BEDROCK RESOURCES, INC.
PERMIT APPLICATION FOR AGGREGATE DREDGING IN LAKE ONTARIO

Executive Summary Report

B.A.R ENVIRONMENTAL INC.
Nicholas Beaver Park
R.R. # 3
Guelph, Ontario
N1H 6H9

August, 1994

TABLES OF CONTENTS

LIST OF TABLES

1 INTRODUCTION TO THE TECHNICAL REPORTS

Bedrock Resources Inc. proposes to mine sand from Lake Ontario offshore from Toronto and the City of Scarborough. In 1992 and 93, as part of the aggregate permit acquisition process, three reports were prepared:

Proposal for Sand Dredging in Lake Ontario; Bedrock Resources Inc., 1992

Environmental Review; BAR Environmental Inc., 1992

Sediment Plume Modelling along the Eastern Toronto Waterfront; Gore and Storrie Ltd., 1992

In February 1993, these reports were circulated among government and non-government agencies for review and comment. Based on the concerns raised during this review, additional work was conducted in the fall of 1993. This work involved a detailed survey of sediment size and sediment contaminant levels inside the proposed permit site, a re-examination of the potential for turbidity plumes and a study of coastal processes in the area. To further reduce the potential for adverse environmental impacts, the proposed dredge has been re-designed to incorporate technology that will minimize the potential for turbidity. The results of these efforts appear in the following "specialist" reports which are included with this submission. These include:

1. Improved Techniques for Dredging Sand in Lake Ontario
   Contributors: Francis Kennette, Bedrock Resources Inc.
   Trevor Chandler, B.A.R. Environmental Inc.

2. Sediment Sampling for Gradational and Contaminant Analyses: Technical Note
   Contributors: Trevor Chandler, B.A.R. Environmental Inc.
   Gary Sirota, B.A.R. Environmental Inc.

3. Lake Ontario Aggregate Mining Project Shoreline Processes Study
   Contributors: Fiona Itamunoala, Atria Engineering Hydraulics Inc.
   Ander Chow, Atria Engineering Hydraulics Inc.

4. Sediment Plume Modelling Along the Eastern Toronto Waterfront
   Contributors: Ray Dewey, Gore and Storrie Ltd.
   Mike Hulley, Gore and Storrie Ltd.
   Trevor Chandler, B.A.R. Environmental Inc.
   Francis Kennette, Bedrock Resources Inc.

5. Environmental Monitoring of Aggregate Mining Activities
   Contributors: Trevor Chandler, B.A.R. Environmental Inc.
   Fiona Itamunoala, Atria Engineering Hydraulics Inc.

To assist readers with the large amount of information presented, the specialist reports have been summarized into this executive summary document. The original Bedrock Resources Inc. proposal and BAR Environmental Inc. Environmental Review also contain additional background information which is summarized here.

2 REVIEW OF THE BEDROCK PROPOSAL FOR MARINE AGGREGATE MINING

BEDROCK RESOURCES INC., (Bedrock) was incorporated in 1981 to facilitate the development of a gravel pit near Cambridge, Ontario and has since grown into a major supplier of fine aggregate in the Hamilton-Burlington-Mississauga area. The Company or its officers have also pursued a serious interest in dredging aggregates from the Great Lakes and in 1980 began to investigate the feasibility of dredging sand from the Ohio waters of Lake Erie. Since then, Bedrock has conducted research in Lakes Erie, Huron and St. Clair, as well as the Detroit and St. Clair Rivers, in an effort to locate a suitable sand deposit in an environmentally safe location. Those investigations culminated with the application to the Ontario Ministry of Natural Resources on August 3, 1990, for a permit to mine aggregates from Lake Ontario in an area 1.5 - 4 km offshore, between the Toronto Islands and the Scarborough Bluffs (Figure 1).

The proposed site covers an area of 1407.1 hectares and the northern, inshore edge of the permit area is 1.5 to 2 km offshore. The southern offshore boundary approximates the edge of a steep shelf which runs parallel to the shoreline 4 km offshore. The proposed site runs east-west for 7.8 km from offshore Ashbridge's Bay to east of the Scarborough Bluffs. The average depth of water in the permit area is 18 m and ranges from 10 to 40 m. The substrate in the permit area is generally fine to very coarse sand, 1 m to 5.25 m thick, overlying the Scarborough and Don Formations (Karrow 1967). The total volume of sand in the site amounts to approximately 28 million cubic metres (54 million tonnes), based on an average dredgable thickness of 2.0 metres.

Bedrock proposes to mine the surface sand from the permit area using a trailing suction hopper dredge. This type of dredge "vacuums" a narrow swath of sand as it passes over a sand deposit. Each pass of the proposed Bedrock dredge would recover an area of sand 1 metre in width and approximately 15 cm deep. The company proposes to initially mine the deposit on a single shift basis (145,900 m^3 per year), and later expand this to double and triple shifts (291,800 and 437,700 m3 per year, respectively). Based on these extraction rates, the deposit will be viable for 65 to as long as 195 years. The dredging season would extend from April 1 to November 30 and total area affected in one year would be 97 ha., at single shift rates. Since total area of the proposed permit site is 1407 ha., it would take just over 14 years to mine the top 15 cm of sand from the surface of the entire permit site.

Bedrock is committed to using the best available technology to ensure that the project is safe and environmentally responsible. The president of Bedrock, Mr. Francis Kennette, has visited several major international dredging operations to inspect the latest and most environmentally sound operating techniques. The equipment and techniques proposed in Bedrock's report

"Improved Techniques for Dredging Sand in Lake Ontario", are the best available technology in the world today. These techniques will be applied to this project to ensure that there will be minimal impacts to the local environment and other users of the area.

3 IMPROVED TECHNIQUES FOR SAND DREDGING IN LAKE ONTARIO

BEDROCK RESOURCES INC., 1994

The report "Improved Techniques for Dredging Sand in Lake Ontario"describes the design modifications that were made to the proposed Bedrock dredge in response to the concerns raised by the agencies who reviewed the original Bedrock proposal in 1992. These concerns were specifically related to the potential for turbidity plumes and sedimentation caused by the release of suspended solids into Lake Ontario.

In the original Bedrock proposal, presented to review agencies in 1992, turbid water was to be discharged at a depth of either one or three metres above the lakebed. At the time, this was considered to be sufficient to alleviate the potential for extensive turbidity plumes. However, there remained some concern that turbidity plumes could still affect water quality in the vicinity of the R.C. Harris water intakes. In response to this, Bedrock has agreed to incorporate into the dredge design several highly effective state-of-the-art turbidity reduction systems.

The design of the Bedrock dredge has been improved and will be outfitted with systems designed to reduce the amount of solids re-released into Lake Ontario. The most significant design improvement is the incorporation of a turbid water recirculation system. Instead of being discharged at depth, turbid water will be recycled to the draghead to be used to loosen the sand on the lake bed and transport it up into the hopper. This system is expected to reduce turbid water discharges by 80% compared to the originally proposed non-recirculation mining vessel.

Additional design improvements were made to encourage particle settling in the hold. A series of baffle plates will be installed inside the hopper, which will enhance its ability to function as a settling pond. The deposit consists of clean sand and fine gravel with trace amounts (0.1%) of silt and clay-sized sediment. The predominately coarse texture of the sediment encourages quick settling and serves as an ideal filter for overflow water.

Further improvements were made to the onboard dewatering system. Turbid water in the hopper will be filtered through the sand load and then channelled into a network of underflow drains. The clarified water will then be recirculated to the draghead or released directly into the lake, depending on the phase of the mining cycle.

These design improvements will not completely eliminate the potential for the release of

turbid water into Lake Ontario. As slurry enters the hopper, water inside the hopper will be displaced. The recirculation system cannot entirely make up for this difference and it will be necessary to release turbid water at the end of the dredge run when the recirculation system is disengaged and the sand load is too thick to serve as an efficient filter. At this point, turbid water will be discharged approximately 3 metres above the lake bed. This will reduce settling times and, subsequently, the size of the turbidity plume.

4 SEDIMENT SAMPLING AND CONTAMINANT ANALYSIS - TECHNICAL NOTE

B.A.R. ENVIRONMENTAL INC., 1994

4.1 INTRODUCTION

The purpose of the technical note was to describe sediment grain size and contaminant concentrations within the permit site.

4.2 OBJECTIVES OF 1993 SEDIMENT SAMPLING

1. To obtain reliable sediment grain size data for use in the coastal study and plume analysis.

2. To measure the concentration of contaminants in the sediments and, if necessary, the sediment leachate.

4.3 METHODS

Sediment Sampling

Fifty samples were collected from 34 sites inside the permit site and an additional 30 samples were collected from 30 sites inshore of the proposed permit site. All samples were collected by divers with 15 cm or 30 cm cores.

Sediment Analysis

All 80 samples were subjected to grain size analysis. The whole sample was passed through a sieve series and a representative sample of material finer than 1 mm was passed through a sedimentation tower.

Contaminant Analysis

Sixteen - 30 cm cores were collected for sediment contaminant analysis. The cores were analyzed in a phased approach to limit costs. Sediment from the 4 most sensitive sites was analyzed first (Figure 1). Two cores were selected from sites closest to the R.C. Harris Intakes (3I and 3K) and two from sites with the finest median grain size (3C and 3E). The latter two sites were selected because they would have the greatest potential for clay-adhered

contaminants. It was reasoned that finer sediments with higher clay content would likely be more contaminated than in coarser material - if the fine sediments showed unacceptable levels of contamination, then further analysis of the remaining samples would have been performed.

The 4 cores were spilt into top and bottom subsamples, each 15 cm thick. This was done to determine the vertical distribution of contaminants. Thus a total of 8 samples from 4 sites were analyzed.

4.4 RESULTS OF ANALYSES

Grain Size

The grain size analysis results were used to partition each sample into the various proportions of gravel, sand and silt/clay (Table 1). The data include 1993 diver core samples and those collected by C.C.I.W. (Rukavina 1968). Silt and clay proportions were combined, due to their low concentrations.

Table 1. Percent gravel, sand and silt/clay in samples from the proposed permit site

Gravel (2.00 - 64.0 mm)			**Sand** (0.0625 - 2.00 mm)			**Silt/clay** (< 0.0625 mm)		
High	Low	Mean	High	Low	Mean	High	Low	Mean
77.78%	0.00%	29.93%	99.73%	22.20%	70.00%	5.87%	0.01%	0.07%

Contaminants

Sediment samples from stations 3C, 3E, 3I and 3K were analyzed for contaminants. Levels of contaminants in these sediments were low with exceptions shown in table 2. The sediment core samples that contained trace metal levels in excess of the lowest effect level of the Province of Ontario Sediment Criteria are listed in Table 2.

Table 2. Concentrations (mg/L, ppm) of Trace Metals in Excess of Sediment Quality Criteria (Lowest Effect Level)

	3I-bottom	3K-top	3K-bottom	LOE (Persaud et al 1992)
copper		19.2	20.7	16
manganese	647			460
nickel		18.5	18.4	16

Other contaminants were all not detected (below detection limit) or in a very few cases at "trace" levels (a peak was detected but not quantifiable). These include:

PAH = Not Detected
Pesticides = Not Detected
PCB = Not Detected (at 10 ppb level)
Oil & Grease = Not Detected at all sites except 3K-top where level of 18.6 mg/kg (ppm) was found (LOE = 1500 ppm)

Leachate

For trace metals, all levels were low below Ontario Drinking Water Maximum Allowable Concentrations (for health). Iron levels in samples 3C-top and bottom, 3E-bottom, and 3I-top were slightly in excess of the Ontario level for aesthetic quality. These data are summarized in the table 3.

Table 3. Concentration of Water Quality Indicators (mg/L, ppm) in Leachate Samples in Excess of Existing Potable Water Guidelines.

	3C-top	3C-bottom	3E-top	3E-bottom	3I-bottom	3K-bottom	criteria
iron	0.368	0.342	0.376	0.484			0.3(1)
ammonia					0.62	0.56	0.5(2)

(1) Ontario Drinking Water Standards - criteria for aesthetic quality (MOE 1984)
(2) Federal Maximum allowable levels for drinking water (Environment Canada undated).

4.5 CONCLUSIONS

- Surficial sediments are generally coarse with silt and clay contents averaging 0.1%. The amount of material finer than 75 microns averaged 0.5%.

- Contaminant levels in both the sediment and leachate samples were acceptably low at the four sites that were analyzed.

References

Department of National Health and Welfare Canada, 1969 *in* ENVIRONMENT CANADA, WATER QUALITY SOURCEBOOK - A GUIDE TO WATER QUALITY PARAMETERS.

MOE 1984, Ontario Drinking Water Objectives. ISBN 0-7743-8985-0

PERSAUD. D., R. JAAGUMAGI, and A. HAYTON 1992. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Ontario Ministry of the Environment, Water Resources Branch. ISBN 0-7729-9248-7.

5 SEDIMENT PLUME MODELLING ALONG THE EASTERN TORONTO WATERFRONT

GORE & STORRIE LTD., 1994

Computer models have been developed and applied to assess the impact of a plume created by a proposed marine mining operation offshore of the Toronto eastern waterfront. There were two tasks associated with predicting the concentration of Suspended Solids (SS) in the plume and receiving waters. The first was to determine the overflow discharge rate and its SS concentration. The second task was to apply these data to a dynamic lake model to predict the plume behaviour in the lake and to assess the impact of the mining operations on water quality in the vicinity of the R.C. Harris water intakes.

A dredge model was developed to predict the operating characteristics of the dredge hopper and the recirculation system. The model was applied to determine the SS levels in the overflow during the filling cycle of the hopper. The amount of fine material remaining in the hopper and the time required to drain all the available water from the mined material were also predicted. The excess water in the hopper was modelled as 20% of the recirculation rate and was considered a reliable value. The actual rate will be determined through trials and as operating experience is gained. There are no data presently available regarding the overflow rates and SS concentrations for an operation of this type. The sediment quality in this part of Lake Ontario is ideal for the application of recirculation technology for the proposed marine mining operation, ie it contains minimal fines and has low contaminant levels.

The model predicted that the hopper would not start to overflow until 2.6 hours after the dredging operation starts. The dredge model assumed that 20% of the recirculation flow, which consists of turbid water from hopper overflow and clear underflow water, would exceed the requirements of the draghead and be discharged approximately 3 metres above the bottom. The hopper would fill in about 5 hours and the maximum overflow discharge rate was 0.22 $m^3 s^{-1}$ (Table 4).

Table 4. Summary of overflow and underflow discharges and suspended sediment concentrations during a typical dredge run

Dredge Cycle	Start of Cycle			End of Cycle			Flow Duration (hours)	Solids Discharge (kg)
	Q (m^3/s)	C (mg/L)	time index (hr)	Q (m^3/s)	C (mg/L)	time index (hr)		
Overflow 1	0.15	70	2.1	0.22	95	4.7	2.6	200
Overflow 2	0.15	225	2.1	0.22	320	4.7	2.6	660
Underflow	0.13	0	0.0	0.04	0	8.0	8.0	0

Overflow 1 = sediment from SW corner of permit site excluded
Overflow 2 = sediment from SW corner of permit site included
Time index = 0.0 at beginning of dredge run
Total run time = 4.7 hours

The concentrations in the overflow did not vary significantly over the discharge period and typical concentrations were about 100 mg L^{-1}. These estimates do not consider the particle size data from the southwest corner of the proposed permit site which had higher proportions of fine sand. Including the finer material in the hopper, the suspended sediment concentration was predicted to increase by a factor of three.

The overflow rates and SS concentrations were used as input data in a dynamic water quality model of the lake in the area of the proposed mining operation. The model used real time current meter data as boundary conditions. Currents flowing to the east or west as well as upwelling events with onshore currents were simulated.

The overflow was discharged at 3 m (10 feet) above the bottom of the lake directly below the dredge. The dredge travelled at a speed of 1200 m/hour along a predescribed path inside the dredging permit area. The dredge will require about 5 hours to fill the hopper to its capacity after which it will return to port for unloading. As it travels back it will continue to discharge drainage water using the same overflow system. The discharge will have no impact at the R.C. Harris intakes as the dredge will be remote from them at this point.

The discharged SS particles were modelled as settling out (first order decay) and as a conservative material that would not settle out during the mining operation. The typical particle sizes in the overflow water would settle out in about 1.0 hour from a discharge height of 3 metres.
In all scenarios, the plume was always confined to an area of 200 m by 800 m. Within this area, the plume model predicts the maximum increase in suspended particles ranged from a background level of 0.001 mg/L to 3.0 mg/L during easterly current conditions. The maximum increase in suspended particles during westerly currents was 2.5 mg/L. The maximum increased SS concentration during an upwelling event was predicted to be 2.0 mg/L. Levels similar to this were predicted for reversing current conditions. Concentrations in the tail of the plume ranged from 0.01 to 1.0 mg/L.

The area impacted by the plume was always within the permit site when particle settling was considered by the model. The model predicted that there would be no increase in the turbidity of the water in the vicinity of the R.C. Harris intakes as a result of dredging under any of the current scenarios that were modelled.

The accumulation of fine material on the lake bottom from the overflow discharge was very small (<0.1 mm per year) and will not affect the performance of the dredge on subsequent passes.

The dredge will not operate during strong current conditions that are typical of storm events in the spring and fall, therefore model predictions for these events were not required.

6 SHORELINE PROCESSES STUDY

ATRIA ENGINEERING HYDRAULICS INC., 1994

6.1 INTRODUCTION

The marine aggregate mining proposed by Bedrock Resources will take place 1.5 to 4 kilometres offshore of the eastern Toronto and Scarborough waterfronts in depths of 10 to 40 metres. The sand reserve is expected to remain productive for over 60 years and it will take 7 to 14 years to completely mine the top 15 cm of sand from the entire permit site, depending on the extraction rates.

Potential impacts on coastal processes may result from the gradual deepening of the offshore bathymetry. This may influence wave directions as well as the total wave energy reaching the nearshore zone. In response, sediment transport processes may also be affected. The potential for marine aggregate mining to impact the coastal environment is summarized below and is discussed in greater detail in the Shoreline Processes Study report prepared by Atria Engineering Hydraulics Inc.

6.2 OBJECTIVES OF COASTAL STUDY

1. To assess any changes to the nearshore wave climate, and the potential for erosion at the shoreline and in the nearshore zone as a result of aggregate mining.

2. To evaluate the sediment processes inshore of the proposed mine site.

3. To evaluate the threshold of sediment movement for the grain sizes encountered at the site.

4. To recommend a monitoring programme to identify the impacts of dredging on shoreline stability and to differentiate these impacts from the influences of other shoreline projects in the vicinity of the Bedrock permit site.

6.3 ANALYSES

Numerical models were used to evaluate the effects of dredging on the nearshore wave climate, at five locations inshore of the proposed permit site. The models were run for existing conditions and with the lake bed altered to reflect post dredging conditions. In all cases, the impact of aggregate mining on the nearshore wave climate was minimal (less than 5%). At 4 of the 5 locations analyzed, there was a slight decrease in the wave energy at the

shoreline. The net wave energy direction changed by less than 1 degree. There were no changes in the maximum wave events at the shoreline.

Changes in the potential alongshore sediment transport rates resulting from the proposed dredging, were evaluated based on changes to the nearshore wave climate. The change was found to be at most 5 percent, and in all cases the potential alongshore transport decreased slightly. In all cases, the net direction of alongshore transport was unchanged.

An analysis was carried out to determine if the proposed mine site is inside the active sediment transport zone. The northern edge of the permit site is in the offshore zone where sediment transport is reportedly negligible (Hallermeier, 1981).

Although it was not possible to determine sediment transport rates inside the permit site, an attempt was made to define the depths at which movement does occur. Sediment motion under waves was evaluated using the method of Ackers and White (1973). Movement of sediment with D_{50}=0.4 mm can take place at the proposed permit site during a storm with 2 m wave heights. This is consistent with ripples observed on the lake bed.

6.4 SUMMARY OF RESULTS

Wave Climate

- For post dredging conditions, wave energy at the shoreline decreased at 4 of the 5 locations analyzed. In all cases the change was less than 5 percent.
- Net wave energy direction changed by less than 1 percent at the locations analyzed.
- Extreme wave heights were unchanged for post dredging conditions.

Sediment Transport

- The net direction of alongshore sediment transport will not change as a result of the proposed dredging, however the rate of transport may decrease slightly.
- Sediment transport zones were delineated for the waters in the vicinity of the proposed permit site;

littoral zone (active transport)	0-4.5 metres ;
shoal zone (some transport)	4.5-7.7 metres;
offshore zone (minimal transport)	7.7+ metres.

The permit site is located in the offshore zone where sediment transport is reportedly minimal.

- Wave heights of 2 metres can mobilize sediment with a grain size of 0.4 mm (typical of site), in depths of up to 15 metres. A 2 metre wave height is exceeded approximately 1.3 percent of the time. For depths of 20 metres, a 3 metre wave is required. Ripple observations support this prediction.

6.5 DISCUSSION OF RESULTS

The maximum wave height reaching the nearshore zone is limited by the shallow water depth therefore wave heights during severe storms will not be increased by the mining operations. From this point of view, the erosion potential of storm events would not be increased by the proposed dredge area.

At present, the net alongshore sediment transport direction is from east to west.

The proposed mining operations will not change the alongshore sediment transport direction, but its net rate may be reduced by approximately 0.2% to 5.0% depending on the location along the shoreline. The reduction in sediment transport rate results from reduced wave energy in the nearshore zone and slight changes to wave directions.

The slight decrease in potential alongshore sediment transport rates, resulting from the dredging, may slightly decrease shoreline erosion in the long term. Decreased erosion potential along cohesive shorelines (Scarborough Bluffs) may result from decreased wave energy at the shoreline. Along non-cohesive shorelines (Eastern Beaches), a decrease in potential alongshore transport rates may lessen the gap between potential transport rates and actual available sediment, which has resulted from the recent protection of the Scarborough Bluffs.

The analysis indicated that the proposed dredge area is not in the littoral zone where significant sediment transport takes place. Rather, it is located in the offshore zone where sediment transport is reportedly negligible. This suggests that the proposed dredge area would not likely affect the nearshore sediment processes.

The wave activity can disturb the fine materials at the proposed dredge area and re-suspend sediments in the water column. The suspended fine materials could be transported by currents. Based on the measured current data at East Point (where the net current direction for the measurement period was toward the southwest), the possible direction of sediment

transport around the proposed dredge area is toward the southwest. This is consistent with the observation that finer materials are located around the southwest portion of the proposed dredge site.

6.6 CONCLUSIONS AND RECOMMENDATIONS

Based on the analyses carried out, the impacts of the proposed dredging on the nearshore wave climate and sediment processes appear to be minimal. Sediment processes in deeper water are more difficult to quantify, however it has been shown that the proposed dredge area is located in the offshore zone where sediment movement is reportedly minimal.

Monitoring of the site prior to and during dredging is recommended. Suggestions have been made for a monitoring programme which would involve the use of sediment stakes, current meters and wave hindcasting. It is also suggested that a pilot dredge pit could be dredged and monitored prior to commencement of the full scale operation.

References:

ACKERS, P. and WHITE, W.R. 1973. Sediment transport; new approach and analysis. Journal of the Hydraulics Division, ASCE, Vol. 99, No.HY11, 2041-2060.

HALLERMEIER, R.J. 1981. A profile zonation for seasonal beaches from wave climate. Coastal Engineering, 4, 253-277.

7 PHYSICAL IMPACTS MONITORING REPORT

B.A.R. ENVIRONMENTAL INC., 1994

The permit for which Bedrock has applied must be renewed every five years. Monitoring programs have been developed to provide data relevant to the impacts of the mining operations for each five year renewal application. Three reports were prepared in support of the Bedrock proposal which discussed the physical nature and processes of the sand deposit, and included sediment characteristics, coastal processes and sediment plume modelling. To verify the predicted impacts of dredging, as outlined in these reports, a detailed monitoring program has been developed. The monitoring report describes the proposed techniques and equipment that will be used to determine the physical impacts of the aggregate mining operations. A schedule of monitoring tasks is also presented which will encompass the full lifetime of the proposed dredging operations.

The monitoring operations will encompass three main areas of concern:

1. Monitoring of Deposit Characteristics:

- The thickness of the sand deposit will be measured with a sub-bottom profiling device. The data will be used to prepare isopach maps of the sand reserve which will be updated every five years.

- Diver core sediment samples will be retrieved every five years to monitor sediment gradation throughout the permit site.

- Cruise reports

2. Turbidity Plume Monitoring:

- The turbidity plume concentration, duration and extent will be measured as soon as the dredge becomes operational. These data will be used to verify the sediment plume modelling conducted by Gore and Storrie Ltd.

- Plume monitoring will be conducted every five years, in the final year of the five year permit, as a check of the dredge's environmental performance.

3. Coastal Processes Monitoring

- Sediment stake transects will be established to monitor the depths at which sediment

3. Coastal Processes Monitoring

- Sediment stake transects will be established to monitor the depths at which sediment moves. The transects will be located at the eastern and western extremities of the permit site.

- Current meters will be stationed near the transects. The data, in addition to wave hind casting analyses, will help to determine the direction of sediment movement.

- In the second year of the mining operation, a pilot dredge pit, 10 metres by 10 metres and 2 metres deep, will be excavated near the inshore margin of the permit site. Additional stakes will be placed near the pit to evaluate the potential for drawdown.

A report of the first year monitoring results will be prepared prior to the second year of dredging operations. Subsequent monitoring reports will be made before the expiration of the aggregate permit (5 years). All data collected during the monitoring exercises will be made available to the Ministry of Natural Resources.