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GIANT MINE

Supplemental Borrow Source Identification Report

Submitted to:

Public Works and Government Services Canada
Giant Mine Remediation Team
ATB Place Tower North
5th Floor, 10025 Jasper Avenue
Edmonton, AB T5J 1S6

Attention: Ms. Jennifer Singbeil, Project Manager

REPORT

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Executive Summary

Public Works and Government Services Canada (PWGSC) retained Golder Associates Ltd. (Golder) to complete a supplemental borrow source identification at the Giant Mine. The scope of this work was to conduct a desk-based study updating previous borrow source studies with new and relevant information collected in the past years from ongoing works. The work was confined to borrow areas located within the current lease limits of the property.

For the purpose of this study, borrow materials have been divided into two categories:

- fine-grained materials which include silty-clay, clay, and fine sand
- coarse-grained materials which include crushed coarse-grained borrow (crushed 75 mm and 20 mm aggregate) and coarse rock

The possible sources of material have been grouped into two categories:

- **Defined Borrow Sources**—This refers to areas that have been specifically characterized as borrow sources through past investigations.
- **Potential Borrow Sources**—This refers to potential sources of borrow material that have been identified through the review of available background information as potentially viable, but would require further study to quantify.

A summary of the defined and potential borrow material is presented in the following table.

E1: Estimated Quantities of Defined and Potential Borrow Material

Borrow Material Type	Defined (m ³)	Potential (m ³)
Fine-grained	743,000	1,182,000 ^(a)
Coarse-grained	2,035,966	689,000 (Baker Creek Realignment Option A) ^(b)

- a) This total potential volume includes fine-grained material that would be made available if tailings are removed from the South and Central Ponds. If the tailings remain in place, the total potential fine-grained material would reduce to 45,000 m³.
- b) The potential coarse-grained material available may be more depending which Baker Creek realignment option is chosen. Three options have been defined (A, B, C, as shown on Figure 1). The potential coarse-grained volume would increase to 818,000 m³ for Option B and 1,433,000 m³ for Option C.

Development of borrow sources in the Northwest Territories requires the appropriate permits. Typically the key permit is a quarry permit. Based on the experience with the C1 Pit Buttress, a quarry permit is not required for on-lease borrow development, and all of the sources considered in this report are on-lease. Some of the identified sources of borrow material are excess material that would be generated through planned or possible site works, and all applicable permissions for the site works themselves would apply.

The estimated volumes shown are preliminary, and based on a desktop evaluation of existing data. Further field investigation will be required to confirm and refine these values. The potential values in particular should be taken with caution, as they are contingent on closure measures which may or may not take place.



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1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC) retained Golder Associates Ltd. (Golder) to carry out a supplemental borrow source identification desktop study. The Giant Mine is an abandoned open pit and underground mine located approximately 5 kilometers (km) north of Yellowknife, NT (referred to in the rest of this document as the Site). The purpose of the study was to identify potential borrow sources within the Giant Mine lease boundary that may be used for closure and reclamation works at the mine.

The scope of work consisted of:

- a desktop review of previously identified borrow sources
- the identification of potential borrow sources within the current lease boundary, based on updated information obtained since 2012 (the date of the most recent previous borrow source assessment)
- a brief summary of regulations and guidelines applicable to the development and closure of new borrow areas

For the purpose of this study, the physical characteristics of borrow materials have been grouped into two broad categories:

- fine-grained materials which include silty-clay, clay, and fine sand
- coarse-grained materials which include crushed coarse-grained borrow (crushed 75 mm and 20 mm aggregate) and coarse rock, as well as rock that would be generated by blasting

These categories reflected a functional division, related to the classes of materials that are needed for closure works, particularly the alternative tailings cover designs currently under consideration. The possible sources of material have been grouped into two categories:

- **Defined Borrow Sources**—This refers to areas that have been specifically characterized as borrow sources through past investigations.
- **Potential Borrow Sources**—This refers to sources of borrow material that have been identified through the review of available background information as potentially viable, but would require further study or design to quantify.

The reader is referred to the Study Limitations which follows the text and forms an integral part of this report.



2.0 INFORMATION SOURCES

The data sources used for the development of this study have been grouped into information developed between 2004 and 2012 (when the last characterization of borrow sources was completed), and supplementary information that can be interpreted from other reports prepared as part of investigations and studies completed after June 2012. Both information sources are described in more detail in the following sections.

2.1 Assessments from September 2004 to June 2012

Several assessments from September 2004 to June 2012 were carried out to identify potential borrow sources on the site. These studies were completed due to the need for borrow material of various characteristics for the closure activities planned at the Site. The findings of these investigations were most recently summarized in the *Borrow Source Assessment Preliminary Design Report* (Golder 2012b) (PDR). The PDR presented a strategy for identifying and developing soil and rock borrow sources at the Site. The PDR identified twelve fine-grained material borrow sources and six coarse-grained material borrow sources. The PDR included review and incorporation of information from the following reports:

- *Air Photo Interpretation of Potential Borrow Areas North of Giant Mine* (Golder 2004a)
- *Giant Mine Borrow Investigation* (Golder 2004b)
- *Summary of Potential Borrow Sources on Giant Mine Lease and in the Immediate Area* (SRK 2005a)
- *Giant Mine Remediation Plan: Tailings and Sludge Containment Areas* (SRK 2005b)
- *Borrow Source Sampling Data Report 2006* (SRK 2007b)
- *Giant Mine Quarry Options and Volumes* (SRK 2010)
- *Phase I – Borrow Investigation – Giant Mine Remediation Project* (Golder 2011)
- *Phase II – Borrow Site Investigation – Giant Mine Remediation Plan* (Golder 2012a)

Unlike the current study, the PDR included field investigation and characterization of potential borrow sources.

Lease Boundary

The availability of borrow source material as defined in the past studies has been affected by changes to the mine lease boundary between 2005 and 2012. The total area within the lease boundary has reduced, eliminating some potential borrow sources, tending to reduce the total amount of material available. There have been no official changes to the lease boundary since 2012, although there have been several proposed revisions. It is our understanding that none of these proposed revisions have been executed, and the boundaries remain unchanged since 2012. For the purpose of this study, Golder has used the most updated mine lease boundary provided by AECOM Canada Ltd. (AECOM) on 12 October 2016.



2.2 Assessments from June 2012 to October 2016

Several relevant Site assessments have been completed since the PDR was issued. While none of these studies included in their scope the quantification or identification of potential borrow sources, they have nevertheless improved the understanding of the Site, and have provided relevant information which has been reviewed as part of this study. The assessments reviewed were:

- *Preliminary Design Report Surface Water Drainage* (Golder 2012c)
- *Preliminary Design Report Baker Creek* (Golder 2012d)
- *C1 Pit Buttress Quarry Assessment report (AECOM 2015a) and issued for record drawings (AECOM 2015b)*
- *Assessment of Regional Soil Quality* (Golder 2016a)
- *Geotechnical and Environmental Investigation Factual Report – North, Central, and Sound Ponds* (Golder 2016b)
- *Road Ground Penetrating Radar (GPR) Investigation* (Golder 2016c)

In addition to the above assessments, the following changes have also occurred since the since the PDR was issued in June 2012:

- Highway No. 4 has been realigned starting from a location south of the mine site. The new route reconnects back onto the original alignment southeast of the Northwest Pond.
- The NW2 Area, located northeast of Northwest Pond, was identified as a fine-grained borrow source in Golder (2012b). Since June 2012, material from this borrow source has been used for ongoing mine closure operations, and the remaining amount of potential borrow from this source is unknown.
- A cover was placed at JoJo Lake. Material from a previously defined source at the hill South of Brock Pit (The Hill) was used.

Finally, there are several studies which are underway which have not been documented at the time of this report preparation. Where appropriate, relevant information from those studies, such as design options under development, have also been taken into consideration.



3.0 BORROW MATERIALS

This section summarizes the results of the desktop review, and includes updated estimates of quantities of defined borrow sources and new potential borrow sources. The previously identified borrow sources are summarized in Section 3.1 and new potential borrow sources are summarized in Section 3.2.

3.1 Defined Borrow Sources

The borrow sources defined in previous reports for fine-grained and coarse-grained material are summarized in Table 1 and Table 2, respectively. Each table includes the original estimate of the available volume at the identified source, and an updated estimate where newer information suggests that the value may have changed since June 2012. Additional comments are provided including a description of the location, references, and where available, previously estimated total arsenic concentration levels at borrow source areas. Figure 1 shows the location of the defined borrow source areas.

The defined borrow sources have been affected by the realignment of Highway No.4 and the development of the Brock Pit Quarry. The realignment and development of the quarry have reduced the available quantity of both fine-grained and coarse-grained borrow material available. Specifically, the realignment has affected material that was available in the borrow sources previously identified as “Clearing Area” and “B2 Area” (east of pocket lake, both shown on Figure 1), and the quarry has affected the previously identified “Brock Pit Area”.

Previously defined borrow sources at the areas designated NW2 (northeast of the Northwest Pond) and 3D (downstream of Dam 3D) are not included in this summary of defined borrow sources. They have been classified as “potential borrow sources” for motives that are discussed in Section 3.2 of this report.



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Table 1: Defined Fine-Grained Borrow Sources

Borrow Source	Previously Defined Fine-Grained Borrow Available (m ³)	Updated Estimate of Defined Fine-Grained Borrow Available (m ³)	Estimated Average Thickness, Based on Report Data (m)	Location Description	Referenced Quantities	Estimated Average Surface Measurement of Total Arsenic Levels in Area (µg/g)
Narrow Valley - Back Bay (BB)	53,000	53,000	1.1	A narrow valley parallel to Back Bay, beside the power line from the Bluefish Power Plant and south of Dam 7.	Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	236
North of A1 Pit (A1)	121,200	121,200	2.5	An area north of A1 Pit.	Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	2950
Hill South of Brock Pit (The Hill)	170,000	150,000	6.7	A hill south of the access road to Brock Pit and east of the access road to A1 Pit.	Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	NA
North of Brock Pit (Brock Pit)	41,700	33,800	1.2	A flat low lying area north of the Brock Pit.	Estimated volume based on previously estimated volume from Golder 2004b and area identified from Golder 2012b, while considering the area developed for the Brock Pit Quarry (AECOM 2015b).	NA
North of B2 Pit (B2)	19,500	14,000	0.4	An area north of the Brock Pit.	Volume has been reduced due to highway realignment. Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	6200
Clearing East of Pocket Lake (Clearing Area)	285,000	264,000	4.6	A Clearing Area east of Pocket Lake and south of the Vee Lake Road.	Volume has been reduced due to highway realignment. Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	1773
East of closed Propane Tank Storage Yard (ICG)	30,000	30,000	0.9	An area east of the propane tank storage yard below Dam 21B and Dam 21C. All tanks have been removed.	Previously estimated volume from Golder 2004b and area identified from Golder 2012b.	NA
Downstream of Dam 3D (3D)	108,000	For the purpose of this study this area is considered a potential borrow source since there is uncertainty as to the amount available within the lease boundary. Refer to Table 4.	NA	An area downstream of Dam 3D.	Previously estimated volume from Golder 2004b and area identified from Golder 2012b. There is uncertainty as to the amount of borrow material available within the lease boundary, and area has therefore been classified as potential borrow source. Refer to Table 4.	NA
Northeast of C1 Pit (C1)	6,000	6,000	1.0	An area north east of C1 Pit.	Previously estimated volume from Golder 2012a.	NA
NW1	66,000	66,000	2.5	Southwest of Northwest Pond.	Previously estimated volume from Golder 2012a and area identified from Golder 2012b.	NA
NW2	75,000	0	NA	An area northeast of Northwest Pond.	Previously estimated volume from Golder 2012a and area identified from Golder 2012b. Since June 2012, material from this borrow source has been used for ongoing mine closure operations, and the remaining amount of potential borrow from this source is unknown. This area is considered a potential borrow source. Refer to Table 4.	NA
SP1	5,000	5,000	0.6	South of South Pond.	Previously estimated volume from Golder 2012a and area identified from Golder 2012b.	NA
Fine-grained material from New Hwy. Construction	39,400	0	NA	Highway No. 4	Previously estimated volume from Golder 2012a and area identified from Golder 2012b. Works are now completed and there are no known stockpiles of excess material generated by the works.	NA
Total Estimated Volume of Defined Fine-Grained Soil Borrow	1,019,800	743,000				

Estimated average surface measurement of total arsenic levels in area referenced from *Assessment of Regional Soil Quality* (2016a).

NA = not applicable/no measurement; µg/g = microgram over gram.



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Table 2: Defined Coarse-Grained Borrow Sources

Borrow Source	Previously Defined Coarse-Grained Borrow Available ^(a) (m ³)	Updated Estimate of Defined Coarse-Grained Borrow Available ^(a) (m ³)	Location	Referenced Quantities
North Pond Spillway Area 1	1,020,000	1,020,000	Closure spillway designed to connect the North Pond to B3 Pit for dewatering of pond.	Construction of spillway to generate excess material that will be available as borrow. Volume estimated in SRK (2010). No change has been made to design assumptions in that report.
NWP 1	104,230	104,230	An area northeast of Northwest Pond.	Previously estimated volume from SRK 2010. For this study Golder has estimated an approximate area of 36,921 m ² which indicates an average depth of 2.8 m.
NWP 2	223,234	223,234	An area northeast of Northwest Pond.	Previously estimated volume and area identified from SRK 2010. For this study Golder has estimated an approximate area of 52,864 m ² which indicates an average depth of 4.8 m.
NWP 3	256,402	256,402	An area southwest of Northwest Pond.	Previously estimated volume and area identified from SRK 2010. For this study Golder has estimated an approximate area of 37,060 m ² which indicates an average depth of 5.0 m.
Brock Pit Quarry	246,635	186,600	An area northeast of the Brock Pit.	A previously estimated potential quarry volume of 164,423 m ³ (bank cubic meter) was identified in AECOM 2015a. This is approximately 246,600 m ³ if an extracted bulk volume void ratio of 0.5 is assumed. PWGSC have estimated that a bulk volume of approximately 60,000 m ³ was used from this quarry for the C1 buttress, which leaves approximately 186,600 m ³ .
Baker Creek Pond Quarry	116,500	116,500	An area east of Baker Pond	A previously estimated potential quarry volume of 77,700 m ³ (bank cubic meter) was identified in AECOM 2015a. This is approximately 116,500 m ³ if an extracted bulk volume void ratio of 0.5 is assumed. This quarry has not been developed.
Baker Creek Realignment	90,000	No decision has been made to realign Baker Creek and therefore this source is now considered a potential source. Currently 3 options are being evaluated. Refer to Table 4 for potential quantities.	An area south of Baker Pond.	Previously estimated volume from Golder 2012b. No decision has been made to realign Baker Creek and therefore this source is now considered a potential source. Currently 3 options are being evaluated. Refer to Table 4 for potential quantities.
Channels and ditches to be developed for general surface run-off	129,000	129,000	Previously designed channels and ditches located in various location on the Site.	Previously estimated volume from Golder 2012c. These channels are to be re-configured in detailed design stage. Based on preliminary understanding of design, it is anticipated that less material may be available in final design configuration.
Highway Rock Cut	19,325	0	Highway No. 4	Previously estimated volume from Golder 2012b. Based on previous proposed highway designs, an estimated volume was provided. Due to design changes, it is assumed that no material is available from this source.
Total Estimated Volume of Defined Coarse-Grained Soil Borrow	1,842,191	2,035,966		

a) Significant figures reflect information provided in original sources. Accuracy to this level is not implied.



3.2 Potential Borrow Sources

Potential borrow source were identified based on a review of all available site information, as listed in Section 2.0, incorporating studies completed after the PDR. The potential borrow sources are summarized in Table 3 and Table 4.

The designation “Potential Borrow Source” is applied considering that there is no confirmation of the type nor quantity of material that may be available at this source. All quantities shown are meant only to be indicative, and could vary significantly based on field investigations. Investigation of potential borrow sources will be needed before any estimates can be relied upon for planning purposes.

Each table includes volume estimates and a comment section that includes both a description of the potential borrow source, and highlights the key assumptions around that borrow source. All assumptions will need to be evaluated and confirmed or refined. The potential borrow areas identified were as follows:

South, Central, and North Ponds

Drilling studies carried out in 2016 by Golder have identified that a significant quantity of fine-grained natural soil underlies the tailings in the original three tailings storage ponds (South, Central, and North). The fine-grained material is made up of clay and silty-clay overlying bedrock. Detailed estimations of the total volume present in each pond are currently underway, but an initial estimate has been made for the purposes of this report.

The key limitation on the availability of this material for use in closure is that it would only be of use in closure options where tailings are completely removed from one or more of the ponds, and disposed of in an alternative location. Initial evaluation of such options is underway. If the tailings remain in place, then the underlying material will not be available.

North Pond Spillway

The construction of a spillway from the North pond would generate a significant amount of rockfill. The current proposed spillway alignment was defined in SRK (2010), and includes an initial route to B3 Pit for discharge of impacted water. Rockfill that would be generated by this initial route was captured in Table 2 as an identified borrow source. A potential additional source of rockfill is the later alignment that would be needed in the case of long term discharge of clean water to Baker Creek. This alignment is shown in Figure 1. The estimated volume shown in Table 4 for potential coarse-grained material is based on assumptions that will give a conservative (low) volume. More detailed design of the spillway alignment will improve the estimate of rockfill generation. The need for rockfill could be taken into account during the development of the final spillway alignment, and optimized to generate an important portion of the fill needed for closure works, both for the original alignment to B3 Pit and the later alignment to Baker.



Baker Creek

Various scenarios for the final configuration of Baker Creek are under consideration. Implementation of these scenarios could result in the generation of both fine-grained and coarse-grained material. The quantity of fine-grained material that could be generated has not been defined, however, preliminary estimates of coarse-grained materials for various scenarios have been developed, and are summarized in Table 4. The three options consider three different alignments, which are shown on Figure 1 as Option A, Option B, and Option C. These options are located to the immediate south of the B2 Pit.

Other Sources

The previous three sources have the potential to be the most significant additions to the current register of borrow sources. For the purpose of this study, other smaller sources have been identified based on knowledge of site, inspection of air photos and accessibility, and are included in Table 3 and Table 4. Conservative assumed depths have been used in the development of the volume estimates. These depths have been estimated considering exploitation schemes that would minimize impact on the landscape. Greater volumes may be available with greater excavation depths.

A portion of the area downstream of Dam 3D (3D), northeast of the North Pond was previously identified as a fine-grained material borrow source within the lease boundary in Golder (2004b). This conflicts with Golder (2012b) which indicates that the entire borrow source is outside the lease boundary. The borrow area within the lease boundary has been included in the present study as a potential borrow source, considering that while our current understanding is that a portion of this area lies within the lease boundary, there is some uncertainty. Therefore, the volume is now registered with the potential borrow sources in Table 3.

The available quantity of fine-grained material from the previously defined NW2 Area, located northeast of Northwest Pond, is unknown. This reflects the ongoing use of material from this borrow source since 2012. This area is now considered a potential borrow source with an unknown quantity of borrow. Therefore, this area has been included in the Table 3 summary (with a zero volume placeholder) until the quantity of borrow can be confirmed.



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Table 3: Potential Fine-Grained Borrow Sources

Borrow Source	Estimated Potential Fine-Grained Borrow Available (m ³)	Assumed Depth (m)	Key Assumptions
Roads	31,000	0.5	Assumed average depth of 1.1 m based on Golder 2016c, a road width of 4.5 m, and 25% of on-site roads will be used as borrow sources.
South Pond	422,000	NA	Data referenced from Golder 2016b.
Central Pond	695,000	NA	Data referenced from Golder 2016b. 7 holes drilled in the Central Pond, field interpretation data and Civil 3D modelling used to calculate volumes.
3D	12,000	0.5	An area Northwest of North Pond.
Potential Borrow Source 1	13,000	0.5	An area Northwest of Pocket Lake.
Potential Borrow Source 2	9,000	0.5	An area Southeast of Gar Lake.
NW2 Area	0	NA	Located northeast of Northwest Pond, was identified as a fine-grained borrow source in Golder (2012b). Known to have been depleted during activities since 2012, remaining volumes unknown. On-site investigation needed to confirm if there are viable reserves.
Total Estimated Volume of Potential Fine-Grained Soil Borrow	1,182,000		

Note: The fine-grained material under the North Pond has not been included in this summary table as relocation of the North Pond tailings is not considered a viable option at this point. For reference, the currently estimated volume of fine-grained material under the North Pond tailings is 1,863,000 m³.

NA = not available/no measurement.



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Table 4: Potential Coarse-Grained Borrow Sources

Borrow Source	Estimated Potential Coarse-Grained Borrow Available (m ³)	Assumed Depth (m)	Key Assumptions
Potential Borrow Source 3	113,000	2	An area West of B2 Pit, after the area is cleared of potential fine-grained material.
Potential Borrow Source 4	54,000	2	An area Southwest of Pocket Lake.
Potential Borrow Source 5	426,000	2	An area North of North Pond.
Proposed North Pond Spillway Route	4,000	NA	The spillway to divert clean water from the North Pond to Baker Pond. Assumed 5 m base width, depth of 1.5 m, and 2H:1V side slopes at a 1% grade. It may be possible to design the spillway such that additional coarse material may be sourced from it if required.
Baker Creek Realignment Option A	92,000	NA	The Baker Creek Spillway Option values are based on ongoing studies of re-alignment alternatives, and will be finalized at a later date. The material available is assumed all coarse-grained material. Each option has potential fine-grained material but quantities are unknown at present and will need to be confirmed.
Baker Creek Realignment Option B	221,000	NA	
Baker Creek Realignment Option C	836,000	NA	
Total Estimated Volume of Potential Coarse-Grained Soil Borrow (with Option A)	689,000		
Total Estimated Volume of Potential Coarse-Grained Soil Borrow (with Option B)	818,000		
Total Estimated Volume of Potential Coarse-Grained Soil Borrow (with Option C)	1,433,000		

NA = not available/no measurement.



4.0 PERMITS AND RECLAMATION GUIDELINES

Based on the experience with the C1 Pit Buttress, a Quarry permit is not required for on-lease borrow development, and all of the sources considered in this report are on-lease. The Government of the Northwest Territories only requires the submission of the planned area for borrow and the approximate amount of material that will be excavated or used. This information is kept on file, but no permit issued. Blasting permits and explosive handling certificates will be required by the contractor doing the work.

Some of the defined and potential borrow sources identified in this report reflect excess material generated through on-site closure activities, such as spillway construction or excavation and relocation of tailings. While applicable permissions/approvals for these activities will be required, these the generation of "borrow" material through these activities is not expected to be subject to any specific permit requirements.

Before development of a borrow source on a mine site, regulatory requirements usually include an approved Closure and Reclamation Plan (CRP) (INAC 2007). The Site Water License will establish guidelines for closure and reclamation, but the actual plan may need to be completed by the contractor who operates the quarry. The CRP would be based on the actual size and configuration of the quarry. A number of closure objectives should be considered for any developed borrow source. Table 5 summarizes closure objectives with some guidelines provided in the Northern Land Use Guidelines for Pits and Quarries (INAC 2009).

Table 5: Summary of Closure Objectives

Closure Objectives	Comments
Site cleanup	Materials and debris must all be removed. These include but not limited to garbage, machineries, fuel containers, unused soil piles.
Landscape reconstruction	Borrow source area must be stable. Loose material should be removed from pit walls and overhang at the top of the wall. Design landscapes to be compatible with future uses.
Drainage and erosion control	Drainage measures include: <ul style="list-style-type: none"> ■ Installing relief wells at toe of slope if necessary ■ Diverting runoff to the bottom of a slope through drainpipe or ditch (INAC 2009) ■ Installing horizontal drains as needed
Revegetation	CRP should consider natural vegetation over invasive plant species. And if seeding is required, native seed mixes are recommended.
End-pit lake	Design a CRP where surface water does not flood a pit and create a lake. This will lead to warming and subsidence of the ground (INAC 2009).
Reclamation monitoring	Site monitoring of borrow source area.

Source: The Northern Land Use Guidelines for Pits and Quarries (INAC 2009).



5.0 RECOMMENDATIONS

Based on the desktop review of previous assessments and recent investigations of fine and coarse-grained borrow sources, the following recommendations are presented for consideration:

- Based on the available information, the available extent of the defined fine-grained and coarse-grained material sources may have changed from previous calculations. Estimates have been made as to the magnitude of these changes, however field investigation will be necessary to confirm potential volumes. Any field investigation should include revisiting all previously defined borrow sites, to confirm their current conditions, and update as required. It is not uncommon for borrow sources to be exploited without clear documentation at mine sites, and all mention of defined borrow sources should take into account that it has been more than four years since locations were investigated in the field.
- The potential fine-grained and coarse-grained borrow sources identified should be investigated in the field, to estimate the quantities of borrow material available. Quantities presented in this report are preliminary only. Field investigations should include delineation of area and testing of depths for fine-grained materials. Detailed design may also require investigation of groundwater conditions, as some locations may require dewatering to exploit fully.
- For coarse-grained materials, the majority of the new quarries would require blasting to obtain the rock. A detailed quarry plan would be needed for each potential area to finalize the estimated volume. Greater depths than those considered in this evaluation may be possible, but this will carry with it potential impacts on the landscape.
- NW2 Area – the amount of fine-grained material available in this area has been assumed to be near zero, due to ongoing exploitation of fines from this area for various projects since 2012. However, the true remaining volume should be determined through a field investigation.
- There is uncertainty about how much of the borrow source downstream of Dam 3D is located within the lease boundaries. This should be clarified and the volume within the lease area confirmed.
- Total arsenic concentrations, where shown, are adapted from a separate report (Golder 2016a), and are indicative only. If necessary for the planned material use, detailed characterization of arsenic concentrations, including depth profiles in one or more locations within the borrow source, should be considered.
- In developing plans that could generate coarse-grained material (such as blast rock) as a by-product, consideration to material needs should be given. It may be possible to optimize designs to maximize the excess rock production, helping to minimize the needs for specific quarries. Note that the effective implementation of this would require an integrated design approach, as maximizing excess rock production would not normally be considered a design criteria. Further, the overall staging of the project should be taken into consideration, such that the excess material is generated when needed, and that (ideally) it can be transported directly to where it is needed to minimize double-handling and stockpiling. The areas where this is most applicable include spillway design for the North Pond, and Baker Creek realignment works.
- The permitting needs should be evaluated and updated as part of design, to ensure that any changes in regulations are captured.



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- Closure and reclamation plans should be prepared for borrow sources prior to exploitation. The Site Water License will establish guidelines for closure and reclamation, but the actual plan may need to be completed by contractor who operates the quarry. The plan would be based on the actual size and configuration of the quarry.
- This draft report should be updated with the results of other studies that are currently under development. In particular, the estimated quantity of fine-grained material available under the South and Central Ponds should be updated once the corresponding study has been completed.



6.0 CLOSURE

The reader is referred to the Study Limitations, which follows the text and forms an integral part of this report.

We trust the above meets your present requirements. If you have any questions or requirements, please contact the undersigned.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Malcolm Shang, BSc Eng
Geotechnical Specialist

MS/BW/JAH/rs

ORIGINAL SIGNED

Bjorn Weeks, PhD., P.Eng. (NWT/NU, BC, MB)
Principal, Senior Geo-environmental Engineer

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PRELIMINARY
 NOT FOR CONSTRUCTION



0	ISSUED FOR INFORMATION	16/FEB/17
Revision/Revision	Description/Description	Date/Date

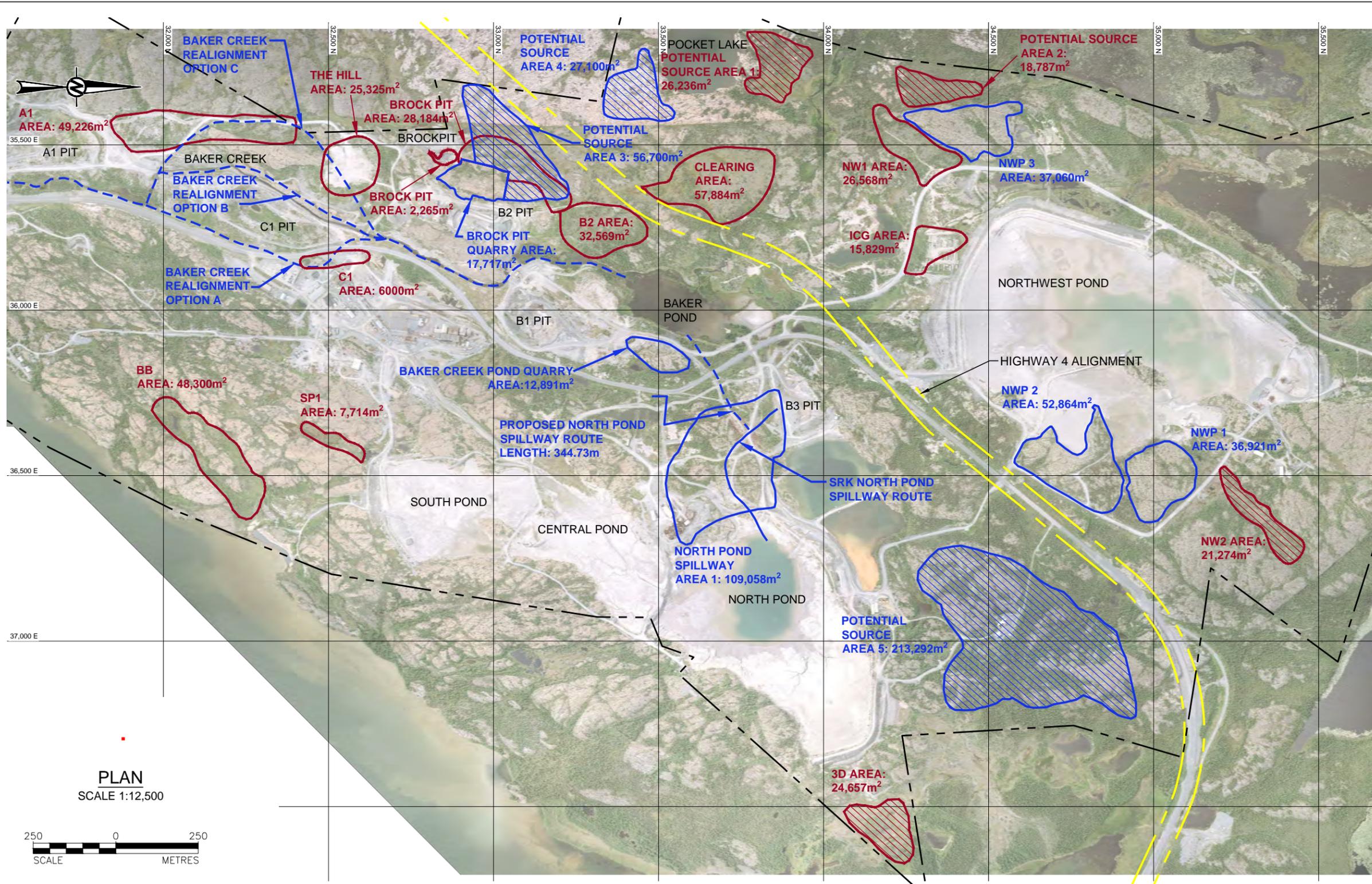
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

Project title/Titre du projet
GIANT MINE REMEDIATION PROJECT
 YELLOWKNIFE, N.W.T.
POTENTIAL BORROW SOURCES

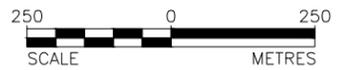
Approved by/Approve par
 BW
 Designed by/Concept par
 MS
 Drawn by/Dessine par
 MSH
 PWGSC Project Manager/Administrateur de Projets TPSGC
 JENNIFER SINGBEIL
 PWGSC, Architectural and Engineering Resources Manager/
 Ressources Architectural et de Directeur d'Ingénierie, TPSGC

Client/client
 PWGSC
 Drawing title/Titre du dessin
DEFINED AND POTENTIAL BORROW SOURCES

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
13-1377-0115	1	0



PLAN
 SCALE 1:12,500



- LEGEND**
- DEFINED FINE-GRAINED BORROW SOURCE SITES
 - DEFINED COARSE-GRAINED BORROW SOURCE SITES
 - POTENTIAL FINE-GRAINED BORROW SOURCE SITES
 - POTENTIAL COARSE-GRAINED BORROW SOURCE SITES
 - POTENTIAL COARSE-GRAINED BORROW SOURCE SITES
 - HIGHWAY 4 ALIGNMENT

- NOTES**
- TOPOGRAPHIC CONTOURS SHOWN ARE IN METRES TO GMRP DATUM AT 2.5m INTERVALS.
 - COORDINATES SHOWN ARE IN METRES GMRP GRID.

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 - AECOM CANADA LTD. LEASE BOUNDARY, CAD FILE: GIANT MINE - LEASE BOUNDARY.dwg RECEIVED ON OCT 12 2016.

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

solutions@golder.com
www.golder.com

Golder Associates Ltd.
Suite 200 - 2920 Virtual Way
Vancouver, BC, V5M 0C4
Canada
T: +1 (604) 296 4200

