CCE AWARD SUBMISSION

GIANT MINE REMEDIATION PROJECT
MINE SUPPORT SERVICES, PHASE 1

Golder Associates

PROJECT OUTLINE

Golder Associates Ltd. was retained by Public Works and Government Services Canada (PWGSC), on behalf of Aboriginal Affairs and Northern Development Canada (AANDC), to assist with the stabilization of underground openings at Giant Mine in Yellowknife, Northwest Territories (NWT). Remediation focused on backfilling to address risks to public and worker safety and the environment. Development of an economic backfill approach required innovative methods because of complex underground geometry, environmental conditions, arsenic contamination and related regulatory constraints.

Photo 1 - Giant Mine shaft

PROJECT HIGHLIGHTS

Innovation

Geotechnical hazard assessment at the closed Giant Mine (Photo 1) had yielded an unacceptably high risk profile rating for some underground voids. The failure of stope crown pillars would pose immediate physical hazards to the public, on-site workers and could lead to surface water infiltrating the underground. Over time, these events would jeopardize the current remediation plan, including the re-freezing of the arsenic trioxide vaults, and could contaminate Great Slave Lake.

Golder completed underground stability assessments and hazard analysis which led the team to prioritize which voids required stabilization (Photo 2). PWGSC approved the backfilling approach and tasked Golder with assisting to procure the required contractors to execute these plans. This was deemed emergency work to prevent surface water from entering the mine and needed to be completed on a strict timeline.

Photo 2 - Underground openings at Giant Mine to be backfilled with cemented paste tailings

The team developed underground mitigation approaches which involved borehole drilling, bulkhead construction and backfilling the stopes with cemented paste tailings. Investigative boreholes were successfully completed under a tight schedule that intersected openings as narrow as two metres in width and 140 metres in depth. Remote placement techniques and state of the art laser cavity scanning were used to gather inaccessible underground information to create 3D models (Photo 3) and two-dimensional level plans. This allowed the team to develop mitigation plans based on optimal positions for backfill delivery and containment barricades.

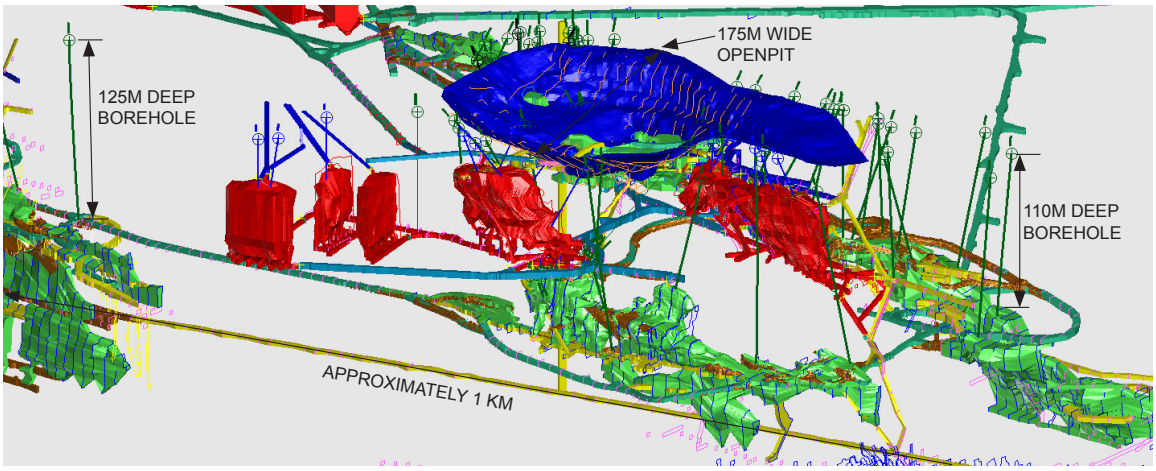

Photo 3 - Isometric view of three-dimentional digital mine model.

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Photo 4 - Cemented Paste Produced

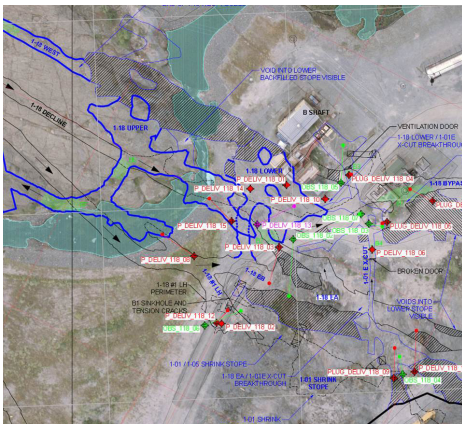

Photo 5 - Mine Plan Showing Complexity and Boreholes Required To Backfill Voids Under Baker Creek

Photo 6 - Underground Backfill Barricade

Photo 7 - Underground Breakthrough of 50 m Long Borehole With Steel Casing From Surface

Process design studies and laboratory testing were completed to assess the suitability of the on-site tailings to be used as a possible economic backfill feed material. Multiple paste mixes were developed including bulk void fill, remote barricade fill, and fill suitable for plugging leaks (Photo 4).

Development of detailed step-by-step work plans to deal with the complex underground mine geometry (Photo 5), regulatory commitments and the extreme cold involved unprecedented and unique flexibility and innovation. Construction of conventional and remotely-placed fill barricades (via boreholes drilled from the surface (Photo 6)), accurately-drilled paste delivery boreholes (Photo 7), and the installation of an infra-red camera system allowed for management and monitoring of the backfilling progress.

Backfilling began in October and ceased in mid-December with crews working in the extreme cold (temperatures ranged from -25 to -52 ^{o}C) and under artificial lighting platforms. Technical innovation in paste production and delivery included the use of mobile paste mixers, material blending, remotely-placed barricades and on-the-fly paste recipe changes to react to underground performance.

Complexity

Project complexities included:

- Variable tailings grain size and water content
- Silica and arsenic in the tailings
- Complex underground mine geometry and uncertainty in mine plans
- Limited safe underground access
- Surface space constraints
- Proximity of surface water (Baker Creek) in the remediation zone requiring stringent regulatory constraints
- Limited mine utilities and facilities
- Extreme cold

Producing paste backfill with an outdoor mobile system using highly variable frozen arsenic-laden tailings (Photo 8) at extremely cold temperatures had never been done before. Mine utilities were limited; the team adapted by implementing artificial lighting, heating water and equipment, erecting tents for monitoring and slump testing, and erecting indoor tailings storage facilities to raise tailings temperatures (Photo 9).

Limited underground access and incomplete mine plans led to uncertainty in the underground geometry. This uncertainty manifested itself as ‘leak points’ where paste migrated into unknown areas, requiring paste recipes and volumes to be adjusted on the fly, all while maintaining the schedule. This meant sequencing plans had to be developed for multiple options and had to include various ‘if-then-else’ scenarios so hot changes could be made.

Working within stringent regulatory constraints, the methodology undertaken required a high degree of trust from the client, an elevated level of technical awareness to changing conditions and exceptional communication between the project team's technical specialists from across Canada. The technical team (Photo 10) worked closely with the multiple contractors on site in a multi-disciplinary approach and counted on teamwork to overcome hurdles such as paste freezing in the pipeline in mid-pump stroke.

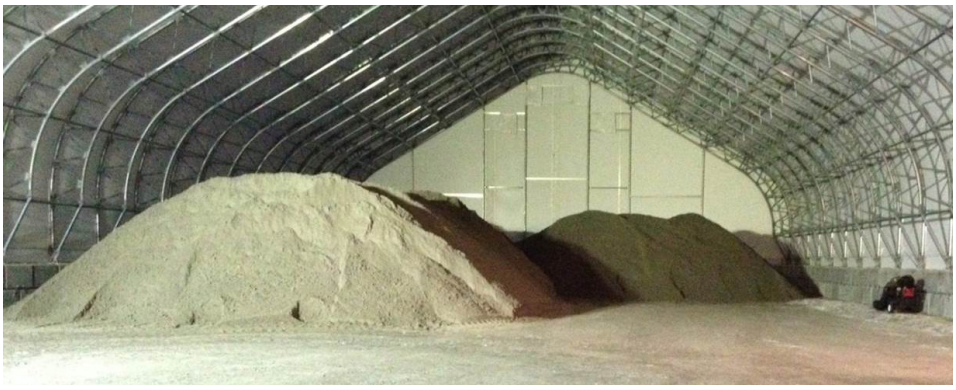

Photo 9 - Storage of Processed Tailings In Temporary Storage Building

Social and/or Economic Benefits

The Giant Mine Remediation project aims to clean up one of the most contaminated and highly public sites in Canada, with numerable social benefits being realized when the work is eventually completed.

Proving that local tailings material (Photo 11) present at the site can be used to stabilize underground openings that pose a risk to safety, and to current remediation plans, represents a large cost savings to the project. The lessons learned on this project will help reduce the $903 million liability attributed to the overall Giant Mine Remediation Project in the public accounts of the federal government.

Golder endeavoured to use local contractors, engineers and scientists to carry out the majority of the labour. Four NWT-based, and one Alberta-based contractor were chosen to carry out the work. They were aided by Golder personnel from our Yellowknife office who were involved in quality assurance and oversight work.

As part of our proposal to PWGSC to carry out the project, Golder committed to providing a monetary award for work done by Aboriginal people in an educational setting and to support local communities through Aboriginal training and apprenticeships. To this end, and together with the Mine Training Society, Golder established The Star of Excellence Safety Award, which aims to reinforce safety throughout mine sites in the North and elsewhere. The inaugural award, including $1000.00, was presented to Grace Blake as part of the Underground Miner Program, for being the top student in that particular session. This award will continue to be presented twice annually to the top student in the program.

Photo 8 - Existing Tailings Pond At Giant Mine

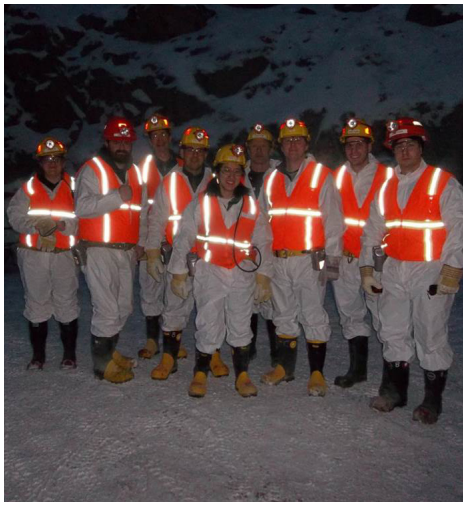

Photo 10 - Golder Engineering Team on Site at Giant Mine

Photo 11 - Stockpile of Processed Tailings for Paste Production

Environmental Benefits

Ongoing day-to-day management of the mine, (which is currently in a care and maintenance mode to keep it in regulatory compliance) includes dealing with risks to public and worker health and safety and keeping arsenic contaminants out of surface water. Backfilling of prioritized stopes, whose failure could lead to an upset of the regulatory compliance of the site, is seen as a major priority for the project.

The long-term goals of the Giant Mine Remediation project are to environmentally remediate the site to alleviate risks to public health and safety and to limit the requirement for ongoing care and maintenance and associated costs to the Government of Canada. This includes the long-term containment and management of arsenic trioxide waste, the demolition and removal of buildings and the remediation of all surface areas including the tailings ponds. Developing an economically efficient paste backfill program to stabilize all underground voids (whose failure could jeopardize the overall environmental remediation plan for the site and limit future end land uses when portions of the site are eventually turned over to the City of Yellowknife), are key to realizing the goals of the project.

The existing tailings ponds on the site will need to be covered and re- vegetated during the final stages of site remediation. Use of a portion of the tailings for backfilling underground voids will limit the requirements to remediate and reduce the environmental impact of these tailings in the post-closure period.

Photo 12 - Partially Backfilled Stope Void Under Baker Creek

Meeting Client's Needs

The client's overall objective for the Giant Remediation Project is to stabilize the underground and open pits in order to prevent further instability and possible collapse; safely decommission and demolish mine infrastructure and mitigate the potential for arsenic to cause damage to the environment.

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One particular stope complex (Photo 12) required immediate attention to reduce the potential for surface water to enter the mine and eventually contaminate Great Slave Lake (Photo 13) which would jeopardize the overall remediation plan.

This backfilling work was tendered as an emergency scope of work and Golder was able to accomplish this piece under an aggressive schedule. The ability to adapt to changing conditions and circumstances contributed to a successful project. The client's needs were met in the following ways:

- The project was delivered on time and on budget
- The project's technical, environmental and management risks were met through open communication and working cooperatively with the contractors on site
- The project was completed without any health and safety incidents
- The Golder team's commitment to their corporate values helped when dealing with technical and health and safety issues, which ended up benefitting the project
- The responsive and proactive approach to addressing changes and requests for information aided the client's ability to communicate with stakeholders
- The trusting relationship developed with the client was used to maximize the performance efficiency of the contractors on site

In addition to completion of the immediate emergency works, many lessons were learned that will be used to efficiently backfill other stopes that pose risks to the site.

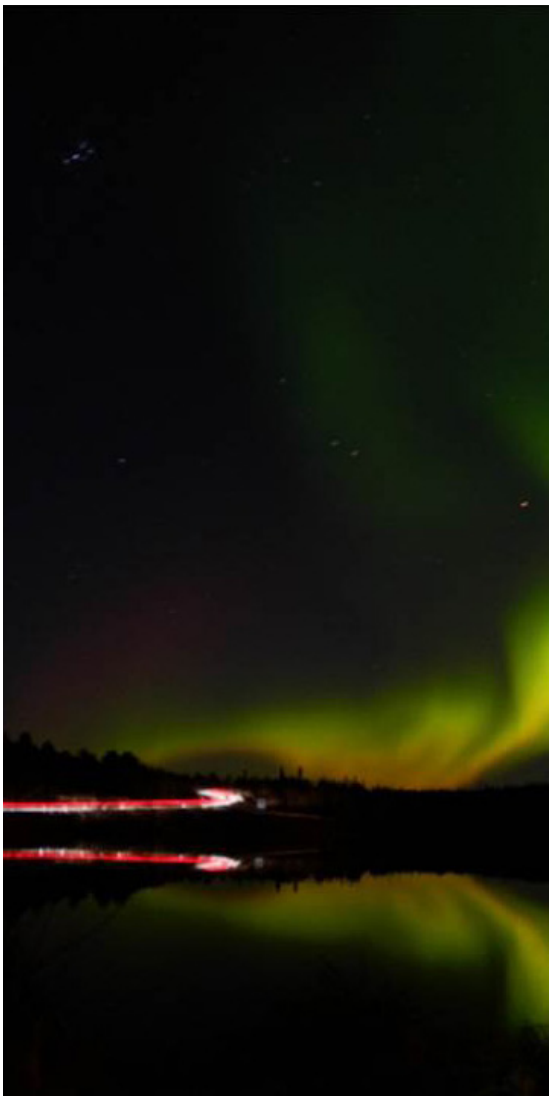
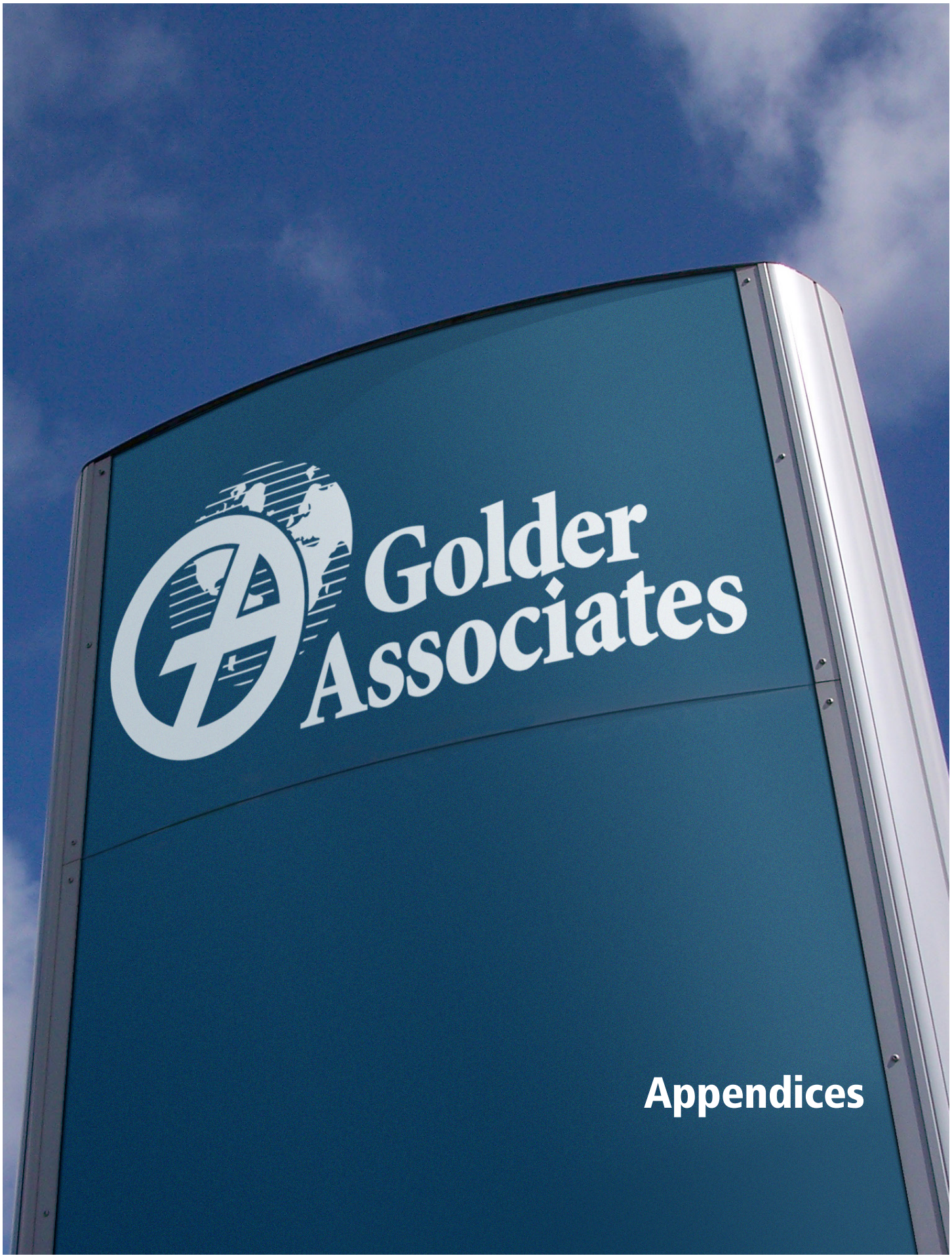


Photo 13 - Northern Lights over Great Slave Lake Adjacent to Contaminated Mine Site



Appendices