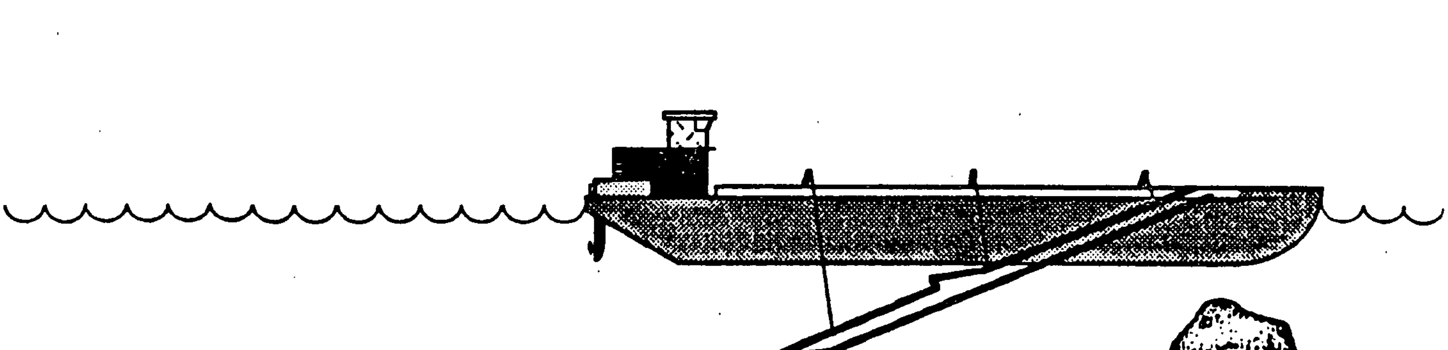
# PROPOSAL FOR SAND DREDGING IN LAKE ONTARIO

submitted by

*Bedrock Resources, Inc.*


4325 Division Road
R.R. #1
Windsor, Ontario
N9A 6J3


October 1992



S.I.D. #02207

BEDROCK

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# 1 INTRODUCTION

BEDROCK RESOURCES, INC. was incorporated in 1981 to facilitate the development of a gravel pit near Cambridge, Ontario, and has since grown into a major fine aggregate supplier in the Hamilton-Burlington-Mississauga area. An affiliated company, BEDROCK AGGREGATES, INC., produces concrete and asphalt aggregates at a quarry south of Windsor, and together the two companies have produced and sold over 700,000 tons of aggregate annually. The Bedrock Manufacturing Division of Bedrock Resources provides metal fabricating and erection services for bulk material handling projects, as well as conveyor design and manufacturing.

Serious interest in dredging aggregates from the Great Lakes has been pursued by the company or its officers since 1980, when the feasibility of dredging sand in the Ohio water of Lake Erie was investigated. Since then Bedrock has undertaken research in Lakes Erie, Huron, and St. Clair, as well as the Detroit and St. Clair Rivers, in an effort to find a suitable aggregate deposit in an environmentally safe location. Those investigations culminated with an application to the Ontario Ministry of Natural Resources on August 3, 1990, to dredge aggregates from Lake Ontario in an area about 2 km offshore, between the Toronto Islands and the Scarborough Bluffs.

Research of various potential sites identified serious concerns associated with dredging aggregates from open waters. These included the potential to disrupt spawning grounds, shoreline erosion, and the dispersal of contaminants into the water column. In response to these concerns, Bedrock restricted the search for a suitable dredging site to areas where these effects could be reduced, eliminated, or positively mitigated. Critical review of Bedrock's efforts to be an environmentally sensitive company have been positive, as evidenced by the newspaper article reproduced in Figure 1.

In 1988 Bedrock obtained a small suction dredge in order to gain first hand experience in aggregate dredging. This dredge was employed in the final rehabilitation of a gravel pit into a residential subdivision at a site near Chatham. The dredge was also used to deepen a pond and to reclaim low lying land in a former gravel pit, now known as Leisure Lake Trailer Park, near Leamington. This experience was augmented by visits to international "state-of-the-art" aggregate dredging operations in Holland. Bedrock now has a very complete understanding of the technical requirements for environmentally safe dredging in Lake Ontario.

Concrete and asphalt producers in the Greater Toronto Area have been dependent on sand imported by truck from areas as far away as Mosport, Sunderland, Orangeville, and Cambridge. The search for aggregates in Lake Ontario is in direct response to the depletion of gravel deposits close to the Metropolitan Toronto area, and the increasing pressure by environmental groups to reduce or eliminate gravel extraction on the Niagara Escarpment and Oak Ridges Moraine.

It is recognized that aggregate removal from the lake poses alternative environmental concerns. Several environmental consulting firms and individuals have been retained to address the various issues, and the reports produced are contained within this master report.

B8 THE WINDSOR STAR THURSDAY, MAY 10, 1990

# Company down to bedrock in environmental concern

DAN WATKIN

OUTDOORS

On more than one occasion over this past year I have expressed my concern regarding the often cavalier attitude demonstrated by industry toward the environment. Without much effort numerous examples of how environment has suffered at the hands of industry can be found.

Alternatively, there are companies and individuals whose efforts give us cause to hope that all is not doom and gloom environmentally. These individuals work diligently with regulatory agencies and environmental groups to assure that our air and waters remain safe. Although their ultimate practical goals may differ, they share one concern, and that is the preservation or improvement of air and water quality.

Bedrock Resources Inc., of Windsor and Cambridge, is one example of a company which has placed environmental issues high on its corporate priority list.

Francis Kennette, company president telephoned me several weeks ago expressing his concern over the accuracy of an article I had written on environmental degradation. Specifically, he challenged my concern about the potential deleterious effects dredging sand from the bottom of Lake Erie might have on the lake itself.

Kennette pointed out that the proposed dredging site was east of Pelee Island, not west of it as I had stated in the article, and that it was in fact the same area where Erie Sand and Gravel Ltd. of Erie Pennsylvania had been working for some time.

Subsequent to our telephone conversation, Bedrock forwarded to me detailed documentation of their proposed operation. Their thorough and often lengthy dealings with the Ministry of the Environment and the Natural Resources were included.

After reading most of the information they had supplied I was hard pressed to think of a single area of potential environmental impact that Bedrock Resources hadn't addressed. If more of our industrial citizens would demonstrate the responsibility that Bedrock has they would be doing much toward allaying the fear and the apprehension that the public has for industry and the environment.

On March 27, I received a letter from Ian Naisbitt, the Environmental Science teacher at Concord School in Windsor. Ian included an article he had written detailing the efforts of his group to improve wetland habitat along a stretch of the Little River.

It's exciting to see communities becoming involved in environmental improvements projects. Tremendous dividends usually result. The public's environmental conscience is most certainly heightened and as a result of the reclamation of small niches of marshland, we ensure that there will be a wetlands legacy for our children to inherit.

Naisbitt was in the process of obtaining a CWIP grant for the Little River creek, and I'm sure such a grant would go a ng way towards ensuring the ultimate success of his project.

**Potshots:** I would like to clear up some ambiguities in an article I wrote on March 29.

The controlled deer hunt which took place last fall was not in Rondeau Provincial Park, but rather in the Long Point Wildlife area, which is managed by the Canadian Wildlife Service. The confrontation between the MNR and Indian fishermen from the Kettle Point Reserve occurred September 27, 1989, and not two summers ago as stated in the article.

**Moose tag draw:** Deryl Smith, MNR's Information Service co-ordinator in Chatham has asked me to bring the following to the attention of hunters with regard to the 1990 adult moose validation tag draw.

"An application form for the draw is attached to the moose licence which goes on sale in early April. To be eligible for the draw, applications must reach the post box indicated on the back of the application form by 5 p.m. Tuesday, May 15, 1990. Applications may also be submitted to any MNR office prior to the deadline."

Figure 1. Review of Bedrock's efforts in a newspaper article.

There are some obvious benefits to switching to a local, lake dredged source for Toronto's sand. Aggregate provided by dredging in Lake Ontario can drastically reduce the truck traffic associated with land based gravel extraction, while at the same time preserve neighbouring farmland. The royalties paid on lake dredged aggregates will provide a significant source of income to the Province of Ontario, while at the same time satisfying the objective of achieving "Sustainable Development" in the economy.

In the search for new sources of sand aggregates for the Greater Toronto Area and Golden Horseshoe markets, Bedrock has considered the following options, all of which were determined to be inferior alternatives in comparison to dredging in Lake Ontario:

- Production of sand "manufactured" from crushed stone (problems with concrete being difficult to finish, product is inferior to natural sand, excessive waste and power consumption is required for production, and no large scale reserves are available that would not have great difficulties in licensing);

- Rail shipment of sand from Cambridge pit (rail cost too high compared to trucking rates, large capital investments required by both shipper and customer, truck transport still required if customer is not located on rail line);

- Sand from Northern Ontario shipped by lake freighter (shipping costs too high due to excessive distance and need to transit Welland canal, no suitable deposits exist adjacent to potential deep draft loading dock sites, remote locations are expensive to operate);

- Various land based deposits (all existing deposits are subject to a variety of constraints such as neighbourhood resistance to establishment of pits, excessive trucking distance, and the general inability to extract aggregates from beneath the water table at sites that are to be returned to agriculture).

- Recycled concrete, asphalt, and buildings (while recycled materials can successfully be used in granular base construction, it is impractical to adequately control the incoming materials to a high enough standard to allow for the production of consistently high quality fine aggregate products; the crushing necessary to provide the fine aggregate fractions would result in excessive dust generation).

None of the alternatives investigated could provide sand to the Greater Toronto Area (GTA) and Golden Horseshoe as efficiently as dredging from Lake Ontario. **From an economical and ecological viewpoint, sand dredged from this deposit in Lake Ontario is the most viable alternative to meet the long term requirements of the largest and most important aggregate market in Ontario.**

## 2 LOCATION AND DREDGING APPLICATION

Bedrock researched the sand and gravel deposits in the Great Lakes and became aware of the deposit between the Toronto Islands and the Scarborough Bluffs area from a variety of publications and verbal communications. The requirements and procedures necessary to consider the extraction of aggregates from the bed of Lake Ontario were outlined in a letter received in March of 1990 from Mr. Abraham Bosman, Land Management Supervisor at O.M.N.R., Maple District, in response to a request for same. A copy of this letter is contained in Appendix A.

On August 3, 1990, Bedrock applied to the O.M.N.R. for an "Aggregate Permit" under the Aggregate Resources Act, (Bill 170, 1989) to dredge sand and gravel in the general area outlined in Figure 2. Appendix A also contains a copy of the initial application, preliminary site plan, and subsequent work permit which was issued to proceed with on-site research and sample collection.

The area proposed for dredging was determined primarily by analysis of a report prepared by Dr. N.A. Rukavina of the Canada Centre for Inland Waters (C.C.I.W.), at the National Water Research Institute in Burlington, Ontario. This limited distribution report, prepared for the Industrial Minerals Section of the O.M.N.R., is titled "Data on Nearshore Sand and Gravel Deposits in Lake Ontario", and is on file at the O.M.N.R. offices in Toronto (Rukavina, 1983). Five C.C.I.W. test locations in the general area of the Bedrock application indicated the presence of sand and gravels to a thickness of 5.25 metres (17.2 feet). More complete details on the aggregate deposit are described in the section of this report titled "Deposit Characteristics".

In determining the initial boundaries of the proposed dredging area it was decided to apply for a permit to extract aggregate only in areas where water depths exceeded 10 metres (32.8 feet). Previous research for dredging aggregates from Lake Erie by the Great Lakes Institute at the University of Windsor (Schwartz, 1989) indicated that this restriction would minimize the impacts of the operation to fish spawning. It was also generally felt that this was far enough off shore to reduce or eliminate conflict with shore related recreational activities and erosion concerns. The original permit application was for an area bounded on the offshore side by the very steep drop off from depths of approximately 20 metres (65.6 feet) to over 50 metres (164.0 feet), which is too deep for current aggregate dredging technology. The western boundary of the proposed dredging area was drawn where the material became too fine to be useful. At the eastern end, the deposit thins out and larger gravel (and subsequently better fish spawning habitat) take over. Areas of thin material deposits were excluded to minimize the possibility of removing all the available aggregate from an area, which would permanently change any existing spawning or fish habitat substrate.

Since the initial application by Bedrock and the submission of this report, further data and information have been gathered to address the issues raised by Mr. Bosman of the O.M.N.R.

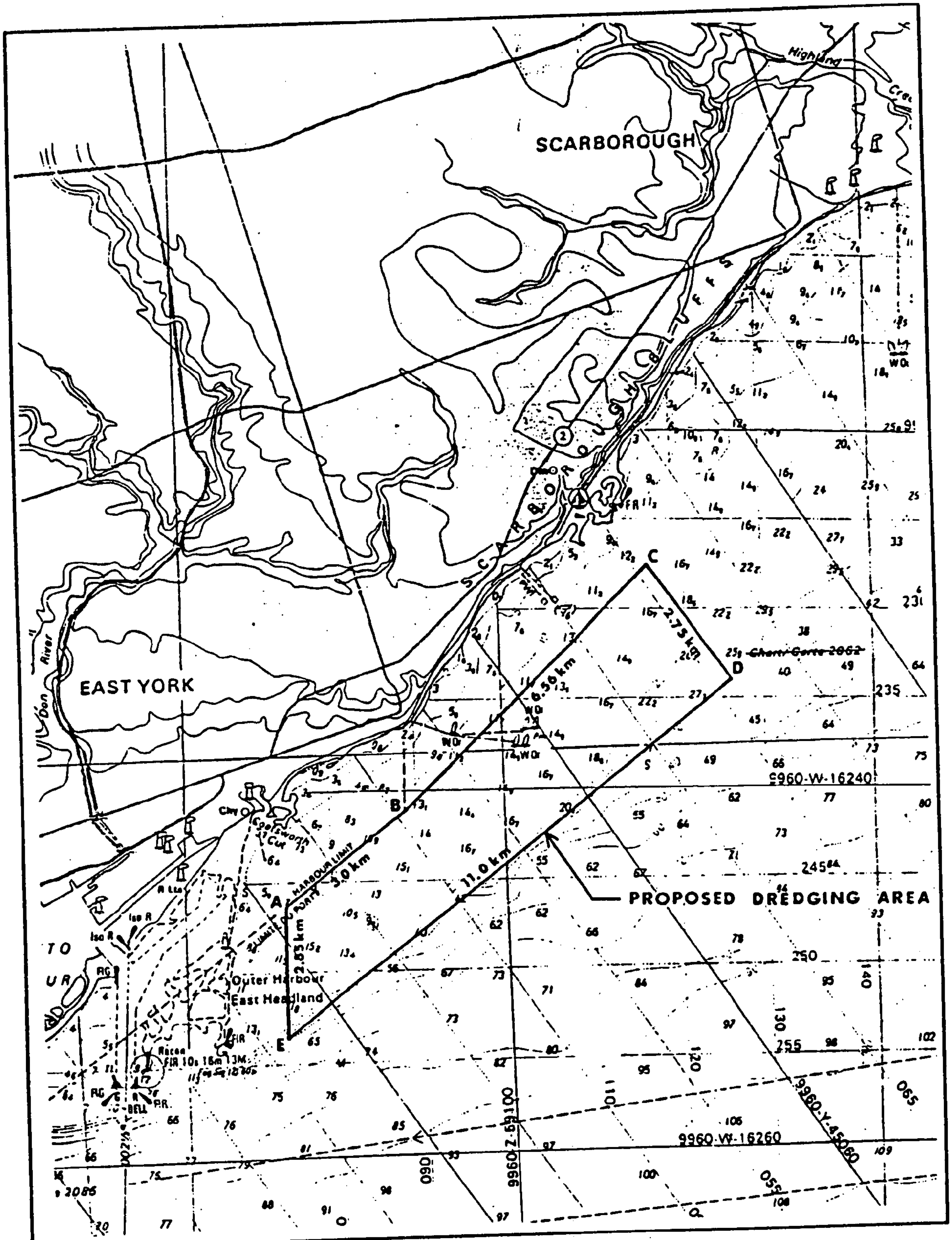



**Figure 2.** Outline of Dredging Research Area.

The quality and quantity of the aggregate deposit was also extensively tested, requiring several work permit renewals.

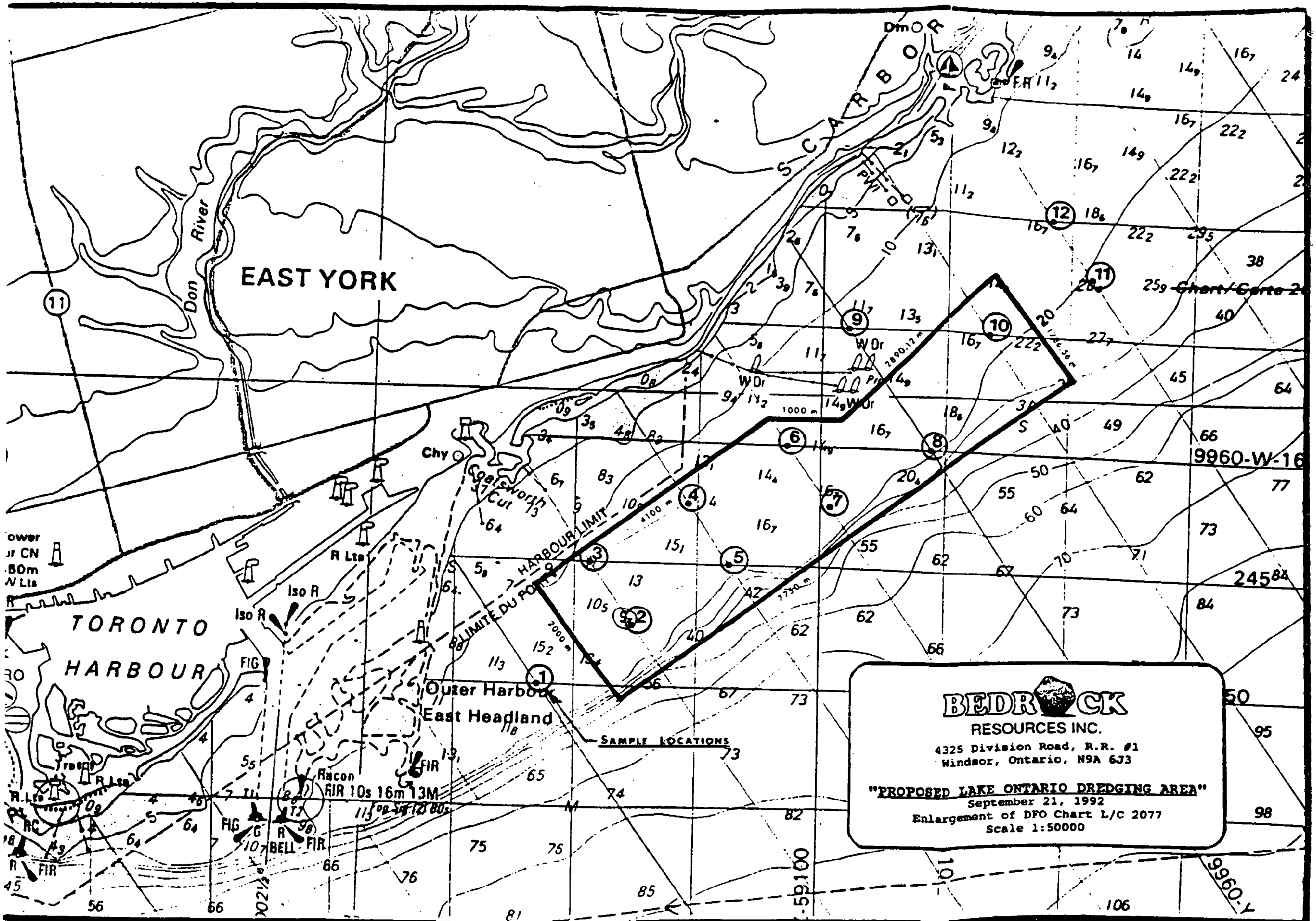
The firm of B.A.R. Environmental Inc., of Guelph, Ontario, has been retained by Bedrock as the lead consultant to investigate the Ministry's concerns about the effect of dredging in Lake Ontario. Particular attention was paid to potential impacts to fish spawning or foraging habitat, to the potential for turbidity impacts and to assess the presence of possible contaminants. Gillian M. Booth, M.Sc., President of B.A.R., is heading the investigative team. B.A.R. has established the study design in consultation with the Ontario Ministry of the Environment (Central Region), the Ministry of Natural Resources (Maple District), and the Federal Department of Fisheries and Oceans. B.A.R. Environmental Inc.'s report is an integral part of this application.

Based on the physical findings of B.A.R. and Bedrock's research, and the turbidity concerns for the R.C. Harris Water Treatment Plant, the dredging area was reduced to that shown in Figure 3. Appendix B contains the revised key plan and line drawing of the area with reference to a shore based benchmark, as submitted to the O.M.N.R. The reduced dredging area encompasses an aggregate deposit of adequate thickness. In addition, the new area lies well off-shore and beyond the R.C. Harris water intakes and will avoid the problems of added turbidity in the waters adjacent to the intakes. Finally, this new area is within a water depth that will allow for economical dredging.

The revised area comprises 1,407.1 hectares and is best described as follows:

> "Using the Toronto East City Limit at the high water mark (Lat. 043-40-15.84493 N, Long. 079-16-48.86550 W) as a land based starting reference, proceed astronomic south a distance of 1,750.00 m to the inshore boundary of the dredging area, then 232 degrees true for a distance of 2,500.00 m , then 142 degrees true for a distance of 2,000.00 m, then 52 degrees for a distance of 7,750.00 metres, then 322 degrees true for a distance of 1,786.56 m, then 224 degrees true for a distance of 2890.12 m, then 270 degrees true for a distance of 1000.00 m and then, finally, 232 degrees true for a distance of 1,600.00 m."

The results of the research for potential fish habitat, turbidity, coastal erosion and possible contaminants are appended in the consultant's reports.




c Ontario dredging a.

## 3 GEOLOGICAL DEVELOPMENT

Geologists in the past have paid extensive attention to the Quaternary geology of the Great Lakes region, which has the distinction of being the largest body of fresh water in the world. The works of such prominent authors as Chapman and Putnam (1966) give an excellent account of the area's physiography, and together with the research performed by other geologists the development of this region's prominent landforms have been explained.

While the work of most geologists has been confined to studying the landforms of the region, comparatively little work has been done on the development of the sediment patterns in the large lakes of the area. The early work of Kindle (1925) laid the groundwork as the first comprehensive study of the sediments of Lake Ontario. Other works on which this section of the report have relied include Thomas *et al* (1972), Rukavina (1976) and Lewis and Sly (1971).

To understand the development of the modern sediment deposits in Lake Ontario, it is essential to look at the surrounding land areas as this is the "host" area from which these sediments have been transported through the actions of wind, water and ice. The pocket at the back of this report contains O.M.N.R. Preliminary Map P. 2204, Quaternary Geology of Toronto and Surrounding Area. Reference Section 3 on this map is an excellent illustration of the stratigraphy of the Scarborough Bluffs, and the accompanying legend depicts the various deposits present in the immediate vicinity of the application area. The shore-bluff created by glacial Lake Iroquois dominates the area surrounding present day Lake Ontario, and illustrates the long history of erosion since the close of the Pleistocene epoch over 10,000 years ago.

According to Lewis and McNeely (1967), the sediments of present day Lake Ontario can be placed into three major categories: (1) complex nearshore sediments, (2) glaciolacustrine clays and (3) postglacial muds. Localized areas of the lake, especially in the nearshore area, show wide variation in the type and thickness of deposit found. Figure 4 depicts the distribution of Lake Ontario sediments based on the echo sounding work of Thomas *et al* (1972).

The major erosional forces acting on the shoreline and bottom of the lake are currents, especially the longshore currents, and wave action in the nearshore zone. Rukavina (1976) states that nearshore sediment is derived from three sources: discharge from rivers and streams, bluff erosion, and subaqueous erosion in the nearshore zone. Eroding shore bluffs are the major contributor of bottom sediment in this area.

The intense energy of large waves driven against the Scarborough Bluffs has caused extensive erosion. Combined with the general east to west direction of littoral drift in this area, this process has led to the development of the Toronto Islands as well as the sand and gravel deposits in the nearshore zone.

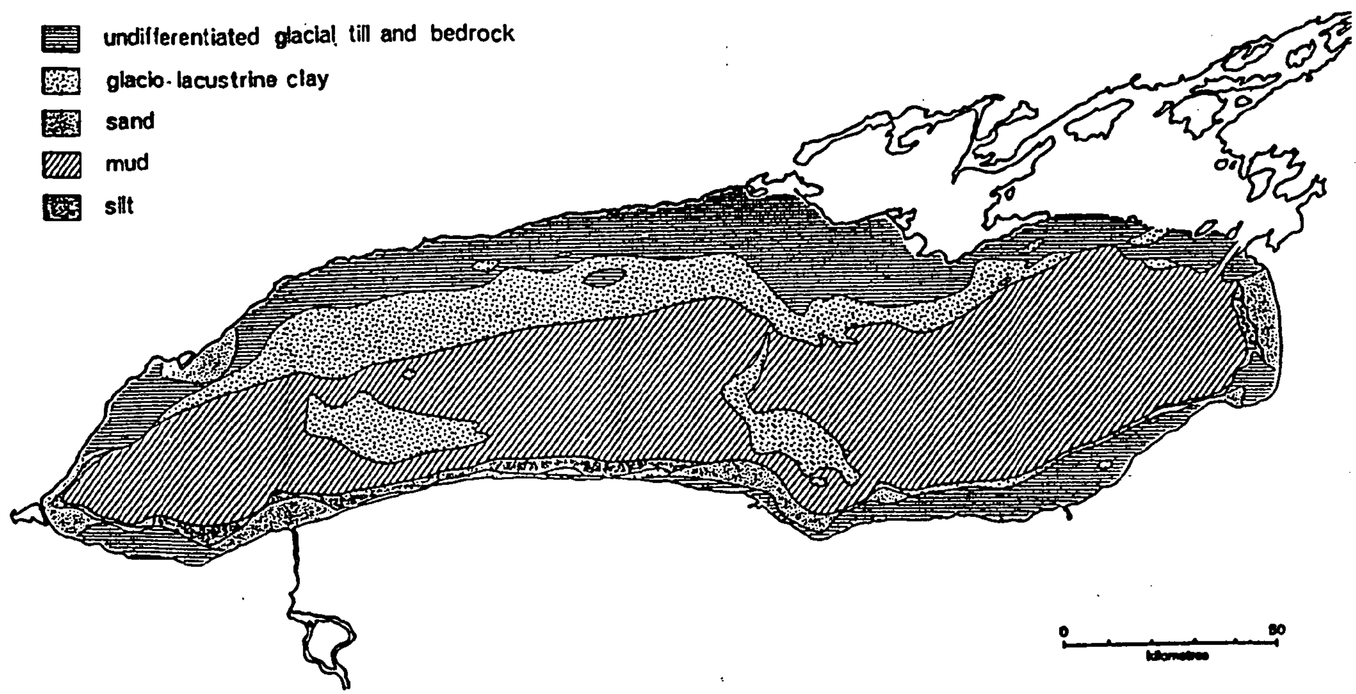



**Figure 4.** The distribution of glacial and postglacial sediment units based upon echo profiles of Lake Ontario.

Figure 5 shows the net longshore drift and zones of sediment accumulation (Rukavina 1976), which is consistent with theories on the direction of average currents and the presence of actual sediment. Figure 6 depicts the total annual sediment input during the period of 1973/74, based on volumetric data from the Marine Services Directorate erosion profiles, combined with grain size data from selected profiles (Rukavina 1976). The very fine grained silts and clays will stay in suspension much longer than the coarser grained sands and gravels, and are thus carried until the current velocity drops significantly, which is typically in deep offshore areas. As a result, all the material that erodes will not be deposited in the adjacent lake bottom, but rather sands and gravels will be transported the shortest distances, while silts and clays will be transported the farthest. The nearshore accumulation rates are approximately 0.31 mm $yr^{-1}$ (Figure 7); however, these rates have been shown to be conservative by test borings (Rukavina 1976). The areas of greatest accumulation of fine sediment are the offshore basins (Figure 8), of which the Rochester basin had the greatest accumulation at approximately 3.6 mm per year (Thomas, *et al* 1972). These sediments consist of very fine grained material that lie in extremely deep water, therefore they are of no commercial value to the sand and gravel industry.

The bathymetry map of Lake Ontario shown in Figure 9 (Thomas *et al* 1972) has 20 metre isobaths which illustrate the great depth of the lake in most areas. In areas deeper than 20 m sediment transportation and accumulation is almost entirely due to the action of currents, as waves will not stir bottom sediments at these depths. The map also shows that the majority of the Lake Ontario bottom exceeds the depths required to permit economical dredging. Depths less than 40 m are suitable for dredging.

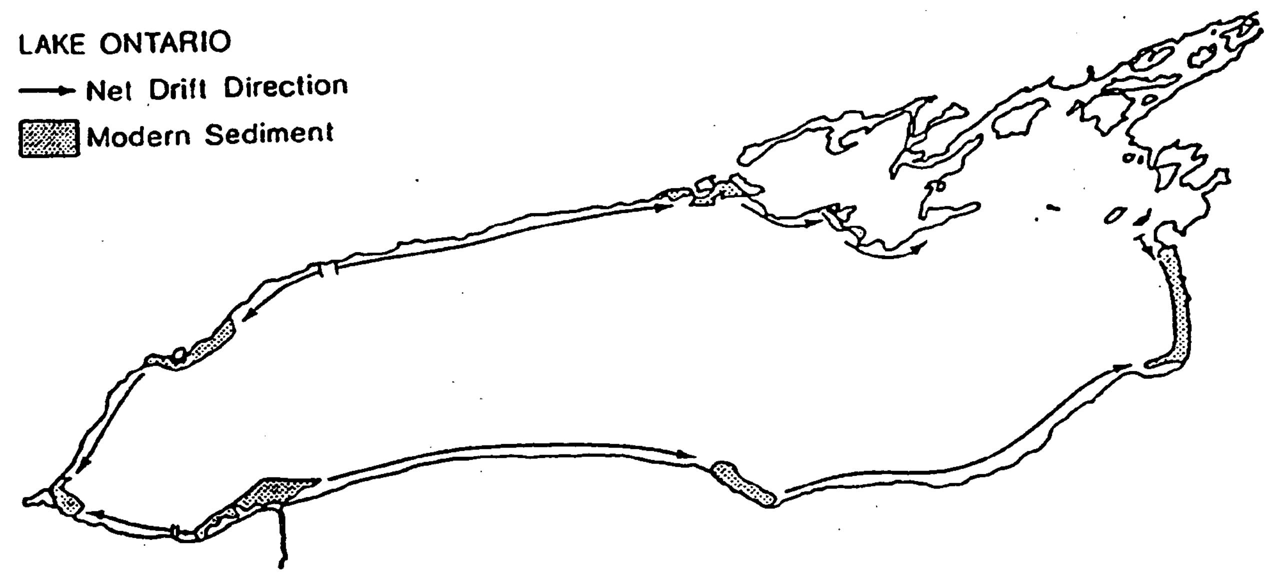



**Figure 5.** Net longshore drift direction, Lake Ontario.

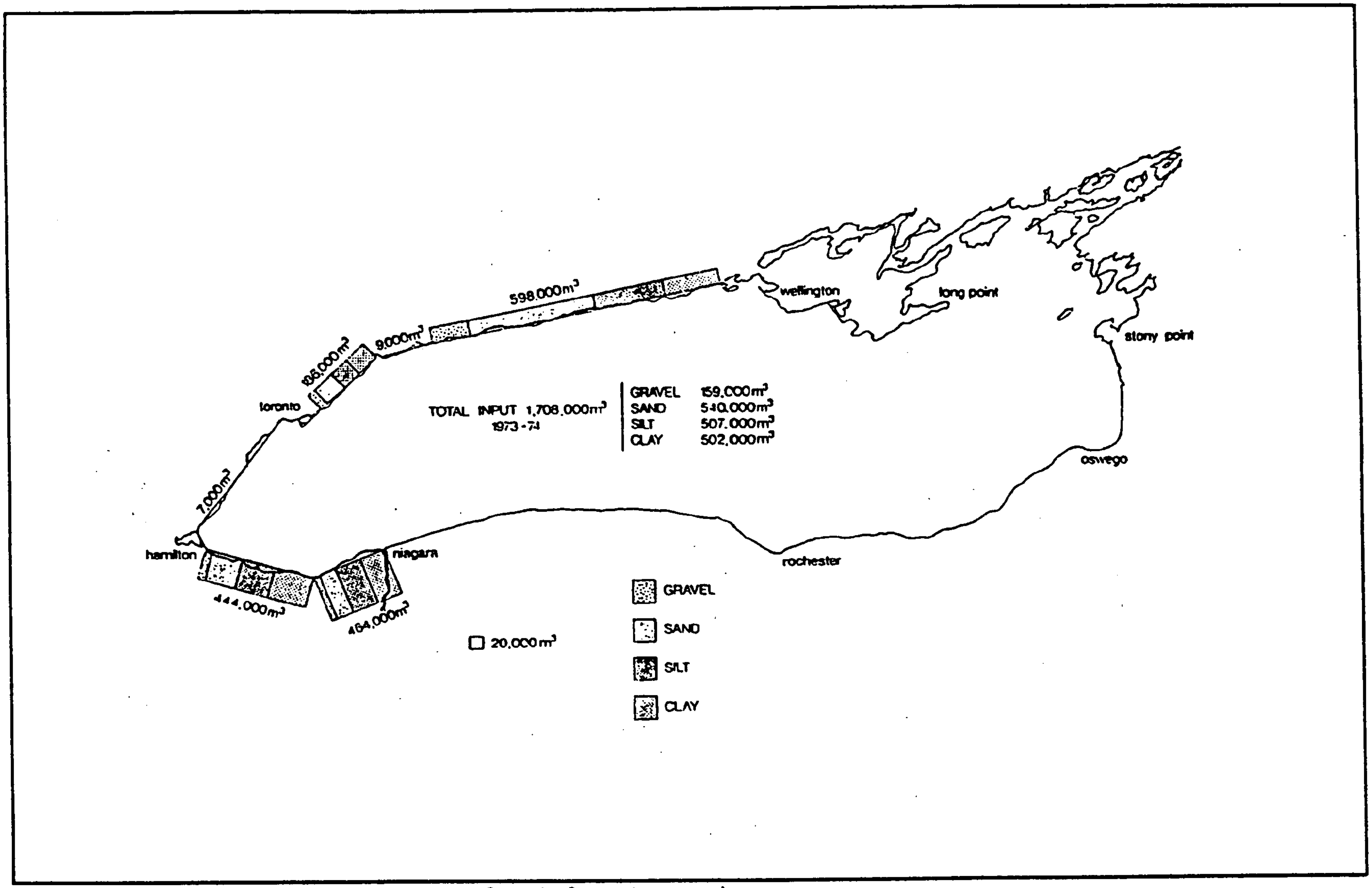



**Figure 6.** Annual sediment input to Lake Ontario from shore erosion.

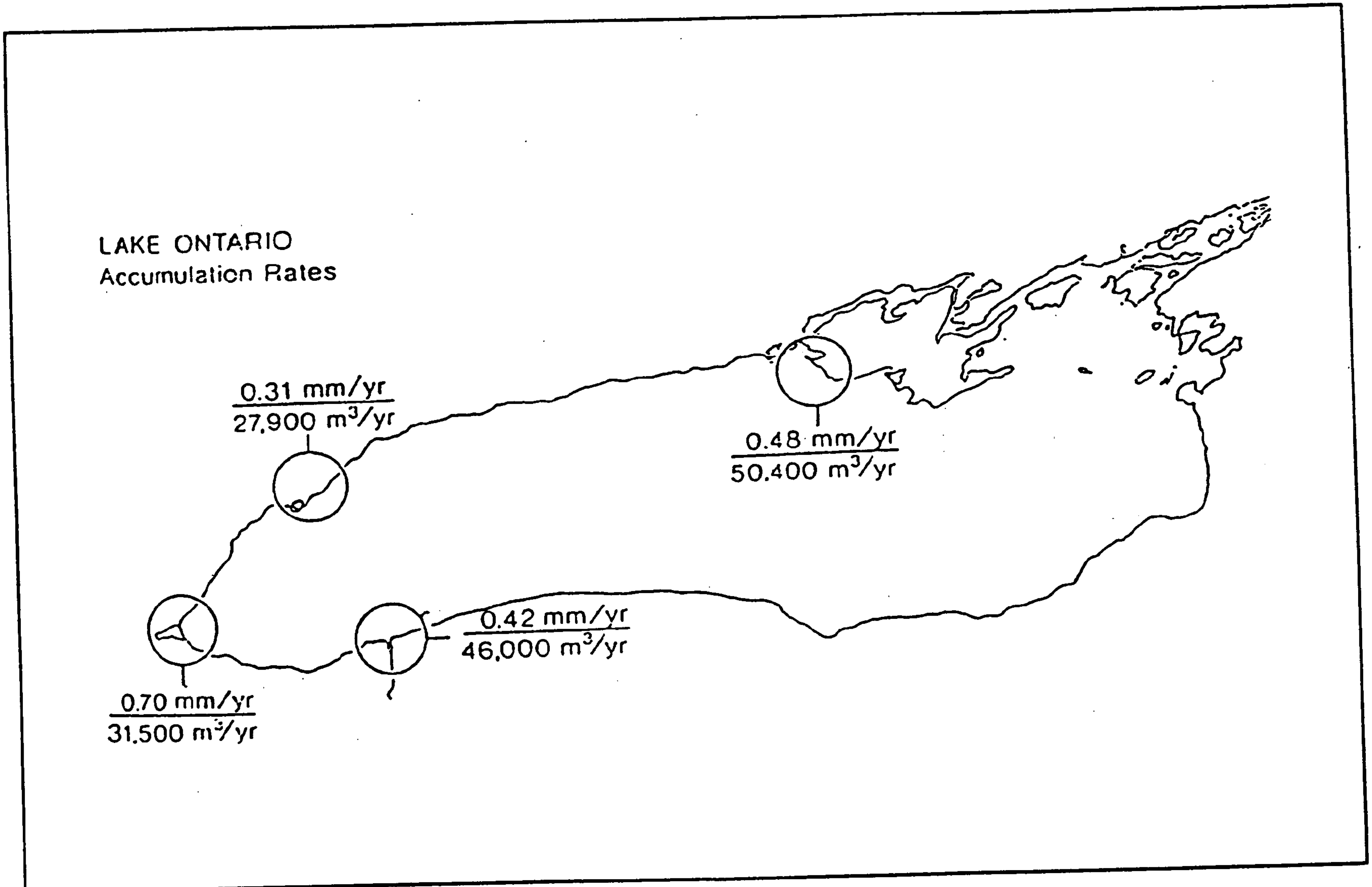



**Figure 7.** **Accumulation rate of Lake Ontario deposits.**

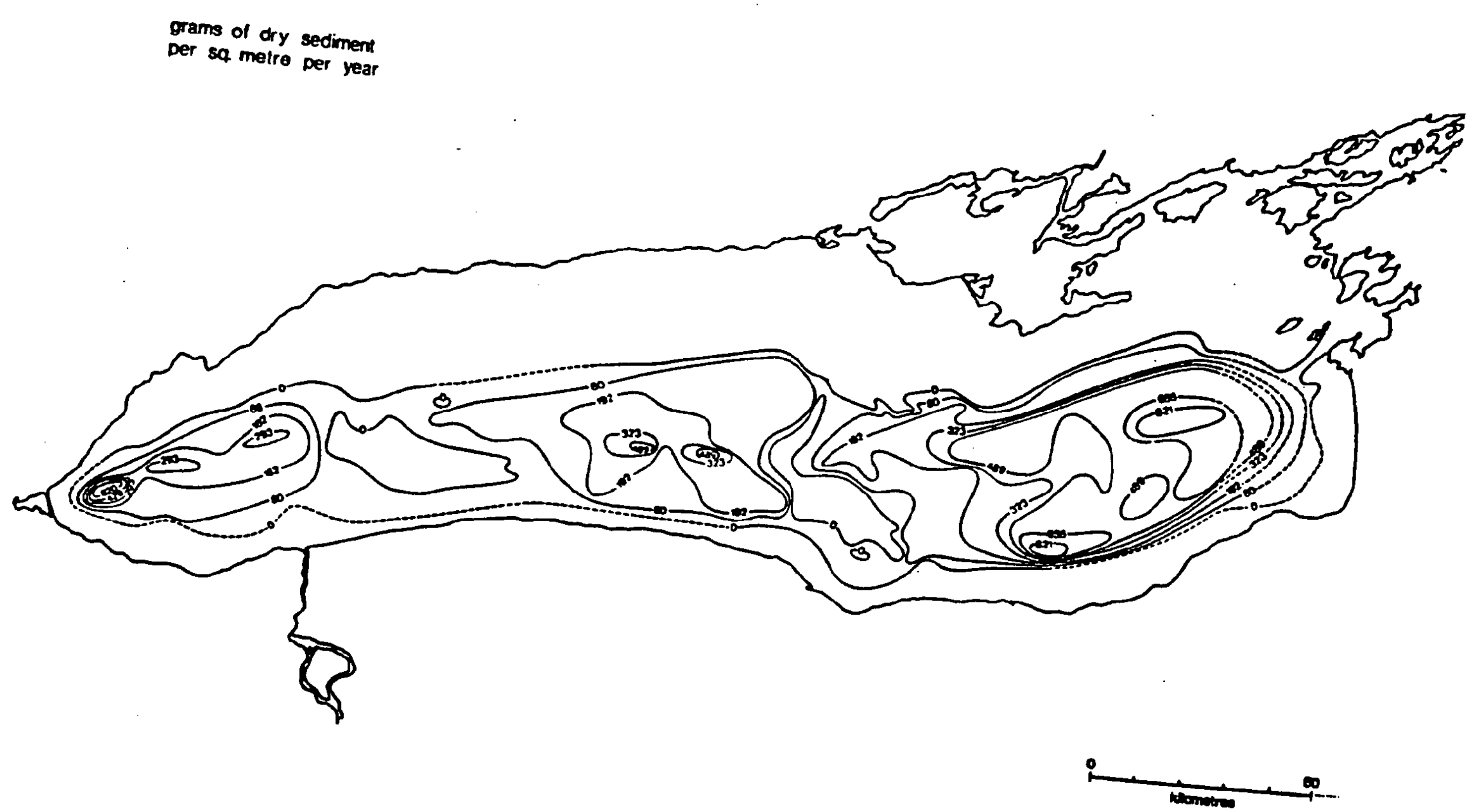



**Figure 8.** Contour diagram showing estimated present day accumulation rates in the basins of Lake Ontario.

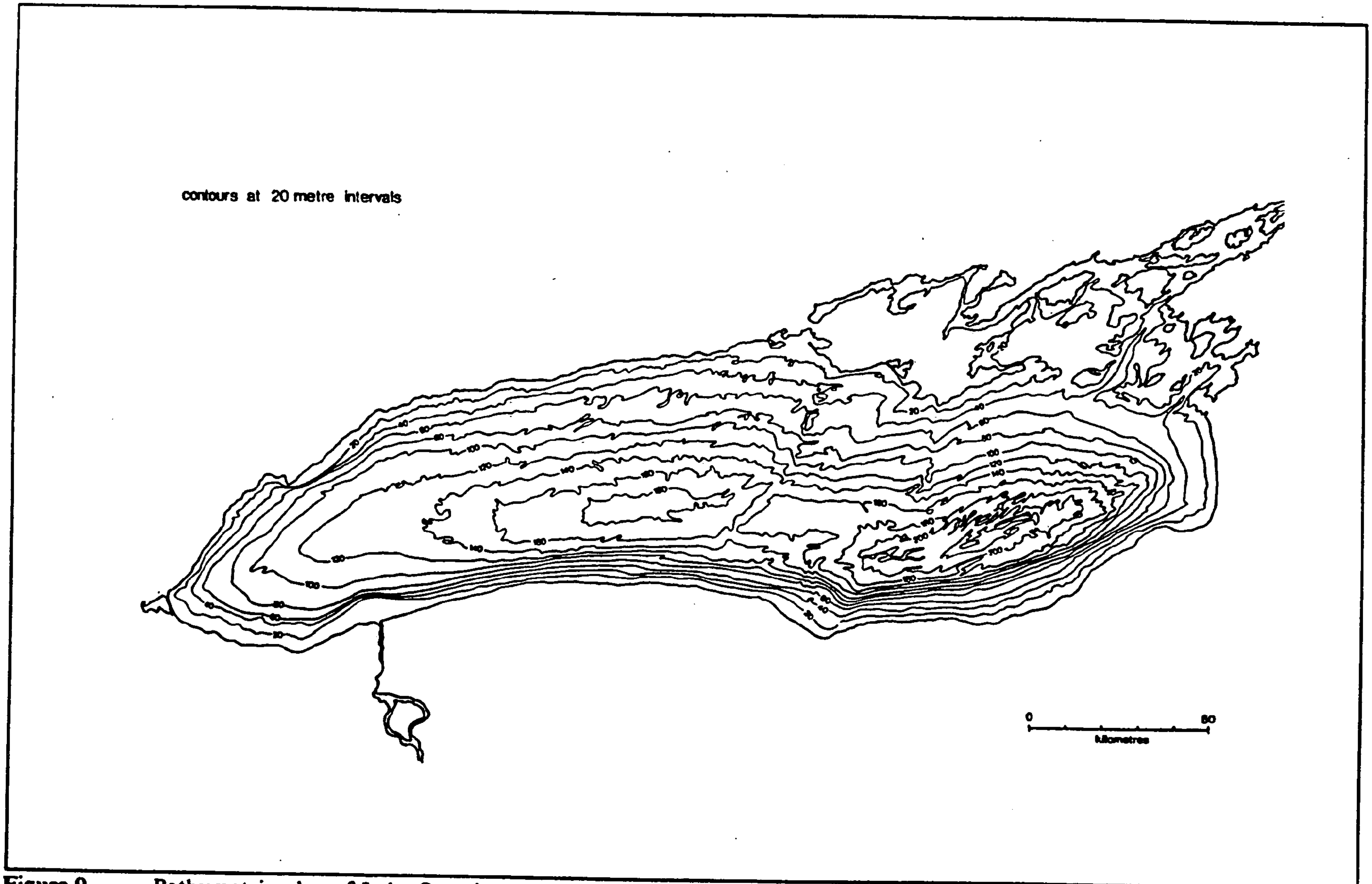



**Figure 9.** Bathymetric plan of Lake Ontario with a 20 m contour interval.

## 4 DEPOSIT CHARACTERISTICS

To select a suitable dredging area and determine the deposit characteristics (ie. gravel and sand content and its suitability for use as construction aggregates), data from previous research were referenced. Although others have indicated the presence of sand and gravel in this area (Rukavina 1976, 1983; Lewis and Sly 1971), it was necessary to positively confirm the extent of the deposit through a comprehensive sampling and analysis program.

A work permit to take samples was obtained from the Ontario Ministry of Natural Resources, and actual on water sampling took place on three occasions during the summer of 1991, for a total of six days. Depending on water conditions and desired sample recovery method, three sampling techniques were used. The following sample recovery equipment was employed:

> Single-Line Clam Bucket
> This device consisted of a heavy walled pipe hinged into a clam bucket configuration, with a cocking mechanism that released upon contact with the bottom to allow retrieval with a single wire cable and electric winch. The clam bucket was especially useful for first samples at a particular site to allow visualization of the bottom conditions.
>
> Vibro-Coring Equipment
> Several pieces of vibrating coring equipment were available for use on this project, including a large mast equipped version for use in rough water conditions. Best performance was achieved using a vibrator with 11,000 vpm coupled to a standard 2 ½" split spoon. However, other cores were taken with 3" aluminum tubes or a special 12' long steel tube fitted with the retainers from the standard split spoon.
>
> Air-Lift Sampler
> Best results for large sample quantities, as well as for determining deposit thickness, were achieved using a 3" aluminum tube extending from bottom to surface. The sampler was fitted with a stainless steel double walled section at the bottom where air from an 85 cfm compressor was injected. The subsequent mixture of sand, air and water exhausted at the top was collected in geotextile lined containers for sub-sampling. Depth of penetration until "choking" or contact with silt/clay layers was recorded in order to determine deposit thickness.

A total of 59 samples were analyzed for gradation, the results of which are contained in Appendix C. Upon completion of the sampling program, it was determined that sites 1, 9, 11 and 12 were less than 1.5 metres thick. These sites were excluded from further consideration for dredging because of concerns regarding elimination or disruption of existing bottom types for fish habitat.

Three separate composite samples of the remaining sites under consideration were made by taking near equal portions of all the remaining samples (except for small split-spoon samples) and mixing them to provide a sample that would approximate the type of cargo that could be retrieved by a trailing suction hopper dredge. Two of these composite samples were sent to independent testing labs to determine the following characteristics and tests, which are essential for fine aggregate use in concrete, asphalt, or winter ice control sand:

- Sieve Analysis
- Petrographic Examination
- Magnesium-Sulphate Soundness Test
- Potential for Alkali Reactivity
- Density (Specific Gravity)
- Absorption
- Attrition Test for Ice Control Sand

The results of these tests are contained in Appendix C, and all indicate that the deposit is suitable for use as fine aggregate in concrete, asphalt, and ice control sand.

The deposit within the licence site contains all of the grain sizes necessary for the aggregate industry. Nevertheless, gradations may differ considerably from the required specifications for various finished sand products, but these differences can be corrected by an on-shore processing plant that will adjust gradation. This facility will also beneficiate the coarser fractions of the sand to provide a premium specification concrete sand product. A summary of commonly specified fine aggregate gradation requirements are depicted in Figure 10.

The dredging area depicted in Figure 3 measures approximately 7.75 km long by 2.0 km wide, and, considering the irregular boundary around the water intake area, it comprises approximately 1,407.1 ha. Assuming an average minimum dredgeable deposit thickness of 2.0 m and a density of 1,919 kg $m^{-3}$ (density of slightly damp sand according to The Consumer's Guide to Construction Aggregates, 1991-92), there are 28,142,000 $m^3$, or 54,004,498 metric tonnes of material in the proposed dredging area; however, this appears to be a very conservative estimate. Evidence suggests that the deposit is substantially thicker than 2.0 m. For example, at C.C.I.W. hole number J069, located between Bedrock's test locations 7 and 8, Rukavina (1983) found deposits 5.25 m thick.

It is anticipated that the entire deposit will never be completely dredged, as dredging would be curtailed in areas as soon as evidence of thinning deposit occurs. This would be apparent as muddy discharge into the hopper of the dredge, thus indicating that the dredge draghead has come in contact with the silt or clay layers underneath the sand deposit. Moreover, the influx of silt/clay particles would contaminate the cargo and impair an otherwise environmentally sound dredging practice. To ensure that adequate deposit thickness remains over the long term duration of this operation, as well as following the completion of operations, a monitoring program will be implemented and will include periodic testing to confirm remaining deposit thickness.

| FINE AGGREGATE GRADATION SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| Sieve | Percentage Passing | | | | | |
| | Concrete Sand | Asphalt Sand HL1 & 3 | HL2 | HL4 & 8 | Masonry Sand | Winter Sand |
| 9.5mm | 100 | 100 | 100 | 100 | | |
| 6.7mm | | | | | | 100 |
| 4.75mm | 95-100 | 90-100 | 85-100 | 85-100 | 100 | 90-100 |
| 2.36mm | 80-100 | 70-100 | 70-90 | 60-100 | 95-100 | 50-95 |
| 1.18mm | 50-85 | 50-90 | 50-75 | 34-90 | 60-100 | 20-90 |
| 600um | 25-60 | 30-70 | 30-55 | 17-70 | 35-80 | 0-70 |
| 300um | 5-30 | 15-40 | 15-35 | 9-40 | 15-50 | 0-35 |
| 150um | 0-10 | 5-15 | 5-15 | 3-15 | 2-15 | 0-15 |
| 75um | 0-3 | 0-5 | 3-8 | 0-7 | 0-5 | 0-5 |
| OPSS Spec | 1002 | 1003 | 1003 | 1003 | 1004 | 1004 |
| CSA Spec | A23.1 | 23.1 | 23.1 | 23.1 | A82.56 | |

Figure 10. Summary of specified fine aggregate gradation requirements.

## 5 PROPOSED DREDGING OPERATIONS

Several different types of vessels and processing plants are used in other parts of the world for bringing marine dredged aggregates to market. Bedrock has monitored activities in this segment of the aggregate business since 1980 by subscribing to various trade magazines for the dredging industry. Research trips to determine the "best available technology" have been made to similar operations as far away as Holland, New Jersey and Ohio in the United States, and to an older Canadian dredge working a sand deposit off the mouth of the Niagara River.

While a vast amount of aggregate dredging occurs in Japan, Holland, and Great Britain, it is relatively rare in North America. Traditionally, there has been ready access to cheap land based deposits near major urban centres. But these reserves are rapidly being depleted, creating a need for alternative sources of quality aggregates. To fulfil this demand, Bedrock proposes an operation which takes advantages of the international experience in sand dredging.

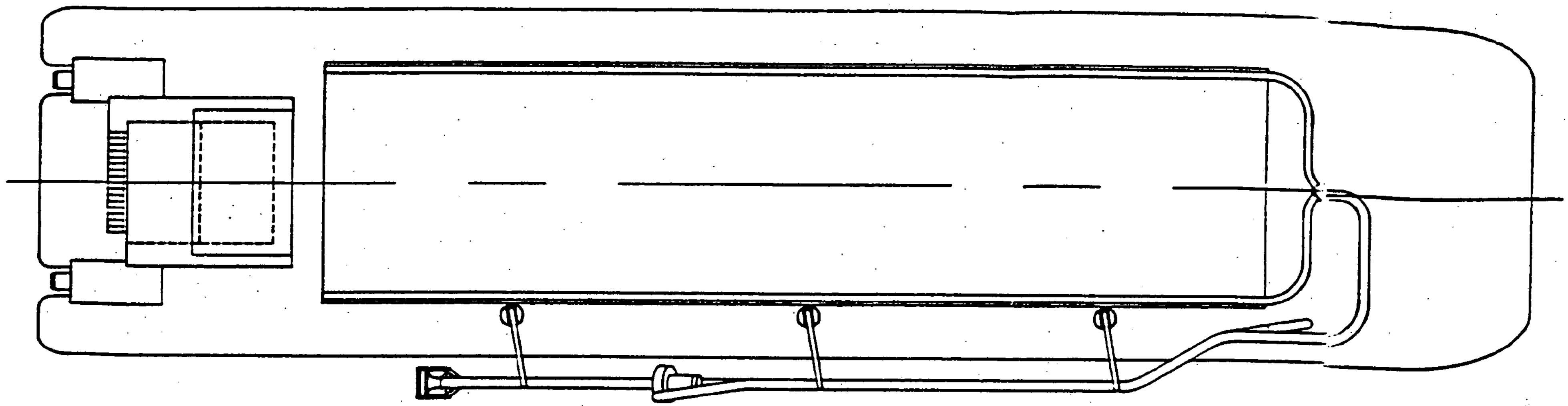
As mentioned, the dredged material will be processed at a shore based facility, which is necessary to achieve the degree of quality control required by today's stringent product specifications. Shore-based processing will reduce dredging time by allowing higher dredge production rates, as adding sand processing equipment to the dredge would reduce load size capabilities on the dredging vessel, and possibly restrict the dredging rate. Shore-based processing will minimize waste because periodically surplus aggregate sizes can be stockpiled and used later when they are required.

### 5.1 Vessel Description

It is proposed that the most practical and economical vessel to begin operations with is a modified conventional hopper barge equipped with a dredging ladder and unloading system, with the barge powered by either a separate tug or stern mounted propulsion units. A preliminary design and the general arrangement of such a vessel is shown in Figure 11. This style of dredge is generally referred to as a "trailing suction hopper dredge".

A professional marine engineering firm will be retained to supervise the configuration and conversion of a vessel; however, it is anticipated to be of the following approximate size and capacity (based on a powered hopper barge designed by the Robt. Allan Naval Architect firm in British Columbia, modified accordingly):

| | | | |
|---|---|---|---|
| Length | 60.0 metres (197') | Speed, Loaded | 13 km/hr (7 kts) |
| Width | 14.4 metres (47.2') | " Light | 16 km/hr (8.6 kts) |
| Depth | 4.5 metres (14.8') | Loading Rate | 375 tonnes/hr |
| Draft, Loaded | 3.6 metres (11.8') | Discharge Rate | 600 tonnes/hr |
| Cargo Capacity | 1,800 tonnes | | |



BEDROCK
RESOURCES INC.
Proposed Hopper Dredge

| | |
|---|---|
| L.O.A. | 60.0 m |
| BEAM | 14.4 m |
| DEPTH | 4.5 m |
| LOADED DRAFT | 3.6 m |
| CAPACITY | 1,800 mt |

(lifelines not shown
for clarity)

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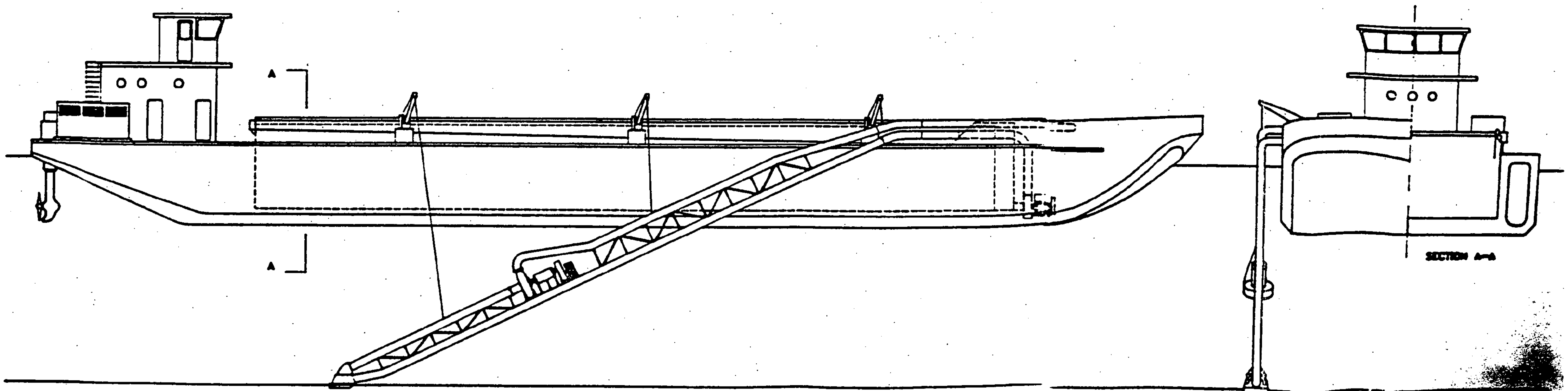


The other vessels currently mining sand in Ontario are a crane equipped barge used in Whitefish Bay, Lake Superior, by the A. B. McLean Company; and a small tanker converted to a stationary dredge (resembling a small freighter) used by McKeil Marine Limited in Lake Ontario. These vessels dredge from a stationary position, excavating large holes wherever they operate. In comparison, a trailing suction hopper dredge resembles a vessel equipped with a vacuum cleaner style draghead that "sweeps" the bottom and constantly moves until the cargo hold is sufficiently filled. This type of vessel leaves the bottom in much the same condition as occurs naturally. This has the advantage of avoiding the creation of deep holes which act as silt traps and disrupt the natural bottom configuration.

Based on research of the best available international technology for dredging in an environmentally protective manner, the following technological advances will be incorporated on the dredge:

- Submerged Dredge Pump:
  Mounting the dredge pump on the dredge ladder, such as seen in Figure 12 (depicting a German designed vessel with a submerged pump (Pohlke, 1974)), increases pumping efficiency and suction capabilities to provide a maximum density of sand/water slurry, optimizing removal of sand particles in suspension as a result of contact with the draghead. Figure 13 shows the flow of water and sand in a typical Dutch draghead with and without jetting water to break up the compacted sand bottom (Koning, 1970).

- Anti-Turbidity Overflow Collection System:
  Traditional hopper dredges allow the hopper to overflow excess water unrestrained over the side of the vessel (creating turbid water conditions near the surface); the proposed dredge will incorporate a system of weirs and channels around the perimeter of the hopper which will collect overflow water and pump it below the thermocline, in the cold water of the hypolimnion. This will minimize surface turbidity and the plume of turbid water by reducing the suspension time of particles present in the overflow water. Figure 14 shows the "Anti-Turbidity Overflow System" developed by researchers at Ishikawajima-Harima Heavy Industries Co., Ltd., Japan (Ofjui & Ishinatsu, 1976). The unique feature of this system is that it removes the majority of the air bubbles entrained in the overflow water, which otherwise hinder the settling of the silt/clay particles present in the overflow.

- Silt/Clay Detection System:
  Grain size analyses indicate that the average proportion of silt and clay in the deposit is below 1%. Nevertheless, as a precaution, areas of silt and clay - if they exist, will be avoided by monitoring the outflow with a turbidity metre or other means of measuring viscosity of a slurry. The monitoring device will be incorporated into the dredge water overflow system to detect the presence of elevated quantities of silt or clay which overflow the hopper instead of settling in the hold. In addition, other monitoring systems will indicate when the hopper is reaching capacity, thereby preventing unnecessary dredging and minimizing the possibility of discharging excess amounts of turbid water.

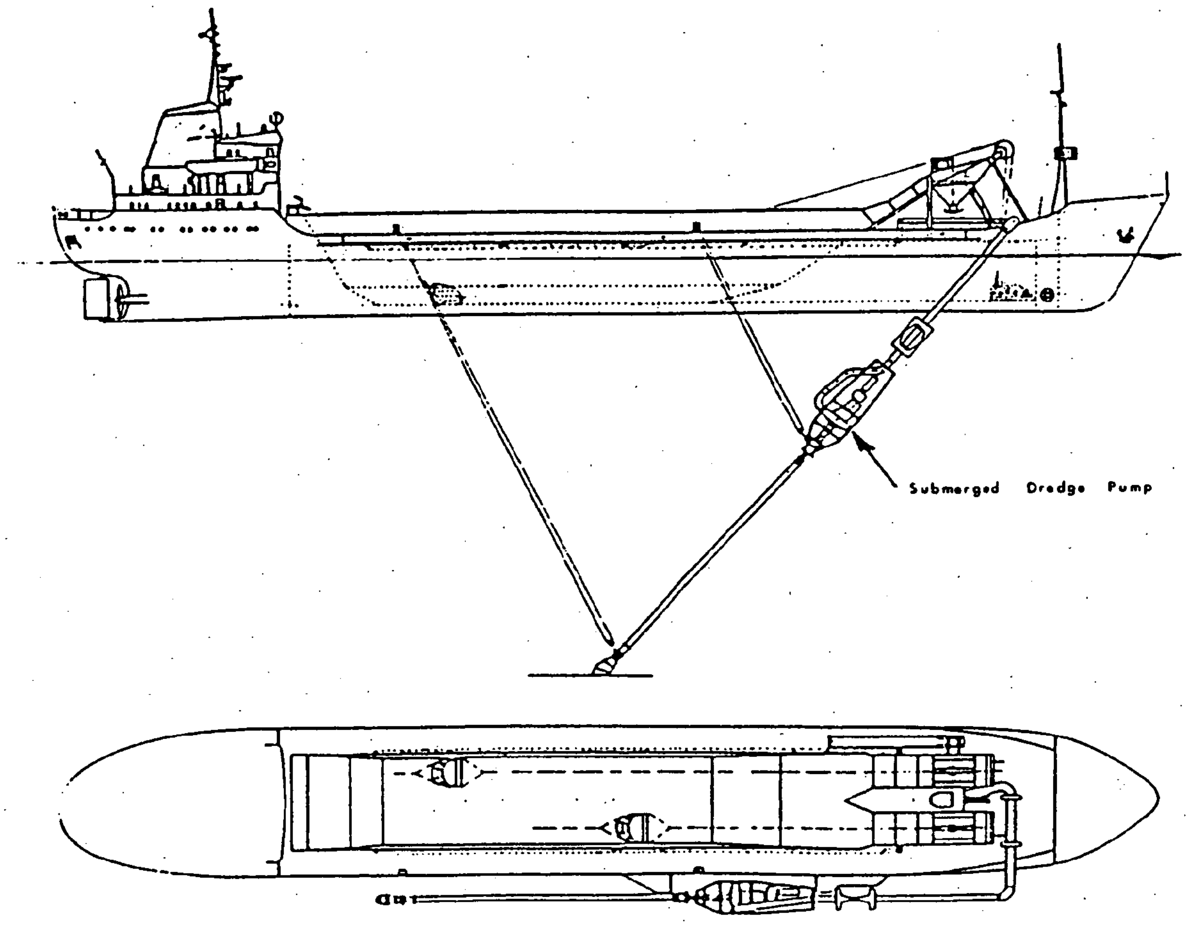



**Figure 12.** German vessel with submerged pump.

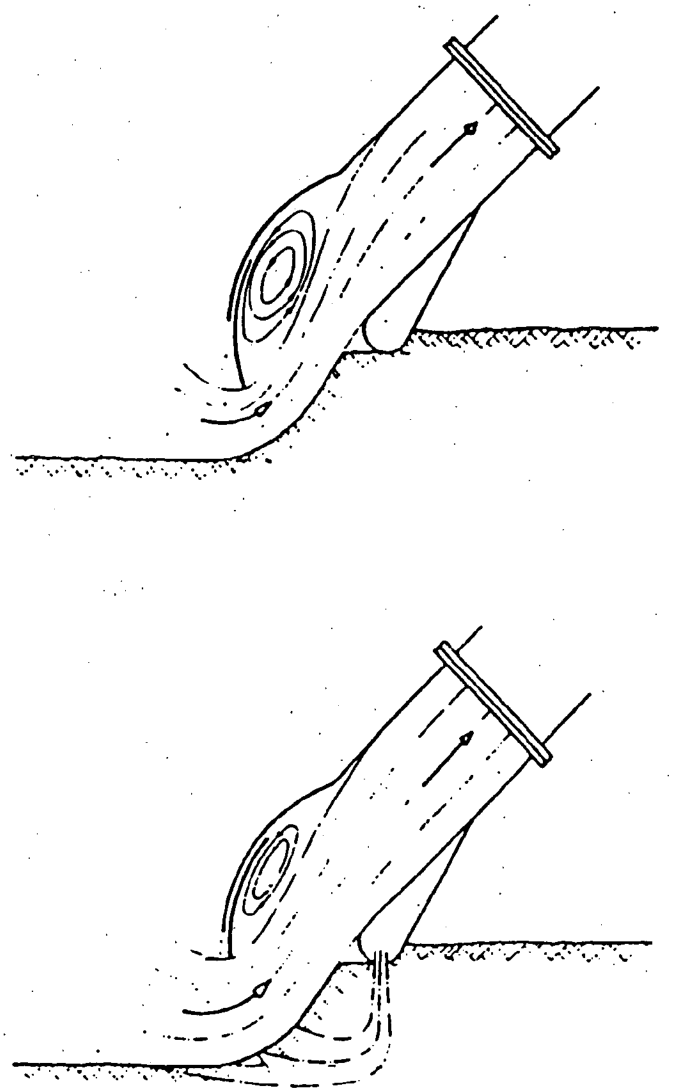



Figure 13. Hydraulic erosion in the entrance of a trailing hopper dredge draghead.

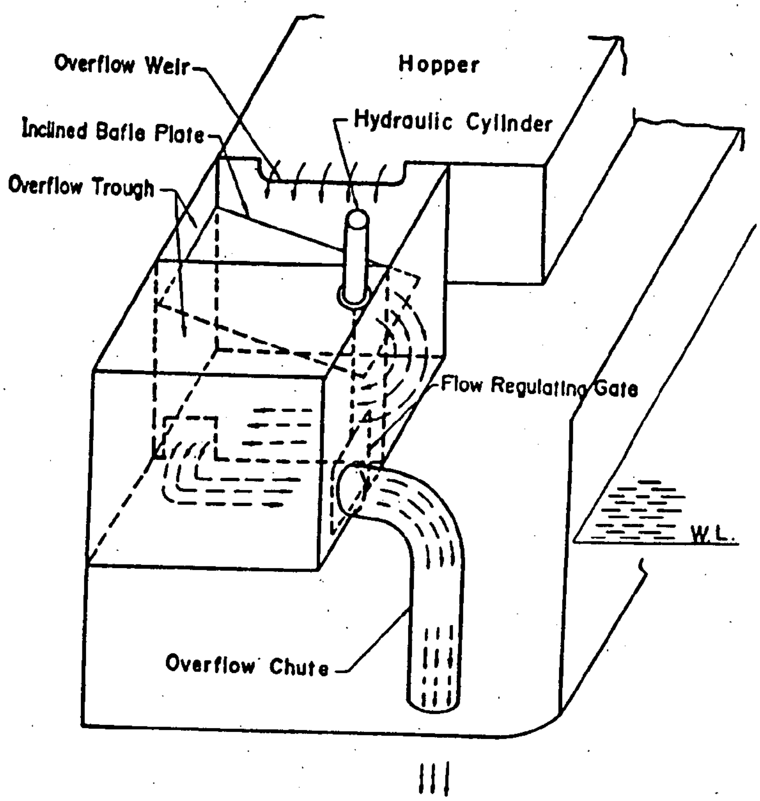



**Figure 14.** Anti-turbidity overflow system.

- **Up-dated Electronics**
  The vessel will incorporate "state-of-the art" electronic systems for monitoring dredge performance. These include doppler flow meters and density measurement systems which will monitor dredging performance and subsequently decrease effects on the bottom through inefficient dredging practices; modern navigation equipment such as GPS will also permit extremely accurate planning of dredging passes.

## 5.2 Annual Production Capabilities

Based on the proposed dredge design, the typical production capabilities of the operation can be predicted with reasonable accuracy. It should be noted, however, that production depends on a variety of factors, particularly:

- travel speed and currents
- cargo size
- load/unload rate
- distance from port to dredge site
- weather conditions and length of season
- downtime for repairs and maintenance.

The distance from a possible dock location in the Ship Channel on the eastern end of Toronto Harbour to the start of a typical dredging cycle is approximately 12.5 km, of which about 7.5 km is in the lake with an estimated average current of 1 km/hr (flowing along shore towards south west). It is projected that a normal season will extend from April 1 to November 30, and that adverse weather conditions will occur 20% of this time. A further reduction of 5% is anticipated for unscheduled repairs and maintenance. Allowances for positioning, turning, and set-up time at the dredge site will reduce dredging efficiency to about 90% of maximum capabilities. Taking all the above variables in to consideration, a typical round trip would be as follows:

| | |
|---|---|
| Travel, light in harbour and entrance<br>5 km @ 6km/hr | .83 hrs |
| Travel, light in lake to typical start of dredging area (ie. western end)<br>7.5 km @ 16 km/hr less current @ 1 km/hr | .50 hrs |
| Loading<br>1,800 tonnes @ 340 tph (90% efficiency)<br>(dredge would travel east through central part of dredge area, then turn to complete cycle near starting area) | 5.29 hrs |
| Travel, loaded from end of dredging area to harbour entrance<br>7.5 km @ 13 km/hr plus current @ 1 km/hr | .54 hrs |

| | |
|---|---|
| Travel, loaded in entrance and harbour<br>5 km @ 5km/hr | 1.00 hrs |
| Docking and set-up to unload | .25 hrs |
| Unload<br>1,800 tonnes @ 600 tph | <u>3.00 hrs</u> |
| Total Cycle Time | <u>11.41 hrs</u> |

An average cycle time of 11.41 hours, (or 11 hours and 25 minutes), would be ideal in the event a second shift is implemented, and would allow crews to spend time at home instead of living on the boat as most seamen do. With unloading left to the shore based workers, boat crews will enjoy a nine hour work day.

The days available in a typical dredging season are as follows:

| | |
|---|---|
| Dredging Season, April 1 to November 30, dredging scheduled 6 days/week, less holidays,total number of days available (1991 calendar) | 205 |
| Inclement Weather, less 20% | -41 |
| Unscheduled Downtime, less 5% | <u>-10</u> |
| Projected Dredging Days | <u>154</u> |

Based on the dredge capacity projections and with initial operations on a single shift, annual production for 154 trips would be approximately 277,200 tonnes, and with a double shift operation this would increase to about 554,400 tonnes landed annually. These figures are a practical tonnage to expect to market in the first years of the operation, and it is expected that production requirements may approach 1,000,000 tonnes annually by the year 2000. The present application is, however, an initial period of 5 years during which no more than a double shift will be employed. Additional equipment and manpower would be added to achieve such production levels.

= 4 units } = 2 shifts x 2 boats }

The annual demand for concrete, asphalt, masonry, and ice control sand in the Toronto area is much greater than the initially predicted production capabilities. Other markets exist in such areas as Hamilton and the Niagara area where suitable dock facilities are in place; however, the primary marketing emphasis is on supplying customers immediately adjacent to the Toronto docks area.

### 5.3 Effects of Dredging On Deposit

Using the conservative estimate of 54,004,498 tonnes of aggregate available for extraction, the deposit will last almost 195 years at the single shift production rate, about 97.5 years if double shift rates are introduced, and 54 years if long term production averaged a million tonnes per year.

The extremely long deposit life will allow for a continued study of the effects of dredging, as only a very small percentage of the deposit will be extracted in any particular year. Given the proposed dredging practices and the large size of the deposit, the bottom substrate will not change appreciably from year to year and will remain capable of maintaining the fish populations that it currently supports.

Another way to assess the impact of dredging on the deposit is to compare the annual dredging activity on the area of the deposit. The draghead to be used on the end of the suction ladder will excavate a shallow trench as the dredge moves forward while loading. If the draghead cut a "swath" that averaged 1.00 m wide (3.28 feet) by 15 cm deep (5.9 inches), the length of the dredge passages required to fill the hold would be as follows:

Cargo size conversion to volume:

$$\frac{1{,}800\,tonnes}{1.9\,tonnes\ m^{3}}$$

Cargo volume divided by cross section area of swath, 1.0 x .15 metres:

$$\frac{947.4m^{3}}{0.15m^{2}}$$

Length of Dredge Passes multiplied by approximate width of swath:

$$6.316m\ x\ 1.0m$$

Area of Dredge Passes per Load:

$$6{,}316\ m^{2}$$

In the event that no two dredge passes overlapped, the area annually effected by dredging would be 6,316 $m^2$ times 154 trips, or 972,664 $m^2$ (97.27 ha, or approximately one square kilometre). The bottom area dredged each year would be less than 7% of the total dredging area at single shift production rates.

The effect of extraction could also be compared to lowering the entire licensed area by the volume of sand dredged, assuming that over a long period of time waves, currents and multiple dredge passes will gradually level out any undulations in the lake bottom that are the result of dredging. Dividing the annual single shift production of approximately 145,900 $m^3$ by the area of the deposit, 14,071,000 $m^2$, indicates that the deposit would be lowered an average of .010 metres annually, or 1 centimetre (.35 inches). This figure agrees with the calculation predicting 195 years of reserves for single shift operations, assuming an average dredgeable deposit thickness of 2.0 metres.

Fish habitat will be protected since the existing bottom configuration and sediment quality will be maintained, a sound environmental consideration. It also makes practical economic sense for the dredging operation. It would not be good dredging practice to extract all the sand to expose the underlying silts or clays, as this would unnecessarily contaminate the cargo, as well as being environmentally unsound. Careful planning of extraction sequences and patterns will ensure that sandy bottom conditions, similar to what currently exist, will remain throughout and after the life of the dredging project.

It is important to place the amount of material proposed for dredging in context with the scope of other dredging activities around the Great Lakes, which is much more extensive than the public is generally aware of. Sly (1977) indicated that average annual Great Lakes maintenance dredging quantities in 1975 were about 8,942,000 $m^3$, with an additional 1,062,000 $m^3$ (10.6% of total) extracted as resource recovery dredging. Further analysis shows Lake Ontario with 1,832,000 $m^3$ dredged for maintenance purposes in 1975, with an additional 99,000 $m^3$ of construction sand dredged off the Niagara Bar area.

The main reasons for the extent of the dredging activity include:

- maintenance or improvement of navigable waterways and harbours
- removal of undesirable material (ie. pollutants, debris, etc.)
- extraction of sand and gravel aggregates for use as construction materials, beach nourishment, land reclamation, etc.

Figure 15 shows the extent of annual dredging activity in the Great Lakes.

## 5.4 Shore-Based Operations

When the dredge arrives in port, the cargo will be discharged on to a shore based stacking conveyor system, which will build a surge pile of sand to feed to a "state of the art" sand and gravel processing plant. Crushers are not anticipated in the system due to the very low stone content of the raw material. The plant will blend fine and coarse sands from the surge pile into specification products by first screening to a proper top size, upgrading the coarse fractions through a beneficiation circuit, and then adjusting gradations in a computer controlled sand classifying tank. The finished products will be stockpiled by conveyor for loadout by front end loader to either trucks or barges. All the aggregate that is brought to port can be utilized without waste.

Several sites are available for shore based operations along the Toronto Harbour Ship Channel (Figure 16). Also shown in Figure 16 are the locations of major concrete sand

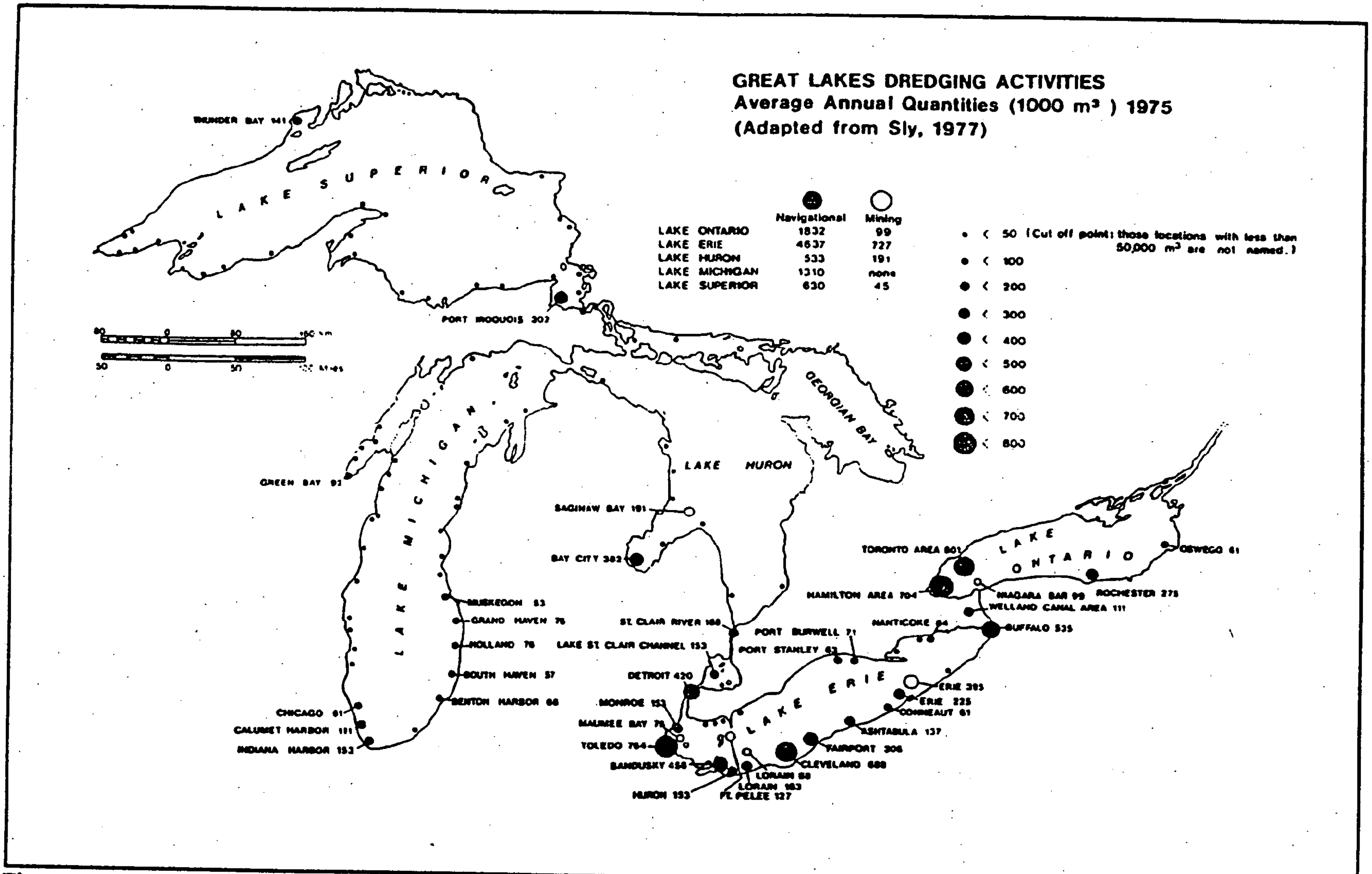
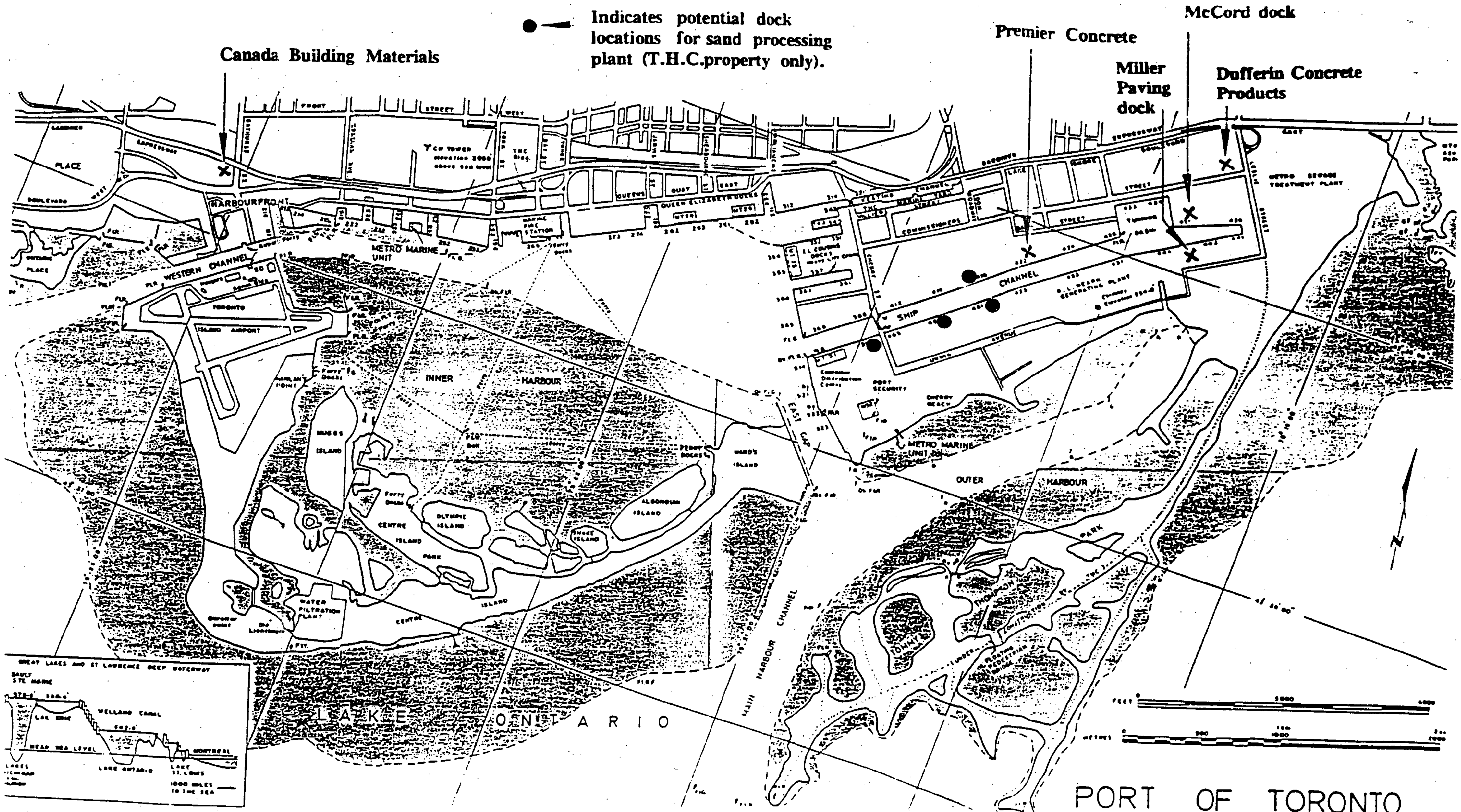



**Figure 15.** Great Lakes dredging activities.



Indicates potential dock locations for sand processing plant (T.H.C.property only).
Canada Building Materials
Premier Concrete
McCord dock
Miller Paving dock
Dufferin Concrete Products
HARBOURFRONT
WESTERN CHANNEL
TORONTO ISLAND AIRPORT
METRO MARINE UNIT
INNER HARBOUR
SHIP CHANNEL
OUTER HARBOUR
EAST GAP
MAIN HARBOUR CHANNEL
CENTRE ISLAND PARK
WATER FILTRATION PLANT
L A K E O N T A R I O
PORT OF TORONTO

customers in the immediate vicinity of the harbour. Figures 17a, and 17b, are from the Port of Toronto News, Vol. 36, No. 5, 1989, and they show the growing importance of aggregates to the harbour traffic volume, as well as the historical significance of the building materials trade. Figure 18 is a reprint of an article from the Daily Commercial News (1989) reporting that the Royal Commission on the future of the Toronto waterfront is also encouraging the port to be used more extensively for the handling of construction materials.

Truck traffic to the harbour area can be greatly reduced by the success of this project, since bringing a minimum of 277,200 tonnes into port by barge would eliminate over 9,000 truck loads of material annually from the highway system leading downtown. Over 30,000 truck loads annually would be removed from the highway system when operations achieve 1,000,000 tonnes annually as projected. Short haul delivery truck activity could be reduced by shipping and storing sand in barges at customer locations that are on the waterfront. Water for sand processing will be obtained from the harbour, and will be recycled and clarified to prevent the discharge of silt particles into the harbour.

The type of shore based operations required will fit in well with the heavy industrial neighbours currently occupying the adjoining sites, and, moreover, will actually make an aesthetic improvement to the area.

## 6 CONCLUSION

Bedrock Resources, Inc. is a strong, solid firm with over a decade of experience in the aggregate business. We are applying for an initial 5 year permit to dredge sand in an environmentally responsible manner, using state of the art technology from a large deposit which is 1.5 to 4 km offshore the eastern end of Toronto. This would provide an alternative source of building sand to that currently being extracted from land based deposits in the Oak Ridges Moraine and the Niagara Escarpment, with advantages of reduced environmental consequences. Our consultants have worked closely with us to design the dredging system we have described using techniques developed around the world to minimize impacts to the environment. They have investigated the environmental impacts posed by this project (see appended reports) and found them to be mitigable. We feel this is an appropriate project to be located in the Port of Toronto Waterfront.