Mine Closure 2011 — A.B. Fourie, M. Tibbett and A. Beersing (eds)

doi:10.36487/ACG_rep/1152_116_Sulatycky

Closing out gold mining legacies in the Porcupine Camp

T.M. Sulatycky *Porcupine Gold Mines, Goldcorp Canada Ltd., Canada*

L. Götz *Porcupine Gold Mines, Goldcorp Canada Ltd., Canada*

D. Bucar *Porcupine Gold Mines, Goldcorp Canada Ltd., Canada*

R. Taillefer *Porcupine Gold Mines, Goldcorp Canada Ltd., Canada*

Abstract

The Porcupine Camp, currently under the ownership of Goldcorp Canada Ltd., Porcupine Gold Mines (PGM), consists of a large land package of amalgamated historic mine sites, a result following decades of mergers and acquisitions. In addition to resource potential, PGM has inherited the rigorous requirement to rehabilitate historic mine hazards under recently enacted Ontario Regulation 240/00 (Reg. 240). Limited reclamation work had taken place by predecessors until the turn of the century which left PGM the arduous task of prioritising the risk to the public and the environment caused by dozens of tailings deposits, deteriorating infrastructure, contaminated soils, and hundreds of mine shafts, raises and open stopes.

A risk based exercise was completed to prioritise mine hazards under PGM ownership. Rehabilitation exercises in the early part of the decade focused on stabilisation of mine openings to surface that presented an immediate risk to ensure protection against inadvertent access by the public. This included such measures as shaft and raise capping, backfilling open stopes and fencing off large areas. Larger, multi-year projects would be targeted at a later date as much more study and engineering would be required. This began with the Coniaurum tailings facility which had significantly degraded and was depositing tailings into the Porcupine River via erosive forces. Physical stability work was performed between 2005 and 2008 that would allow minimal long term management of the tailings facility. Following the success at Coniaurum, PGM would focus their attention on the Hollinger Tailings Management Area (HTMA) in 2009 where acid generating waste was degrading water quality downstream of PGM property including Town Creek. Chemical stability work began in 2009 to prevent further generation of acids and to clean up Town Creek downstream. Land ownership and financial constraints amongst other issues would challenge PGM to find unique solutions.

1 Introduction

In 1896, when E.M. Burwash, a geologist with the Ontario Bureau of Mines, commented on the potential for Gold exploration when his survey party landed in Nighthawk Lake, he unknowingly initiated a spark of exploration and development that would last more than 100 years and produce over 70 million ounces of gold from the city with a heart of gold, Timmins, Ontario. One hundred years later, the legacy of these historic mines is still apparent in the presence of crumbling concrete foundations, rusty headframes, a plethora of unstable crown pillars, and tailings stacks that cover vast stretches of land, scarring an otherwise beautiful northern landscape and tarnishing the memories of a legendary mining camp.

The Porcupine Camp is currently under the ownership of Goldcorp Canada Ltd. Porcupine Gold Mines (PGM) and consists of a large land package of amalgamated historic mine sites (Figure 1), a result following decades of mergers and acquisitions. In addition to resource potential, PGM has inherited the rigorous requirement to rehabilitate historic mine hazards under recently enacted Ontario Regulation 240/00 (Reg. 240). Limited reclamation work had taken place by predecessors until the turn of the century which left PGM the arduous task of prioritising the risk to the public and the environment caused by dozens of tailings deposits, deteriorating infrastructure, contaminated soils, and hundreds of mine shafts, raises and open stopes.

This paper is a summary of the successful rehabilitation work that has been completed over the last ten years with focus on the Coniaurum mine and the Hollinger tailings deposition area, the unique challenges encountered technically and socially, and the ambitious plans leading into the future.

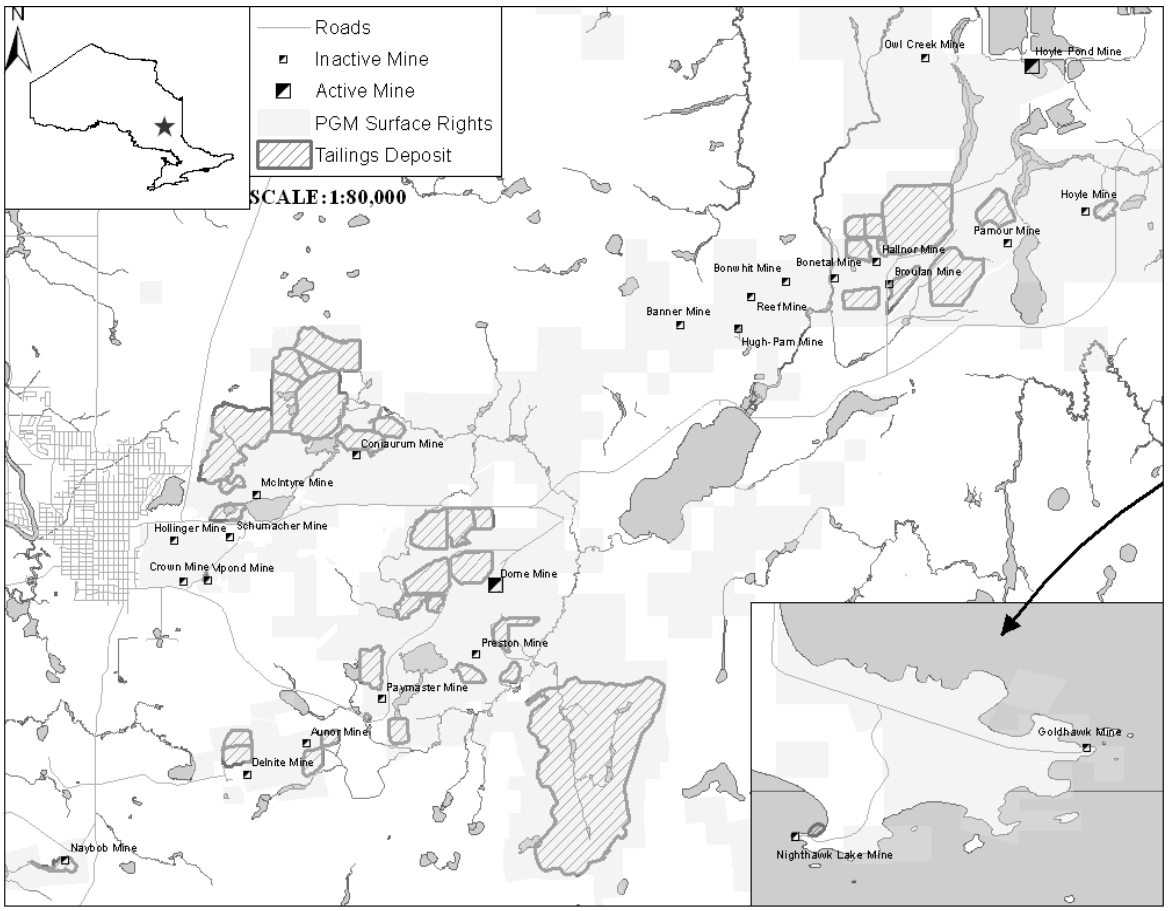

Figure 1 PGM owned active and inactive mines

1.1 Closure planning

The first attempt at introducing legislation to mandate mine rehabilitation came in 1988 under Bill 71. For the first time, a mining company was required to submit a closure plan for advanced exploration, new, and existing operating mines and abide by the terms within. Inactive mines were required to file closure plans only by order of the director (Cowan and Robertson, 1999).

After much consultation, this legislation was passed and became Part VII Rehabilitation of Mining Lands in the *Mining Act*. To supplement this, rehabilitation guidelines were developed to assist companies in order to ensure mitigative measures met regulatory expectations. The legislation was effective in the context that the Ministry now had a commitment with funds set aside from mining companies to rehabilitate. The legislation however lacked any real body in terms of the level of detail expected from a closure plan or accountability of the preparer.

Consultation and further refining of the legislation lead to the passing of Ontario Regulation 240/00 Mine Development and Closure. Reg. 240 raised the standard in the context that significantly more detail was required in a closure plan before it would be considered acceptable. The supplementary guidelines became The Rehabilitation Code of Ontario (The Code) and were written into law setting a standard for minimum acceptable mitigation.

For the Porcupine Camp, this put extraordinary pressure on owners to prepare and submit an acceptable closure plan, act on it and provide the necessary financial assurance during a period of mining reform and stagnant development.

1.2 History of liabilities

In the early part of the twentieth century, mining in the Porcupine Camp advanced at a feverish rate with new and existing companies rapidly moving forward with exploration programmes, increasing production and acquiring more property. The standard of the day was to encourage production to retain jobs and investment, often at the sacrifice of safety and certainly without much consideration of environmental consequences or future land use. Times of prosperity were often followed with times of hardship during the cyclic lows typical of resource extraction and many smaller companies consolidated, merged and, in many events, abandoned leaving relics of the past for future generations.

Survivors of the hard times would continue to dominate through the early to mid decades until even the mighty began to fall, beginning with the Hollinger Mine in 1968 and followed by the Hallnor Mine, the Aunor Mine and the McIntyre Mine in 1988. These large operations included significant liabilities that continued to increase the portfolio of risks in Timmins to public safety and the environment if left uncontrolled.

The first merging of significance occurred on July 22, 1991 when Royal Oak Mines Inc. (RYO) was formed through a large amalgamation of several international mining companies in an effort to consolidate resources. The Porcupine properties under RYO direction included the McIntyre, Hollinger, Pamour, Coniaurum, Aunor, Delnite, Hallnor, Nighthawk and many other smaller exploration properties. In addition to a steadily decreasing gold price, RYO faced a new mandate to prepare and submit a closure plan for its existing mines as well as the potential to submit closure plans for many inactive mines. During their eight year tenure, little rehabilitation work was completed at any site as the operation struggled and by 1999, the price of gold hit a twenty year low, bankrupting RYO and leaving the government of Ontario with millions of dollars in liability.

At the turn of the century, neighbouring gold mining giant Kinross Gold Corporation (KGC), owner and operator of the Hoyle Pond and Owl Creek mines, purchased the RYO mining package. With this acquisition, a cost sharing agreement was struck between KGC and the Ministry of Northern Development, Mines and Forestry (MNDMF) to rehabilitate all mine-related hazards located in areas where public safety could be compromised. Similar to RYO, KGC was faced with a new, more stringent mine closure regulation and millions of dollars in liability.

1.3 Mine closure – the early years

As Reg 240 was still in its infancy, it had yet to be tested by either the MNDMF or KGC. Initial closure plans were developed focusing on the significant issues present at each mine and less on formality which was typically accepted by the MNDMF at the time knowing that amendments could be requested at a later date.

Using a risk-based approach, KGC began prioritising their safety and environmental liabilities, laying out a plan that the MNDMF would be satisfied with and KGC could reasonably manage. Mine openings such as shafts, raises and open stopes as well as unstable crown pillars presented immediate threats to community safety, for example, and were targeted for rehabilitation immediately. The Hollinger and McIntyre Mine presented the greatest risk due to the mining methods of the day, the proximity of the mine to the City as well as the number of mine hazards. Also, when the mine dewatering system associated with the McIntyre mine was decommissioned, subsidence of unstable crown pillars began to occur near local businesses (Figure 2).

KGC and new joint venture partner, Placer Dome (PD), owner and operator of the Dome mine, formed the Porcupine Joint Venture (PJV) who commenced a five to six year programme where the majority of mine openings accessible to the public were capped with concrete or fenced in groups with other mine hazards. PJV would cap over sixty shafts and raises with concrete in accordance with The Code, backfill several open stopes and install over twenty-five kilometres of fencing to restrict public access at several mining properties. During this time, aging infrastructure was torn down with concrete foundations, broken up and buried, and a layer of biosolids, a waste by-product obtained from Abitibi Consolidated who operate in the forestry industry, was applied to several mine sites to encourage vegetation.

During this period, PJV was working towards developing a closure plan that would provide details to successfully rehabilitate for long term physical and chemical stability, the Coniaurum Mine tailings facility.

Figure 2 Subsidence near downtown Timmins

2 The Coniaurum Mine

The Coniaurum Mine was first actively explored in 1911. A 350 tpd mill constructed in 1928 ensured continuous operation until the doors were closed in 1961 after extracting 4.5 million tonnes of ore. Following the closure of the mine, the site was abandoned.

2.1 Project description

In 1988, an Australian company, ERG Resources Inc. (ERG), obtained ownership of the property with the intent to reprocess tailings to recover residual gold. The project was poorly executed and within one year, ERG went bankrupt leaving a portion of the tailings partially mined out on the western side and unreclaimed. RYO purchased the property from ERG though no work was done until under the ownership of PJV. Goldcorp Canada Ltd. took over the Porcupine assets of both joint venture parties in 2007, operating as Porcupine Gold Mines (PGM).

During the period of operation, tailings were deposited into a two tiered tailings facility consisting of the Upper Tailings Area (UTA) and Lower Tailings Area (LTA), a total of 58 hectares. The pre-mining topography allowed tailings to be naturally contained by high ground along most of the perimeter as can be seen in Figure 3.

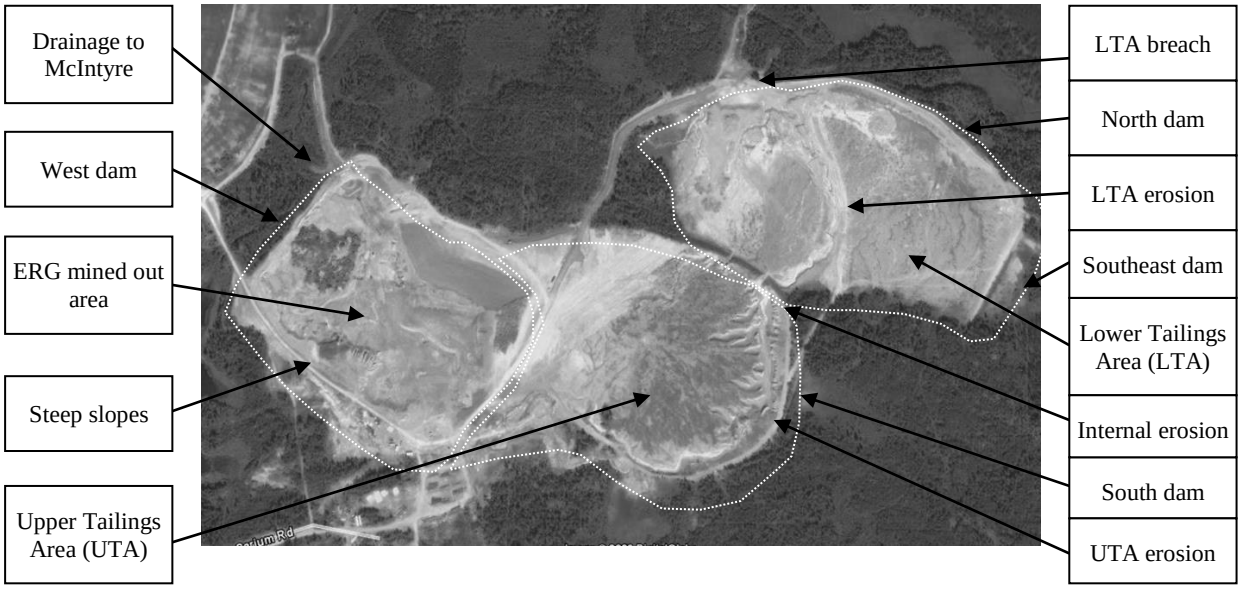

Figure 3 Coniaurum Mine tailings facility pre-construction (2002)

Figure 4 Internal dam breach at Coniaurum tailings facility

The eastern portion of the UTA drained east towards the LTA via two internal dam breaches. The lack of erosion protection accelerated the process cutting deep gullies with steep side slopes over a forty-five year period (Figure 4). The LTA discharged to the Porcupine River (PR) via a breach in the North dam carrying fine tailings. The western portion of the UTA drained west towards the McIntyre tailings area, a result of the hydraulic mining method used by ERG. Steep 5 m to 6 m faces were left further elevating the release of tailings into the PR.

A geotechnical study was undertaken to evaluate the tailings facility for long term stability physically. The primary concern was the potential release of tailings into the Porcupine River in the event of a dam failure. The calculated FOS under the design event was found to be inadequate under static loading conditions for the existing dam slopes and liquefaction of the tailings and some foundation zones was considered possible.

Geochemistry assessments concluded that the tailings would likely not pose an environmental issue in terms of acid generation and metal leaching.

2.2 Rehabilitation strategy for Coniaurum

The general concept for rehabilitation was to stabilise existing dams, construct an appropriate surface water drainage system and install self sustaining erosion protection across the site. Some of the principal design criteria used for the rehabilitation works were as follows:

1. The rehabilitated site should require only nominal maintenance and inspection. There should be no ponds or associated containment structures.
2. Water quality leaving the site will be equal to or better than background levels, once the area is fully revegetated.
3. A self-sustaining vegetative cover will be established over the tailings surface, internal slopes and dams to stabilise the surface material and prevent loss of tailings to the surrounding environment by wind and water erosion.
4. The drainage system is to use the existing eroded channels to the greatest extent possible to minimise the amount of cut, fill and grading that would be required to achieve a stable long-term solution.

To facilitate the design criteria, the tailings facility was divided into three distinct watersheds; the UTA west, UTA east and LTA (Figure 5). Runoff would be directed from the UTA east via the main erosion gully which would be stabilised from further erosion with rip rap and become the main ditch. Secondary feeder channels would be constructed peripheral to the main ditch to encourage rapid drainage towards the LTA. A sedimentation pond constructed at the outlet of the main ditch would tie in secondary drainage from the LTA with the main ditch prior to discharge to the PR. On the west side, multiple drainage ditches were constructed to move water towards a second discharge point leading to the McIntyre tailings sump.

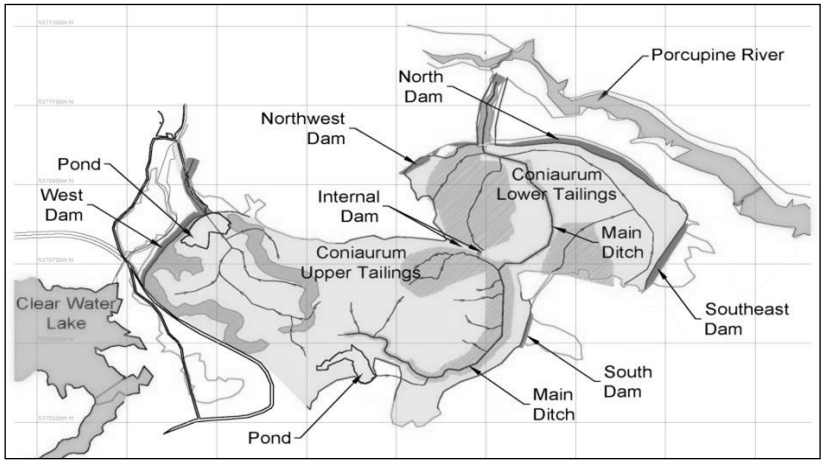

Figure 5 Rehabilitation measures proposed

Significant sloping would take place to ensure long term stability of the existing dams. The north and southeast dam would be graded to a 3.5 horizontal to 1 vertical slope and covered with rockfill. A rockfill buttress would be placed at the toe of south dam. The exposed faces from ERG at UTA west would be graded to a 5 horizontal to 1 vertical slope. Following construction, the entire site would be covered with biosolids and seeded.

2.3 Post construction and environmental monitoring

The construction work began in 2005 and was spread over four years, wrapping up in 2008. From the onset, challenges hampered the construction season. Originally the project was anticipated to be completed in two to three years however budget constraints resulted in searching for cost savings at every opportunity. The biggest savings were realised when the contract to complete the rehabilitation work was switched from a unit rate type contract to a time and material type contract though this increased project management responsibilities for PGM. During this period of time, contractor rates were on the rise in Timmins and the cost savings with project management likely counteracted this effect.

Construction advancement also experienced challenges with:

- Poor drainage of tailings causing unstable conditions for equipment.
- Vibration of tailings causing liquefaction.
- Difficulties trying to match design specifications for sloping.
- Site access issues resulting in extra costs to build new road plus extra haulage costs.
- Erosion control during spring runoff.
- Obtaining the necessary permits for construction.

Often modifications were made to the design ex situ because field conditions recognised an opportunity for improvement or because there was difficulty meeting the specification. The number of secondary ditches and removal of a hidden decant pipeline found while grading the north dam are examples of such modifications.

Spring melt is typically an annual challenge to the quality of work of any rehabilitation project and the spring of 2008 and 2009 put the design to the test with higher than normal melt conditions. Environmental monitoring of water quality at the point of discharge to the PR was found to be well within Provincial Water Quality Objectives during the freshet even with the channels swelled with water and moving quickly. Vegetation was quickly and firmly established across the property, as can be seen in Figure 6, resulting in limited erosion and a post construction Dam Safety Inspection (DSI) in 2009 reported only minor maintenance. A post closure Dam Safety Review (DSR) is scheduled in 2011 as part of the closure plan and three year review of the project.

Figure 6 Post closure aerial photo looking southwest (2010)

Further monitoring of the tailings reclamation work is showing signs of stabilising and future monitoring requirements will likely be reduced as justified by the overall improvement to both physical and chemical stability. PGM intends to allow access to the site as a nature trail system in consideration of future land use.

3 The Hollinger Tailings Management Area

Following the success at Coniaurum, PGM began ramping up to begin construction at The Hollinger Tailings Management Area (HTMA) following several years of investigative work.

3.1 Project description

The HTMA consists of two tailings deposits from two respective mines; the Hollinger Tailings Basin (Gillies Lake) and the McIntyre Concentrate Dump (MCD). The Hollinger and McIntyre Mines were both discovered in 1909 and collectively produced more than 29 million ounces of gold. The properties were eventually acquired by ERG in 1988, followed by RYO, though little reclamation work took place until the properties were taken over by KGC.

The Hollinger Mine deposited tailings in Gillies Lake from 1920 until around 1960. The lake was not filled to capacity, leaving only about 20 % remaining on the western end. Surface water was allowed to run off the tailings from several channels that had developed towards the northwest. In 1988, ERG mined a portion of the tailings basin which was left un-reclaimed and subsequently filled with runoff creating a pond (Gillies Pond). Overflow from Gillies Pond continued to follow established drainage channels.

Upstream of Gillies Pond, the McIntyre Mine deposited an off spec gold-sulphide concentrate as part of their milling process between 1931 and 1956 into a natural depression with a containment dam installed at the point of drainage. ERG mined a portion of the MCD leaving small ponds to form. Surface runoff from the MCD flowed north on the west side of Gillies Pond and merged just downstream of the Gillies Pond discharge. Under backwater conditions, discharge from the MCD was observed to enter the south side of Gillies Pond. The combined flows entered Town Creek which connects with the Mattagami River much farther down. Given the small watershed area, flows were mostly intermittent after the spring melt.

As erosion protection was not constructed, a significant quantity of tailings from both impoundments migrated downstream into Town Creek, likely under severe storm events. Some of the migration of tailings is attributed to ERG during their operation. Figure 6 depicts existing conditions and proposed measures for reclamation.

Water quality was measured from 1991 at several stations including the MCD discharge, Gillies Pond discharge and their combined discharge into Town Creek. As expected of acidic drainage, the MCD discharge had low pH and high metals. Similarly, Gillies Pond contained low pH and high metals likely caused by impacting acidic drainage. The combined discharge however was consistent around pH 7-8, with

the exception of an annual blip during spring runoff, up until 1997. An explanation to this is that the discharge channel from the MCD contained appreciable neutralising capacity in addition to dilution effects. Post 1997, the pH continued to drop year after year until stabilising around a value of 3 (Figure 7). The transition is assumed to be caused by the depletion of neutralising minerals in the drainage channel. Following the degradation of water quality at the HTMA, water quality downstream showed signs of degradation and increased metal content.

The issue of concern was the degrading water quality at HTMA and impact downstream (Figure 8). To complicate the issue further, PGM did not own surface rights downstream of the impacted area and thus had to discuss rehabilitation strategies with neighbouring land owners for access.

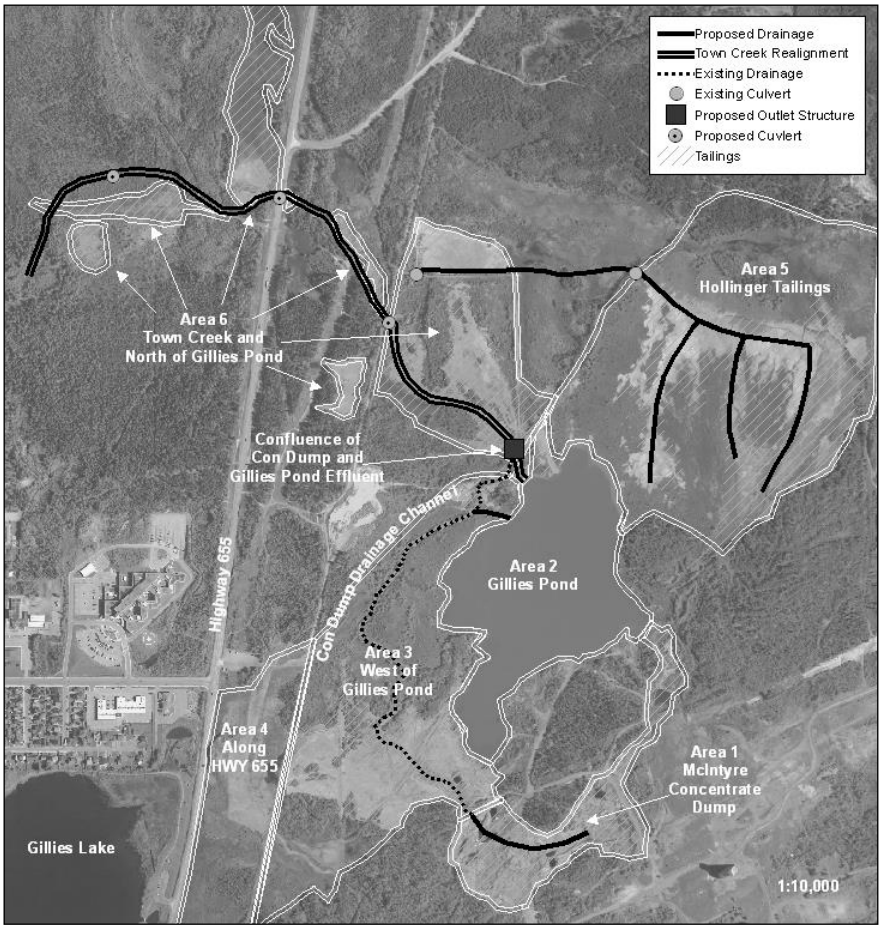

Figure 7 HTMA site plan and proposed rehabilitation measures

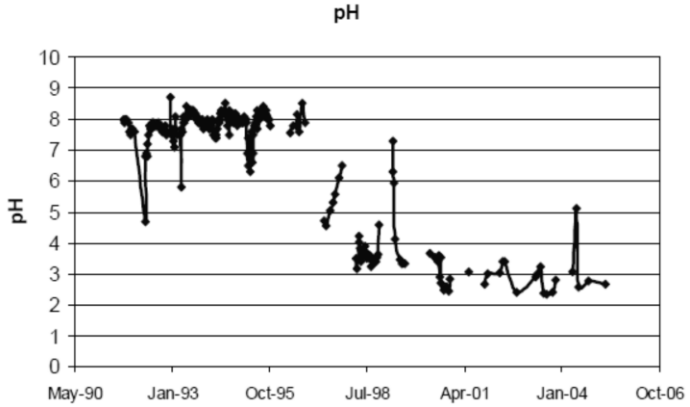

Figure 8 Historic pH at combined discharge

3.2 Rehabilitation strategy for the HTMA

The general closure concept for the HTMA entails the rehabilitation of Town Creek, the deposition of acid generating tailings under water in Gillies Pond and the application of a vegetative cover to achieve a green space at the site. The closure measures for the HTMA were proposed for execution in two phases.

Phase 1 focuses on Town Creek (Area 6) by removing acid generating tailings and constructing a new outlet control structure and channel. Drainage from the MCD will be managed by diverting runoff into the south end of Gillies Pond while the lower reach will be diverted into the north end of Gillies Pond. Closure activities in Areas 5 and 6 will also be carried out in this phase of the project.

Phase 2 focuses on the relocation of concentrate within the MCD and acid generating tailings from Area 3 and 6 into the pond. Following the relocation of the concentrate and tailings, the remaining exposed tailings in Areas 1 and 3 will be covered with a layer of acid-consuming tailings and a vegetative cover. Drainage channels will be constructed in the rehabilitated areas, as required. Reshaping and stabilisation of the shoreline around Gillies Pond and the remediation of two former settling ponds east of Gillies Pond will also be undertaken in this phase of the project.

3.3 Challenges encountered during construction

For the HTMA construction work, a full budget was assured from upper management in order to maintain a good social relationship with the community and carry out the work as scheduled. Following lessons learned at Coniaurum, a time and material type contract was used. Preparatory work was carried out in the fall of 2008 which included the diversion of runoff from the MCD and upper reach of Area 3 to the southern end of Gillies Pond and drainage from the lower reach of Areas 3 to the northern end of Gillies Pond.

The first phase of the project began in 2009. Consultation with neighbouring land owners to secure access impeded the first phase of the project as it involved rehabilitation work on private land. With equipment mobilised, PGM scrambled to modify the schedule to allow continuation of work and reduce contractor standby time. A back up plan had to be on hand at all times while working on private land as access would continue to challenge project advancement.

As the project was phased to rehabilitate from the end backward, control of effluent from Gillies Pond and the MCD was essential. Gillies Pond would be divided into three sections, the north, central and south, to allow a phased deposition of tailings while maintaining adequate retention time. In 2010, tailings were excavated from Area 6 and Area 1 and deposited in the south and central cells of Gillies Pond. The year 2010 was wrapped up following the installation of a drainage ditch from Gillies Pond to Town Creek and the subsequent spreading and seeding of biosolids, (Figure 9).

Figure 9 Town Creek pre construction (2006)

Figure 10 Town Creek post-construction (2010)

The HTMA is expected to wrap-up around late summer of 2011 following the reshaping of Gillies Pond, the relocation of Area 3 and Area 1 tailings to Gillies Pond, and the installation of a drainage channel from the MCD to the northern end of Gillies Pond. Pending water quality, the outlet will be opened up and allowed to drain naturally towards Town Creek. Environmental monitoring will continue at the current frequency to monitor conditions in the short term until the site shows signs of stabilising and PGM is comfortable reducing the frequency of inspections.

4 Reclamation post-2010

Following the completion of the HTMA, rehabilitation of the four tailings dams at the Hallnor Mine is expected to phase in mid 2011 to allow long term physical stability. Simultaneously, detailed engineering is progressing at the Aunor and Delnite Mines tailings facilities. The Delnite Mine in particular is challenged by high arsenic content within the tailings stack which is impacting areas down gradient.

PGM has and continues to improve the safety and the environment associated with the many historic hazards, the benefits of which are immediate to the community. PGM continues to move forward on the long term rehabilitation strategy of the Porcupine Camp as the land is transformed into usable green space for future generations, removing the blemishes of the past and allowing memories of the legendary mines to shine brightly as they once did.

References

Cowan, W.R. and Robertson, J.G.A. (1999) Mine Rehabilitation in Ontario, Canada: Ten Years of Progress, The Government of Ontario.