Appendix A

2006 Bathymetry (Golder Associates)

Golder Associates Ltd.

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REPORT ON

BATHYMETRIC SURVEYS
HOPE BAY PROJECT
HOPE BAY, NUNAVUT

Submitted to:

SRK Consulting Canada Inc.
#800, 1066 West Hastings Street
Vancouver, BC
V6E 3X2

DISTRIBUTION:

6 Copies - SRK Consulting Canada Inc.
2 Copies - Golder Associates Ltd.

October 20, 2006 06-1419-007

EXECUTIVE SUMMARY

Golder Associates Ltd. (Golder) was retained by SRK Consulting Canada Inc. (SRK) to conduct bathymetric surveys for the proposed development of the Hope Bay Gold Project. This report is carried out in accordance with our proposal 06-1419-007, dated March 7, 2006. The field investigations were completed during a period extending from July 31 to August 29, 2006.

The objective of the site investigation was to provide single-beam bathymetric data on selected lakes in the area of the Hope Bay Project. Low-density bathymetric coverage was required on Doris, Windy, Patch, and Spyder Lakes and high-density coverage was required in Tail Lake, two areas of Roberts Bay, and approximately one-third of each of Windy, Patch and Spyder Lakes.

In particular, high-density information is required at specific areas of various lakes to aid the design of docking facilities, volume calculations and general mine design. The detailed bathymetric data can also provide a visual aid for the evaluation of potential faults and possible sediment flows. To complete this work single-beam bathymetry with real-time sub-metre positioning was used. In addition, low-resolution sidescan sonar imaging was observed during bathymetric fieldwork on selected lines for qualitative evaluation that the chosen density coverage was sufficient to map the terrain.

The bathymetry data provided good resolution of subsurface features. All of the lakes presented a non-uniform topography similar to surface topography in the areas. Many lineaments, including probable bedrock ridges are seen to extend into the lakes.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by SRK Consulting Canada Inc. (SRK) to conduct bathymetric surveys for the proposed development of the Hope Bay Gold Project. This report presents the results from these investigations.

The objective of the site investigation was to provide single-beam bathymetric data on selected lakes in the area of the Hope Bay Project. Low-density bathymetric coverage was required on Doris, Windy, Patch, and Spyder Lakes and high-density coverage was required in Tail Lake, two areas of Roberts Bay, and approximately one-third of each of Windy, Patch and Spyder Lakes.

In particular, high-density information is required at specific areas of various lakes to aid the design of docking facilities, volume calculations and general mine design. The detailed bathymetric data can also provide a visual aid for the evaluation of potential faults and possible sediment flows.

2.0 SCOPE OF WORK

The proposed scope of work was as follows:

- General bathymetry of Doris, Windy, Patch and Spyder Lakes at 50-m line spacing;
- Detailed bathymetry (10-m line spacing) of approximately one-third of the survey areas of Windy, Patch and Spyder Lakes;
- Detailed bathymetry of Tail Lake;
- Detailed bathymetry of two areas within Roberts Bay;
- Global positioning system (GPS) positioning with 1-m to 2-m accuracy presented in NAD83 datum; and
- Preparation of bathymetric drawings based on supplied AutoCAD base maps.

In consultation with SRK, (the prime consultant to Miramar Hope Bay Ltd. for the mine design) the following techniques were selected to achieve the stated objectives in the survey area:

- Single-beam echo sounding;
- Low-resolution sidescan sonar to evaluate density coverage; and
- Real-time differential navigation utilizing the Canadian Differential Global Positioning System (CDGPS) with tide monitoring and tie-in to locally provided reference locations.

3.0 INSTRUMENTATION AND FIELD OPERATIONS

The surveys were carried out using a winterized Zodiac inflatable boat powered by a 15-horsepower outboard motor supplied by Miramar Hope Bay Ltd. This provided a lightweight boat that was moveable by helicopter and also provided relatively rapid surveying and good access and maneuverability to the frequent shallow areas encountered during the surveys.

The work was completed during the period July 31 to August 29, 2006. The sea state was generally good during data collection. As the survey progressed, the weather conditions deteriorated. In all, there were three days with no data collection due to adverse weather conditions affecting GPS quality, bathymetry accuracy (due to wave height) and safety. On these days, data processing and equipment maintenance was undertaken. The geophysical instruments and navigation system all operated within specification throughout the course of the entire survey. No reportable health and safety incidents occurred during the fieldwork.

The vessel position was acquired with a single-frequency code-based Trimble DGPS (Ag132) which in good GPS conditions can be accurate to approximately +/-0.5 m (see Section 3.2).

The bathymetry was measured using an ODOM® Hydrotrac Survey Echo Sounder with a 200-kHz transducer. This provided high-resolution bottom detection at a rate of 10 Hz. Velocity calibrations were completed at each of the lakes for accurate determination of sound velocity in water.

To ensure good coverage of lake-bottom features, especially for 50-m line spacing, we operated a low-resolution sidescan sonar during data collection. The sidescan sonar provides qualitative images (seismically) of bottom topographical variations to indicate whether additional bathymetric coverage should be completed.

The sidescan sonar was recorded using an Imagenex digital dual sidescan sonar (SportsScan). The SportScan utilizes two transducers of 330 kHz to provide a low resolution image of the lake bottom up to 60 m from the sensor in each direction. The data was recorded in conjunction with the GPS stream from the Ag 132 using the Imagenex software, Win881SS. The sonar was braced to the side of the boat at a depth of 1.2 m.

3.1 Survey Coverage

The boundaries of the survey were outlined and SRK requested coverage of all the selected lakes at a minimum of 50-m intervals. This line spacing ensured adequate

coverage for volume calculations and identification of any unusual topographical features on the lake floors. Higher density areas were required in the following areas:

- the northern half of Patch Lake;
- the southern third of Windy Lake;
- all of Tail Lake and both Roberts Bay areas; and
- the western half of the Spyder Lake survey area.

Sidescan sonar data were obtained at Roberts Bay, Windy, Patch, and Tail Lakes. The survey lines were profiled on multiple traverses to provide a good overview of the lakebed features. Due to time constraints and adverse weather conditions, no sidescan data were obtained on Doris and Spyder Lakes.

3.2 Navigation

Positioning of the survey vessel and the sonar equipment was provided by Trimble Differential Global Positioning System (DGPS) receivers. Real-time corrections were obtained using industry-standard Canadian Differential GPS (CDGPS) corrections, and Wide-Area Augmentation System (WAAS) system as a backup. Vessel navigation data were acquired with a single-frequency code-based Trimble DGPS (Ag132) accurate to approximately +/-0.5 m. The navigation GPS antenna was installed directly above the bathymetry transducer to minimize offset errors. The onboard receiver provided differentially corrected WGS84 latitude and longitude values at 5 Hz to both the navigation computer and SportScan sonar.

Hypack Max software produced by Coastal Oceanographics was used for navigation. During the survey, the vessel position was continuously plotted on a chart showing the planned and actual survey lines. This information was displayed to the helmsman on a LCD monitor along with additional navigation parameters. The vessel position and single-beam bathymetric data were acquired digitally and stored on the navigation computer. Fix marks were recorded at 60-second intervals.

3.3 Datum and Tidal Corrections

At each of the sites, a stake was driven into the lake and water levels were recorded daily. Each of the stakes was surveyed by the on-site surveyor to the Miramar Hope Bay datum. All horizontal positioning was recorded internally as latitude and longitude using the WGS84 datum, then displayed as UTM Zone 13 coordinates using the NAD83 datum. All coordinates given in this report use the NAD83 datum, and UTM coordinates are plotted on the relevant deliverable figures.

Tidal corrections were obtained at Roberts Bay by observations of water levels noted on a wooden tidal post, placed in a sheltered cove at Area A. Our tidal measurements have confirmed that predicted tides from Canadian Hydrographic Service (CHS) models have similar phases and peak values to predicted tides. To convert the observed water level readings to the mine datum, the tidal post was surveyed in by Miramar Hope Bay surveyors.

4.0 RESULTS AND INTERPRETATION

This section summarizes the results of the bathymetric surveys. The data coverage and the interpreted bathymetry data are presented in Figures 2 to 8, in combination with the land topography. The water depths are contoured to 1-m intervals and blue-shaded to enhance visualization. The actual survey tracklines are presented on Figures 9 through 15. All figures are provided in electronic format on CD and were provided on an FTP site for downloading. The bathymetric data are also provided on CDs contained in each hardcopy report.

4.1 Positioning

Due to continued excellent satellite coverage, the Trimble DGPS positioning equipment provided high quality location fixes continuously throughout the surveys.

Real-time CDGPS corrections provided differential correction during most of the survey. Occasional loss of this differential signal occurred during the survey, due to rough water conditions or blocking of the satellite signal behind nearby topographical highs. During these periods, the system was set to utilize the WAAS corrections which still provided sub-metre differential corrections.

In post-processing, the navigation data are automatically filtered for any non-differential, high Horizontal Dilution of Precision (HDOP), or anomalous GPS data. This occurred in rare cases but not for any long time periods. When weather conditions were too rough to reliably gain a differential fix, a standby day was required.

The position in NAD83 coordinates and water elevation (at the time of surveying) of each of the survey stakes as provided by Miramar Hope Bay Ltd. are summarized below:

Survey Area	Easting	Northing	Elevation (m)
Patch	433893.3	7552217.8	26.28
Windy	432569.5	7550525.0	18.24
Doris	433800.0	7559050.0	21.42
Roberts Bay	432221.7	7563305.5	temporary mark = 0.92 m
Spyder	441135.5	7505824.0	65.63
Tail	435263.0	7557635.5	28.12

To record the tidal fluctuations at Roberts Bay, a stake was placed in the shallows at the coordinates mentioned above. A temporary depth scale was drawn on the stake and referenced each hour whilst surveying. The surveyors then calculated a true elevation for the temporary scale marked on the stake. True tidal elevations were calculated using the corrected information.

4.2 Bathymetric Results

The single-beam bathymetric data were of high quality and provide reliable depth data for the required lakes and ocean areas. The data have been combined, filtered, and contoured using AutoCAD and Surfer by Golden software.

The bathymetric results are presented in Figures 2 to 8 and have been provided in electronic format to SRK for incorporation into engineering drawings. For interpretation and planning purposes, we have also combined the bathymetric data with land topographical data that were provided by Miramar Hope Bay Ltd. through SRK.

Post-processing of the data included tidal corrections, removal of outliers and erroneous GPS positions.

4.2.1 Roberts Bay

The two areas within Roberts Bay were surveyed over two days during extremely calm weather, which provided reliable data and consistent tidal matches between days. Area A bathymetry data (Figure 2) indicate that water depths gradually increase to more than 7 m at the mouth of the cove. A shallow gradient shelf extends from shoreline to approximately 100 m into the cove. The water depths deepen rapidly from 3 m to 6 m at the edge of this shelf. The eastern side of Area A indicates a very shallow area which limited surveying due to insufficient draft for boat operation.

The data from Area B (Figure 3) shows the sea floor topography to be consistent with the shoreline trend. The near-shore area is characterized by shallow gradients. At 3 m depth, the gradient increases and depths increase to beyond 13 m at the edge of the survey area. Both areas within Roberts Bay were surveyed in a grid with a 20-m line spacing.

4.2.2 Doris Lake

The Doris Lake data (Figure 4) indicate water depths ranging up to 20 m. Notable features are a steep cliff at shoreline on the eastern shore of the lake which deepens to more than 16 m within a few metres from shore. The southern third of the lake is characterized by a relatively flat, shallow lake bottom, with depths not in excess of 6 m. Doris lake was surveyed at 50-m line spacing.

4.2.3 Tail Lake

Tail Lake (Figure 5) was surveyed at 10-m line spacing and indicates water depths of up to 7 m. Two north-south channels are present in the centre of the lake which are both approximately 1.5 m deeper than the surrounding area.

4.2.4 Windy Lake

The Windy Lake data (Figure 6) indicates water depths in excess of 22 m at a deep bowl located in the area of 431400E, 7553900N. An isolated shallow ridge occurs in the centre of Windy Lake with depths slightly less than 5 m encountered. The southern third of the lake was surveyed at 10-m line spacing, and indicates a gradual shoaling of water depth to the south with no major anomalies.

4.2.5 Patch Lake

The Patch Lake data (Figure 7) indicate a shallow lake of approximately 5 m in depth with three significant deep bowls of up to 16 m in depth. These depressions are indicated by the darker colours on the contour plan. The northern half of Patch Lake was surveyed at 10-m line spacing which delineated a number of smaller features such as a steep cliff down to 6 m in depth, located at 434500E, 7550800N.

A smaller lake (centered on 433700E, 7551400N) was attempted on three separate occasions. However, no GPS lock could be gained, due to the large cliff on the southwest shoreline obstructing the view of the satellites. This effect was also noticed in the northernmost area of Patch Lake where CDGPS correction could not be gained and the WAAS system was exclusively used. The depths observed in the small lake were all less than 4 m and a shallow area of under 1 m in depth occurs at the northeastern shore. Unfortunately due to lack of GPS signal, we did not record any data at this lake.

4.2.6 Spyder Lake

The Spyder Lake data shown on Figure 8 indicate water depths up to 19 m. The western half of the survey area reveals a deep, irregular channel which was surveyed with a line spacing of 25 m to provide extra delineation of the features. The eastern half of the survey area is generally flat with water depths of less than 5 m. Due to extremely low water conditions at the time of surveying, a few areas were too shallow and could not be surveyed. This includes; south of 7503300N and the small inlet near camp, centered at 441600E, 7505600N. A shallow reef is present at 440600E, 7505700N which broke the surface at the time of surveying and may also present a hazard to boats during times of higher water levels.

5.0 DISCUSSION AND SUMMARY OF INTERPRETED RESULTS

The bathymetry data provides accurate resolution of the underwater topography, especially in the high-resolution areas where 10-m line spacing was undertaken. The GPS data was consistently within sub-metre accuracy and multiple velocity calibrations were completed at each site to ensure using accurate sound velocity values.

Low-resolution sidescan sonar was conducted whilst surveying to help identify any major anomalies or highly variable lake bottom, that would require additional survey lines. This data was reviewed at the end of each day to ensure adequate coverage at the time of surveying. In general, this data presented few reflectors and anomalies in the centre of the lakes and significant boulders in near-shore areas.

All of the surveying was undertaken during a particularly dry summer which produced low water levels, especially in the case of Spyder Lake. We note that Spyder Lake at the time of surveying had an elevation of 65.63 m (approximately 1.5 m lower than springtime water levels) which resulted in many drill casings being partially exposed creating a safety hazard. The low water levels created problems entering certain bays (Figure 8) and also slowed survey progress due to frequent shallows. If more detail is required in these areas, it is recommended to conduct extra bathymetry during the high-water levels in the springtime or alternatively conduct an over-ice program, utilizing ground-penetrating radar.

In general, the strike and shape of the lake bottom topography reflects lineaments present on land, which may aid visual interpretation of faults and possible landslides.

No specific sediment or rock information can be gained from the bathymetry data. However, shape and gradient of slope may be useful in identifying areas of possible bedrock exposure. In all of the shallow areas encountered during the survey where bottom characteristics could be viewed by field personnel, the lake bottom consisted of soft silts interspersed with medium-sized boulders.

6.0 CLOSURE

This report has been prepared based on the information obtained for the purposes outlined above.

We trust that this report meets your immediate requirements. Please contact the undersigned should you have any questions or concerns.

GOLDER ASSOCIATES LTD.

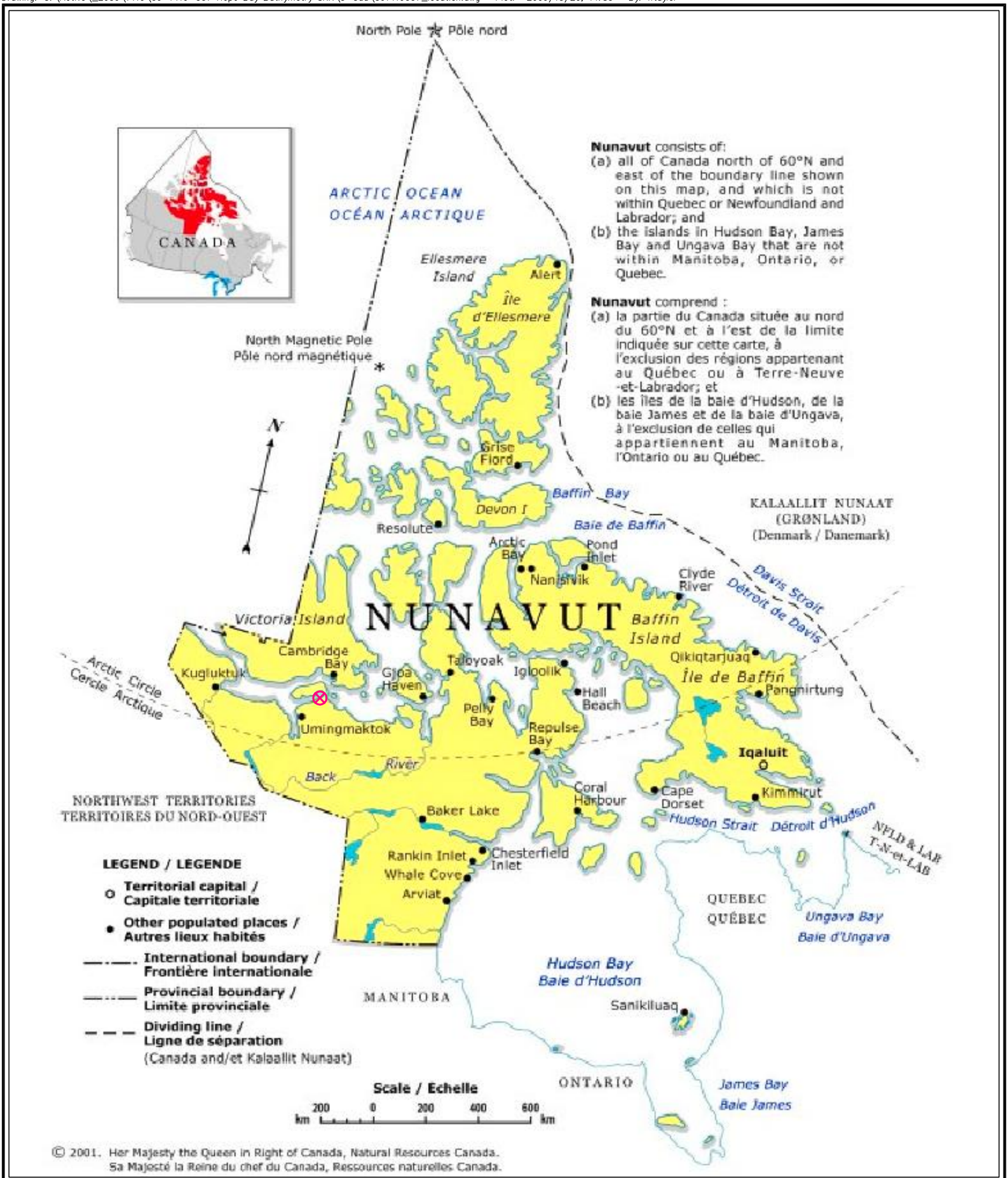
ORIGINAL SIGNED BY

John Woods, E.I.T.
Geophysicist

ORIGINAL SIGNED BY

Michael Maxwell, Ph.D.
Senior Geophysicist, Principal

JKW/MGM/vee
06-1419-007
N:\FINAL\2006\1419\06-1419-007\RPT1020_06 - SRK - HOPE BAY BATHYMETRY.DOC



Nunavut consists of:
(a) all of Canada north of 60°N and east of the boundary line shown on this map, and which is not within Quebec or Newfoundland and Labrador; and
(b) the islands in Hudson Bay, James Bay and Ungava Bay that are not within Manitoba, Ontario, or Quebec.

Nunavut comprend :
(a) la partie du Canada située au nord du 60°N et à l'est de la limite indiquée sur cette carte, à l'exclusion des régions appartenant au Québec ou à Terre-Neuve-et-Labrador; et
(b) les îles de la baie d'Hudson, de la baie James et de la baie d'Ungava, à l'exclusion de celles qui appartiennent au Manitoba, l'Ontario ou au Québec.

Reference:
Location image provided by SRK.

Legend:
⊗ Survey Area Location

Golder Associates

TITLE
SITE LOCATION PLAN

PROJECT
SRK
Hope Bay, NT

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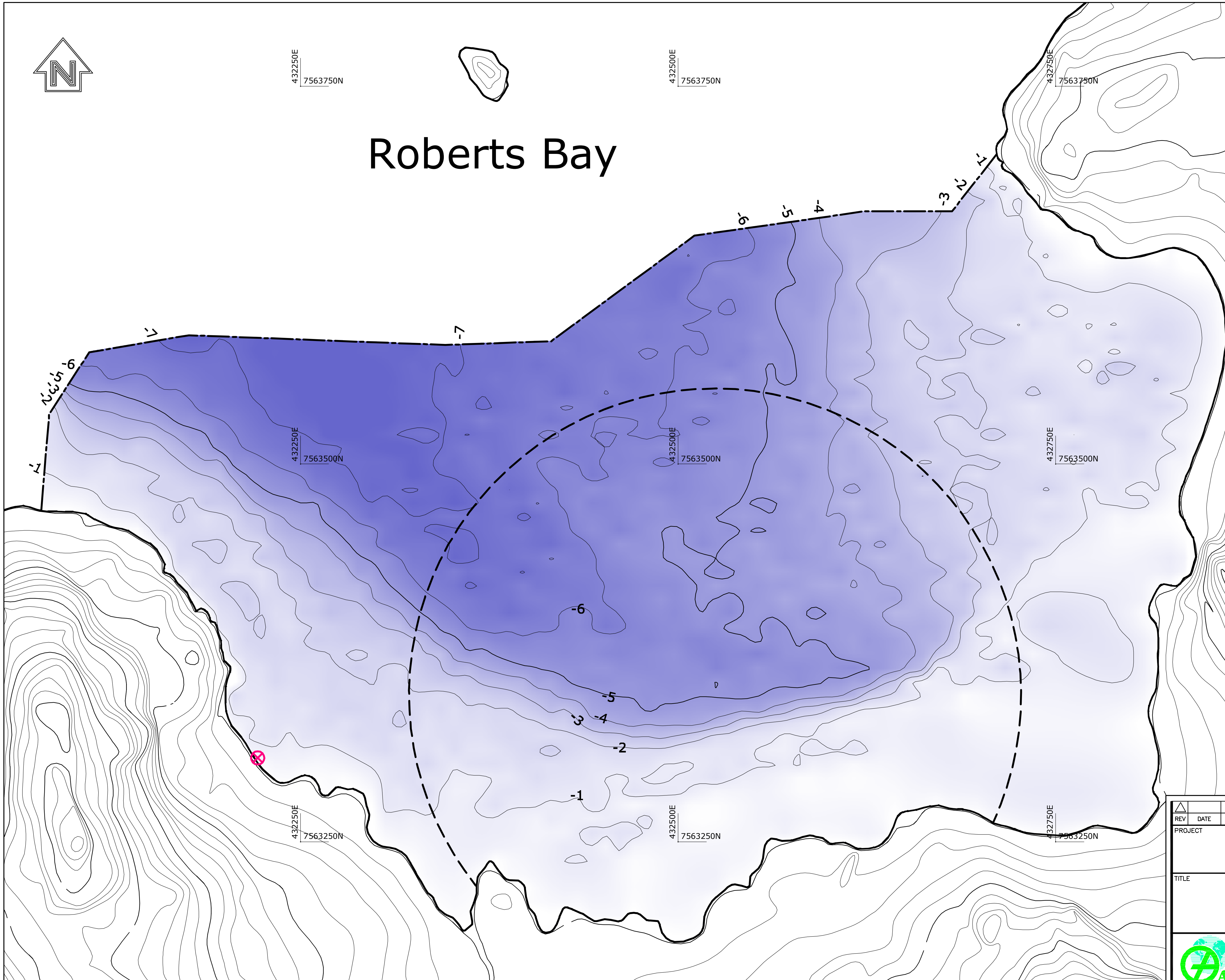
CHECK JW 20061019	
REVIEW MM 20061019	

Figure 1



Reference:
Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

Legend:

- Sea-bed Contour, Major
- Sea-bed Contour, Minor
- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:

1. Sea-bed contours are at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 1m.
4. Roberts Bay shoreline is shown at -0.05m elevation in topographic base map.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
SRK
Hope Bay, NT

TITLE
ROBERTS BAY, AREA A
SEA-BED ELEVATIONS

Golder Associates

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CHECK	JW 20061004		
REVIEW	MM 20061004		

Figure 2

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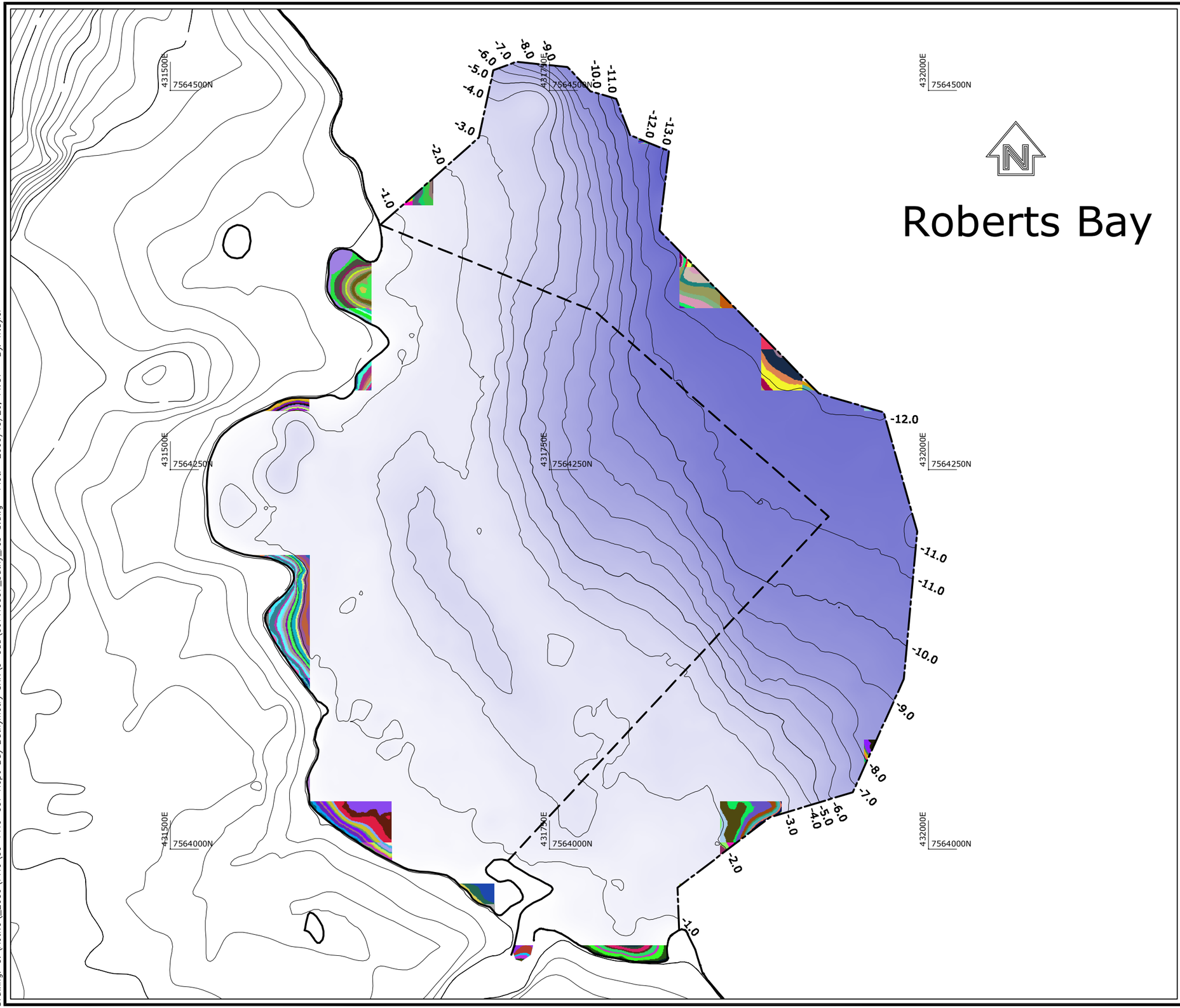

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

Legend:

- Sea-bed Contour, Major
- Sea-bed Contour, Minor
- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:

1. Sea-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 1m.
4. Roberts Bay shoreline is shown at -0.05m elevation in topographic base map.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

ROBERTS BAY, AREA B
SEA-BED ELEVATIONS

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_bathy_rob-b	
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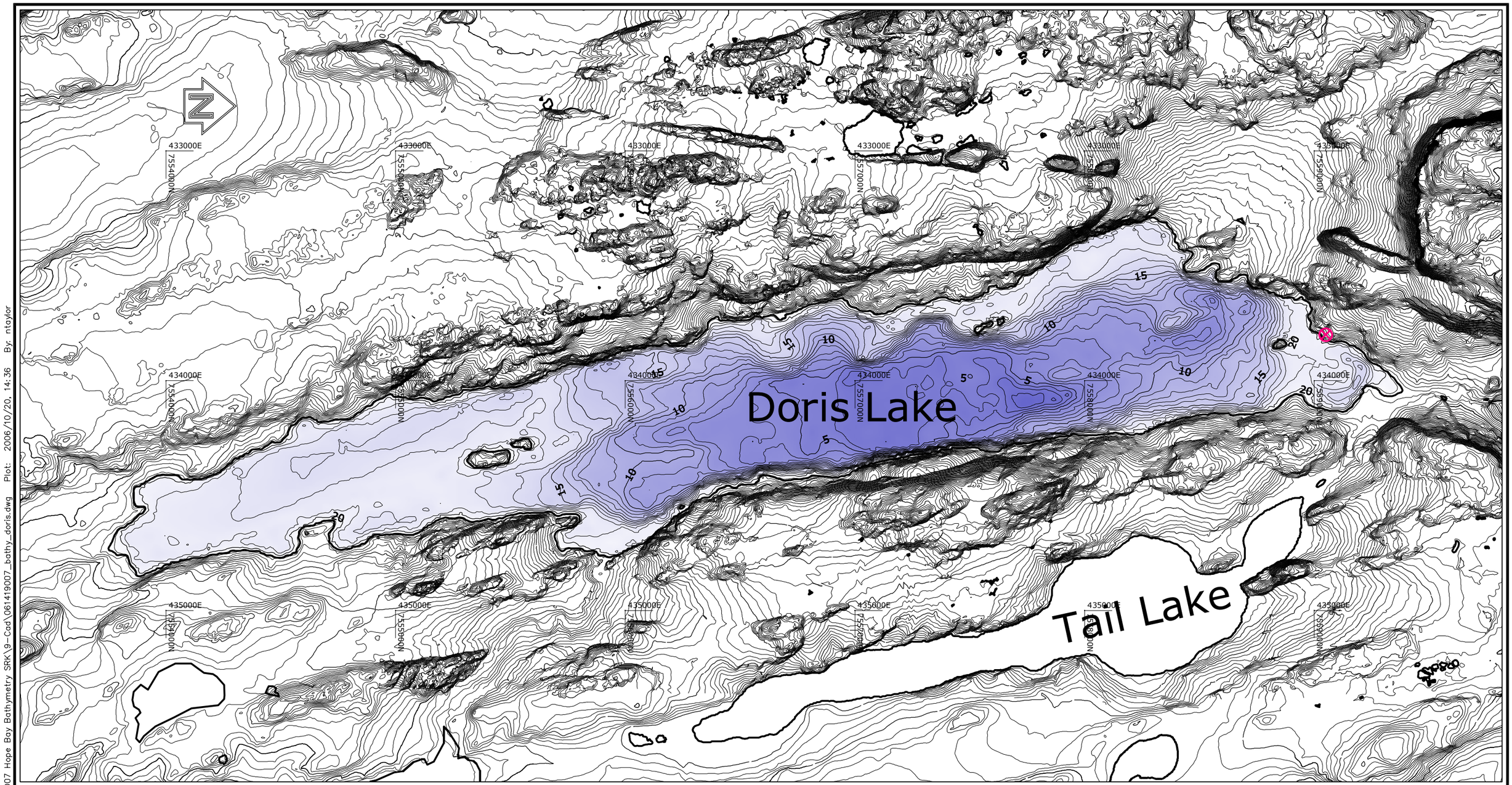

Legend:

- Lake-bed Contour, Major
- Lake-bed Contour, Minor
- Shoreline
- Survey Stake

Note:

1. Lake-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 1m and 2m.
4. Doris Lake shoreline at +21.42m elevation geodetic interpolated from topography and survey data.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

DORIS LAKE
LAKE-BED ELEVATIONS

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_bathy_doris		
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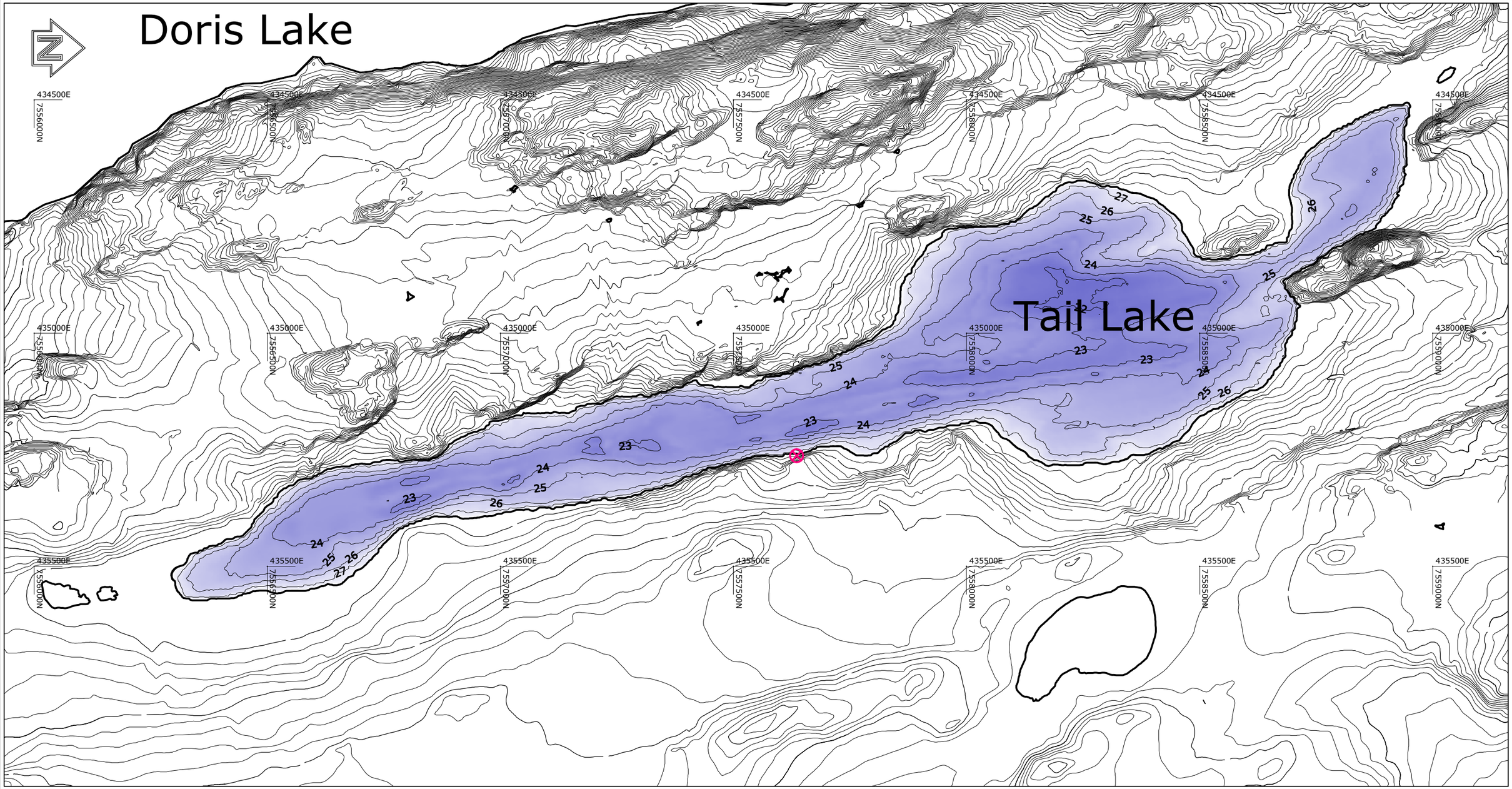
Doris Lake

Tail Lake



Legend:

- Lake-bed Contour, Major
- Lake-bed Contour, Minor
- Shoreline
- Survey Stake

Note:

1. Lake-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 1m and 2m.
4. Tail Lake shoreline at +28.12m elevation geodetic interpolated from topography and survey data.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
△						

PROJECT

SRK
Hope Bay, NT

TITLE

TAIL LAKE
LAKE-BED ELEVATIONS

Golder Associates

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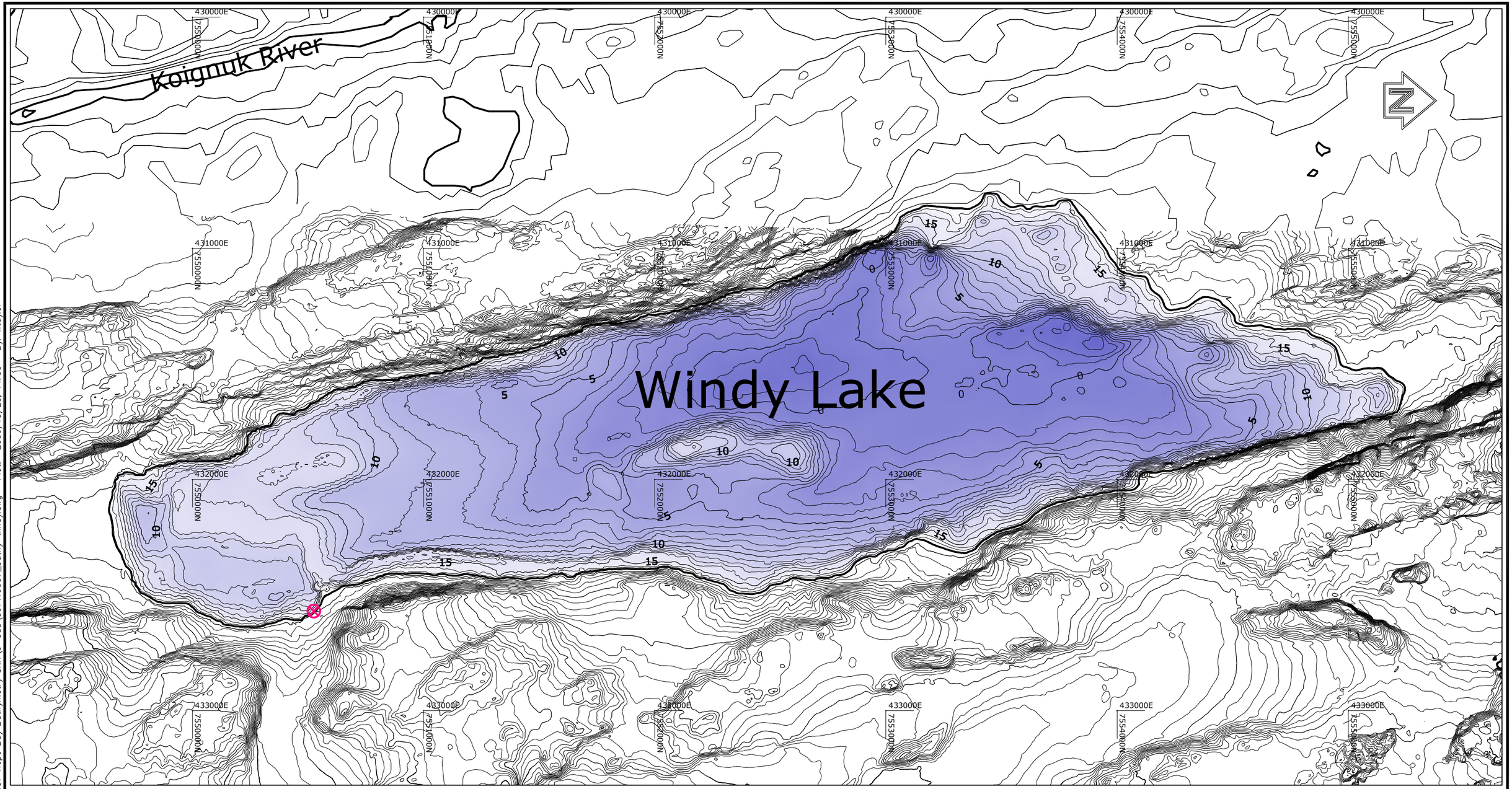

Legend:

- Lake-bed Contour, Major
- Lake-bed Contour, Minor
- Shoreline
- Survey Stake

Note:

1. Lake-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 2m, except for coarse topography to west of lake at 10m intervals.
4. Windy Lake shoreline at +18.235m elevation geodetic interpolated from topography and survey data.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
△						

PROJECT

SRK
Hope Bay, NT

TITLE

WINDY LAKE
LAKE-BED ELEVATIONS

Golder Associates

PROJECT No. 06-1419-007			FILE No. 06141907_bathy_windy		
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REVIEW	MM	20061005			

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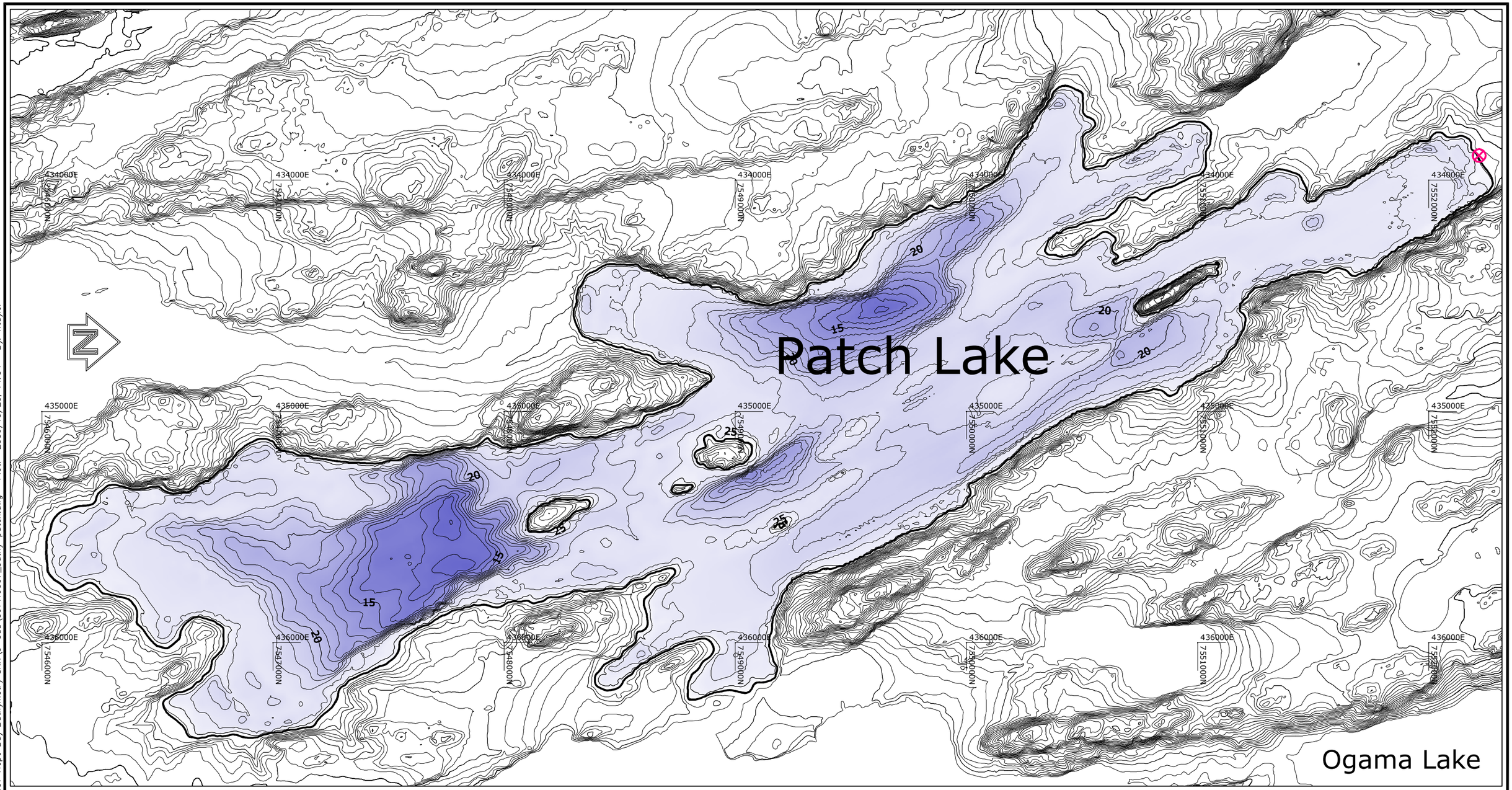

Legend:

- Lake-bed Contour, Major
- Lake-bed Contour, Minor
- Shoreline
- Survey Stake

Note:

1. Lake-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 2m.
4. Patch Lake shoreline at +26.275m geodetic elevation interpolated from topography and survey data.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

PATCH LAKE
LAKE-BED ELEVATIONS

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_bathy_patch		
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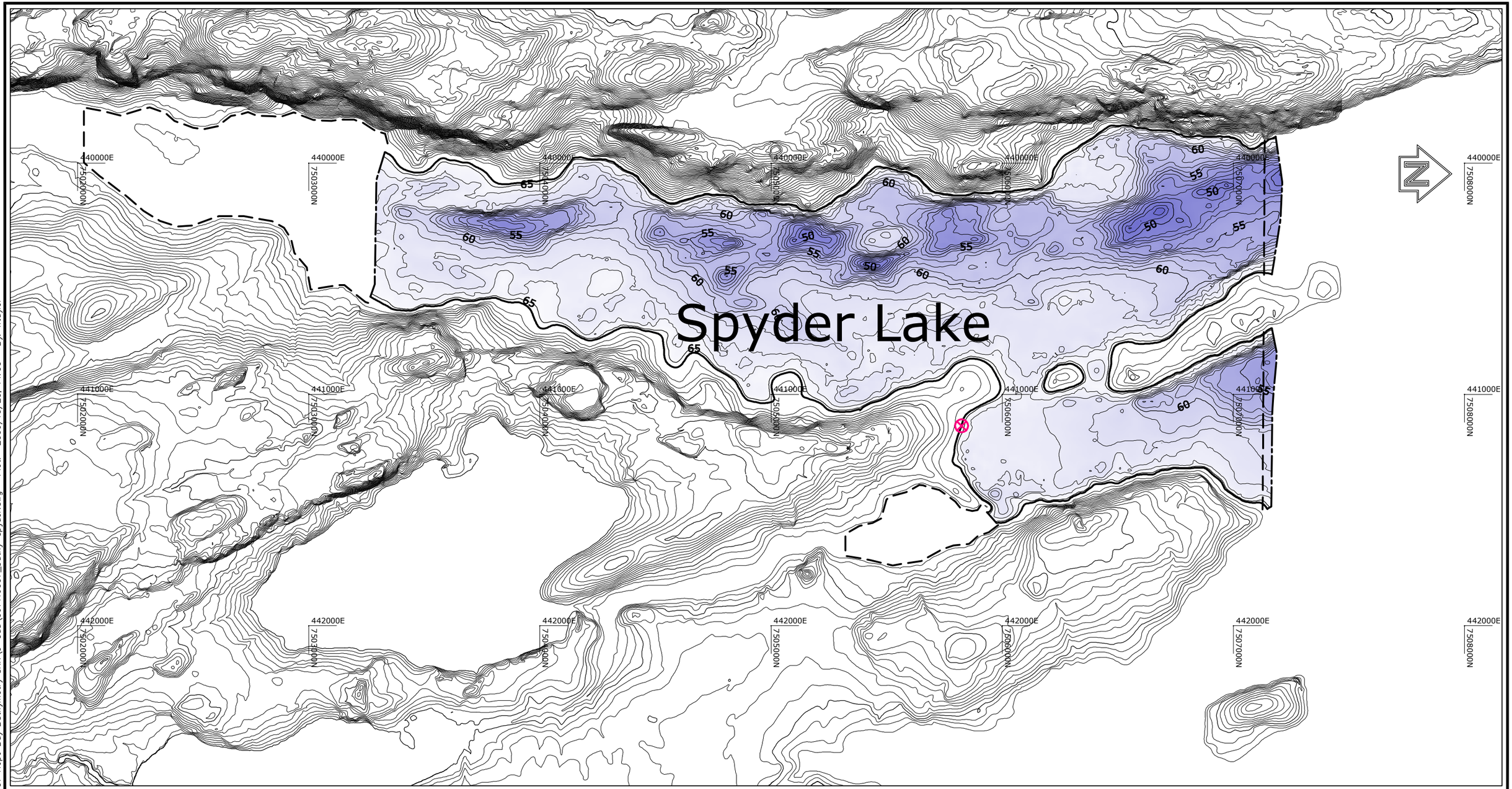

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Legend:

- Lake-bed Contour, Major
- Lake-bed Contour, Minor
- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:

1. Lake-bed contours at geodetic elevation are shown at 1m intervals.
2. Grid coordinates are NAD83, Zone 13N.
3. Topographic contour intervals are 1m.
4. Spyder Lake shoreline at +65.625 geodetic elevation interpolated from topography and survey data.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

SPYDER LAKE
LAKE-BED ELEVATIONS

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_bathy_spyder
DESIGN			SCALE As Shown REV. 0
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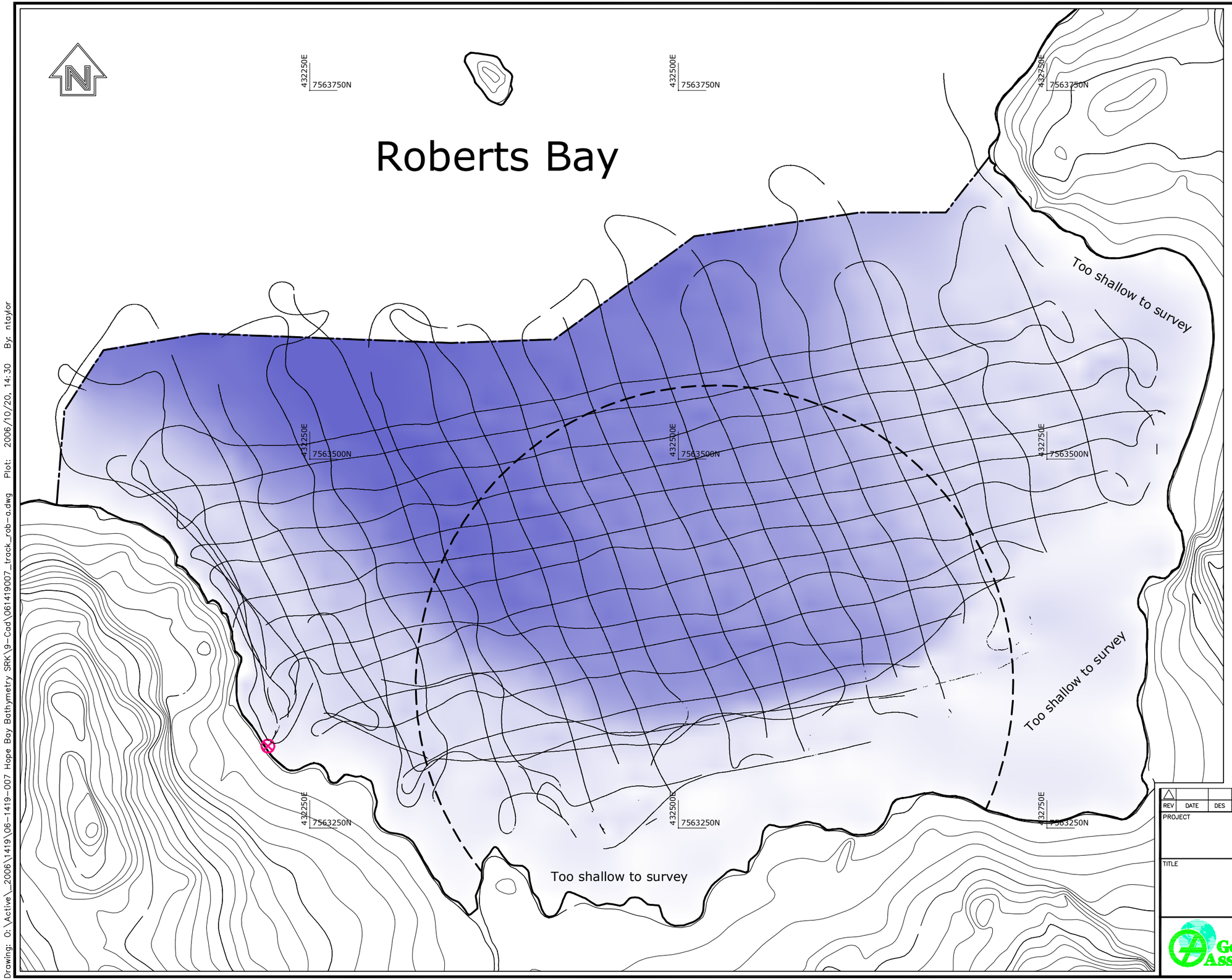
CHECK	JW	20061004	Figure 8
REVIEW	MM	20061004	



Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

Legend:

- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 1m.
3. Roberts Bay shoreline is shown at -0.05m elevation in topographic base map.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

ROBERTS BAY, AREA A
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_rob-a		
DESIGN			SCALE As Shown	REV.	0
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CHECK	JW	20061016			
REVIEW	MM	20061016			

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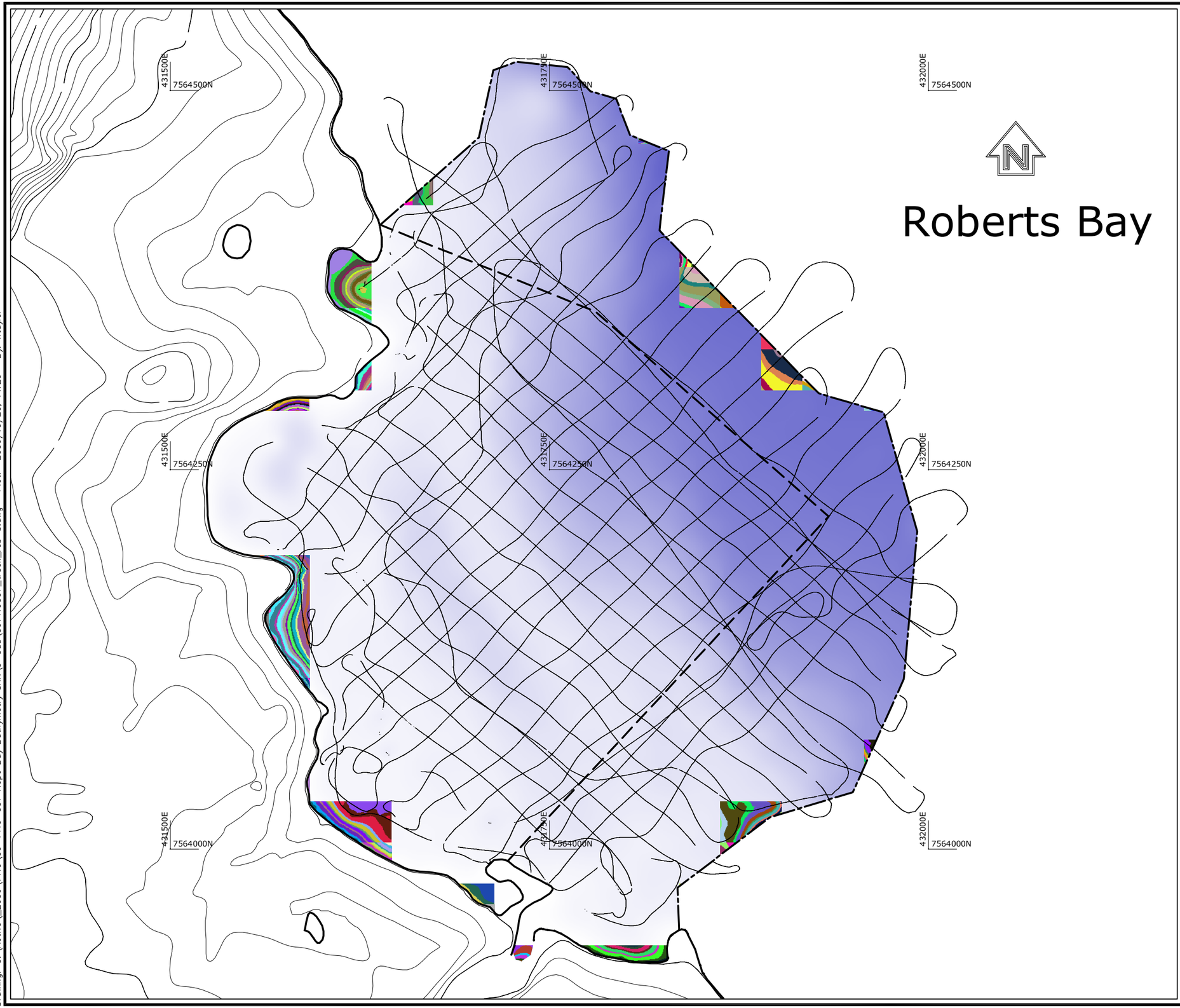

Reference:
Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

Legend:
- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:
1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 1m.
3. Roberts Bay shoreline is shown at -0.05m elevation in topographic base map.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
SRK
Hope Bay, NT

TITLE
ROBERTS BAY, AREA B
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_rob-b		
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REVIEW	MM	20061016			

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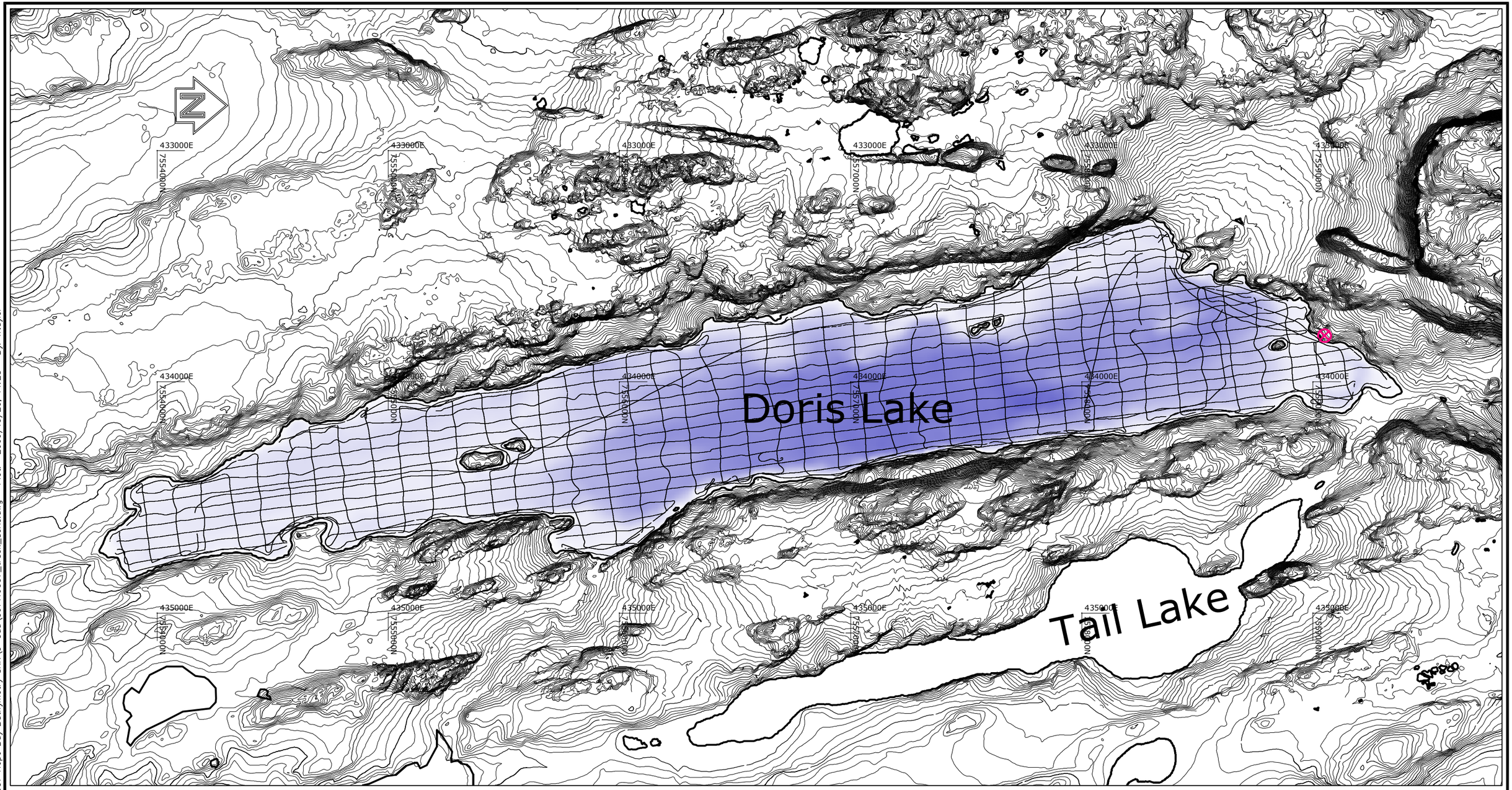

Legend:

- Shoreline
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 1m and 2m.
3. Doris Lake shoreline at +21.42m elevation geodetic interpolated from topography and survey data.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

DORIS LAKE
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_doris		
DESIGN			SCALE As Shown	REV. 0	
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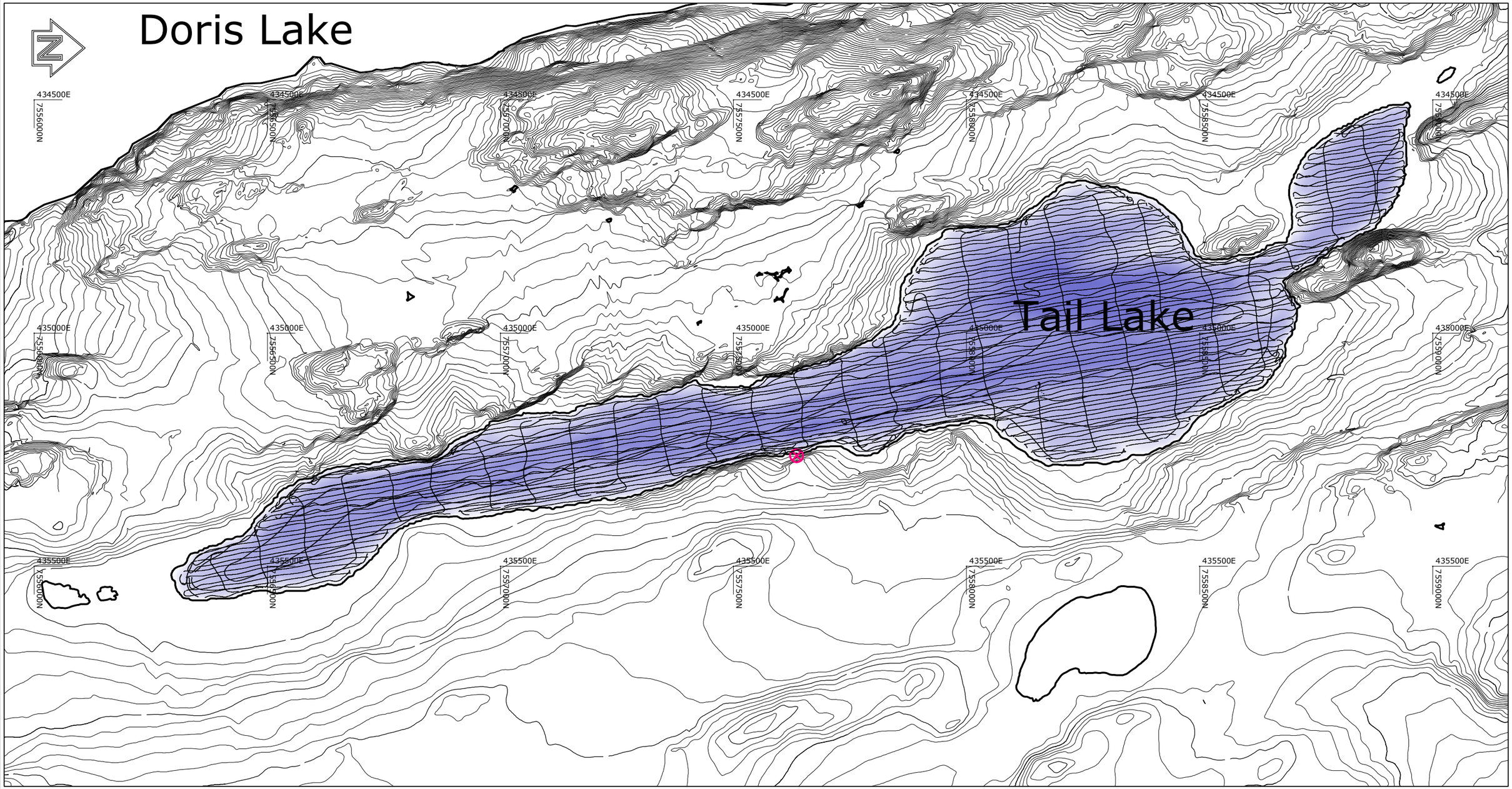
CHECK	JW	20061016			
REVIEW	MM	20061016			

Drawing: O:\Active_2006\1419\06-1419-007 Hope Bay Bathymetry SRK\9-Cad\061419007_track_doris.dwg Plot: 2006/10/20, 14:28 By: ntaylor

Doris Lake



Legend:

- Shoreline
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 1m and 2m.
3. Tail Lake shoreline at +28.12m elevation geodetic interpolated from topography and survey data.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
△						

PROJECT

SRK
Hope Bay, NT

TITLE

TAIL LAKE
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_tail		
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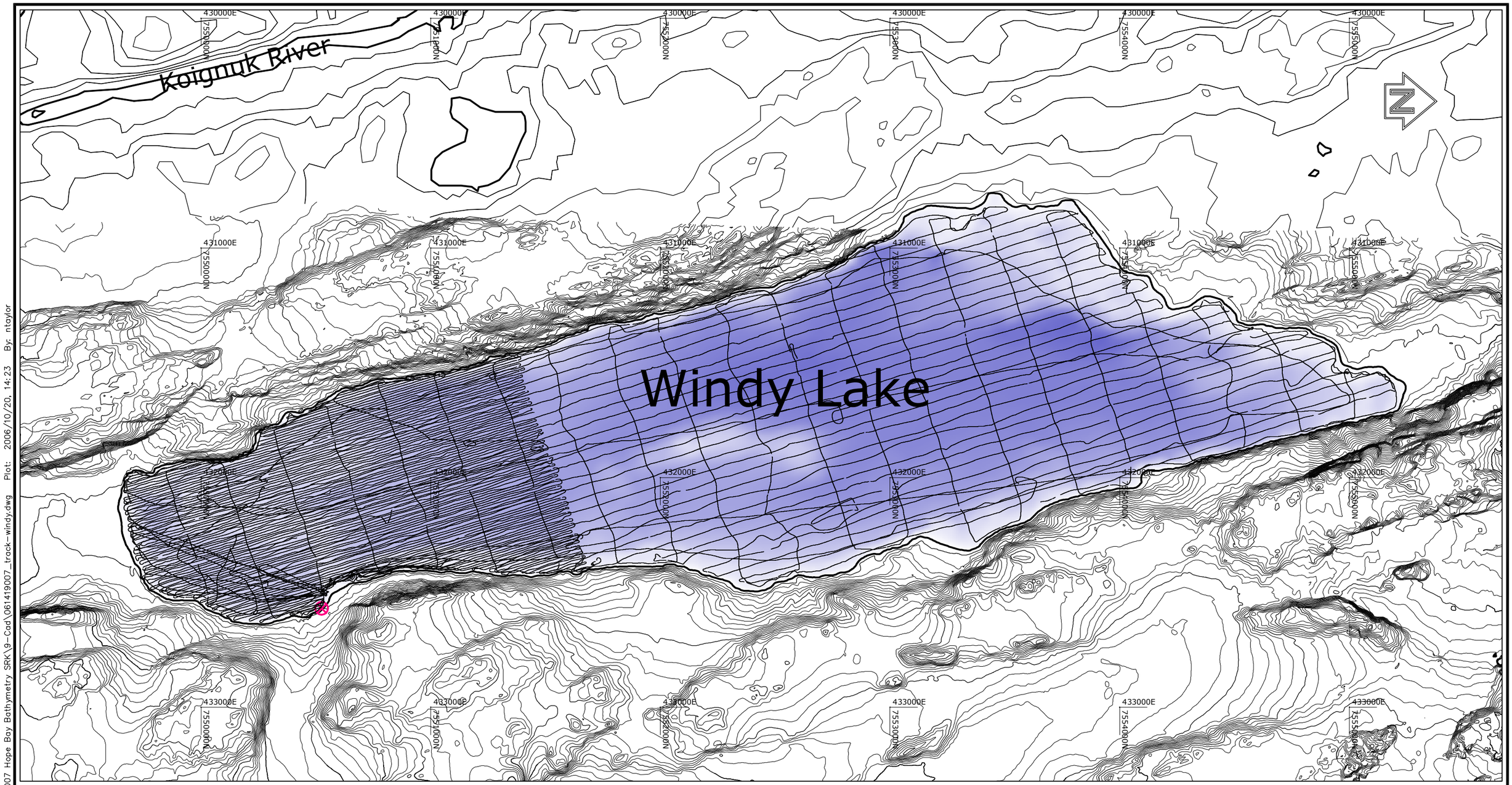
CHECK	JW	20061016			
REVIEW	MM	20061016			

Drawing: O:\Active_2006\1419\06-1419-007 Hope Bay Bathymetry SRK\9-Cad\061419007_track_tail.dwg Plot: 2006/10/20, 14:26 By: ntaylor



Legend:

- Shoreline
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 2m, except for coarse topography to west of lake at 10m intervals.
3. Windy Lake shoreline at +18.235m elevation geodetic interpolated from topography and survey data.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

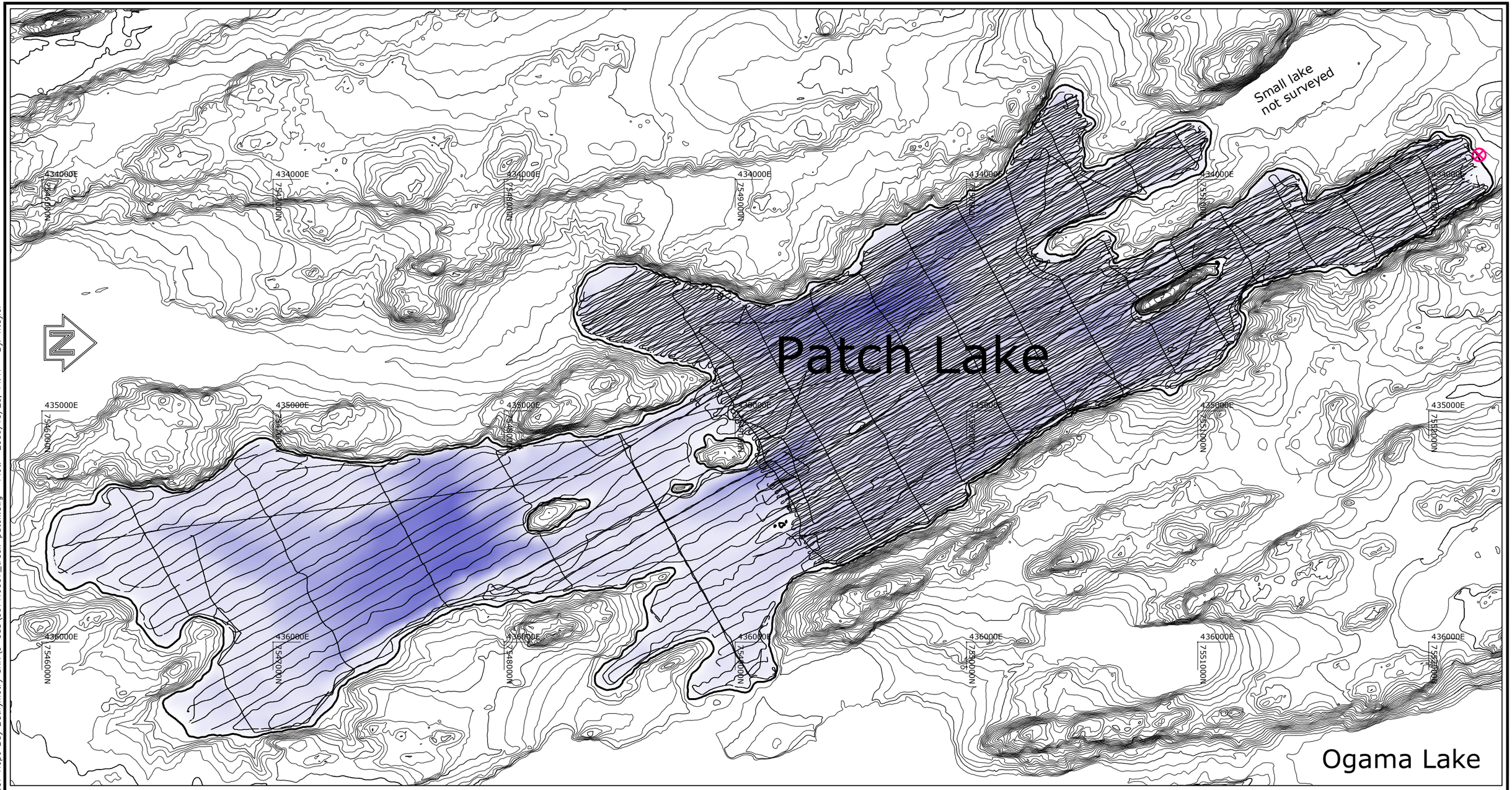
TITLE

WINDY LAKE
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_windy		
DESIGN			SCALE As Shown	REV.	0
CADD	NFT	20061016	Figure 13		
CHECK	JW	20061016			
REVIEW	MM	20061016			

Drawing: O:\Active_2006\1419\06-1419-007 Hope Bay Bathymetry SRK\9-Cad\061419007_track-windy.dwg Plot: 2006/10/20, 14:23 By: ntaylor



Legend:

- Shoreline
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 2m.
3. Patch Lake shoreline at +26.275m geodetic elevation interpolated from topography and survey data.
4. Small lake at NW end of Patch Lake was not surveyed due to cliff blocking GPS signal.
5. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

PATCH LAKE
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_patch		
DESIGN			SCALE As Shown	REV.	0
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CHECK	JW	20061016			
REVIEW	MM	20061016			

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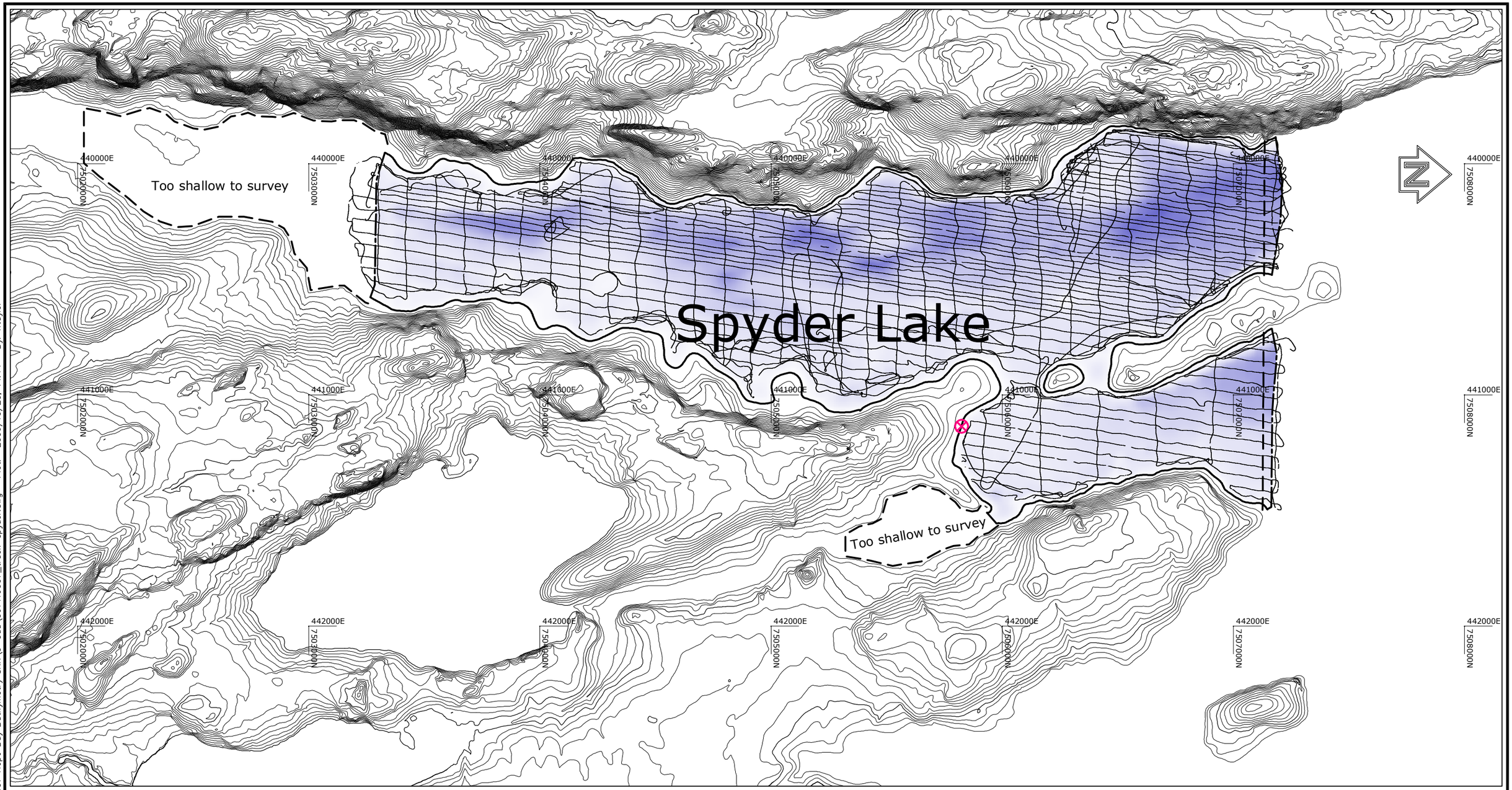

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Legend:

- Shoreline
- SRK Survey Area
- Golder Survey Limit
- Survey Stake

Note:

1. Grid coordinates are NAD83, Zone 13N.
2. Topographic contour intervals are 1m.
3. Spyder Lake shoreline at +65.625 geodetic elevation interpolated from topography and survey data.
4. Figure to be read in conjunction with Golder report "Rpt1019_06 - SRK - Hope Bay Bathymetry".

Reference:

Topographic information (NAD83, Zone 13N) generated by BHP 1997 and provided by MHBL.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

SRK
Hope Bay, NT

TITLE

SPYDER LAKE
SURVEY TRACKLINES

Golder Associates

PROJECT No. 06-1419-007			FILE No. 061419007_track_spyder		
DESIGN			SCALE As Shown	REV.	0
CADD	NFT	20061016			
CHECK	JW	20061016			
REVIEW	MM	20061016			

Figure 15

Appendix B

Phase III Foundation Investigation (SRK 2006)

Phase III Foundation Investigation Proposed Roberts Bay Jetty Location, Doris North Project, Nunavut, Canada

Prepared for

Miramar Hope Bay Limited

Prepared by

SRK Consulting
Engineers and Scientists

August 2006

Phase III Foundation Investigation Proposed Roberts Bay Jetty Location, Doris North Project, Nunavut, Canada

Miramar Hope Bay Limited

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SRK Project Number 1CM014.008-260

August 2006

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Reviewed by
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1 Introduction

1.1 Background

Miramar Hope Bay Limited (MHBL) is planning a new gold mine in the Hope Bay Belt in Nunavut. This project, called the Doris North Project, lies on the Artic coastline, and as a result annual re-supply for the mine will be via sealift. A permanent off-loading facility will be constructed at Roberts Bay, which is approximately 4 km north of the proposed mine site, as indicated in Figure 1. This facility will be a 103 m long continuous rockfill jetty (SRK 2005a).

In preparation for final detailed engineering designs of this jetty, MHBL contracted SRK Consulting (Canada) Inc. (SRK) to carry out additional geotechnical investigations to further characterize the foundation conditions. This study, which was carried out in May 2006, was intended to fill the remaining data gaps identified during two previous geotechnical foundation investigations in April 2004 (SRK 2004) and April 2005 (SRK 2005b).

This report presents the results of the study as described. It includes drill logs, core photos as well as the complete laboratory testing data.

1.2 Summary of Drill Program

Seven drill holes were completed at the head of the jetty as illustrated in Figure 2. Drill holes SRK06-11 to SRK06-17 was advanced using a portable vibro-core drill, and in-tact (undisturbed) soil samples were collected and sent for laboratory characterization in order to obtain design parameters to be used in the detailed design of the jetty.

Seasonal weather conditions prevailed for the duration of the drilling operation. Winds were generally from the north and northeast at 5-20 km/h, with daytime temperatures up to 4°C and overnight lows of -10°C. During daylight hours, conditions ranged from sunny to overcast.

2 Methodology

2.1 Drilling

The holes were completed using a portable BQ (size 36.5 mm) vibro-core system, complete with vibration pack and rod extraction using a hydraulic power pack. The drilling equipment was supplied by Rocky Mountain Soil Sampling Inc. (RMSS), from Hornby Island, British Columbia. The drill was operated by a two-man crew from RMSS, working a single 12-hour day shift.

Actual drilling was done from the top of the sea ice in Roberts Bay. Drilling consisted of penetrating hollow drill rods through the marine sediments (foundation soils). The driving force was a combination of gravity and vibration. Continuous (undisturbed) samples were gathered during rod penetration. These samples were subsequently pumped out by a piston using a hydraulic pack after all the rods were extracted at the completion of the hole.

SRK engineer, Mr. Alvin Tong, E.I.T. supervised the drilling and logged and photographed the extracted core on-site as drilling progressed. Selected representative samples were prepared and shipped to EBA Engineering's soil testing laboratories in Yellowknife and Edmonton for geotechnical characterization. All remaining soil core is stored in core boxes, outside, under ambient conditions at Windy Camp, approximately 11 km south of Roberts Bay.

The drill hole locations were set out by the SRK engineer using a hand-held GPS according to planning co-ordinates selected by SRK. After completion of the drilling, Miramar surveyed in the actual hole locations.

2.2 Laboratory Testing

18 samples was collected from the extracted core and sent to the laboratory for geotechnical testing. Although theoretically all samples were "undisturbed", the soft nature of the material did result in some consolidation, and handling of the core also resulted in the "undisturbed" nature of the core being affected. In reality the SRK engineer could only reliably classify six of the collected samples are truly "undisturbed", as depicted in Table 1.

From the 18 samples, SRK selected 13 samples only (including the six "undisturbed" samples) on which to carry out geotechnical testing as listed in Table 2.

Table 1: Samples collected and sent to laboratory

Sample [ID:Depth (Type)][1]	Sample Condition
SRK06-11-01: 1.1m (SP)[2]	Bulk – disturbed
SRK06-12-01: 4.0m (CL)[3]	Bulk – disturbed
SRK06-12-02: 7.9m (CL)	In-tact – undisturbed
SRK06-12-03: 18.6m (CL)	Bulk – disturbed
SRK06-13-01: 5.5m (CL)	In-tact – undisturbed
SRK06-13-02: 18.6m (CL)	Bulk – disturbed
SRK06-14-01: 5.1m (CL)	Bulk – disturbed
SRK06-14-02: 6.9m (CL)	In-tact – undisturbed
SRK06-14-03: 17.7m (SP)	Bulk – disturbed
SRK06-15-01: 3.9m (ML)[4]	In-tact – undisturbed
SRK06-15-02: 7.0m (CL)	Bulk – disturbed
SRK06-15-03: 5.6m (SP)	Bulk – disturbed
SRK06-16-01: 5.5m (CL)	Bulk – disturbed
SRK06-16-02: 8.3m (CL)	In-tact – undisturbed
SRK06-16-03: 17.7m (SP)	Bulk – disturbed
SRK06-17-01: 2.8m (SP)	Bulk – disturbed
SRK06-17-02: 8.0m (CL)	Bulk – disturbed
SRK06-17-03: 12.8m (CL)	In-tact – undisturbed

1. Soil type is designated soil symbol according to the Unified Soil Classification System (USCS).
2. SP = Poorly graded sand.
3. CL = Clay.
4. ML = Silt.

Table 2: Laboratory testing program

Sample [ID:Depth (Type)][1]	Natural Moisture Content	Particle Size Distribution		Atter-berg Limits	Salinity	Triaxial (UU)[5]	Consoli-dation
		Sieve	Hydro-meter				
SRK06-11-01: 1.1m (SP)[2]	✓	✓	✓	✓	✓		
SRK06-12-02: 7.9m (CL)[3]	✓	✓	✓	✓		✓	
SRK06-12-03: 18.6m (CL)	✓	✓	✓	✓			
SRK06-13-01: 5.5m (CL)	✓	✓	✓	✓			
SRK06-13-02: 18.6m (CL)	✓	✓	✓	✓			
SRK06-14-02: 6.9m (CL)	✓	✓	✓	✓			✓
SRK06-15-01: 3.9m (ML)[4]	✓	✓	✓	✓			
SRK06-15-02: 7.0m (CL)	✓	✓	✓	✓			
SRK06-16-01: 5.5m (CL)	✓	✓	✓	✓			
SRK06-16-02: 8.3m (CL)	✓	✓	✓	✓		✓	
SRK06-17-01: 2.8m (SP)	✓	✓	✓	✓			
SRK06-17-02: 8.0m (CL)	✓	✓	✓	✓			
SRK06-17-03: 12.8m (CL)	✓	✓	✓	✓			✓

1. Soil type is designated soil symbol according to the Unified Soil Classification System (USCS).
2. SP = Poorly graded sand.
3. CL = Clay.
4. ML = Silt.
5. UU = Unconsolidated Undrained triaxial shear test.

3 Results

3.1 Drilling Hole Locations

The as-built collar locations differed slightly from those set out using a hand-held GPS; however, Table 3 list the actual survey co-ordinates as provided by MHBL after completion of the holes.

Table 3: As-built drill hole coordinates

Hole ID	Northing[1]	Easting[1]	Elevation[2]	Inclination
SRK06-11	7563305.4	432543.8	-0.2	-90°
SRK06-12	7563336.7	432549.8	-0.5	-90°
SRK06-13	7563353.0	432539.3	-0.5	-90°
SRK06-14	7563339.5	432526.1	-0.6	-90°
SRK06-15	7563324.8	432514.9	-0.5	-90°
SRK06-16	7563340.0	432502.3	-0.5	-90°
SRK06-17	7563319.1	432536.8	-0.3	-90°

1. UTM Projection NAD 83 Zone 13.
2. Negative values represent collar elevation below survey grid datum.

Drilling results are summarized in a series of drill logs, included as Appendix A. Drill core photos are included as Appendix B. A generalized profile through the drill holes (Figure 3) displays the interpreted stratigraphy along the proposed jetty centreline. This profile includes drill holes from the April 2004 drill program (SRK 2004), and the bathymetric contours are based on a survey done by Frontier Geosciences in 2003 (Frontier Geosciences 2003).

3.2 Foundation Conditions

3.2.1 SRK06-11

The sea ice at this hole was about 1.07 m thick. The sea ice was frozen to the bed sediments. The surface sediments consist of a layer of sand and gravel. The drill system used for this program in not well suited to penetrate this type of stratigraphy, and as a result the hole was terminated, before the base of the sand zone was found. Sample recovery in this hole was 100%.

3.2.2 SRK06-12

The sea ice at this hole was about 1.83 m thick, which overlies about 2.13 m of unfrozen seawater. The surface sediments consist of a layer of silty clay up to a depth of 19.20 m. The hole was terminated at this depth after refusal of the drill in sand and gravel. Sample recovery of the silty clay was 100%.

3.2.3 SRK06-13

Sea ice at this hole was again about 1.83 m thick, and the unfrozen seawater beneath it was about 2.89 m. From 4.72 m to 19.2 m there was 100% recovery of the same silty clay stratigraphy observed in SRK06-12. The hole was again terminated at this depth due to refusal on sand and gravel.

3.2.4 SRK06-14

This hole encountered sea ice of about 1.83 m, overlying about 2.74 m of unfrozen seawater. Between 4.57 m and 17.68 m the same layer of silty clay was encountered as in previous holes, before reaching a 0.39 m thick layer of sand and gravel. The hole was terminated in bedrock. Sample recovery in this hole was 100%.

3.2.5 SRK06-15

About 1.83 m unfrozen seawater was overlain by about 1.83 m of sea ice in this hole. The upper stratigraphic unit between 3.66 and 6.86 m is silty clay. This overlies a sand layer which was penetrated about 2.28 m before drill refusal. Sample recovery in this hole was 100%.

3.2.6 SRK06-16

The sea ice at this hole was about 1.83 m thick, overlying about 2.74 m of unfrozen seawater. The silty clay in this hole was found between 4.57 m to 17.68 m, overlying a sand layer. Drill refusal was encountered about 0.46 m into the sand layer. Sample recovery in this hole was again 100%.

3.2.7 SRK06-17

Sea ice in this hole was only about 1.37 m thick, and extended directly onto the sediments. The surface sediments consist of a layer of sand and gravel from 1.37 m to 3.81 m underlain by 9.91 m of silty clay. Drill refusal was encountered at the base of the silty clay layer; however, it was not clear whether refusal was due to the presence of bedrock or frozen soil. Ice lenses were observed in the silty clay between 9.60 m and 13.72 m, with the ice content about 10%. Recovery in this hole was 100%.

3.3 Laboratory Testing Results

13 samples were subjected to basic foundation indicator testing, with the primary results summarized in Table 4. Four of these samples were subjected to more specialized geotechnical testing, the results of which are summarized in Table 5. Complete laboratory data sheets are included as Appendix C.

Table 4: Results of foundation indicator testing

Sample [ID:Depth (Type)]	Salinity (ppt)	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
SRK06-11-01: 1.1m (SP)	89	19.2	N/A	N/A	N/A
SRK06-12-02: 7.9m (CL)	-	45.5	27	16	11
SRK06-12-03: 18.6m (CL)	-	46.5	40	20	20
SRK06-13-01: 5.5m (CL)	-	43.8	38	21	17
SRK06-13-02: 18.6m (CL)	-	49.2	42	22	20
SRK06-14-02: 6.9m (CL)	-	43.3	36	20	16
SRK06-15-01: 3.9m (ML)	-	27.2	19	16	3
SRK06-15-02: 7.0m (CL)	-	43.3	36	20	16
SRK06-16-01: 5.5m (CL)	-	37.3	29	17	12
SRK06-16-02: 8.3m (CL)	-	70.7	48	22	26
SRK06-17-01: 2.8m (SP)	-	20.3	N/A	N/A	N/A
SRK06-17-02: 8.0m (CL)	-	35.7	34	19	15
SRK06-17-03: 12.8m (CL)	-	43.4	41	22	19

Table 5: Results of specialized geotechnical testing

Sample [ID:Depth (Type)]	Specific Gravity	Wet Density (Mg/m^3)	Dry Density (Mg/m^3)	Void Ratio	Peak Stress (kPa)
SRK06-12-02: 7.9m (CL)	-	1.918	1.329	-	9.6
SRK06-14-02: 6.9m (CL)	2.703	1.887	1.390	0.945	-
SRK06-16-02: 8.3m (CL)	-	2.076	1.329	-	16.8
SRK06-17-03: 12.8m (CL)	-	2.128	1.576	0.525	-

4 Discussion

Figure 3 shows a longitudinal profile along the proposed jetty centerline, which shows the stratigraphy inferred from the recent drilling results together with those from the April 2004 geotechnical drilling program (SRK 2004).

Based on the current drill hole results is would appear as if the deep sand pocket observed in SRK45 during the April 2004 program, which was always questioned, may not be present. Based on the profile found in SRK06-17, it would appear as if there is a thin layer of sand that occasionally overlie the silt and clay layer; however, it is not likely to be more than a couple of meters thick and is likely present as a result of continuously moving shoreline processes.

The laboratory testing carried out on the silt and clay zone confirm results previously obtained during the April 2005 vane shear testing program. This investigation confirms that the design parameters used for the proposed jetty design (SRK 2005a) is appropriate.

This report, **"Phase III Foundation Investigation Proposed Roberts Bay Jetty Location, Doris North Project, Nunavut, Canada"**, has been prepared by SRK Consulting (Canada) Inc.

Prepared by:

Alvin Tong, E.I.T.
Staff Engineer

Reviewed by:

Maritz Rykaart, Ph.D., P.Eng.
Principal Engineer

5 References

Frontier Geosciences Inc., 2003. *Report on Marine Bathymetry Survey, Proposed Roberts Bay Docking Facilities, Cambridge Bay Area, Nunavut.* Report submitted to SRK Consulting, September 2003.

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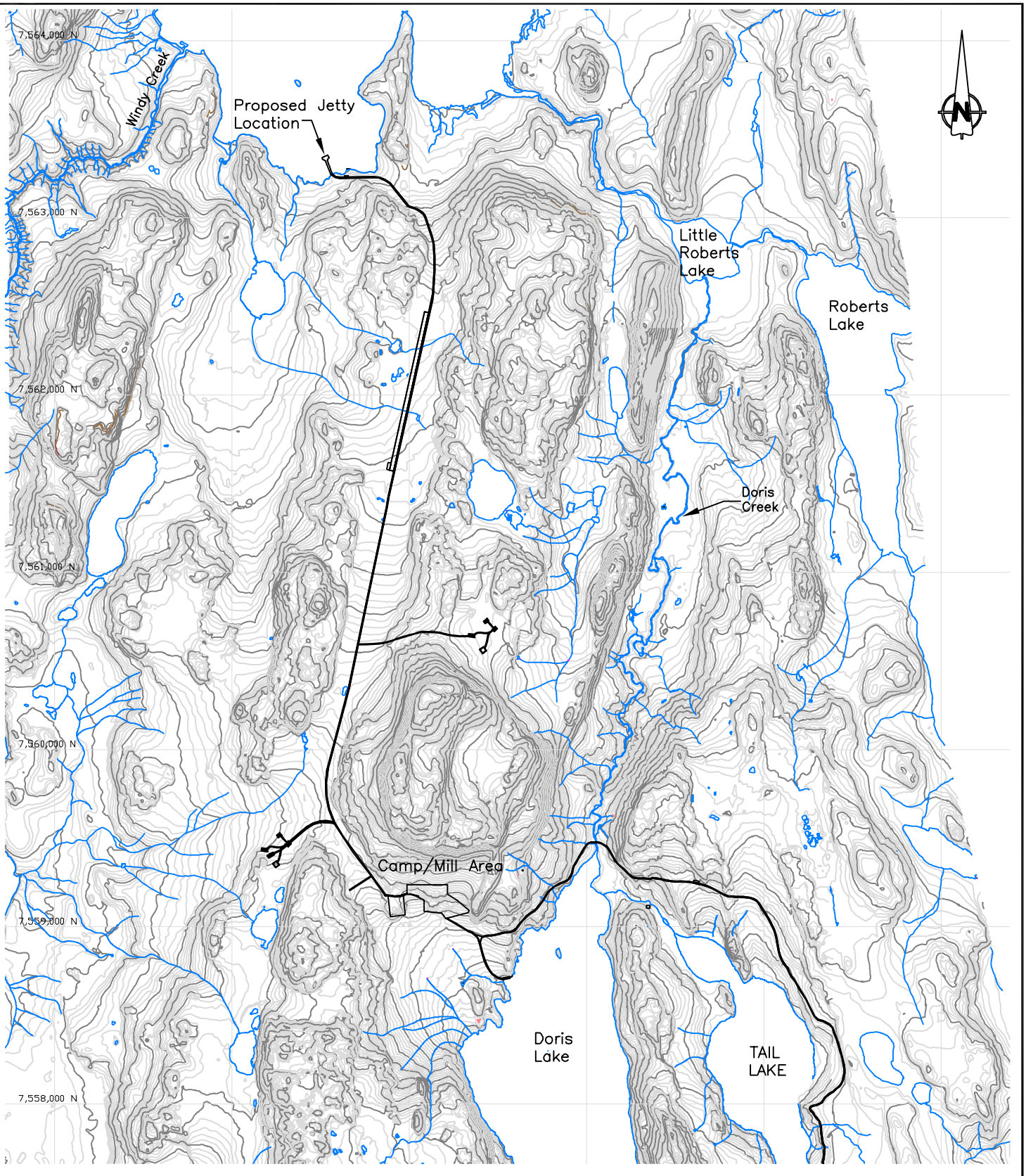
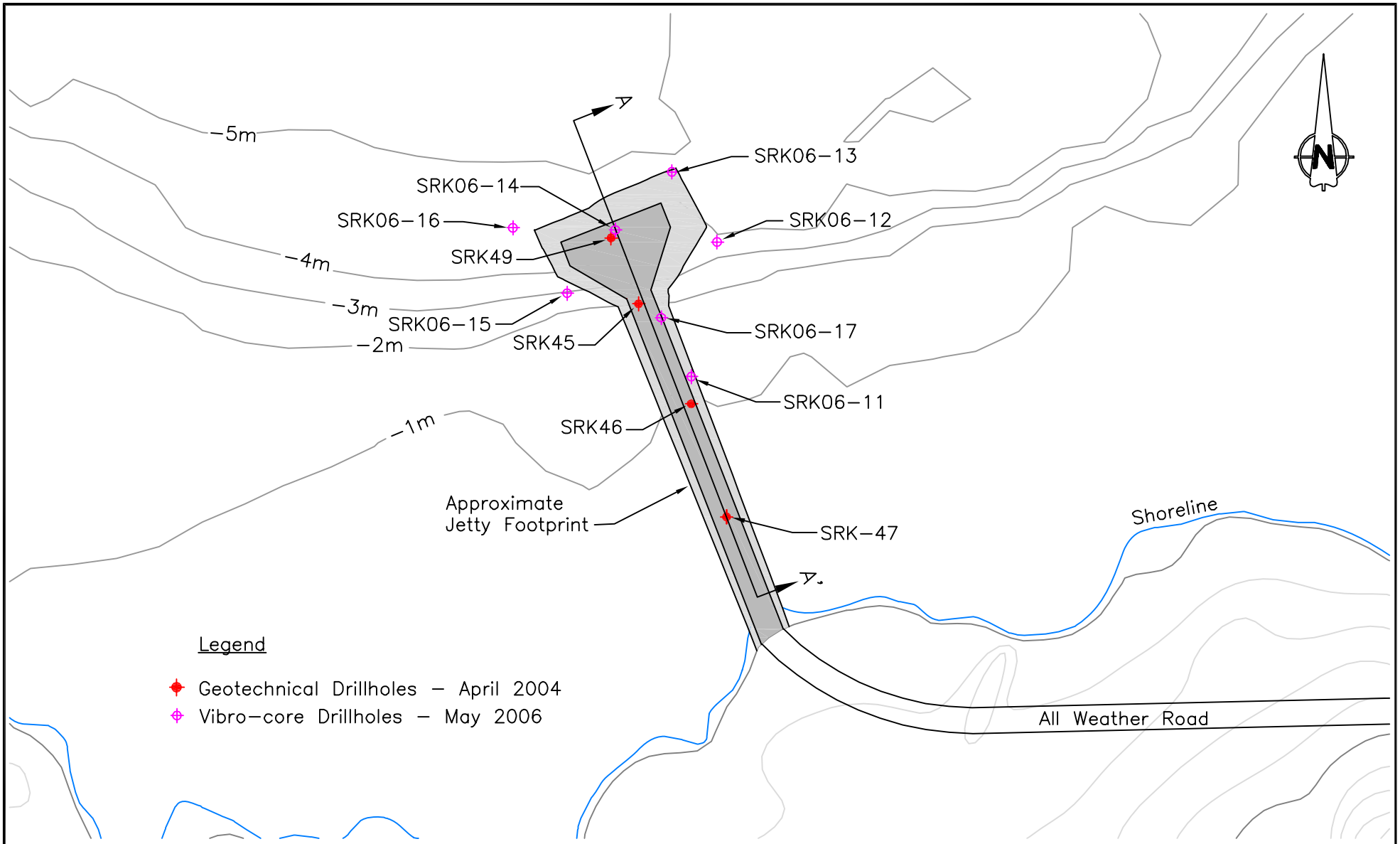
SRK Consulting (Canada) Inc., 2005b. *Phase II Foundation Investigation, Proposed Roberts Bay Jetty Location, Doris North Project, Nunavut, Canada.* Report submitted to Miramar Hope Bay Ltd., Project No. 1CM014.04-0110, May.

Figures



SRK Consulting Engineers and Scientists Vancouver	MIRAMAR HOPE BAY LIMITED	Doris North Project Phase III Jetty Design
SRK JOB NO.: 1CM014.008	Doris North Project	Site Layout and Jetty Location
FILE NAME: SITE-MAP.dwg	DATE: Aug. 2006 / APPROVED: EMR / FIGURE: 1	



0 10 20 30 40 50 Metres

1:1250

Contour Interval = 1m

UTM Projection: NAD83 Zone 13

Bathymetry: Frontier Geosciences Inc. (2003)

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SRK JOB NO.: 1CM014.008

FILE NAME: jetty plan.dwg

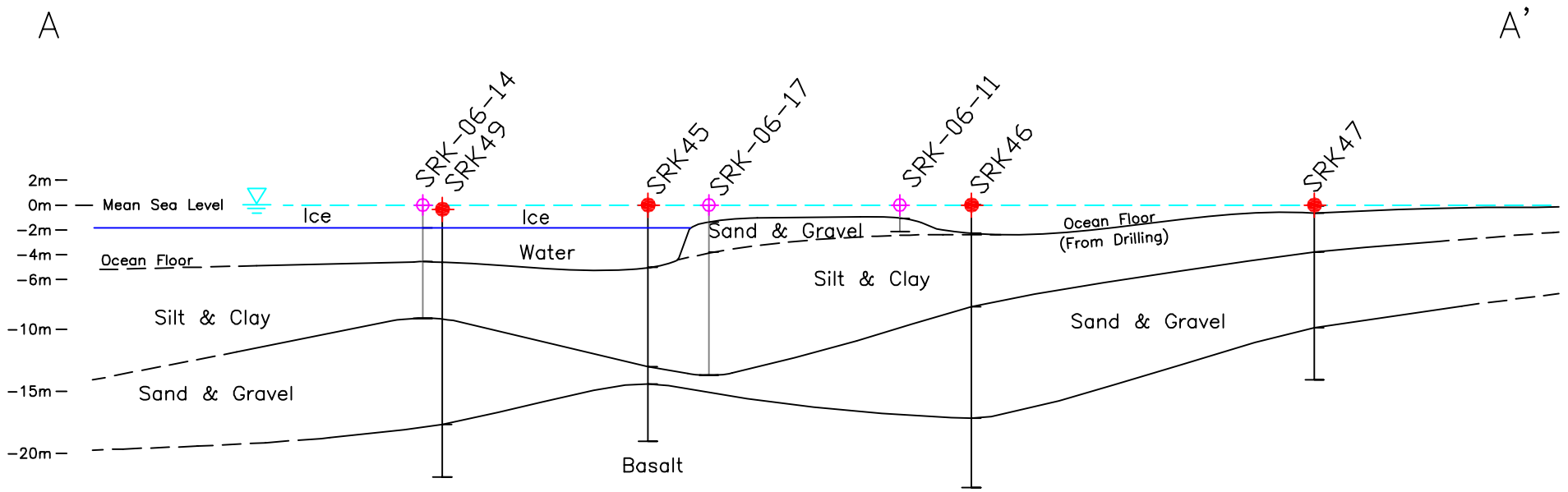
MIRAMAR HOPE BAY LIMITED

Doris North Gold Project

Doris North Project
Phase III Jetty Design

Drill Hole Locations

DATE:	APPROVED:	FIGURE:
Aug. 2006	EMR	2



Legend

- Geotechnical Drillholes – April 2004
- Vibro-core Drillholes – May 2006

0 5 10 15 20 Metres

1:500

Bathymetry: Frontier Geosciences Inc. (2003)

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SRK JOB NO.: 1CM014.008

FILE NAME: Jetty_Profile.dwg

MIRAMAR HOPE BAY LIMITED

Doris North Gold Project

Doris North Project
Phase III Jetty Design

Jetty Centerline Profile

DATE:	APPROVED:	FIGURE:
Aug. 2006	EMR	3

Appendix A
Drill Logs

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-11
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-18 **TO** 2006-05-18
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING:
COORDINATES: 7563305.40 N 432543.80 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	STRATIGRAPHY: DESCRIPTION	STRATIGRAPHY: SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: CONDITION	SAMPLES: RECOVERY %	SAMPLES: N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
	1		0.00 -1.07	ICE							
5	2		1.07 -2.13	SAND and GRAVEL with a trace of silt, well graded, dense		SRK06-11-01		100	0		
			2.13	END OF BOREHOLE							
10	3										
	4										
15	5										
20	6										
	7										
25	8										
30	9										
	10										
35	11										
40	12										
	13										
45	14										
50	15										
	16										
55	17										
	18										
60	19										
65											

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-12
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-18 **TO** 2006-05-18
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING: None
COORDINATES: 7563336.73 N 432549.82 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
			0.00	ICE							
5	1		-1.83								
	2		1.83	Water							
10	3		-3.96								
	4		3.96	Dark grey silty CLAY, saturated soft, medium plasticity, poorly graded, low consistancy, low dilatency		SRK06-12-01		0	0		
15	5		-5.79								
20	6		5.79	Same as above but higher consistency and higher silt content							
	7										
25	8					SRK06-12-02		100	0		
30	9										
	10										
35	11										
40	12										
	13										
45	14										
50	15										
	16										
55	17										
	18		-17.98								
60	19		17.98	Silty CLAY with a trace of sand, low-med consistency, low dilatency, soft, low, plasticity		SRK06-12-03		100	0		
65			-19.20								
			19.20	EOH							
				END OF BOREHOLE							

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-13
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-18 **TO** 2006-05-18
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING: None
COORDINATES: 7563352.97 N 732539.25 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	STRATIGRAPHY: DESCRIPTION	STRATIGRAPHY: SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: CONDITION	SAMPLES: RECOVERY %	SAMPLES: N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L
			0.00	ICE							20 40 60 80 100 120
5	1		-1.83								
	2		1.83	Water							
10	3										
	4		-4.72								
15	5		4.72	Dark grey silty CLAY, saturated, soft, medium plasticity, poorly graded, low consistancy, low dilatency							
20	6		-6.25			SRK06-13-01		100	0		
			6.25	Same as above but higher consistency and lower dilatency							
25	7										
	8										
30	9										
35	10										
	11										
40	12										
	13										
45	14										
50	15										
	16										
55	17										
	18										
60											
	19		-19.20			SRK06-13-02		100	0		
65			19.20	EOH END OF BOREHOLE							

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-14
LOCATION: Jetty Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-17 **TO** 2006-05-17
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING:
COORDINATES: 7563339.45 N 432526.07 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
			0.00	ICE							
5	1		-1.83								
			1.83	Water							
10	3										
	4		-4.57								
15			4.57	Dark grey silty CLAY, saturated, soft, medium plasticity, poorly graded, low consistency, low dilatency. Reduced in core length expected due to consolidation from drilling vibrations		SRK06-14-01		0	0		
20	6										
	7					SRK04-14-02		100	0		
25	8										
			-9.14								
30	9		9.14	Same as above but ligher in colour							
35	10										
	11										
40	12										
	13										
45	14										
50	15										
	16										
55	17										
			-17.68								
60	18		17.68	SAND and GRAVEL, loose, well graded, saturated		SRK06-14-03		0	0		
			-18.07	EOH EOH							
	19		18.07	END OF BOREHOLE							
65											

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-15
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-19 **TO** 2006-05-19
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING:
COORDINATES: 7563324.81 N 432514.88 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
			0.00	ICE							
5	1		-1.83								
	2		1.83	Water							
10	3		-3.66								
	4		3.66	Dark grey silty CLAY, saturated, soft, medium plasticity, poorly graded, low consistency, low dilatency		SRK06-15-01		100	0		
15	5		-5.18								
			5.18	Same as above but higher consistency							
20	6		-6.86			SRK06-15-03		0	0		
	7		6.86	SAND with some gravel, loose to dense, well graded, gravel deposited in layers, saturated		SRK06-15-02		100	0		
25	8		-7.62								
			7.62	EOH							
	9			END OF BOREHOLE							
30	10										
35	11										
40	12										
	13										
45	14										
50	15										
	16										
55	17										
	18										
60	19										
65											

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-16
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-17 **TO** 2006-05-17
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING:
COORDINATES: 7563339.95 N 432502.27 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
			0.00	ICE							
5	1		-1.83								
	2		1.83	Water							
10	3										
	4		-4.57								
15	5		4.57	Dark grey silty CLAY, saturated, soft, medium plasticity, poorly graded, low consistency, low dilatency							
20	6					SRK06-16-01		100	0		
	7										
25	8					SRK06-16-02		100	0		
30	9										
35	10										
40	11										
45	12										
50	13										
55	14										
	15										
	16										
	17		-17.68								
60	18		17.68	SAND, loose, poorly graded, saturated		SRK06-16-03		0	0		
			-17.98								
			17.98	SAND and GRAVEL, loose, well graded, saturated							
	19		-18.14								
65			18.14	EOH							
				END OF BOREHOLE							

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Doris North - Detailed Infrastructure Design
BOREHOLE: SRK06-17
LOCATION: Jetty
PAGE: 1 **OF** 1
FILE No: HOPE BAY (1CM014.008)
DRILL TYPE:
BORING DATE: 2006-05-18 **TO** 2006-05-18
DRILL:
DIP: 90.00 **AZIMUTH:**
CASING:
COORDINATES: 7563319.13 N 432536.83 E **DATUM:**

SAMPLE CONDITION
- Remoulded
- Undisturbed
- Lost
- Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS
- C Consolidation
- D Bulk density (kg/m3)
- Dr Specific gravity
- Ksat Saturated hydraulic cond. (cm/s)
- Ku Thermal conductivity Unfrozen (W / m°C)
- Kf Thermal conductivity Frozen (W / m°C)
- PS Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY: ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	WATER CONTENT and LIMITS (%)
			0.00								W_P W W_L 20 40 60 80 100 120
	1		0.00	ICE							
			-1.37								
5	2		1.37	SAND and GRAVEL with trace of silt, well graded, dense, saturated							
10	3		-3.81			SRK06-17-01		100	0		
	4		3.81	Dark graded silty CLAY, saturated, soft, medium plasticity, poorly graded, low consistency, low dilatency							
15	5										
20	6										
	7										
25	8					SRK06-17-02		100	0		
30	9		-9.60								
	10		9.60	Same as above but has evidence of ice lenses, Vr, 10% ice							
35	11										
40	12										
	13					SRK06-17-03		100	0		
45	14		-13.72								
			13.72	EOH. Driller could not tell if refusal is due to frozen soil or bedrock END OF BOREHOLE							
50	15										
55	16										
	17										
60	18										
	19										
65											

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Appendix B
Drill Core Photos

Photo 1: SRK06-11, 3.5' – 7.0' (1.07m – 2.13m)

Photo 2: SRK06-12, 13.5' – 63.0' (3.96m – 19.20m)

Photo 3: SRK06-13, 15.5’ – 63’ (4.72m – 19.2m)

Photo 4: SRK06-14, 15.0’ – 59.4’ (4.57m – 18.07m)

Photo 5: SRK06-15, 12' – 48' (3.66m – 7.62)

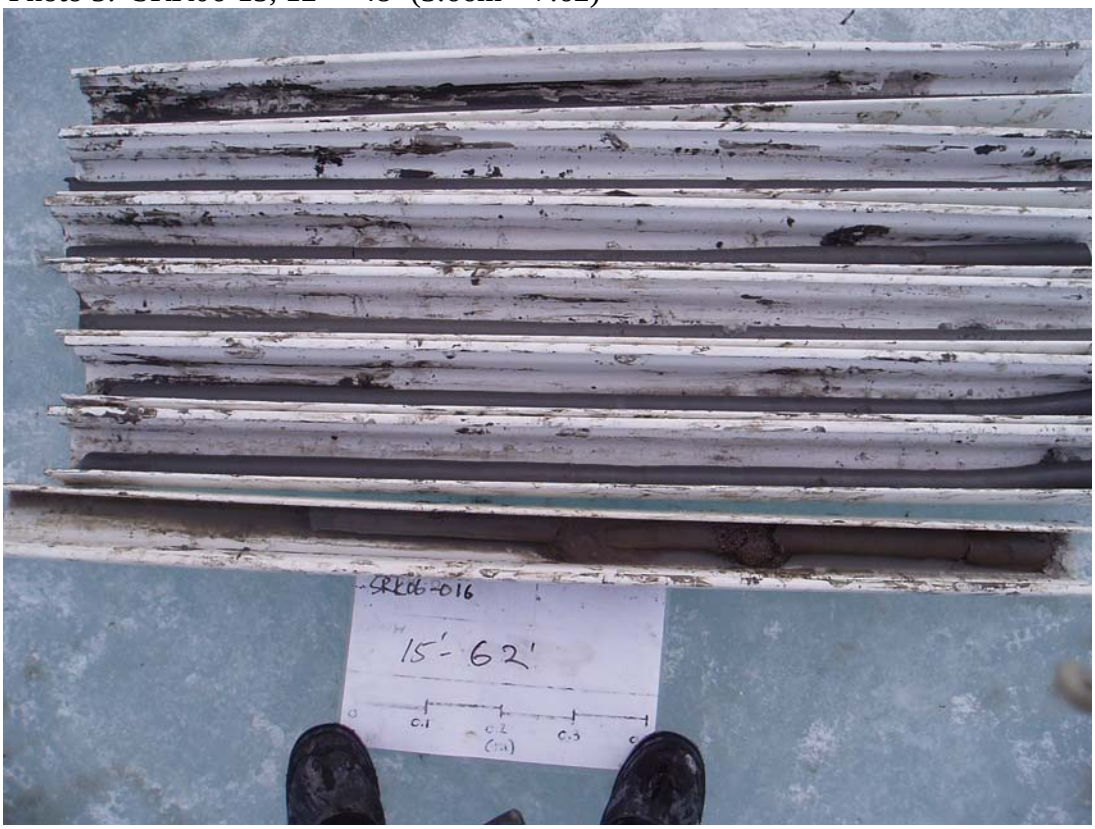


Photo 6: SRK06-16, 15' – 62' (4.57m – 18.14m)

Photo 7: SRK06-17, 4.5' – 45.0' (1.37m – 13.72m)

Appendix C

Laboratory Test Results

EBA Engineering Consultants Ltd.

MOISTURE CONTENT TEST RESULTS

Project:	SRK 2006 Testing Services	BH No:	
	Hope Bay Gold Project		
Project No.:	1780176	Date Tested:	1-Jun-06
Location:	Hope Bay, NT	By:	DKKS
Client:	SRK Consulting		

Test No.	SampleNo.	Depth(m)	Wet+Tare	Dry+Tare	Tare	% Moisture Content
SRK06-01-03	4150-3	N/A	660.9	522.8	12.2	27.0
SRK06-01-06	4150-6	N/A	441.9	285.4	12.5	57.3
SRK06-01-10	4150-10	N/A	707.9	559.7	12.3	27.1
SRK06-02-01	4150-11	N/A	518.4	322.1	12.2	63.3
SRK06-02-06	4150-16	N/A	586.1	405	14.2	46.3
SRK06-02-10	4150-20	N/A	826.9	497.8	13.9	68.0
SRK06-02-13	4150-23	N/A	903.8	750.3	13.9	20.8
SRK06-11-01	4150-25	N/A	705.0	593.4	12.4	19.2
SRK06-12-02	4150-27	N/A	270.2	189.5	12.1	45.5
SRK06-12-03	4150-28	N/A	640.9	441.3	12.4	46.5
SRK06-13-01	4150-29	N/A	292.4	207.0	12.2	43.8
SRK06-13-02	4150-30	N/A	701.6	474.3	12.5	49.2
SRK06-14-02	4150-32	N/A	242.8	173.1	12.2	43.3
SRK06-15-01	4150-34	N/A	288.9	229.8	12.3	27.2
SRK06-15-02	4150-35	N/A	603.9	425.1	12.3	43.3
SRK06-16-01	4150-37	N/A	654.0	479.5	12.2	37.3
SRK06-16-02	4150-38	N/A	176.8	108.6	12.1	70.7
SRK06-17-01	4150-40	N/A	793.9	662.5	13.9	20.3
SRK06-17-02	4150-41	N/A	693.0	514.5	13.9	35.7
SRK06-17-03	4150-42	N/A	262.5	186.8	12.4	43.4

EBA Engineering Consultants Ltd.

POREWATER SALINITY

Project:	Hope Bay Gold	Sample No.:	SRK06
Project No.:	0701-1780176	Date Tested:	06-06-28
Client:	Miramar Hope Bay Limited	Tested By:	KP

Sample Number	Depth (m)	Salinity (ppt)
01-03		67
01-06		44
01-10		67
02-01		6
02-06		60
02-10		80
02-13		86
11-01		89

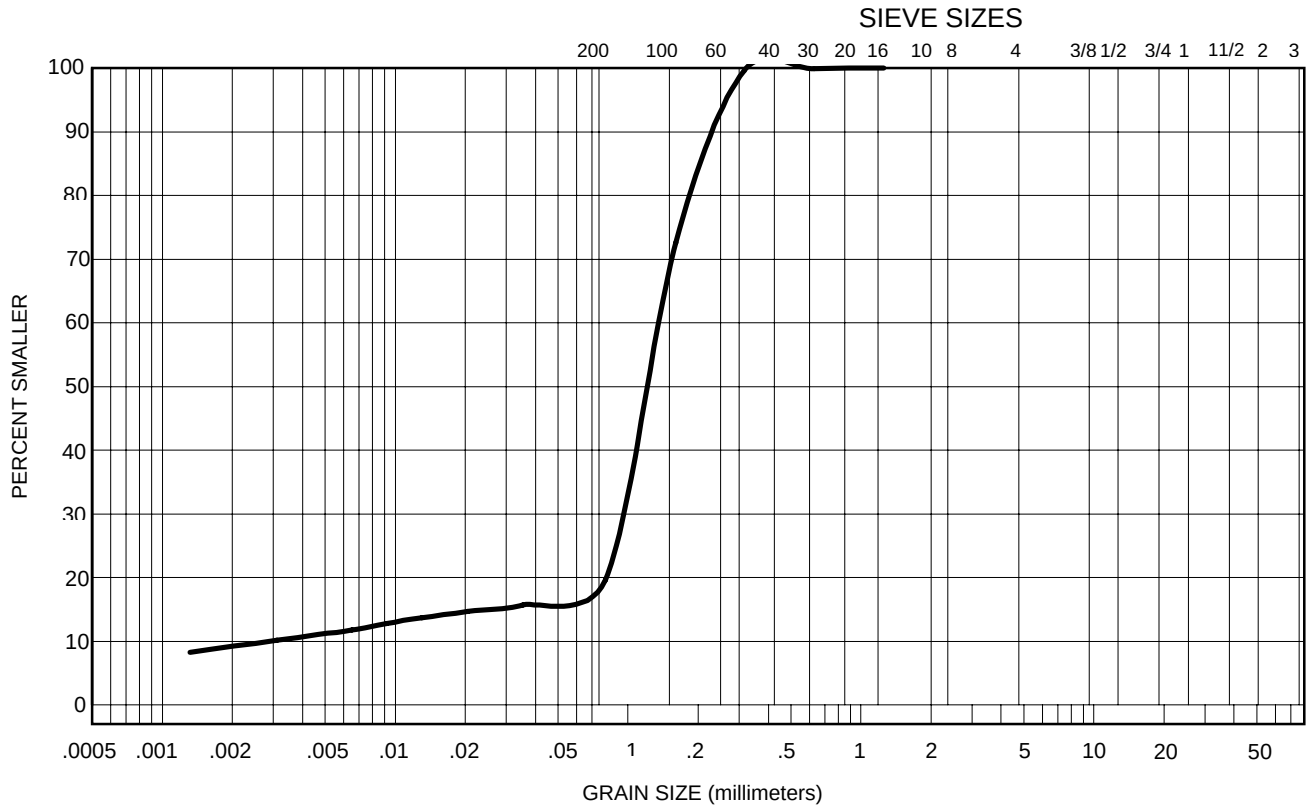
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 13-14, 2006
Sample ID: SRK06-11-01
Depth: n/a
Sample Number: n/a
Lab Number: 4150-25
Soil Description: SAND, some silt, trace clay
Natural Moisture Content: 19.2%
Remarks: N.P.

SIEVE, mm	PERCENTAGE PASSING
2.5	
1.25	
0.630	
0.315	100
0.160	73
0.08	20
0.035	16
0.020	15
0.0130	14
0.0092	13
0.0065	12
0.0031	10
0.0013	8

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

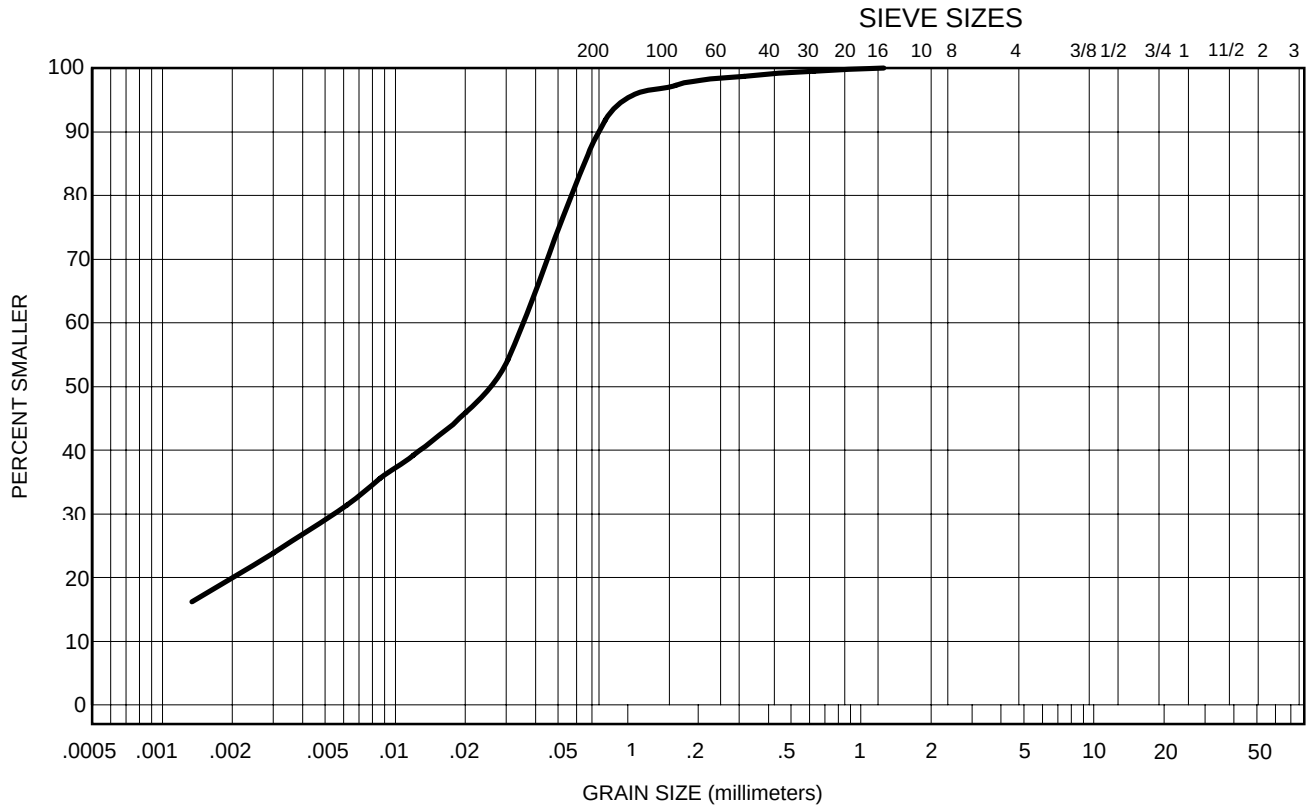
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 12-13, 2006
Sample ID: SRK06-12-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-27
Soil Description: SILT, some clay, trace sand
Natural Moisture Content: 45.5%
Remarks: LL=27%, PL=16%, PI=11%

SIEVE, mm	PERCENTAGE PASSING
2.5	
1.25	100
0.630	99
0.315	99
0.160	97
0.08	92
0.031	54
0.020	46
0.0120	39
0.0086	36
0.0062	31
0.0030	24
0.0013	16

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

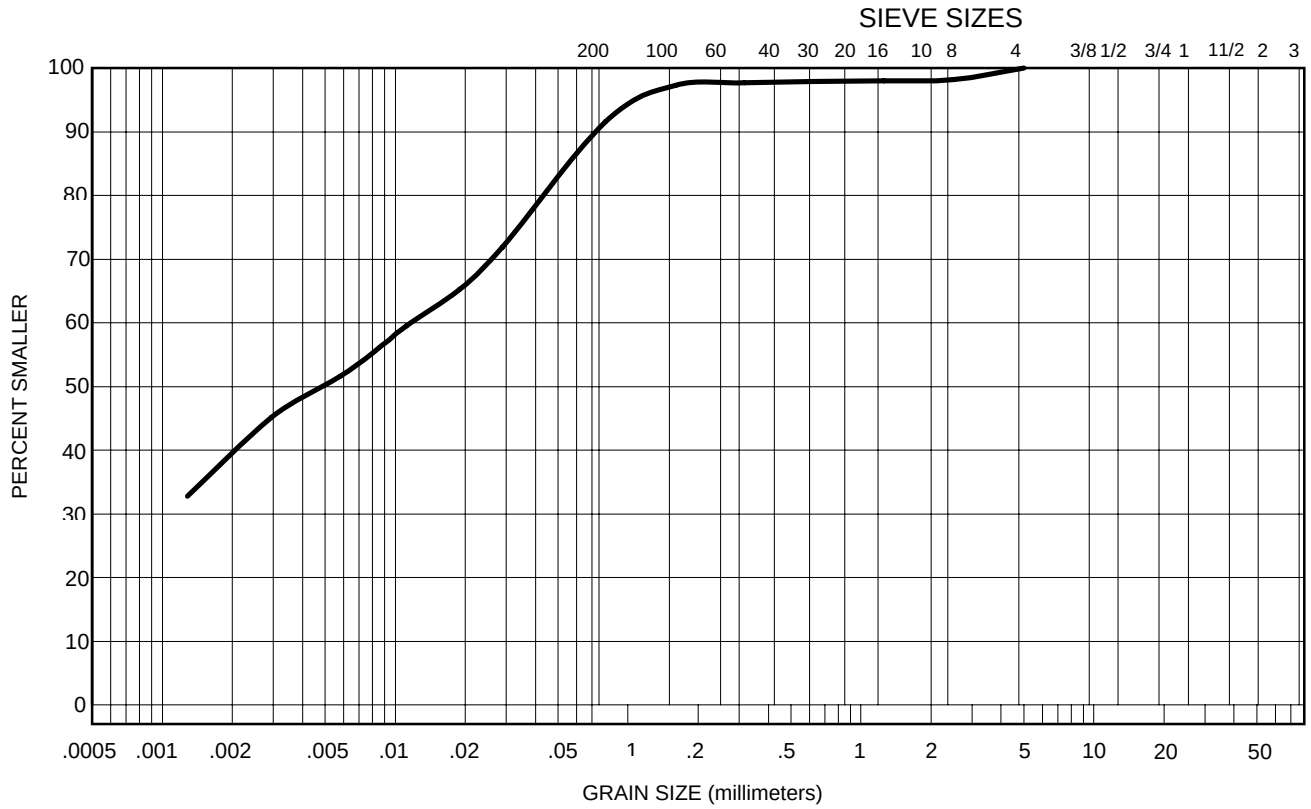
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 12-13,14-15, 2006
Sample ID: SRK06-12-03
Depth: n/a
Sample Number: n/a
Lab Number: 4150-28
Soil Description: SILT and CLAY, trace sand
Natural Moisture Content: 46.5%
Remarks: LL=40%, PL=20%, PI=20%

SIEVE, mm	PERCENTAGE PASSING
5.00	100
2.5	98
1.25	98
0.630	98
0.315	98
0.160	97
0.08	92
0.029	72
0.019	65
0.0112	59
0.0081	55
0.0058	52
0.0029	45
0.0013	33

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

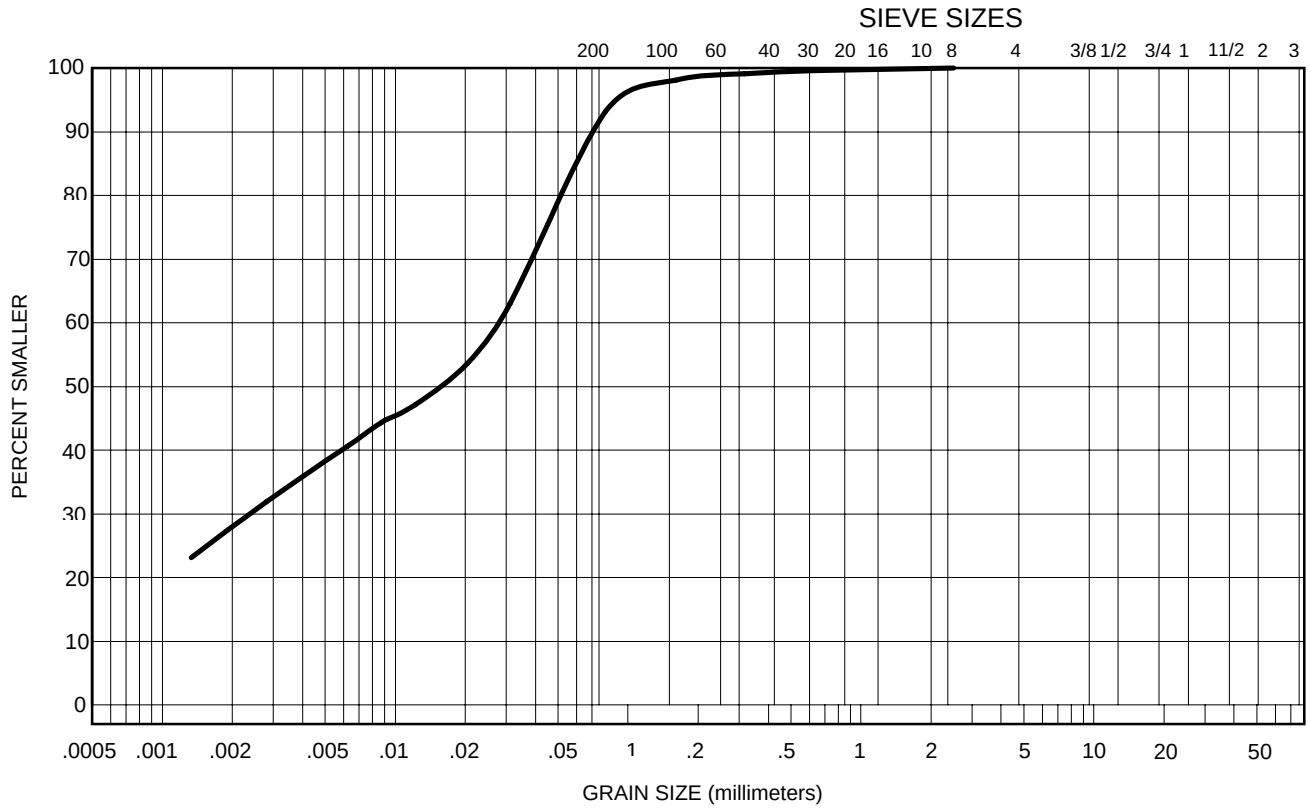
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project.
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 7-9, 2006
Sample ID: SRK06-13-01
Depth: n/a
Sample Number: n/a
Lab Number: 4150-29
Soil Description: SILT, clayey, trace sand
Natural Moisture Content: 43.8%
Remarks: LL=38%, PL=21%, PI=17%

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	100
0.315	99
0.160	98
0.08	93
0.031	63
0.021	54
0.0122	47
0.0087	44
0.0063	41
0.0028	32
0.0013	23

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

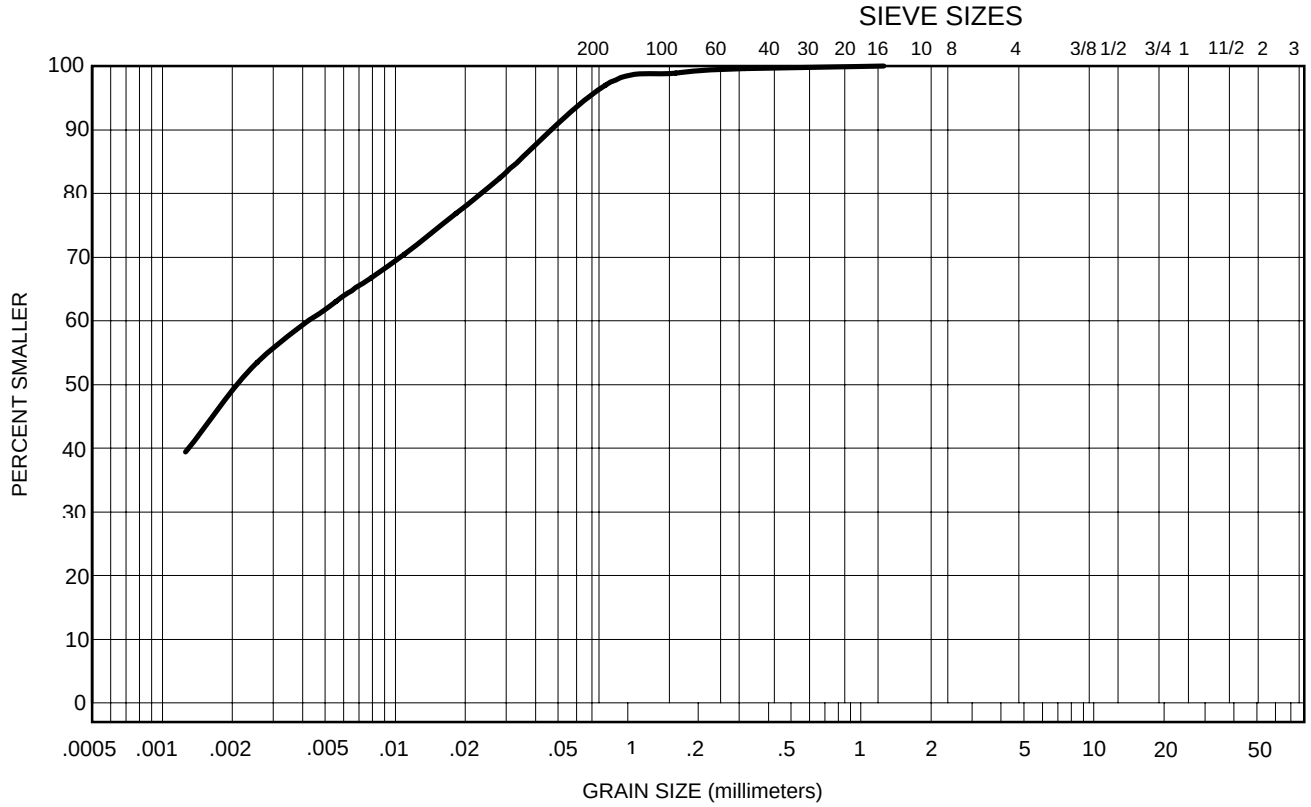
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services. Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 7-9, 2006
Sample ID: SRK06-13-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-30
Soil Description: CLAY and SILT, trace sand
Natural Moisture Content: 49.2%
Remarks: LL=42%, PL=22%, PI=20%

SIEVE, mm	PERCENTAGE PASSING
2.5	
1.25	
0.630	
0.315	100
0.160	99
0.08	97
0.028	82
0.018	77
0.0109	70
0.0079	67
0.0056	63
0.0026	54
0.0013	39

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

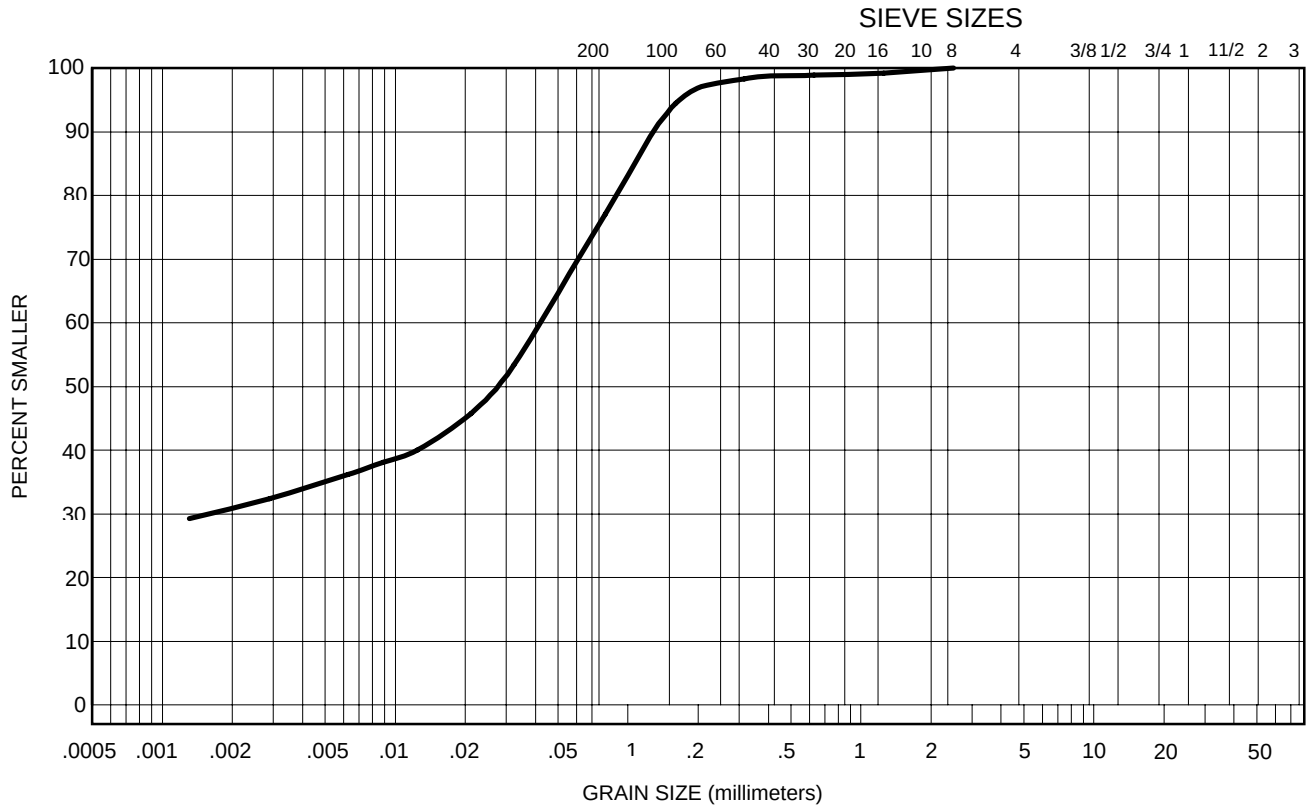
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services. Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr.Alvin Tong
Date Tested: June 7-9,13, 2006
Sample ID: SRK06-14-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-32
Soil Description: SILT, clayey, sandy
Natural Moisture Content: 43.3%
Remarks: LL=36%, PL=20%, PI=16%

SIEVE, mm	PERCENTAGE PASSING
2.5	100
1.25	99
0.630	99
0.315	98
0.160	94
0.08	77
0.032	53
0.021	46
0.0125	40
0.0089	38
0.0063	36
0.0029	32
0.0013	29

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

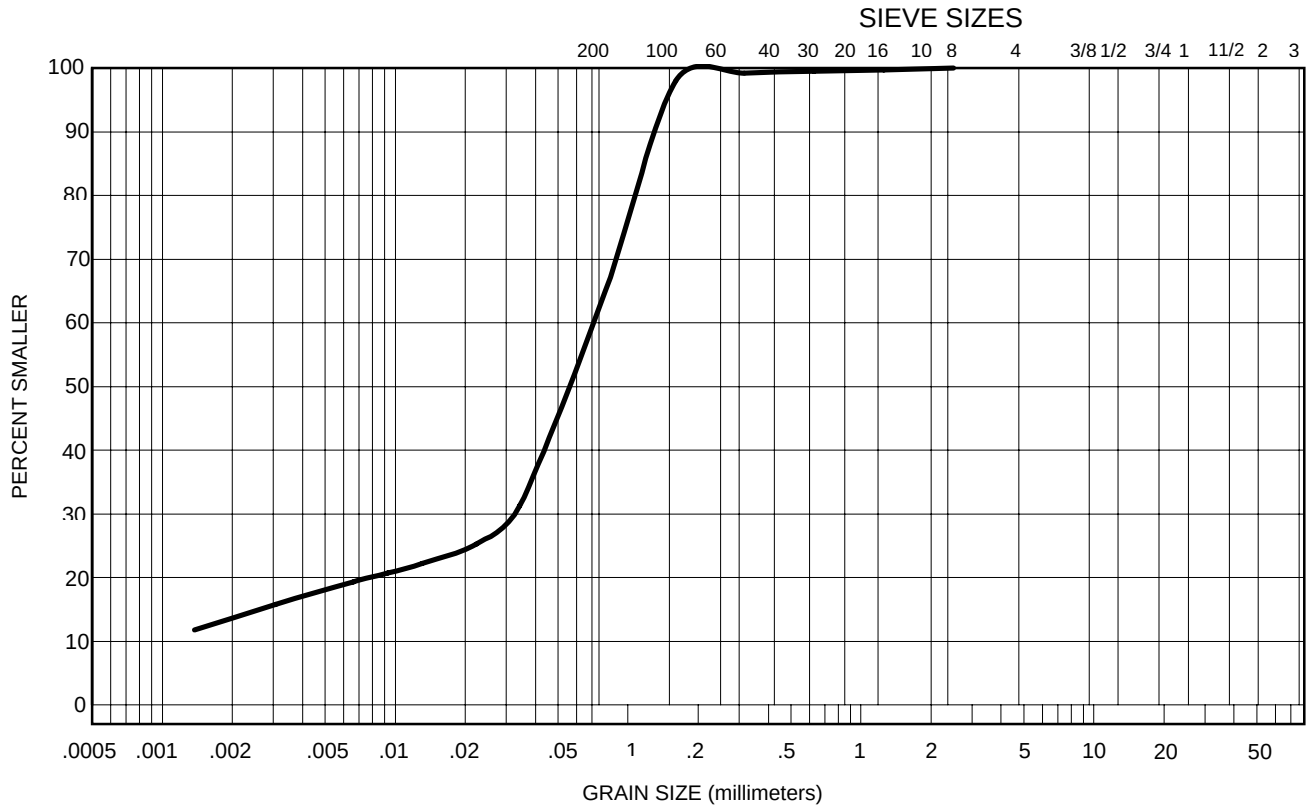
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services. Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr.Alvin Tong
Date Tested: June7-9,13, 2006
Sample ID: SRK06-15-01
Depth: n/a
Sample Number: n/a
Lab Number: 4150-34
Soil Description: SILT, sandy, some clay
Natural Moisture Content: 27.2%
Remarks: LL=19%, PL=16%, PI=3%

SIEVE, mm	PERCENTAGE PASSING
2.5	
1.25	
0.630	100
0.315	99
0.160	98
0.08	65
0.034	31
0.022	25
0.0131	22
0.0093	21
0.0066	19
0.0031	16
0.0014	12

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

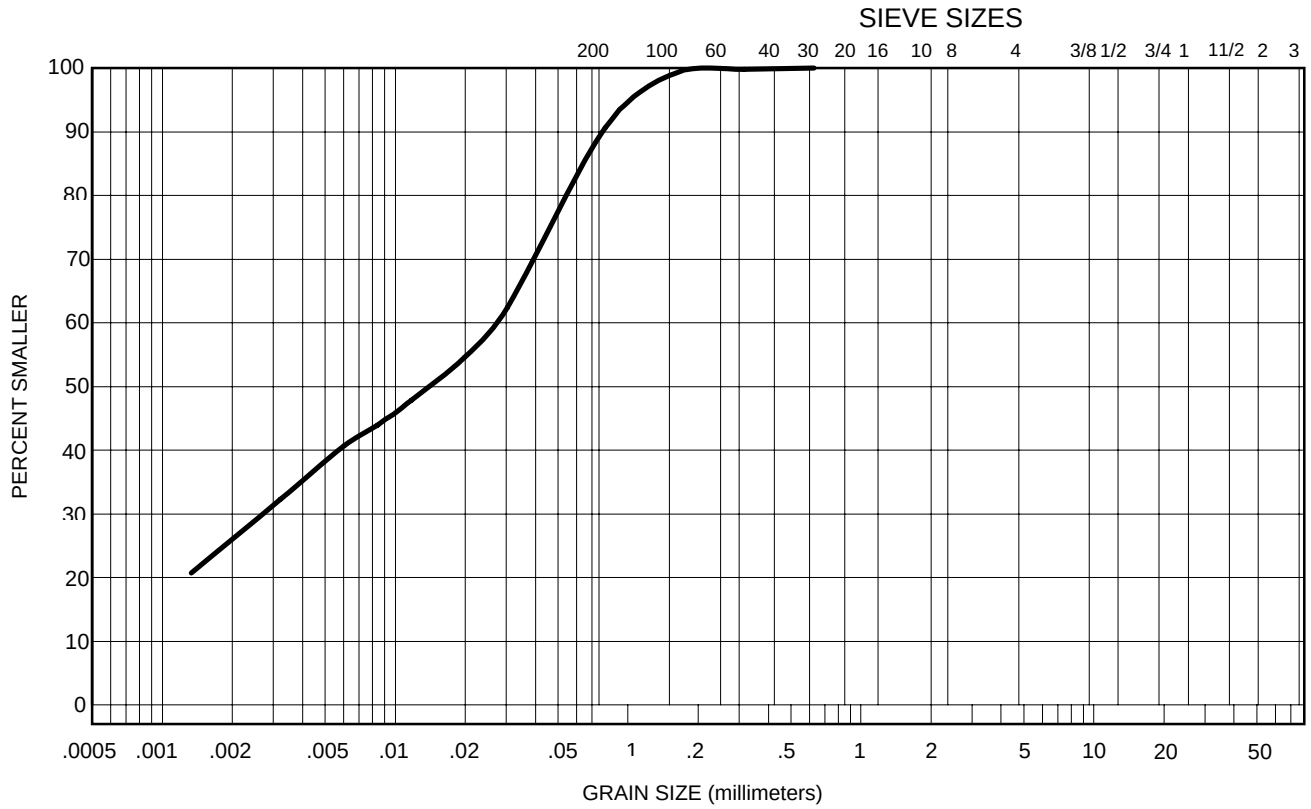
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 10-11,13, 2006
Sample ID: SRK06-15-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-35
Soil Description: SILT clayey, trace sand
Natural Moisture Content: 43.3%
Remarks: LL=36%, PL=20%, PI=16%

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	
0.315	100
0.160	99
0.08	91
0.030	62
0.020	55
0.0117	48
0.0084	44
0.0061	41
0.0032	32
0.0013	21

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

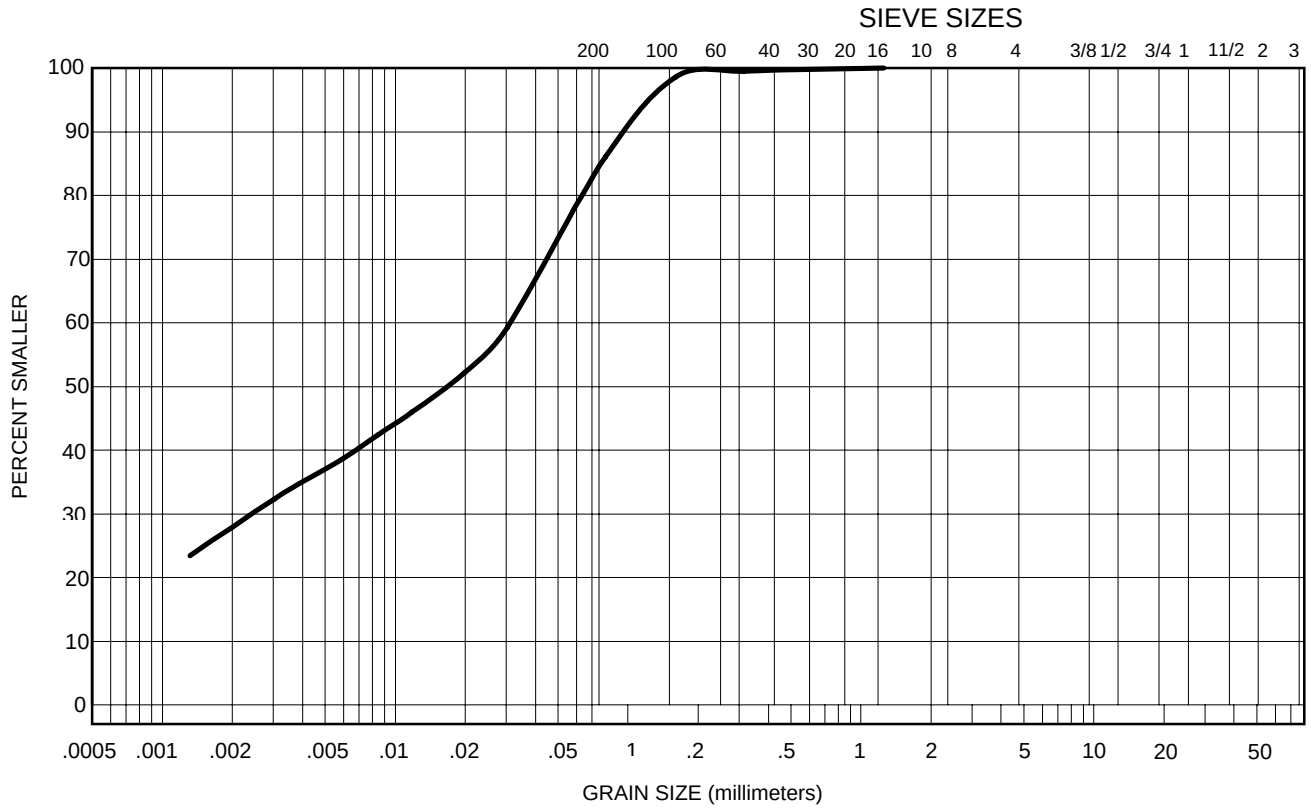
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 10-11, 14-15, 2006
Sample ID: SRK06-16-01
Depth: n/a
Sample Number: n/a
Lab Number: 4150-37
Soil Description: SILT, clayey, some sand
Natural Moisture Content: 37.3%
Remarks: LL=29%, PL=17%, PI=12%

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	100
0.315	99
0.160	99
0.08	86
0.030	59
0.020	52
0.0118	46
0.0084	42
0.0061	39
0.0030	32
0.0013	23

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

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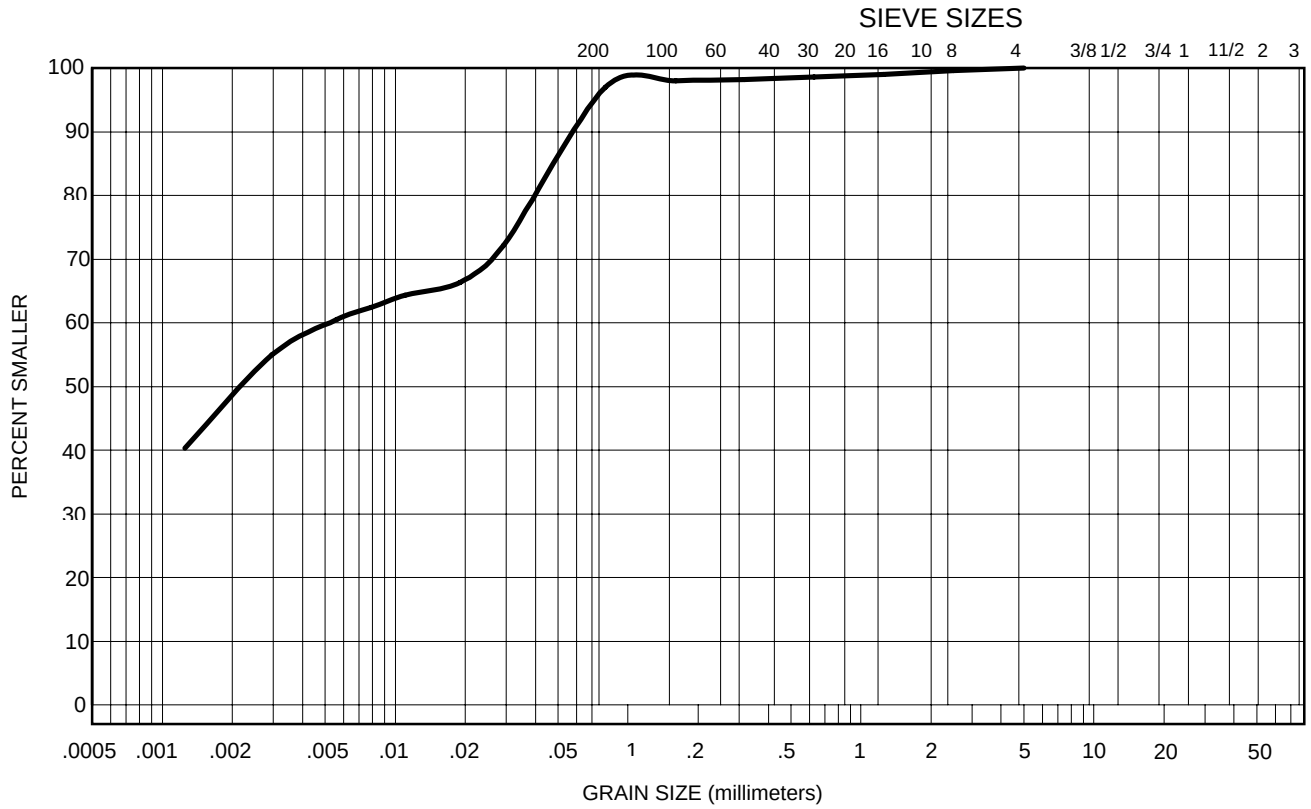
GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 10-11,14-15, 2006
Sample ID: SRK06-16-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-38
Soil Description: SILT and CLAY, trace sand
Natural Moisture Content: 70.7%
Remarks: LL=48%, PL=22%, PI=26%

SIEVE	PERCENTAGE PASSING
2.5	100
1.25	99
0.630	99
0.315	98
0.160	98
0.08	97
0.029	72
0.019	66
0.0111	64
0.0079	62
0.0056	60
0.0030	55
0.0013	40

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

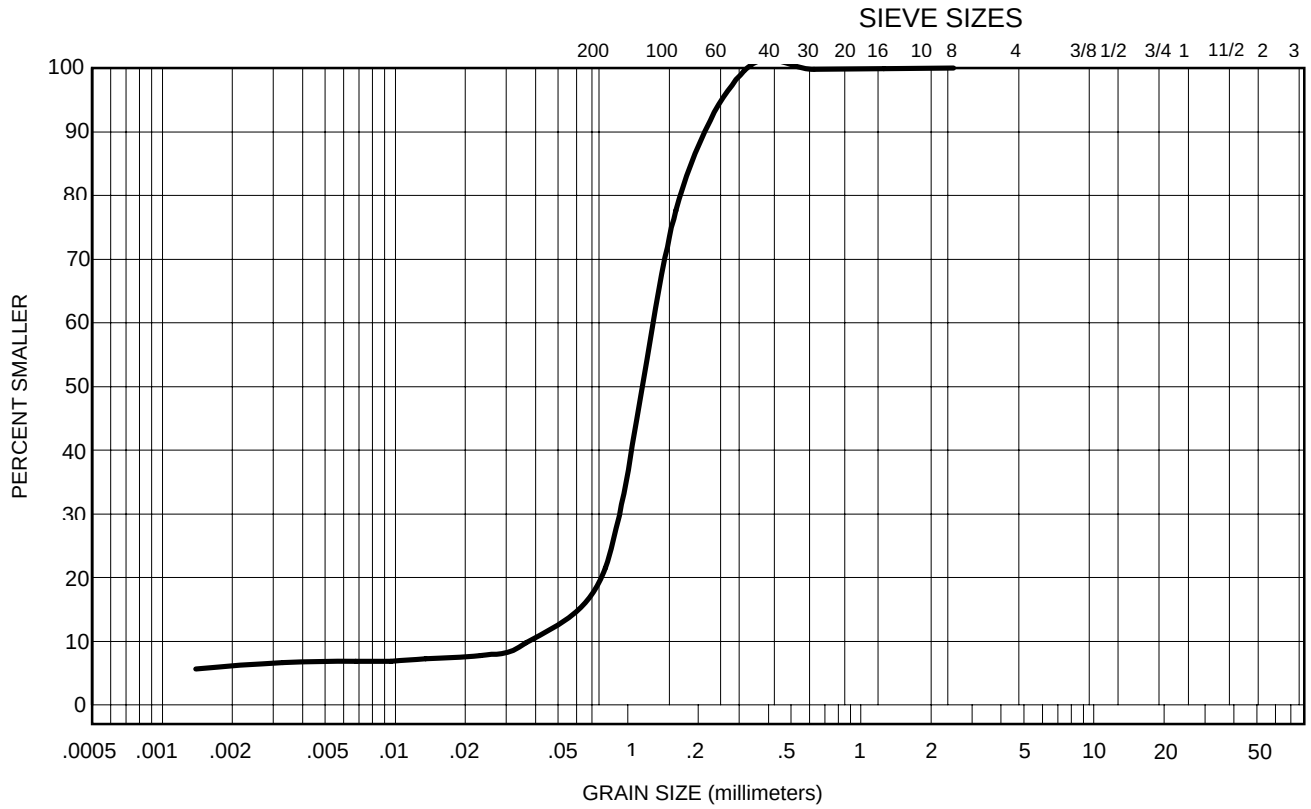
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 10-11, 2006
Sample ID: SRK06-17-01
Depth: n/a
Sample Number: n/a
Lab Number: 4150-40
Soil Description: SAND, some silt, trace clay
Natural Moisture Content: 20.3%
Remarks: N.P.

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	
0.315	100
0.160	78
0.08	21
0.036	10
0.023	8
0.0135	7
0.0096	7
0.0068	7
0.0033	7
0.0014	6

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

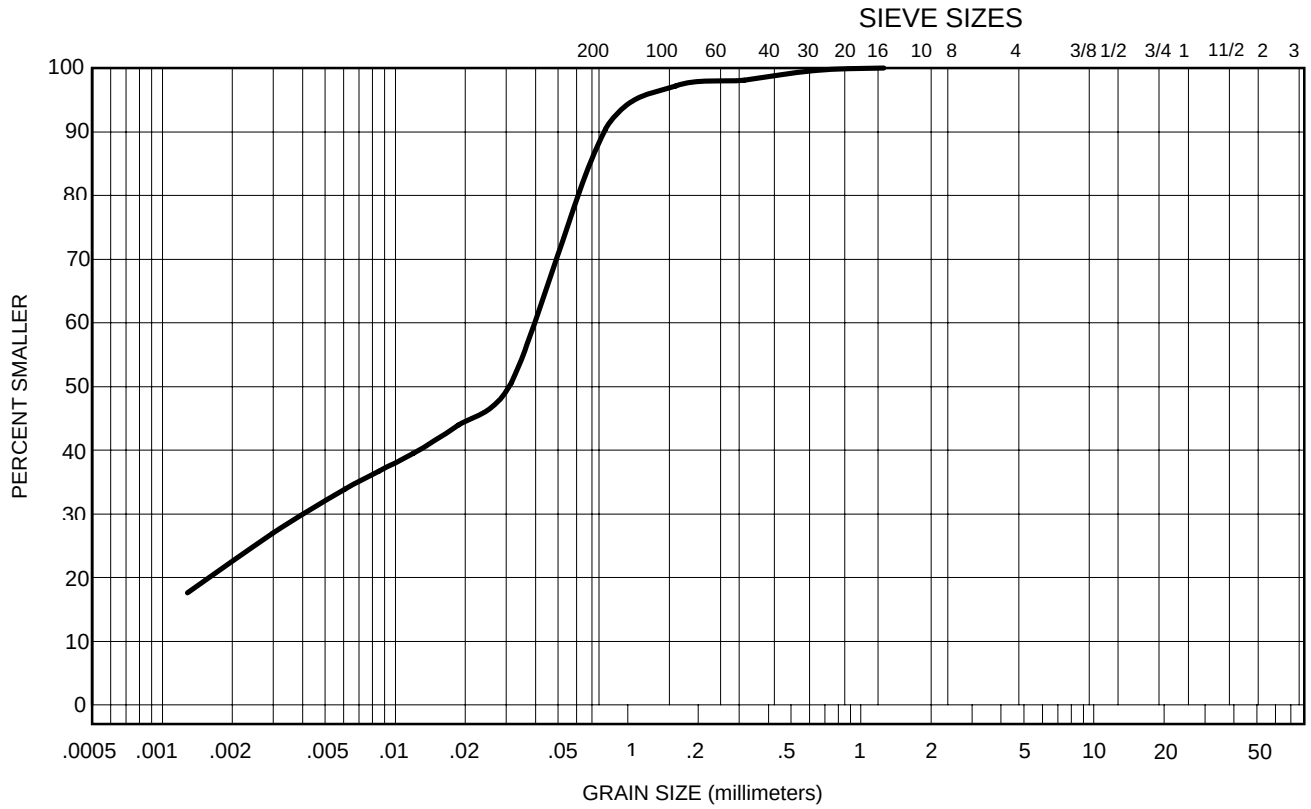
EBA Engineering Consultants Ltd.

GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 13-14,15-16, 2006
Sample ID: SRK06-17-02
Depth: n/a
Sample Number: n/a
Lab Number: 4150-41
Soil Description: SILT, clayey, some sand
Natural Moisture Content: 35.7%
Remarks: LL=34%, PL=19%, PI=15%

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	100
0.315	98
0.160	97
0.08	90
0.032	51
0.019	44
0.0119	40
0.0085	37
0.0061	34
0.0030	27
0.0013	18

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

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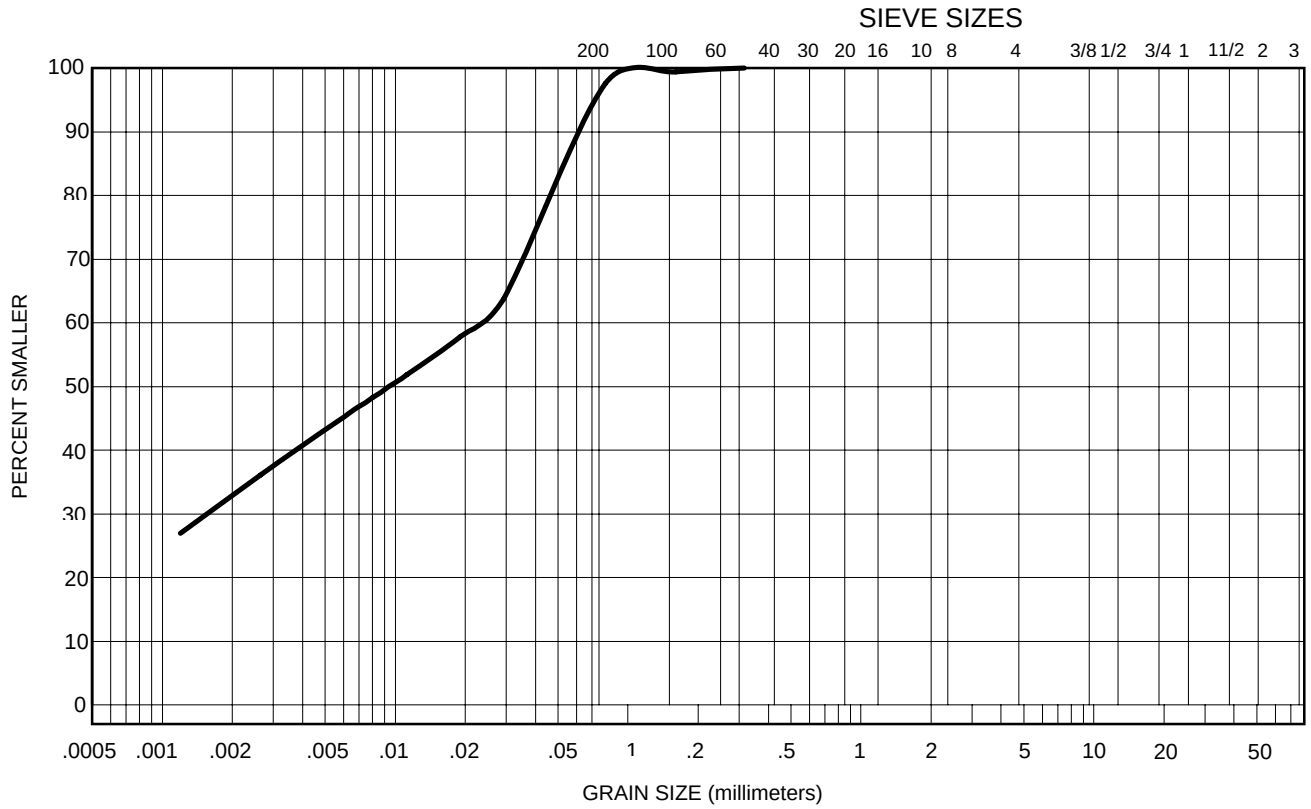
GRAIN SIZE DISTRIBUTION

Project: SRK 2006 Testing Services.Hope Bay Gold Project
Project Number: 1780176
Client: SRK Consulting Inc.
Attention: Mr. Alvin Tong
Date Tested: June 14-16, 2006
Sample ID: SRK06-17-03
Depth: n/a
Sample Number: n/a
Lab Number: 4150-42
Soil Description: SILT, clayey, trace sand
Natural Moisture Content: 43.4%
Remarks: LL=41%, PL=22%, PI=19%

SIEVE	PERCENTAGE PASSING
2.5	
1.25	
0.630	
0.315	100
0.160	99
0.08	98
0.029	64
0.019	58
0.0112	52
0.0080	48
0.0057	45
0.0026	36
0.0012	27

CLAY	SILT	SAND			GRAVEL	
		FINE	MEDIUM	COARSE	FINE	COARSE



Reviewed By:_____ P.Eng.

EBA Engineering Consultants Ltd.

14535 - 118th AVENUE
EDMONTON, ALBERTA
Phone (403) 451-2121

5664 BURLEIGH CRES. S.E.
CALGARY, ALBERTA
Phone (403) 253-7121

SPECIFIC GRAVITY OF SOIL

(ASTM Designation D854)

Project: Tail Lake and Jetty 2006 Test Hole No.: SRK 06-14-02

Address: _____ Depth: _____

_____ Sample No.: _____ Lab No.: _____

Project No.: 1780176 Sample Description: _____

Date Tested: 06.07.20 By: KP _____

TRIAL	1	2	3
Pycnometer No.	K	C	
Wt. of Soil, Pycnometer & Water (Wb)	174.45	177.59	
Wt. of Pycnometer	58.64	61.82	
Wt. of Dry Soil (Wo)	25.46	25.53	
Temp. of Soil & Water (Tx °C)	20.87	20.72	
Wt. of Pycnometer & Water @ Tx °C (From Calibration Curve)			
Specific Gravity (Gs)	2.701	2.706	
Avg. Specific Gravity	2.703		

$$G_s = \frac{W_o}{W_o + W_a - W_b}$$

Where: W_o = Dry wt. of soil

W_a = Wt. of pycnometer & water @ Tx °C (Calibration Curve)

W_b = Wt. of pycnometer, soil & water @ Tx°C

G_s = Specific Gravity of soil sample

Remarks: _____

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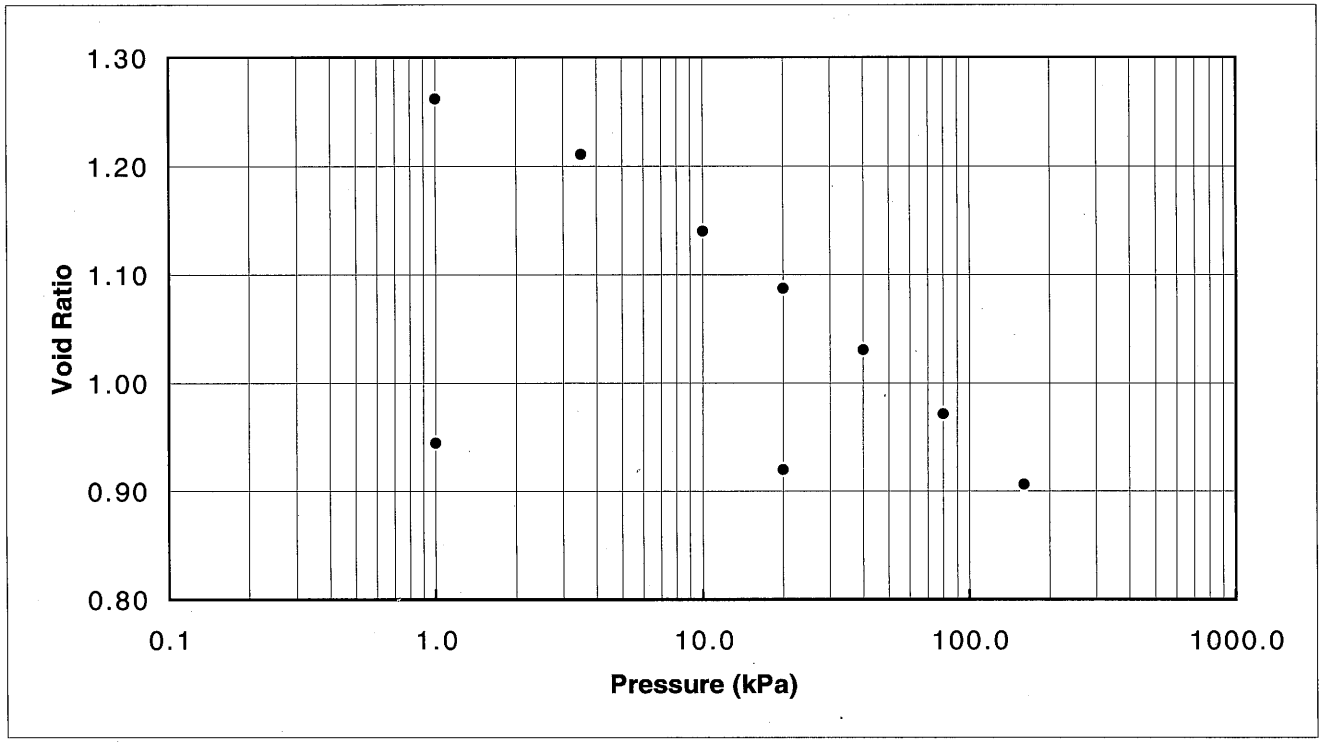
CONSOLIDATION TEST **TAIL LAKE AND JETTY 2006**

Project No.:	1780176	Test No.:	C-4
Date Tested:	06-07-20	Sample ID:	SRK06-14-02

	Initial	Final	
Height (mm):	26.47	22.75	
Moisture (%):	48.02	35.74	
Wet Dens. (Mg/m3):	1.769	1.887	
Dry Dens. (Mg/m3):	1.195	1.390	
Void Ratio:	1.2624	0.9447	Spec.Grav.= 2.70
Saturation:	100	100	



P (kPa)	Void Ratio	Cv (m2/yr)	Mv (m2/MN)	K (m/s)
1	1.26			
3.5	1.2114	0.25	9.0140	6.939E-10
10	1.1410	0.41	4.8937	6.180E-10
20	1.0878	0.59	2.4850	4.591E-10
40	1.0306	0.73	1.3697	3.112E-10
80	0.9714	1.15	0.7292	2.602E-10
160	0.9065	1.61	0.4119	2.062E-10
20	0.9196		0.0494	
1	0.9447		0.6869	

SAMPLE INFORMATION

Project: Tail Lake and Jetty 2006
Address: _____
_____
Project Number: 1780176
Date Tested: 06.07.20 By: S.K.
Test Apparatus: Consolidation
Machine Number: 6
Rate of Strain: _____ mm% / minute
Normal Stress: _____ kPa
Cell Pressure: _____ kPa
Back Pressure: _____ kPa
Head Differential: _____ kPa
Swelling Pressure: _____ kPa

Borehole Number: SRK06-14-02
Depth: _____
Test Number: C-4
Sample Description: CLAY, silty, reconstituted.

Sample Description	Diameter (mm)	Height (mm)
1		
2		
3		
4		
Mean	49.96	26.47

$V = 51.89\ cm^3$

	Trimmings	Initial	Final
Tare Number			
Mass of Wet Soil & Tare g		173.05	(84.18) 171.93
Mass of Dry Soil & Tare g			(62.02) 149.82
Mass of Tare g		81.25	6.70
Mass of Dry Soil g			
Mass of Moisture g			
Moisture Content %		48.02	35.74
Wet Density Mg/m^3		1.769	1.887
Dry Density Mg/m^3		1.195	1.390

6.89
6.74
.15

Sketch and Remarks:

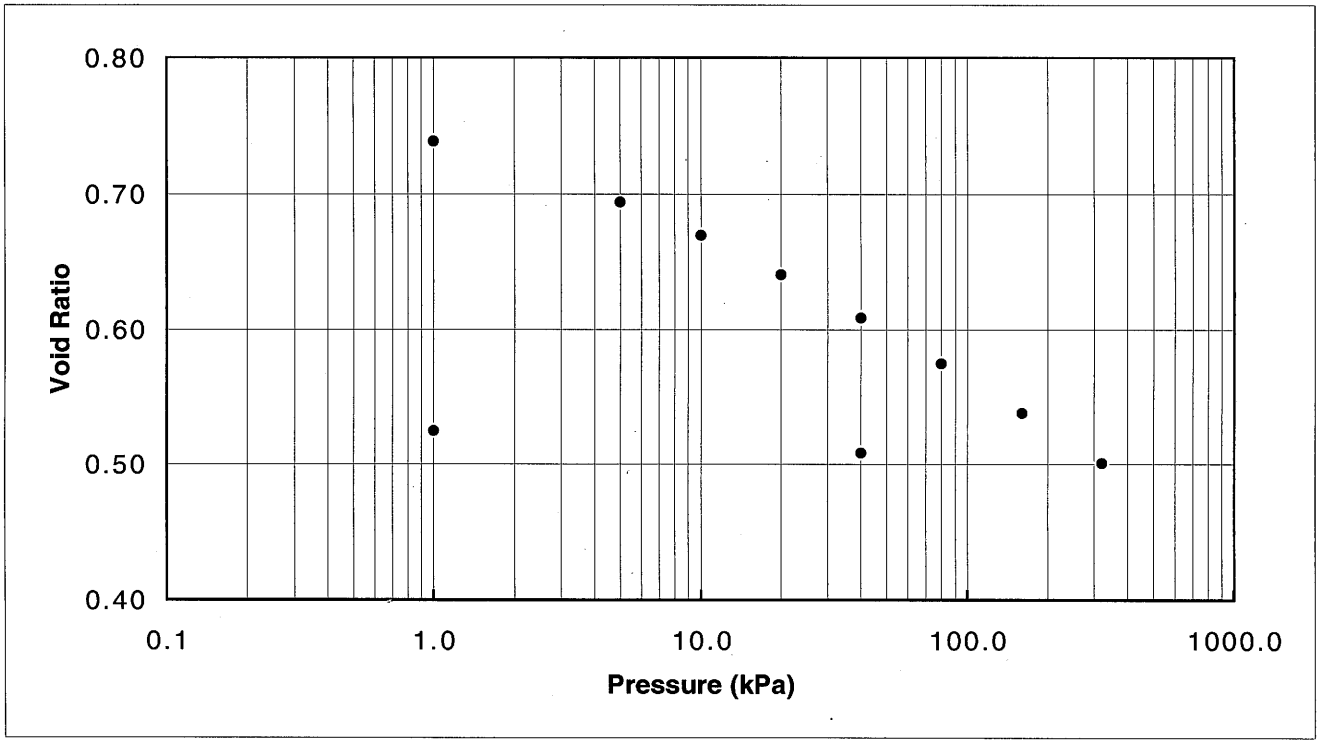
Angle of Shear: _____

EBA Engineering Consultants Ltd.

CONSOLIDATION TEST **TAIL LAKE AND JETTY 2006**

Project No.: 1780176 Test No.: C-5
Date Tested: 06-07-18 Sample ID: SRK06-17-03

	Initial	Final	
Height (mm):	26.56	23.30	
Moisture (%):	27.56	20.03	
Wet Dens. (Mg/m3):	1.983	2.128	
Dry Dens. (Mg/m3):	1.555	1.773	
Void Ratio:	0.7390	0.5252	Spec.Grav.= 2.70
Saturation:	100	100	



P (kPa)	Void Ratio	Cv (m2/yr)	Mv (m2/MN)	K (m/s)
1	0.74			
5	0.6945	0.27	6.4031	5.394E-10
10	0.6698	0.30	2.9153	2.726E-10
20	0.6405	0.43	1.7509	2.329E-10
40	0.6086	0.71	0.9722	2.147E-10
80	0.5749	0.88	0.5240	1.436E-10
160	0.5380	1.46	0.2931	1.328E-10
320	0.5012	2.72	0.1495	1.265E-10
40	0.5087		0.0179	
1	0.5252		0.2808	

SAMPLE INFORMATION

Project: Tail Lake and Jetty 2006
Address: _____
_____
Project Number: 1780176
Date Tested: 06.07.18 By: S.K.
Test Apparatus: Consolidation
Machine Number: 8
Rate of Strain: _____ mm% / minute
Normal Stress: _____ kPa
Cell Pressure: _____ kPa
Back Pressure: _____ kPa
Head Differential: _____ kPa
Swelling Pressure: _____ kPa

Borehole Number: SRK06-17-03
Depth: _____
Test Number: C-5
Sample Description: CLAY, silty, reconstituted.

Sample Description	Diameter (mm)	Height (mm)
1		
2		
3		
4		
Mean	49.96	26.56

$V = 52.07\ cm^3$

	Trimmings	Initial	Final
Tare Number			
Mass of Wet Soil & Tare g		187.34	(97.18) 187.73
Mass of Dry Soil & Tare g			(80.96) 171.55
Mass of Tare g		84.07	6.70
Mass of Dry Soil g			
Mass of Moisture g			
Moisture Content %		27.56	20.03
Wet Density Mg/m^3		1.983	2.128
Dry Density Mg/m^3		1.555	1.773

6.83
6.65
.18

Sketch and Remarks:

Angle of Shear: _____

EBA Engineering

Unconsolidated Undrained Triaxial Test **Tail Lake and Jetty 2006**

Project No.: 1780176
Date Tested: 06-07-27

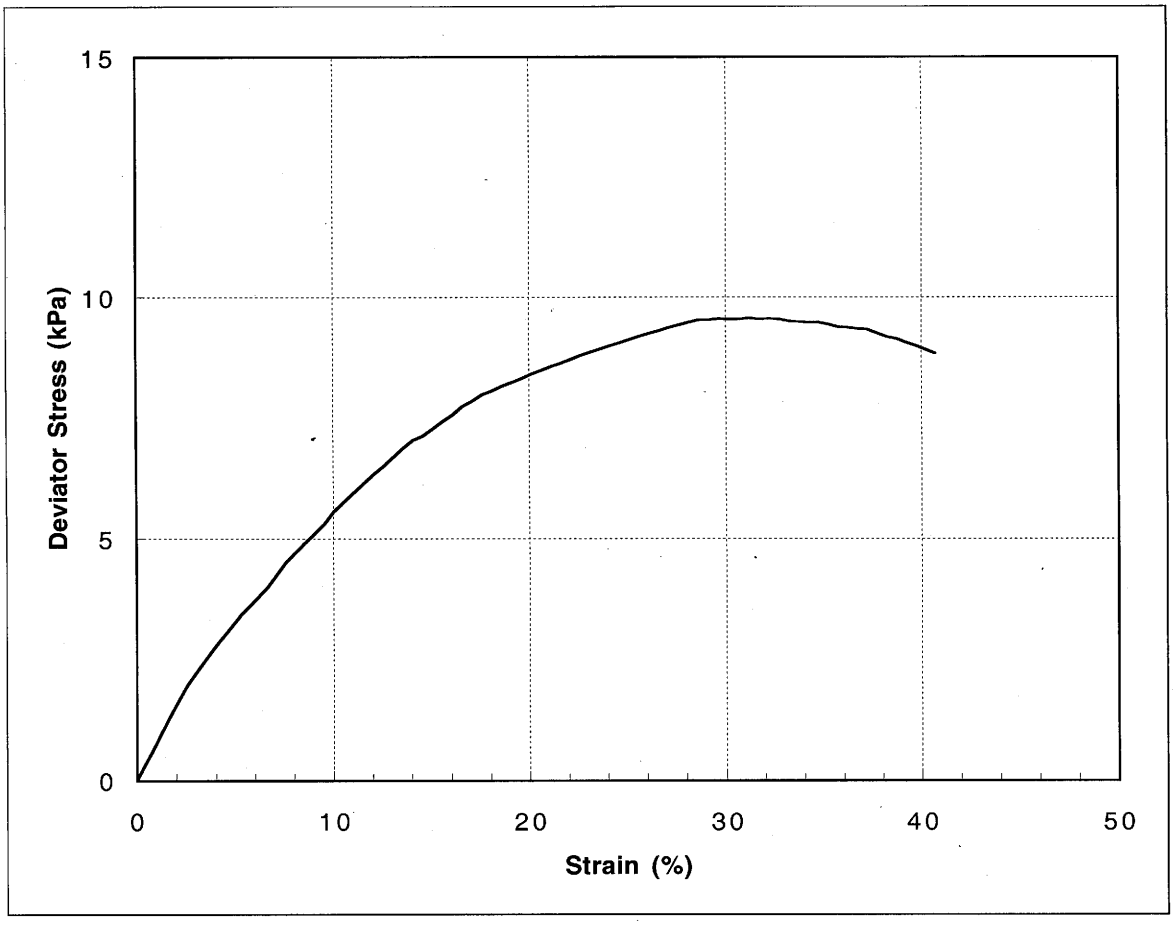
Sample ID: SRK06-12-02
Test Number: UU-3
Confining Stress (kPa): 130

Initial Sample Conditions

Moisture Content (%):	44.3
Wet Density (Mg/m^3):	1.918
Dry Density (Mg/m^3):	1.329

Rate of Strain (%/min.): 0.5

Peak Stress (kPa): 9.6



SAMPLE INFORMATION

Project: Tail Lake and Jetty 2006
Address: _____
_____
Project Number: 1780176
Date Tested: 06.07.27 By: S.K.
Test Apparatus: TX (UU)
Machine Number: 1
Rate of Strain: 0.5 ~~mm~~ % / minute
Normal Stress: _____ kPa
Cell Pressure: 130 kPa
Back Pressure: _____ kPa
Head Differential: _____ kPa
Swelling Pressure: _____ kPa

Borehole Number: SRK06-12-02
Depth: _____
Test Number: UU-3
Sample Description: CLAY, silty, some sand, very soft, wet, dark gray.

Sample Description	Diameter (mm)	Height (mm)
1		
2		
3		
4		
Mean	41.20	74.50

$V = 99.32\ cm^3$

	Trimmings	Initial	Final
Tare Number			
Mass of Wet Soil & Tare g		190.53	191.97
Mass of Dry Soil & Tare g			135.07
Mass of Tare g			6.65
Mass of Dry Soil g			128.42
Mass of Moisture g			
Moisture Content %			44.31
Wet Density Mg/m^3		1.918	
Dry Density Mg/m^3		1.329	

Sketch and Remarks:

Note: Sample slumped somewhat during set up.

Angle of Shear: _____

EBA Engineering

Unconsolidated Undrained Triaxial Test **Tail Lake and Jetty 2006**

Project No.: 1780176
Date Tested: 06-07-28

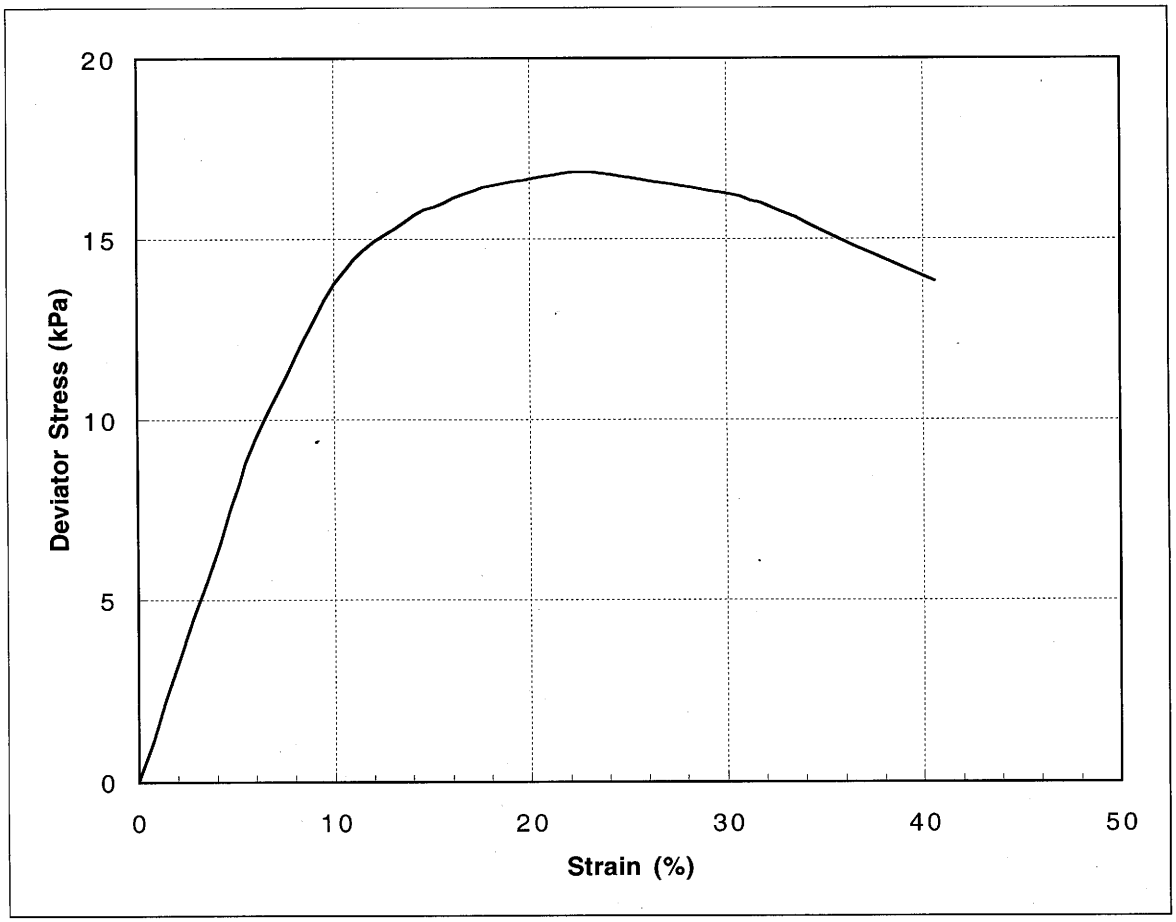
Sample ID: SRK06-16-02
Test Number: UU-4
Confining Stress (kPa): 111

Initial Sample Conditions

Moisture Content (%):	31.8
Wet Density (Mg/m^3):	2.076
Dry Density (Mg/m^3):	1.576

Rate of Strain (%/min.): 0.5

Peak Stress (kPa): 16.8



SAMPLE INFORMATION

Project: Tail Lake and Jetty 2006 Borehole Number: SRK06-16-02

Address: _____ Depth: _____

_____ Test Number: UU-4

Project Number: 1780176 Sample Description: CLAY, silty, some sand, soft, dark gray

Date Tested: 06.07.28 By: S.K.

Test Apparatus: TX(UU)

Machine Number: 1

Rate of Strain: 0.5 % / minute

Normal Stress: _____ kPa

Cell Pressure: 111 kPa

Back Pressure: _____ kPa

Head Differential: _____ kPa

Swelling Pressure: _____ kPa

Sample Description	Diameter (mm)	Height (mm)
1		
2		
3		
4		
Mean	38.64	77.40

$V = 90.76\ cm^3$

	Trimmings	Initial	Final
Tare Number			
Mass of Wet Soil & Tare g		188.45	192.12
Mass of Dry Soil & Tare g			147.39
Mass of Tare g			6.65
Mass of Dry Soil g			140.74
Mass of Moisture g			
Moisture Content %			31.78
Wet Density Mg/m^3		2.076	
Dry Density Mg/m^3		1.576	

Sketch and Remarks:

Note: Sampled slumped somewhat during set up.

Angle of Shear: _____

Appendix C

Technical memorandum outlining jetty design calculations

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Technical Memorandum

To:	Brian Labadie - MHBL	**Date:**	September 14, 2005
cc:	Project File	**From:**	Maritz Rykaart, Ben Wickland
Subject:	Preliminary Jetty Design Calculations	**Project #:**	1CM014.006

1 Introduction

This technical memorandum documents design calculations and assumptions for the geotechnical aspects of the proposed continuous rock fill jetty in Roberts Bay, Hope Bay, Nunavut, Canada. This jetty will be part of the development infrastructure for the proposed Doris North Project, a small gold mine being developed by Miramar Hope Bay Limited. Complete details and drawings of the proposed jetty are documented in the following report;

SRK Consulting (Canada) Inc. 2005. *Preliminary Jetty Design, Doris North Project, Hope Bay, Nunavut, Canada*. Technical report submitted to Miramar Hope Bay Limited, Project No. 1CM014.006, October 2005.

This design is preliminary in nature, and is intended to be used to confirm general feasibility of the concept proposed, and allow for cost estimation to ±15% accuracy.

2 Preliminary Design

2.1 Design Approach

The continuous rock fill jetty will be constructed on soft marine sediments. It is therefore necessary to confirm that the load applied by the jetty will be less than the allowable (ultimate) bearing capacity of the marine sediments. For the purpose of this design it is reasonable to assume that the base of the rock fill jetty is a shallow foundation (Holtz and Kovacs 1981).

2.2 Data Sources

Geotechnical data for the jetty foundation material has been documented in the Preliminary Jetty Design Report mentioned in Section 1 of this technical memorandum. This data includes drill holes, in-situ vane shear testing and laboratory foundation indicator testing. The data is deemed adequate to conduct a preliminary design for the jetty.

2.3 Applied Loads

2.3.1 Dead Loads

The limiting case for the proposed jetty geometry is described by a cross section through the jetty head. This jetty head consists of a 25 m wide roadway crown over a 6.5 m deep fill with side slopes of 1.2:1. Under this scenario, the base of the foundation is 40.8 m wide, and the water level is 1.5 m below the roadway.

For a 1 m deep section through the jetty head fill, the volumes, unit weights, and total dead load for the geometry described above are included in Table 1.

Table 1. Jetty head section volumes, unit weights, and loads.

Section	Volume m^3	Unit Wt. (kN/m^3)	Load (kN)
Unsaturated upper fill	40.2	19.62	789
Saturated lower fill	173.0	9.81 (submerged)	1,697
Total fill	**213.2**		**2,486**

Thus, for a total area of 40.2 m^2, the applied load of 2,486 kN, due to the weight of the fill, results in an applied stress, q_a, of 61.8 kPa over the area of the footing.

2.3.2 Live Loads

Live loads on the jetty include the traffic of loaders, as well as the action of ice, wind, and snow. The action of ice, wind and snow are not considered here.

The total load applied by a Komastsu WA500-3 Wheeled Loader (the largest equipment to be used) with a fully laden shipping container is approximately 48,100 kg. Over a 1 m deep section of the jetty head, the applied load is equivalent to an additional increase in applied stress, q_a, of 1.2 kPa.

2.3.3 Total Load

The total load exerted by the jetty on the marine foundation is thus the sum of the live and the dead load, i.e. 61.8 + 1.2 = 63 kPa.

2.4 Bearing Capacity

Nilcon vane shear test results for the upper 5 m of marine sediment at the jetty head location are summarized in Table 2.

Table 2. Nilcon vane shear test results for proposed jetty head location.

	Peak (kPa)	Residual (kPa)	Remoulded (kPa)
Maximum	28.1	12.7	4.4
Minimum	13.3	4.7	0.6
Average	20.4	8.6	3.2

The bearing capacity of the sediment was calculated on the basis of peak undrained shear strength of 15 kPa. The average plasticity index of CL samples taken from the proposed jetty location, and from the 1997 investigation in the area (EBA 1997) was 17.5%, and no vane shear correction was applied to field values.

For undrained loading at the surface of the marine sediment, the ultimate bearing capacity equation reduces to:

$$q_u = N_c C_u$$

where, q_u is ultimate bearing capacity, N_c is a bearing capacity coefficient, and C_u is the undrained shear strength. The value of N_c for a soft sediment varies to a maximum of 5.14. Accordingly, the ultimate bearing capacity, q_u, of the sediment is 77.1 kPa.

2.5 Bearing Capacity Factor of Safety

The factor of safety is calculated as follows:

F.S. = q_u/q_a = 77.1 kPa / 63 kPa = 1.22

2.6 Consolidation Settlement

2.6.1 Total Settlement

The proposed jetty will undergo settlement due to the consolidation of the underlying marine sediment. Samples were not tested for compressibility, but total settlements and time to consolidation are estimated here based on sample void content as determined from saturated water content, the depth of the sediment layer, and assumed values of compression index and coefficient of consolidation. Values of parameters used for the calculation of total settlement are included in Table 3.

Table 3. Design values for consolidation calculations.

Component	Value
Thickness of marine sediment layer	13 m
Saturated unit weight of marine sediment	18 kN/m^3
Initial effective stress at midpoint of the layer	53.2 kPa
Initial void ratio	1.27
Compression Index	0.25 to 0.5 (assumed)
Applied stress	62 kPa
Coefficient of consolidation	10 m^2/year (assumed)

Assuming an increase in effective stress equal to the dead load of 61.8 kPa, the midpoint of the profile will undergo a change in effective stress from 53.2 kPa to 115.2 kPa. The total expected settlement is estimated to be approximately 0.5 m to 1.0 m.

2.6.2 Time Rate of Consolidation

Estimates of time of consolidation indicate up to 0.15 m settlement after one year, and up to 0.3 m after 5 years. The actual rates of settlement may vary considerably from estimates.

Rates of consolidation are estimated from coefficient of consolidation. The coefficient of consolidation of 10 m^2/year listed in Table 3 was approximated from the average liquid limit of near 40% and Figure 9.10, page 404, Holtz and Kovacs (1981).

Time to consolidation is highly dependent on the hydraulic conductivity of the sediment, which was not measured. The drilling program observed some sandier sediments, which will have higher hydraulic conductivity than clay rich portions. The presence of sandy layers may increase the rate of consolidation.

3 Design Options

Alternative geometries and the effect of including geosynthetic re-enforcement of the base of the jetty fill were examined for effect on applied load q_a and factor of safety, F.S.

3.1 Jetty Head Geometry

Options for decreasing the pressure at the base of the jetty head fill include flattening the side slopes, and reducing the width of the fill. The variation in applied stress is illustrated in Table 4. The most conservative design includes a design profile with a 6 m roadway with 4:1 side slopes. Predicted loads are converted to factors of safety, F.S.'s, in Table 5.

Table 4. Variation in applied stress, q_a, due to changes in jetty head geometry.

Side Slope (H:V)	Top Width (m)			
	25	15	10	6
1.2:1	61.2	55.6	51.1	46.1
2:1	55.6	50.0	46.1	42.0
3:1	51.1	46.1	42.7	39.6
4:1	48.2	43.6	40.8	38.2

Table 5. Factor of Safety for alternate jetty head geometries (excluding live loads).

Side Slope (H:V)	Top Width (m)			
	25	15	10	6
1.2:1	1.26	1.39	1.51	1.67
2:1	1.39	1.54	1.67	1.84
3:1	1.51	1.67	1.80	1.95
4:1	1.60	1.77	1.89	2.02

3.2 Geosynthetic Re-Enforcement

The use of geosynthetic (geotextile and geogrid) re-enforcement at the base of the fill was investigated for effect on bearing capacity (Koerner 2005). Two suppliers were also contacted for information regarding the use of geosynthetics. Principle advantages to using a geosynthetic re-enforcement at the base of the jetty fill include:

- Prevent rock fill from sinking upon initial placement during construction
- Reduction of differential settlements
- Even distribution of stress over marine sediment – allowing use of N_c = 5.14
- Prevent movement of fines into overlying coarse layers

The soft marine sediments at the proposed jetty location may fail during construction if the ultimate bearing capacity is exceeded. With time, the sediments will consolidate, and the allowable load will increase. However, localized loading may cause a failure, and a geosynthetic re-enforced pad will help reduce the potential for failure.

A possible re-enforcement configuration over the base of the jetty fill includes a multiple layer structure of three to four layers of bi-axial geogrid, separated by 0.6 m of rock fill passing 30 cm. The jetty embankment fill may be constructed directly on top of the re-enforced layers.

Case studies where geosynthetics has been used for this type of application are listed on the web site of one of the suppliers (www.tenax.net/geosynthetics/case_history). SRK is not aware of any case study of geosynthetic re-enforced pad constructed in an arctic environment. However, geosynthetics are commonly used in conventional applications in the arctic (liners, ponds, etc.), and therefore there is no reason to believe that this application would not be feasible. This statement is supported by the suppliers that was contacted, that are prepared to guarantee their product for this application in the arctic.

4 Recommendations for Further Work

Based on the results of this preliminary design, it is evident that a jetty can be constructed as planned. Prior to conducting the detailed design it would be beneficial to conduct another field investigation in the jetty foundation sediments, specifically to collect undisturbed samples upon which triaxial shear testing and consolidation testing can be done.

5 References

EBA Engineering Consultants. 1997. *Boston Gold Project Geotechnical Investigation Proposed Roberts Bay Port*. Report Submitted to BHP World Minerals, October.

Holtz, R.D., and Kovacs, W.D. 1981. *An Introduction to Geotechnical Engineering*. Prentice-Hall Inc. New Jersey, pp.733.

Koerner, R.M. 2005. *Designing with Geosynthetics, Fifth Edition*, Pearson Prentice Hall, N.J., 796 pages.

Appendix D

Technical memorandum on thermal pad design

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Technical Memorandum

To:	Brian Labadie	**Date:**	August 20, 2006
cc:	Project File	**From:**	Michel Noël/Maritz Rykaart
Subject:	Doris North Project - Thermal modelling to support design thickness for granular pads	**Project #:**	1CM014.008.420

1 Introduction

This technical memorandum presents the modelling that was carried out to determine the minimum thickness for granular pads used for surface infrastructure foundations at the Doris North Project. The granular fill material will consist of crushed rock, and will be placed directly onto the sensitive permafrost overburden soils during the winter.

The intent is to carry out no excavation of permafrost soils, except in areas where there is only a very shallow veneer of overburden covering competent bedrock, and then only for the most critical structures, i.e. the crusher and mill foundations, as well as the fuel tank farm and the airstrip. Therefore, all other surface infrastructure must be constructed on rockfill pads that will remain stable, but that will not result in undue damage to the permafrost environment. It is furthermore understood that upon closure, the pads will not be completely removed, thus it is not expected that the site be returned to its pre-mining state.

The thickness of the granular pads will be dependent on the required bearing capacity and on the thermal behaviour in relation with the permafrost. The thickness of the granular pads discussed herein was calculated using the modified Berggren equation developed by Aldrich and Paynter (1966).

2 Input Parameters

The granular pads will be fabricated from crushed basalt rock. The thermal properties were estimated using the method by Johansen (1975) and had the following properties:

- Porosity: 0.30
- Degrees of saturation: 60%
- Unsaturated thermal conductivity: unfrozen: 161 kJ m^{-1} day^{-1} $°C^{-1}$; frozen: 178 kJ m^{-1} day^{-1} $°C^{-1}$
- Unsaturated volumetric heat capacity: unfrozen: 2,230 kJ m^{-3} °C; frozen: 1,916 kJ m^{-3} °C

Climatic data was collected at the Doris North and the Boston Camp sites during exploration work. But because of limited data, the local climatic data was complemented using three regional weather stations operated by Environment Canada, namely Lupin, Ikaluktutiak (Cambridge Bay) and Kugluktuk (Coppermine) (AMEC 2003a, b). The climatic data collected at the Doris North and Boston Camp sites was then used to develop correlations for the Doris North site using the Environment Canada weather stations.

The correlated data from the Environment Canada weather stations over a 30 year period give the following values:

- mean annual ambient temperature: -12.1 °C
- amplitude of annual ambient temperature: 20.3 °C
- air thawing index: 748 °C-days
- air freezing index: -5,135 °C-days
- days with mean daily temperature above freezing: 108

The surface temperature was assigned a value of -6 °C. The ground temperature measured at the site outside the influence of water bodies averaged about -8 °C over a range of -10 to -6 °C (SRK 2005a, b).

3 Results

Using the method by Aldrich and Paynter (1966) with the input values listed herein, a pad thickness of about 2.1 m would be required to maintain the active zone within the granular pad, i.e. the original ground is below the active zone and remains permanently frozen. This recommended pad thickness can be reduced if the original ground does not contain massive ice within the active zone while having good draining capabilities (i.e. sand deposits). In this case, the thickness of the granular pad would then be controlled by bearing capacity requirements. On bedrock outcrops; the pad thickness would be determined by the grading requirements.

It should further be noted that the Doris North site ground surface is generally covered with hummocky vegetation or by muskeg where overburden is present. Such organic layer provides good insulation to the underlying permafrost but is sensitive to disturbance. The removal of the organic layer will increase the depth of the active layer. Basic thermal simulations indicate that the thermal value of the organic cover can be approximated by about 1 m of granular fill, i.e. if the organic layer was to be removed, it should be replaced by at least 1 m of granular fill to ensure that the active layer remains unchanged.

4 Design Recommendations

If the pad thickness is not sufficiently thick to ensure that the active layer remains within the pad fill material, then the depth to which the active layer does penetrate beneath the pad will consolidate when the soil thaws, which may lead to settlement and subsequent damage to the foundation pad and any associated infrastructure on the pad.

The extensive geotechnical investigations carried out at the Doris North site does confirm that the overburden soils are ice rich; however, these ice rich zones are generally not found within the active layer which ranges between 0.5 to 2 m thick. Therefore, having absolute design criteria that requires the active layer to remain within the construction pad is probably not necessary, since settlement is likely to be small. Furthermore such settlement is not likely to occur rapidly, but could take days, or more likely weeks and months to produce noticeable results. Such improvements could thus easily be managed and mitigated through the adoption of a regular monitoring and maintenance program.

Monitoring should include installation of thermistor cables to determine how deep the active layer penetrates beneath the pad, as well as visual observation of pads and road alignments. Mitigation will consist of a program of infill and levelling of pad and roadway surfaces using pre-stockpiled and graded fill material.

For the preliminary design stage of the Doris North Project, SRK recommended that MHBL adopt a minimum pad thickness of 2.5 m for structures that would be susceptible to damage from settlement, such as the mill and crusher foundations, and for less important structures such as roads, a pad

thickness of 2 m would be sufficient. This decision was made at the time with a limited understanding of the physical site conditions and therefore the highest margin of conservatism was adopted. Furthermore, MHBL did not wish to underestimate the potential costs associated with capital construction for the Project.

For the final detailed design stage, MHBL requested that SRK consider reducing the pad thickness requirement, taking into account the additional information that is available about the site physical conditions. Reducing the pad thickness requirement would not only result in a significantly lower amount of quarry development and thus a lower environmental impact, but could also offer some cost saving to the Project.

SRK would be satisfied that all non-critical pads be have a minimum overall thickness of 1.0 m. This thickness will ensure physical stability based on the expected loads, and also in some areas it will be sufficiently thick that the active layer will remain within the pad. In those areas that the active layer will extend beneath the pad, MHBL is advised that settlement will occur, and that such settlement will lead to the need to be monitored and repairs will have to be carried out to ensure safe and efficient operation. MHBL is also advised that in some instances settlement may lead to the temporary closure of roads or facilities until the necessary repairs have been completed.

For important structures, the minimum pad thickness should be 2.0 m. whilst this is probably sufficiently thick that the active layer would remain in the fill material, there does remain a small possibility for some settlement, so MHBL should put in place a monitoring and maintenance plan as described previously that includes these structures.

This reduced pad thickness will not result in any greater environmental impact on the permafrost environment, especially since the fill will not be removed at closure.

5 REFERENCES

AMEC. 2003a. *Draft Environmental Impact Statement, Doris North Project, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, January 2003.

AMEC. 2003b. *Meteorology and Hydrology Baseline, Doris North Project, Nunavut, Canada*. Report submitted to Miramar Hope Bay Limited, August 2003.

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Aldrich, H.P. and Paynter, H.M. 1966. *Depth of Frost Penetration in Non-uniform Soil*. U.S. Army Cold Reg. Res. Eng. Lab. Spec. Rep. 104.

Johansen, O. 1975. *Thermal conductivity of soils*. Ph.D. diss., Norwegian Technical Univ., Trondheim; also, U.S. Army Cold Reg. Res. Eng. Lab. Transl. 637, July 1977.

SRK Consulting (Canada) Inc. 2005a. Preliminary Surface Infrastructure Design, Doris North Project, Hope Bay, Nunavut, Canada. Report submitted to MHBL, Project No. 1CM014.006, October.

SRK Consulting (Canada) Inc. 2005b. Preliminary Tailings Dam Design, Doris North Project, Hope Bay, Nunavut, Canada. Report submitted to MHBL, Project No. 1CM014.006, October.

Appendix E

Technical memorandum on construction quantities

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Technical Memorandum

To:	Larry Connell	**Date:**	October 25, 2006
cc:	Project File	**From:**	Maritz Rykaart
Subject:	Construction Quantities for the Doris North Project	**Project #:**	1CM014.008

All surface infrastructure components for the Doris North Project that require fill, i.e. roads, runway, pads etc. will be constructed from clean rock quarried from one of the four quarry sites identified.

Table 1 below lists preliminary volumes of construction rock, as well as the most likely quarry source. These volumes and footprint areas are based on the Preliminary designs carried out in October 2005. Revised quantities will be calculated as Schedule 1 to the Technical Specifications at the time of tender.

The construction rock properties have been assumed to be as follows;

- specific gravity = 2.50,
- swell = 40%,
- load cubic metre (LCM) density = 1.79 Mg/m^3,
- moisture content = 4%,
- reconsolidation = 50%, and
- reconsolidated (excavated cubic metre (ECM)) density = 2.08 Mg/m^3.

Table 2 lists estimated quarry rock requirements for maintenance of the surface infrastructure components. Additional construction rock volumes that may be required at mine closure is listed in Table 3. Finally, Table 4 list a cumulative total quarry rock volume expected to be developed from each of the four rock quarries.

Table 1: Estimated Footprint Size, Quarry Rock Volumes (Neat) and Quarry Locations for Surface Infrastructure Components

Infrastructure Component	General Detail	Estimated Quantity[1]		Footprint Surface[1] Area (m^2)	Quarry Source
		ECM (m^3)	Dry Tonnes		
Jetty	6m wide traffic surface; 1.2:1 side slopes; 0.5m sediment consolidation; 103m length (SRK 2005b)	5,600	11,600	1,800	Q1
Jetty (contingency)	Allowance for excessive slumping and settlement during construction (SRK 2005b)	2,800	5,800	900	Q1
Beach lay-down area	60m x 100m surface area; 1.2:1 side slopes; 2.5m average thickness	16,300	33,800	6,700	Q1
Fuel transfer station	32m x 16.5m surface area; 1.2:1 side slopes, 3m average thickness; 0.8m high containment berm	2,000 (300 m^2 HDPE, 600 m^2 geotextile)	4,000	600	Q1
Tank farm at mill (7.5 million litre)	71m x 71m surface area; 1.2:1 side slopes; 0.5m average thickness; 0.8m high containment berm	5,200 (4,700 m^2 HDPE, 9,400 m^2 geotextile)	10,800	5,000	Q2
Tailings discharge decant road	5.1m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 378m length	5,700	11,900	2,400	Q2
Tailings discharge pump house pad	20m x 20m surface area; 1.2:1 side slopes; 2.0m average thickness	700	1,500	400	Q2
All-weather road (barge site to mill)	6m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 4.8km length	80,700	167,800	51,900	Q1 (20%) Q2 (80%)
Road turnouts (2) (barge site to mill)	10m wide; 30m long; 1.2:1 side slopes; 2.0m average thickness	1,200	2,500	800	Q1
All-weather road (tailings service road)	5.1m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 5.9km length	88,500	184,100	59,000	Q2
Caribou crossings (8)	10m long; 5:1 approach slopes; 2.0m average thickness	2,500	5,200	2,500	Q2
Road turnouts (8) & turnaround (tailings service road)	10m wide; 30m long; 1.2:1 side slopes; 2.0m average thickness & 10m x 10m turnaround	5,000	10,500	3,100	Q2
Explosives magazine access road	5.1 m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 525m length	7,900	16,400	5,200	Q2
Float plane & boat dock service road	6m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 300m length	8,500	17,600	3,300	Q2
Landfill access road	6m wide traffic surface; 1.2:1 side slopes; 2.0m average thickness; 150m length	2,600	5,300	1,600	Q2

Infrastructure Component	General Detail	Estimated Quantity[1]		Footprint Surface[1] Area (m^2)	Quarry Source
		ECM (m^3)	Dry Tonnes		
Bridge crossing and abutments (2)	10m wide traffic surface; 1.2:1 side slopes; 2.5m average thickness; 27m length	1,900	3,800	900	Q2
Permanent all-weather airstrip	23m wide traffic surface; 2.5:1 side slopes; 2.5 m average thickness; 914m length	66,900	139,100	32,500	Q2
Airstrip apron	17m x 40m surface area; 2.5:1 side slopes; 2.5m average thickness	2,000	4,100	1,600	Q2
Explosives magazines	3 pads, total 550m^2 surface area; 1.2:1 side slopes; 2.5m average thickness; safety berm; AN/FO pad	8,500	17,600	1,700	Q2
Mill and camp area	Mill Crusher Ore Stockpile Workshop Fuel tank farm Mill reagents storage Lay-down area Power supply Camp/Dry Mine office Sewage treatment plant Potable water treatment plant Waste rock pile pad and berm Waste rock pile pond berm	55,100 (1,000m^2 HDPE, 2,000m^2, geotextile)	114,600	62,600	Q4
Float plane & dock	10m x 30m surface area; 1.2:1 side slopes; 3.0m average thickness	900	1,900	1,000	Q2
Tailings emergency dump catch basins (4)	25.2m x 25.2m surface area; 2:1 side slopes; 2.0m average base thickness; 1m high containment berm	5,100 (1,200 m^2 HDPE, 1,200 m^2 geotextile)	10,600	4,400	Q2
North Dam	Refer to SRK (2005a) for details of this structure	65,400	136,100	12,100	Q2
South Dam	Refer to SRK (2005a) for details of this structure	42,100	87,400	12,800	Q2
Roberts Bay fish habitat	8 spurs with each 5m x 15m surface area; 0.5m thickness; and 6 rock spurs each with 5m x 20m surface area; 0.5m thickness (Golder 2005)	600	1,200	1,200	Q1
Doris Lake fish habitat	5 areas each with 25m x 25m surface area; 1.5m thickness; and 1 area with 30m x 30m surface area; 1.5m thickness (Golder 2005)	6,000	12,500	4,000	Q2
Shoreline protection	20% of 12.9 ha surface area (up to elev. 29.4m); 0.5m thickness (SRK 2005c)	12,900 (25,800m^2 geotextile)	26,800	25,800	Q3
TOTALS		**502,600**	**1,044,500**	**305,800**	**-**

1. All estimated quantities and areas have been rounded to nearest 100.

Table 2: Estimated Quarry Rock Volumes Required for Maintenance of the Surface Infrastructure Components

Infrastructure Component	General Detail	Estimated Quantity[1]		Footprint Surface[1] Area (m^2)	Quarry Source
		ECM (m^3)	Dry Tonnes		
Jetty maintenance	Allow 50cm to be added to Jetty surface every year for 5 years	1,400	2,800	n/a	Q1
All surface road maintenance	Allowance for all surface road maintenance @ 10cm new surfacing grade every year for 8 years	73,000	151,800	n/a	Q1 (10%) Q2 (90%)
Landfill interim cover	100m x 100m surface area; 1.2:1 side slopes; 0.3m average thickness added on top of waste every year for 8 years	24,000	50,000	n/a	Q2
Shoreline erosion (contingency)	20% of 12.9 ha surface area (up to elev. 29.4m); 0.5m thickness (SRK 2005c)	12,900 (25,800m^2 geotextile)	26,800	25,800	Q3
TOTALS		**111,300**	**231,400**	**25,800**	**-**

1. All estimated quantities and areas have been rounded to nearest 100.

Table 3: Estimated Quarry Rock Volumes Required for Closure of Surface Infrastructure Components

Infrastructure Component	General Detail	Estimated Quantity[1]		Footprint Surface[1] Area (m^2)	Quarry Source
		ECM (m^3)	Dry Tonnes		
Landfill closure	100m x 100m surface area; 1.2:1 side slopes; 1m average thickness for ultimate cover	10,000	20,800	n/a	Q2
Shoreline erosion (contingency)	Remaining 60% of 12.9 ha surface area (up to elev. 29.4m); 0.5m thickness (SRK 2005c)	38,700 (77,400m^2 geotextile)	80,500	77,400	Q3
Shoreline erosion (worse case contingency)	36.7 ha surface area (up to full supply level); 0.5m thickness (SRK 2005c)	183,500 (367,000m^2 geotextile)	381,600	367,000	Q3
TOTALS		**232,200**	**482,900**	**444,400**	**-**

1. All estimated quantities and areas have been rounded to nearest 100.

Table 4: Total Volume of Material Excavated from Each Quarry

Quarry	Estimated Quantity	
	ECM (m^3)	Dry Tonnes
#1	52,000	108,000
#2	491,000	1,020,500
#3	248,000	515,700
#4	55,100	114,600
TOTAL	**846,100**	**1,758,800**