April 2012

GAHCHO KUÉ PROJECT

2011 Shoreline and Channel Erosion Assessment

Submitted to:
De Beers Canada Inc.

REPORT

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1.0 INTRODUCTION

De Beers Canada Inc. (De Beers) is proposing to develop the Gahcho Kué Project (Project), a diamond mine in the Northwest Territories (NWT). The Project is located in the North Slave region of the NWT at Kennedy Lake, approximately 140 kilometres (km) northeast of Łutselk'e and 280 km northeast of Yellowknife.

Baseline studies have been conducted to support the Environmental Impact Assessment (EIS) for the Project and the Environmental Impact Review (EIR) Process. These data were reported in the December 2010 EIS (De Beers 2010). Baseline data reported in the 2010 EIS are sufficient to support the environmental assessment within the EIS. However, De Beers is committed to ongoing data collection in advance of regulatory approval of and the permitting process for the Project. As such, supplemental baseline data have been collected in 2011, and will continue to be collected and reported annually, until such time that these activities are no longer required prior to Project construction or evolve into future monitoring programs associated with an approved Project.

The purpose of collecting and reporting the supplemental baseline data for the Project is to support a consistent and transparent baseline program. In general, the goals of the supplemental data collection are to:

- reduce uncertainty and increase the level of confidence in impact predictions;
- broaden the baseline areas of investigation; and
- contribute to long-term future monitoring and adaptive management of the Project.

The focus of the 2011 supplemental data collection reported herein is to evaluate the potential for shoreline and channel erosion. Section 8 of the 2010 EIS (De Beers 2010) and 2011 EIS Update (De Beers 2011) outlined potential effects from erosion based on predicted changes to hydrological flows from the Project. More specifically, erosion is anticipated along new lake shorelines that will be created and within modified lake outlet channels that will be subject to increased flows following dyke constructions and diversion of existing streams. Shoreline field data were collected in 2010 to address these potential effects. The objective of the 2011 data collection was to enhance the existing database.

The 2010 field data provided for a qualitative assessment of the potential effects from erosion on shorelines and channels (De Beers 2010, Addendum HH, Section HH3.7). The 2011 field data, reported herein, augmented the 2010 data set to provide a more comprehensive shoreline erosion potential assessment. Results from this assessment helped define site specific mitigation, where required, to manage flows and minimize the potential for erosion during Project constructions and operations as well as provide predictions on conditions at closure.

This supplemental report focuses on only those lake and channel shorelines that are predicted to be affected by changes in hydrological flows resulting from the Project. The entire collected field data are presented in this report, but the shoreline assessment and mitigation measures were only carried out for potentially affected areas based on the Project description current at the time of writing this report.

1.1 Study Area

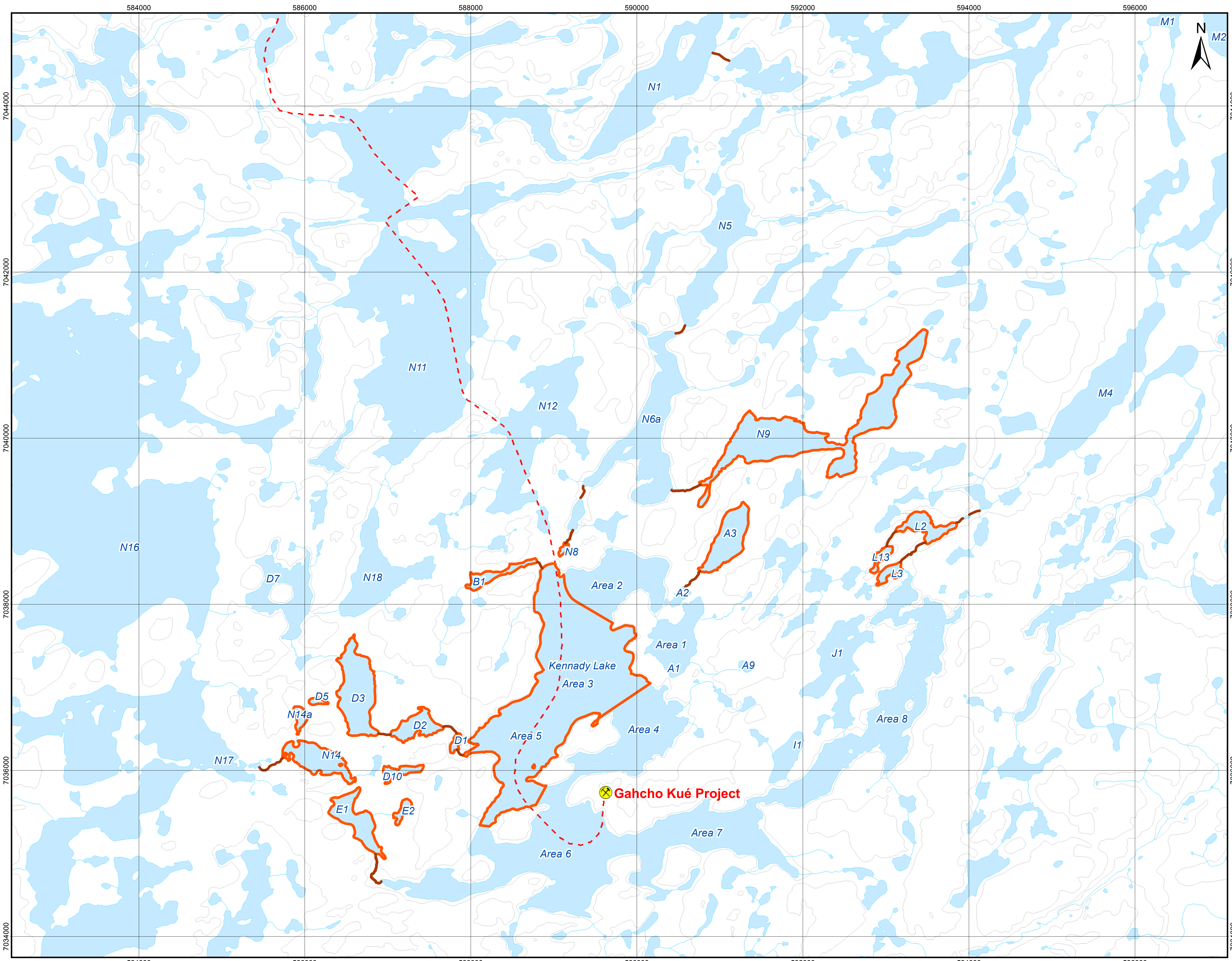
Various lakes and outlet channels were assessed for shoreline erosion potential in 2010 and 2011. The qualitative assessment of shoreline and channel erosion was conducted during the 2010 field season on Lakes A3, B1, D2, D3, E1, N8, N9 and N14, and on outlet channels from these lakes. In 2011, a more comprehensive data collection program was developed based on a better understanding of regulatory requirements and the updated project description (De Beers 2012), and an additional field assessment of shoreline and channel erosion was conducted during the 2011 field season. The field survey covered both proposed lake shoreline elevations associated with proposed water diversions and water storage, as well as lake outlet channels where flows will be increased as a result of proposed flow diversions during mine construction and operation.

The lakes assessed for shoreline erosion potential in 2011 included Lakes A3, B1, D2, D3, D5, D10, E1, L2, L3, L13, N8, N9, N14, N14a, and Kennady Lake Area 3 and Area 5 shorelines (Figure 1). These lakes will be affected differently during the mine life:

- Lake water levels are proposed to increase in Lakes D2, D3, and E1, following dyke construction and diversion to N14 watershed.
- Lake water levels are proposed to remain the same during mine operations in lakes with direct flow diversions (Lakes B1, N8, and N14) following flow diversions from neighbouring areas, in others where diversion rates will be limited in magnitude and duration (Lakes L2 and L3), and in several lakes that are not expected to be affected by flow diversions (Lakes A3, D5, D10, L13, and N9).

The lake outlet channels assessed for erosion potential in 2011 included the outlets of Lakes A3, B1, D1, D2, D3, E1, L2, L3, L13, N2, N6, N8, N9, and N14. These outlets will be affected differently, depending on their location in the watersheds:

- Lake outlet channels from Lakes B1, D2, D3, and E1 are proposed to be flooded or covered by water management structures for the Project (i.e., dykes).
- Lake outlet channels from Lakes N8 and N14 are proposed to have increased flows as a result of water diversions.
- Lake outlet channels from Lakes L2 and L3 are proposed to have decreased flows as a result of water diversions, except for an extended freshet period during one year of Kennady Lake dewatering.
- New outlet channels are proposed to be created to increase flow capacity for the lakes where surface flow is diverted from the existing outlets. These include outlets from Lakes B1, D2-D3, E1, and N8.
- Lake outlet channels are not expected to be affected by flow diversions at Lakes A3, L13, or N9, or significantly affected by flow diversions at Lakes N2 and N6, and flows are expected to be greatly reduced during operations at the outlet of Lake D1.



LEGEND

- Gahcho Kué Project
- Winter Access Road
- Watercourse
- Waterbody
- Contour (10m interval)
- Surveyed Channel
- Surveyed Lake
- A1 Lake Identifier

NOTES

Base data source: National Topographic Base Data (NTDB) 1:50,000

GAHCHO KUÉ PROJECT

Lakes and Channels Surveyed in 2011 for Potential Erosion Assessment

PROJECTION:	DATUM:	
UTM Zone 12	NAD83	DE BEERS CANADA
Scale: 1:45,000 750 375 0 750 Meters		
FILE No: B2011-Soils-001-GIS		DATE: February 29, 2012
JOB NO: 11-1365-0001	REVISION NO: 1	Figure 1
OFFICE: GOLD-CAL	DRAWN: CW	CHECK: JF

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1.2 Methods

The updated analysis presented here expands on the qualitative assessment presented by De Beers (Section 8.7.3.3 of De Beers 2010).

The 2010 hydrological field data, terrain data, wind data, and available baseline soils information (De Beers 2010, Annex H and Addendum HH) were reviewed to evaluate the shorelines. In addition, lake shorelines were surveyed between July 14 and 18, 2011, in those watersheds where baseline lake water levels and baseline channel outlet characteristics will be affected by mine operations.

The surveys included new shoreline elevations where changes in lake water level were proposed (i.e., Lakes D2-D3, and E1) and lakes with flow diversions (i.e., Lakes N8, N14, L2, and L3). The surveys also included geomorphological characterization of outlet channels where flows will be increased as a result of diversions. Characterizations were also undertaken for the outlets of Lakes A3, B1, D1, D2, D3, E1, L2, L3, L13, N2, N6, N8, N9, and N14.

Methods used in the surveys were:

- Lakeshore survey locations were determined based on existing information within the EIS, referencing soil and terrain types. Shore-normal survey transect lengths were determined based on existing water levels and the proposed raised shoreline elevation.
- For each lake, a number of shore-normal survey transects were surveyed to represent homogeneous sections of shoreline with similar slope, soil and wave exposure. One transect was surveyed per section.
- At each transect, a shoreline topographic profile was measured using a SOKKIA GPS RTK system to provide accurate position and elevation data. Depending on the proposed lake water level conditions, the profiles typically extended from existing water level to above the anticipated high water level of the new lake elevation.
- Shoreline sections were delineated in the field based on the visually observable characteristics of aspect, wave exposure (a combination of prevailing wind and fetch length), slope gradient and terrain and sediment types (gradation and origin). Ice thrust effects (e.g., ice-push berms at the shoreline) were considered as evidence of thermal erosion at existing water level elevations.
- The geomorphological characterization of lake outlet channels was assessed in the field based on measured data of the cross-sectional profiles, slope measurements of the channel, water level, bed and bank material, bank vegetation type, active erosion or depositional areas if present.
- Photographic documentation was carried out simultaneously with the field surveys for each homogeneous section of the shoreline and along each lake outlet channel and is presented in Appendix A.

The assessment of shoreline and outlet channels erosion potential considered both survey data sets collected in 2010 and in 2011. The general nomenclature for slope descriptions in this report is:

<10%	Flat to Shallow
10% to 20%	Gentle
20% to 30-40%	Moderate
30-40% to 50-60%	Moderately steep
>50-60%	Steep

< = less than; > = greater than; % = percent.

To estimate the shoreline erosion potential, a number of parameters were considered and used to produce a classification system. The shoreline erosion susceptibility was classified into a five-class system, ranking from Very Low to Very High. The classification was based on a modified version of the Alberta Sustainable Resource Development tool for calculating lakeshore erosion potential (Government of Alberta 2011).

The shoreline characteristics and parameters considered in the analysis were divided into three categories: bank and shoreline features, exposure characteristics, and attenuation characteristics (Table 1), more detailed information on the categories are presented in Appendix B. Each category contains different parameters with different classes and assigned scores. The final score for the erosion susceptibility class was calculated by using a weighted average method of all the parameters and is described in Appendix B.

Table 1: Categories for the Shoreline Characteristics and Parameters

Bank and Shoreline Features	Exposure Characteristics	Attenuation Characteristics
Bank Height	Shore Orientation (wind direction)	Aquatic Vegetation
Bank Vegetation	Fetch Length	Bank Composition
Bank Stability	Depth at 6 m	Bank Slope
Shoreline Geometry	Depth at 30 m	—

m = metre; — = not applicable.

2.0 REVIEW OF EXISTING DATA

2.1 Meteorology

The main meteorological parameter that affects shoreline erosion potential is wind speed and wind direction. This is because wind over open water generates waves. As wind speed and fetch increase, wave height typically increases; the height of the waves is related to the strength of the wind and the length of open water (fetch) over which the wind blows. As wave height increases, the erosive power of the waves increase. Water depth serves to modify this general relationship.

At the project site a baseline meteorology monitoring program was initiated in August 1998, but wind data are only available for the period of May 2004 to September 2005. The closest wind station with a more extended data set is located at Snap Lake with wind data available from 1998. The results of the wind analysis are presented in Air Quality Baseline of the 2010 EIS (Annex B of DeBeers 2010), and it was concluded that the wind speeds and frequency of calms were similar at the two sites. The small differences in wind direction between the two sites can be attributed to differences in the terrain near the monitoring locations (i.e., near surface wind directions can be affected by local features such as lakes and small hills).

The analysis was done using the wind data for the open water season, defined as the period from June to October for each year of record. Table 2 presents the directions and the wind classes frequency distribution measured at Snap Lake for 13 years of recordings.

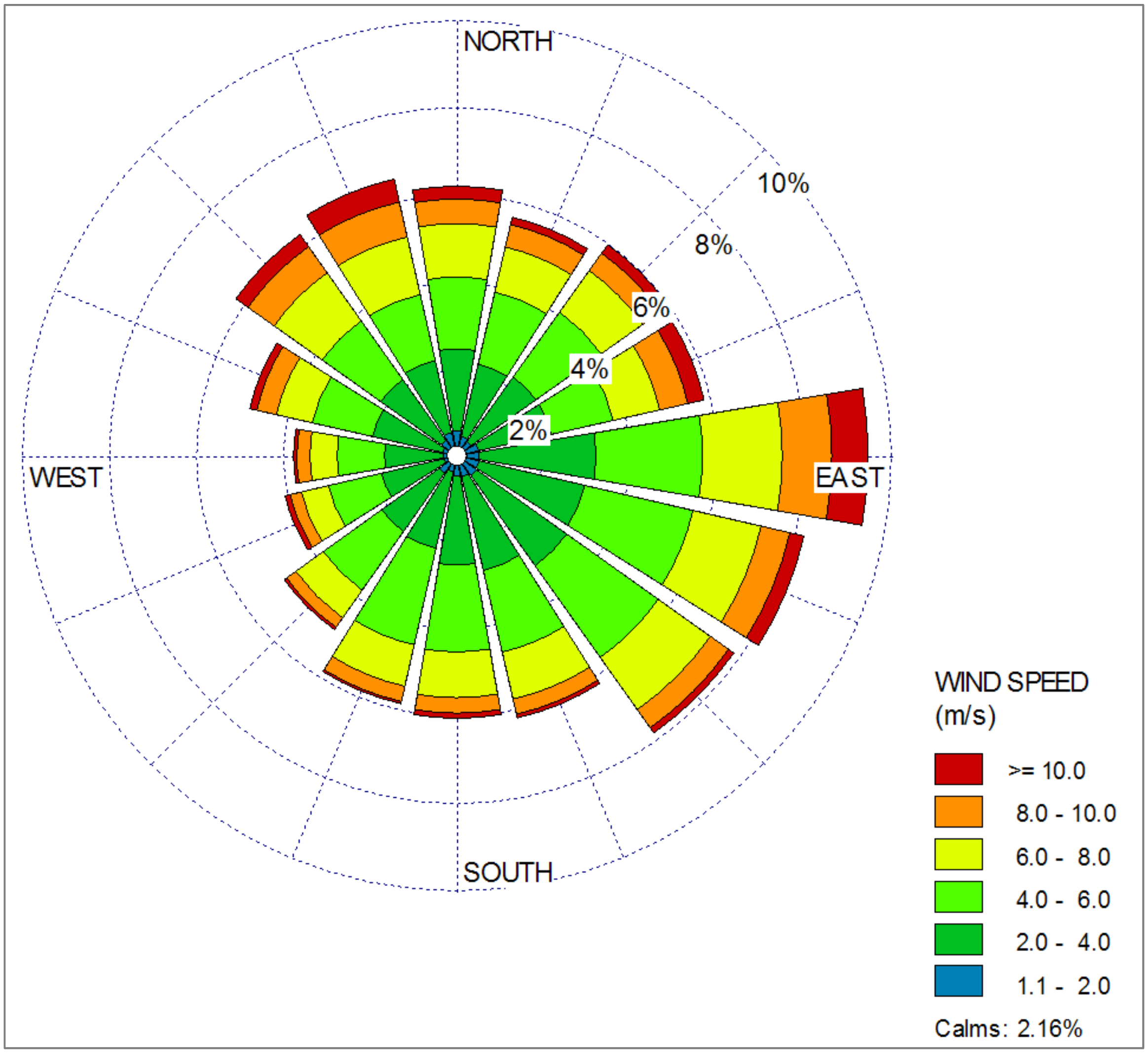
Table 2: Snap Lake Wind Rose and Directions Frequencies, 1998 to 2010

Direction		Wind Classes (m/s)						
Cardinal or Intermediate	**Sector Midpoint (degrees)**	**1.0 - 2.0**	**2.0 - 4.0**	**4.0 - 6.0**	**6.0 - 8.0**	**8.0 - 10.0**	**>= 15.0**	**Total (%)**
N	0.0	0.60	1.87	1.64	1.22	0.56	0.30	5.30
NNE	22.5	0.48	1.69	1.70	1.06	0.53	0.17	4.82
NE	45.0	0.43	1.82	1.83	1.16	0.49	0.24	5.10
ENE	67.5	0.55	1.71	1.45	1.09	0.66	0.38	4.99
E	90.0	0.54	2.68	2.43	1.83	1.13	0.84	8.08
ESE	112.5	0.55	2.48	2.55	1.60	0.67	0.34	7.01
SE	135.0	0.58	2.54	2.57	1.47	0.51	0.15	6.68
SSE	157.5	0.52	2.20	1.92	1.10	0.35	0.09	5.29
S	180.0	0.49	2.04	1.98	1.05	0.35	0.12	5.16
SSW	202.5	0.41	1.79	2.26	0.98	0.35	0.05	5.00
SW	225.0	0.52	1.63	1.64	0.77	0.26	0.07	4.19
WSW	247.5	0.32	1.47	1.25	0.64	0.26	0.13	3.48
W	270.0	0.33	1.35	1.09	0.62	0.30	0.07	3.22
WNW	292.5	0.36	1.65	1.42	0.84	0.46	0.17	4.18
NW	315.0	0.47	1.70	1.65	1.34	0.73	0.34	5.33
NNW	337.5	0.58	1.68	1.55	1.34	0.82	0.54	5.57
Sub-Total		6.60	25.92	24.75	15.50	7.23	3.41	83.40
Calms								**2.16**
Missing/ Incomplete								**4.44**
Total								**100.00**

N = north; NNE = north-northeast; NE = northeast; ENE = east – northeast; E = east; ESE = east-southeast; SE = southeast; SSE = south-southeast; S = south; SSW = south-southwest; SW = southwest; WSW = west-southwest; W = west; WNW = west-northwest; NW = northwest; NNW = north-northwest; m/s= metres per second; > greater than; % = percent.

The analysis indicated that the recorded prevailing winds are from east and south-east, followed by winds from the north-west sector. The calm frequency, defined as wind with less than 1.0 metres per second (m/s), is 2.16 percent (%) of the time and the least frequent wind direction is the west sector (Figure 2).

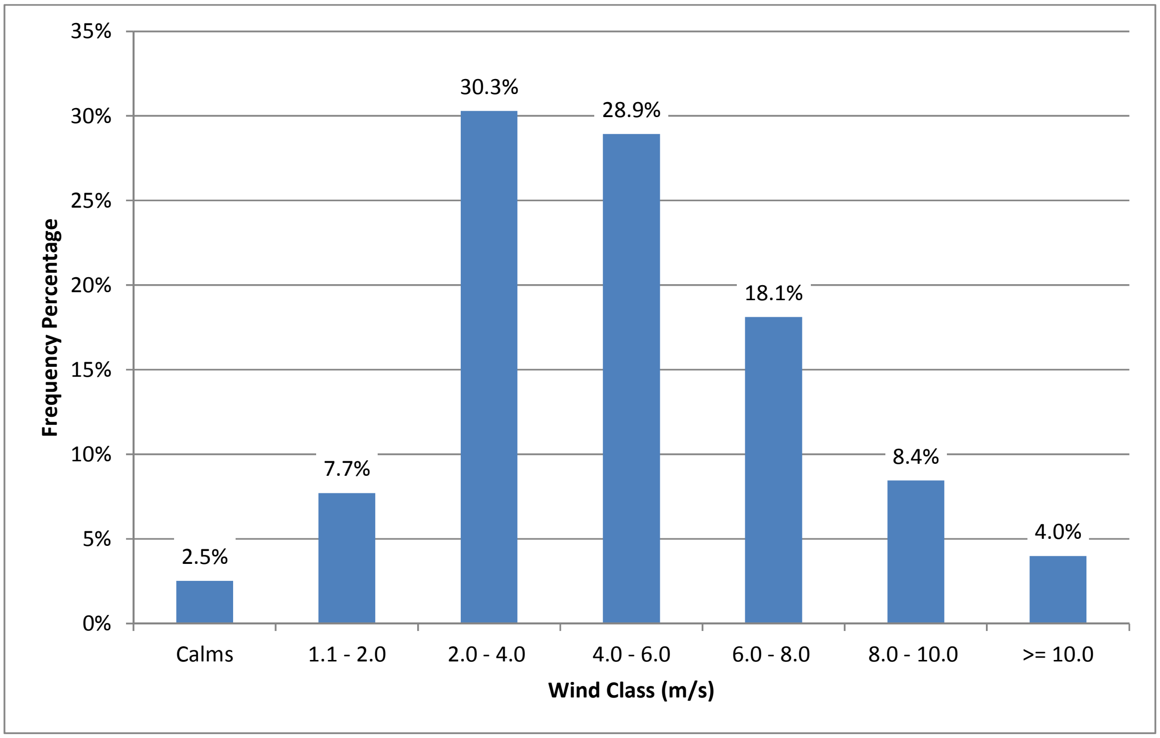
Figure 2: Snap Lake Mean Wind Speed and Direction Frequency Rose, June to October 1998 to 2010



m/s = metres per second; % = percent.

The mean values for wind speed show that the strongest winds tend to be from the east and southeast and from the north and northwest sectors. The wind class frequency distribution shows that the most frequent winds have velocities of 2.0 to 6.0 m/s and they occur almost 60% of the time (Figure 3). However, strong winds with velocities higher than 8 m/s are also frequent and they are more common than winds with velocities of 1.0 to 2.0 m/s.

Figure 3: Snap Lake Mean Wind Class Frequency Distribution, June to October 1998 to 2010



m/s = metres per second; % = percent.

2.2 Terrain

"Terrain" is a comprehensive term used to describe a tract of landscape and the associated natural physical features. Terrain maps can show surficial materials, material texture, surface expression, relief, elevation, drainage, or material modifying processes. A detailed terrain analysis was presented in the Bedrock Geology, Terrain, Soil and Permafrost Baseline of the 2010 EIS (Annex D of De Beers 2010), and was used in the geomorphological analysis for the shorelines and outlet channels.

Surficial materials in the study area are geologically recent sediments deposited around the end of the last glaciation as well as fluvial and organic (peat) deposits, which have accumulated in the last few thousand years. The major surficial materials include bedrock, morainal deposits, glaciofluvial sediments, lacustrine and glaciolacustrine sediments, fluvial sediments, aeolian sediments, and organic (bog and fen) accumulations.

While morainal materials and landforms are predominant in the area, they occur in association with other materials, especially organic materials of peat areas. Consequently, most map units describing terrain areas depict complexes of one type of terrain with another type or types. Table 3 shows a summary of the terrain units within the surveyed watersheds. A description of the surficial materials and landforms associated with each terrain unit are provided. Morainal terrain accounts for the largest portion within the surveyed watersheds, with various terrain complexes in which moraine is dominant, followed by bog and fen complexes.

Table 3: Terrain Units within the Surveyed Watersheds (Annex D of De Beers 2010)

Terrain Unit Symbol	Surficial Material	Landform
BN	mixed bog and fen peat	bog (B) and fen (N) forms
BN-M/Ru	mixed bog and fen with sub-dominant morainal veneer over bedrock	bog and fen forms with undulating morainal areas
M/Ru	morainal veneer overlying bedrock, with some areas of blanket	undulating
M/Ruh	morainal veneer overlying bedrock, with some areas of blanket	undulating to hummocky; rolling and whaleback forms in places
M/Ru-B	morainal veneer (as in M/Ru), with sub-dominant bog	undulating with bog forms
M/Ruh-B	morainal veneer (as in M/Ruh), with sub-dominant bog	undulating to hummocky and rolling, with bog forms
M/Ruh-B-R	morainal veneer (as in M/Ruh), with sub-dominant bog and bedrock outcrops	undulating to hummocky and rolling, with bog forms
M/Ru-BN	morainal veneer (as in M/Ru), with sub-dominant bog and fen complex	undulating, with bog and fen forms
M/Ruh-BN	morainal veneer (as in M/Ruh), with sub-dominant bog and fen complex	undulating to hummocky and rolling, with bog and fen forms
N	fen peat	lowland polygon and horizontal

Elevations in the surveyed area range from approximately 415 metres above sea level (masl) at the outlet of the Lake N2 up to approximately 440 masl at the crest of the highest hills in the Kennady Lake watershed. Local relief is commonly in the range of 15 to 20 metres (m), but slopes are mainly gentle (i.e., slope gradients typically less than 10%), resulting in undulating to rolling topography associated in many areas with hummocky topography. The effects of permafrost processes on the terrain are evident within the surveyed area. Landscape features resulting from piping, boiling and heaving of the active layer and thermokarst and thermo-erosion were observed on all shorelines within the surveyed area.

2.3 Soil

The 2010 EIS report presents the soil baseline assessment with soil maps and descriptions for the study areas (Annex D of De Beers 2010). Within the survey area soils are grouped into eight distinct soil associations (Soil Classification Working Group 1998). Table 4 summarizes the relationships between surficial materials and soil associations. Similar to terrain map units, most soil units are complexes of major soil types.

Water erosion risk for soils was evaluated in Annex D of the 2010 EIS (De Beers 2010) and the risk was rated in five classes considering the dominant and subdominant soil type within the map unit and these are: high (H), moderate (M), low-moderate (L-M), low-high (L-H), and low (L).

For the surveyed watersheds it was concluded that most of the area has a low rating in terms of water erosion, although small areas of moderate and high susceptibility occur. The ratings “low-moderate” and “low-high” indicate that there are some areas of soils complexes in which one of the soil components has a rating higher than low and generally occur on hummocky topography with slopes in the 6% to 15% or higher.

Table 4: Relationships between Surficial Geological Deposits and Soil Associations within the Survey Area (Annex D of De Beers 2010)

Surficial Material	Association	Dominant Soil Great Group(s)
Soils developed on coarse to moderately coarse textured, non-calcareous glacial till		
Moraine veneer; till <1 m thick	Wolverine Lake	Dystric Brunisol
Moraine blanket; till >1 m thick	Lobster Lake	Dystric Brunisol
Moraine blanket; till >1 m thick; deposits re-worked by permafrost processes	Blob Lake	Turbic Cryosol
Soils developed on glaciofluvial deposits		
Ice-contact (esker)	Hoarfrost River	Regosol
Soils developed on organic deposits		
Shallow to deep fen peat	Dragon Lake	Organic Cryosol
Shallow to deep bog and mixed fen and bog peat	Sled Lake	Organic Cryosol
Soils developed in actively flooded areas		
Shallow peat and mineral soil deposits	Goodspeed Lake	Fibrisol or Mesisol Humic Regosol
Bedrock	Bedrock	n/a

< = less than; > = greater than; n/a = not applicable.

3.0 LAKE SHORELINE AND CHANNEL EROSION SURVEY RESULTS

This section presents the survey results for each surveyed lake at a watershed level. The detailed photography survey for each lake is presented in Appendix A.

3.1 A3 Watershed

The A3 watershed is located northeast of Kennady Lake and has an area of approximately 0.84 square kilometres (km^2) of which 0.24 km^2 is lake surface. The average water level elevation of Lake A3 at the time of the 2011 field survey was 423.5 m. A3 is the main lake in the watershed and drains south into Lake A2. No predicted impacts are expected from changes in flow on the A3 watershed and therefore an erosion susceptibly/potential assessment was not undertaken.

3.1.1 Lake A3 Shoreline Survey

A total of 22 transects were surveyed around the perimeter of Lake A3 (Figure 4). The main transect parameters are presented in Table 5. Lake A3 is oriented north-east to south-west, with a steeper bank (typically 20% to 40% slope gradients) on the north-west side (Transects 1 to Transect 15) and with low slopes (typically 5% to 10% slope gradients) on the south-east bank (Transects 16 to 22).

Figure 4: Lake A3 Shoreline Transect Locations with Terrain Type Units

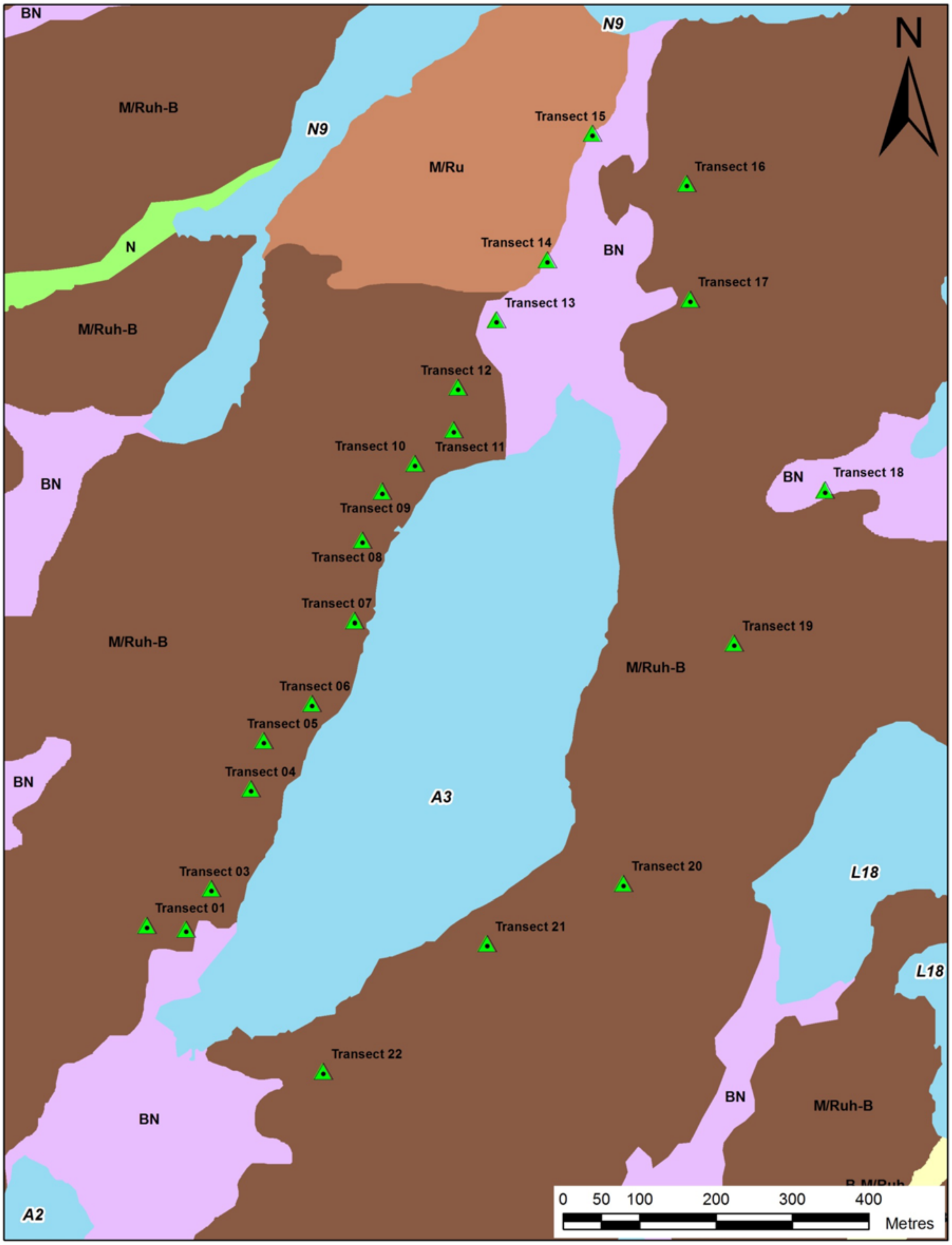


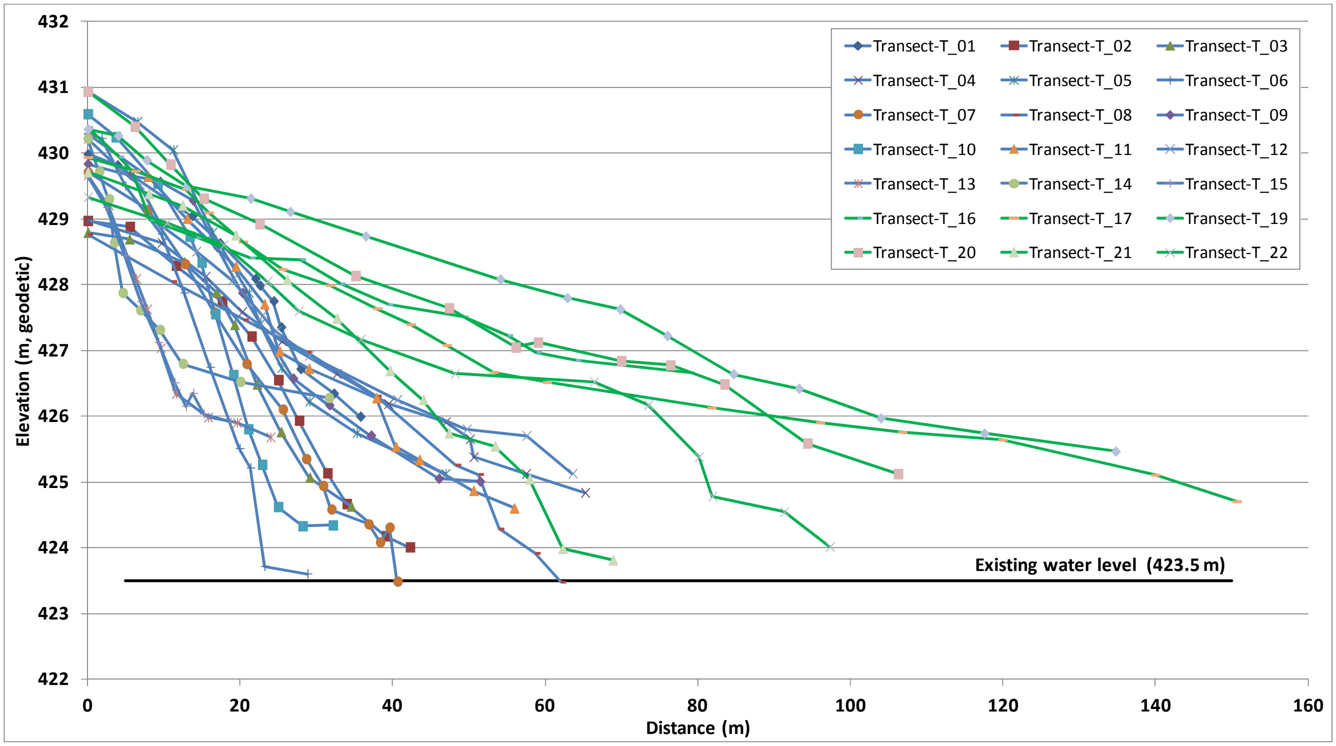
Table 5: Lake A3 Surveyed Transect Parameters

Transect	Maximum Elevation (m, geodetic)	Minimum Elevation (m, geodetic)	Length (m)
Transect 1	429.984	425.995	35.7
Transect 2	428.969	424.007	42.2
Transect 3	428.790	424.628	34.5
Transect 4	428.978	424.838	65.2
Transect 5	430.944	425.124	46.9
Transect 6	430.302	423.605	28.8
Transect 7	429.709	423.488	40.6
Transect 8	428.765	423.479	62.0
Transect 9	429.836	425.008	51.4
Transect 10	430.592	424.329	32.1
Transect 11	430.288	424.600	55.9
Transect 12	430.219	425.130	63.6
Transect 13	429.666	425.679	23.9
Transect 14	430.219	426.279	31.6
Transect 15	429.651	425.909	18.7
Transect 16	430.390	426.663	78.9
Transect 17	429.934	424.703	150.6
Transect 19	430.363	425.464	134.7
Transect 20	430.934	425.122	106.2
Transect 21	429.709	423.811	68.8
Transect 22	429.329	424.012	97.3

m = metres.

Figure 5 presents the cross-section profiles of the surveyed transects, coded into two groups representing the steeper north and west sides and the more gentle east and south sides.

Figure 5: Lake A3 Shoreline Transect Profiles



m = metres.

During the shoreline survey the terrain types previously delineated were field checked and additional details on the shoreline types were identified and presented in Table 6.

Table 6: Lake A3 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	164° - SSE	8.6	15	300	M/Ruh-B	L-M
Transect 2	144° - SE	10.7	19	300	BN	L
Transect 3	120° - ESE	13.0	23	300	M/Ruh-B	L-M
Transect 4	111° - ESE	4.2	7	450	M/Ruh-B	L-M
Transect 5	123° - ESE	8.6	15	450	M/Ruh-B	L-M
Transect 6	119° - ESE	17.0	31	500	M/Ruh-B	L-M
Transect 7	81° - E	11.2	20	500	M/Ruh-B	L-M
Transect 8	112° - ESE	4.3	8	500	M/Ruh-B	L-M
Transect 9	130° - SE	8.1	14	500	M/Ruh-B	L-M
Transect 10	144° - SE	20.3	37	500	M/Ruh-B	L-M
Transect 11	128° - SE	3.2	6	500	M/Ruh-B	L-M
Transect 12	108° - ESE	4.8	8	500	M/Ruh-B	L-M
Transect 13	155° - SSE	12.7	23	300	BN	L
Transect 14	115° - ESE	3.4	6	200	BN	L
Transect 15	121° - ESE	7.3	13	60	BN	L
Transect 16	294° - WNW	0.9	2	60	M/Ruh-B	L-M
Transect 17	220° - SW	1.4	2	300	M/Ruh-B	L-M
Transect 19	296° - WNW	2.6	5	500	M/Ruh-B	L-M
Transect 20	339° - NNW	2.7	5	450	M/Ruh-B	L-M
Transect 21	325° - NW	6.3	11	450	M/Ruh-B	L-M
Transect 22	286° - WNW	1.1	2	300	M/Ruh-B	L-M

Note: Please see Table 3 for definitions of terrain units.

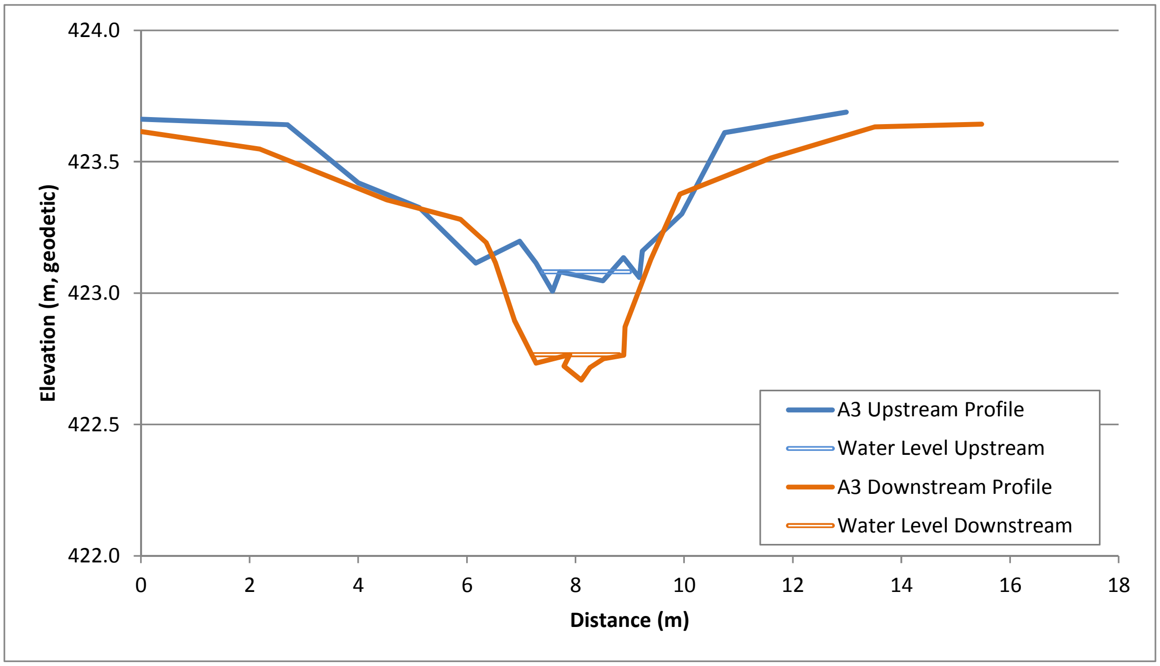
° = degrees; % = percent; m = metres; SSE = south-southeast; SE = southeast; ESE = east-southeast; E = east; WNW = west-northwest; SW = southwest; NNW = north-northwest; NW = northwest; L-M = low-moderate; L = low.

3.1.2 A3 Outlet Channel Survey

Lake A3 outlet channel was surveyed from the outlet of Lake A3 to the inlet of Lake A2. Two cross-sections were measured, one upstream within a relatively low slope gradient section of approximately 0.3% and one downstream where the slope gradient increased to approximately 0.7%. The average slope gradient of the channel between Lake A3 and A2 was 0.76%. Two cross-sections are presented in Figure 6. The longitudinal profile along the outlet channel is presented in Figure 7.

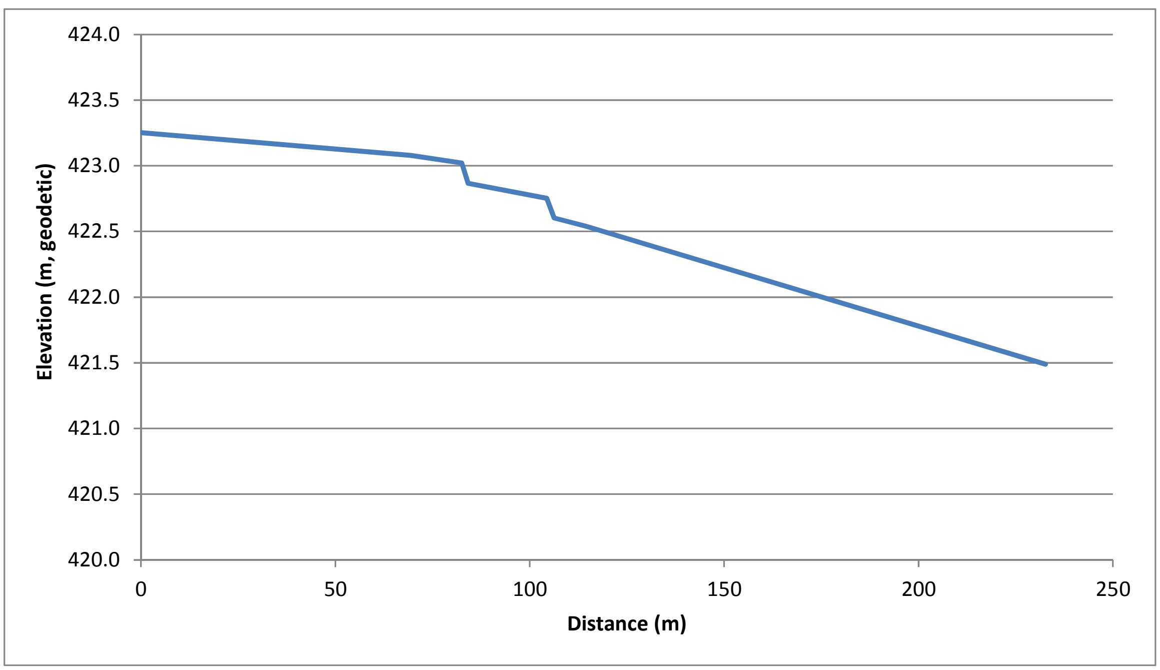
The outlet channel flows through relatively flat terrain, with surficial material of mixed bog and fen peat. Both banks of the channel have soils consisting of primarily organic materials with some cobbles and trace boulders. The channel is typically less than one metre deep relative to the surrounding terrain and varies in width between 0.5 m and 1 m. The channel banks were observed to be a mixture of organic materials and cobbles. Small nickpoints were observed where cobbles predominate within the channel along the longitudinal profile.

Figure 6: Lake A3 Outlet Channel Cross-Sections



m = metres.

Figure 7: Longitudinal Profile along the Outlet Channel of Lake A3



m = metres.

3.2 B1 Watershed

The B1 watershed is located north-west of Kennady Lake, and has an area of approximately 1.27 km^2, of which 0.40 km^2 is lake water surface. The average water level elevation of Lake B1 at the time of the 2011 field survey was approximately 423.5 m. Lake B1 is the main lake of B watershed and drains directly into Kennady Lake. During the mine operations phase, the outlet channel of Lake B1 will be diverted to Lake N8, and will be restored during mine closure. Minor changes in water levels are expected (less than 0.1 m).

3.2.1 Lake B1 Shoreline Survey

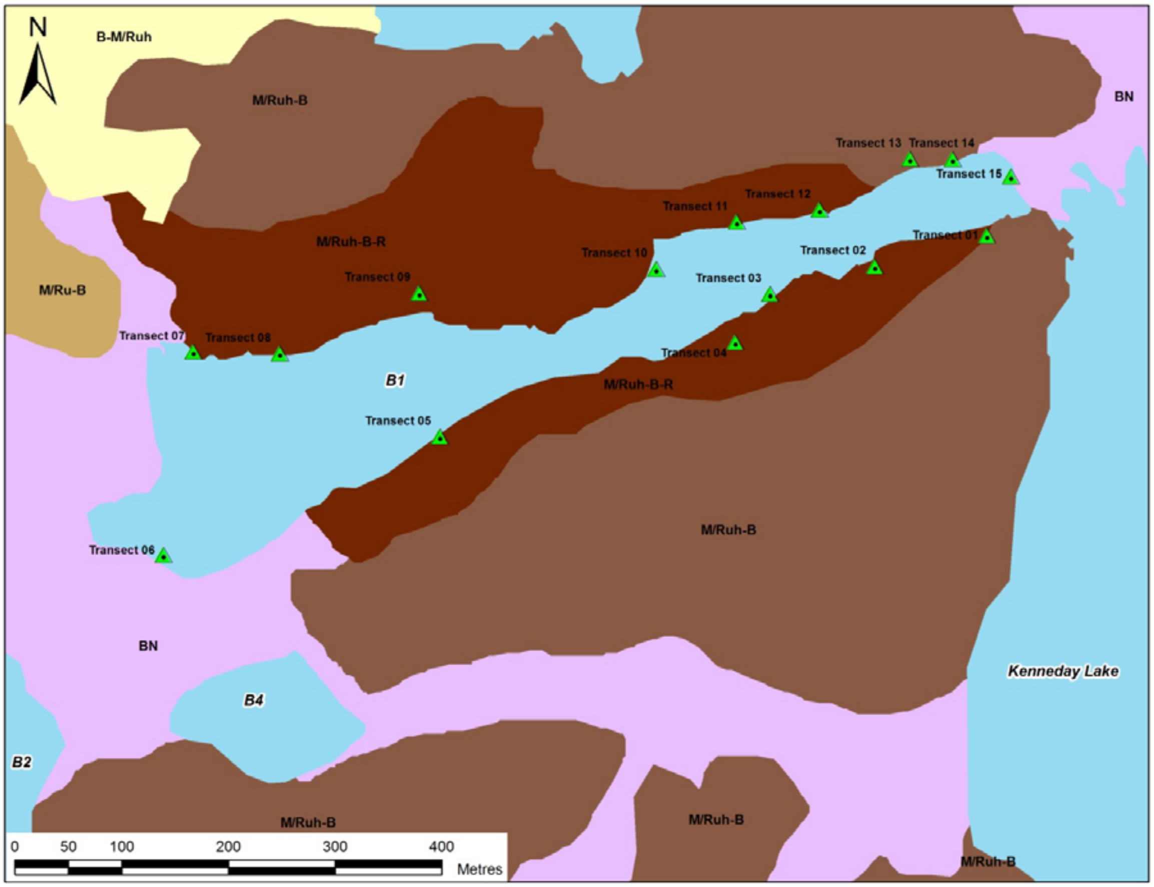
A total of 13 transects were surveyed around the perimeter of Lake B1 (Figure 8). The main transect parameters are presented in Table 7. Lake B1 is oriented west to east, and has small sections of steep banks (typically 60% to 100% slope gradient, e.g., Transect 3, Transect 11) on the north and south banks but moderate slopes (typically 15% to 40% slope gradients) are the characteristics of the shoreline. The north and south shorelines have a moraine type of terrain with small areas of bog and bedrock outcrops, the latter creating steep banks along the shoreline (Transect 3, Transect 8). The east and west shorelines have a mix of bog and fen peat materials that generates low slopes (Transect 6 and Transect 15). Figure 9 presents the cross-section profiles of the surveyed transects.

Table 7: Lake B1 Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	426.157	423.451	30.6
Transect 2	426.220	423.469	20.3
Transect 3	425.640	422.198	7.5
Transect 4	427.465	423.731	36.9
Transect 5	424.638	422.910	24.9
Transect 6	424.068	422.977	25.1
Transect 7	423.954	422.827	15.8
Transect 8	425.259	422.069	12.0
Transect 9	427.261	423.462	41.4
Transect 10	425.568	422.865	42.8
Transect 11	427.080	422.772	8.4
Transect 12	424.857	422.806	11.4
Transect 13	425.900	423.451	22.5
Transect 14	424.762	422.902	16.5
Transect 15	424.006	422.992	12.2

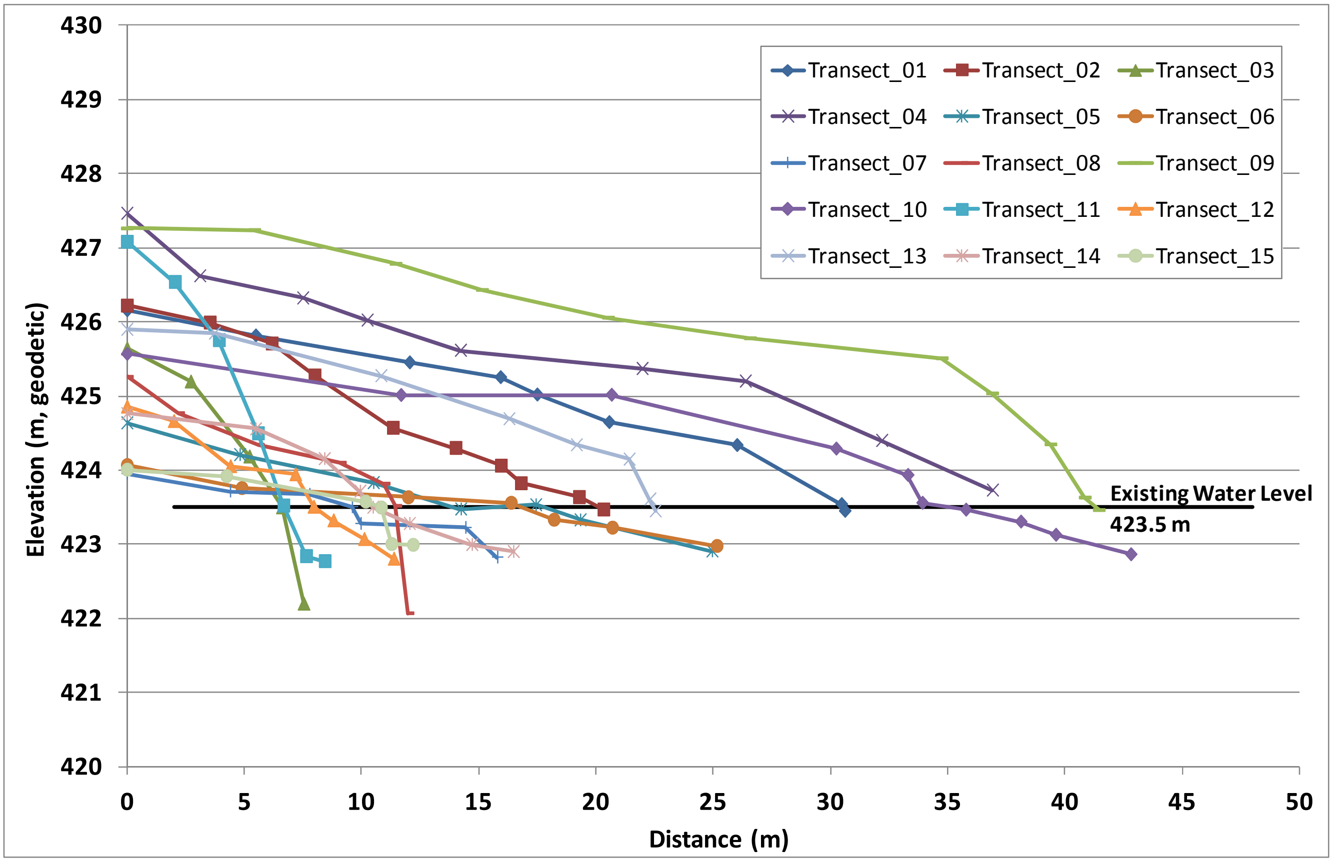
m = metres.

Figure 8: Lake B1 Shoreline transect locations with terrain type units



During the shoreline survey the terrain types previously delineated were field checked and additional details on the shoreline types identified. The lake water levels will remain near to baseline conditions and therefore no further lake shoreline erosion assessment was necessary.

Figure 9: Lake B1 Shoreline Transect Profiles



m = metres.

The main parameters for surveyed transects are presented in Table 8.

Table 8: Lake B1 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	347° - NNW	10.9	19	70	M/Ruh-B-R	L-M
Transect 2	340° - NNW	5.7	10	70	M/Ruh-B-R	L-M
Transect 3	326° - NW	40.6	86	80	M/Ruh-B-R	L-M
Transect 4	341° - NNW	7.9	14	90	M/Ruh-B-R	L-M
Transect 5	324° - NW	4.0	7	120	M/Ruh-B-R	L-M
Transect 6	20° - NNE	2.8	5	870	BN	L
Transect 7	201° - SSW	2.8	5	200	M/Ruh-B-R	L-M
Transect 8	187° - S	35.2	71	140	M/Ruh-B-R	L-M
Transect 9	174° - S	17.0	31	100	M/Ruh-B-R	L-M
Transect 10	115° - ESE	7.1	12	80	M/Ruh-B-R	L-M
Transect 11	163° - SSE	29.0	55	80	M/Ruh-B-R	L-M
Transect 12	175° - S	15.2	27	70	M/Ruh-B-R	L-M
Transect 13	175° - S	32.1	63	70	M/Ruh-B	L-M
Transect 14	166° - SSE	10.4	18	70	M/Ruh-B	L-M
Transect 15	251° - WSW	6.6	12	870	BN	L

Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; SSE = south-southeast; ESE = east-southeast; WSW = west-southwest; SSW = south-southwest; S = south; NNW = north-northwest; NW = northwest; L-M = low-moderate; L = low.

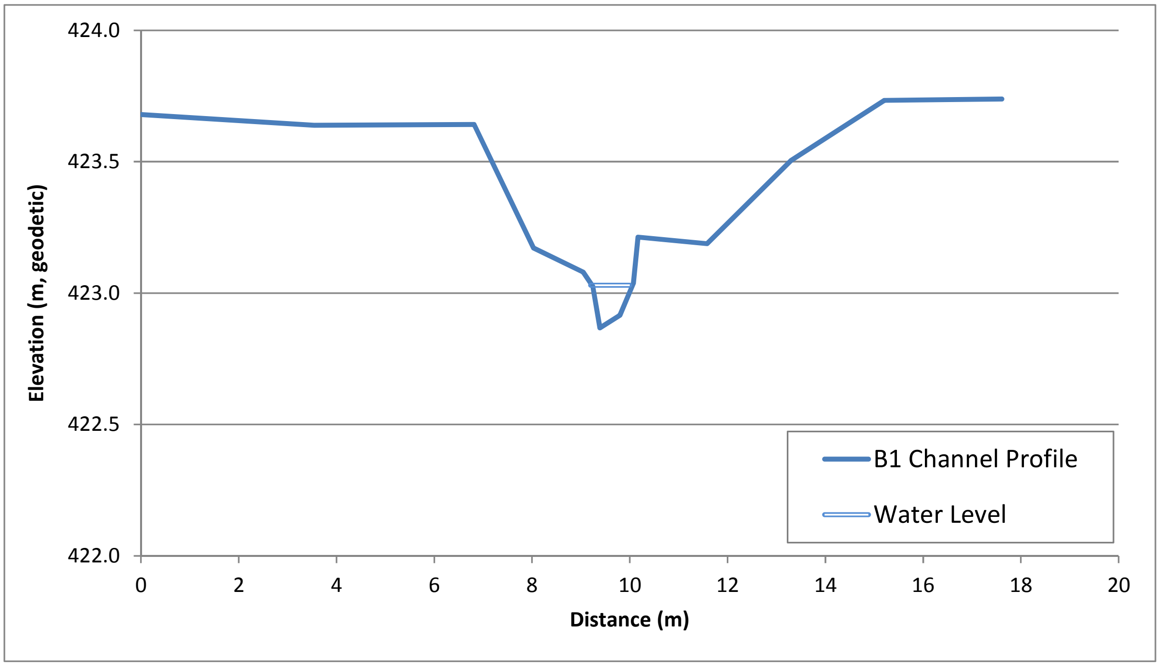
3.2.2 B1 Outlet Channel Survey

The Lake B1 outlet channel was surveyed and a cross-section was measured downstream of the outlet (Figure 10). The average channel slope gradient at the cross-section location was measured to be approximately 1.2% and approximately 0.9% for the entire channel from Lake B1 to Kennady Lake.

The outlet channel flows into Kennady Lake through relatively flat terrain, with surficial material of mixed bog and fen peat. Both banks of the channel have soils consisting of primarily organic materials with some cobbles and trace boulders that armour each bank. The channel is typically less than 1 m deep relative the surrounding terrain and varies in width between 1 and 2.5 m. The channel banks were observed to be a mixture of cobbles with boulders. Small nickpoints were observed where cobbles predominate within the channel along the longitudinal profile.

This channel is proposed to be diverted to Lake N8 during mine operations. The predicted elevation of the outlet from Lake B1 to Lake N8 is within 0.1 m of the existing outlet to Kennady Lake.

Figure 10: Lake B1 Outlet Channel Cross-Section



m = metres.

3.2.2.1 B1 Outlet Channel Mitigation

This channel is proposed to be diverted north-east to Lake N8 during mine operations phase. The newly created channel will be approximately 250 m long with an elevation drop of approximately 1.2 m and therefore a slope gradient of approximately 0.5%. The value is lower than the baseline slope gradient condition of 0.9% and is not expected to produce significant erosional effects along the proposed channel.

The new channel will flow across the same terrain type as the existing channel. It is recommended to recreate the same cobble armoured channel banks and bed channel, with small nickpoints.

3.3 N8 Watershed

The N8 watershed is located north of Kennady Lake and has an area of approximately 0.12 km^2 of which 0.01 km^2 is lake water surface. Lake N8 is the only lake in the watershed. During mine operations N8 watershed will not be directly affected by direct mine operations but Lake N8 will receive the diverted flows from Lake B1 and it will discharge to Lake N6b (Figure 11). At mine closure, the diversion from Lake B1 will be removed and N8 watershed is predicted to return to baseline condition.

3.3.1 Lake N8 Shoreline Survey

A total of seven transects were surveyed around the perimeter of Lake N8 (Figure 11). The main transect parameters are presented in Table 9. Lake N8 shoreline is surrounded by morainal material with bog as a sub-dominant type, with the exception of the south-west section, which is a mixed bog and fen peat. A small section of bedrock is present on the north-west shoreline (Transect 1 and Transect 7). Slope gradients are shallow (typically less than 10%) except in the bedrock areas where slope gradients are steeper (typically 40% to 60%). Figure 12 presents the cross-section profiles of the surveyed transects.

Figure 11: Lake N8 Shoreline Transect Locations with Terrain Type Units

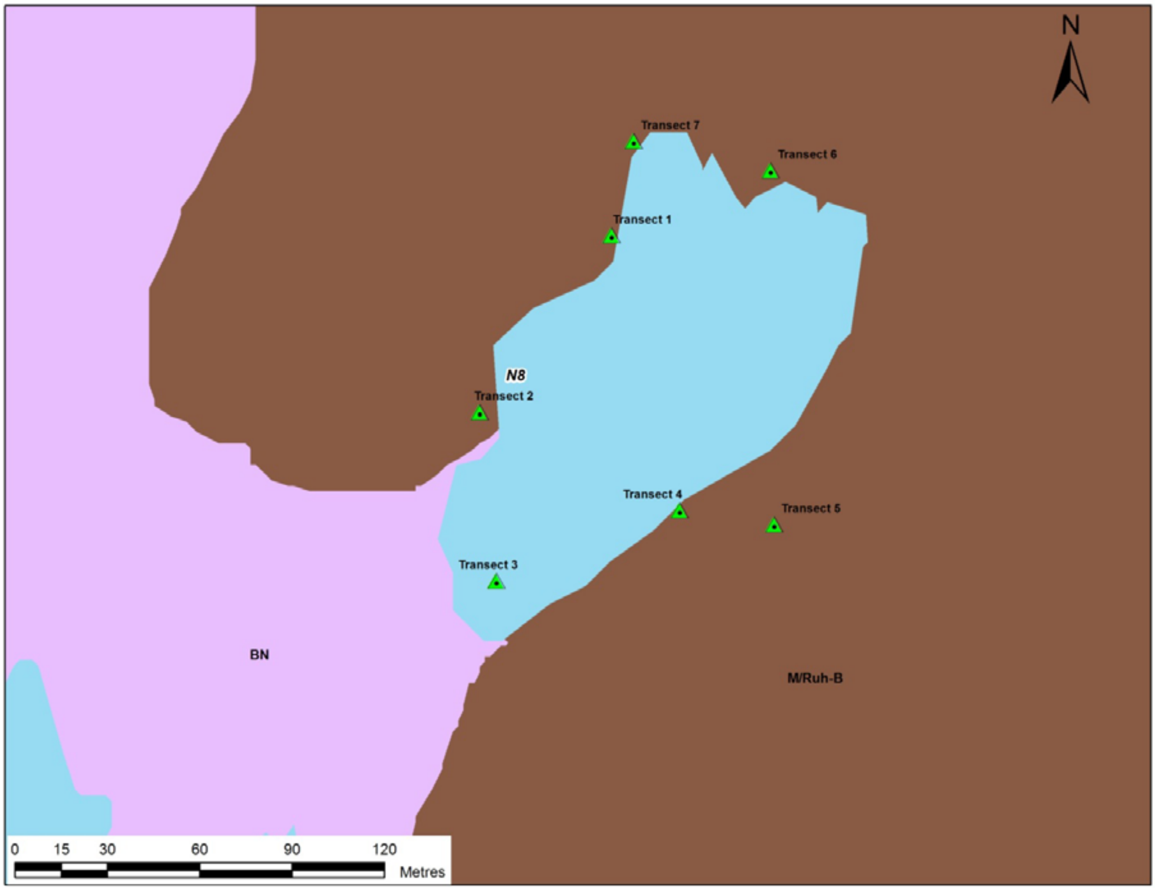


Table 9: Lake N8 Surveyed Transect Parameters

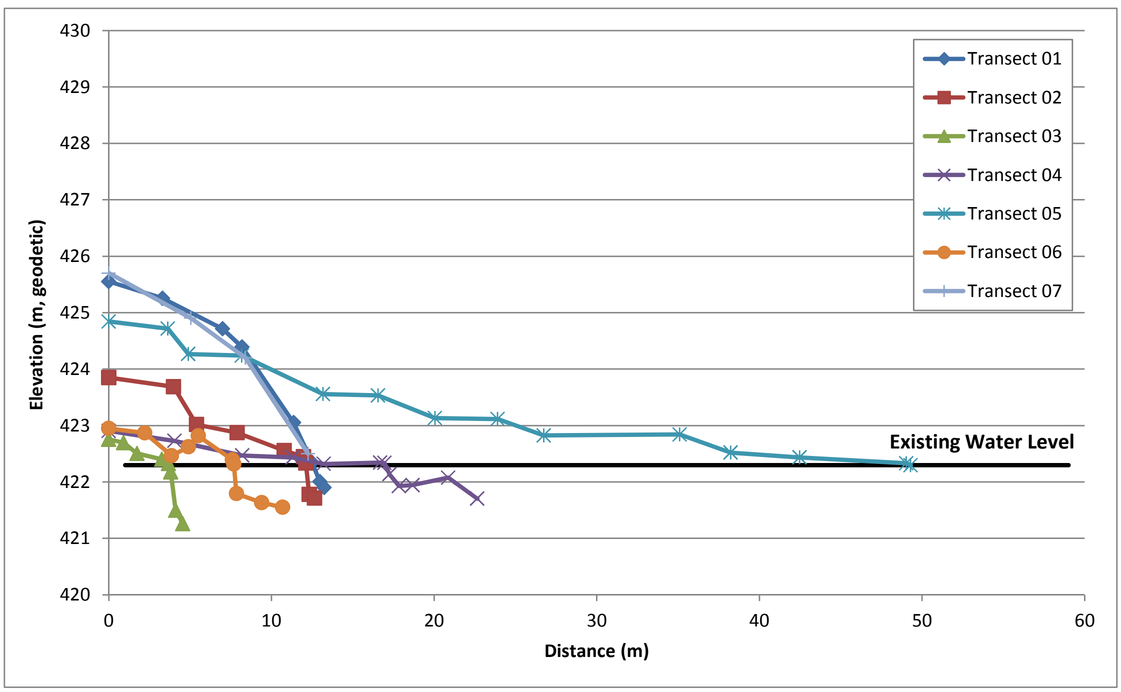
Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	425.553	421.899	13.2
Transect 2	423.852	421.713	12.7
Transect 3	422.756	421.261	4.5
Transect 4	422.905	421.704	22.7
Transect 5	424.842	422.297	49.3
Transect 6	422.950	421.552	10.7
Transect 7	425.701	422.500	12.3

m = metres.

During the shoreline survey the terrain types previously delineated were field checked and additional details on the shoreline types identified. The lake water levels during diversion will remain within natural variations of baseline conditions (Water Balance Modeling, Section 8.7 and Section 9.7 [De Beers 2010]) and therefore no further erosion assessment was necessary.

The main parameters for surveyed transects are presented in Table 10.

Figure 12: Lake N8 Shoreline Transect Profiles



m = metres.

Table 10: Lake N8 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	147° - SSE	26.2	49	80	M/Ruh-B	L-M
Transect 2	135° - SE	27.0	51	80	M/Ruh-B	L-M
Transect 3	61° - ENE	22.4	41	150	BN	L
Transect 4	328° - NNW	2.1	4	80	M/Ruh-B	L-M
Transect 5	324° - NW	2.2	4	80	M/Ruh-B	L-M
Transect 6	181° - S	23.5	43	150	M/Ruh-B	L-M
Transect 7	77° - ENE	14.6	26	80	M/Ruh-B-R	L-M

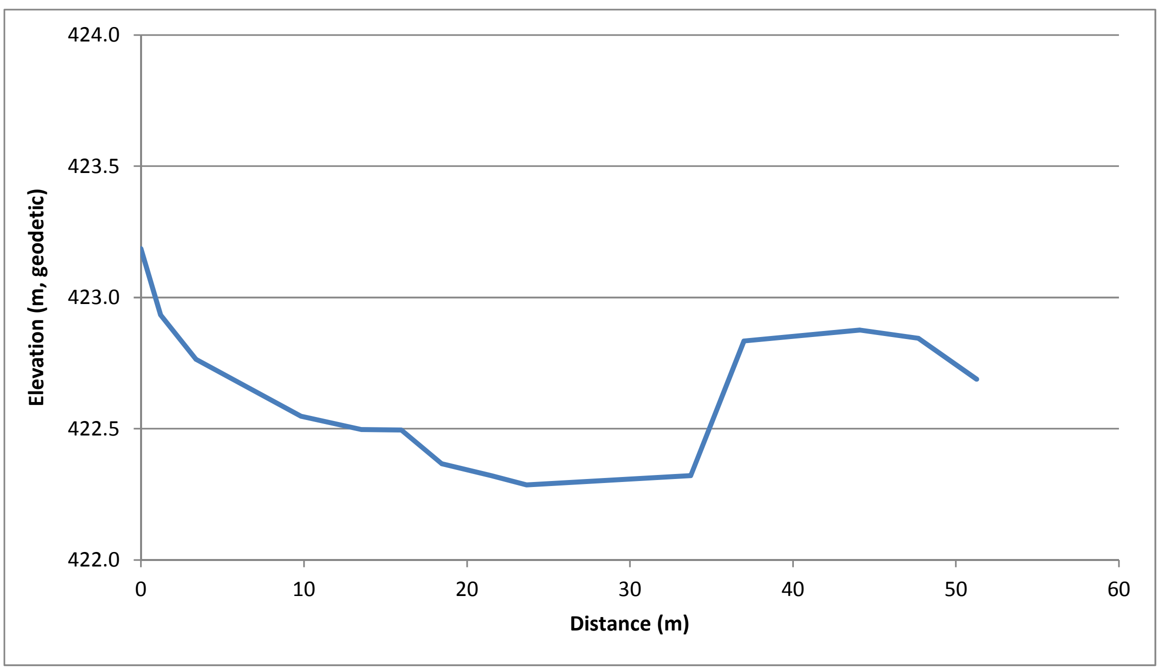
Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; SSE = south-southeast; SE = southeast; S = south; ENE = east-northeast; NNW = north-northwest; NW = northwest; L-M = low-moderate; L = low.

3.3.2 N8 Outlet Channel Survey

Lake N8 outlet channel was surveyed and a cross-section was measured downstream of the outlet (Figure 13). The N8 watershed discharges into Lake N6b only during the spring freshet through a poorly defined channel, which is of a low and relatively wide area with vegetation and organic materials. At the time of the site visit there was no discharge at the outlet.

Figure 13: Lake N8 Outlet Channel Cross-Section



m = metres.

3.3.2.1 N8 Outlet Channel Mitigation

From terrain data and GPS surveys the average slope gradient from Lake N8 to Lake N6b is approximately 1.5%. Following the diversion from Lake B1 into Lake N8 during mine operations, the outlet channel of N8 will have to be redesigned to support the flow increase. However, the existing terrain conditions for N8 outlet channel are similar to terrain conditions at B1 outlet channel in terms of slope (1.5% and 0.9% to 1.2% respectively) and in terms of terrain type. Therefore it is anticipated that only minimum works will be required on the channel to recreate similar channel characteristics as B1 outlet channel. It is recommended to recreate the same cobble-armoured channel banks and bed channel, with small nickpoints as the B1 outlet channel.

3.4 N6 Watershed

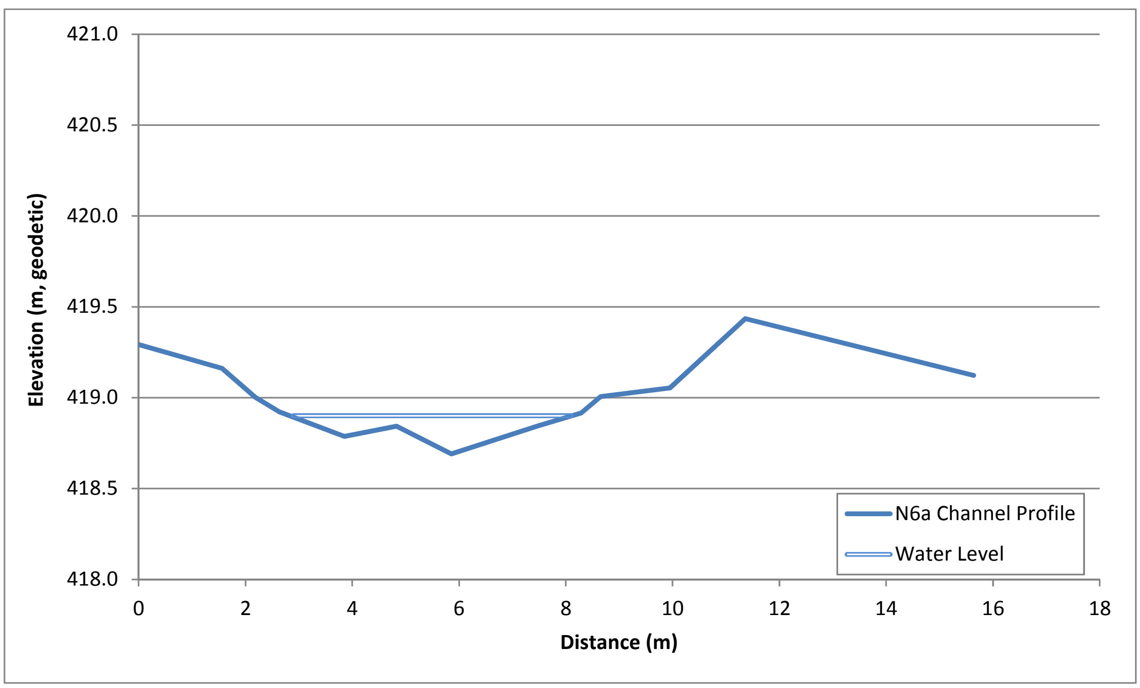
The N6 watershed is located north of Lake N8 and has an area of approximately 9.91 km^2, of which 2.38 km^2 is lake water surface. Lake N6a is the largest lake in the N6 watershed with an area of approximately 0.77 km^2 and second in size after Lake N9 in the entire N6 watershed which has an area of 1.0 km^2. The N6 sub-watershed has two main lakes: N6a (downstream) and N6b (upstream), and the water level elevation at the time of the 2011 field survey was 419.08 m for Lake N6a and 419.09 m for Lake N6b.

The channel that connects Lakes N6b and N6a is a broad channel that was 5 to 10 m wide and flooded at the time of visit. This indicates that the two lakes are easily connected and almost form one single waterbody. During the mine operations, the N6 watershed will not be directly affected by the Project but will convey the flows from Lake B1.

3.4.1 N6a Outlet Channel Survey

Lake N6a outlet channel was surveyed and a cross-section was measured downstream of the outlet (Figure 14). The longitudinal profile of the channel is shown on Figure 15 and has a general slope gradient of 2.6%.

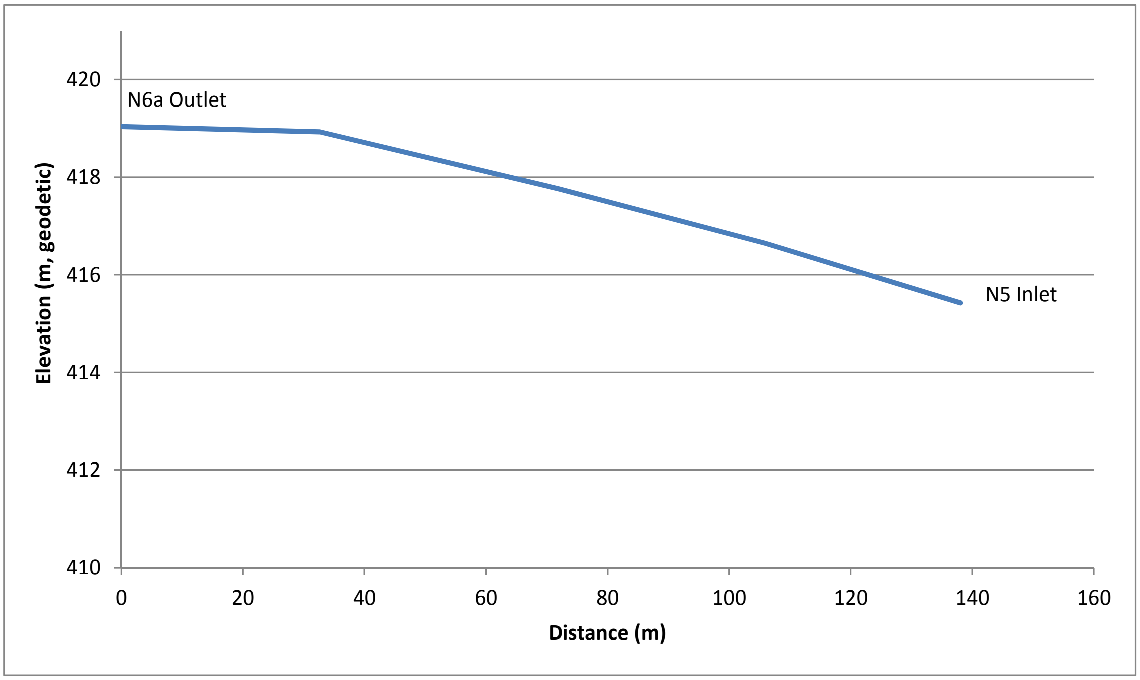
Figure 14: Lake N6a Outlet Channel Cross-Section



m = metres.

The outlet channel flows through morainal terrain, with outcrops of cobbles and boulder, and has an average width of 6 m and is less than a metre deep relative to the surrounding terrain. Both channel banks are covered with brush and are armoured with boulders. The channel bed is formed of boulders with cobbles in between, with the water flowing through a uniform and relatively flat boulder substrate.

Figure 15: Longitudinal Profile along the Outlet Channel of Lake N6a



m = metres.

Because of its configuration and surficial materials, the N6a outlet channel is capable of conveying the slightly higher flows associated with the Lake B1 outlet diversion, with no additional mitigation necessary during the period with increased flows.

3.5 L2 Watershed

The L2 watershed is located north of Area 8 of Kennady Lake and has an area of approximately 3.63 km^2, of which approximately 0.82 km^2 is lake water surface. The L2 watershed drains into Lake L1b, part of the L watershed. The lakes surveyed for shoreline assessment within L2 watershed were Lake L2, its tributary Lake L3, which drains Kennady Lake) and its tributary Lake L13, which drains Lakes L14 and L15. The water levels at the time of the 2011 field survey were 419.20 m for Lake L2, 420.47 m for Lake L3 and 420.58 m for Lake L13. Lakes L2 and L3 will be subject to one year of sustained freshet flows during Kennady Lake dewatering, and thereafter affected by the close-circuiting of the Kennady Lake watershed upstream of Area 8, which will lower the discharge through the L2 watershed. No dykes or other direct diversions are proposed to be built within the L2 watershed.

3.5.1 Shoreline Surveys within L2 Watershed

A total of nine transects were surveyed within L2 watershed (Figure 16). The main transect parameters are presented in Table 11.

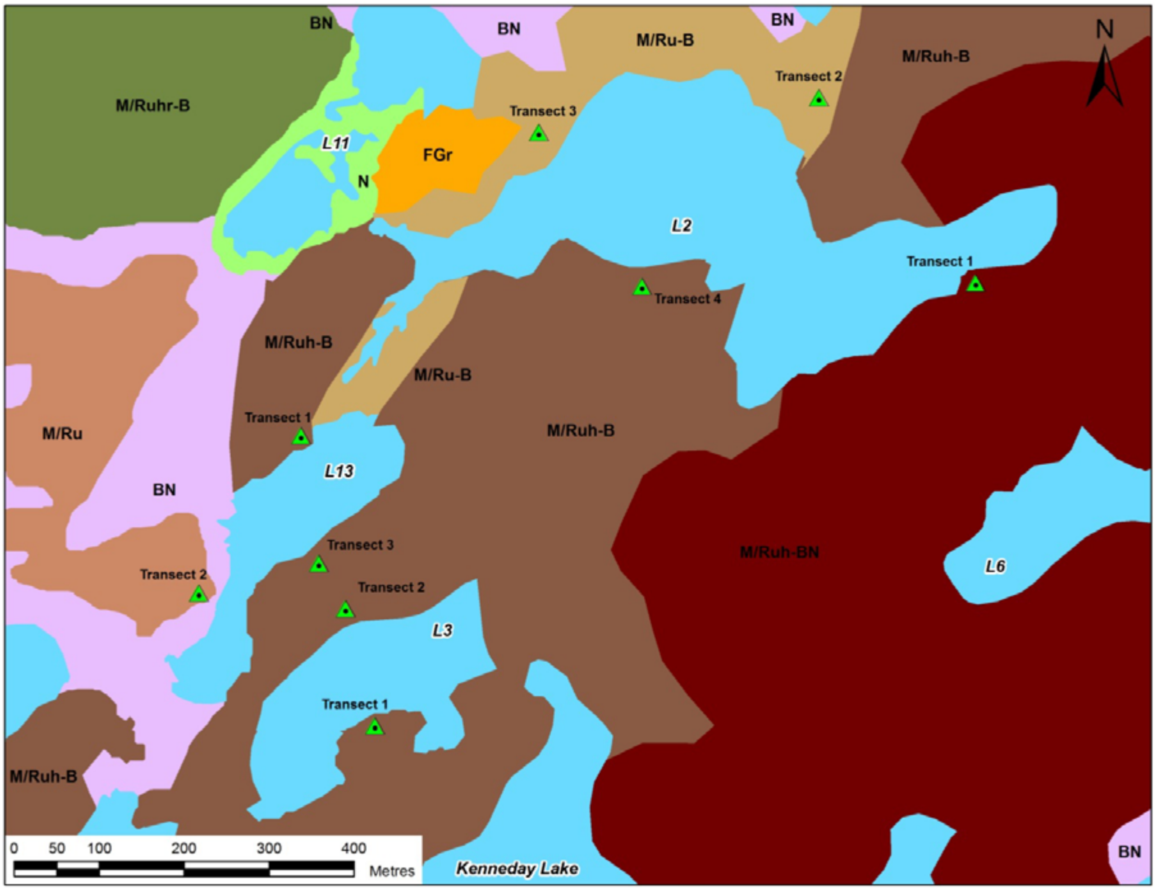
Table 11: Lake L2 Watershed Surveyed Transect Parameters

Lake	Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
L2	Transect 1	420.630	419.161	69.5
L2	Transect 2	421.117	419.197	82.6
L2	Transect 3	421.928	419.140	23.3
L2	Transect 4	427.015	419.152	73.3
L13	Transect 1	421.692	420.575	10.5
L13	Transect 2	422.502	420.567	52.1
L13	Transect 3	422.497	420.574	43.7
L3	Transect 1	421.955	420.463	30.6
L3	Transect 2	422.622	420.428	49.2

m = metres.

The Lake L13 shoreline was surveyed at 3 locations around the perimeter of Lake L13, and is mostly composed of morainal material with bog the sub-dominant type, and with a small area of bog and fen peat complex on the west and south-west shoreline. The shoreline has also a small area of bedrock on the north-west side of the lake. Slope gradients are typically less than 15%.

Figure 16: L2 Watershed shoreline transect locations with terrain type units



The shoreline of Lake L3 was surveyed at two locations around the perimeter of Lake L3, and is composed of morainal material with bog the sub-dominant type. The shoreline has two small sections of bedrock on the south side of the lake, within the two existing embayments. Slope gradients are typically less than 15%.

The shoreline of Lake L2 was surveyed at four locations around the perimeter of Lake L2, and is composed of morainal material with bog the sub-dominant type for most of the shoreline and with fen complex sub-dominant on the south-east part of the lake. The shoreline has one section of bedrock on the south shore of the lake at Transect 4. Slope gradients are typically less than 15% except where the bedrock outcrop results in steeper slope gradients (typically 70% to 90%).

The main parameters of all surveyed transects are presented in Table 12 and the cross-section profiles of the surveyed transects are shown on Figure 17 to Figure 19.

During the shoreline survey, the terrain types previously delineated were field checked and additional details on the shoreline types were identified. During mine operations the lake water levels within the L2 Watershed are anticipated to drop compared to baseline conditions (Section 9.7 of De Beers 2010) because of flow diversions from upstream in Kennady Lake watershed and therefore no further shoreline erosion assessment was necessary.

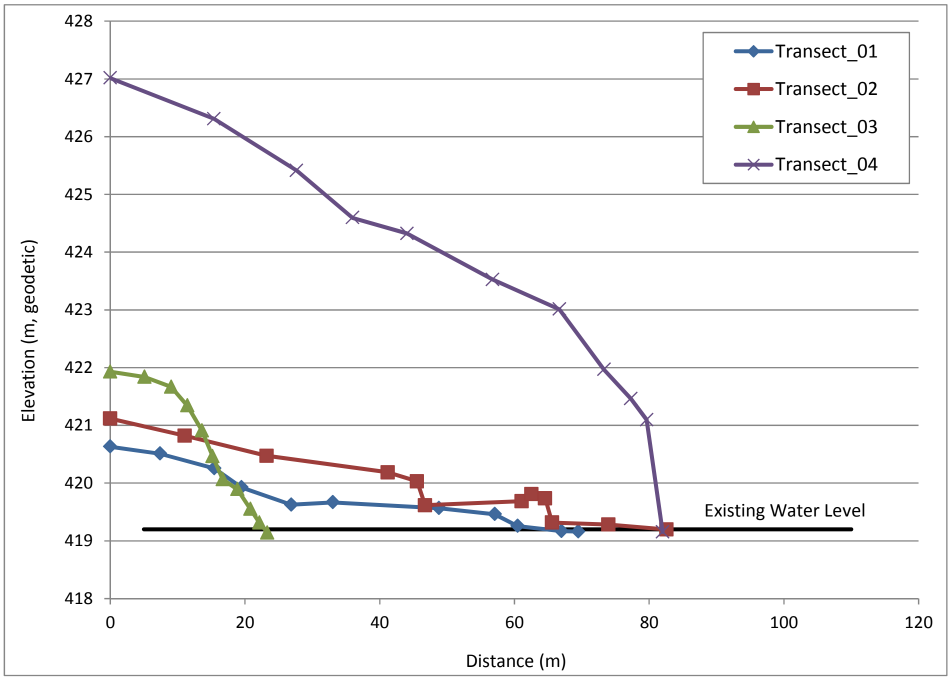
Table 12: L2 Watershed Main Transect Parameters

Lake	Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
			(degrees)	(%)			
L2	Transect 1	336° - NNW	0.9	2	440	M/Ruh-BN	L-H
L2	Transect 2	224° - SW	0.7	1	440	M/Ru-B	L-M
L2	Transect 3	130° - SE	8.0	14	450	M/Ru-B	L-M
L2	Transect 4	23° - NNE	39.4	82	220	M/Ruh-B	L-H
L13	Transect 1	136° - SE	7.7	14	110	M/Ruh-B	L-M
L13	Transect 2	123° - ESE	5.3	9	35	BN	L
L13	Transect 3	320° - NW	6.0	11	100	M/Ruh-B	L-H
L3	Transect 1	333° - NNW	2.5	4	110	M/Ruh-B	L-H
L3	Transect 2	154° - SSE	6.5	11	180	M/Ruh-B	L-H

Note: Please see Table 3 for definitions of terrain units.

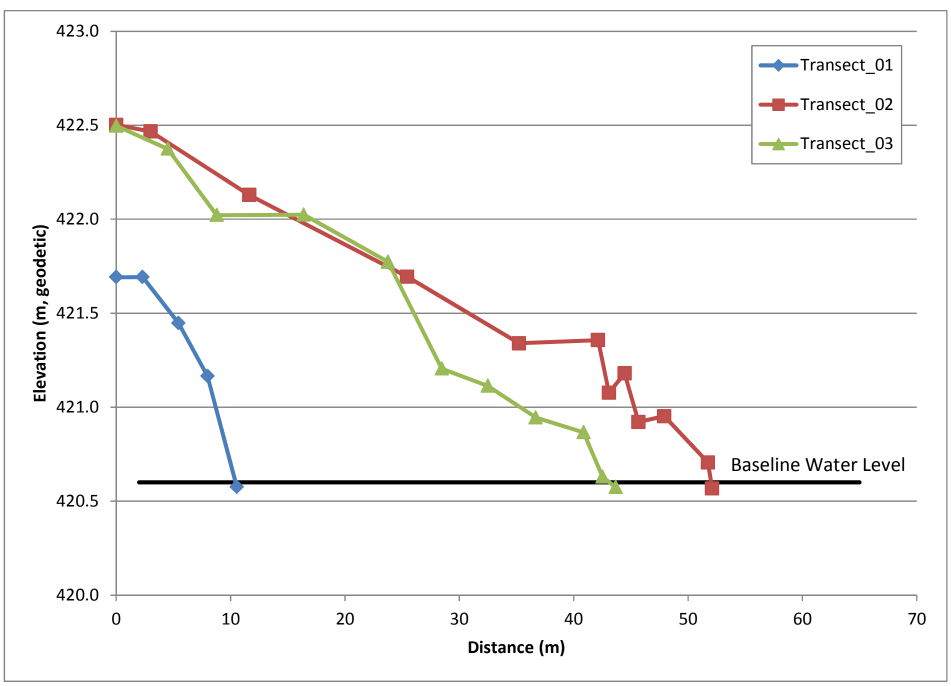
° = degrees; % = percent; m = metres; SSE = south-southeast; SE = southeast; ESE = east-southeast; NNE = north-northeast; SW = southwest; NNW = north-northwest; NW = northwest; L-H = low-high; L-M = low-moderate; L = low.

Figure 17: Lake L2 Shoreline Transect Profiles



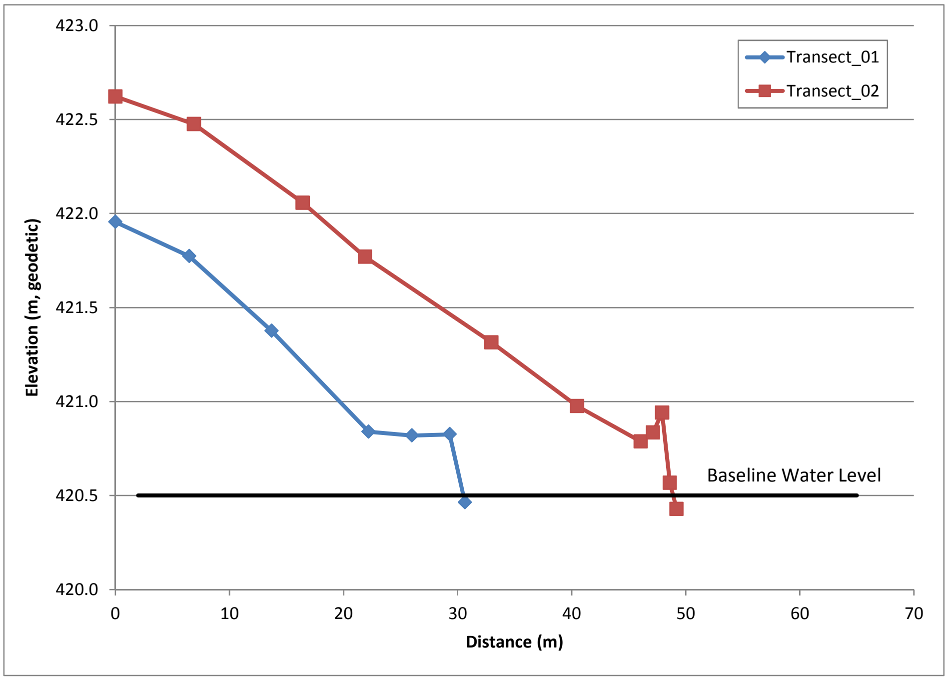
m = metres.

Figure 18: Lake L13 Shoreline Transect Profiles



m = metres.

Figure 19: Lake L3 Shoreline Transect Profiles



m = metres.

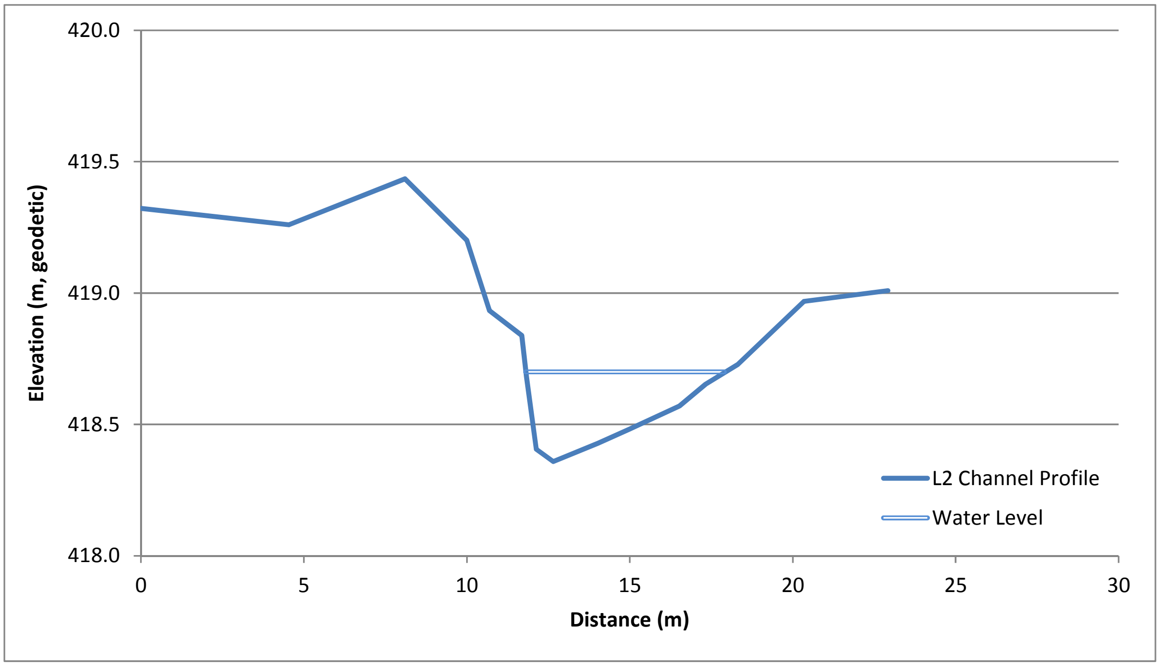
3.5.2 Outlet Channel Surveys within L2 Watershed

The outlet channels of all three lakes were surveyed with cross-sections measured for each outlet channel (Figure 20 to Figure 22). Longitudinal profiles were also measured (Figure 23). The measured slopes gradients for Lake L3 and L13 are similar, between 0.3% for Lake L3 and 0.6% for Lake L13. The slope gradient for Lake L2 outlet channel was measured to be 1.2% between the lake outlet and the first unnamed pond downstream on the main channel.

The outlet channels flow through moraine type of terrain, with outcrops of boulders mixed with cobbles. The channels are typically less than 1 m deep relative to the surrounding terrain and vary in width between 1 to 2 m at Lake L13 and 2 to 8 m at Lake L3 and Lake L2. The channel banks for Lake L3 and L13 are covered with brush and armoured with boulders. The channel bed is formed of boulders with cobbles in between, with the water flowing through a defined channel with small nickpoints.

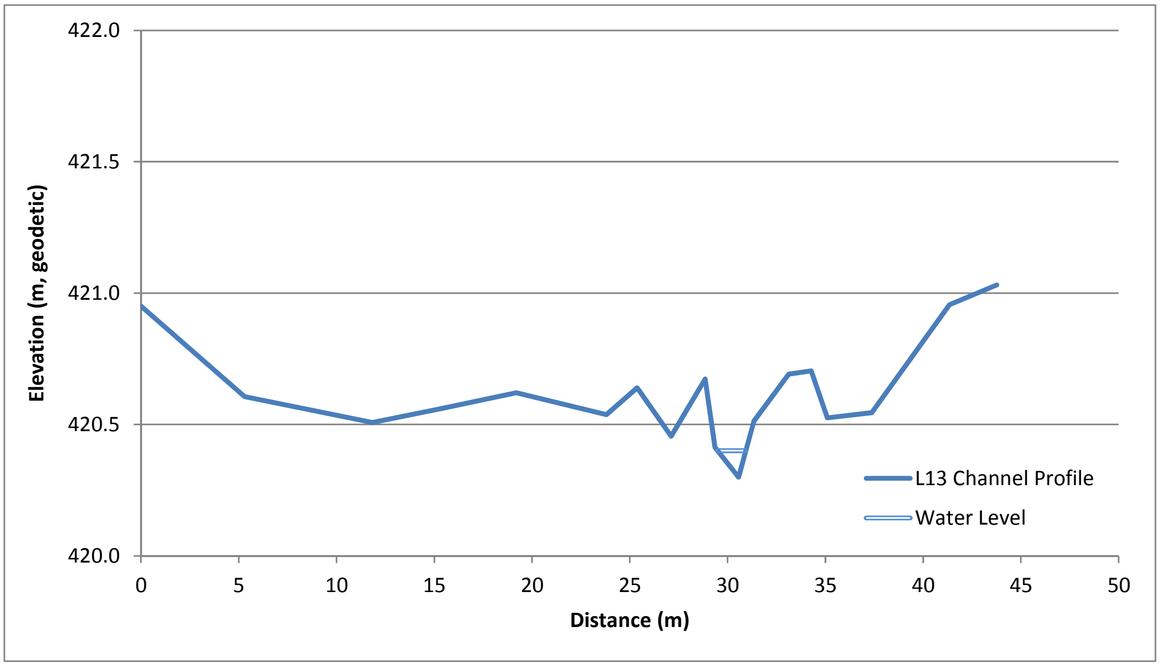
During mine operations the flows through this watershed will be lowered, with the exception of one year with an extended freshet, during the dewatering of Kennady Lake, and therefore no erosion effects are expected on any outlet channel as flow volumes and velocities are expected to be reduced.

Figure 20: Lake L2 Outlet Channel Cross-Section



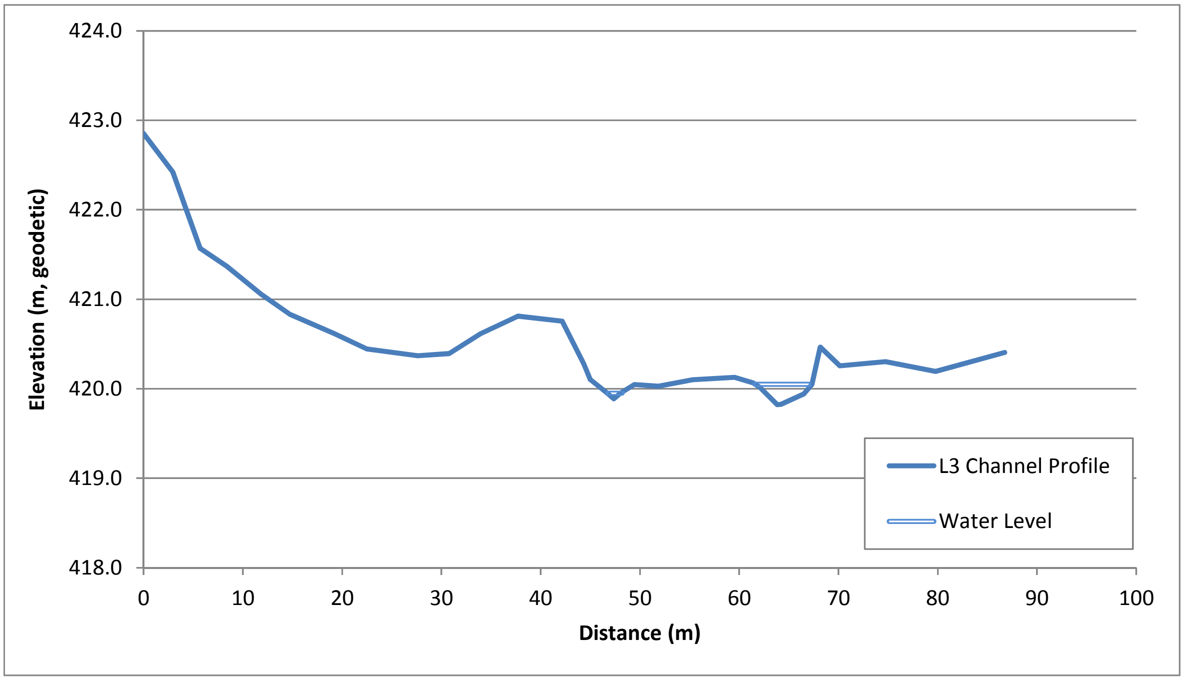
m = metres.

Figure 21: Lake L13 Outlet Channel Cross-Section



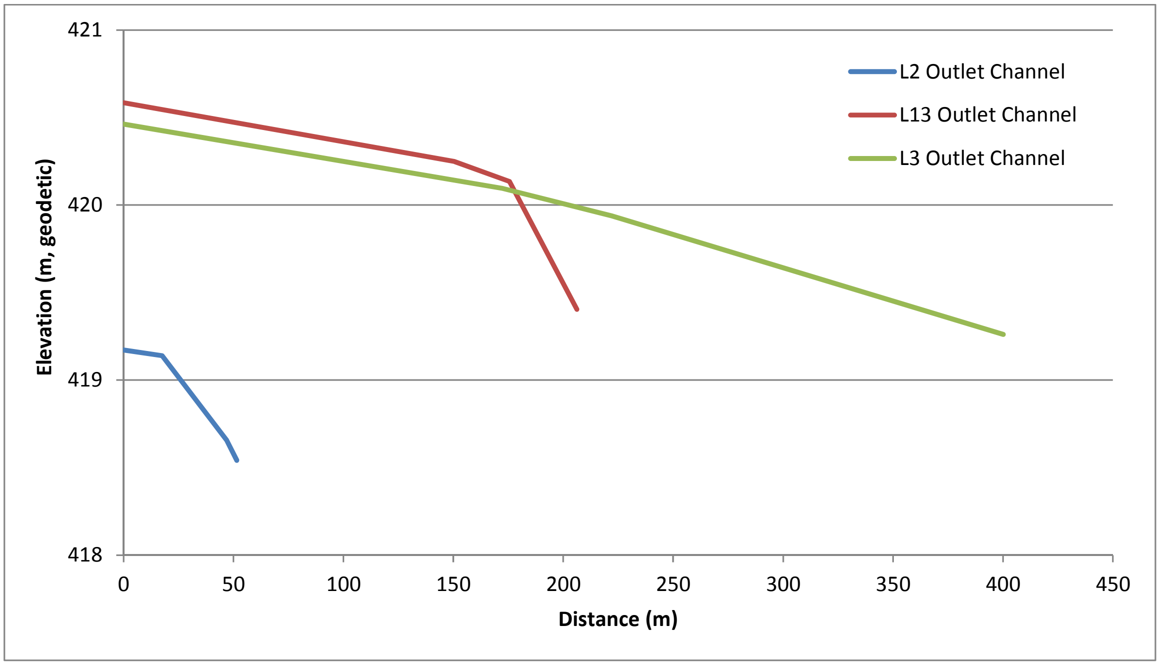
m = metres.

Figure 22: Lake L3 Outlet Channel Cross-Section



m = metres.

Figure 23: Longitudinal Profiles for Outlet Channels Surveyed within L2 Watershed



m = metres.

3.6 E1 Watershed

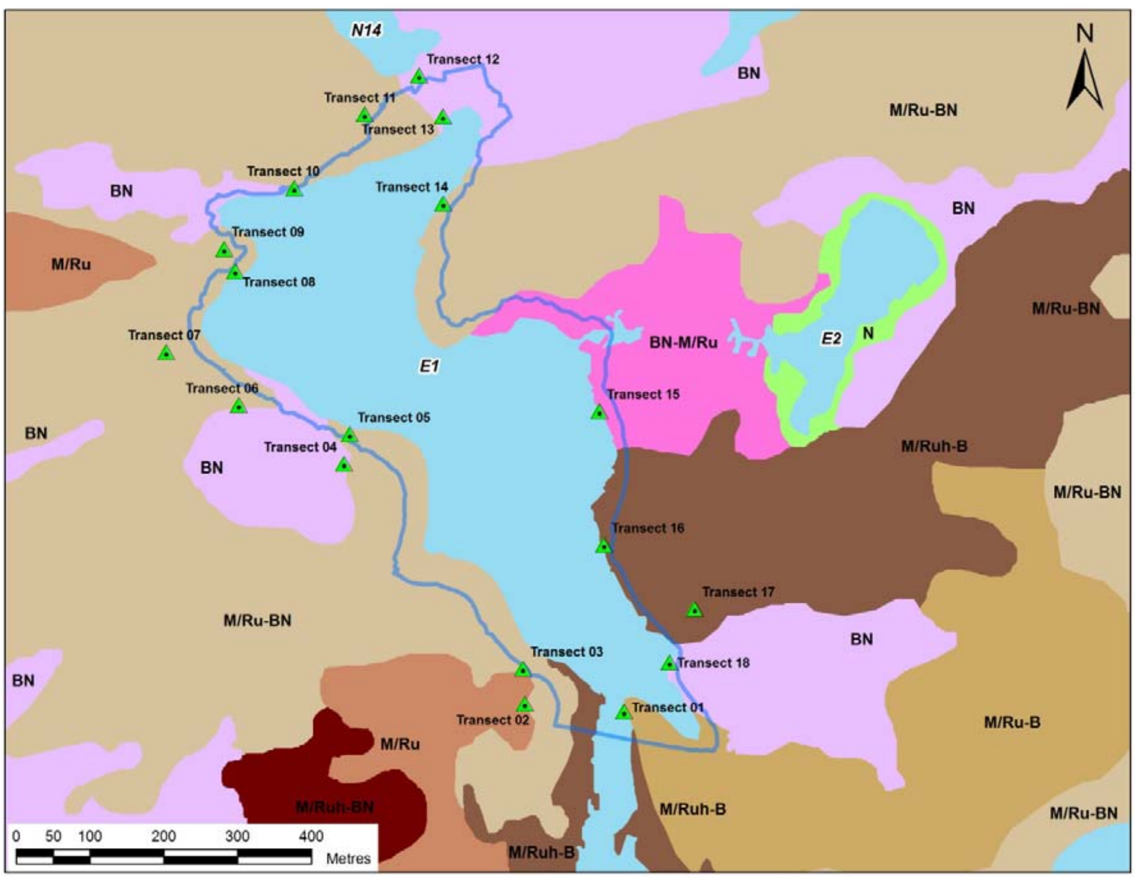
The E1 watershed is located west of Kennady Lake and south of D2 watershed and has an area of approximately 1.22 km^2, of which approximately 0.23 km^2 is lake surface. Lake E1 presently drains naturally into Kennady Lake. The largest lake in the watershed is Lake E1 with an average water level elevation measured during the 2011 field surveys of 425.2 m. Lake E2 drains into Lake E1.

During the mine operations the E1 watershed will be disconnected from Kennady Lake and the water level will rise to 426 m resulting in the drainage being re-directed northwards to Lake N14. The E1 watershed will be reconnected with Kennady Lake at mine closure.

3.6.1 Lake E1 Shoreline Survey

A total of 18 transects were surveyed around the perimeter of Lake E1 (Figure 24) including the area to be flooded. The main transect parameters are presented in Table 13. Lake E1 is oriented north-west to south-east, and has small sections of moderately sloped banks on the north-west banks (typical slope gradients of 20% to 30% around Transect 10) but the bulk of the shoreline is characterized by shallow to gentle slopes (typically less than 15%).

Figure 24: E1 Shoreline Transect Locations with Terrain Type Units and the Predicted New Water Level



The majority of the shoreline is composed of morainal materials with complexes of bog and fen peat. Bedrock outcrops are present on the north-west shore, from Transect 8 to Transect 10, and are responsible for the steeper shorelines that extend below the water surface. Figure 25 presents the cross-section profiles of the surveyed transects.

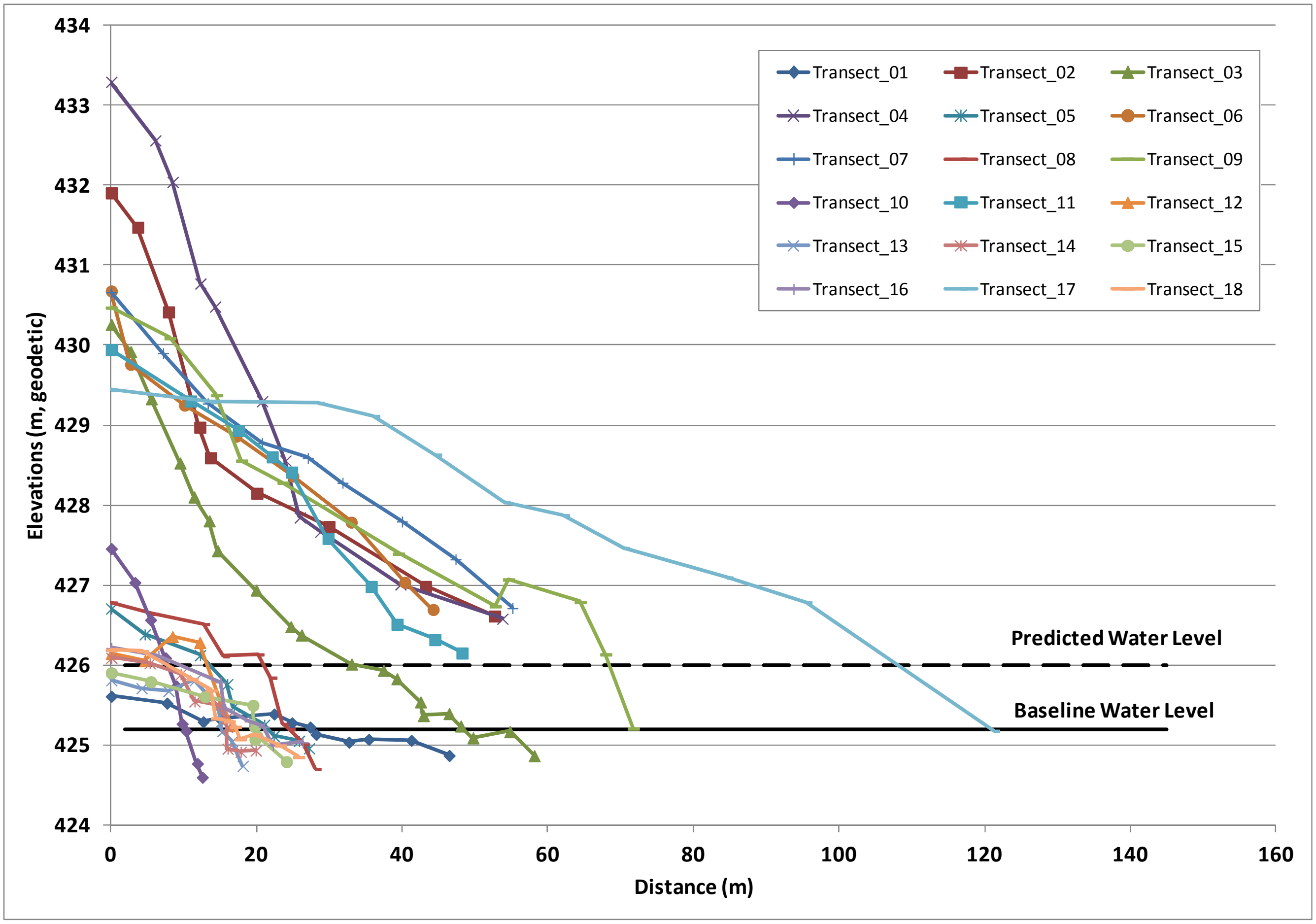
Table 13: Lake E1 Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	425.613	424.873	46.4
Transect 2	431.910	426.617	52.6
Transect 3	430.264	424.870	58.1
Transect 4	433.299	426.584	53.7
Transect 5	426.711	424.962	27.2
Transect 6	430.683	426.699	44.2
Transect 7	430.667	426.716	55.1
Transect 8	426.785	424.704	28.0
Transect 9	430.474	425.211	71.7
Transect 10	427.460	424.600	12.5
Transect 11	429.950	426.155	48.2
Transect 12	426.359	425.251	16.6
Transect 13	425.813	424.743	18.0
Transect 14	426.094	424.919	19.8
Transect 15	425.907	424.796	24.0
Transect 16	426.217	425.003	26.3
Transect 17	429.443	425.182	121.2
Transect 18	426.195	424.853	25.7

m = metres.

During the shoreline survey the terrain types previously delineated were field checked and additional details on the shoreline types were identified. The lake water levels will rise during mine operations and Lake E1 will flow north-west into Lake N14 through a new channel.

Figure 25: Lake E1 Shoreline Transect Profiles



m = metres.

3.6.1.1 Erosion Potential Assessment

Table 14 presents the main parameters derived for each transect that were used to estimate the shoreline erosion potential.

Each parameter from Table 14 was weighted according to the methods presented in Appendix B and the erosion susceptibility class was determined for each transect of the lake and the final classes are shown in Table 15.

Table 14: Lake E1 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	13° - NNE	0.6	1	850	M/Ru-B	L-M
Transect 2	80° - E	2.2	4	160	M/Ru-BN	L-M
Transect 3	35° - NE	3.6	6	200	M/Ru-BN	L-M
Transect 4	60° - ENE	1.8	3	320	M/Ru-BN	L-M
Transect 5	9° - N	4.4	8	460	M/Ru-BN	L-M
Transect 6	27° - NNE	4.2	7	500	M/Ru-BN	L-M
Transect 7	59° - ENE	3.8	7	350	M/Ru-BN	L-M
Transect 8	122° - ESE	6.8	12	650	M/Ru-BN	L-M
Transect 9	95° - E	6.2	11	280	M/Ru-BN	L-M
Transect 10	169° - S	14.7	26	850	M/Ru-BN	L-M
Transect 11	94° - E	2.3	4	160	M/Ru-BN	L-M
Transect 12	327° - NNW	7.7	14	120	BN	L
Transect 13	149° - SSE	3.4	6	120	BN	L
Transect 14	304° - NW	5.7	10	160	M/Ru-BN	L-M
Transect 15	244° - WSW	1.2	2	350	BN-M/Ru	L-M
Transect 16	253° - WSW	3.1	5	210	M/Ruh-B	L-H
Transect 17	236° - SW	2.4	4	180	M/Ruh-B	L-H
Transect 18	286° - WNW	3.5	6	220	BN	L-M

Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; SSE = south-southeast; S = south; ESE = east-southeast; ENE = east-northeast; E = east; WNW = west-northwest; WSW = west-southwest; SW = southwest; N = north; NNE = north-northeast; NNW = north-northwest; NE = northeast; NW = northwest; L-M = low-moderate; L-H = low-high; L = low.

Table 15: Lake Shoreline Erosion Susceptibility Classes for Lake E1

Transect	Erosion Susceptibility Score	Erosion Susceptibility Class
Transect 1	38	Very High
Transect 2	9	Very Low
Transect 3	9	Very Low
Transect 4	9	Very Low
Transect 5	8	Very Low
Transect 6	9	Very Low
Transect 7	7	Very Low
Transect 8	9	Very Low
Transect 9	8	Very Low
Transect 10	12	Very Low
Transect 11	11	Very Low
Transect 12	31	High
Transect 13	23	Moderate
Transect 14	24	Moderate
Transect 15	15	Very Low
Transect 16	15	Very Low
Transect 17	13	Very Low
Transect 18	18	Low

For the high and very high erosion susceptibility class, the following should be noted:

- Transect 1 is located at the existing outlet which will be covered by a dyke during the life of the mine. This will reduce the effective erosion which may occur along this lake shoreline section.
- Transect 12 is located at the outlet to Lake N14. Erosion at this location may be controlled by adequate design of the outlet. If erosion does occur, a new wave-cut bank may be expected to form. Sediments eroded from the shoreline are expected to settle within the lake.

3.6.1.2 Lake E1 Shoreline Mitigation

The mitigation for the shoreline erosion potential at Lake E1 include two design options for areas with High and Very High erosion susceptibility scores:

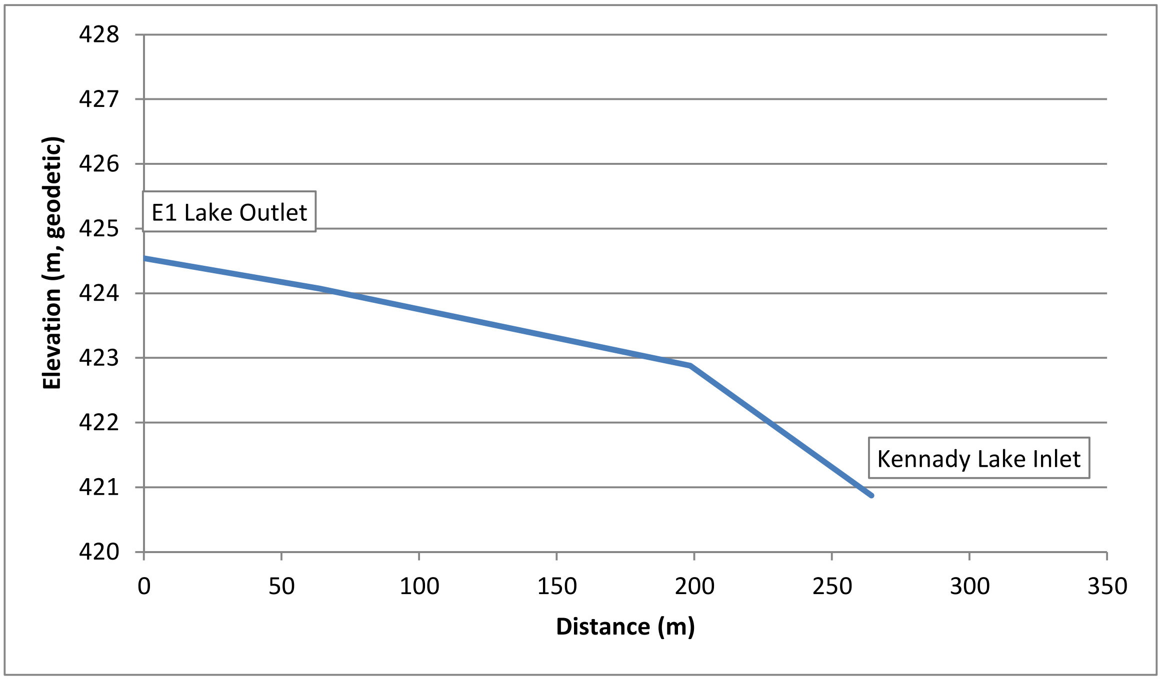
- Structural mitigation – it is proposed to build or adjust the shoreline so that the erosion potential will be minimized before the lake water levels will reach the new proposed elevation. This will mean constructing the shoreline so that it has a low slope with reduced wave action that will extend approximately 5 m from shore into the lake, with boulders and cobbles as the main shoreline material.
- Non-structural mitigation that will not disturb the existing terrain, but after the lake rises to the proposed elevation, barriers (i.e., rock liners) will be added to protect the shoreline at those exposed locations after a field inspection.

The remainder of the shoreline with lower scores is recommended to be monitored regularly, with mitigation measures implemented following the field visits if necessary.

3.6.2 E1 Outlet Channel Survey

The E1 outlet channel flows into Kennady Lake through a relatively flat terrain with surficial material of mixed bog and fen peat. The channel has a general slope gradient of approximately 1.4% (Figure 26) and consists of multiple small channels forming a braided system which combine into a single-thread system as the outlet approaches Kennady Lake. All these channels are small and flow through vegetation (i.e., cotton grass and brush) with low density of cobbles and boulder that appear only at the lower part of the channel, close to Kennady Lake. The main channel at the lake outlet is typically less than 0.5 m deep relative to its surrounding terrain and varies in width between 0.3 m and 1 m.

Figure 26: Longitudinal Profile along the Outlet Channel of Lake E1



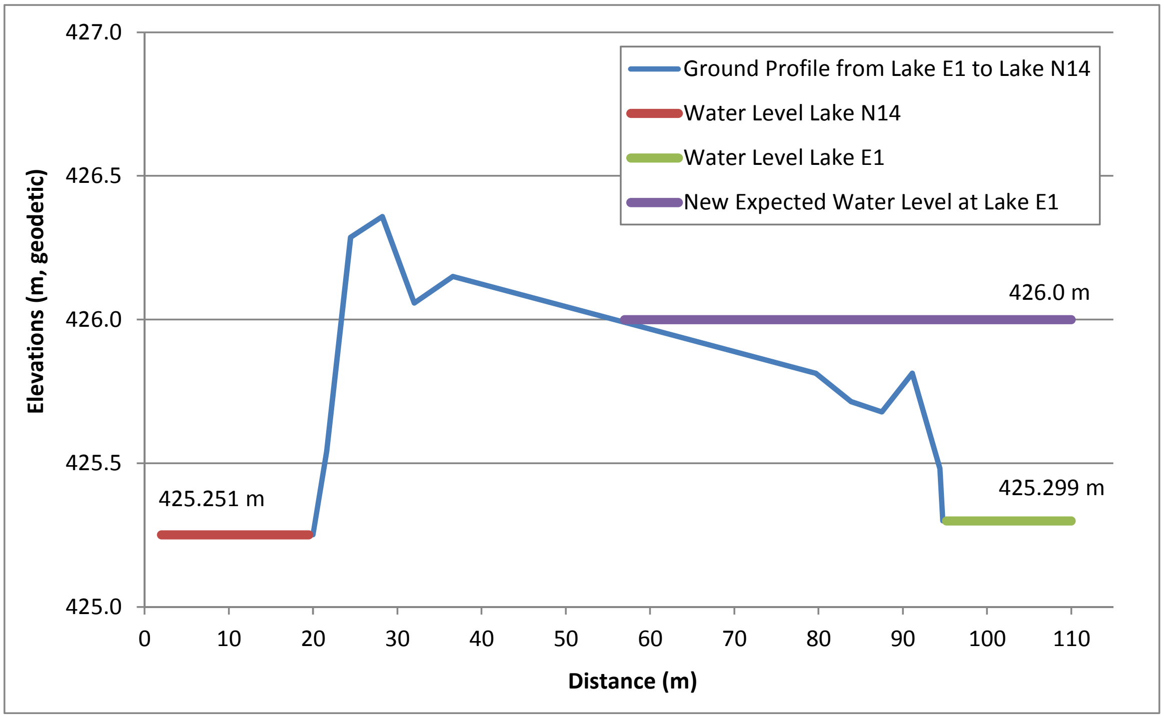
m = metres.

3.6.2.1 E1 Outlet Channel Mitigation

The existing outlet channel will be covered by a dyke that will block the flow from Lake E1 to Kennady Lake. The dyke will result in the water level rising in Lake E1 to the level where the flows will divert north-west into Lake N14. The newly created channel is expected to flow through the same type of surficial organic materials. Figure 27 presents the ground profile from Lake E1 to Lake N14.

Based on the field conditions at the time of survey (July 19, 2010), the new channel will have an approximate length of 40 m and slope gradient of approximately 2%, which is close to the 1.4% value that was measured for the E1 outlet channel to Kennady Lake at baseline conditions. Because the new channel will flow on similar organic terrain and slope gradient, it is expected that minimum mitigation will be required when delineating the new channel.

Figure 27: Ground Profile from Lake E1 to Lake N14



m = metres.

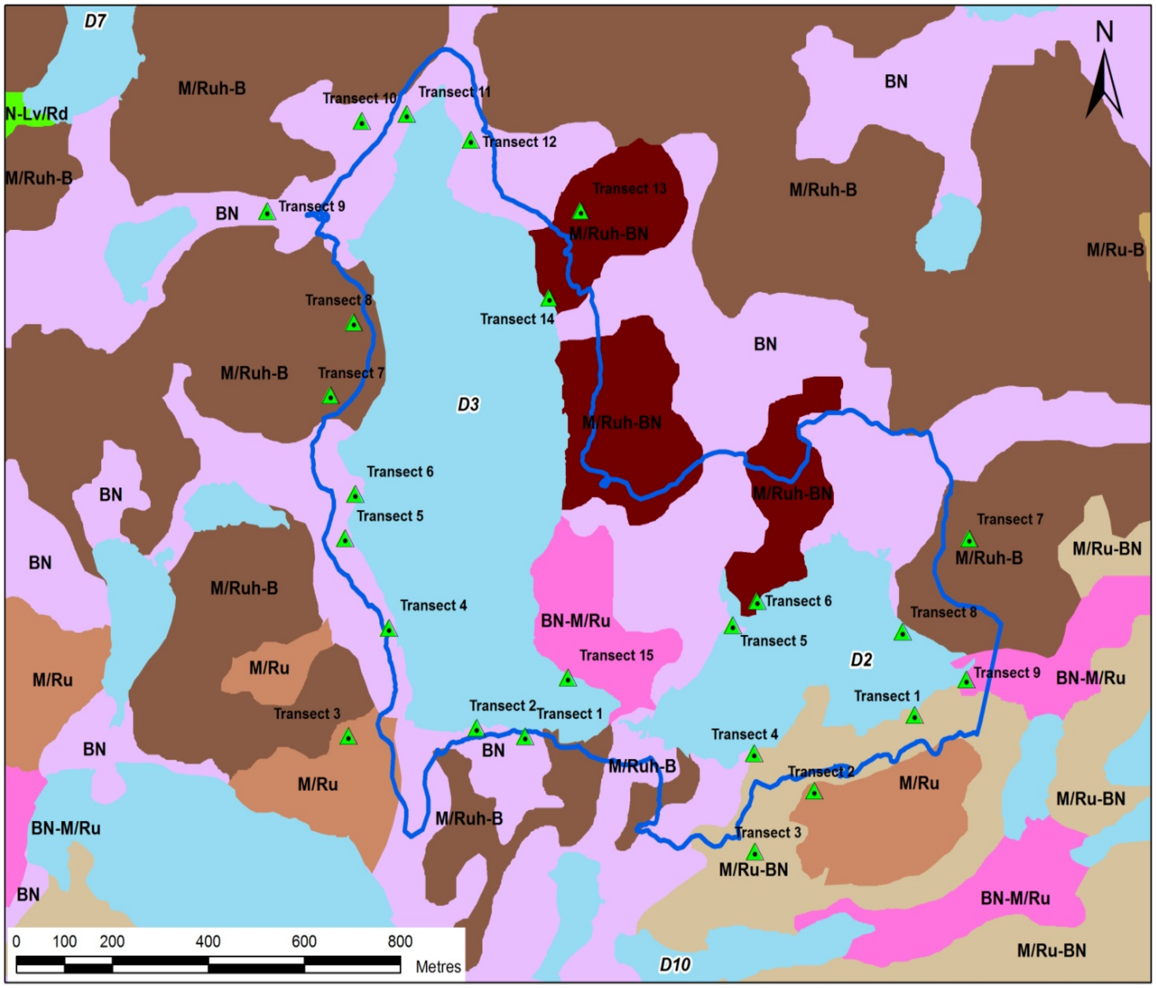
3.7 D2 Watershed

The D2 watershed is located west of Kennady Lake and has an area of approximately 2.49 km^2, of which 0.94 km^2 is lake water surface. The D2 watershed drains naturally into Lake D1. The largest lakes in the watershed are Lakes D7, D3 and D2. During mine operations, Lake D2 will be disconnected from Lake D1 by a dyke and the water level will rise to 427.0 m, resulting in flooding Lake D3 upstream. The new proposed Lake D2-D3 will discharge at its south west corner into Lake N14. The lakes in D2 watershed will return to their initial baseline conditions at mine closure.

3.7.1 Lake D2-D3 Shoreline Surveys

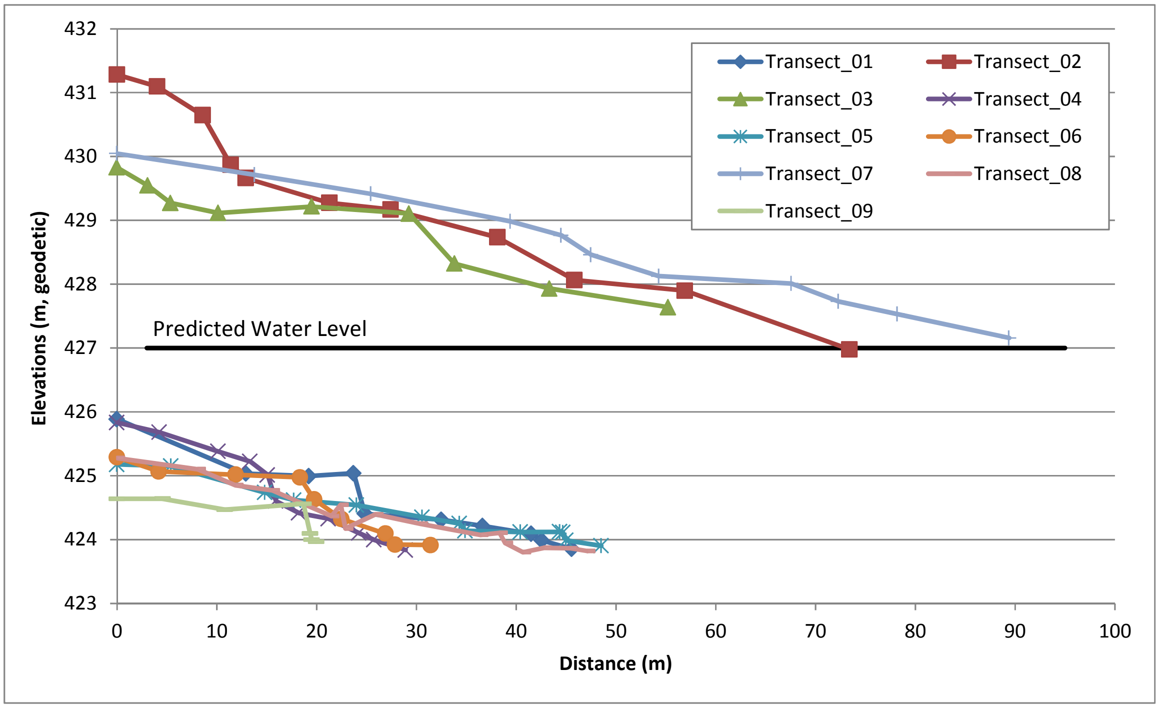
A total of nine transects were surveyed around the perimeter of Lake D2 and 15 transects around the perimeter of Lake D3 (Figure 28 to 30) including the area to be flooded. The main transect parameters are presented in Table 16 and Table 17. Lake D2 is oriented east to west and Lake D3 north to south. Small sections of steep banks (Transect 1 for Lake D2, and Transect 1 and 2 for Lake D3) can be found on the south shore at each lake but gentle to moderate slopes (typically less than 20% slope gradient) developed on morainal terrain types are characteristic of the shoreline.

Figure 28: Lake D2 and D3 Shoreline Transect Locations with Terrain Type Units and the Predicted New Water Level



During the shoreline survey the terrain types previously delineated were field checked and additional details on the shoreline types were identified and used to estimate the erosion potential classes.

Figure 29: Lake D2 Shoreline Transect Profiles



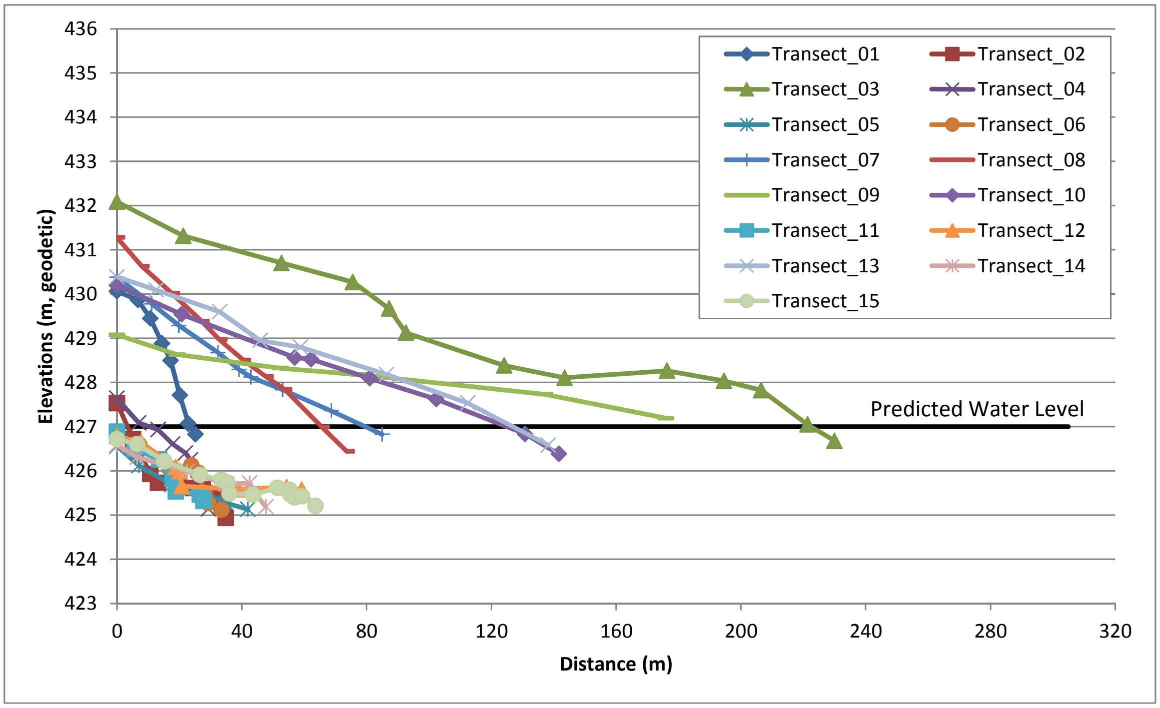
m = metres.

Table 16: Lake D2 Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	425.884	423.853	45.6
Transect 2	431.283	426.979	73.4
Transect 3	429.828	427.638	55.2
Transect 4	425.833	423.835	28.9
Transect 5	425.177	423.903	48.5
Transect 6	425.287	423.912	31.4
Transect 7	430.047	427.156	89.4
Transect 8	425.276	423.801	47.1
Transect 9	424.639	423.966	20.0

m = metres.

Figure 30: Lake D3 Shoreline Transect Profiles



m = metres.

Table 17: Lake D3 Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	430.059	426.826	25.1
Transect 2	427.530	424.932	34.9
Transect 3	432.085	426.676	230.0
Transect 4	427.639	425.137	29.3
Transect 5	426.558	425.129	41.9
Transect 6	426.737	425.118	33.4
Transect 7	430.375	426.824	85.0
Transect 8	431.278	426.440	73.6
Transect 9	429.074	427.192	176.0
Transect 10	430.196	426.380	141.7
Transect 11	426.887	425.318	27.7
Transect 12	426.791	425.468	60.0
Transect 13	430.386	426.583	138.3
Transect 14	426.582	425.187	47.7
Transect 15	426.716	425.203	63.6

m = metres.

3.7.1.1 Erosion Potential Assessment

The main parameters derived for each transect that were used to estimate the shoreline erosion potential are presented in Table 18 and Table 19.

Table 18: Lake D2 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	341° - NNW	1.5	3	650	M/Ru-BN	L-M
Transect 2	357° - N	2.3	4	600	M/Ru-BN	L-M
Transect 3	267° - W	1.8	3	n/a	n/a	n/a
Transect 4	333° - NNW	3.1	5	600	M/Ru-BN	L-M
Transect 5	181° - S	1.5	3	650	BN	L
Transect 6	139° - SE	1.0	2	n/a	n/a	n/a
Transect 7	256° - WSW	2.2	4	1300	M/RuH-BN	L-H
Transect 8	229° - SW	1.8	3	n/a	n/a	n/a
Transect 9	292° - WNW	1.9	3	n/a	n/a	n/a

Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; SE = southeast; SW = southwest; WNW = west-northwest; SW = southwest; NNW = north-northwest; N = north; L-M = low-moderate; L-H = low-high; L = low; n/a = not applicable.

Table 19: Lake D3 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		(degrees)	(%)			
Transect 1	355° - N	10.0	18	1300	BN	L
Transect 2	348° - NNW	8.5	15	1300	BN	L
Transect 3	104° - ESE	2.8	5	100	M/Ru	M
Transect 4	82° - E	3.3	6	1200	BN	L
Transect 5	81° - E	2.1	4	n/a	n/a	L
Transect 6	121° - ESE	1.5	3	n/a	n/a	L
Transect 7	124° - SE	2.0	3	1400	M/Ruh-B	L-H
Transect 8	75° - ENE	3.6	6	450	M/Ruh-B	L-H
Transect 9	91° - E	0.5	1	450	BN	L
Transect 10	129° - SE	1.5	3	600	BN	L
Transect 11	130° - SE	3.4	6	250	BN	L
Transect 12	257° - WSW	3.1	5	380	BN	L
Transect 13	242° - WSW	1.5	3	500	M/Ruh-BN	L-H
Transect 14	234° - SW	1.4	2	600	M/Ruh-BN	L-H
Transect 15	225° - SW	1.6	3	n/a	n/a	n/a

Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; N = north; NNW = north-northwest; ESE = east-southeast; E = east; ENE = east-northeast; SE = southeast; WSW = west-southwest; SW = southwest; L-M = low-moderate; L-H = low-high; L = low; n/a = not applicable.

Each parameter from was weighted and the erosion susceptibility class was determined for each surveyed transect and are presented in Table 20.

Table 20: Lake Shoreline Erosion Susceptibility Classes for Lake D2 and Lake D3

Lake	Transect	Erosion Susceptibility Score	Erosion Susceptibility Class
Lake D2	Transect 1	9	Very Low
Lake D2	Transect 2	9	Very Low
Lake D2	Transect 4	9	Very Low
Lake D2	Transect 5	12	Very Low
Lake D2	Transect 7	12	Very Low
Lake D3	Transect 1	7	Very Low
Lake D3	Transect 2	14	Very Low
Lake D3	Transect 3	9	Very Low
Lake D3	Transect 4	9	Very Low
Lake D3	Transect 5	9	Very Low
Lake D3	Transect 6	9	Very Low
Lake D3	Transect 7	9	Very Low
Lake D3	Transect 8	21	Moderate
Lake D3	Transect 9	78	Very High
Lake D3	Transect 10	33	High
Lake D3	Transect 11	24	Moderate
Lake D3	Transect 12	10	Very Low
Lake D3	Transect 13	13	Very Low
Lake D3	Transect 14	13	Very Low

Transects 9 and 10 are located on ice-rich gentle slopes, which are exposed to east winds. As a result the erosion susceptibility classes were classified as High to Very High. Once a new wave cut notch develops erosion should be limited as the profile will become more like the existing profiles on Transects 5 and 6.

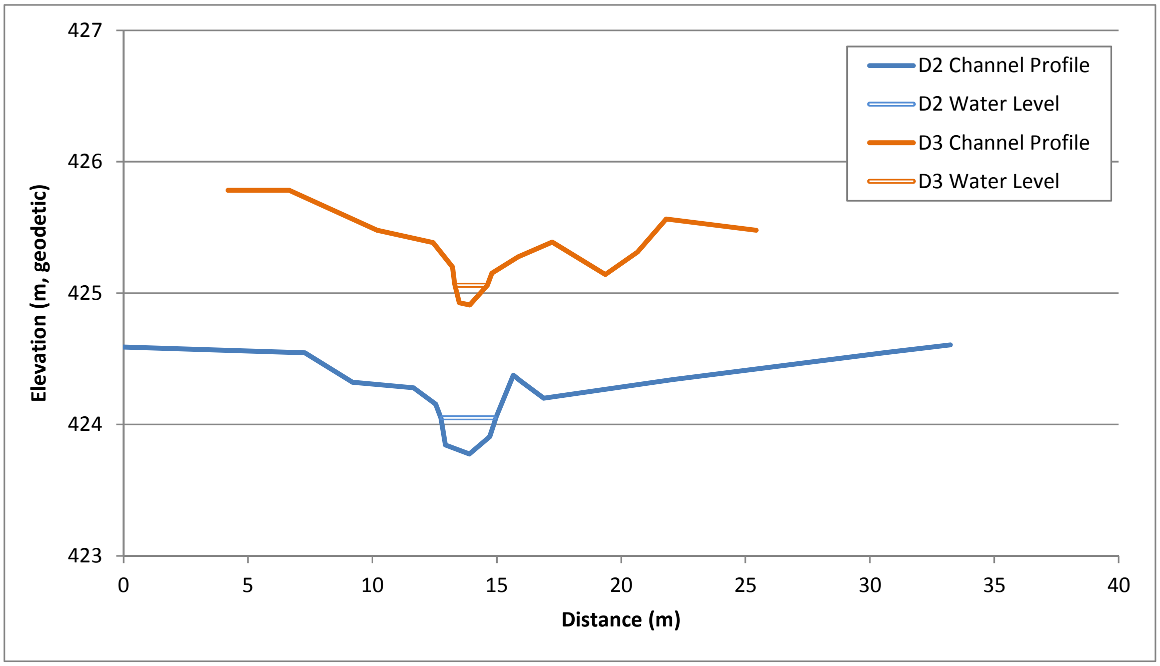
3.7.1.2 Lake D2-D3 Shoreline Mitigation

The mitigation for the shoreline erosion potential at Lake D2-D3 for areas with High and Very High erosion susceptibility scores are recommended to be structural measures. It is proposed that a rock blanket may be required at the shoreline margin where the new shoreline will be located. The materials recommended for use in the rock blanket should be a boulder and cobble mixture. The remainder of the shoreline with lower scores is recommended to be monitored regularly with mitigation measures implemented following the field visits if necessary.

3.7.2 D2 and D3 Outlet Channel Surveys

D2 and D3 outlet channels were surveyed over their entire length. Cross-sections and longitudinal profiles were measured and are shown on Figure 31 and Figure 32, respectively. The measured slope gradients for both channels are very similar, and are within the 1.3% range.

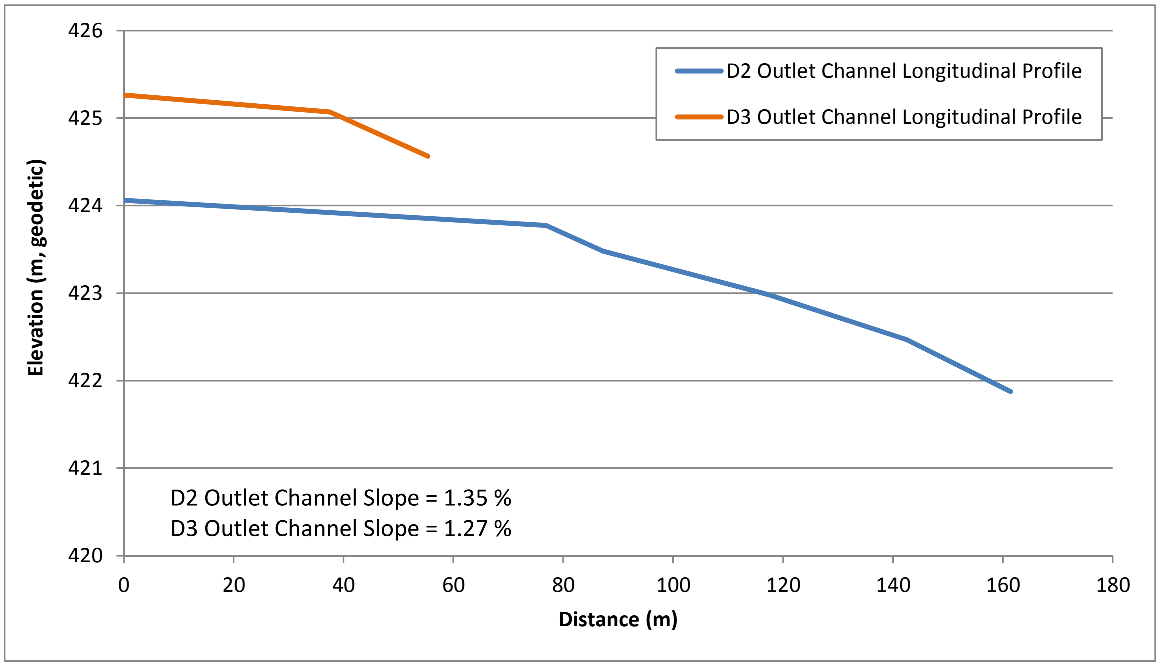
Figure 31: Lake D2 and D3 Outlet Channel Cross-Sections



m = metres.

Both outlet channels flow through similar terrain types of mixed bog and fen peat, with banks armoured with cobbles and boulders and with a thin layer of organic soil on top. The channels are typically less than 1 m deep relative to the surrounding terrain and vary in width between 0.5 and 2 m. The channels banks were observed to be a mixture of boulders and cobbles. Small nickpoints were observed where a boulder substrate predominates within the channel along the longitudinal profile.

Figure 32: Longitudinal Profile along the Outlet Channel of Lake D2 and D3

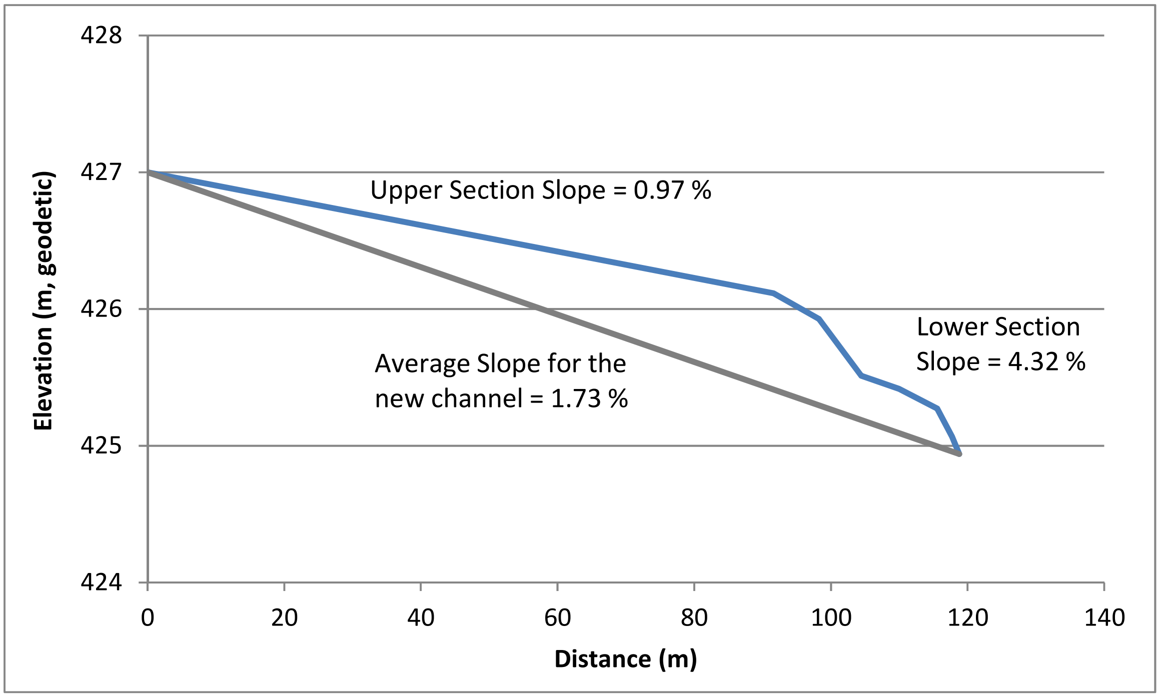


% = percent; m = metres.

3.7.2.1 D2-D3 Outlet Channel Mitigation

The D2 outlet channel will be covered by a dyke that will block the flow to Lake D1. The water level upstream of the dam will rise to an approximated elevation of 427.0 m, flooding the Lake D3 and creating a single larger lake. The outlet channel of this new lake will flow south into Lake N14. A shoreline transect was surveyed in the area where the new channel is proposed to be and is presented on Figure 33.

Figure 33: Shoreline Transect at Lake N14 for the new outlet channel from D2-D3 lake.



% = percent; m = metres.

The figure shows a low slope gradient of approximately 1.0% on the upper part of the transect , and more steep terrain at the existing shoreline with a slope gradient of 4.3%. However, the general slope from the outlet of the new D2-D3 lake to Lake N14 is estimated at 1.7% and this should characterize the slope gradient of the proposed outlet channel. At the same time, the 1.7% slope gradient is close to the measured slope gradient of 1.35% at the outlet of Lake D2 during pre-mining conditions.

The new channel will be located in the same terrain type conditions as the existing D2 outlet channel, therefore delineating and constructing the new channel will require minimum works. It is recommended that mitigation include recreating the same cobble armoured channel banks and bed channel, with small nickpoints as the D2 and D3 outlet channels.

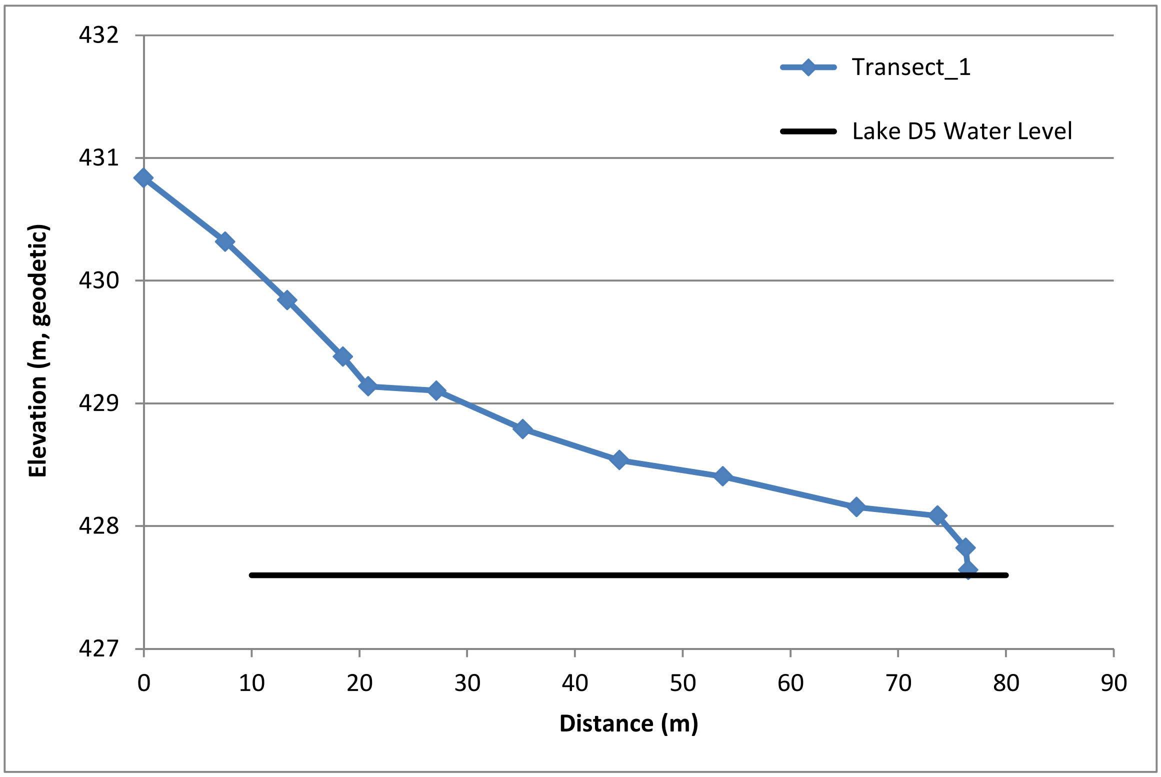
3.7.3 Lake D5, D10 and D1

Lake D5 and D10 are part of the D2 watershed and they are located west of Lake D3 and south of Lake D2 respectively. Lake D5 has an area of approximately 0.013 km^2, and Lake D10 an area of approximately 0.045 km^2. During the mine operations these lakes are not going to be affected directly by any works or diversions. Lake D1 is located downstream (southeast) of D2 watershed, drains directly into Kennady Lake, and has an area of approximately 0.019 km^2.

3.7.3.1 Lake D5 and D10 Shoreline Surveys

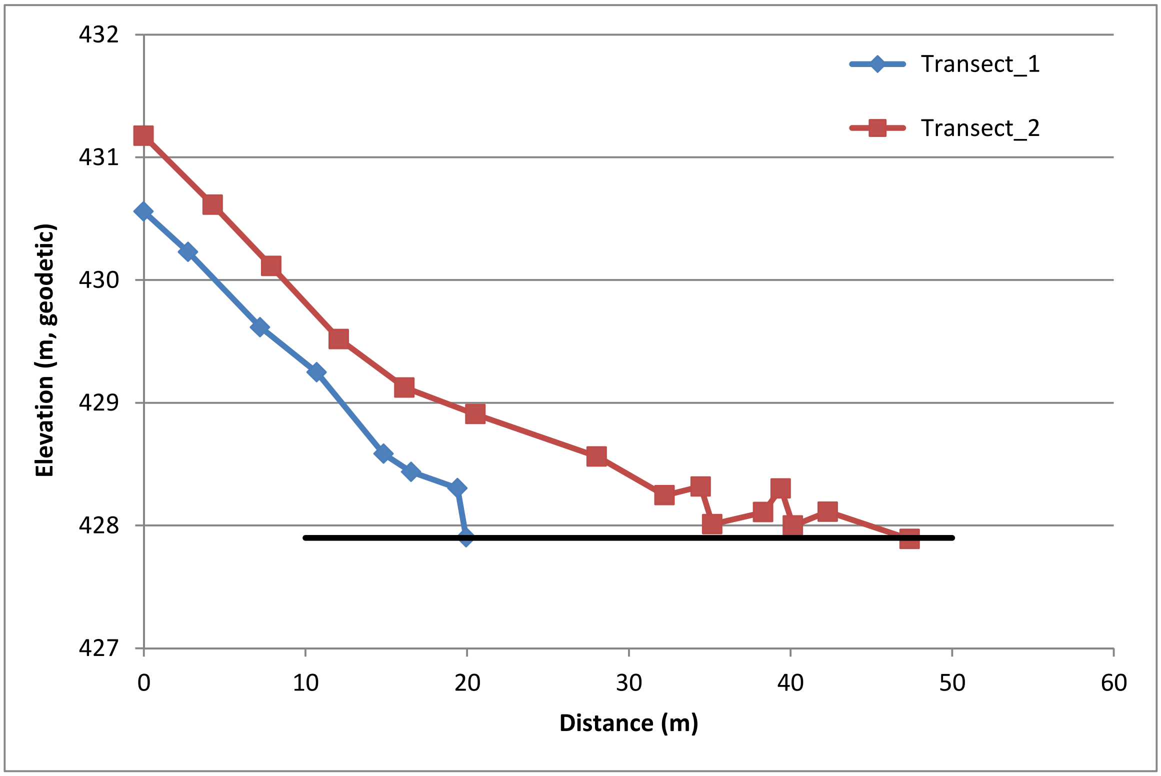
One transect was surveyed at Lake D5 (Figure 34) and two transects were surveyed around the perimeter of Lake D10 (Figure 35). The main transect parameters are presented in Table 21. Both lakes are oriented east to west and have shorelines which consist mostly of alternating sections of morainal material and a mix of bog and fen peat. A small section of bedrock is present on the west shore of Lake D10.

Figure 34: Lake D5 Shoreline Transect Profile



m = metres.

Figure 35: Lake D10 Shoreline Transect Profiles



m = metres.

Table 21: Lake D5 and D10 Main Transect Parameters

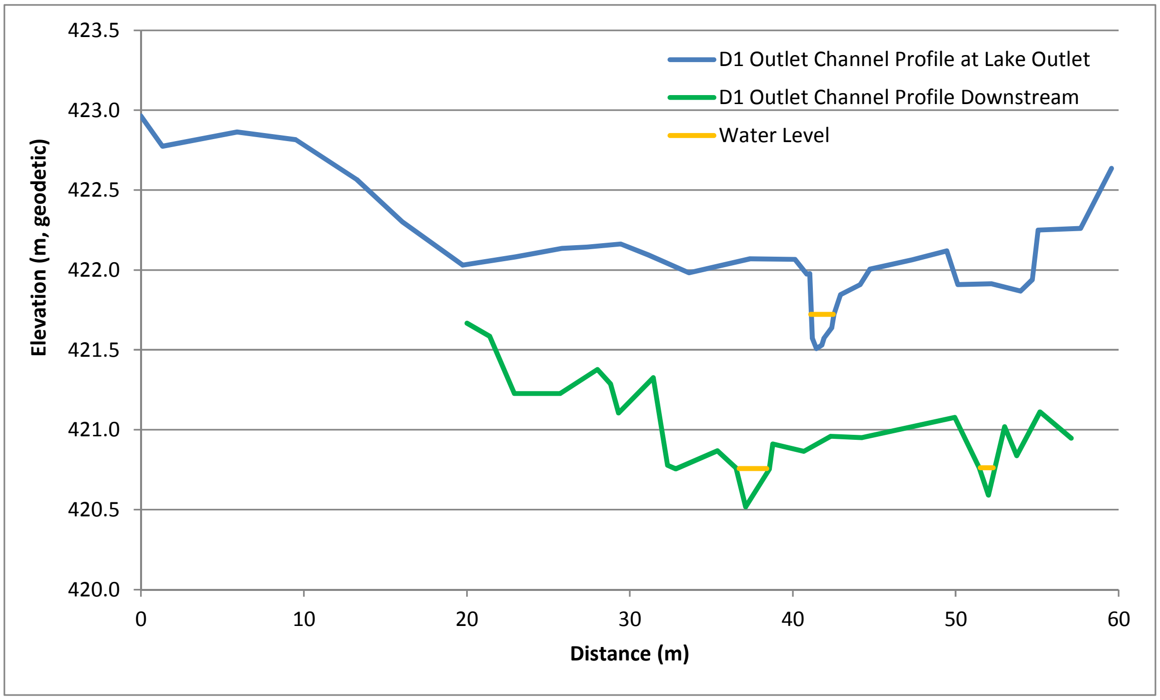
Lake	Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Lake D5	Transect 1	430.836	427.643	76.5
Lake D10	Transect 1	430.558	427.903	19.9
Lake D10	Transect 2	431.175	427.889	47.4

m = metres.

3.7.3.2 D1 Outlet Channel

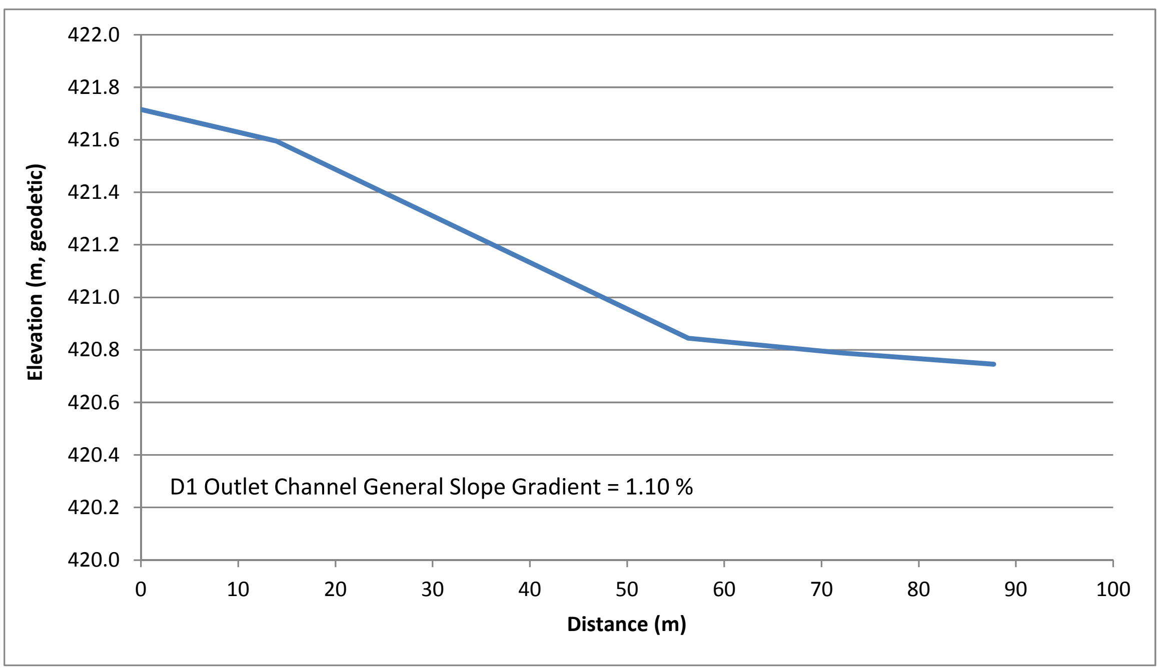
The outlet channel of Lake D1 was surveyed at two locations, one at the lake outlet and one downstream before the outlet channel reaches Kennady Lake. These cross-sections are shown on Figure 36. The measured general slope gradient was 1.10%, with a higher value on the upstream half of the channel (1.55%) and a lower value for the downstream section of the channel (0.31%). The channel profile is shown in Figure 37.

Figure 36: D1 Outlet Channel Cross-Sections



m = metres.

Figure 37: Longitudinal Profile along the Outlet Channel of Lake D1



m = metres.

3.8 N14 Watershed

The N14 watershed is located west of Kennady Lake and has an area of approximately 0.97 km^2, of which 0.26 km^2 is lake water surface. The watershed drains into Lake N17. The largest lake in the watershed is Lake N14. During mine operations Lake N14 will not be directly affected by the Project; however, during this period two upper watersheds of Kennady Lake will be diverted and will drain into Lake N14: the E1 watershed and the D2 watershed through the new proposed Lake D2-D3. The N14 watershed will return to its initial baseline conditions at mine closure when the two diversions will be disconnected.

Lake N14a is a small lake located north of Lake N14, with an area of approximately 0.032 km^2, and will not be directly affected by the Project during mine operations.

3.8.1 Lake N14 Shoreline Survey

A total of 13 transects were surveyed around the perimeter of Lake N14 (Figure 38). The main transect parameters are presented in Table 22. Lake N14 is oriented east to west, with most of the shoreline consisting of alternating sections of morainal materials and a mix of bog and fen peat. Sections of bedrock are present on the south shore between Transect 7 and Transect 9 and between Transect 12 and Transect 13. Figure 39 shows the cross-section profiles of the surveyed transects.

Figure 38: Lake N14 and N14a Shoreline transect locations with terrain type units

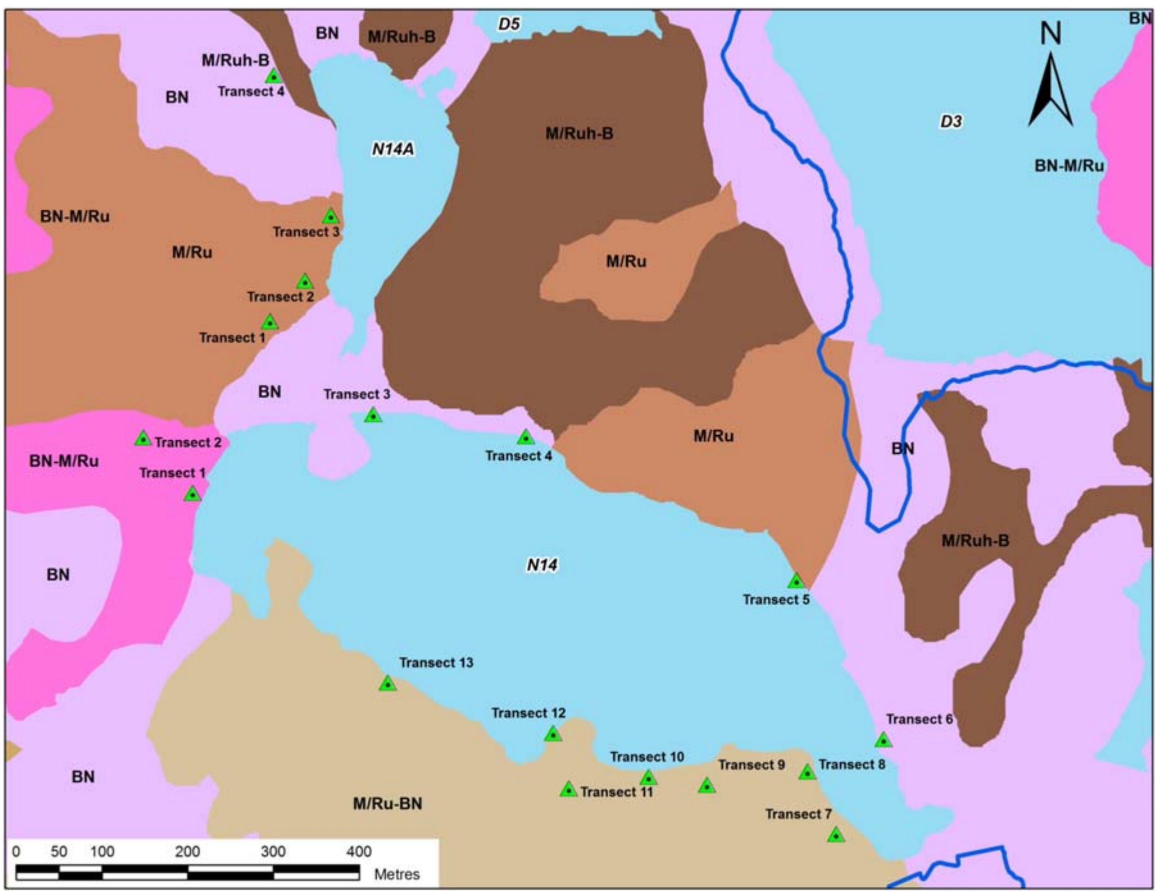
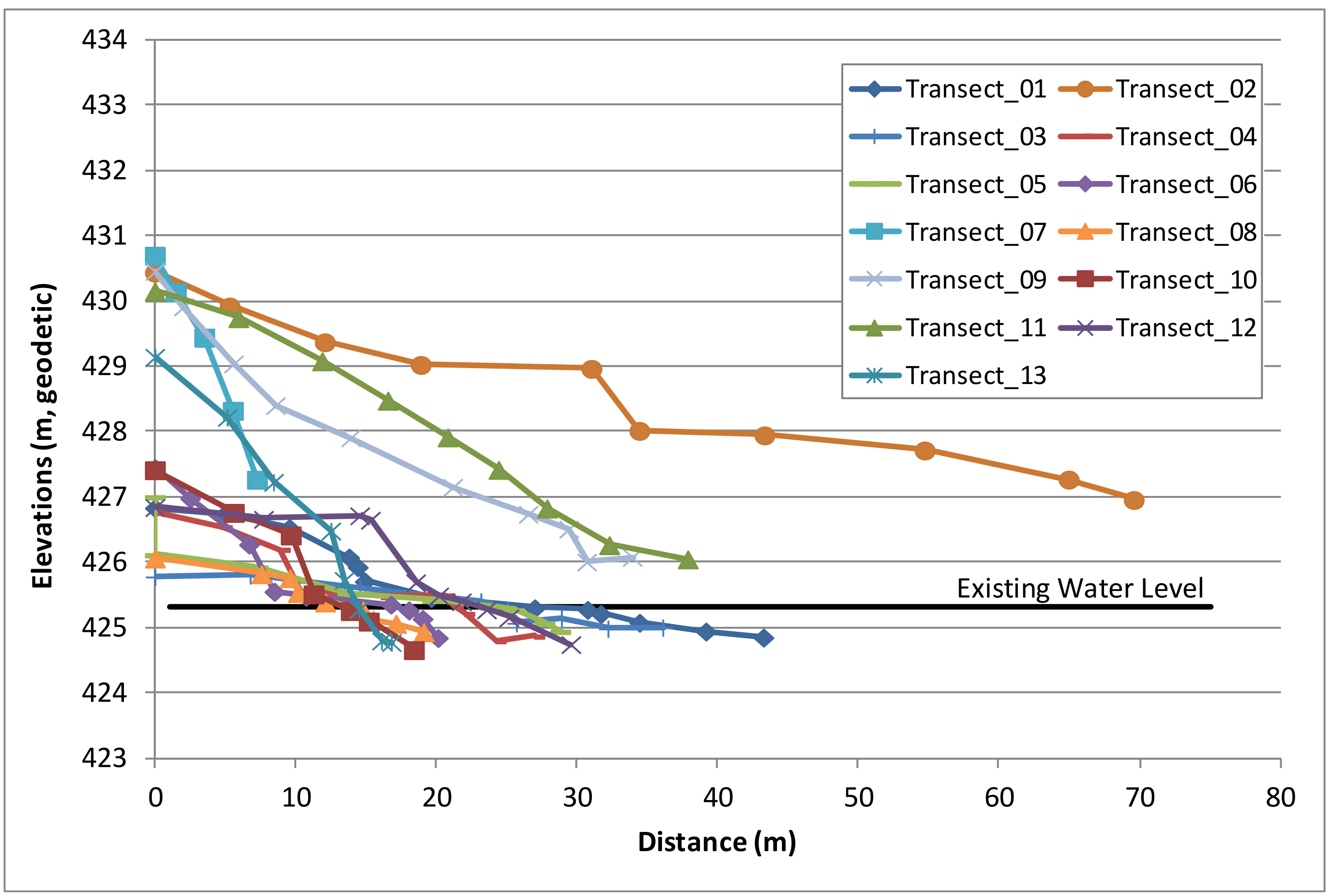


Table 22: Lake N14 Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	426.835	424.852	43.3
Transect 2	430.439	426.959	69.6
Transect 3	425.802	424.987	36.1
Transect 4	426.763	424.798	27.0
Transect 5	426.113	424.940	28.8
Transect 6	427.449	424.846	20.1
Transect 7	430.699	427.268	7.3
Transect 8	426.062	424.934	19.1
Transect 9	430.458	426.007	33.9
Transect 10	427.415	424.661	18.4
Transect 11	430.152	426.051	37.9
Transect 12	426.842	424.745	29.6
Transect 13	429.145	424.776	16.8

m = metres.

Figure 39: Lake N14 Shoreline Transect Profiles



m = metres.

The main transect parameters are presented in Table 23. During operations, when diverted flows from Lake E1 and Lakes D2-D3 are diverted to Lake N14, the water level variations at Lake N14 will be within the natural multi annual variation. Therefore no erosion assessment was done.

Table 23: Lake N14 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		[degrees]	[%]			
Transect 1	95° - E	10.0	18	750	BN-M/Ru	L-M
Transect 2	140° - SE	8.5	15	900	BN-M/Ru	L-M
Transect 3	173° - S	2.8	5	300	BN	L
Transect 4	196° - SSW	3.3	6	320	BN	L
Transect 5	213° - SSW	2.1	4	300	M/Ru	M
Transect 6	242° - WSW	1.5	3	100	BN	L
Transect 7	49° - NE	2.0	3	90	M/Ru-BN	L-M
Transect 8	80° - E	3.6	6	100	M/Ru-BN	L-M
Transect 9	2° - N	0.5	1	300	M/Ru-BN	L-M
Transect 10	359° - N	1.5	3	320	M/Ru-BN	L-M
Transect 11	355° - N	3.4	6	n/a	M/Ru-BN	L-M
Transect 12	322° - NW	3.1	5	500	M/Ru-BN	L-M
Transect 13	33° - NNE	1.5	3	330	M/Ru-BN	L-M

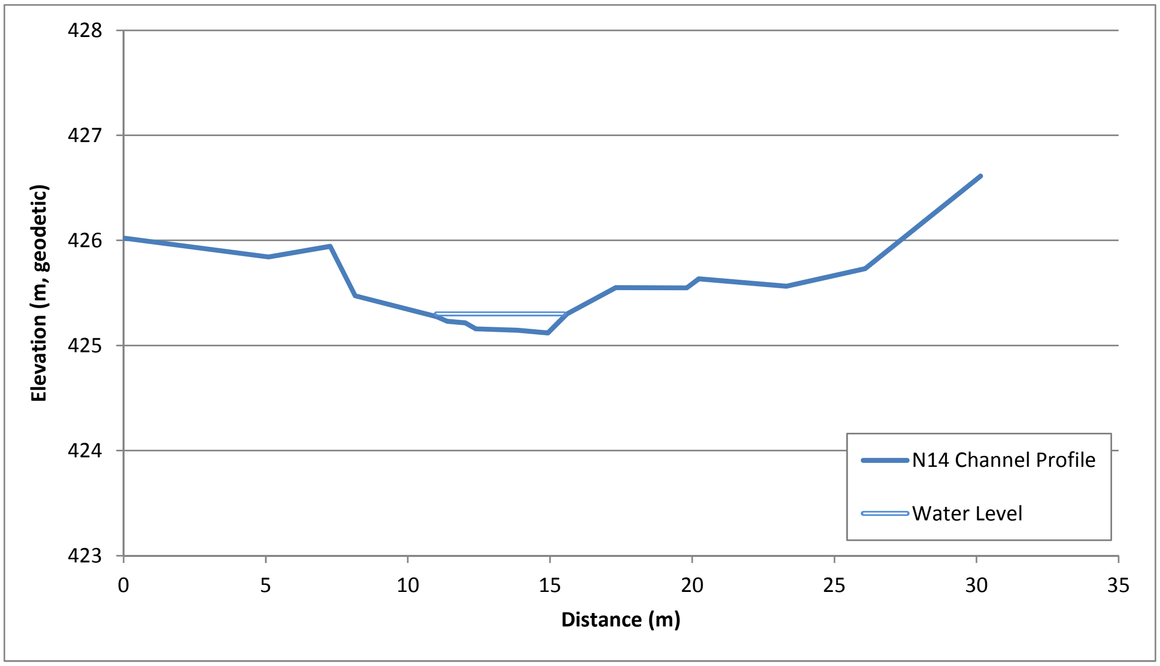
Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; E = east; SE = southeast; S = south; SSW = south-southwest; WSW = west-southwest; NE = northeast; N = north; NW = northwest; NNE = north-northeast; L-M = low-moderate; M = moderate; L = low.

3.8.2 N14 Outlet Channel Survey

Lake N14 outlet channel was surveyed and a cross-section was measured downstream of the outlet (Figure 40). The longitudinal profile of the outlet channel has a low slope gradient of approximately 0.06% for the first half of the outlet channel, which increases to approximately 0.6% at the inlet of Lake N17.

Figure 40: Lake N14 Outlet Channel Cross-Section



m = metres.

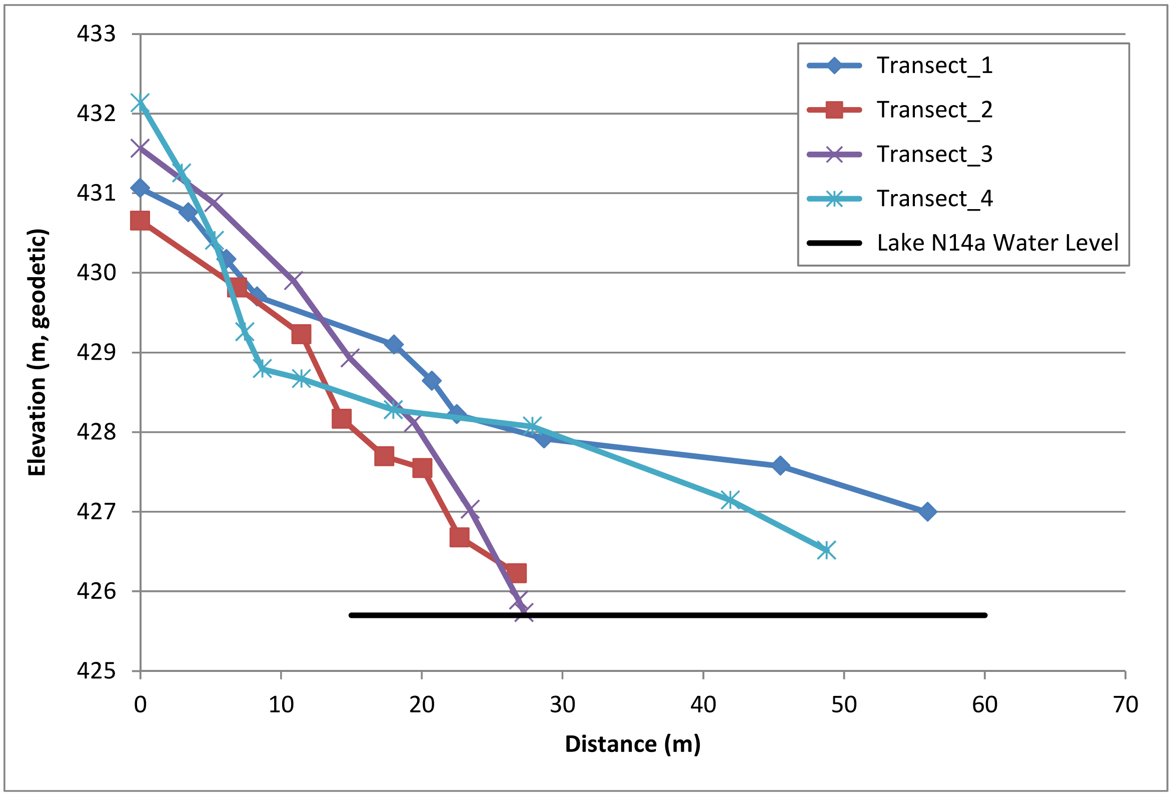
The outlet channel flows through a flat terrain consisting mostly of bog and fen peat on top of moraine material. The channel banks on the upstream half of the channel with low slope gradient are armoured with cobbles and boulders. The same material is found on the channel bed with small pockets of gravel and some fine particulate material deposited as a fine layer. On the downstream half of the channel with higher slope gradient, the cobbles and boulders have low density and most of the bed material consists of sand and soils with small nickpoints.

Because of its configuration and surficial materials, and the small change in water level variations during the mine operations period with increased flow, the N14 outlet channel is expected to be within the natural multiannual variation limits (De Beers 2010, Section 9). However, for the downstream half of the channel with mostly sand and soil materials it is recommended as a mitigation measure, to recreate the same cobble armoured channel banks and bed channel as the upstream half of the channel.

3.8.3 Lake N14a Shoreline Survey

A total of 4 transects were surveyed around the perimeter of Lake N14a (Figure 38). The main transect parameters are presented in Table 22. Lake N14 is oriented north to south, with most of the shoreline consisting of morainal materials and a mix a bog and fen peat on most of the shoreline with the exception of west shore which is bedrock. Figure 41 show the cross-section profiles of the surveyed transects.

Figure 41: Lake N14a Shoreline Transect Profiles



m = metres.

3.9 N9 Watershed

The N9 watershed is located north-east of Kennady Lake watershed and has an area of approximately 5.17 km^2, of which 1.34 km^2 is lake surface. The watershed drains into the N6 watershed. The N9 watershed includes the smaller N10 watershed with an area of approximately 0.38 km^2. The largest lake in the watershed is Lake N9, with an area of approximately 1.0 km^2. During mine operations the N9 watershed will not receive any diversions.

3.9.1 Lake N9 Shoreline Survey

A total of 44 transects were surveyed at Lake N9 (Figure 42). The main transect parameters are presented in Table 24. Lake N9 consists of two main embayments, one on the east half of the lake and oriented north-east to south-west and one on the west half of the lake and oriented east to west. The shoreline has alternating sections of morainal materials and sections of bedrock outcrop. Small sections of mixed bog and fen peat are found on the slopes close to the present shoreline. The shoreline cross-section profiles for the two embayments are presented on Figure 43 and Figure 44 for the east and west embayments respectively.

Figure 42: Lake N9 Shoreline Transect Locations with Terrain Type Units

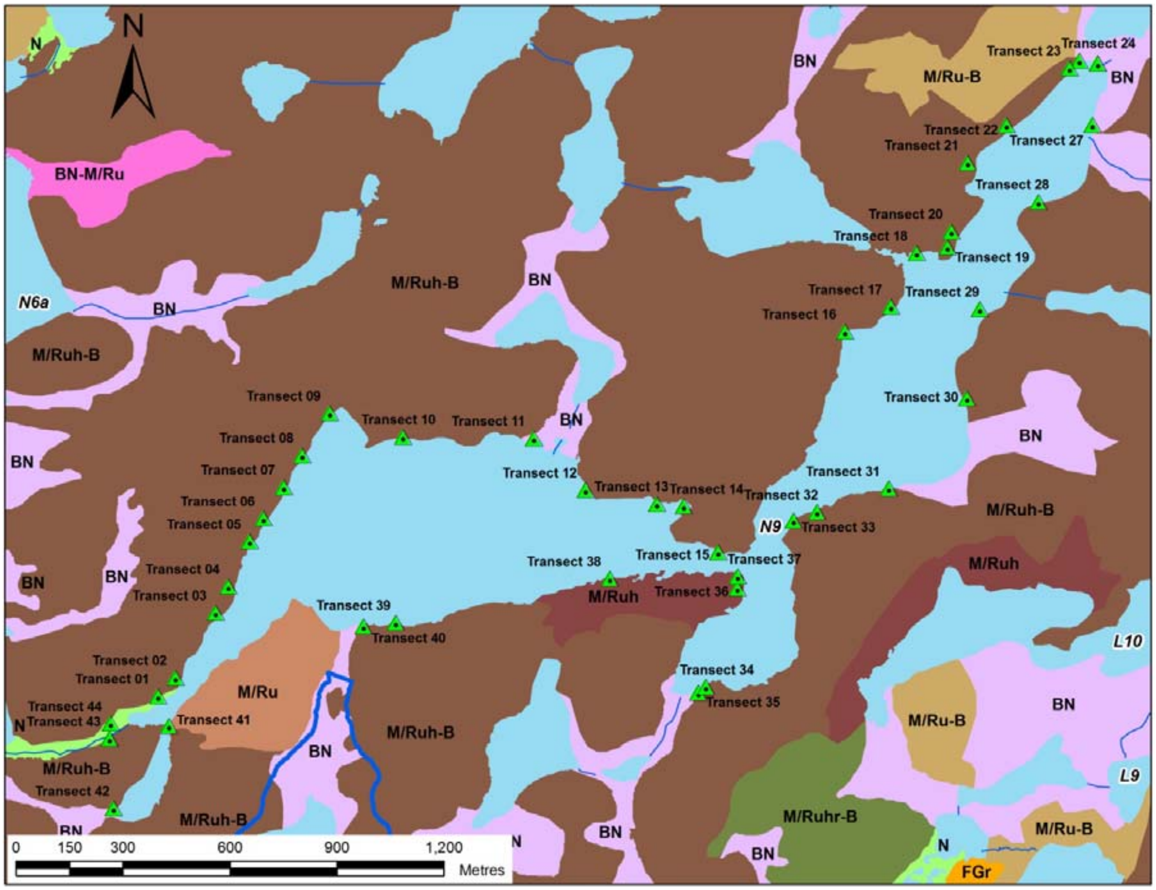
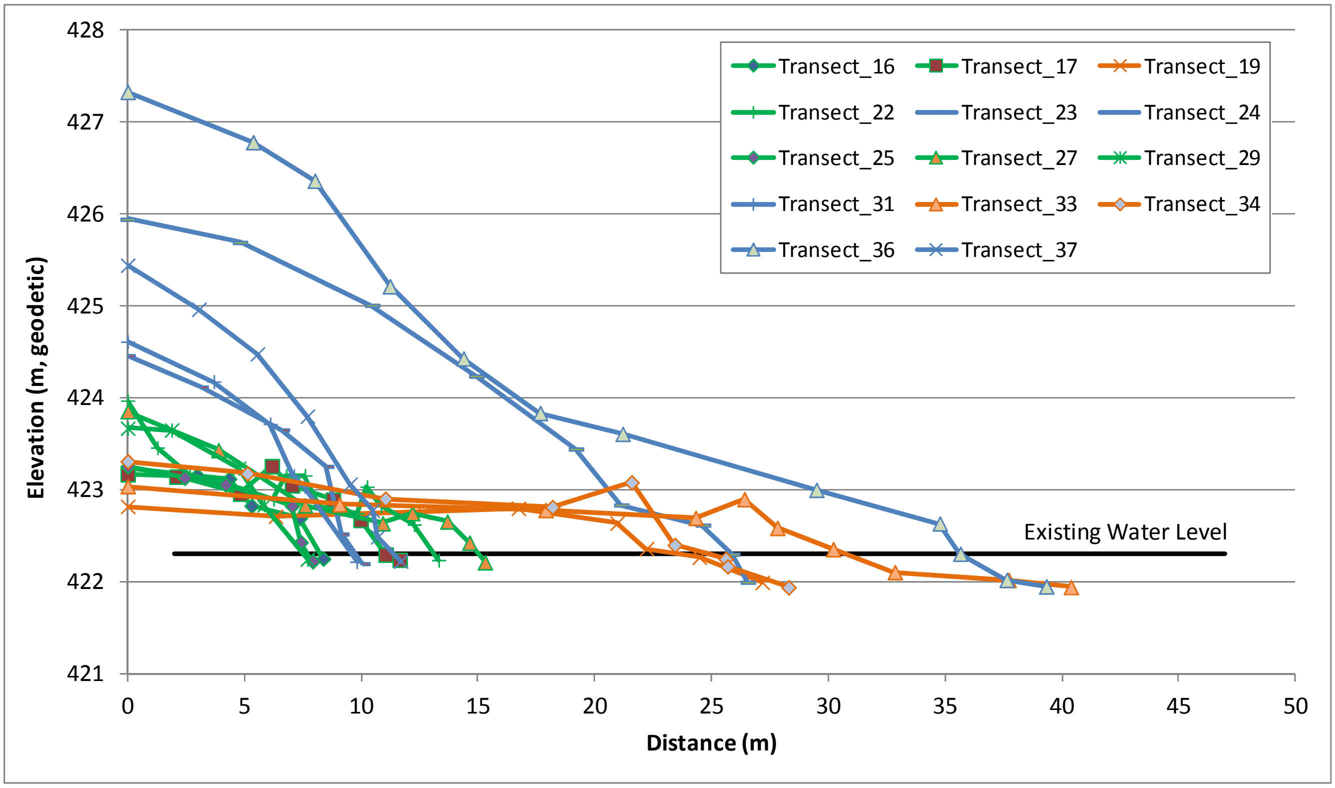


Table 24: Lake N9 Surveyed Transect Parameters for East Embayment

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	424.628	421.578	17.0
Transect 2	423.912	422.289	12.2
Transect 3	425.223	422.278	12.3
Transect 4	424.912	422.277	23.6
Transect 5	425.402	422.494	12.1
Transect 6	423.573	422.155	20.4
Transect 7	424.328	422.545	11.4
Transect 8	424.183	421.997	21.5
Transect 9	424.815	422.415	9.2
Transect 10	423.734	422.291	18.7
Transect 11	423.198	422.283	22.0
Transect 12	423.147	421.846	28.3
Transect 13	424.449	422.243	9.1
Transect 14	423.265	422.264	16.5
Transect 15	425.198	422.416	10.5
Transect 16	423.238	422.251	8.4
Transect 17	423.257	422.238	11.6
Transect 18	423.405	422.230	9.2
Transect 19	422.819	421.993	27.2
Transect 20	423.031	422.201	36.3
Transect 21	422.960	422.269	13.1
Transect 22	423.969	422.236	13.3
Transect 23	424.458	422.196	10.0
Transect 24	425.941	421.994	26.6
Transect 25	423.256	422.222	7.9
Transect 26	423.302	421.977	17.7
Transect 27	423.854	422.211	15.3
Transect 28	423.721	422.244	20.5
Transect 29	423.669	422.246	7.7
Transect 30	423.092	422.191	14.2
Transect 31	424.610	422.218	9.8
Transect 32	423.172	422.090	13.9
Transect 33	423.039	421.942	40.4
Transect 34	423.310	421.939	28.3
Transect 35	423.121	422.258	12.1
Transect 36	427.326	421.948	39.3
Transect 37	425.441	422.224	11.7
Transect 38	423.725	422.265	12.1
Transect 39	424.123	422.283	10.7
Transect 40	423.624	422.306	15.0
Transect 41	423.387	421.831	37.8
Transect 42	423.659	422.188	25.3
Transect 43	424.169	422.342	34.3
Transect 44	423.218	422.306	17.7

m = metres.

Figure 43: Lake N9 Shoreline Transect Profiles for the east embayment

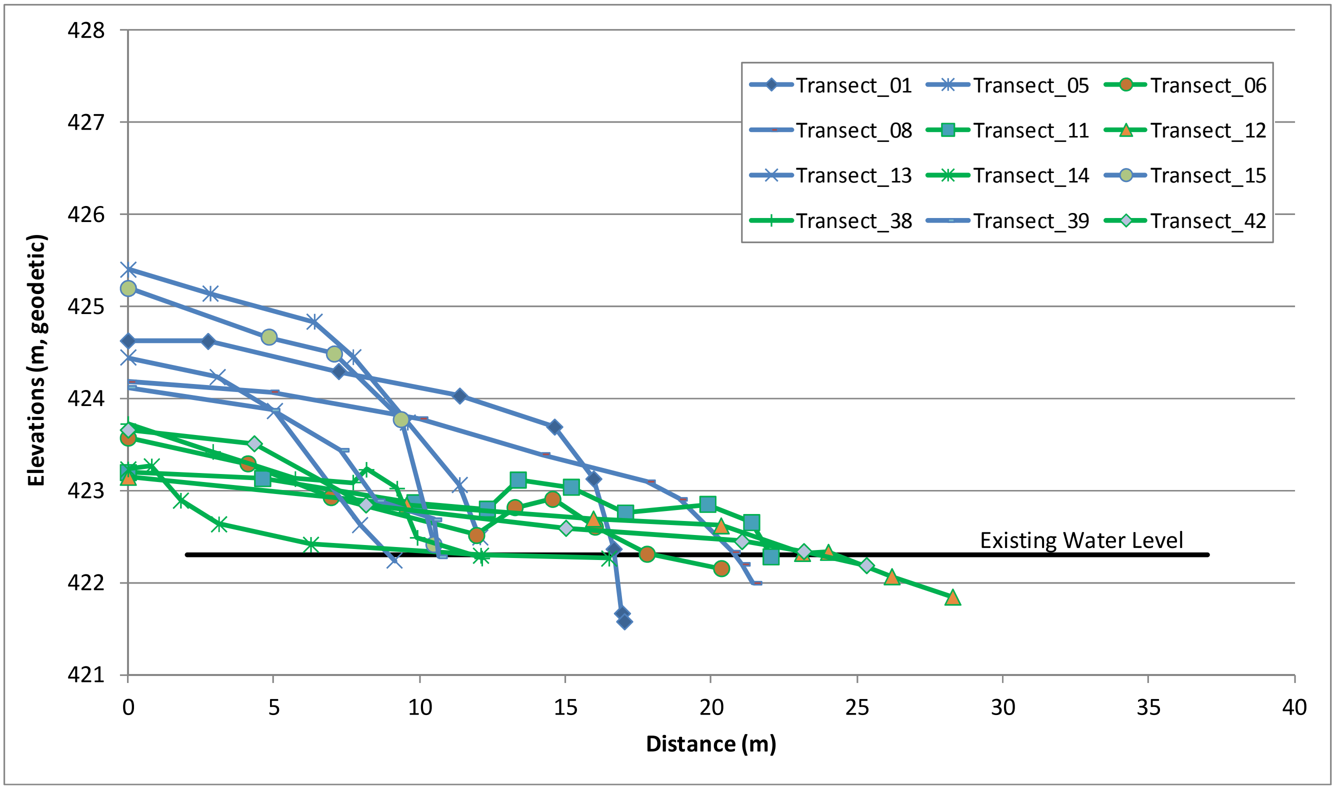


m = metres.

For the east embayment three main types of shoreline can be distinguished:

- Low slope gradient morainal terrain type, with boulders and cobbles that form a steeper line at the water edge. These sections occupy the largest extent of the embayment shoreline and are located on the east and west shores.
- Low slope gradient morainal terrain type with boulders and cobbles that do not form a steeper line edge, and continue with the same slope gradient below the water level. These sections are in the same areas as the previous shoreline type but are the sub-dominant type and less extended.
- High slope gradient bedrock outcrops with limited areas in the north part of the embayment and in the south-east corner.

Figure 44: Lake N9 Shoreline Transect Profiles for the west embayment



m = metres.

For the west embayment, two main types of shoreline can be distinguished:

- Low slope gradient morainal terrain type, with boulders and cobbles that form a continuous and uniform water edge. These sections occupy the largest extent of the embayment shoreline and are located on the north and south shores.
- Very inclined shores with bedrock outcrops that form a steep shoreline on the west shore of the embayment. However, smaller areas can be found on the north and south shores but with limited extension.

The main parameters for the surveyed shoreline transects are presented in Table 25. During mine operations Lake N9 will not be affected by mine activities, therefore no erosion assessment was necessary (Section 9 of De Beers 2010).

Table 25: Lake N9 Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		[degrees]	[%]			
Transect 1	152° - SSE	10.2	18	60	N	L
Transect 2	114° - ESE	7.6	13	60	M/Ruh-BN	L-H
Transect 3	126° - SE	13.5	24	130	M/Ruh-BN	L-H
Transect 4	106° - ESE	6.4	11	1,500	M/Ruh-BN	L-H
Transect 5	126° - SE	13.5	24	1,500	M/Ruh-BN	L-H
Transect 6	118° - ESE	4.0	7	1,500	M/Ruh-BN	L-H
Transect 7	115° - ESE	8.9	16	1,500	M/Ruh-BN	L-H
Transect 8	131° - SE	5.8	10	1,500	M/Ruh-BN	L-H
Transect 9	141° - SE	14.7	26	600	M/Ruh-BN	L-H
Transect 10	194° - SSW	4.4	8	520	M/Ruh-BN	L-H
Transect 11	196° - SSW	2.4	4	420	BN	L
Transect 12	240° - WSW	2.6	5	800	M/Ruh-BN	L-H
Transect 13	177° - S	13.6	24	200	M/Ruh-BN	L-H
Transect 14	246° - WSW	3.5	6	1,100	M/Ruh-BN	L-H
Transect 15	187° - S	14.9	27	50	M/Ruh-BN	L-H
Transect 16	148° - SSE	6.7	12	440	M/Ruh-BN	L-H
Transect 17	122° - ESE	5.0	9	230	M/Ruh-BN	L-H
Transect 18	165° - SSE	7.3	13	650	M/Ruh-BN	L-H
Transect 19	152° - SSE	1.7	3	180	M/Ruh-BN	L-H
Transect 20	105° - ESE	1.3	2	220	M/Ruh-BN	L-H
Transect 21	110° - ESE	3.0	5	300	M/Ruh-BN	L-H
Transect 22	118° - ESE	7.4	13	230	M/Ruh-BN	L-H
Transect 23	150° - SSE	12.7	23	90	M/Ruh-BN	L-H
Transect 24	152° - SSE	8.5	15	1,500	BN	L
Transect 25	244° - WSW	7.4	13	1,500	BN	L
Transect 26	237° - WSW	4.3	8	1,500	BN	L
Transect 27	296° - WNW	6.1	11	160	BN	L
Transect 28	341° - NNW	4.1	7	210	M/Ruh-BN	L-H
Transect 29	327° - NNW	10.5	19	230	M/Ruh-BN	L-M
Transect 30	250° - WSW	3.6	6	500	M/Ruh-BN	L-M
Transect 31	358° - N	13.7	24	650	M/Ruh-BN	L-M
Transect 32	325° - NW	4.5	8	140	M/Ruh-BN	L-M
Transect 33	327° - NNW	1.6	3	130	M/Ruh-BN	L-M
Transect 34	330° - NNW	2.8	5	150	M/Ruh-BN	L-M
Transect 35	351° - N	4.1	7	130	BN	L
Transect 36	105° - ESE	7.8	14	150	M/Ruh	H
Transect 37	30° - NNE	15.4	28	160	M/Ruh	H
Transect 38	359° - N	6.9	12	220	M/Ruh	H
Transect 39	20° - NNE	9.8	17	520	M/Ruh-BN	L-M
Transect 40	351° - N	5.0	9	520	M/Ruh-BN	L-M
Transect 42	108° - ESE	3.3	6	80	M/Ruh-BN	L-H
Transect 43	341° - NNW	3.0	5	-	N	L
Transect 44	157° - SSE	2.9	5	-	N	L

Note: Please see Table 3 for definitions of terrain units.

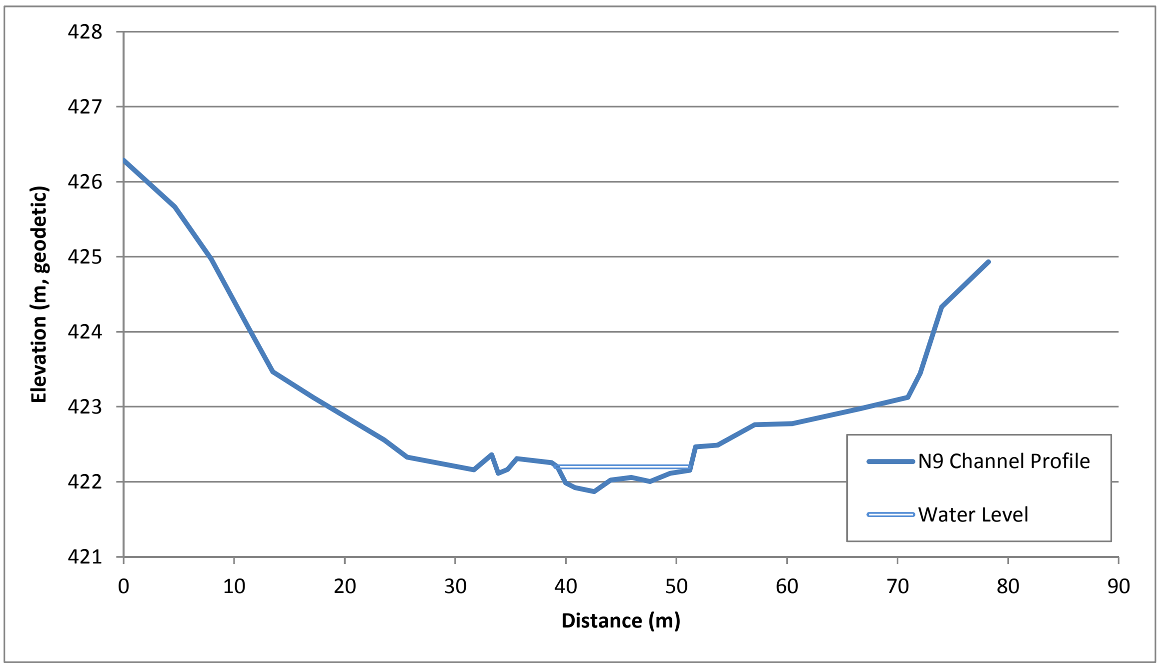
° = degrees; % = percent; m = metres; SSE = south-southeast; SE = southeast; S = south; ESE = east-southeast; WSW = west-southwest; WNW = west-northwest; SE = southeast; NNE = north-northeast; N = north; NNW = north-northwest; L-M = low-moderate; L-H = low-high; H = high; L = low.

3.9.2 N9 Outlet Channel Survey

The Lake N9 outlet channel was surveyed and a cross-section was measured downstream of the outlet (Figure 45). The longitudinal profile of the outlet channel (Figure 46) has an average slope gradient of approximately 1.3%.

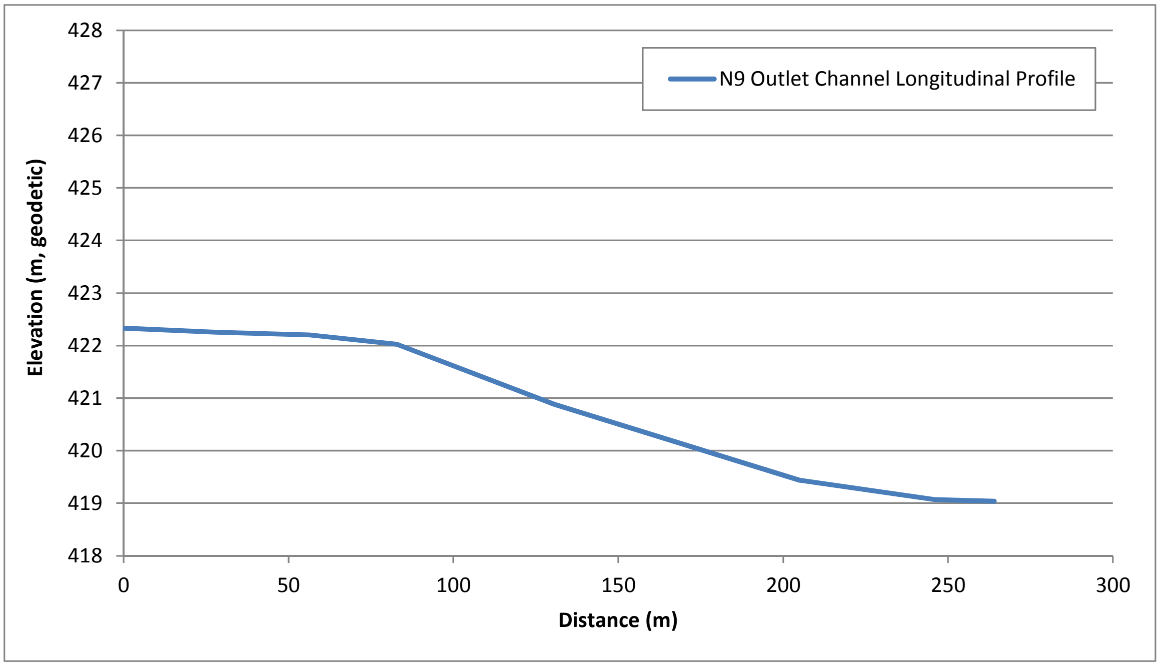
The outlet channel flows through a flat terrain consisting mostly of fen on top of moraine material with a boulder substrate. The outlet channel has more than one main channel and flows during high waters occur through multiple smaller channels. Channel banks are armoured with boulders and the same material is found on the channel bed with small pockets of cobbles and some fine particulate material deposited as a fine surface layer.

Figure 45: Lake N9 Outlet Channel Cross-Section



m = metres.

Figure 46: Longitudinal Profile along the Outlet Channel of Lake N9



m = metres.

3.10 Area 3 and Area 5 of Kennady Lake Shoreline Survey

During mining, Areas 3 and 5 of Kennady Lake will be part of the control area and its water level is expected to rise to 422.5 m, approximately 1.5 m above baseline conditions. A total of 6 transects (Figure 47) were surveyed along the perimeter of Area 3 and 5 to evaluate the shoreline area that will be exposed to high water levels. The main transect parameters are presented in Table 26.

Figure 47: Kennady Lake Shoreline Transect Locations with Terrain Type Units

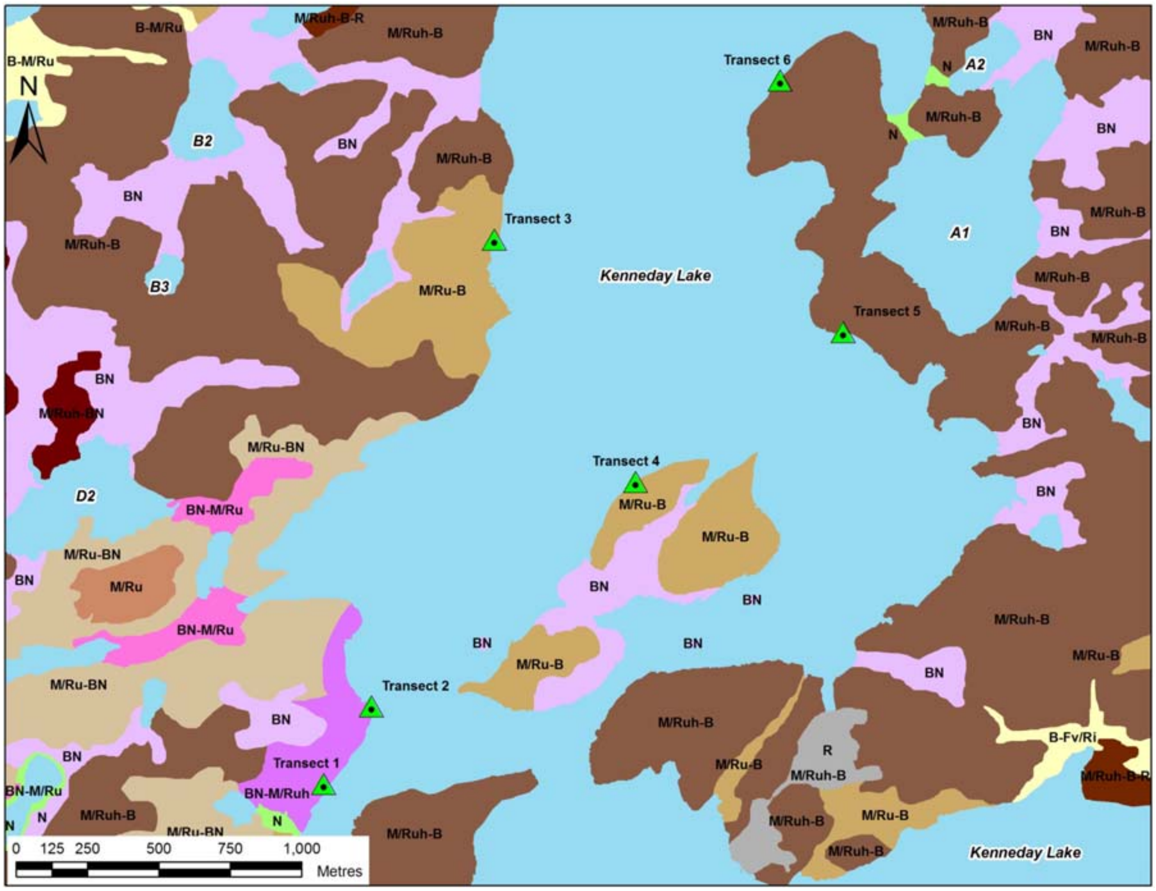


Table 26: Kennady Lake Surveyed Transect Parameters

Transect	Maximum Elevation [m, geodetic]	Minimum Elevation [m, geodetic]	Length [m]
Transect 1	429.166	419.974	40.8
Transect 2	423.688	420.660	22.8
Transect 3	424.827	420.665	74.2
Transect 4	423.263	420.630	66.7
Transect 5	424.694	420.654	46.2
Transect 6	422.301	420.625	50.8

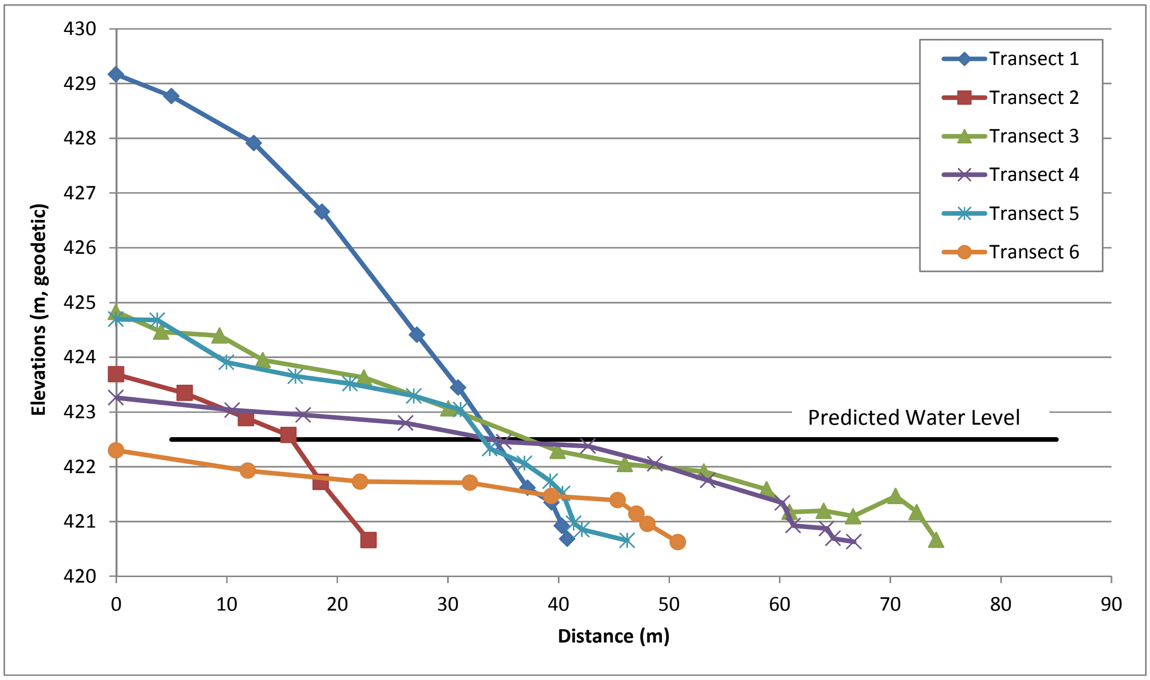
m = metres.

Along the shoreline of both areas can be distinguished two different shore types:

- the west shore with mostly boulders and bedrock sections with a layer of peat above the high water level mark; and
- the east shore with moraine materials at the shoreline and with alternating with bog and fen peat.

Figure 48 presents the cross-section profiles of the surveyed transects.

Figure 48: Kennady Lake Shoreline Transect Profiles



m = metres.

3.10.1.1 Erosion Potential Assessment

Table 27 presents the main parameters derived for each transect that were used to estimate the shoreline erosion potential.

Table 27: Kennady Lake Main Transect Parameters

Transect	Direction (degrees-cardinal/ intermediate)	Average Bank Slope		Fetch Length [m]	Terrain Unit	Water Erosion Class
		[degrees]	[%]			
Transect 1	311° - NW	25.0	47	170	BN	L-M
Transect 2	34° - NE	3.9	7	750	BN	L-M
Transect 3	291° - WNW	12.3	22	1,000	M/Ru-B	L-M
Transect 4	144° - SE	5.6	10	750	M/Ru-B	L-M
Transect 5	145° - SE	3.7	6	630	M/Ruh-B	L-H
Transect 6	17° - NNE	8.0	14	600	M/Ruh-B	L-H

Note: Please see Table 3 for definitions of terrain units.

° = degrees; % = percent; m = metres; SE = southeast; WNW = west-northwest; NNE = north-northeast; NE = northeast; NW = northwest; L-M = low-moderate; L-H = low-high.

Each parameter from Table 27 was weighted and the erosion susceptibility class was determined at each surveyed transect and presented in Table 28.

Table 28: Lake Shoreline Erosion Susceptibility Classes for Kennady Lake

Transect	Erosion Susceptibility Score	Erosion Susceptibility Class
Transect 1	9	Very Low
Transect 2	7	Very Low
Transect 3	9	Very Low
Transect 4	44	Very High
Transect 5	38	Very High
Transect 6	29	High

3.10.1.2 Kennady Lake Shoreline Mitigation

The transects surveyed on the west shore of Area 3 and 5 at Kennady Lake show a very low erosion susceptibility class. This shoreline is recommended to be monitored regularly and mitigation measures implemented after field visits as required.

The transects surveyed on the east shore have High and Very High erosion susceptibility classes, mostly due to the shoreline orientation and typical bank materials. Structural mitigation is proposed for this section, to build or adjust the shoreline so that the erosion potential is minimized before the lake water levels will reach the new proposed elevation. This will mean constructing the shoreline so that it has a low slope with reduced wave action that will extend approximately 5 m from shore into the lake, with boulders and cobbles as the main shoreline.

4.0 SUMMARY

In 2011, lake shorelines and outlet channels were surveyed in the watersheds predicted to be affected by the Project development. This survey augmented the field data collected in 2010 to provide a more comprehensive assessment of the shoreline, and added surveys for the lake outlet channels that are part of those watersheds. Table 29 presents the summary of the 2011 lake shoreline and lake outlet channel survey results.

Table 29: Summary of 2011 Lake Shoreline and Lake Outlet Channel Survey Results

Surveyed Watershed	Lake Shoreline / Outlet Channel	Affected by Project Development	Mitigation	Status at Closure
A3 Watershed	Lake A3	Not affected	Not required	Not affected
	A3 Outlet Channel	Not affected	Not required	Not affected
B1 Watershed	Lake B1	Not affected	Not required	Not affected
	B1 Outlet Channel	Yes - diverted from Kennady Lake to Lake N8	Required - new channel design and construction	Reconnected with Kennady Lake
N8 Watershed	Lake N8	Not affected	Not required	Not affected
	N8 Outlet Channel	Yes - will convey flows from Lake B1	Required - enhancement of existing channel	Channel flows will return to pre-mining conditions
N6 Watershed	N6a Outlet Channel	Yes - will convey increased flows from Lake N8	Not required	Channel flows will return to pre-mining conditions
L2 Watershed	Lake L2	Yes - will receive less flow from Kennady Lake (Area 8) except for extended freshet for one year during Kennady Lake dewatering	Not required	Water Levels will return to pre-mining conditions
	Lake L3		Not required	Water Levels will return to pre-mining conditions
	L2 Outlet Channel		Not required	Channel flows will return to pre-mining conditions
	L3 Outlet Channel		Not required	Channel flows will return to pre-mining conditions
	Lake L13	Not affected	Not required	Not affected
	L13 Outlet Channel			
E1 Watershed	E1 Lake	Yes - disconnected from Kennady Lake with flow diverted to Lake N14	Minimum mitigation because of low erosion risk	Reconnected with Kennady Lake
	E1 Outlet Channel	Yes - diverted from Kennady Lake to Lake N14	Required - new channel redesign and construction	Reconnected with Kennady Lake
D2 Watershed	Lake D2-D3	Yes - diverted from Lake D1 to Lake N14	Minimum mitigation because of low erosion risk	Reconnected with Lake D1
	D2-D3 Outlet Channel	Yes - diverted from Lake D1 to Lake N14	Required - new channel redesign and construction	Reconnected with Lake D1
	Lake D5	Not affected	Not required	Not affected
	Lake D10	Not affected	Not required	Not affected
	Lake D1	Yes - will receive less flow from Lake D2	Not required	Water Levels will return to pre-mining conditions
N14 Watershed	Lake N14	Yes - will receive flows from Lake D2-D3	Not required	Will be disconnected from Lake D2-D3
	N14 Outlet Channel	Yes - will convey increased flows from Lake D2-D3	Required - enhancement of existing channel	Channel flows will return to pre-mining conditions
N9 Watershed	Lake N9	Not affected	Not required	Not affected
	N9 Outlet Channel	Not affected	Not required	Not affected
Kennady Lake Watershed	Area 3 and Area 5 of Kennady Lake	Yes - water level will increase during operations	Required - but at minimum because of low risk of erosion	Water Levels will return to pre-mining conditions

5.0 CLOSURE

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

GOLDER ASSOCIATES LTD.

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Signed on behalf of:
Rowland Atkins, P.Geo.(BC)
Associate, Senior Geomorphologist

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6.0 REFERENCES

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7.0 ABBREVIATIONS

ENE	east-northeast
ESE	east-southeast
H	high
L	low
L-H	low-high
L-M	low-moderate
M	moderate
NE	northeast
NNE	north-northeast
NNW	north-northeast
NW	northwest
Project	Gahcho Kué Project
SE	southeast
SSE	south-southeast
SW	southwest
WNW	east-northwest
WSW	west-southwest

7.1 Units of Measure

%	percent
<	less than
>	greater than
°	degree
km	kilometre
km^2	square kilometre
m	metre
masl	metres above sea level
m/s	metre per second
mm	millimetre

8.0 GLOSSARY

Active Layer	The near surface portion of permafrost, that is subject to melting during the summer.
Baseline	Describes the current environmental setting, against which changes in the environment from the Snap Lake Diamond Project could be assessed; as there are no approved developments within the Regional Study Area (RSA), the baseline case focuses on summarizing the available monitoring data gathered at the Snap Lake Diamond Project.
Dyke	An embankment built to hold semi-solids or fluids.
Effects	A noticeable change in the receptor beyond normal variability due to a chemical of concern or other stressor.
Embayment	A recess in a coastline forming a bay.
Frequency	Refers to how often an effect will occur.
Hummocky	A very complex sequence of slopes extending from somewhat rounded depression or kettles or various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls and depressions.
Mean	A value that is computed by dividing the sum of a set of terms by the number of terms.
Mitigation	The elimination, reduction or control of the adverse environmental effects of a project, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means.
Nickpoint	A break in the longitudinal slope profile of a river or stream caused by different rates of erosion which are typically controlled by changes in water level downstream.
Parameter	A particular physical, chemical, or biological property that is being measured in a waterbody; whatever it is you measure in a waterbody.
Permafrost	A permanently frozen layer at variable depth below the surface in frigid regions of a planet; permafrost reduces soil water infiltration.
Substrate	The material which comprises the bottom of a waterbody; described by substrate particle size.
Thermokarst	Pock-marked topography in northern regions caused by the collapse of permafrost features.
Topography	The configuration of a surface including its relief and the position of its natural and man-made feature.
Transect	A method of sampling vegetation, along a path or fixed line.
Waterbody	An area of water such as a river, stream, lake or sea.

APPENDIX A

Shoreline Survey Photos

Lake A3: Shoreline Survey

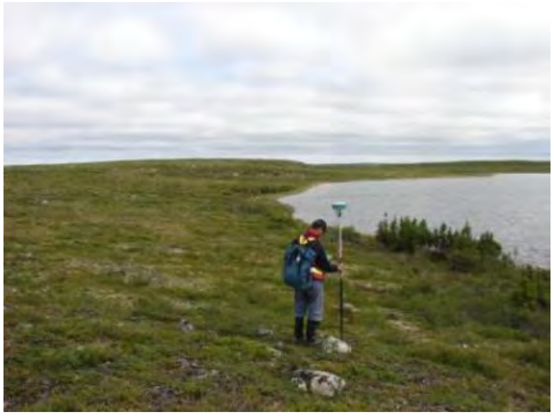

Figure 1: Lake A3 West Shoreline looking North

Figure 2: Lake A3 West Shoreline looking East

Figure 3: Lake A3 South East Shoreline looking West

Figure 4: Lake A3 East Shoreline looking West

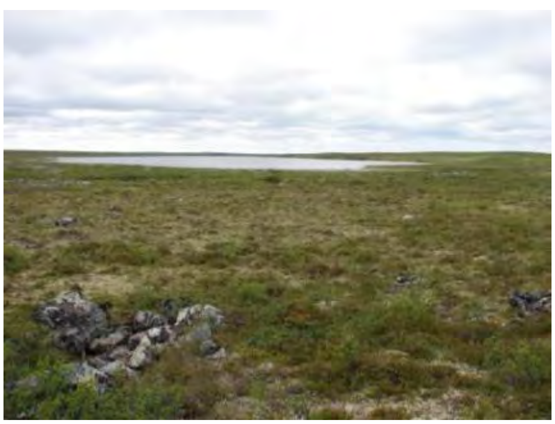

Figure 5: Lake A3 North Shoreline looking South

Figure 6: Lake A3 West Shoreline looking South

Figure 7: Lake A3 South Shoreline looking Northeast

Lake A3: Outlet Channel Survey

Figure 8: Outlet Channel A3 looking Upstream

Figure 9: Outlet Channel A3 Detail

Figure 10: Outlet Channel A3 looking Upstream

Lake B1 Shoreline Survey

Figure 11: Lake B1 Northeast Shoreline looking Southwest

Figure 12: Lake B1 East Shoreline looking Southwest

Figure 13: Lake B1 East Shoreline looking Northeast

Figure 14: Lake B1 East Shoreline looking North

Figure 15: Lake B1 Southeast Shoreline looking Northeast

Figure 16: Lake B1 Southwest Shoreline looking South

Figure 17: Lake B1 West Shoreline looking North

Figure 18: Lake B1 West Shoreline looking South.

Figure 19: Lake B1 Northwest Shoreline looking Northeast

Figure 20: Lake B1 Northwest Shoreline looking East

Figure 21: Lake B1 Northwest Shoreline looking South

Figure 22: Lake B1 Northwest Shoreline looking East

Figure 23: Lake B1 Northwest Shoreline looking West

Figure 24: Lake B1 North Shoreline looking East

Figure 25: Lake B1 North Shoreline looking West

Lake B1: Outlet Channel Survey

Figure 26: Outlet Channel B1 looking Downstream

Lake N8: Lakeshore Survey

Figure 27: Lake N8 West Shoreline looking South

Figure 28: Lake N8 East Shoreline looking West

Figure 29: Lake N8 East Shoreline looking North

Figure 30: Lake N8 North Shoreline looking West

Lake N8: Outlet Channel Survey

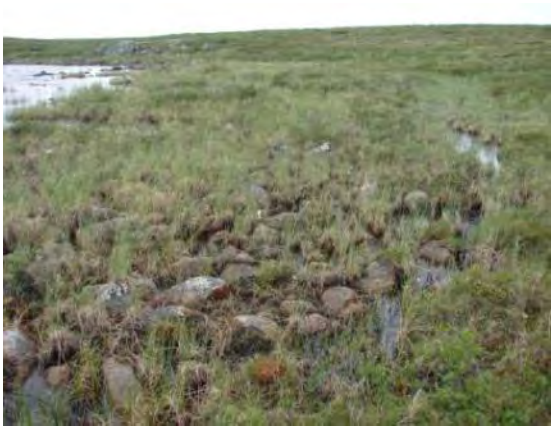

Figure 31: N8 Outlet Channel on downstream half

Figure 32: N8 Outlet Channel at Lake N6 inlet

Lake N6: Outlet Channel Survey

Figure 33: N6 Outlet Channel downstream view from left downstream bank (LDB)

Figure 34: N6 Outlet Channel downstream panorama view from LDB

Figure 35: N6 Outlet Channel downstream view from LDB

Lake L2: Lakeshore Survey

Figure 36: Lake L2 South Shoreline looking Northeast

Figure 37: Lake L2 South Shoreline looking Northeast

Figure 38: Lake L2 South Shoreline looking Northwest

Figure 39: Lake L2 West Shoreline looking Southeast

Figure 40: Lake L2 West Shoreline looking Northeast

Figure 41: Lake L2 Southeast Shoreline looking West

Figure 42: Lake L2 North Shoreline looking Southwest

Figure 43: Lake L2 West Shoreline looking North

Lake L3: Lakeshore Survey

Figure 44: Lake L3 West Shoreline looking Northeast

Figure 45: Lake L3 Southwest Shoreline looking North

Figure 46: Lake L3 Southwest Shoreline looking South

Figure 47: Lake L3 Southwest Shoreline looking Northeast

Figure 48: Lake L3 East Shoreline looking West

Figure 49: Lake L3 North Shoreline and Outlet looking South

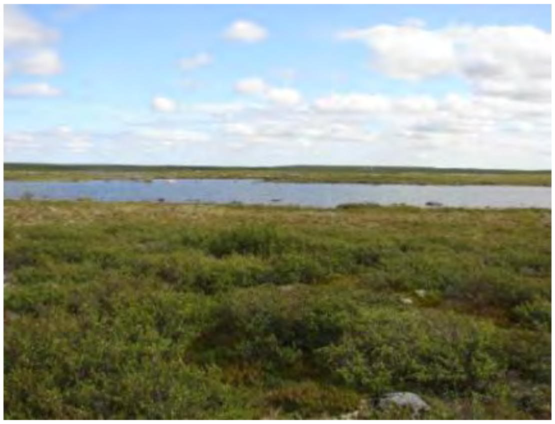

Figure 50: Lake L3 Northwest Shoreline looking Southeast

Lake L13: Shoreline Survey

Figure 51: Lake L13 West Shoreline looking North

Figure 52: Lake L13 West Shoreline looking South

Figure 53: Lake L13 West Shoreline looking East

Figure 54: Lake L13 East Shoreline looking North

Figure 55: Lake L13 West Shoreline looking East

Lake L2: Outlet Channel survey

Figure 56: L2 Outlet Channel looking Downstream

Figure 57: L2 Outlet Channel looking Upstream

Figure 58: L2 Outlet Channel looking Upstream

Figure 59: L2 Outlet Channel looking Downstream

Lake E1: Shoreline Surveys

Figure 60: Lake E1 East Shoreline looking West

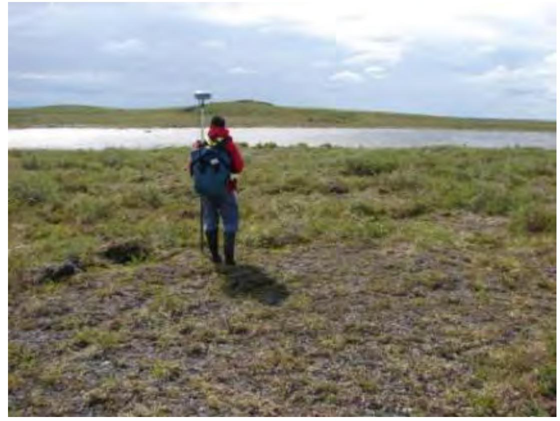

Figure 61: Lake E1 Southeast Shoreline looking Southwest

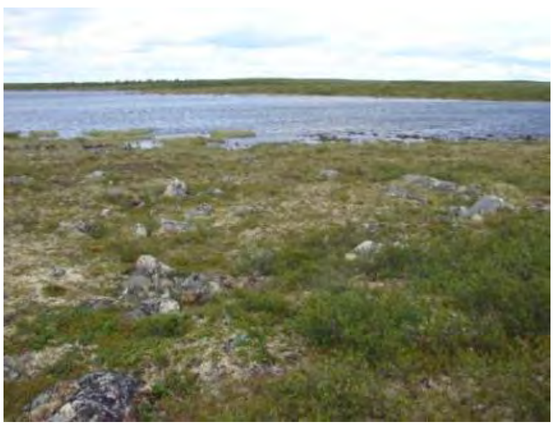

Figure 62: Lake E1 Southwest Shoreline looking Northwest

Figure 63: Lake E1 West Shoreline looking East

Figure 64: Lake E1 West Shoreline looking North

Figure 65: Lake E1 Southwest Shoreline looking Southeast

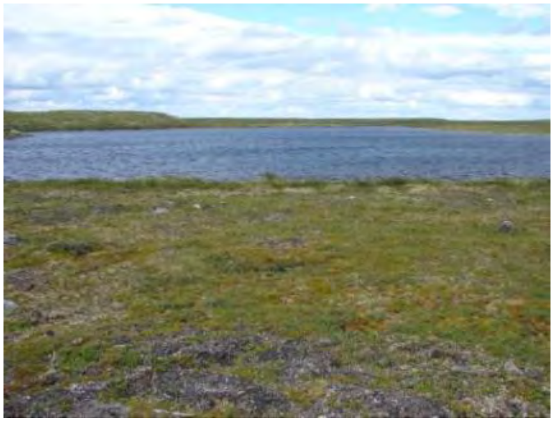

Figure 66: Lake E1 West Shoreline looking East

Figure 67: Lake E1 West Shoreline looking North

Figure 68: Lake E1 West Shoreline looking South

Figure 69: Lake E1 North Shoreline looking South

Lake E1: Outlet Channel Survey

Figure 70: E1 Outlet Channel looking Downstream

Figure 71: E1 Outlet Channel Detail

Figure 72: E1 Outlet Channel looking Downstream

Figure 73: E1 Outlet Channel looking downstream at Kennady Lake Inlet

Lake D2: Shoreline Survey

Figure 74: Lake D2 East Shoreline looking Southwest

Figure 75: Lake D2 East Shoreline and Outlet looking West

Figure 76: Lake D2 South Shoreline looking North

Lake D2: Outlet Channel Survey

Figure 77: D2 Outlet Channel looking Downstream

Figure 78: D2 Outlet Channel looking Downstream

Figure 79: D2 Outlet Channel looking Upstream

Figure 80: D2 Outlet Channel looking Upstream

Lake D3: Shoreline Survey

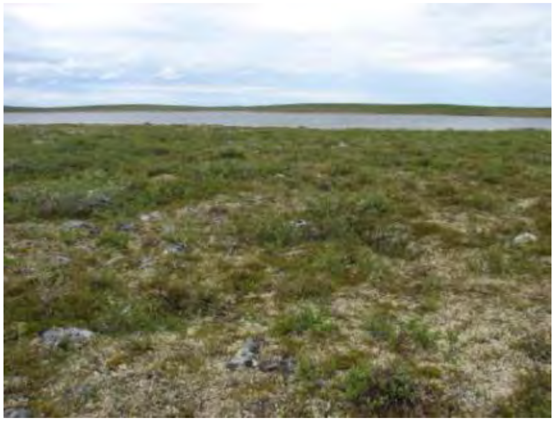

Figure 81: Lake D3 East Shoreline looking West

Figure 82: Lake D3 West Shoreline looking East

Figure 83: Lake D3 West Shoreline looking North

Figure 84: Lake D3 West Shoreline looking South.

Figure 85: Lake D3 West Shoreline looking East

Figure 86: Lake D3 North Shoreline looking South

Lake D3: Outlet Channel Survey

Figure 87: D3 Outlet Channel looking Upstream

Figure 88: D3 Outlet Channel looking Upstream

Figure 89: D3 Outlet Channel looking Downstream

Figure 90: D3 Outlet Channel looking Downstream at Lake D2 Inlet

Lake D5: Shoreline Survey

Figure 91: Lake D5 North Shoreline looking East

Figure 92: Lake D5 North Shoreline looking Southwest

Lake D10: Shoreline Survey

Figure 93: Lake D10 North Shoreline looking East

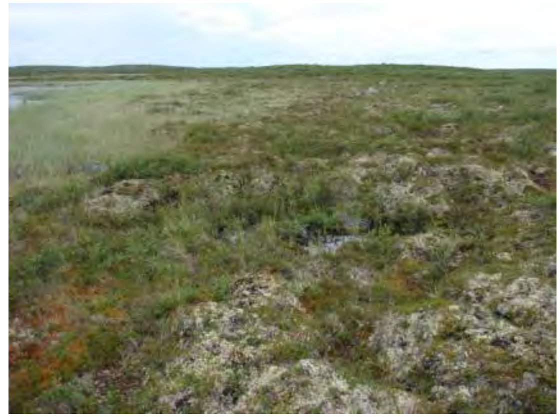

Figure 94: Lake D10 North Shoreline looking West

Figure 95: Lake D10 North Shoreline looking East

Figure 96: Lake D10 North Shoreline looking West

Lake N14: Shoreline Survey

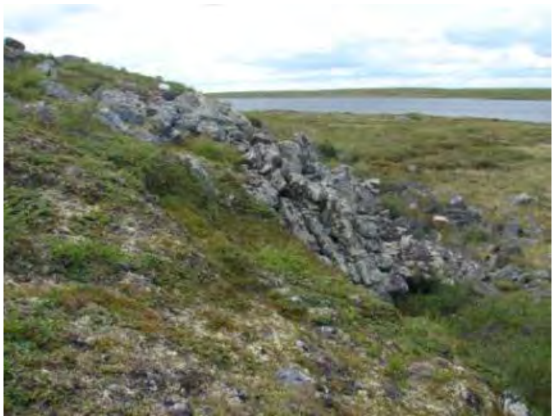

Figure 97: Lake N14 Southwest Shoreline looking North

Figure 98: Lake N14 Southwest Shoreline looking South

Figure 99: Lake N14 South Shoreline looking North

Figure 100: Lake N14 South Shoreline looking West

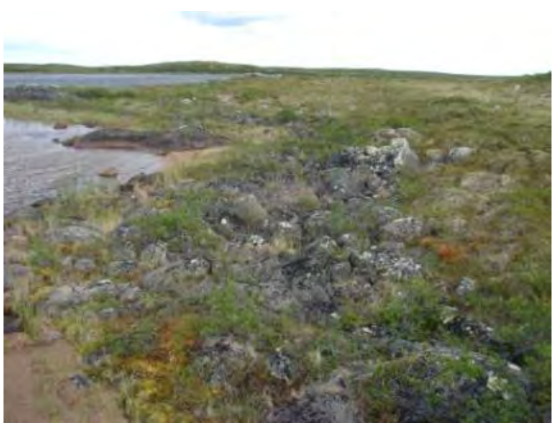

Figure 101: Lake N14 South Shoreline looking East

Figure 102: Lake N14 South Shoreline looking North


Figure 103: Lake N14 South Shoreline looking West


Figure 104: Lake N14 West Shoreline looking East

Lake N14: Outlet Channel Survey

Figure 105: N14 Outlet Channel looking Upstream

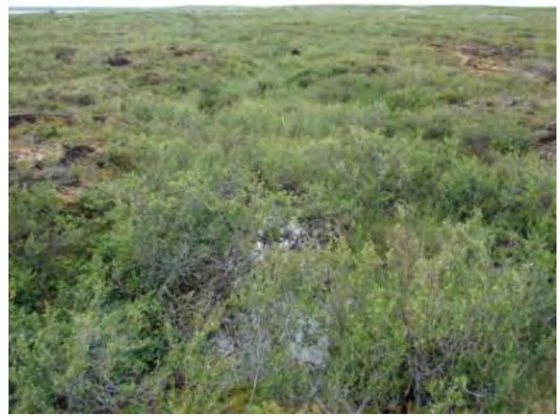

Figure 106: N14 Outlet Channel looking Upstream

Figure 107: N14 Outlet Channel looking Downstream

Figure 108: N14 Outlet Channel looking Downstream

Lake N14a: Shoreline Survey

Figure 109: Lake N14a West Shoreline looking North

Figure 110: Lake N14a West Shoreline looking South

Figure 111: Lake N14a North Shoreline looking East

Figure 112: Lake N14a North Shoreline looking South

Lake N9: Shoreline Survey

Figure 113: Lake N9 West Shoreline looking North

Figure 114: Lake N9 West Shoreline looking South

Figure 115: Lake N9 West Shoreline looking North

Figure 116: Lake N9 West Shoreline looking South

Figure 117: Lake N9 West Shoreline looking North

Figure 118: Lake N9 North Shoreline looking Southwest

Figure 119: Lake N9 North Shoreline looking East

Figure 120: Lake N9 North Shoreline looking West

Figure 121: Lake N9 Northeast Shoreline looking West

Figure 122: Lake N9 East Shoreline looking North West

Figure 123: Lake N9 East Shoreline looking Southwest

Figure 124: Lake N9 Southeast Shoreline looking Northeast

Figure 125: Lake N9 Southeast Shoreline looking West

Figure 126: Lake N9 South Shoreline looking West

Figure 127: Lake N9 South Shoreline looking East

Lake N9: Outlet Channel Survey

Figure 128: N9 Outlet Channel looking at Right Bank

Figure 129: N9 Outlet Channel looking Upstream

Figure 130: N9 Outlet Channel looking Downstream

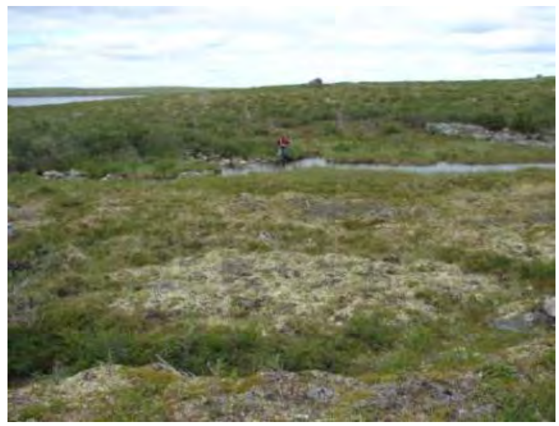

Figure 131: N9 Outlet Channel looking at Right Bank

Figure 132: N9 Outlet Channel looking Upstream

Kennady Lake: Shoreline Survey

Figure 133: Area 5 West Shoreline looking North

Figure 134: Area 5 West Shoreline looking South

Figure 135: Area 5 East Shoreline looking East

Figure 136: Area 5 East Shoreline looking East

Figure 137: Area 3 West Shoreline looking North

Figure 138: Area 3 West Shoreline looking South

Figure 139: Area 3 East Shoreline looking North

Figure 140: Area 3 East Shoreline looking South

Figure 141: Area 3 North Shoreline looking North

Figure 142: Area 3 North Shoreline looking North

APPENDIX B

Shoreline Methods for Erosion Susceptibility Class

This Appendix presents the methods used to derive the erosion susceptibility class for the shoreline erosion assessment and the scores at each transect for all parameters.

1.0 EROSION SUSCEPTIBILITY METHODS

To estimate the shoreline erosion susceptibility class, the parameters used were separated into three categories: bank and shoreline features, exposure characteristics, and attenuation characteristics, with each category having its own parameters (Table 1). The shoreline erosion susceptibility was classified into a five-class system, ranking from Very Low to Very High and the classification was based on a modified version of tool developed to calculate Lakeshore erosion potential for Alberta Sustainable Resource Development.

Table 1: Categories for Shoreline Characteristics and their Parameters

Categories	Parameters
Bank and Shoreline Features	Bank Height Bank Vegetation Bank Stability Shoreline Geometry
Exposure Characteristics	Shore Orientation (wind direction) Fetch Length Depth at 6 m from shore Depth at 30 m from shore
Attenuation Characteristics	Aquatic Vegetation Bank Composition Bank Slope

For each parameter a score range and a number of class were assigned and they are presented in Table 2. The class values for each parameter were determined based on field observations at site, including:

- bank height (collected at existing lake levels; it was assumed that these values will apply for the new shoreline in the same area);
- bank vegetation;
- bank stability;
- shoreline geometry;
- shore orientation (wind directions scores and class were calculated based on wind data collected at Snap Lake weather station and presented in the main report);
- fetch length (based on maps measurements in GIS);
- lake depth at 6 and 30 m from shore (determined from site cross-section profiles and proposed lake water surface elevations);
- aquatic vegetation; and

- bank slope (calculated from cross-section profiles).

Table 2: Score Range and Number of Class for Shoreline Parameters

Bank and Shoreline Features

Parameter	Score and Class
Bank Height (BH)	1 = <0.3 m 2 = 0.3-1.5 m 3 = 1.5-3.0 m 4 = 3.0-6.0 m 5 = >6.0 m
Bank Vegetation (BV)	0 = rocky outcrop with no vegetation 1 = mixed boulders and cobbles with little vegetation (mostly grass fen) 4 = bog peat and brush vegetation on top of boulder moraine 7 = organic materials with no rocky materials
Bank Stability (BSt)	0 = bedrock or boulder with no vegetation 1 = boulders or bedrock with small patches of peat 2 = boulders and cobbles with patches of peat 4 = boulders and cobbles with vegetation on top (brush and fen) 6 = soils with thermo-erosion processes 7 = organic materials with bog and fen peat and not rocky materials
Shoreline Geometry (SG)	1 = coves or bays 4 = irregular or straight shorelines 8 = headland or islands
Exposure Characteristics	
Shore Orientation (SO) (wind direction)	0 = 45° to 65°; 215° to 295° 1 = 5° to 45°; 65° to 75°; 145° to 215°; 295° to 325°; 345° to 355° 2 = 355° to 5°; 75° to 85°; 135° to 145°; 325° to 345° 3 = 105° to 135° 4 = 85° to 105°
Fetch Length (m) (FL)	0 = < 50 m 1 = 50 to 100 m 2 = 100 to 200 m 3 = 200 to 400 m 4 = 400 to 800 m 5 = 800 to 1000 m 6 = > 1000 m
Lake Depth (LD) at 6 and 30 m from shore	

	Depth at 6 m				
Depth at 30 m	**0**	**0.3**	**0.9**	**1.8**	**3.7**
0	-1	-1	-1	-2	-2
0.3	0	-1	-1	-2	-2
0.9	0	0	-1	-1	-1
1.8	1	1	0	-1	-1
3.7	1	1	0	-1	-1

Bank and Shoreline Features

Parameter	Score and Class
Attenuation Characteristics	
Aquatic Vegetation (AV)	0 = no vegetation, spares or submerged -1 = moderate -2 = dense or abundant
Bank Slope (BSp)	0 = < 5 degrees 1 = 5 to 25 degrees 2 = 25 to 45 degrees 4 = > 45 degrees
Modified Bank Composition (MBC)	Bank Composition Scores (BC) 0 = bedrock or boulder with no vegetation 1 = boulders or bedrock with small patches of peat 2 = boulders and cobbles with patches of peat 3 = boulders and cobbles with vegetation on top (brush and fen) 4 = soils with thermo-erosion processes 5 = organic materials with bog and fen peat and not rocky materials Modified Bank Composition (MBC)

	Bank Slope Score			
Bank Composition Score	**0**	**1**	**2**	**4**
0	0	0	0	0
1	-1	0	0	+3
2	-1	0	+1	+3
3	-1	0	+1	+4
4	0	-1	+1	+4
5	0	-1	+2	+4

For each of the three categories a single score was calculated and the final score was determined from the three combined scores indicating the susceptibility erosion class. The method to calculate the final score and associated classed are presented in Table 3.

Table 3: Final Score Calculation

<table>
<tr><th>Category</th><th>Score Description and Formulas</th></tr>
<tr><td>Bank and Shoreline Features (BSF)</td><td>The sum of score of all parameters
BSF = BH + BV +BSt + SG</td></tr>
<tr><td>Exposure and Attenuation Characteristics (EAC)</td><td>The final score is the sum of the modified fetch length with the wind scores (MFLW) and the modified score of the bank composition modified score (BCMS)
EAC = MFLW + BCMS
where
MFLW = SO * (FL + LD + AV)
BCMS = BSp & MBC</td></tr>
<tr><td>Erosion Potential (EP)</td><td>EP = BSF + EAC
EP Class:
<table><tr><th>EP Class</th><th>EP Score</th></tr><tr><td>Very Low</td><td>< 15</td></tr><tr><td>Low</td><td>15 to 20</td></tr><tr><td>Moderate</td><td>20 to 25</td></tr><tr><td>High</td><td>25 to 35</td></tr><tr><td>Very High</td><td>> 35</td></tr></table></td></tr>
</table>

2.0 SCORES FOR CONTRIBUTING PARAMETERS

Table 4 presents the scores for each parameter measured at the transects surveyed at each lake.

Table 1: Scores for each parameter measured

Lake	Transect	BH Score	BV Score	BSt Score	SG Score	BSF Score	FL Score	AV Score	LD Score	SO Score	MFLW Score	BC Score	MBC Score	BCMS Score	EAC Score	EP Score	EP Class
A3	Transect 1	3	1	1	4	10	3	0	-1	1	2	1	0	1	2	12	Very Low
A3	Transect 2	3	1	1	4	10	3	0	-1	2	4	1	0	1	4	14	Very Low
A3	Transect 3	3	1	1	4	10	3	0	-1	3	6	1	0	1	6	16	Low
A3	Transect 4	3	4	6	4	18	4	0	-1	3	9	4	0	4	36	54	Very High
A3	Transect 5	3	1	1	4	10	4	0	-1	3	9	1	0	1	9	19	Low
A3	Transect 6	3	1	1	4	10	4	0	-1	3	9	1	0	1	9	19	Low
A3	Transect 7	3	1	1	4	10	4	0	-1	2	6	1	0	1	6	16	Low
A3	Transect 8	3	1	1	4	10	4	0	-1	3	9	1	-1	0	0	10	Very Low
A3	Transect 9	3	1	1	4	10	4	0	-1	3	9	1	0	1	9	19	Low
A3	Transect 10	3	1	1	4	10	4	0	-1	2	6	1	0	1	6	16	Low
A3	Transect 11	3	1	1	4	10	4	0	-1	3	9	1	-1	0	0	10	Very Low
A3	Transect 12	3	1	1	4	10	4	0	-1	3	9	1	-1	0	0	10	Very Low
A3	Transect 13	3	0	0	4	8	3	0	-1	1	2	0	0	0	0	8	Very Low
A3	Transect 14	3	0	0	4	8	3	0	-1	3	6	0	0	0	0	8	Very Low
A3	Transect 15	3	0	0	4	8	1	0	-1	3	0	0	0	0	0	8	Very Low
A3	Transect 16	2	1	2	4	10	1	0	-1	0	0	2	-1	1	0	10	Very Low
A3	Transect 17	2	1	2	4	10	3	0	-1	0	0	2	-1	1	0	10	Very Low
A3	Transect 19	2	1	2	4	10	4	0	-1	1	3	2	-1	1	3	13	Very Low
A3	Transect 20	2	1	4	4	12	4	0	-1	2	6	3	-1	2	12	24	Moderate
A3	Transect 21	2	1	2	4	10	4	0	-1	1	3	2	0	2	6	16	Low
A3	Transect 22	2	1	2	4	10	3	0	-1	0	0	2	-1	1	0	10	Very Low
B1	Transect 1	2	1	1	4	9	1	0	-1	1	0	1	0	1	0	9	Very Low
B1	Transect 2	2	1	1	4	9	1	0	-1	2	0	1	0	1	0	9	Very Low
B1	Transect 3	3	0	0	4	8	1	0	-1	2	0	0	0	0	0	8	Very Low
B1	Transect 4	3	0	1	4	9	1	0	-1	2	0	1	0	1	0	9	Very Low
B1	Transect 5	2	1	1	4	9	2	0	-1	1	1	1	-1	0	0	9	Very Low
B1	Transect 6	2	0	0	1	4	5	0	-1	1	4	0	0	0	0	4	Very Low
B1	Transect 7	2	0	0	1	4	3	0	-1	1	2	0	0	0	0	4	Very Low
B1	Transect 8	2	0	0	4	7	2	0	-2	1	0	0	0	0	0	7	Very Low
B1	Transect 9	3	0	0	4	8	2	0	-1	1	1	0	0	0	0	8	Very Low
B1	Transect 10	2	1	1	1	6	1	0	-1	3	0	1	0	1	0	6	Very Low
B1	Transect 11	4	0	0	4	9	1	0	-1	1	0	0	0	0	0	9	Very Low
B1	Transect 12	2	0	0	4	7	1	0	-1	1	0	0	0	0	0	7	Very Low
B1	Transect 13	2	1	1	4	9	1	0	-1	1	0	1	3	4	0	9	Very Low
B1	Transect 14	2	1	1	4	9	1	0	-1	1	0	1	0	1	0	9	Very Low
B1	Transect 15	2	7	7	1	18	5	0	-1	0	0	5	1	6	0	18	Low
N8	Transect 1	3	0	0	1	5	1	0	-1	1	0	0	0	0	0	5	Very Low
N8	Transect 2	3	0	0	4	8	1	0	-1	3	0	0	0	0	0	8	Very Low
N8	Transect 3	2	1	2	1	7	2	0	-1	0	0	2	1	3	0	7	Very Low
N8	Transect 4	2	1	2	4	10	1	0	-1	2	0	2	-1	1	0	10	Very Low
N8	Transect 5	2	1	2	4	10	1	0	-1	1	0	2	-1	1	0	10	Very Low
N8	Transect 6	2	1	2	1	7	2	0	-1	1	1	2	1	3	3	10	Very Low

Lake	Transect	BH Score	BV Score	BSt Score	SG Score	BSF Score	FL Score	AV Score	LD Score	SO Score	MFLW Score	BC Score	MBC Score	BCMS Score	EAC Score	EP Score	EP Class
N8	Transect 7	3	0	0	1	5	1	0	-1	2	0	0	0	0	0	5	Very Low
L2	Transect 1	2	1	1	4	9	4	0	-1	2	6	1	-1	0	0	9	Very Low
L2	Transect 2	2	1	1	1	6	4	0	-1	0	0	1	-1	0	0	6	Very Low
L2	Transect 3	5	4	1	4	15	4	0	-1	3	9	1	0	1	9	24	Moderate
L2	Transect 4	5	0	0	4	10	3	0	-1	1	2	0	0	0	0	10	Very Low
L13	Transect 1	5	4	6	4	20	2	0	-1	2	2	4	1	5	10	30	High
L13	Transect 2	4	4	6	4	19	0	0	-1	3	-3	4	1	5	-15	4	Very Low
L13	Transect 3	4	4	6	4	19	2	0	-1	1	1	4	1	5	5	24	Moderate
L3	Transect 1	3	4	4	4	16	2	0	-1	2	2	4	0	4	8	24	Moderate
L3	Transect 2	5	4	4	4	18	2	0	-1	1	1	4	1	5	5	23	Moderate
E1	Transect 1	2	7	7	1	18	5	0	-1	1	4	5	0	5	20	38	Very High
E1	Transect 2	2	1	1	4	9	2	0	-1	2	2	1	-1	0	0	9	Very Low
E1	Transect 3	2	1	1	4	9	3	0	-1	1	2	1	-1	0	0	9	Very Low
E1	Transect 4	2	1	1	4	9	3	0	-1	0	0	1	-1	0	0	9	Very Low
E1	Transect 5	2	1	0	4	8	4	0	-1	1	3	0	0	0	0	8	Very Low
E1	Transect 6	3	1	0	4	9	4	0	-1	1	3	0	0	0	0	9	Very Low
E1	Transect 7	3	1	1	1	7	3	0	-1	0	0	1	-1	0	0	7	Very Low
E1	Transect 8	3	1	0	4	9	4	0	-1	3	9	0	0	0	0	9	Very Low
E1	Transect 9	2	1	0	4	8	3	0	-1	4	8	0	0	0	0	8	Very Low
E1	Transect 10	3	4	0	4	12	5	0	-1	1	4	0	0	0	0	12	Very Low
E1	Transect 11	2	4	0	4	11	2	0	-1	4	4	0	0	0	0	11	Very Low
E1	Transect 12	3	7	7	1	19	2	0	-1	2	2	5	1	6	12	31	High
E1	Transect 13	2	7	7	1	18	2	0	-1	1	1	5	0	5	5	23	Moderate
E1	Transect 14	2	7	7	1	18	2	0	-1	1	1	5	1	6	6	24	Moderate
E1	Transect 15	2	4	4	4	15	3	0	-1	0	0	3	-1	2	0	15	Very Low
E1	Transect 16	2	4	4	4	15	3	0	-1	0	0	3	-1	2	0	15	Very Low
E1	Transect 17	2	4	2	4	13	2	0	-1	0	0	2	-1	1	0	13	Very Low
E1	Transect 18	2	7	7	1	18	3	0	-1	0	0	5	0	5	0	18	Low
D2	Transect 1	2	1	1	4	9	4	0	-1	2	6	1	-1	0	0	9	Very Low
D2	Transect 2	2	1	1	4	9	4	0	-1	1	3	1	-1	0	0	9	Very Low
D2	Transect 3	2	1	1	4	9	#N/A	0	-1	0	#N/A	1	-1	0	#N/A	#N/A	#N/A
D2	Transect 4	2	1	1	4	9	4	0	-1	2	6	1	-1	0	0	9	Very Low
D2	Transect 5	2	4	1	4	12	4	0	-1	1	3	1	-1	0	0	12	Very Low
D2	Transect 6	2	4	1	4	12	#N/A	0	-1	2	#N/A	1	-1	0	#N/A	#N/A	#N/A
D2	Transect 7	2	4	1	4	12	6	0	-1	0	0	1	-1	0	0	12	Very Low
D2	Transect 8	2	4	1	4	12	#N/A	0	-1	0	#N/A	1	-1	0	#N/A	#N/A	#N/A
D2	Transect 9	2	4	1	4	12	#N/A	0	-1	0	#N/A	1	-1	0	#N/A	#N/A	#N/A
D3	Transect 1	2	0	0	4	7	6	0	-1	1	5	0	0	0	0	7	Very Low
D3	Transect 2	2	1	1	4	9	6	0	-1	1	5	1	0	1	5	14	Very Low
D3	Transect 3	2	1	1	4	9	2	0	-1	4	4	1	-1	0	0	9	Very Low
D3	Transect 4	2	1	1	4	9	6	0	-1	2	10	1	-1	0	0	9	Very Low
D3	Transect 5	2	1	1	4	9	6	0	-1	2	10	1	-1	0	0	9	Very Low
D3	Transect 6	2	1	1	4	9	6	0	-1	3	15	1	-1	0	0	9	Very Low

Lake	Transect	BH Score	BV Score	BSt Score	SG Score	BSF Score	FL Score	AV Score	LD Score	SO Score	MFLW Score	BC Score	MBC Score	BCMS Score	EAC Score	EP Score	EP Class
D3	Transect 7	2	1	1	4	9	6	0	-1	3	15	1	-1	0	0	9	Very Low
D3	Transect 8	2	4	4	4	15	4	0	-1	1	3	3	-1	2	6	21	Moderate
D3	Transect 9	2	7	7	1	18	4	0	-1	4	12	5	0	5	60	78	Very High
D3	Transect 10	2	4	4	4	15	4	0	-1	3	9	3	-1	2	18	33	High
D3	Transect 11	2	4	4	1	12	3	0	-1	3	6	3	-1	2	12	24	Moderate
D3	Transect 12	2	4	2	1	10	3	0	-1	0	0	2	-1	1	0	10	Very Low
D3	Transect 13	2	4	2	4	13	4	0	-1	0	0	2	-1	1	0	13	Very Low
D3	Transect 14	2	4	2	4	13	4	0	-1	0	0	2	-1	1	0	13	Very Low
D3	Transect 15	2	1	1	1	6	#N/A	0	-1	0	#N/A	1	-1	0	#N/A	#N/A	#N/A
N14	Transect 1	2	1	1	4	9	4	0	-1	4	12	1	0	1	12	21	Moderate
N14	Transect 2	2	1	1	4	9	5	0	-1	2	8	1	0	1	8	17	Low
N14	Transect 3	2	4	2	1	10	3	0	-1	1	2	2	-1	1	2	12	Very Low
N14	Transect 4	2	4	2	4	13	3	0	-1	1	2	2	-1	1	2	15	Very Low
N14	Transect 5	2	4	2	4	13	3	0	-1	1	2	2	-1	1	2	15	Very Low
N14	Transect 6	3	1	2	4	11	2	0	-1	0	0	2	-1	1	0	11	Very Low
N14	Transect 7	2	0	0	1	4	1	0	-1	0	0	0	0	0	0	4	Very Low
N14	Transect 8	2	1	1	4	9	2	0	-1	2	2	1	-1	0	0	9	Very Low
N14	Transect 9	2	1	1	4	9	3	0	-1	2	4	1	-1	0	0	9	Very Low
N14	Transect 10	2	1	1	4	9	3	0	-1	1	2	1	-1	0	0	9	Very Low
N14	Transect 11	2	1	1	4	9	3	0	-2	1	1	1	-1	0	0	9	Very Low
N14	Transect 12	2	1	1	4	9	4	0	-2	1	2	1	-1	0	0	9	Very Low
N14	Transect 13	2	0	1	4	8	3	0	-2	1	1	1	-1	0	0	8	Very Low
KL	Transect 1	2	1	1	4	9	2	0	-2	0	0	1	0	1	0	9	Very Low
KL	Transect 2	2	0	0	4	7	4	0	-1	1	3	0	0	0	0	7	Very Low
KL	Transect 3	2	1	1	4	9	6	0	-1	0	0	1	0	1	0	9	Very Low
KL	Transect 4	2	1	6	4	14	4	0	-1	2	6	4	1	5	30	44	Very High
KL	Transect 5	2	1	6	4	14	4	0	-1	2	6	4	0	4	24	38	Very High
KL	Transect 6	2	1	6	4	14	4	0	-1	1	3	4	1	5	15	29	High

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