to direct flow to a specific location within the TSF, flow exits the drop bars—reducing flow energy and creating laminar flow along the perimeter of the TSF. Deposition in this manner results in a "beach" development by deposition of the coarser fraction of the tailings sand adjacent to the TSF embankment. The finer fraction of tailings moves away from the embankment along with the process water slurry.

The tailings beach development serves as a topographic feature within the TSF that would confine the TSF Reclaim Pond within the TSF to the southern end of facility. Process water from the TSF Reclaim Pond is reclaimed and pumped back to the Mill for reuse in the mill process. (See Figure A-66 TSF Reclaim Pond and Pumping Facility.) Process water that drains through the tailings is collected by the TSF underdrain collection system, which feeds the TSF Underdrain Collection Pond, and is pumped back into the TSF Reclaim Pond and eventually back to the Mill for reuse as process water. The reclaim pipeline is in a lined HDPE trench that drains toward the Process Events Pond (from the 601 Overpass toward the Process Mill Plant) or toward the TSF (from 601 Overpass to the TSF).

Figure A-66 TSF Reclaim Pond and Pumping Facility
Source: Haile 2019

The process water reclaim system within the TSF can reclaim water for reuse at the Mill. As a closed-loop system, process water would circulate only between the TSF and the Mill (zero discharge) and is separate from other water management systems.

The TSF is open to the air and, except for water that evaporates, any precipitation that falls on the facility is part of the closed-loop process water system. The TSF Underdrain Collection Pond is sized to contain the calculated underdrain flow for a 24-hour period in the event of a pump or power outage, plus precipitation from a 100-year, 24-hour storm event falling directly on the pond surface, and an additional 2 ft. of freeboard. Given the size of the TSF Underdrain Collection Pond, 2 ft. of freeboard provides an additional factor of safety. The TSF Underdrain Collection Pond is further protected against overflow because the valve can be closed, or it can be pumped directly into the TSF Reclaim Pond, which can contain the PMP event in addition to 4 ft. of freeboard at minimum.

An Emergency Action Plan (EAP) has been developed to reduce the potential for loss of life and injury and to minimize property damage during an unusual or emergency event at the TSF. Locations and contact information for any residents or structures that may be flooded if the TSF should breach are noted. Names and numbers for federal, state, and local emergency contacts are provided in the notification list. The EAP provides an overview for roles and responsibilities, including methods to detect and evaluate the emergency condition, methods to assess the situation and determine the emergency level for notification, and procedures for communication and expected actions.

An Operations, Maintenance, and Inspection Manual has been prepared for the TSF. This manual is intended to serve as an operating guide for initial, normal, and emergency operating procedures for the TSF. The main components of the manual cover the following topics:

- Fluid management for the TSF Reclaim and TSF Underdrain Collection Pond;
- Facility instrumentation and monitoring for geotechnical and groundwater concerns;
- Operation of the tailings management system;
- Emergency operating procedures (power outage, extreme rainfall, excessive pond volumes);
- Component failure (leakage through liners, blockage of pipe works, pump and pipeline failures); and
- Inspection and maintenance (daily, weekly, quarterly, and annually).

10. SURFACE AND GROUNDWATER WATER MANAGEMENT

Water is managed in the Project area based on its classification into one of three designations: non-contact water, contact water, and process water. Non-contact water is groundwater captured via depressurization well pumping, any flow withheld from Haile Gold Mine Creek by the FWSD, stormwater runoff that does not come in contact with mined PAG material, and effluent from the CWTP. Contact water is water that has come in contact with PAG material in the mine pits, underground mine, ore stockpiles, or PAG Cells. Process water is water used in the Mill, which circulates in a closed-loop system within the Mill and the TSF and has come in contact with sodium cyanide. These three classifications of water are each described in the sections below. Figure A-67 illustrates the management and use of non-contact (green), contact (purple), and process water (orange).

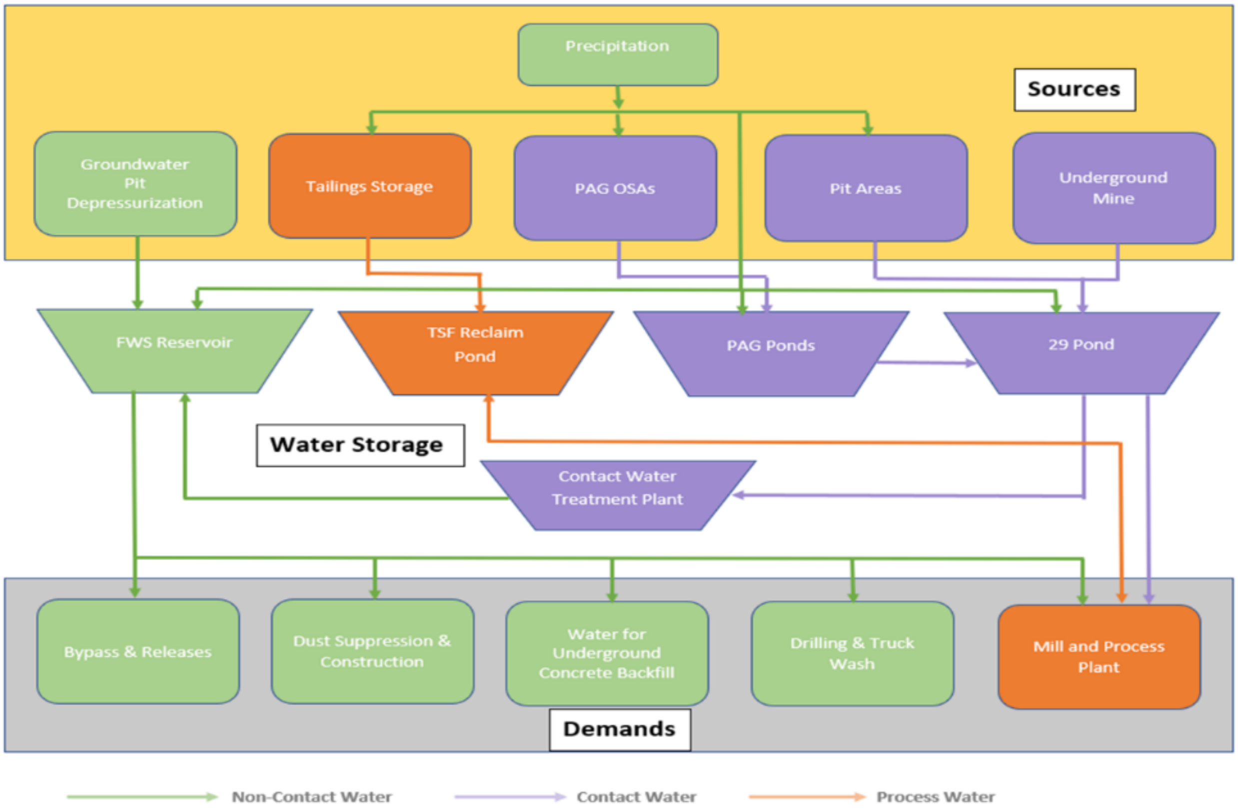

Figure A-67 Management of Non-Contact, Contact, and Process Water
Source: ERC 2018.

10.1. Non-Contact Water

Non-contact water does not require treatment at the CWTP; it includes (1) precipitation and runoff from the property and Project facilities that do not contain PAG materials; (2), groundwater depressurization well water; (3) retained stream flow from Haile Gold Mine Creek; and (4) effluent from the CWTP.

Non-contact stormwater is subject to the SCDHEC, Bureau of Water, Stormwater Permitting Section's stormwater management practices and the permit conditions in Haile's Industrial General Permit.

Non-contact water may be used to meet non-contact water demands in the Mill, dust suppression and construction water demands, with any excess discharged to Haile Gold Mine Creek.

10.1.1. Stormwater Management

Management of non-contact stormwater involves routing runoff from undisturbed areas around mine facilities, collection of stormwater runoff from non-PAG mine facilities, sediment control, and release of non-contact waters to the stream system. Figure A-68 shows a typical Sediment Pond with a Faircloth Skimmer.

Figure A-68 Sediment Pond with Faircloth Skimmer
Source: Haile 2018

The first role of the non-contract stormwater system is to keep runoff from undisturbed areas from coming into contact with mine facilities and operations. Diversion facilities are designed to capture runoff from undisturbed areas before it reaches disturbed ground. For major drainages, such as Haile Gold Mine Creek and the North Fork of Haile Gold Mine Creek, stormwater management includes collecting flows and routing them past active mining areas in diversion pipes and releasing them into Lower Haile Gold Mine Creek.

Runoff from undisturbed areas that would otherwise come into contact with mine-related facilities (including such areas as PAG Cells, the TSF, OSAs, Borrow Areas, and roads) is captured in diversion channels and routed past the disturbed area without commingling runoff from undisturbed and disturbed areas. This water is released into natural drainages.

Runoff originating from non-PAG mine facilities is also classified as non-contact stormwater but is managed in a different manner than runoff from undisturbed areas. Given that ground disturbance occurs at all non-PAG facilities, it is possible that sediment loading in runoff from these areas could be elevated. Thus, Haile implements measures to minimize the amount of erosion from all disturbed areas, which reduces the sediment loading carried in runoff from non-PAG mine facilities. Temporary erosion control measures are implemented to minimize erosion and soil loss associated with initial ground disturbance. Methods of managing sediment and erosion control during construction follow guidelines presented in the Stormwater Management Handbook (SCDHEC 2005) and comply with Haile’s Industrial General Permit.

General runoff collection practices include minimization of soil loss through direct stabilization of disturbed areas, including surface roughening, seeding, mulching, and erosion control blankets. Runoff collection measures are implemented to limit erosion and movement of soils that are not contained in place. Concurrent reclamation practices are implemented to minimize the duration of impacts and stabilize disturbed areas as quickly as possible.

Runoff and sediment that originates from non-PAG facilities is captured in collection channels, including the outer perimeter of the TSF, the non-PAG OSAs, growth media storage areas, roads, and non-process areas of the Mill Site. Collection channels route runoff from these areas to individual sediment collection basins. Each sediment basin is sized for particle removal efficiencies based on the SCDHEC, Bureau of

Water standards and Haile’s Industrial General Permit. Sediment ponds effectively limit peak runoff rates and provide sediment removal, positively affecting both water quantity and quality from the non-PAG facilities. All sediment control systems, including collection channels and spillways, have the capacity to convey the 10-year, 24-hour storm event.

10.1.2. Depressurization Water Management

The proposed mine pits would extend below the water table, requiring extraction of groundwater in and around the open pit to remove the hydraulic pressure on the pit walls, stabilize the pit walls, and promote safe and efficient mining practices during mining operations. This process is referred to as “depressurization” and involves drawing down the localized groundwater table by pumping from wells located near each pit before and during mining operations.

The depressurization systems have been planned to intercept groundwater from the upper weathered and fractured bedrock units where the majority of groundwater occurs and is transmitted. Figure A-69 is a generalized cross section of a mine pit with depressurization and water management features such as depressurization wells, horizontal drains, and dewatering pumps. The objective is to draw down the water table to below the operating depth of the pit, as illustrated by the dashed blue line in the figure.

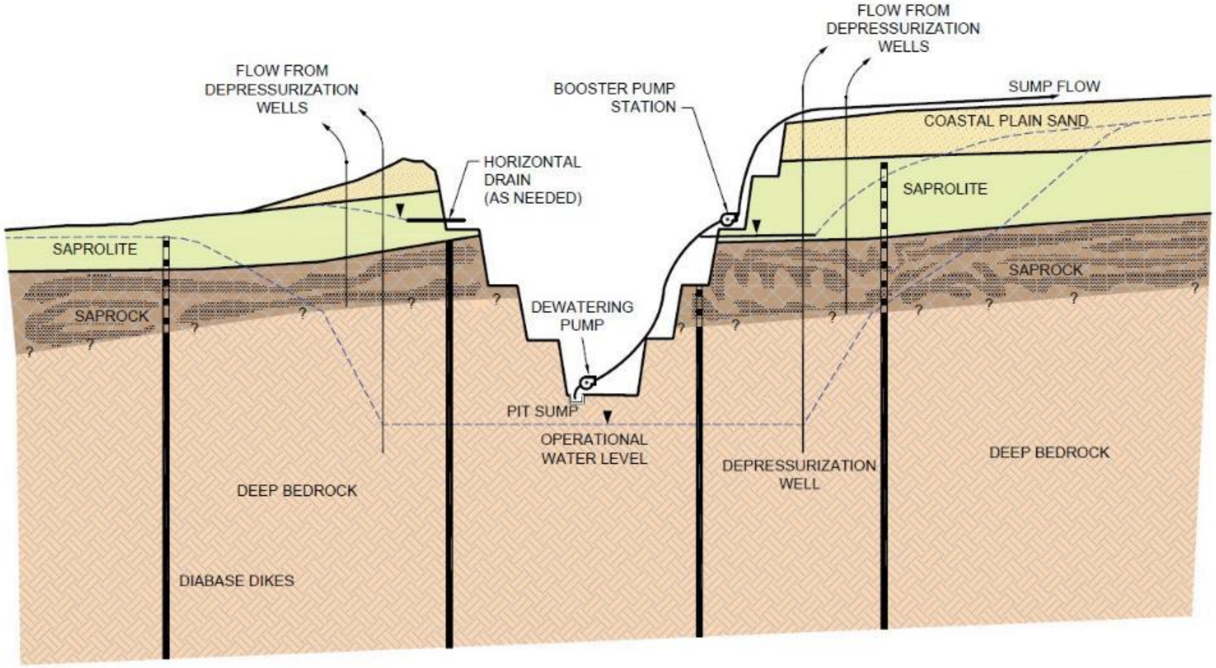

Figure A-69 Mining Pit Cross Section Showing Groundwater Depressurization
Source: Haile 2018

Depressurization of the pits is a significant, consistent source of non-contact water throughout the Project. The range of potential pumping rates from depressurization wells has been predicted using a numerical groundwater model (NewFields 2018). This water will be used for process water at the Mill, supply water for the fire hydrant network, and for dust suppression.

The number of depressurization wells may vary depending on the hydrogeology of each pit's area. Depressurization wells installed adjacent to mine pits will also aid in the depressurization of underground workings. The wells will discharge into the Fresh Water Storage Tank. This 250,000-gallon tank has the capability to pump water to the Mill, to the fire-water pump, or may be used for dust control in mine water truck(s). Any depressurization water not used on site would remain in the tank until the tank is full. When the depressurization tank is full, overflow is discharged into the upper north fork of Haile Gold Mine Creek via a pipe to a designed outfall.

Depressurization pumping from wells would continue through mining operations. In some cases, depressurization would continue after mining has ended to support backfilling operations, mining in nearby pits, or support for concurrent reclamation activities.

10.1.3. Surface Water Diversion

For temporary surface water control, diversion ditches are installed to enable flow around active open pit mining activities. In 2016, a HDPE-lined diversion channel was constructed to divert the Haile Gold Mine Creek flow below the historic Ledbetter Reservoir around the Mill Zone Pit (See Figure A-70).

Figure A-70 Mill Zone Diversion Ditch
Source: Haile 2018.

For permanent water control, the FWSD is a retention structure within the footprints previously permitted under the FEIS for a detention structure and "Pit-Related Activities" south of there. The FWSD initially will be used as a retention (and stream diversion) dam that will have the capacity to detain up to 100-year precipitation event and will allow for controlled flow into the diversion pipes. Stormwater exceeding the design event would flow through the emergency spillway into Ledbetter Pit. The FWSD ultimately will be operated as a retention dam that captures and retains some Haile Gold Mine Creek stream flow up to 470' AMSL operating level (creating a Fresh Water Storage Area (FWSA) and diverts the remaining stream flow around the open pits. Figure A-71 shows the plan view of the Haile Gold Mine Creek FWSA.

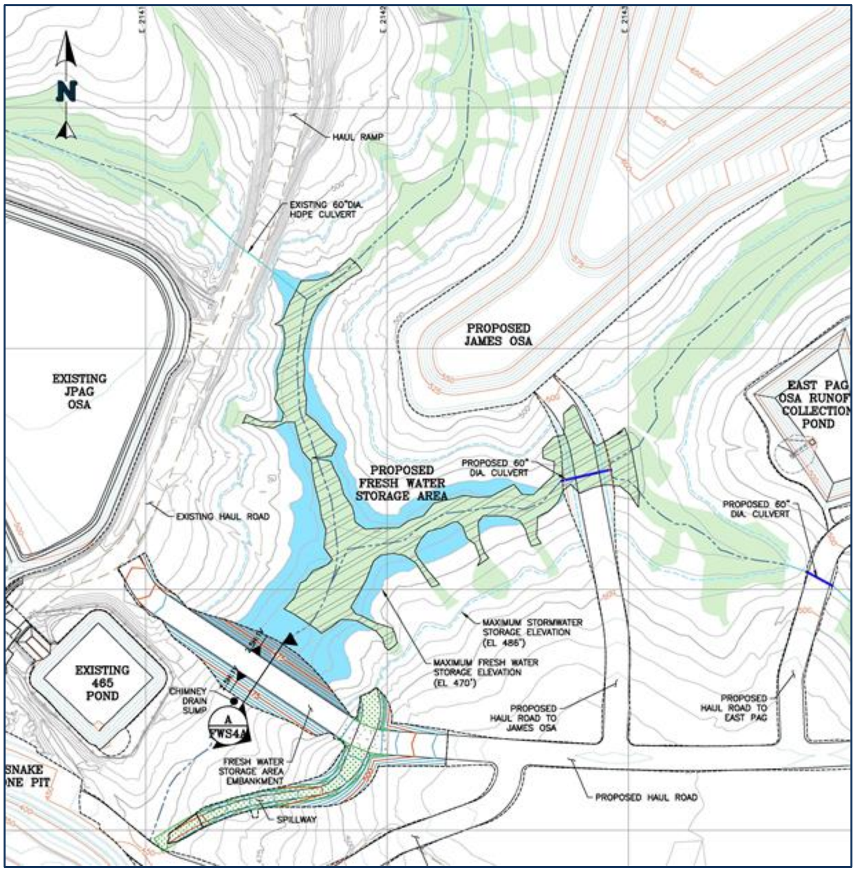

Figure A-71 Haile Gold Mine Creek Fresh Water Storage Area
Source: Haile 2018.

During filling of the new Ledbetter Reservoir post-mining, the FWSD will be modified to function as a low-head dam that would continue to divert flow into the diversion pipes consistent with the SCDHEC, Bureau of Water, Surface Water Withdrawal Permitting Section standards for safe yield. The intent of the low-head dam is to maintain, at a minimum, regulated minimum instream flows while allowing the remaining stream flows to flow into the Ledbetter Pit to expedite pit filling.

Upon filling of new Ledbetter Reservoir to equilibrium (approximately 95 percent), the low-head dam would be removed, and all stream flows would flow into the new pit lake. Flows would exit the pit lake through an engineered outlet structure into reestablished stream channels constructed over the backfilled pits, into the Lower Haile Gold Mine Creek, and into the Little Lynches River.

10.2. Contact Water

10.2.1. Sources of Contact Water

Contact water is water that comes into contact with PAG material that originates from the following sources:

- Dewatering of the surface water within pits mined into PAG material, including seepage, stormwater runoff, and pit wall runoff;
- Depressurization water pumped from the Horseshoe underground mine;
- Runoff and seepage from PAG Cells; and

- Runoff and seepage from ore stockpiles, including Low-grade stockpiles and Run-of Mine ore stockpile at the Mill crusher.

Depressurization of the Horseshoe Underground Mine to facilitate safe and efficient mining will be performed by pumping from within the underground mine and will be aided by pumping from adjacent depressurization wells (Section 10.1.2). Water that flows into the underground workings through PAG materials will be contact water, which will be used for make-up water in the Mill or treated as described in Section 10.2.2. The pumping rates of contact water from the underground mine has been predicted using a numerical groundwater model (NewFields 2018).

Contact water is collected, stored in HDPE-lined ponds, and either used in the Mill or treated at the on-site CWTP and then either stored in the FWSA or discharged as a point source under an NPDES permit. Figure A-72 shows the 003 Outfall that is located downstream of the contact water treatment plant. Haile will submit a separate application to create two new discharge points – Outfall 004 above the Freshwater Detention Dam and Outfall 005, that is south of all mine related pit activities. This outfall type is appropriate for use where flow rates and pressures are low, dispersion of flow is not required, and riprap can be extended to the receiving water without additional stream or wetland impacts. This outfall will have to be relocated prior to construction of the West PAG facility and will need to be redesigned to accommodate potentially higher flow rates and pressures.

Figure A-72 NPDES 003 Outfall for Water Treatment Discharge
Source: Haile 2018.

10.2.2. Treatment and Management of Contact Water

The existing CWTP will be expanded to treat up to 2,000 gpm from the current capacity of 1,200 gpm. The new facility will be a mirror image of the current facility and will be modified to handle variable low flows efficiently. The contact water treatment process is a two-stage clarification system to address the estimated influent metals loading. Redundancy has been provided for critical process areas and unit process equipment to ensure compliance with the NPDES permit and to better handle the variable water quality and loading, as water would have varying levels of contaminants depending on the source.

The CWTP is currently a 7,800-square-foot self-contained facility within the Mill Site (See Figure A-73). This will be expanded to a 15,000-square-foot self-contained facility in approximately 2024. Contact water is collected in the 39 Pond (See Figure A-74), the primary contact water storage pond servicing the CWTP, which is a make-up source for the Mill or can be sent to the CWTP plant. The current treatment process consists of two reaction tanks, two clarifiers, and a multi-media filtration process that is designed to precipitate the metal hydroxides into flocculated solids. These solids settle in containment compartments, are pumped to the cyanide recovery thickener, and ultimately are disposed of in the TSF. The clarified water is reused in the Mill process or discharged from the CWTP.

Figure A-73 Water Treatment Plant with 19 Pond (Background)
Source: Haile 2018.

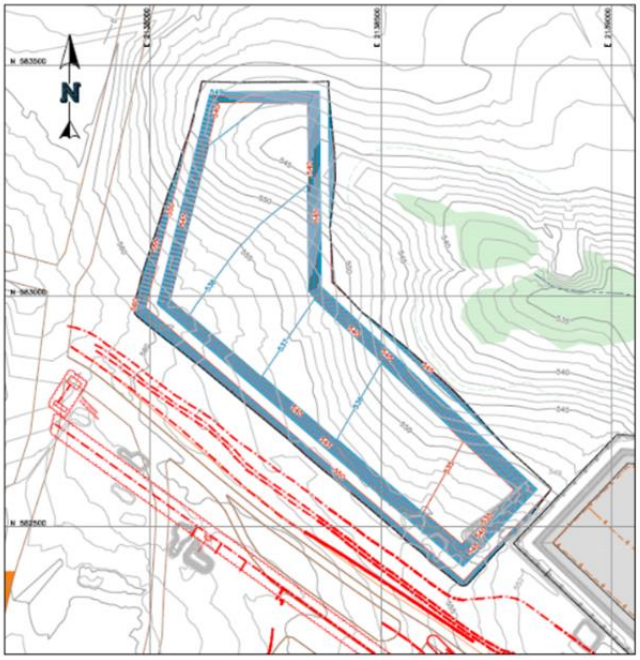

Figure A-74 39 Pond – Converted from 19 Pond
Source: Haile 2020.

The CWTP and associated 39 Pond were sized based on two requirements. First, the facilities were sized to ensure that the combined capacity of the contact water treatment plant and the 39 Pond were sufficient to meet the design criteria that the 465 Pond, 470 Pond, 500 Pond and 525 Pond, which accept runoff and seepage from PAG Cells, can be emptied within a period of 72 hours after a 100-year storm event. Second, the adequacy of the CWTP capacity and 39 Pond storage volume was evaluated based on the site-wide water balance. Detailed water balance modeling indicates that 29 million gallons of storage capacity is adequate for managing contact water in predicted consecutive wet months.

- **465 Pond (east side of the West PAG Cell) –** The 465 Collection Pond (See Figure A-75) is double lined with an LCRS and currently collects internal seepage from within the JPAG PAG Cell and any runoff from the PAG Cell slopes. Ultimately, JPAG will be integrated into West PAG and 465 Pond will collect seepage from the east side of the West PAG Cell. The pond has a capacity of 2.61 million cubic feet (19.5 million gallons), with an additional 3 feet of freeboard and hold runoff from a 100-year, 24-hour storm volume plus 10 percent excess storage capacity. The pond is designed so that the 100-year runoff volume can be emptied in 72 hours, with water pumped to the 39 Pond for treatment and discharge or use as make-up water at the Mill.

Figure A-75 465 Pond
Source: Haile 2018.

- **470 Pond and 525 Pond** (West PAG Cell)– These two ponds are double lined with an LCRS and will collect seepage and runoff from the southwest side of West PAG Cell. The pond has a capacity of 6.7 million cubic feet (50.0 million gallons), with an additional 3 feet of freeboard and hold runoff from the entire 100-year, 24-hour storm volume plus 10 percent excess storage capacity. The pond is designed so that the 100-year runoff volume can be emptied in 72 hours and is pumped to 39 Pond for treatment and discharge or use as make-up water at the Mill.

- **500 Pond** (East PAG) – The 500 Collection Pond is double lined with an LCRS and will collect seepage and runoff from the East PAG Cell. The pond has a capacity of 6.7 million cubic feet (50 million gallons), with an additional 3 feet of freeboard and hold runoff from the entire 100-year, 24-hour storm volume plus 10 percent excess storage capacity. The pond is designed so that the 100-year runoff volume can be emptied in 72 hours and is pumped to 39 Pond for treatment and discharge or use as make-up water at the Mill.

- **39 Pond** – The 39 Pond has expanded from the original 19 Pond to accommodate the additional water that requires treatment. It is double lined with an LCRS; it is designed to store approximately 7.6 million cubic feet (39 million gallons) of water, with an additional 2 feet of freeboard. The 39 Pond is designed to be used as a buffer between the various sources of contact water and the CWTP. The 39 Pond is sized to ensure that the combined volume of 465, 470, 500 and 525 Ponds can be evacuated of runoff from the 100-year event within 72 hours, in coordination with running the CWTP. The water reporting to the 39 Pond can be treated in the CWTP or can be sent to the Mill for use as make-up water.

11. SITE RECLAMATION

Site reclamation would occur both during mining (“concurrent reclamation”) and after mining ceases (“post-mining reclamation”). A revised site reclamation plan will be submitted for approval by the SCDHEC, Bureau of Land and Waste Management, Division of Mining and Solid Waste Management, Mining and Reclamation Program as part of the mining permit application. In concert with the Mining and Reclamation Plan, Haile will develop a Monitoring and Management Plan to continually assess the effectiveness of the reclamation and closure actions in order to detect any failures of closure structures and to initiate any required response actions to maintain environmental standards.

During operations, certain reclamation activities are conducted concurrent with operations. Concurrent reclamation is performed when a portion of mining activity is complete and final reclamation can be safely performed. Final site-wide reclamation would commence upon final cessation of mining and processing operations. Final reclamation is completed as soon as practicable after mining activities cease at a given mine facility.

The objective of the site reclamation plan is to provide stable slopes, manage discharge water quality, and establish vegetation over all portions of the mine site except those areas designated as (1) post-mining pit lakes; (2) pit high walls adjacent to the post-mining pit lakes; and (3) any roads and access areas necessary for post-mining activities and land uses. Visual observations of concurrent reclamation are conducted at various times throughout the mine life to establish and refine appropriate vegetation species and seeding rates, soil and amendment requirements, and overall vegetation procedures to ensure sustainable post-mining vegetation for each facility type.

Reclamation falls into eight types:

1. Backfilled pits;
2. Pit lakes;
3. Red/Yellow Class OSAs (PAG Cells);
4. Green Class OSAs;
5. Stream restoration (portions of North Fork and Haile Gold Mine Creek that were diverted prior to and during mining);
6. Borrow Areas;
7. TSF; and
8. Mill Site, roads, pipelines, and other ancillary facilities (including underground utilities) not needed to support post-closure activities and land uses.

11.1. Backfilled Pits

Mill Zone, Snake, Haile, and Red Hill are backfilled with overburden (See Figure A-76) to an elevation below original contour. After these pits reach planned depths, mining in them will cease and the pits will be backfilled as part of overburden placement taken from mining of other pits during operations. Overburden classified as Yellow and Green Class will be placed as pit backfill. Special precautions are taken when placing Yellow Class overburden in the pits. Yellow Class overburden is placed in the pits up to a level to ensure that this material is permanently inundated with water following the cessation of depressurization pumping.

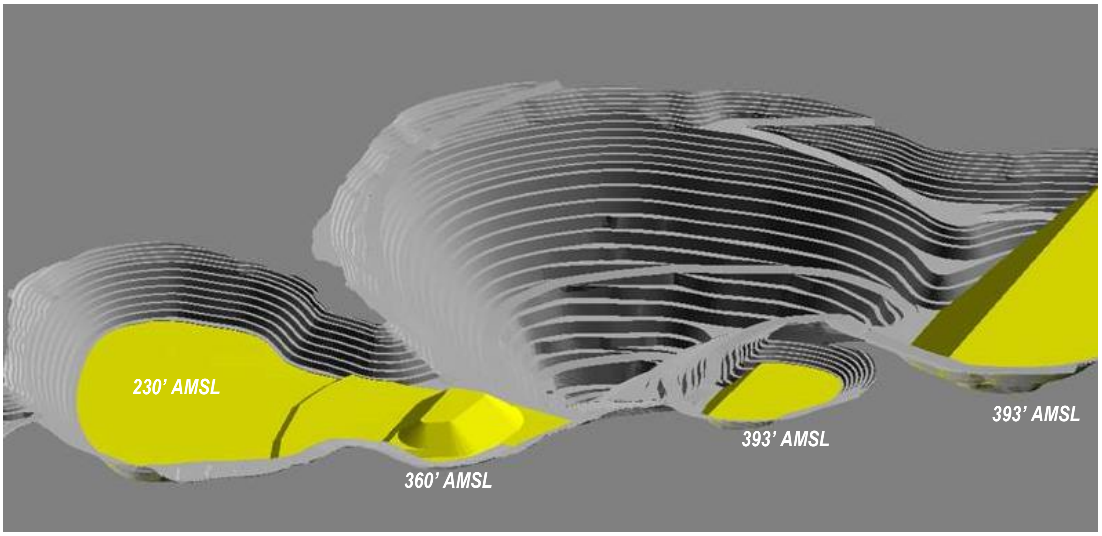

Figure A-76 **Backfilled areas in Mill Zone, Haile, Red Hill and Snake Pits**
Source: Haile 2019

Inundation with water would limit the ability of the overburden material to generate acid rock drainage. Lime, or other suitable pH buffering material (referred to as lime or lime amendment), will be placed concurrently with the Yellow Class backfill. The mixed Yellow Class material is backfilled in compacted layers to limit oxygen transport into the backfilled pit. The addition of lime is performed as part of this concurrent reclamation during normal mining operations. Green Class overburden may be placed in the pits along with or in lieu of Yellow Class overburden but is the only class of overburden that may be placed above the long-term inundation elevation.

11.2. Pit Lakes

Groundwater and surface water will accumulate in the co-mingled mine pits to re-create Ledbetter Reservoir. Champion 1 and 2 Pits are also comingled to create Champion and Champion Southwest Reservoirs. Figure A-77 is a cross-sectional view of Ledbetter Reservoir above the amended Yellow backfill in Mill Zone Pit.

Groundwater modeling results predict that Ledbetter Reservoir reaches a stable stage of 403 ft after approximately 57 years. The larger Champion Reservoir stabilizes at 442 ft after about 54 years, and the smaller Champion Southwest Reservoir reaches a stable level of 424.5 ft after about 68 years. Model predictions indicate that Ledbetter Reservoir and the large Champion Lake will discharge to surface water at that time – Ledbetter discharges a substantial flow into Lower Haile Gold Mine Creek and Champion discharges a nominal amount to surface runoff to an un-named tributary – but that Champion Southwest Reservoir will stabilize below the spill point and is not expected to discharge (NewFields, 2018).

In addition, prior to the end of active mining, another pit lake study will be performed to precisely predict final water levels and water quality of the pit lakes to further instruct their design plans and management. During reclamation, a security fence and/or safety berm will be established around the remaining pit high walls. All surface water inlets or outlets to the pit lakes will be improved to limit erosion and control flow into and out of the pit lakes.

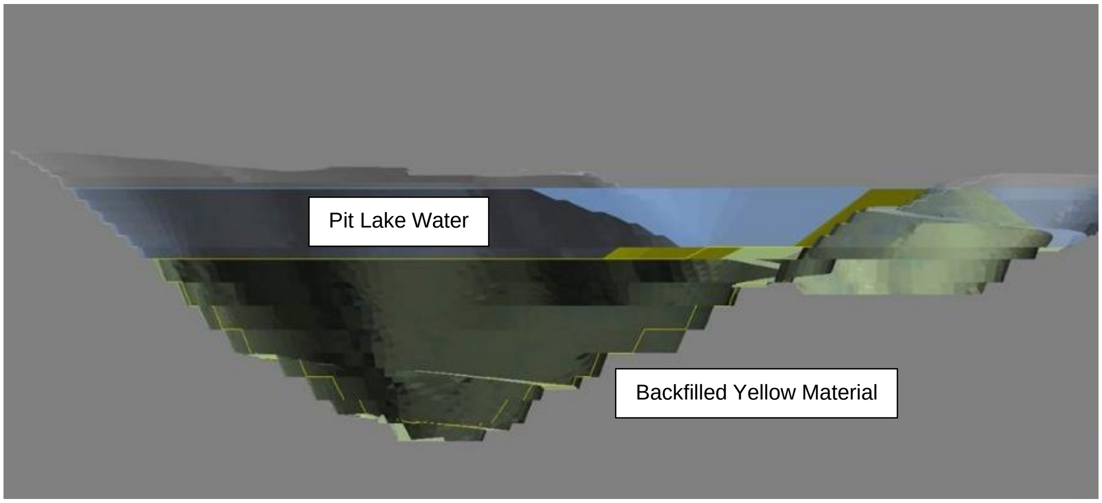

Figure A-77 Cross-section of Ledbetter Reservoir Covering Mill Zone Pit
Source: Haile 2018

The FWSD and pipes would remain in place above the reconstructed Lower Haile Gold Mine Creek channel. However, the Haile Gold Mine Creek flow from upstream of Ledbetter Pit is split between a diversion to allow some flow into Ledbetter Pit Lake and some flow through diversion pipes to the reconstructed stream channel. Haile would divert flow into the Ledbetter Reservoir consistent with standards for safe yield from Haile Gold Mine Creek. During Ledbetter Reservoir filling, the FWSD is modified to a low head dam that continues to divert flow into the diversion pipes consistent with the SCDHEC, Bureau of Water, Surface Water Withdrawal Permitting Section standards for safe yield but also allows any flows exceeding State standards for minimum instream flow to be directed over the low head dam to fill Ledbetter Pit Lake. This would reduce the time needed to achieve stable pit lake levels and inundation of the exposed pit wall.

11.3. PAG Cells - Red and Yellow Class Overburden Storage Areas

During reclamation, a minimum 5 ft. thick layer of saprolite is placed on the entire outer slope of the PAG cells; the saprolite layer is covered by a 60-mil HDPE liner and 2 feet of growth media. See Figure A-78 for a cross section of PAG Cells after reclamation. The final lift is covered with a 5-foot-thick layer of saprolite. The final slopes are constructed with alternating benches and slopes with an overall slope of 3:1 to provide surface water controls to limit erosion and manage stormwater. By designing benches on the outside of the slopes, the length of stormwater flows down the side of the facility is shortened and erosion is minimized. The benches also provide stormwater channels for managing the flows and directing the water off the facility. Finally, the benches are spaced so that equipment can reach areas from the bench above and the bench below, should repairs be needed on the slopes. The side slopes that have been graded are then seeded for stabilization in accordance with the Reclamation Plan approved by the SCDHEC, Division of Mining.

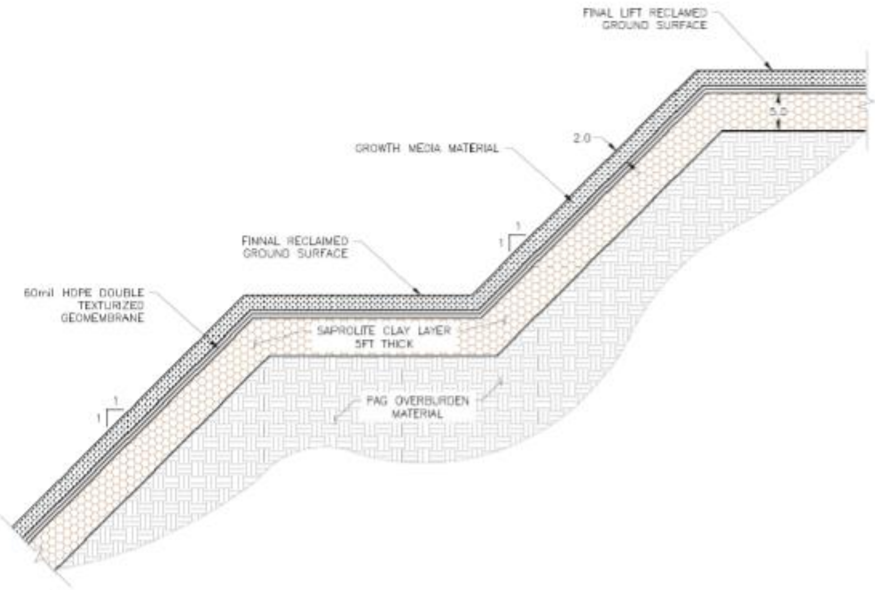

Figure A-78 Cross Section of Reclaimed PAG Cell
Source: Wood, 2019.

As noted, final reclamation of PAG Cells includes a 60-mil HDPE geosynthetic liner cover and a minimum of 2 feet of growth media. The growth media is vegetated. Seepage resulting from years of the PAG being exposed to precipitation and the precipitation infiltrating the PAG material would continue to drain and collect in the underdrain collection system that sits on the HDPE liner under each PAG facility. This PAG seepage would continue to be collected in the PAG Collection Ponds, sent to the 39 Pond, and treated in the same manner as during the operating period. Because precipitation is prevented from infiltrating the overburden once the cap (both the saprolite layer and the HDPE liner) is in place, the seepage from the PAG overburden would decrease significantly in a short time.

Over time, seepage would be reduced where passive treatment systems can effectively treat lower flows. These passive treatment systems would treat the seepage using an anaerobic (no-oxygen) treatment cell filled with organic media containing beneficial bacteria, followed by an aerobic (with oxygen) polishing treatment cell and discharge to Haile Gold Mine Creek. Design, operations, and discharge of the passive systems are permitted through the SCDHEC, Bureau of Water, NPDES Permitting Division. The system is planned to be constructed in the lined PAG Collection Ponds. Due to the passive (no pumping) nature of the system, maintenance is expected to be minimal. The media in the cells may require replacement approximately every 20 years. Passive cell designs are approved by the SCDHEC's NPDES Permitting Division and Mining Division. Maintenance and monitoring of the passive systems is included in Haile's post-mining monitoring plan

11.4. Green Class Overburden Storage Areas

The four OSA's at the Haile Gold Mine designated to receive only Green Class overburden (601, Ramona, Hayworth / South, and James OSAs) will be reclaimed concurrently during mining as each reaches its designed capacity. Final grading of the OSAs will be alternating benches and slopes for an overall slope of 3:1. Surface water controls will be constructed to limit erosion. During reclamation, the Green Class overburden will be vegetated according to the vegetation plan contained in the Reclamation Plan.

11.5. Haile Gold Mine Creek

Flow from Haile Gold Mine Creek upstream of Ledbetter Pit is split to allow some flow into Ledbetter Reservoir and some flow through existing diversion pipes to the reconstructed stream channel. Flow from Haile Gold Mine Creek is diverted into the Ledbetter Reservoir only as authorized by the SCDHEC, Bureau of Water consistent with standards for safe yield. The Haile Gold Mine Creek Retention structure is modified or replaced with a low head dam that continues to divert flow into the diversion pipes but also allows any flows exceeding State standards for minimum instream flow to be directed over the low head dam to fill Ledbetter Reservoir. This would reduce the time needed to achieve stable pit lake levels and inundation of the exposed pit wall.

Once full, the entire flow of Haile Gold Mine Creek is redirected to run through Ledbetter Reservoir. The low head dam is removed, the area reclaimed, and that portion of Haile Gold Mine Creek restored shortly after the new Ledbetter Reservoir is filled.

11.6. Tailings Storage Facility

As the exterior slopes of the TSF achieve final configuration, they are vegetated. At the completion of mining and ore processing, the TSF would consist of an above-grade, lined impoundment, filled with tailings material and unused process water.

The TSF is reclaimed using a dry closure approach that focuses on isolating the tailings material and limiting the infiltration of water into the tailings. TSF process water would continue to drain down within the tailings fill material and any remaining water absorbed, evaporated, or removed via the underdrain collection system to the TSF Underdrain Collection Pond. From there, this TSF water is pumped to the modified CWTP to treat this type of water. Treatment and discharge of this new water source (other than contact water) would require a modified NPDES permit. Prior to cessation of ore processing, Haile would initiate permitting for this water source through the SCDHEC, Bureau of Water, NPDES Permitting Division. This active drain down and water treatment system would continue until the flows have reduced to a level where a passive system can be utilized for long-term water management.

In the final months of ore processing, the tailings are deposited in the TSF in a manner that promotes positive draining of the tailings pond. Specialized equipment designed for working in soft soils is used to achieve final grading contours. As the surface of the tailings is stabilized and shaped for stormwater management, a 60-mil HDPE geosynthetic liner is placed over the tailings in stages. A minimum of 2 feet of growth media is placed over the geosynthetic liner, and the entire area is vegetated using established procedures. This complete closure process may be achieved in sections beginning at the higher elevation (Duckwood Road) and progressing downward to the TSF Reclaim Pond side (lower elevation) as the tailings material stabilizes sufficiently for safe equipment usage. Stabilization of the entire TSF and complete placement of cover will likely take approximately 5 to 10 years after final tailings deposition. During this time, stormwater runoff from the partially covered TSF basin is managed within the basin of the TSF and treated along with the drain-down water from the TSF Underdrain Collection Pond. Stormwater would not be allowed outside the TSF basin until the stormwater was completely isolated from the tailings surface.

Once the surface of the TSF has been successfully reclaimed, water could freely drain off the covered and reclaimed tailings surface without contacting the tailings. Surface water controls will be established at the spillway outlet location to prevent erosion of the embankment during periods of high flow. Drain down will continue to be collected in the TSF Underdrain Collection Pond and treated as specified in the new or modified NPDES permit. Once the cover is in place, drain down from the TSF would decrease significantly over time as the tailings approach ultimate consolidation within approximately 20 years. Once drain down has been reduced sufficiently, a passive treatment cell, using an anaerobic treatment, is constructed in the lined TSF Underdrain Collection Pond. This passive treatment cell would provide long-term management from the TSF with minimal maintenance requirements.

11.7. Mill Site, Roads, Power Lines, Pipelines, and Other Facilities

Other facilities at the mine—including the Mill Site, GMSAs, sediment and settling ponds, roads, power lines, pipelines, and surface water controls—that are not required for post-mining monitoring or maintenance and not needed for post-mining land use are demolished and salvaged, or removed, and the sites are regraded to promote drainage with growth media placed, if needed, to support vegetation. All disturbed areas are vegetated in accordance with the Reclamation Plan.

11.8. Maintenance and Monitoring

The Haile Gold Mine will require maintenance and monitoring after active reclamation work is completed. Haile will follow a Monitoring and Management Plan that describes the requirements for monitoring and management of various environmental resources. This includes monitoring surface water and groundwater, as well as stormwater runoff, from the reclaimed areas.

The TSF and PAG facilities will require monitoring during drain down in addition to monitoring for a period of at least 10 years following completion of drain down and until the quality of untreated drainage comes into compliance with discharge permit standards. During closure and post closure, the passive treatment cells for the TSF and PAG facilities will require replacement every 20 years or as necessary. Monitoring and replacement of water treatment systems will be carried out in accordance with SCDHEC regulations.

In addition, general site monitoring and maintenance will take place for decades after active mining ceases. Groundwater and surface water samples will be collected and analyzed; vegetation will be actively managed (particularly to protect the TSF and PAG facility caps); and wildlife will be monitored and managed to protect all lined facilities.

12. FUTURE USES OF THE SITE

After reclamation, the site is suitable for various uses. Because of the HDPE liner in the reclamation design, woody growth is managed on the TSF and PAG Cells. The remaining property could be used for recreation, agriculture, or more intense land development (e.g., industrial, office or residential development) because utility infrastructure is available.

Appendix A Conversion Factors and Constants

Mass / Density

1 ton = 0.907185 tonnes
1 lb. = 0.453600 kg
1 kg = 2.204600 lb.
1 g = 0.035274 oz. (avoirdupois)
1 g = 0.032151 oz. (troy)
1 lb. = 14.58 oz. (troy)
1 kg/m^3 = 0.062428 lb./ft^3
1 lb./ft^3 = 16.018000 kg/m^3
1 g / tonnes = 0.0291667 oz. (troy) / ton

Length

1 cm = 0.3937 in.
1 in. = 2.5400 cm
1 m = 3.2808 ft.
1 ft. = 0.3048 m

Area

1 ha = 2.471050 acre
1 acre = 0.404686 ha
1 acre = 43,560 sq. ft.

Velocity

1 km/h = 0.62137 mile/h
1 mile/h = 1.60930 km/h
1 m3 / sec = 35.3147 ft3 / sec (air)

Volume / Flow

1 cm3 = 0.061024 in.3
1 in.3 = 16.387000 cm3
1 m3 = 35.314700 ft3
1 ft3 = 0.028317 m3
1 L = 0.035300 ft3
1 gal = 0.003785 m3 (water)
1 gal = 0.133680 ft3 (water)
1 gal = 0.832680 IMPgal
1 gal / min = 0.227125 m3/hr

Power

1 W = 3.4130 Btu/h
1 Btu/h = 2.9300 W
1 kW = 1.3410 hp
1 hp = 2545.0000 Btu/h
1 hp = 550.0000 ft·lbf/s
1 hp = 0.7457 kW

Pressure

1 Pa = 0.000145 lbf/in.2
1 lbf/in.2 = 6,894.757000 Pa
1 bar = 100,000 Pa
1 lbf/in.2 = 144 lbf/ft2
1 atm = 1.013250 bar
1 atm = 14.696000 lbf/in.2

Energy

1 J = 0.737560 ft·lbf
1 ft·lbf = 1.355820 J
1 kJ = 0.947800 Btu
1 Btu = 1.055100 kJ
1 kJ/kg = 0.429920 Btu/lb
1 Btu/lb = 2.326000 kJ/kg
1 J = 0.238846 cal
1 kcal = 4.186800 kJ

Force

1 N = 0.22481 lbf
1 lbf = 4.44820 N
1 lbf = 32.17400 lb·ft/s2

Specific Heat

1 kJ/kg·K = 0.238846 Btu/lb·°R
1 Btu/lb°R = 0.293 kJ/kg·K

Appendix B Haile Gold Mine Timeline (*Recent)*

December 3, 2010	Environmental Assessment Initiated for Haile Gold Mine Project
February 10, 2011	Haile Gold Mine NI 43-101 Technical Feasibility Study
October 27, 2014	ACOE Issues 404 Permit
November 6, 2014	DHEC Issues Modified Mine Permit I-000601
March 29, 2015	HGM Groundbreaking with first shovel in the dirt
October 3, 2015	Romarco Minerals and OceanaGold Joint Venture Announced
November 2, 2015	Construction of Process Plant, JPAG and 465 Pond Initiated
January 19, 2017	First Gold Pour – Commissioning Activities Initiated
June 23, 2017	HGM Open House and Ribbon Cutting
August 10, 2017	Updated NI 43-101 Technical Study for Optimized Operations
October 4, 2017	HGM declares Commercial Operation

Appendix C Glossary

A

Abutment	The weight of the rocks above a narrow roadway is transferred to the sides, which act as abutments of the arch of strata spanning the roadway; and the weight of the rocks over a longwall face is transferred to the front abutment.
Acid mine water	Mine water that contains free sulfuric acid, mainly due to the weathering of iron pyrites.
Active workings	Any place in a mine where miners are normally required to work or travel and which are ventilated and inspected regularly.
Aquifer	A water-bearing bed of porous rock.
Auxiliary operations	All activities supportive of but not contributing directly to mining.
Auxiliary ventilation	Portion of main ventilating current directed to face of dead end entry by means of an auxiliary fan and tubing.

B

Backfill	Mine waste or rock used to support the roof after removal.
Berm	A pile or mound of material capable of restraining a vehicle.
Borehole	Any deep or long drill-hole, usually associated with a diamond drill.
Bottom	Floor or underlying surface of an underground excavation.
Breakthrough	A passage for ventilation that is cut through the pillars between rooms.

C

Comminution	The breaking, crushing, or grinding of ore or rock.
Competent Rock	Rock which, because of its physical and geological characteristics, is capable of sustaining openings without any structural support except pillars and walls left during mining (stalls, light props, and roof bolts are not considered structural support).
Core sample	A cylinder sample generally 1-5" in diameter drilled out of an area to determine the geologic and chemical analysis of the overburden.
Cover	The overburden of any deposit.

D

Deposit	Mineral deposit or ore deposit is used to designate a natural occurrence of a useful mineral, or an ore, in sufficient extent and degree of concentration to invite exploitation.
Dip	The inclination of a geologic structure (bed, vein, fault, etc.) from the horizontal; dip is always measured downwards at right angles to the strike.
Drift	A horizontal passage underground. A drift follows the vein, as distinguished from a crosscut that intersects it, or a level or gallery, which may do either.
Dump	To unload; specifically, a load of ore or waste; the mechanism for unloading, e.g. a car dump (sometimes called tipple); or, the pile created by such unloading, e.g. a waste dump (also called heap, pile, tip, spoil pike, etc.).

E

Explosive	Any rapidly combustive or expanding substance. The energy released during this rapid combustion or expansion can be used to break rock.
Extraction	The process of mining and removal of ore from a mine.

F

Face	The exposed area of material being extracted.
Fault	A slip-surface between two portions of the earth's surface that have moved relative to each other. A fault is a failure surface and is evidence of severe earth stresses.
Fill	Any material that is put back in place of the extracted ore to provide ground support.
Fracture	A general term to include any kind of discontinuity in a body of rock if produced by mechanical failure, whether by shear stress or tensile stress. Fractures include faults, shears, joints, and planes of fracture cleavage.

G

Ground control	The regulation and final arresting of the closure of the walls of a mined area. The term generally refers to measures taken to prevent roof falls or bursts.
Gunite	A cement applied by spraying to the roof and sides of a mine passage.

H

Haulage	The horizontal transport of ore, supplies, and waste. The vertical transport of the same is called hoisting.
Highwall	Face or bank on the uphill side of a contour mine excavation.

I

Incline	Any entry to a mine that is not vertical (shaft) or horizontal (adit). Often incline is reserved for those entries that are too steep for a belt conveyor (+17 degrees -18 degrees), in which case a hoist and guide rails are employed. A belt conveyor incline is termed a slope. Alt: Secondary inclined opening, driven upward to connect levels, sometimes on the dip of a deposit; also called "inclined shaft".
Indicated resources	Estimates of the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.
Inferred resources	Unexplored extensions of the demonstrated resources for which estimates of the quality and size are based on geologic evidence and projection. Quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repletion of which there is geologic evidence; this evidence may include comparison with deposits of similar type.

J

Job Safety Analysis	A job breakdown that gives a safe, efficient job procedure.

K

Kerf	The undercut of a mined face.

L

Lithology	The character of a rock described in terms of its structure, color, mineral composition, grain size, and arrangement of its component parts; all those visible features that in the aggregate impart individuality of the rock.
Low voltage	Up to and including 660 volts by federal standards.

M

Measured resources	Estimates of the rank, quality, and quantity have been computed from sample analyses and measurements from closely spaced and geologically well-known sample sites, such as outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced, and the thickness and extent of ores are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage.

N

Nitrogen oxides (NOx)	Formed when nitrogen (N2) combines with oxygen (O2) in the burning of fossil fuels, from the natural degradation of vegetation, and from the use of chemical fertilizers. A significant component of acid deposition and photochemical smog. The primary source of nitrogen oxide emissions is mobile equipment exhaust.

O

Outcrop	Ore that appears at or near the surface.
Overburden	Layers of soil and rock covering an ore body. In surface mining operations, overburden is removed prior to mining using large equipment. When mining has been completed, it is either used to backfill the mined areas or is hauled to an external dumping and/or storage site.

P

Permissible	That which is allowable or permitted. It is most widely applied to mine equipment and explosives of all kinds which are similar in all respects to samples that have passed certain tests of the MSHA and can be used with safety in accordance with specified conditions where hazards from explosive gas or ore dust exist.
Permit	A document issued by a regulatory agency that gives approval for operations to take place.
Pinning	Roof bolting.
Plan	A map showing features such as mine workings or geological structures on a horizontal plane.
Portal	The structure surrounding the immediate entrance to a mine; the mouth of a tunnel or decline.

R

Raise	A secondary or tertiary inclined opening, vertical or near-vertical opening driven upward form a level to connect with the level above, or to explore the ground for a limited distance above one level.
Ramp	A secondary or tertiary inclined opening, driven to connect levels, usually driven in a downward direction, and used for haulage.
Reclamation	The restoration of land and environmental values to a surface mine site after the ore is extracted. Reclamation operations are usually underway as soon as the ore has been removed from a mine site. The process includes restoring the land to its approximate original appearance by restoring topsoil and planting native grasses and ground covers.
Recovery	The proportion or percentage of ore mined from the original seam or deposit.
Reserve	That portion of the identified mineral deposit resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified resource designated as the reserve base or proven reserves.
Resources	Concentrations of ore in such forms that economic extraction is currently or may become feasible. Resources broken down by identified and undiscovered resources. Identified resources are classified as demonstrated and inferred. Demonstrated resources are further broken down as measured and indicated. Undiscovered resources are referred to as hypothetical and speculative.
Respirable dust	Air-borne dust particles 5 microns or less in size.
Run-of-mine (ROM)	Raw material as it exists in the mine.

S

Section	A portion of the working area of a mine.
Slip	A fault. A smooth joint or crack where the strata have moved on each other.
Slope	Primary inclined opening, connection the surface with the underground workings.
Steeply inclined	Deposits with a dip from 40 degrees to 60 degrees.
Stemming	The noncombustible material used on top or in front of a charge or explosive.
Stope	Any excavation made in a mine to remove ore that has been made accessible by shafts and drifts.

T

Ton	A short or net ton is equal to 2,000 pounds;
Tonnes	A metric ton is approximately 2,205 pounds.
Transfer	A vertical or inclined connection between two or more levels and used as an ore pass. Location in the materials handling system, either haulage or hoisting, where bulk material is transferred between conveyances.
Tunnel	A horizontal, or near-horizontal, underground passage, entry, or haulage-way, that is open to the surface at both ends. A tunnel passes completely through a hill or mountain.

U

Undercut	To cut below or undermine the ore face.

V

Valuation	The act or process of valuing or of estimating the value or worth; appraisal.
Velocity	Rate of airflow in lineal feet per minute.
Ventilation	The provision of a directed flow of fresh and return air along all underground roadways, traveling roads, workings, and service parts.

W

Waste	That rock or mineral which must be removed from a mine to keep the mining schedule practical, but which has no value.