MINING RECLAMATION 101
ACQUISITION TO RECLAMATION – FORMER JOHNNY MOUNTAIN MINE CASE STUDY

Elizabeth Fillatre Miller, M.Sc., R.P.Bio
Kevin Hidber, AScT
Michael Van Arem, R.P.F
Mike Skurski, P.E.
R. Brent Murphy, MSc., P.Geo (NWT)
Jessy Chaplin, M.Sc., R.P.Bio

SnipGold Corp.
1235 Main St. Box 2536
Smithers, B.C. V0J 2N0

ABSTRACT

Seabridge Gold Inc. (Seabridge Gold) is a Canadian based resource exploration company. Seabridge purchased SnipGold Corp. (SnipGold) in 2016 that comprises the Iskut Project and 29,436 hectares (294 km²) of exploration potential in Northwest British Columbia’s famed Golden Triangle. Included in the transaction was the former Johnny Mountain Mine. Accessible via air only, the former Johnny Mountain Mine operated from 1989 to 1990 and briefly in 1993, is located at 1,000 MASL and has only three months of snow-free conditions.

The acquisition of a junior exploration company containing an exploration portfolio of mineral properties with upside potential and with a former operating mine that had not been fully reclaimed, required careful deliberation and the completion of an extensive due diligence process to determine existing and future liabilities associated with the former operating mine.

Historic infrastructure remaining following cessation of the Johnny Mountain Mine includes a 350TPD processing plant, fuel tank farm, an airstrip, 3.5 kms of underground workings, an 11.5 hectares tailings impoundment, waste rock dumps and several waste burial sites. SnipGold committed to reclaiming the historic legacy and outstanding liabilities, with the support of the Tahltan Nation over a multi-year timeline following the approved Closure and Reclamation Plan.

Keywords: SnipGold Corp., Seabridge Gold Inc., tank farm demolition, ventilation shaft closure, project execution planning, liability estimate

SITE BACKGROUND

Johnny Mountain Mine was an underground gold mine located 100km northwest of Stewart, British Columbia (BC), within Tahltan Traditional Territory. This remote, fly-in fly-out mine began commercial production on November 1, 1988 until September 1990 and then a brief re-opening from September to November 1993. Gold was mined from narrow quartz, sulphide veins by underground shrinkage stoping methods. Metals were concentrated using conventional froth flotation and gravity methods. Johnny Mountain produced 90,517 ounces of gold, 19,818 of silver and 2,222,477 pounds of copper from 249,097
tonnes of ore. Johnny Mountain mine ceased operations in 1993 due to low gold prices and high operating costs.

A layout of the mine is provided below in Figure 1. The infrastructure at Johnny Mountain Mine included a 350 tonnes per day mill building, three underground portals with associated waste rock portal pads, five vent raises, fuel tank farm, 1,600m airstrip, 11.5ha tailings impoundment area, landfill, roads and miscellaneous debris dumps. The site is situated on a sub-alpine plateau surrounded by steep valleys and is located near the confluence of the Craig and Iskut Rivers. The Northwest face of Johnny Mountain is covered by an alpine glacier. The site dimensions are approximately 700m by 1,000m (RTEC 2018).


![Figure 1: Johnny Mountain Mine Site Layout (Greenwood 2012)](image)

**Seabridge Gold**

A Canadian based resource exploration company - the corporate philosophy is to purchase exploration projects with existing resources and/or exploration upside potential and grow them through exploration with the assistance of Seabridge Gold’s dedicated and qualified geological team. Seabridge Gold’s model has been very successful and through their geological expertise has grown their reserves many times over (Seabridge Gold 2018).

In 2016, Seabridge acquired 100 percent of the issues and outstanding shares of SnipGold, giving Seabridge a 100 percent ownership interest in the Iskut Project. The Iskut Project contains 29,436 hectares (294 km²) of exploration potential in Northwest BC’s famed Golden Triangle, and also the former Johnny Mountain Mine. The acquisition of SnipGold had one unique complexity in the fact that it is a large package of
underexplored mineral tenures located within the mineral rich Golden Triangle, but included the former Johnny Mountain Mine, with its historical mining and legacy issues.

**Mining Reclamation 101- Johnny Mountain Mine**

Every exploration project acquisition undergoes some level of due diligence (Bullock 2018). Due diligence for the SnipGold acquisition included a land status and legal review, extensive geological and technical review as well as review of reports on the project’s social, economic and environmental disciplines. In the instance of Johnny Mountain, extra deliberation was taken into the environmental and reclamation side, including interviews with the former owners and their consultants, due to its historical mining and legacy issues. Following the extensive due diligence process, Seabridge Gold decided that the 29,436 hectares of significant upside exploration potential, located within British Columbia’s Golden Triangle, located less than 40km away from the geologically similar and flagship KSM Project, outweighed the reclamation liability of Johnny Mountain.

In June 2016, upon the acquisition of SnipGold Inc. (now a wholly owned subsidiary of Seabridge Gold), a qualified team for the project was assembled including employees and contractors to assist with the planning for closure and reclamation of Johnny Mountain Mine. All electronic and paper files from the former property owner were transferred, organized and reviewed. Documents relevant for the historic operations, site conditions, closure and reclamation were studied. An audit of reports against site conditions, interviews with previous key consultants in multiple disciplines were conducted (Figure 2).

Closure objectives were to follow the approved closure and reclamation plan, and to have clear, measurable and visual improvements year after year. The closure and reclamation plan required minimizing potential impacts to surface and groundwater resources, restoring the natural appearance of the area after mining ceases through the re-contouring and re-vegetation of disturbed lands and anthropogenic landforms. Ensuring that disturbances and re-developed landforms are stable from a long-term geotechnical and geochemical perspective, re-vegetating the site through the development of self-sustaining natural succession processes; and developing landforms and vegetative cover that provide a stable and productive wildlife habitat for resident and transient species utilizing the area. The priority was bringing the site into regulatory compliance, as a number of non-compliant activities had occurred on the site historically (for more information see Chaplin 2019). Due to the isolated fly-in fly-out location and no road access, limited and aging construction equipment, and a short snow free season, careful sequential planning of multi-year reclamation activity was required.
**Liability Cost Estimates and Project Execution Planning**

The original Closure Plan for Johnny Mountain Mine was submitted and approved by the Ministry of Energy and Mines in October 1999 (Woznow and Yaeger 1999). The overall objective of the Closure Plan for Johnny Mountain is to return disturbed lands and new anthropogenic landforms to their original land use and capability of alpine tundra wildlife habitat.

Determining the liability cost estimates for Johnny Mountain reclamation was the first action taken after acquiring the Johnny Mountain Mine. With the assistance of Wood (formerly known as AMEC Foster Wheeler), a detailed Work Breakdown Structure (WBS) and Basis of Estimate (BOE) for Johnny Mountain Mine Closure and Reclamation was conducted over a nine-month period. This estimate was based on a Detailed Site Investigation completed at the site (AMECFW 2018) and Project Execution Plan (AMECFW 2017). The $8.2 million liability estimate was calculated and used for internal reporting purposes, to present to company management and Board of Directors and submittal to regulators. Regular and transparent communication with company President/Board of Directors detailing the potential outstanding liability associated with the un-reclaimed project was critical to receive full buy-in. Historic reclamation securities held on the Johnny Mountain Mine was $462,043 (RTEC 2018).

Once liability cost estimates were completed, a detailed Johnny Mountain Mine Reclamation Project Execution Plan was finalized for the site. The Johnny Mountain Reclamation Project Execution Plan is used on an annual basis to guide and prioritize the reclamation works for the calendar year. The plan compiles all relevant Project execution information in one location (AMECFW 2017; SnipGold 2018). This plan is a living document and is updated on an annual basis to focus on the applicable year and includes high level information for the future remaining years of reclamation work.
The Johnny Mountain Mine Reclamation Project Execution Plan included applicable governing regulations and acts, current year reclamation objectives and scope, project risks and opportunities. The Plan outlined internal and external key project contacts, reclamation strategy, project schedules, change management, financial and accounting processes. Engineering scope, technical basis, designs and analysis were also included as well as drawings and reports. Supply chain management, finance and accounting, health safety and environment plans, as well as project procedures, instructions and forms are all contained in this Plan as well. Due to the older and somewhat unknown history of the site, safety planning and site management is critical for the safe implementation of the Johnny Mountain reclamation program. This Plan was particularly important to communicate with external stakeholders and the Tahltan Nation on proposed reclamation activities for the Johnny Mountain Mine as well as to ensure a streamlined program between SnipGold’s exploration and reclamation teams. This Plan also better equipped the SnipGold team to keep costs down, and limit project delays, in a challenging work environment with access constraints.

**Communication with Government Regulators and Tahltan Nation**

Communication internally and externally is critical for the success of any project and stakeholder engagement is key to Johnny Mountain Mine’s ongoing reclamation success. Of utmost importance to the success of this project was the review and audit of site permits, notifying government regulators of the change in ownership, as well as communicating upcoming exploration and reclamation plans for the site (see Chaplin 2019 for more information on permitting). Because the Johnny Mountain Project is located within Tahltan Traditional Territory, it was important to include the Tahltan Central Government, Iskut and Tahltan Bands on project developments, plus in-person meetings and presentations. This included involving the Tahltan Nation Development Corporation on as much of the project as economically and technically feasible. Through this active and open communication with the Tahltan Central Government, the reclamation project has the support of the Tahltan Central Government. Owing to the proximity of the Johnny Mountain Mine to the United States border, information was also disseminated to regulators in the United States.

**Johnny Mountain Mine Reclamation Activities 2016-2019**

Since the acquisition of SnipGold in 2016, Johnny Mountain Closure Planning, Liability Cost Estimates and Project Execution Planning were conducted to establish the guidance required to conduct various activity to achieve the end goal of site reclamation. A Dam Safety Review, Aquatic characterization study, environmental permit compliance monitoring samples collected, and installation of a meteorological station were completed (KCB 2017, RTEC 2018), in addition to gathering significant information during various investigations the first full season at site. In 2017, a detailed site investigation of groundwater and soil conditions including 52 boreholes and monitoring wells, a test pit program and excavation of 53 test pits (AMECFW 2018), tailings impoundment area (TIA) upgrades including piezometer installations and Dam Safety Inspection (KCB 2018) were conducted. Hazardous materials including miscellaneous chemicals, batteries, mercury lights, and asbestos were removed from the mill building and sent off site for disposal (RTEC 2018), environmental permit compliance samples collected, and the tank farm was cleaned and demolished (RTEC 2018). Finally, the removal of seacan and crane from the TIA brought a standing order into compliance. In 2018, five vent raises (Golder 2019) were closed, in-situ hydrocarbon remediation was initiated, the landfill upgraded (Wood 2018) and inert waste was relocated from non-compliant disposal sites into the newly expanded landfill, also removing a compliance order from the site (Northwest Response
The mill building also underwent an extensive clean-up including ore removal from the mill building floor, and a vegetation planting plan was completed (RTEC 2018).

Although an extensive scope of work has been conducted to date, generating ample detail to apply to reclamation solutions, the focus of this paper is limited to two major multi-year work areas - the tank farm demolition and adit closures. These two work tasks were required according to the approved Johnny Mountain Mine closure and reclamation plan, and demonstrate clear, measurable and visual improvements to the site during the last two years. Considering the history of the project site management and safety concerns, these tasks were deemed first priority in all program activities and were managed with appropriate resources.

**TANK FARM DEMOLITION**

Due to the isolated fly-in fly-out location, significant fuel storage was required at the Johnny Mountain Mine. Fuel was flown into the site and stored in twenty-three 7,000 gallon tanks (see Figure 3 below) and one 100,000 gallon tank. The tanks resided in a fully bunded clay lined tank farm impoundment. Fortunately, at the time of acquisition in 2016, the tanks contained only small quantities and remnants of diesel fuel.

The 2017 tank farm demolition plan was comprised of two important steps - cleaning and subsequent demolition. All tasks were conducted following detailed safety planning, by trained and qualified staff with all appropriate personnel protective equipment, fire extinguisher, spill supplies, and fire-fighting equipment.

![Figure 3](image_url)

*Figure 3a) Fuel tanks with the ends cut off b) fuel tanks being cleaned c) fuel tanks being crushed with the excavator*

**Cleaning Tanks**

A gas meter was used to ensure that the Lower Explosive Limit (LEL) was below the dangerous limit before cutting small square holes in the tank (TNDC 2017). A fan was used to circulate air until an acceptable level was reached when required. Three quarters of the tank ends were removed leaving the bottom intact so not to allow the fuel to drain out. Any residual diesel was removed with a hand pump into a 55 gallon drum. When needed, absorbent pads or dry absorbent was used to soak up any remaining fuel for disposal. The inside of the tanks once clean, were burned off to remove remaining product. One of the tank ends was
used to burn off small amounts of remaining fuel.

Micro-Blaze® was used to clean tanks and mixed as per the manufacturer’s instructions. When applied to a hydrocarbon-based or organic spill or contaminant, the wetting agent breaks down the contaminants into smaller molecules for more efficient degradation, by the microbes, into harmless byproducts like carbon dioxide, water, and trace salts. Tank walls were cleaned with Micro-Blaze® and either a pump and a hose, power washer or by splashing water in buckets. A broom was used to scrub the tank. Remaining fuel and absorbent pads were either burned on site or shipped to Prince George, BC for disposal. Both solid and liquid residue was cleaned from the tanks.

**Demolition of Tanks**

As there were two different sizes of tanks on the property, different demolition methodologies were used. The small 7,000 gallons tanks had both ends cut off from the tank. The large remaining tank body was weakened by cutting 70-90 percent of the steel casing along each side of the tank to facilitate crushing by an excavator. The tanks were cut into manageable pieces using a gas-powered cut-off saw and hauled to the landfill using a Kenworth dump truck. To ensure safety of workers and site, all high-temperature cutting work was stopped two hours before quitting time to accommodate a fire watch.

The 100,000 gallon large tank (see Figure 4 below) had three large openings cut into the sides to ensure easy access, egress and aeration. Using working from heights procedures and harnessed workers, the roof was cut into pie shapes using a plasma cutter and allowed to fall into the bottom of the tank. The sides were cut into pieces and allowed to fall into the tank, the excavator was used to assist the sides falling in the tank. Pieces were piled in a manner to make handling easy in the Kenworth dump truck. Tanks were then hauled and placed in the landfill.

*Figure 4a) Large 100,000 gallons fuel tanks being demolished from the top down. b) Large tank partially demolished.*
Soil within the tank farm was then treated in-situ following with OilGator®. According to the manufacturer, OilGator® is produced from recycled chemically modified cellulosic fibers and contains all of the necessary ingredients including nitrogen, sulphur and phosphorous, to enhance biodegradation of hydrocarbons by indigenous bacteria. OilGator® was applied according to the following treatment rates (Table 1) (Northwest Response 2018). Soils was then turned a minimum of three times, approximately every 2-3 weeks.

### Table 1. Northwest Response Guideline for Treating Hydrocarbon Contaminated Soil with Oil Gator

<table>
<thead>
<tr>
<th>EPH Concentration</th>
<th>Oil Gator Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5,000mg/kg</td>
<td>1X 30lbs bag/20m³</td>
</tr>
<tr>
<td>5,000-10,000mg/kg</td>
<td>1X 30lbs bag/10m³</td>
</tr>
<tr>
<td>10,000-20,000mg/kg</td>
<td>1X 30lbs bag/205</td>
</tr>
<tr>
<td>&gt;20,000mg/kg</td>
<td>1X 30lbs bag/1m³</td>
</tr>
</tbody>
</table>

**VENTILATION SHAFTS**

In 2018, one of the larger tasks completed in the season was to seal, close and reclaim five underground ventilation shafts (see Figure 5 below), which were vertical passages historically used to move fresh air underground. Safety was the principal goal of this activity. Reducing overland flow and precipitation into underground workings was a secondary goal of this activity. The ventilation shafts ranged in size (see Table 2 below), with the smallest being 1.5 x 1.5m and the largest being 2.5 x 2.5m. According to the Mines Act (1996) and Health, Safety and Reclamation Code for Mines in British Columbia, Part 10.6.4, adit entrances and all other openings to underground mines that are no longer in use shall be secured against entry in a manner acceptable to an inspector (Ministry of Energy and Mines 2017).

Due to the location of Johnny Mountain with no major infrastructure (i.e. power), isolated location (no roads), and limited equipment and old openings, it was decided to utilize bagged polyurethane foam to seal the shafts. Prior to this, some ventilation shafts were left uncovered, while some others were enclosed with old wire and plywood covers, much of which had deteriorated over time. It is important to note that no bats or bat sign were found in the project area. The Polyurethane foam was shipped by truck from Idaho, U.S.A. to the McLymont laydown area in Northern BC. Finally, the product was slung via helicopter a distance of approximately 30 km on pallets to each shaft location from the laydown.

Polyurethane foam has been used at a significant number of sites in both Canada and the United States (e.g., Breadmore et al. 2016; Burghardt 1994; Prisca et al. 2010). According to the Remediation Guidelines for Abandoned and Mine Openings in Northern Canada and Foam Concepts LLC, approximately 30-50 percent of abandoned mines in the United States use polyurethane foam (Indian and Northern Affairs Canada 2011).
Table 2: Summary of Ventilation Shafts Locations

<table>
<thead>
<tr>
<th>Vent Raise Number</th>
<th>GPS Waypoint Number</th>
<th>Northing (mN) NAD 83 Zone 9V</th>
<th>Easting (mN) NAD 83 Zone 9V</th>
<th>Width (m)</th>
<th>Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-13-03 RSE</td>
<td>4</td>
<td>6277730</td>
<td>373400</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>12-06-05 RSE</td>
<td>5</td>
<td>6277663</td>
<td>373450</td>
<td>2.2</td>
<td>2.5</td>
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<tr>
<td>11-28-66 RSE</td>
<td>6</td>
<td>6277568</td>
<td>373070</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>11-17-76 RSE</td>
<td>7</td>
<td>6277577</td>
<td>373263</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>11-29B STOPE</td>
<td>8</td>
<td>6277514</td>
<td>373016</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Figure 5: Johnny Mountain Mine Aerial Map showing the five vent shafts and three underground portals

Methods used to seal each of the five ventilation shafts were similar to each other, and all crews were trained-in and implemented proper fall restraint procedures to reduce the risk of falling (Golder 2019). To ensure the work site was free of water, surface water was directed away from each ventilation shaft using an excavator and all wood or metal debris was cleared from each ventilation shaft. Inert solid materials were hauled to the landfill for burial and woody debris was burned. Loose rock and surface debris were cleared from the collar and leveled to allow access to the area mitigating trip hazards to provide a safe work area.
Anchor pins were installed at each corner of a raise, from which a false floor formwork was suspended, well below from the ventilation shaft opening. The installed pins doubled as tie off for fall restraint for the crew working around the ventilation shaft. A false floor formwork was lowered into the vent to a minimum of 4m depth. Wire cables were attached to the corners of the false floor to hold it in position. The false floor was comprised of wire mesh, covered with lightweight geotextile and topped with polyurethane foam to create a flat surface. Following the manufacturer’s instructions, the polyurethane foam was mixed and poured over the false floor in a 300mm thick lift, ensuring that this first lift sealed the edges between the false floor and the ventilation shaft rock wall. Continuous mixing and pouring polyurethane foam in lifts of 500mm of risen (expanded) foam per layer was completed. A waiting period of approximately 20-30 minutes per layer was required for the preceding layer to solidify before pouring the next layer of foam. The crews continued to mix and pour in lifts of 500mm until the required thickness was constructed, and foam was within approximately 300mm of the ventilation shaft collar. Once completed, the anchor pins and excess cable protruding above the foam were removed. Using an excavator and surrounding local material, the area was re-contoured with a minimum of 1m of fill over the polyurethane plug for local drainage away from the sealed shaft. The area was then seeded with a reclamation seed mixture and vegetated with transplanted seeds from the project area.

Figure 6a) Example of false floor, b) polyurethane foam close to surface at Ventilation Raise: 12-13-03 RSE c) mineral soils covering polyurethane foam at Ventilation Raise: 12-13-03 RSE

CONCLUSIONS

The acquisition of a junior exploration company containing an exploration portfolio of mineral properties with significant upside potential and a former operating mine that had not been properly reclaimed, required careful deliberation. The completion of an extensive due diligence process to determine existing and future liabilities associated with the former mine supported the acquisition case. Ultimately, the exploration potential of a large underexplored tenure in the Golden Triangle proved to be the determining factor and outweighed the sum of the former Johnny Mountain Mine’s liabilities. The new owners of SnipGold committed to reclaiming the Johnny Mountain Mine site over a multi-year reclamation program.
Reclamation work began with the process of determining tasks required for permit compliance and initiating open communication with regulators and following the approved reclamation and closure plan. In coordination with the Tahltan Nation, SnipGold started working diligently to address the outstanding liabilities associated with the former mine.

A detailed work plan and estimate for the former Johnny Mountain Mine’s Closure and Reclamation was conducted over an initial 9-month period after acquisition. An $8.2 million liability estimate was developed and used for internal company and external stakeholder reporting, versus historic reclamation securities held on the Johnny Mountain Mine was $462,043.00. A detailed Johnny Mountain Mine Reclamation Project Execution Plan was then compiled to guide the reclamation planning activities on an annual basis. This Plan was particularly important for communication with external stakeholders and the Tahltan Nation on proposed reclamation activities for the former Johnny Mountain Mine. It is also advantageous to ensure a streamlined program between SnipGold’s exploration and reclamation teams and better equip the SnipGold team to keep costs down and limit project delays.

In 2017, tank farm demolition and reclamation plan were comprised of cleaning and subsequent demolition of 23 7,000 gallons tanks and one 100,000 gallons tank. Tanks were cleaned and demolished in a safe and environmentally friendly manner. The hydrocarbon contaminated soils were then treated in-situ with Oil Gator.

In 2018, five ventilation shafts were closed and reclaimed. Surface water was directed away from each ventilation shaft, all wood or metal debris was cleared from ventilation shaft and loose rock and surface debris was cleared from the collar. A false floor formwork was lowered into the vent to a minimum of 4m depth. Wire cables were attached to the corners of the false floor to hold it in position. The ventilation shafts were filled with polyurethane foam until foam and re-contoured above the collar with local material to mitigate the ingress of water. The area was then seeded with a reclamation seed mixture and vegetated with transplanted seeds from the project area. The ventilation shafts now meet the Health, Safety and Reclamation Code.

SnipGold committed to close and reclaim the former Johnny Mountain Mine on a multi-year reclamation program and this work contributed to progressively meeting the approved Johnny Mountain Mine closure and reclamation plan, and also demonstrate clear, measurable and visual improvements to the site each year of Seabridge’s ownership.

**Acknowledgements**
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