LAKE ONTARIO SHORELINE MANAGEMENT PLAN

Submitted to the

Central Lake Ontario Conservation Authority
Ganaraska Region Conservation Authority
Lower Trent Region Conservation Authority

By
Sandwell Swan Wooster Inc.
in association with
Beak Consultants Limited and EDA Collaborative

December 1990

EXECUTIVE SUMMARY

A shoreline management plan has been completed for the Central Lake Ontario, Ganaraska and Lower Trent Conservation Authorities.

In preparing the plan, all existing data sources were reviewed, new material was prepared and the site was visited on a number of occasions. More specifically this included

- an overflight of the study area at which time the shoreline was recorded on video,
- an inventory of shoreline structures by boat with accompanying photography,
- a review of all available information relating to shoreline structures, erosion monitoring stations, coastal processes, environmentally sensitive areas, land use and bluff composition,
- refraction and shoaling analysis for the entire shoreline,
- sediment budget calculations including calculation of potential transport rates and actual bluff and stream inputs,
- division of the shoreline into littoral cells, subcells and reaches,
- calculation of the 100 year flood and erosion setbacks,
- development of shore protection concept designs for the shoreline.

The results of the study have been summarized in report form with two sets of accompanying maps at 1:10000 scale which cover the entire study area. The mapping identifies

- land uses,
- erosion set-back limits,
- 100 year flood line,
- environmentally sensitive areas,
- shoreline structures with photograph cross references,
- geological shoreline types,
- erosion rates,
- sediment characteristics,
- damage centres,
- erosion monitoring stations,
- littoral subcells and reaches.

This information was prepared on AutoCAD and is available in both hard copy and disk format. It is suggested that the mapping may be updated on a continual basis as new information becomes available.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

In April 1986, a Shoreline Management Review Committee was appointed to study the long-term management of the Great Lakes shoreline. Over 1,500 people attended 20 meetings and provided 400 briefs, oral reports, etc. on shoreline management issues.

The review committee reported that hazard land construction had increased by approximately 40 percent, in the ten years following the last high water period during the 1970's, in 20 Southern Ontario municipalities. It subsequently identified prevention of future development in hazardous areas as the highest priority for shoreline management. The Committee also concluded that certain areas are in need of shoreline protection and that these areas must be identified and shore protection planned on a shore zone, shore reach and littoral cell basis.

Following a submission of this report to the ministers of Municipal Affairs and Natural Resources, in October 1986, the following announcements were made regarding government actions in response to the Committee recommendations:

a) Conservation Authorities were designated as the agencies responsible for the implementation and administration of the shoreline policies emanating from the Ministry of Natural Resources, Flooding and Erosion Hazard Policies.

b) Mapping should be undertaken to identify shoreline hazard areas (to be completed as a part of the Canada - Ontario , Flood Damage Reduction Program, FDRP).

c) Conservation Authorities should oversee the mapping, and shoreline management plans.

1.0 INTRODUCTION (Cont'd)

The first priority of the Conservation Authorities, resulting from these developments was therefore deemed to be the preparation of long-term Shoreline Management Plans. To this end the Central Lake Ontario Conservation Authority (CLOCA), the Ganaraska Region Conservation Authority (GRCA) and the Lower Trent Region Conservation Authority (LTRCA) are jointly undertaking a shoreline management study of their Lake Ontario Shoreline (Figure 1.1). For this purpose, Sandwell Swan Wooster Inc. (SSW), in association with Beak Consultants Limited (Beak) and EDA Collaborative (EDA), have been contracted to develop a comprehensive shoreline management plan which may be used by the Authority in the implementation of long-term development objectives, and as an aid in setting the extent and timing of shore protection strategies. This plan is expected to also address the impact of any shore protection strategies on areas of special interest and/or environmentally sensitive areas.

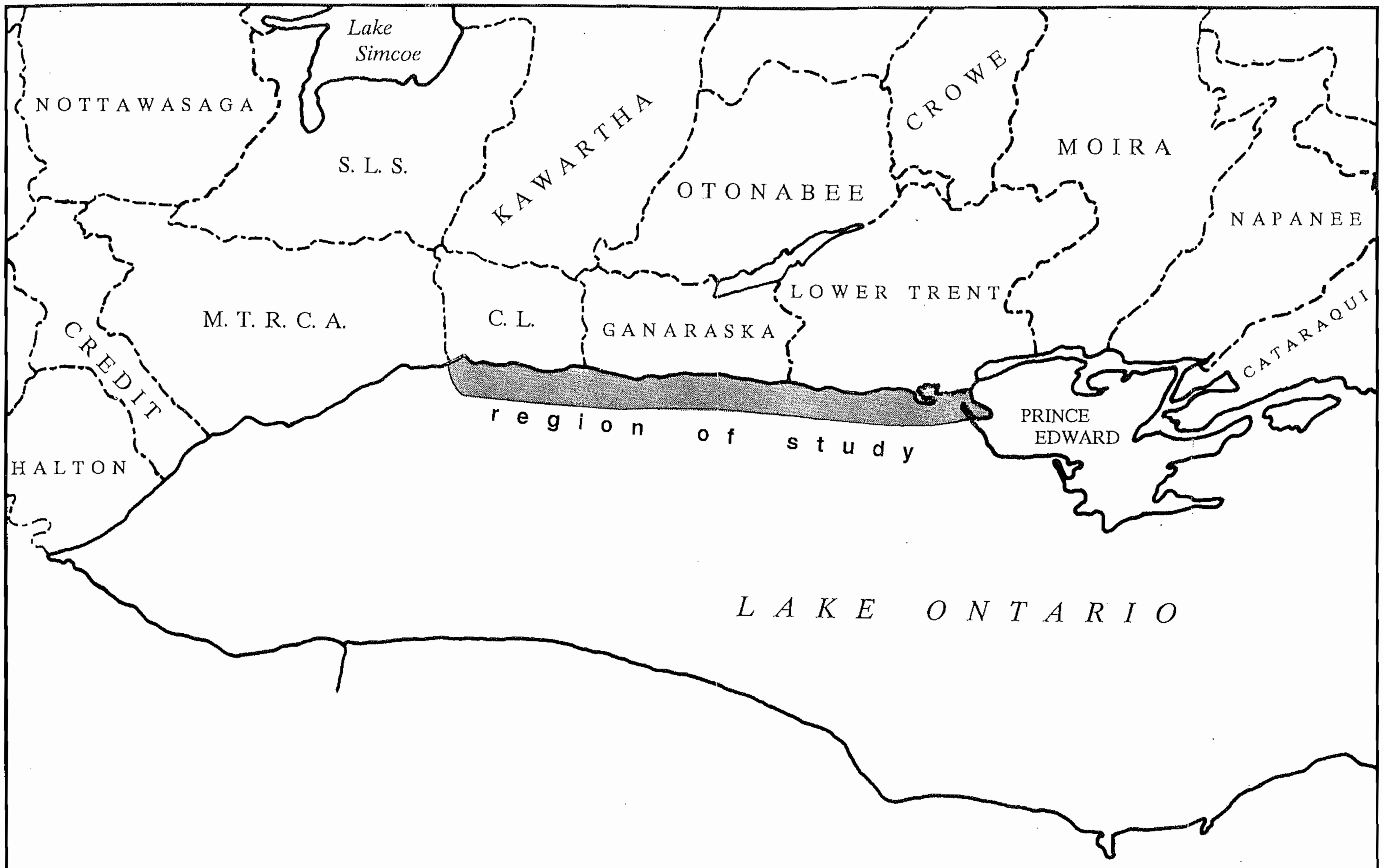


Fig. 1.1 Conservation Regions on Lake Ontario

2.0 THE STUDY AREA

2.1 Definition

The project shoreline is approximately 135 km in length and extends from close to the Whitby and Ajax border in the west to the eastern limit of Brighton Bay in the east (see Figure 1.1). The landward and lakeward limits are generally 500 m and to the 6 m contour, respectively, although all areas of special interest (such as marshes) have been included in their entirety within the study area.

2.2 Bedrock Geology

The bedrocks of southern Ontario rest upon Precambrian rocks, which are among the oldest beds to contain petrified remains of plants and animals. The great thickness of these beds, essentially shale and limestone in the study area, suggests prolonged periods of inundating during which time organic remains fell to the ocean floor and were cemented under the pressure of the overlying strata, forming solid rock. This part of the continent subsequently rose above sea level, thereby exposing the rocks to weathering and erosion. The nature of bedrock geology within the study area is variable in rock type (although generally limestone and shale) and areal and topographic extent.

2.3 Surficial Geology and Physiography

The surficial geology and physiographic structure of the study area is largely a result of the glacial and glaciofluvial processes occurring approximately 12,000 years before present (B.P) i.e., the Wisconsin glaciation.

During the gradual ablation of the Laurentide phase of the Wisconsin glaciation, ice flowed along both north-south and east-west lines through much of the Ontario basin. Ablation by melting and stagnation, characterized by periods of rapid wastage alternating with episodes of increased flow, caused the active ice terminus to recede in a general north-eastward direction.

Final retreat of the ice mass from this region was succeeded by a major ponding of waters in the Lake Ontario Basin resulting in the creation of post-glacial Lake Iroquois (12,500 to 12,400 years B.P.). Consequent with the complete wasting of the

2.0 THE STUDY AREA (Cont'd)

Laurentide ice sheet in southeastern Ontario was the drainage and lowering of this post-glacial lake (12,400 to 11,800 years B.P.). The Lake Ontario Basin subsequently refilled and early Lake Ontario reached its present shoreline limits in the study area about 10,000 years B.P.

The dominant physical processes shaping the area in the post-glacial era have largely been fluvial in nature. The erosive action of the surface drainage and the resultant displacement and deposition of materials have shaped much of the area since the recession of the Wisconsin ice and glacial Lake Iroquois.

Four major and distinctive physiographic features resulted from the glacial processes:

- the interlobate moraine,
- the till plain slopes,
- the Lake Iroquois beach, and
- the lacustrine plain.

These four features are depicted in profile form in Figure 2.1. Note that the Lake Iroquois beach and the lacustrine plain lie within the study area. Within these four physiographic divisions, eleven (11) individual landforms are common through the area (note that most are present beyond the 500 m landward limit of the shoreline). These are:

- the Oak Ridges Interlobate Moraine,
- buried glaciofluvial materials,
- till plains,
- modified till plains,
- drumlins,
- glaciolacustrine beaches,
- glaciolacustrine bars,
- glaciolacustrine plains,
- outwash areas,
- bottomlands (i.e., floodplains), and
- wetlands.

2.0 THE STUDY AREA (Cont'd)

2.4 Soils, Shoreline and Bluff Types

Soils within the general study area are differentiated regionally and locally by the Pleistocene geological surface materials and the hydrologic macro- and micro-climatic variations within the area.

Boyd (1981) characterized the study area shoreline into three main categories. From the Scarborough Bluffs to Raby Head, the shoreline consists of glacial till bluffs (low to moderate in height) with sand collecting in embayments and updrift of man-made structures, to form pockets of beaches. The erosion rates of the shoreline within this area are generally low and tend to be dominated by wave-induced toe erosion. Evidence points to the fact that in some areas, the glacial boulders which once primarily protected the shoreline, were removed by man, thus removing some of the natural protection.

Between Raby Head and Port Hope, high glacial bluffs dominate the shoreline. A complex stratigraphy is in evidence here, and this leads to the occurrence of massive upper slope failures resulting primarily from the piping of groundwater through sand layers in the bluffs. Because of the predominance of these upper slope failures, many "trouble spots" are to be seen in this area. For this section of shoreline upper slope failures appear to be of equal importance to wave induced toe erosion.

From Port Hope to Brighton Bay, the shoreline once again is characterized by lower bluffs and plains, and extensive beach deposits are to be found at Presqu'ile (although relict in nature). Some beaches are also to be found at harbour entrances (Port Hope, Cobourg) and at the mouths of creeks.

2.5 Forest Resources

The characteristic forest association, common to the general region, is sugar maple, beech, basswood, white ash, yellow birch, red oak and black cherry. Soft maple, white cedar, black ash and red ash are commonly found (locally) in swampy areas, while disturbed sites are generally host to pioneering species such as trembling aspen, balsam, poplar, white birch and pin cherry.

2.0 THE STUDY AREA (Cont'd)

Much of the study area has become settled, so that the natural forest has been reduced substantially. Only localized, scattered woodlots remain. The most common species within the study area are:

- hemlock,
- black ash/soft maple,
- hard maple/beech, and
- white cedar.

2.6 Land Uses

In terms of land use, the shoreline within the study area consists largely of agricultural lands. Dotting this backdrop are pockets of development located close to long established towns and major urban areas such as Whitby, Oshawa, Bowmanville, Port Hope, Cobourg and Brighton. It is expected that over the next decade there will be a significant increase in the development of this shoreline as a result of population pressures.

Many special land use areas are found within the shoreline study area, including a nuclear generating station, industrial users, a nuclear waste disposal site, harbours, marinas, parks and recreational areas. In addition, there are many environmentally sensitive areas. This includes a number of major marshes and the mouths of major cold-water streams. These are addressed in Section 9, and detailed land use mapping for the entire project shoreline have been prepared to a 1:10,000 scale, and are presented in Appendix D.

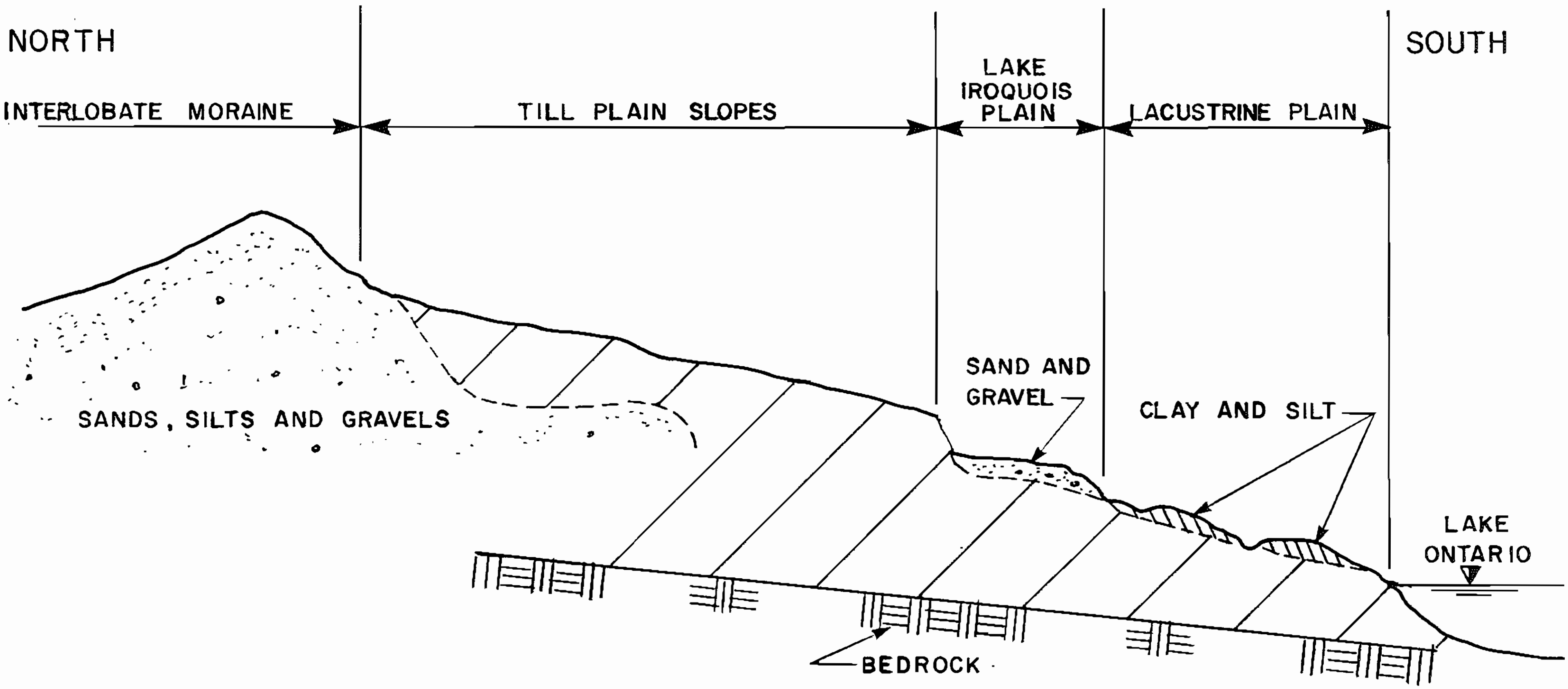


Fig. 2.1 Cross-Section of Physiographic Units

3.0 STUDY OBJECTIVES

The overall objective of this study has been the development of a comprehensive shoreline management plan which will be used by the Conservation Authorities in the implementation of long-term development objectives, and as an aid in setting the extent and timing of shore protection strategies.

The specific objectives of the study are:

a) To establish a program for the prevention of flooding and erosion damages and the protection of existing development from flooding and erosion.

b) To evaluate hazard areas, investigate littoral processes, and to identify and assess potential damage centres and protection strategies along the shoreline.

c) To provide background information useful to planning authorities in developing waterfront plans.

d) To assess the characteristics of the shoreline including sensitive areas, recreational opportunities, wildlife habitat and the Lake Ontario fishery in terms of potential use or preservation of these resources.

e) To determine the optimum management strategy for the shoreline in terms of flood and erosion mitigation and other resource management concerns.

f) To identify the role of Conservation Authorities and that of other relevant agencies in managing the shoreline.

4.0 RESOURCE MATERIAL

A wide range of resource materials were reviewed and incorporated into the study. Much of this information has been condensed and is presented on the mapping (Appendices C & D)

4.1 Shoreline Structures Inventory

- shoreline inventory flight video
- MNR Lindsay files
- MNR Napanee files
- photographs and commentary recorded during boat inspection of shoreline
- LTRCA, 1985. Lake Ontario Shoreline Erosion and Wetlands Inventory
- MNR, Lindsay, 1983. Lake Ontario Shoreline Study - Hope, Hamilton, Haldimand
- MNR Lindsay, 1983. Lake Ontario Shoreline Study - Whitby, Oshawa, Darlington, Clarke

4.2 Coastal Processes

Canadian Hydrographic Charts

2058	Cobourg to Oshawa
2061	Scotch Bonnet Island to Cobourg
2062	Oshawa to Toronto

Field Sheets

8195	Cobourg Harbour Approaches
8375	Brighton Harbour
893	Peter Point to Presqu'ile
3526	Approaches to Presqu'ile Bay
297A	Approaches to Oshawa
306	Presqu'ile Bay
8189	Whitby Harbour Approaches
8191	Oshawa Harbour Approaches
297	Port Whitby to Toronto
296	Port Hope to Oshawa
8193	Port Hope Harbour Approaches
294	Presqu'ile to Port Hope

4.0 **RESOURCE MATERIAL (Cont'd)**

Environment Canada/MNR, 1973. Great Lakes Shore Damage Survey - Coastal Zone Atlas.
MNR, 1988. Wave Hindcast Database for Lake Ontario.
MNR, 1988. Littoral Cell Definition and Sediment Budget for Ontario's Great Lakes
MTRCA. Shoreline Management Program
McColl, 1989. LTRCA Shoreline Management Plan.
Kilborn, 1977. GRCA Report on Port Hope Shorefront Rehabilitation Study.
MNR, 1985-1986. Technical Advisory Service Reports
SSW, 1987. MNR Darlington Provincial Park Shoreline Protection/Stabilization Study.
PACEL, 1988. Lakeview Park - Beach Development, City of Oshawa.

4.3 **Erosion Monitoring Stations** - records from MNR, CLOCA, GRCA, LTRCA.

4.4 **Environmentally Sensitive Areas**

CLOCA, 1984. Lake Ontario Shoreline Inventory
Gartner Lee Assoc., 1978. Environmental Sensitivity Mapping Project.
CLOCA, 1979. Watershed Inventory.
McColl, 1989. LTRCA Shoreline Management Plan

- all environmental reports and guidelines prepared by CLOCA, GRCA, LTRCA and MNR
- all relevant aerial mapping
- BEAK Durham Sewerage (pipe through Bowmanville Marsh)
- BEAK Oshawa Creek Flood Control - for CLOCA under TSH
- BEAK Port Hope Sediment Studies
- BEAK Rare and Endangered Fish Habitat in Southern Ontario
- CLOCA. 1979. Watershed Inventory Study (Whitby to Bowmanville)
- CLOCA. 1984. Westside Marsh
- CLOCA. 1984. Lake Ontario Shoreline Inventory (Pickering/Whitby to Newcastle)
- CLOCA. 1984. Pumphouse Marsh (Wildlife inventory and wetland evaluation)
- CLOCA. 1984. Thickson's Woods and Gully (wildlife inventory survey)
- CLOCA (1984) Whitby Harbour and Goldpoint Marsh (Wildlife inventory survey)

4.0 RESOURCE MATERIAL (Cont'd)

- Environment Canada. 1982. Oshawa Second Marsh Baseline Study
- Environment Canada. 1983. Land Use Change on Wetlands in Southern Canada: Review and Bibliography
- Environment Canada. 1987. The Great Lakes Environmental Atlas and Resource Book
- Environment Canada. 1987. Wetland Distribution and Conversion in Southern Ontario
- Environment Canada. 1988. Wetlands of Canada
- Federation of Ontario Naturalists and Environment Canada. 1987. Wetland Conservation Policy in Canada.
- Fish and Wildlife Service. 1978. Impact of Water Level Changes on Woody Riparian and Wetland Communities
- Gartner Lee and Associates. 1978. Environmental Sensitivity Mapping Project for CLOCA
- Glooschenko et al. 1987. Provincially and Regionally Significant Wetlands in Southern Ontario
- Great Lakes Water Quality Board. 1988. A Review of Lake Ontario Water Quality with Emphasis on the 1981-1982 Intensive Years.
- Great Lakes Water Quality Board. 1988. 1987 Report on Great Lakes Water Quality.
- Ontario Land Inventory Maps
- Ontario Ministry of the Environment. 1980. Lake Ontario Nearshore Water Quality Atlas
- Ontario Ministry of Natural Resources (MNR). 1982. Land Use Strategies, Napanee District
- Ontario MNR. 1983. Land Use Guidelines, Maple District
- Ontario MNR. 1983. Land Use Guidelines, Lindsay District
- Ontario MNR. 1983. Land Use Guidelines, Napanee District
- Ontario MNR. 1984. Life Science Areas of Natural and Scientific Interest in Site District 6-13
- Ontario MNR. 1984. Lindsay District Fisheries Management Plan
- Ontario MNR. 1989. Wetlands Planning Policy Statement
- Ontario MNR. 1984. Environmental Sensitivity Analysis (Whitby to Brighton)
- Ontario MNR. 1988. Fisheries Management Plan, Napanee District
- Ontario MNR. 1989. Wetlands Planning Policy Statement
- Ontario MNR. 1989. Resource Maps for the Lake Ontario Shoreline, Lindsay District
- U.S. Fish and Wildlife Service. 1978. Impact of Water Level Changes on Woody Riparian and Wetland Communities
- Water Quality Records Along the Shoreline

4.0 RESOURCE MATERIAL (Cont'd)

4.5 Land Use Documentation

Moore/George Associates Inc., 1987. Oshawa Waterfront Development Plan.
Totten Sims Hubicki Associates, 1986. Town of Port Hope Land Use Plan.
The Regional Municipality of Durham, 1987. Official Plan.
LTRCA, 1989. Fill, Construction and Alteration to Waterways Regulation #194/89.
LTRCA, 1983. Interim Watershed Plan.
MNR, 1982. Napanee District Land Use Strategy.
Town of Whitby, 1989. Land Use Map.
Town of Newcastle, 1983. Bowmanville Land Use Structure Plan.
Town of Newcastle, 1983. Bowmanville Environmental Sensitivity.
City of Oshawa, 1989. Report from Department of Planning and Development. File No. 17-24.
Township of Hope, 1986. Land Use Plan, Zone Map.
Hamilton Township, 1986. Official Plan
CLOCA, 1989. Correspondence re: Lynde Shores
Town of Cobourg, 1987. Zoning By-Law.
Town of Cobourg, 1984. Land Use Plan.
Town of Newcastle, 1983. Newcastle Village Land Use Structure Plan.
Murray Township. Soils and Land Use Mapping
Murray Township. Official Plan
Township of Haldimand, 1986. Zone Map
Cramahe Township. Land Use Mapping
Port Darlington, 1989. Land Use Mapping
Town of Newcastle, 1984. Schedule 1, By-law 84-63
Town of Newcastle, 1984. Schedule 2, By-law 84-63
Town of Newcastle, 1984. Schedule 5, By-law 84-63
Town of Brighton. Schedule A, Zone map
Grafton Shores, 1980. Plan of Subdivision
Township of Brighton. Schedule A, Zone Map
Totten Sims Hubicki Assoc., 1988. Plan for Brighton Bay Estates.

4.0 RESOURCE MATERIAL (Cont'd)

4.6 Bluff Composition

- Geocon, 1980. Erosion Control Study, Scarborough Bluffs (for MTRCA)
- Shoreline Erosion Monitoring Station - Soil Sampling Data.
- Totten, Sims, Hubicki, bluff composition for Fort Hayden Shore Park.(1979)
- Soil Analysis for Port Granby Waste Site.

4.7 Others

MECG, Generic Emergency Response Plan

5.0 SHORELINE STRUCTURES INVENTORY

During the undertaking of this study, three different methods were used to generate a shoreline structures inventory. First, the project shoreline was overflown in a Cessna 172 fixed wing aircraft, and a video recording was made of the shoreline and existing structures. This recording was then transformed to a VHS format tape, a copy of which will be handed over to each Conservation Authority at the end of the project.

Following this, MNR and LTRCA Shoreline Inventories were used to identify structure locations and type by Lot number. This information was supplemented with MNR records of applications for construction of shoreline works.

Finally, numerous trips were made along the project shoreline in an inflatable boat. During these trips 35 mm still photographs were taken and notes made as to the types and extent of structures observed on the project shoreline. A description of these structures, their locations and aerial extents are shown on the land use maps provided in Appendix D. (Series 1 Mapping)

The different shoreline structures are discussed following and comments made as to their estimated structural integrity and efficacy in the stabilization and/or protection of the relevant shoreline. It should be stated that the structures discussed represent existing structures only and are not necessarily recommended for implementation. Any shore protection construction should be preceded by a detailed coastal engineering analysis and design.

5.1 Armourstone Revetment

This is generally the most cost effective method of shore protection for cohesive bluff type shorelines, however many of the existing armourstone revetments in the study area are not properly engineered. In the event of conditions exceeding the design storm of an armourstone revetment, damage is usually limited to small scale displacement rather than complete structure failure. Common problems include:

- the lack of a filter layer such as a geotextile to prevent leaching of sediment through the structure,
- inadequate armourstone size,
- inadequate height of protection,
- discontinuity between adjacent properties which can result in flanking of the ends, and
- inadequate keying in of toe stone .

5.0 SHORELINE STRUCTURES INVENTORY (Cont'd)

5.2 Gabions

In most cases gabions are inappropriate for use on open shorelines where they are exposed to wave and ice attack. The baskets can be damaged by waves and ice allowing the stones to spill out. Once gabions become damaged, they tend to degrade rapidly and if subject to severe wave attack may fail completely. Other problems include:

- a failure to place a filter layer behind the baskets which can result in leaching out of fines and eventual failure of the structure,
- inadequate filling of the baskets which causes them to break and fail,
- the use of stone which is too small and therefore falls through the mesh,
- failure to protect to an adequate elevation,
- discontinuity between adjacent properties which can lead to flanking of the structure,
- inadequate keying in of toe, and
- breakdown of the wire mesh baskets after only a few seasons of winter ice as well as from the abrading effect of sediment in the water column.

5.3 Steel Sheet Piling

Steel sheet piling is used in several places along the shoreline and there are a number of examples of it failing. The main problem with this type of protection is that the vertical impermeable face reflects the wave energy rather than absorbing it and this causes scour at the toe of the structure. As well as a loss of beach material, this often eventually leads to undermining and failure of the structure. Other problems which should be considered are:

- scour behind the structure if the height is inadequate,
- flanking as adjacent unprotected properties erode,
- the capital and maintenance costs are generally higher,
- this alternative is not generally considered to be as aesthetically pleasing as some of the other options,
- a rip rap scour apron should be placed at the toe of the structure to reduce wave scour, and
- inadequate depth of penetration for cantilever walls and/or lack of tie-backs.

5.0 SHORELINE STRUCTURES INVENTORY (Cont'd)

5.4 Well Heads

Well heads have been used in a number of ways which include stacking and being placed end up and filled with rip rap. Unless there is a filter layer between the wellhead and the beach sand, they have a tendency to sink. If placed vertically and side by side, gaps are invariably created between them as they settle. Furthermore, the protection they provide is limited and for the time, effort, and money spent, other methods are more worthwhile.

5.5 Vertical Reinforced Concrete Walls

Various types of concrete wall are found along the shoreline, ranging in height from a couple of metres to approximately ten metres. They are generally vertical and therefore reflect wave energy rather than absorbing it. This results in wave scour at the toe of the structure and can eventually lead to undermining depending on the depth of the footing. If concrete walls are to be used then the following points should be remembered:

- a sloped wall is always preferable to a vertical wall,
- if a vertical wall is used then rip-rap should be placed at the toe to provide scour protection,
- the footing should be deep enough to prevent undermining, and
- the ends of the structure should be turned shoreward to prevent flanking if the neighbouring property is unprotected.

5.6 Concrete Blocks

Concrete blocks are often used along this shoreline. They are sometimes stacked or cemented together to form a wall or alternatively, placed in a revetment or randomly dumped.

They provide an economical form of shore protection, particularly if they are used in a revetment. Often it is possible to get blocks poured from leftover concrete and these usually come in a 1.8 tonne size. The most important considerations are identical to those for an armourstone revetment.

5.0 SHORELINE STRUCTURES INVENTORY (Cont'd)

5.7 Scrap Concrete

Scrap concrete is most often end-dumped over a bluff and provides temporary, if unsightly, shore protection. It can be effective if dumped in large quantities and underlain with filter fabric, and is most useful in locations where the beach is not used and is not visible from the top of the bluff. This form of shore protection is generally only used by shoreline property owners as a last resort because of its appearance. It is also often inappropriate from a safety point of view particularly if the concrete contains rebars.

An alternative use for the scrap material is in a revetment as an underlayer or core material. This can then be covered with armourstone.

5.8 Timber Walls

Various types of timber walls have been installed along the shoreline. In most cases 8″ x 8″ rough hewn timber is placed horizontally between posts. In one case a variegated wall was designed to absorb wave energy but in most instances the walls are shore parallel and vertical.

In the past, timber used in a marine environment was treated to prevent weathering, however this is no longer permitted for environmental reasons and there is some question as to how well untreated timber will last in a marine environment.

Other points which should be considered are:

- vertical walls reflect wave energy and often result in scour at the toe of the structure,
- protective stone of a suitable size should therefore be placed at the toe for scour protection,
- the wall should be driven sufficiently deep to avoid undermining,
- timber walls do not generally withstand severe wave attack and are often better suited to landscaping in the splash zone, and
- timber walls must be properly engineered.

5.0 SHORELINE STRUCTURES INVENTORY (Cont'd)

5.9 Steel Caisson Walls

One steel caisson wall was found at the east end of the study area in Barcovan. The structure is located on a rocky shoreline and is founded on concrete. It is rather substantial and will most likely provide the property owner with adequate protection.

This type of protection is rarely used because the costs are relatively high. Furthermore, vertical impermeable walls of this nature reflect wave energy resulting in scour at the toe of the structure. They are therefore not well suited to shorelines with erodible foreshores, ie. clay or sand. Other problems include:

- scour behind the structure if the height is inadequate,
- flanking as adjacent unprotected properties erode,
- the capital and maintenance costs are generally higher,
- this alternative is not generally considered to be as aesthetically pleasing as some of the other options, and
- a suitably sized armour material scour apron should be placed at the toe of the structure to reduce wave scour.

5.10 Rail Cribs

Rail cribs with quarry run backfill were used to protect the railway line east of Spicer. This is an effective if somewhat expensive method of protection under normal circumstances. The face of the protection is permeable and therefore absorbs some wave energy, although the lack of beach formation in front of the structure would seem to indicate some reflection off the vertical face. It also limits access to the water.

6.0 RELEVANT COASTAL PROCESSES

An understanding of the coastal processes is vital to the development of the Shoreline Management Plan. The following aspects were studied.

- Water Levels
- Wave Climate
- Sediment Transport Rates
- Shoreline Classification

These are described in detail following.

6.1 Water Levels

The extreme high water level is used to determine flood levels and the elevation to which protection is required. For most shore protection works, water level is of further significance because the waves are depth limited. Therefore the design wave is also dependent on the water level. As a result, both the elevations to which protection is extended and armour unit size are ultimately a function of water level.

The design water level can be divided into four components:

a) static water level
b) storm surge
c) wave set-up
d) wave run-up

Variations in the static water level occur over the long term and are largely a result of variations in precipitation over the drainage basin and evaporation, runoff, ground water flow and snow melt. Lake Ontario as part of the Great Lakes system is also affected by the other lakes, some of which are controlled.

Static levels recorded on Lake Ontario (at Kingston) range from a minimum of 73.6 metres International Great Lakes Datum (IGLD) observed in 1934 to a maximum of 75.6 metres IGLD in 1952; a difference of 2 metres (See Figure 6.1). Although present water levels are close to the mean, they are always changing and shoreline works must therefore be designed for the extremes.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

The second component of water level is storm surge. This is a result of wind shear stress across the surface of the lake, which causes water to circulate. As water flows towards or away from a shoreline, the water level correspondingly increases or decreases.

When a wave breaks, it exerts a force normal to the shoreline. This force results in an increase in the mean water level inshore from the breaking point, referred to as wave set-up. Wave set-up values vary with each specific wave and cannot be listed here. Wave set-up was calculated following the method outlined in Appendix F.

Finally, the uprush movement of a wave breaking on a shoreline is termed wave run-up. This value is a function of the height and periodicity of the breaking wave as well as the foreshore slope. The method of Hawkes (1982) was used in the computation of run-up for this project. (See Appendix F)

The one hundred year extreme water levels, including the static level and storm surge components, were obtained from the MNR. These are as follows:

Oshawa	75.47 metres IGLD
Cobourg	75.60 metres IGLD
Wellington	75.51 metres IGLD

These values must be interpolated to give the extreme water level at any specific location along the shoreline.

Wave set-up and run up values must then be calculated for a given location. These will vary with distance offshore, bed slope and wave characteristics.

6.2 Wave Climate

6.2.1 Offshore Wave Climate

The north central shore of Lake Ontario is exposed to substantial fetches from the directions east through southwest and the wave climate reflects this. Very little measured wave data exists for the Great Lakes and it is therefore necessary to derive the offshore wave climate from wind records.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

A wind wave hindcast was done for this shoreline by MNR in 1988. The hindcast was based on the results of a two-dimensional model which used 20 years of wind data from eight stations around Lake Ontario. The model was calibrated with measured wave data. In addition, data from a number of other wave hindcasts were available which all used the Toronto Island Airport as the only wind station.

At the outset of this study, some questions had been raised regarding the validity of the MNR data. A comparison was done between the MNR Hindcast and previous Hindcasts and it was decided that the MNR data was the most appropriate for this study. Details of the comparison between the different hindcasts are given in Appendix H.

The raw MNR Hindcast data was obtained on diskette. Four MNR Stations were used as indicated in Figure 6.2. These include:

Station 6	Scarborough Bluffs
Station 7	Oshawa
Station 8	Ganaraska
Station 9	Brighton

The MNR data was re-analyzed using an in-house wave statistics program to create directional wave energy distribution and scatter diagrams for a 16 point compass. The MNR data had previously been analyzed for an 8 point compass and it was decided that a more accurate definition of wave direction would be required for sediment transport calculations. The revised scatter diagrams and energy distributions are presented in Appendix G.

6.2.2 Nearshore Wave Climate

The offshore waves were transferred inshore using an in-house ray-tracing refraction model REFRAC. The capabilities of this model are described in detail in Appendix F. The refraction model requires as input, offshore wave data and bathymetric information. The offshore wave data was taken from the MNR Hindcast and the bathymetric information was taken from Hydrographic Charts 2058, 2061 and 2062.

A total of eight bathymetric grids were used for the refraction analysis. Two coarse outer grids with a spacing of 1000 metres spanned the entire study area. Six fine grids with a spacing of 200 metres were constructed for detailed ray tracing in depths less than 20 metres. Three of these fine grids were nested within each of the coarse grids.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

The following deep-water wave conditions were selected from the scatter diagrams to be representative of the wide-ranging wave conditions throughout the study area:

Wave Period (sec)	Wave Direction
	WSW
6	SW
	SSW
8	S
	SSE
10	SE
	ESE

These were refracted inshore and the results are summarised on each of the refraction plots which can be found in Appendix B.

The refraction diagrams, giving near-shore wave directional characteristics, were used to provide some guideline as to the identification and extent of littoral sub-cells. Specifically, these diagrams gave a key to the presence of bathymetric features offshore of the project shoreline which would result in the splitting of wave directions about a specific location (irrespective of the offshore direction). Reaches of shoreline within the study area with similar wave transformation patterns were then examined in greater detail for calculations of sediment transport potential, set-up, beach erosion and run-up limits.

6.3 Sediment Transport

To gain an appreciation of the actual and potential sediment transport rates within the study area, a sediment budget was prepared. Sediment input can originate from several sources including bluff erosion, fluvial sediments from rivers and foreshore erosion. The foreshore is predominantly clay which is composed of fines and does not contain beach building material and therefore it was not considered in this study. Estimates were made of the volume of sediment entering the littoral cell from bluff erosion and rivers and this was compared with potential transport rates which were calculated for a number of profiles within the study area.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

6.3.1 Actual Transport

i) The Bluffs as a Sediment Source

Estimates of annual sediment contribution due to eroding bluffs were performed on a reach by reach basis. The results are given in Table 6.1. For each reach, data from the nearest Erosion Monitoring Station (EMS) was used to calculate the amount of sand lost from the bluff and therefore added to the nearshore zone. Data at the EMS include: height of bluff, normalized erosion rate and bluff composition. The normalized erosion rate is independent of bluff height. Therefore, each reach may be divided into smaller sections of uniform bluff height. The total annual quantity of sand eroded from the bluff is equal to:

$$Q = \Sigma\ (\%\ Sand * height * length * erosion\ rate)$$

The shoreline type, average recession rate, eroded bluff volume and sediment contribution from rivers are summarized on a reach by reach basis in Table 6.1. This gives a total input from bluff erosion of approximately 71,000 m^3 per annum. The material is distributed throughout the different littoral subcells.

It was noted that the EMS are not always ideally located for measuring representative bluff erosion rates. Recommendations regarding this are stated later in Section 7.2.

(ii) Creeks as a Sediment Source

Sediment input from creeks and rivers was calculated using sediment loading data and discharge rates from Environment Canada (1988). Since data was not available for all of the creeks and rivers in the project shoreline, a preliminary relationship between catchment basin size and annual rates of riverine sediment transport was developed for those water courses where sediment rates were known. This relationship was then used to evaluate the annualized sediment rates for the remaining rivers and creeks within the project area. The riverine sediment inputs were then added to the total estimated inputs from bluff recession to arrive at the total estimated actual transport rates. The sediment input from rivers is summarized on a reach by reach basis in Table 6.1 and has been estimated at a total value of 34,900 m^3 per annum distributed throughout the different subcells and reaches.

TABLE 6.1

BLUFF AND RIVER CONTRIBUTIONS TO THE SEDIMENT BUDGET

Reach #	Shoreline Type	Recession Rate (m/year)	Volume of Eroded Bluff (m^3 sand/year)	Volume of River Sediment (m^3 sand/year)
R1	Low bluff	.14	208	--
R2	Marsh	---		3170
R3	Low bluff	.14	755	
R4	Cobble beach	---		
R5	Bluff	.14	616	
R6	Bluff	.14	300	9
R7	Marsh	---		400
R8	High bluff	.14	1240	
R9	High/low bluff	.14	1109	54
R10	Beach	--		
R11	Damage C3	.5	1520	
R12	Low Bluff, Beach/marsh	.2	225	5920
R13	High/low bluff	.21	3900	270
R14	Protected fill	--	--	
R15	High bluff	.21	2250	
R16	Marsh	--	--	90
R17	Beach	--	--	4790
R18	Beach	--	--	
R19	High bluff	.5	990	
R20	Cobble beach	--	--	38
R21	High bluff	.3	2860	
R22	High/low bluff	.6	3070	54

TABLE 6.1 - BLUFF AND RIVER CONTRIBUTIONS TO THE SEDIMENT BUDGET (Cont'd)

Reach #	Shoreline Type	Recession Rate (m/year)	Volume of Eroded Bluff (m^3 sand/year)	Volume of River Sediment (m^3 sand/year)
R23	Cobble beach	--	--	3170
R24	High/low bluff	.6	1930	
R25	Beach/protected Shoreline	--	--	880
R26	High bluff	.3	24,600	
R27	High bluff	.2	4500	
R28	Cobble beach	--	--	170
R29	High bluff	.2	6300	54
R30	Low bluff	.3	350	
R31	Beach/marsh	--	--	190
R32	High bluff	.3	1700	
R33	Beach/marsh	--	--	250
R34	High bluff	.3	3400	
R35	Sandy beach	--	--	210
R36	High/low bluff	.1	1150	
R37	Port Hope Beach	--	--	10,090
R38	High/low bluff	.2	1300	
R39	Marsh Cobble beach	--	--	
R40	Low bluff Cobble beach	.2	750	
R41	Beach	--	--	
R42	Beach	--	--	1450
R43	Low bluff	.2	2370	275
R44	Protected	--	--	350
R45	Low bluff	.2	420	70

TABLE 6.1 - BLUFF AND RIVER CONTRIBUTIONS TO THE SEDIMENT BUDGET (Cont'd)

Reach #	Shoreline Type	Recession Rate (m/year)	Volume of Eroded Bluff (m^3 sand/year)	Volume of River Sediment (m^3 sand/year)
R46	Low bluff	.2	1050	250
R47	Cobble beach			70
R48	Low bluff	.2	240	1830
R49	Gravel beach/bluff	.2	550	9
R50	Low bluff	.2	1040	9
R51	Low/med bluff	.2	240	400
R52	Low/med bluff	.2	30	
R53	Low/med bluff	.2	60	170
R54	Gravel/shale			70
R55	Marsh			70
R56	Low bank Shingle/sand beach			90
R57	Marsh Low bank			
R58	Low bank			
R59	Oldmarsh/fill			
R60	Marsh			
R61	Marsh, fill			
R62	Low bank Marsh			
R63	Beach Low bank			
R64	Low bank			
R65	Low bank			
R66	Wetland Marsh			

Note: Recession data is not available for Reaches 56-66

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

6.3.2 Potential Alongshore Sediment Transport

Potential alongshore sediment transport rates were calculated using the in-house numerical model, SCATRAN. (See Appendix F). This model takes an annualized deep-water scatter diagram and calculates the yearly sediment transport in each direction across a profile. The model combines the results of wave transformation calculations using energy saturation with a bulk sediment transport predictor and then redistributes the sediment transport rate across the surf zone according to the Fulford distribution.

For each selected sediment profile site in the study area, a modified deep-water scatter diagram was constructed from the MNR hindcast database. These modified scatter diagrams used a 16 point compass and weighted average values of the two adjacent existing deep-water MNR hindcast sites. It was felt that this modified scatter diagram better reflected the total energy at each site and gave a smoother distribution of deep-water wave energy by direction.

Seventeen profiles were selected for investigation as shown in Figure 6.3. The profiles were selected in locations, and at particular distances apart, to be representative of all 66 reaches identified in the project shoreline. For example, profiles were selected to represent both bluff-type and beach-type shorelines (or reaches). The results of the sediment transport analysis are presented in Appendix I.

A review of the sediment transport results indicates that the net direction of alongshore drift is from west to east. The net potential transport rates vary significantly along the shoreline and are largely dependent upon shoreline orientation.

At the east end of the study area approaching Popham Bay, potential transport rates are significantly less than elsewhere along the shoreline. This is understandable because the area is protected by a number of shoals and the wave heights are therefore reduced. Potential transport rates east of Presqu'ile and within Weller's Bay are similarly reduced.

The width of the surf zone varies from 500 metres to 1500 metres with peak potential transport rates occurring anywhere from 100 to 500 metres from the shoreline. This information is particularly relevant when designing structures which interrupt alongshore transport. A knowledge of the cross-shore distribution of transport rates can be used to ensure that downstream shorelines are not starved of littoral drift. (See Appendix I)

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

6.4 Shoreline Classification

The project shoreline falls within one main littoral cell stretching from East Point in the west to Presqu'ile in the east. There are however many subcells within this main cell which are either natural or man-made. The natural features consist of bays and headlands such as the promontories at Pickering, Richardson Point, Ross Point, Gold Point, Raby Head, Bouchette Point, Chubb Point and Peter Rock. The manmade structures contributing to the formation of littoral subcells are, for example, harbour jetties at Whitby, Oshawa, Darlington, Port Hope and Cobourg, along with landfills at the Darlington Nuclear Generating Station, the St. Mary's Cement Pier and the artificial filling and pier at Ogden Point.

As part of this study, the limits of littoral cells and subcells, shoreline zones and shore reaches, for the project area were determined. Brief definitions of these three terms follow:

i) Littoral Cells

Littoral cells are self-contained segments of shoreline which neither receive sediments from nor contribute sediments to adjacent littoral cells. Existing beaches and groyne fields depend on the natural supply of littoral drift within the littoral cell. Littoral drift may move in both directions within the cell under different wave conditions but usually has a long term net movement in one direction at a constant rate. Cells can vary from a few hundred metres in length to hundreds of kilometres. On the Great Lakes littoral cells of 100 kilometres or greater are common.

ii) Littoral Sub-Cells

The boundaries of Littoral sub-cells are defined by natural features or man-made structures which act as partial barriers to the alongshore movement of littoral sediments.

The methodologies used in the determination of the above-mentioned shoreline classification parameters for the project shoreline and the parameters themselves are described in the following sections.

iii) Shoreline Zone

Shoreline zones are cross-sections of a shoreline with the limits of flooding and/or erosion forming the inland boundary and the limit of sediment transport forming the offshore boundary.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

iv) Shoreline Reach

A shoreline reach is a portion of a littoral cell and a shoreline containing similar physiographic characteristics and shore dynamics such as like erosion rates, similar flood elevations etc. and include:

i) Shore alignment
ii) Offshore bathymetry
iii) Fetch characteristics
iv) Littoral transport rates
v) Bluff and beach properties

6.4.1 Littoral Cells and Sub-Cells

As previously outlined, the project area falls primarily into one main littoral cell. This cell extends from East Point (at the western boundary of the cell) to Presqu'ile (at the eastern boundary of that cell). This cell is denoted as Cell 0-8 in the MNR Publication "Littoral Cell Definition and Sediment Budget for Ontario's Great Lakes". The eastern end of the project area is characterized by another small littoral cell, 0-9, extending from Presqu'ile to approximately Weller's Bay.

A detailed review of alongshore littoral transport rates and profiles across the surf zone, has allowed us to divide the project shoreline into a number of primary and secondary littoral sub-cells. For the purposes of this study, a primary littoral sub-cell is contained within natural features or man-made structures which appear to intercept upwards of 60% of the alongshore transport in the surf zone. In some cases these appear to be almost total littoral barriers. The secondary littoral sub-cells by contrast are contained by promontories or features which only appear to intercept less than 60% of the alongshore sediment transport in the surf zone.

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

Based on these criteria, eight primary littoral sub-cells have been identified in the project area with approximately ten secondary sub-cells. These are listed in the following table:

Table 6.2 - Littoral Sub-Cells

Primary Sub-Cell	1:	East Point - St. Mary's Cement Pier
Secondary Sub-Cells	1A:	Richardson Pt - Thicksons Pt.
	1B:	Thicksons Pt - Oshawa Harbour
	1C:	Oshawa harbour - St. Mary's Cement Pier
Primary Sub-Cell	2:	St. Mary's Cement Pier - Peter Rock Shoal
Secondary Sub-Cells	2A:	St. Mary's Cement Pier - Port Darlington
	2B:	Port Darlington - Bouchette Point
	2C:	Bouchette Point - Port Hope
	2D:	Port Hope - Peter Rock Shoal
Primary Sub-Cell	3:	Peter Rock Shoal - Cobourg Harbour
Primary Sub-Cell	4:	Cobourg Harbour - Ogden Point
Secondary Sub-Cells	4A:	Cobourg Harbour - Chubb Point
	4B:	Chubb Point - McGlennon Point
	4C:	McGlennon Point - Ogden Point
Primary Sub-Cell	5:	Ogden Point - Presqu'ile
Primary Sub-Cell	6:	Presqu'ile Bay
Primary Sub-Cell	7:	Shoal Point - Barcovan Beach
Primary Sub-Cell	8:	Stoneburg Cove - Young Point

6.0 RELEVANT COASTAL PROCESSES (Cont'd)

6.4.2 Shoreline Zone

The landward extent of the shoreline zone was set by the Terms of Reference at 500 m inshore from the waters edge as shown in the 1:10,000 scale OBM sheets used to generate all CAD mapping.

The offshore boundary of the shoreline zone is defined as the offshore limit of sediment transport. Results of the sediment transport analysis were used to define this limit. As discussed in Section 6.3, SCATRAN calculates potential transport rates and fits a cross-shore distribution to the transport. The transport distribution during the 100 year storm was used to define the offshore limit of transport and thus the offshore boundary of the shoreline zone. The offshore limit of the shoreline zone is generally between 1000 and 1500 metres offshore depending upon the location. The offshore limit for the shore zone is given for each reach in Table 6.3.

6.4.3 Shoreline Reaches

Shoreline reaches were developed for the project area based on the general definitions given at the beginning of Section 6.4. A complete listing, with the location and a description of the relevant features of each reach is given in Table 6.3.

TABLE 6.3 - SHORELINE REACHES AND LIMITS OF SHORELINE ZONE

Shoreline Reach	Municipality	Shoreline Type	Azimuth (degrees)	Littoral Sub-cell	Shore Zone Limits (m offshore)
1	Whitby	Low bluff	35	1A	1350
2	Whitby	Marsh/beach bar	60	1A	1350
3	Whitby	Low bluff	40	1A	1350
4	Whitby	Cobble/Sand beach	90	1A	1350
5	Whitby	Low bluff	110	1A	1400
6	Whitby	Low bluff	60	1B	1400
7	Whitby	Marsh/beach bar	80	1B	1400
8	Whitby/ Oshawa	High bluff	105	1B	1400
9	Oshawa	High bluff	75	1B	1400
10	Oshawa	Sand/cobble beach	80	1B	1400
11	Oshawa	Sand/cobble beach	40	1B	1000
12	East Whitby/ Newcastle	Sand/gravel beach	90	1C	1000
13	Newcastle	High bluff	90	1C	1000
14	Newcastle	Protected bluff	90	1C	1000
15	Newcastle	High bluff	55	1C	1250
16	Newcastle	Marsh/beach bar	70	1C	1250
17	Newcastle	Sandy beach	65	2A	1100
18	Newcastle	Sandy beach	65	2B	1100
19	Newcastle	High bluff	65	2B	1200
20	Newcastle	Sand beach	85	2B	1200
21	Newcastle	High bluff	70	2B	1200
22	Newcastle	Low bluff	90	2B	1200

TABLE 6.3 - SHORELINE REACHES AND LIMITS OF SHORELINE ZONE (Cont'd)

Shoreline Reach	Municipality	Shoreline Type	Azimuth (degrees)	Littoral Sub-cell	Shore Zone Limits (m offshore)
23	Newcastle	Sand bar	85	2B	1200
24	Newcastle	Low bluff	100	2B	1200
25	Newcastle	Sand beach	70	2B	1200
26	Newcastle	High bluff/ gullies	80	2B	1200
27	Newcastle	High bluff	55	2C	1300
28	Newcastle	Sand bar	55	2C	1300
29	Newcastle/Hope	High bluff	65	2C	1300
30	Hope	Low bluff	80	2C	1300
31	Hope	Sand/cobble beach	65	2C	1250
32	Hope	High bluff	50	2C	900
33	Hope	Sand beach bar	80	2C	1250
34	Hope	High bluff	80	2C	1250
35	Hope	Beach	45	2C	900
36	Hope	Low/high bluffs	85	2D	1250
37	Hope	Sand beach	90	2D	1100
38	Hope	Low/high bluffs	70	2D	1550
39	Hope/Hamilton	Sand beach bar	75-90	2D	1600
40	Hamilton	Shingle/sand beach	60-90	3	1100
41	Hamilton	Sand beach	90	3	1600
42	Hamilton	Sand beach	75-120	4A	1600
43	Hamilton	Low bluff	90	4A	1600
44	Hamilton	Low bluff	50	4A	1100
45	Hamilton/ Haldimand	Low bluff	95	4A	1600
46	Haldimand	Sand/cobble beach	85	4A	1600

TABLE 6.3 - SHORELINE REACHES AND LIMITS OF SHORELINE ZONE (Cont'd)

Shoreline Reach	Municipality	Shoreline Type	Azimuth (degrees)	Littoral Sub-cell	Shore Zone Limits (m offshore)
47	Haldimand	Cobble beach	110	4A	1250
48	Haldimand	Cobble beach	55	4B	800
49	Haldimand	Sand/gravel beach	110	4B	1250
50	Haldimand	Gravel beach/low bluff	80	4C	1500
51	Haldimand/Cramahe	Marsh/beach bar	105	4C	1500
52	Cramahe	Shale beach	110	4C	1500
53	Cramahe	Sand beach	70	5	800
54	Cramahe	Shale/gravel beach	75	5	1100
55	Cramahe	Sand/gravel beach	90	5	1100
56	Cramahe	Sand/gravel beach Shingle/sand beach	87	5	1600
57	Murray	Low composite shoreline	60	6	
58	Murray	Low composite shoreline	100	6	
59	Murray	Landfill	55	6	
60	Murray	Wetland/marsh	Variable	6	
61	Murray	Marsh/fill	130	6	
62	Murray	Wetland/fill/beach Marsh	65	7	2000
63	Murray	Shingle beach Low bank	100	7	2000
64	Murray	Low bank	40	7	1900
65	Murray	Low bank	40	8	2000
66	Murray	Wetland marsh	50	8	2000

<u>Note:</u> Reaches 57-61 lie within Presqu'ile Bay.

LAKE ONTARIO (Kingston) LAC ONTARIO

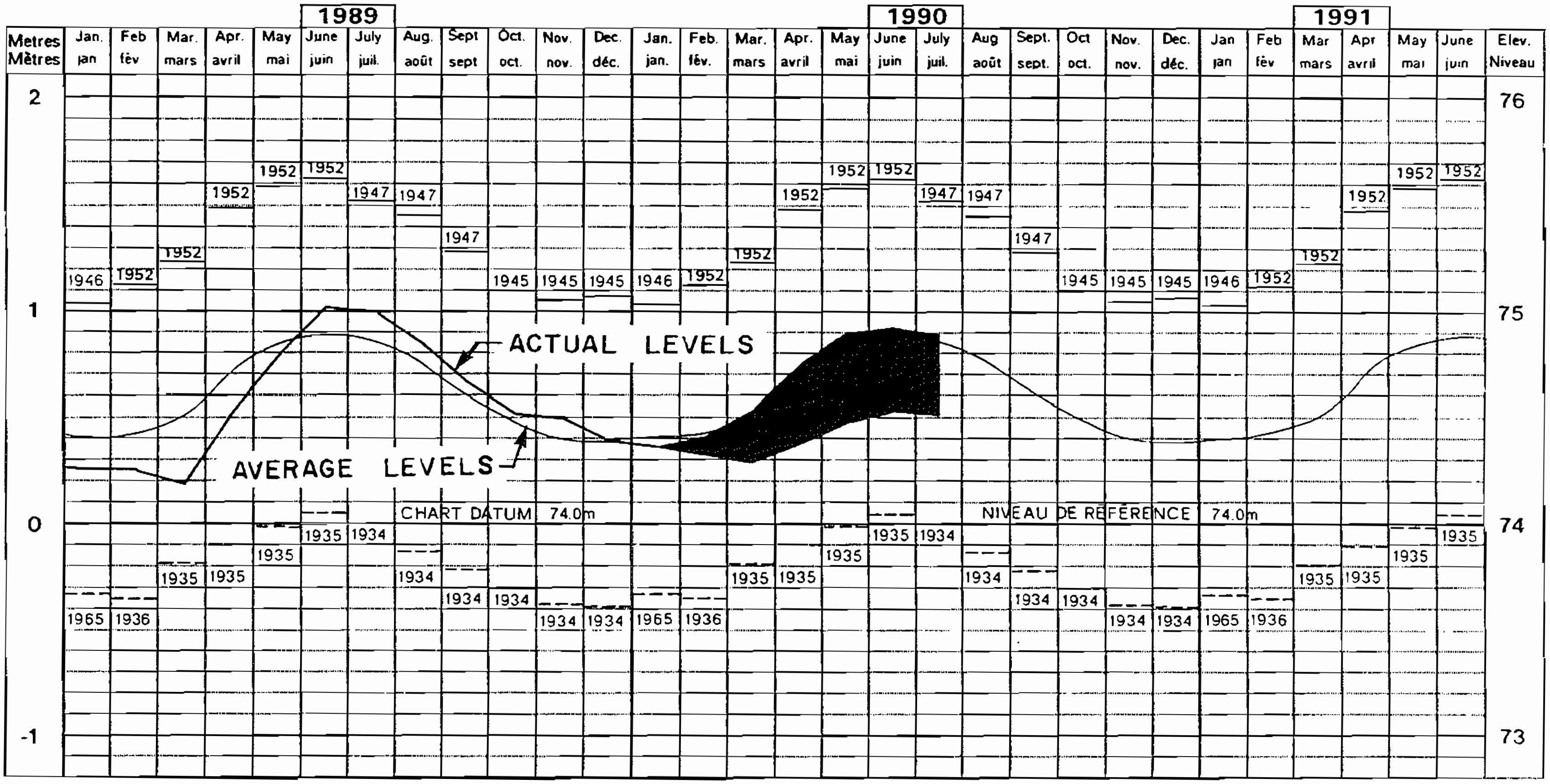


Fig. 6.1 Water Levels

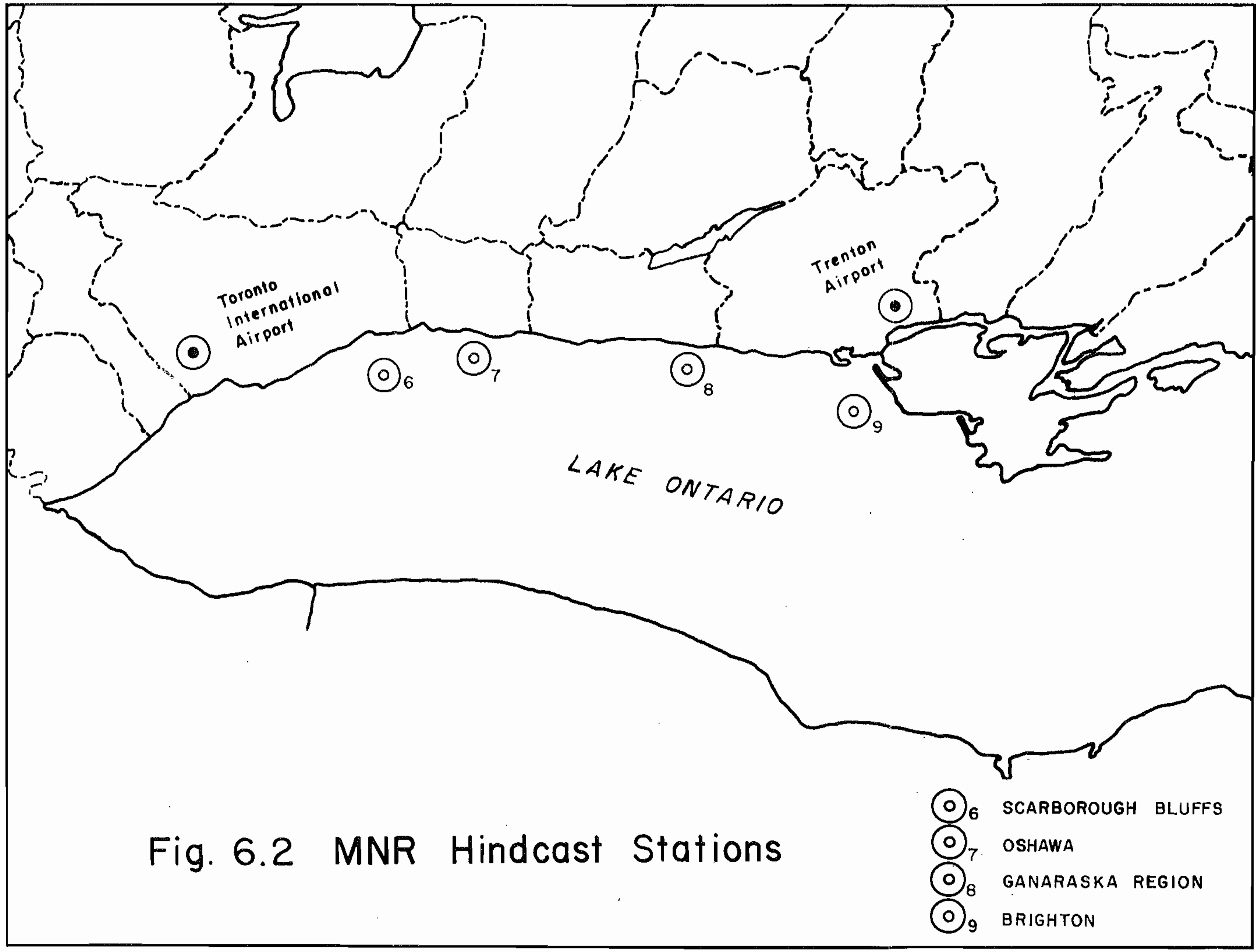


Fig. 6.2 MNR Hindcast Stations

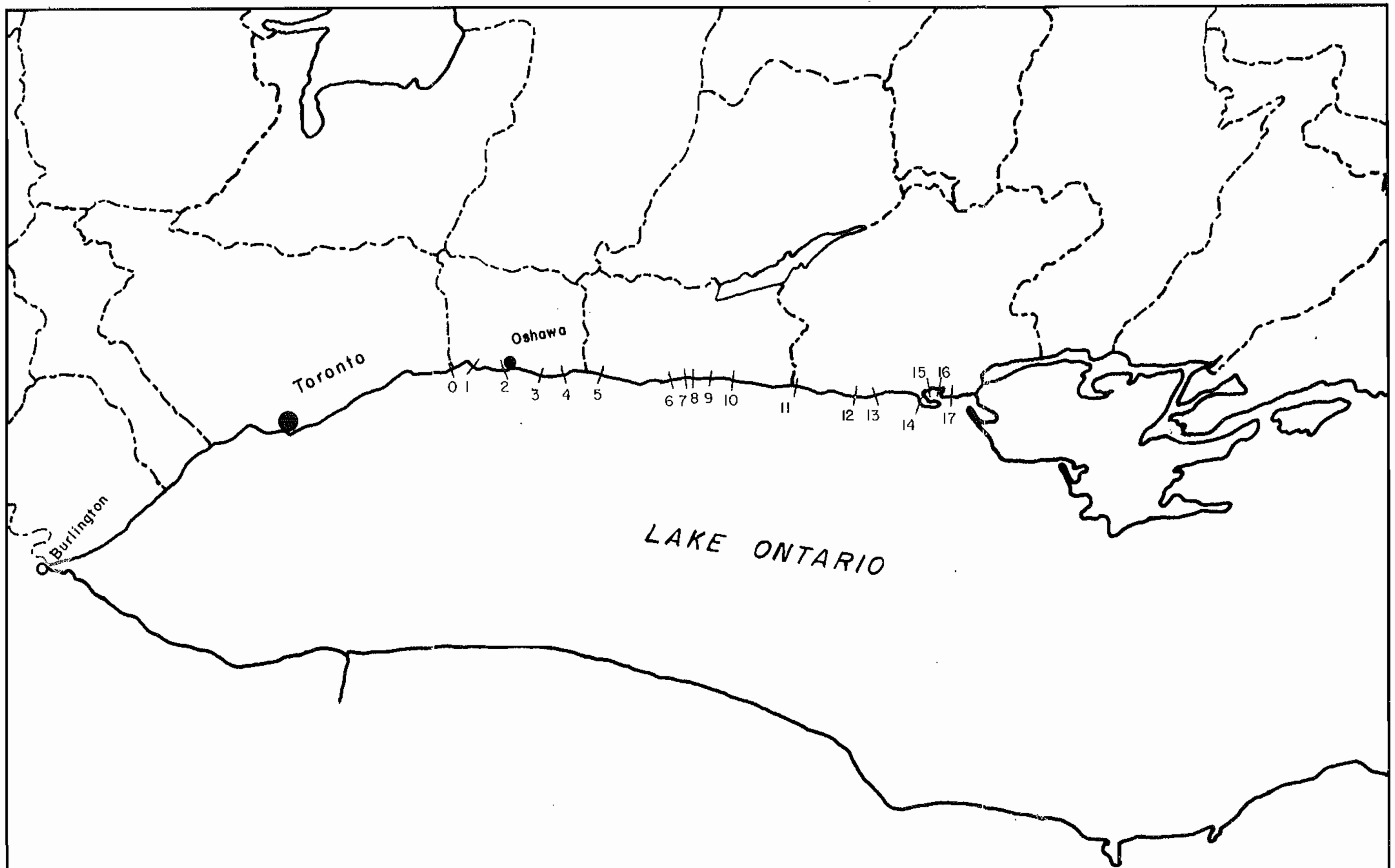


Fig. 6.3 Profile Locations

7.0 FLOOD AND EROSION LIMITS

The 100 year erosion and flood limits were plotted on Series 1 Mapping. Details of the methodology used in determining the limits are discussed following:

7.1 Erosion Limits

The erosion limit was calculated in two ways depending on shoreline type; bluff or beach. The methodologies are described in detail following:

7.1.1 Bluffs

Annual shoreline recession rates were calculated using the EMS data. For each station, all available profiles were plotted and reviewed. (See Appendix A). Any profile which looked suspicious was rejected.

The recession rate at the top of bluff was then calculated for each profile. The recession rate obtained for each EMS compared very closely to the value obtained by Boyd (1981), who used only 7 to 10 years of survey data.

Set-back distances were calculated for the 100 year erosion limit plus an additional distance required to establish a stable slope. The stable slope value of three times the bluff height was uded as recommended by MNR.

The 100 year set back limits for each EMS were extrapolated over the adjacent shoreline to give limits for each reach. These were plotted on Series 1 Mapping along with the 100 year flood limit.

7.0 FLOOD AND EROSION LIMITS (Cont'd)

The 100 year erosion limit represents the estimated location of the shoreline for the year 2089 (i.e 100 years from present). Since the mapping is based on aerial photography from 1979, the annual recession rate was multiplied by 110 years to give the shoreline position in 2089.

7.1.2 Beaches

Beaches must be treated differently from bluffs because they erode and accrete, i.e. the process is reversible. Furthermore, because the beach profile is constantly changing, it is not possible to define an erosion set-back limit.

It is therefore recommended that no permanent construction be encouraged in the area immediately behind the active beach face. If development is to be considered, a cross-shore beach survey should be undertaken and the most lakeward line of dunes should be preserved. (See Figure 7.2). Any proposed works must take into consideration the sensitive nature of the beach and options such as the planting of dune grass to 'hold' the dune may be specified.

To provide some idea of the beach erodibility, the Advanced Nearshore Profile Model (ANPM) was used to calculate the limit of beach erosion under the 100 year storm event with the 100 year water level. The model is described in detail in Appendix F but basically, uses an energetics approach to model wave transformations and sediment transport. A value of 30 m was added to the beach erodibility extent to conform to the most recent MNR definition of the dynamic beach. The erosion limit is denoted as ΔS and is shown in Figure 7.2.

ΔS values are given on Map Series 1. It is emphasized that these are not set-back limits, but rather, an indication of the beach erodibility. Where development is proposed along a beach type shoreline, the beach stability must be assessed through the examination of historical data, grain size analyses, cross-shore surveys and an evaluation of sediment transport characteristics.

The 100 year erosion limits shown on Map Series 1 are intended to give a visual impression of areas of high and low recession. When advising homeowners of set-back limits, the Authorities would be advised to have measured the 100 year set-back from the top of bluff in the field as shown on Figure 7.1. The 100 year set-back limits are summarized in Table 7.1.

7.0 FLOOD AND EROSION LIMITS (Cont'd)

7.2 Flood Limits

The 100 year flood limit was also plotted on Series 1 Mapping. The limit reflects runup levels which would be expected when the 100 year extreme water level combines with the 100 year storm event. The 100 year extreme water level, as defined in Section 6.1, includes two components: static water level and storm surge.

Runup levels were calculated using Hawkes method which is incorporated within the Advanced Nearshore Profile Model (see Appendix F). Seventeen profiles within the study area were selected to represent the different shoreline types and wave exposures. The profiles were the same as those used for potential sediment transport calculations as shown in Figure 6.3.

Wave set-up values were also developed for each of the seventeen offshore profiles. The wave refraction diagrams generated were then compared in order to facilitate the runup values generated for each of the 17 profiles to be extended throughout the entire project area.

As discussed, the 100 year flood limit is shown on the Series 1 Mapping. Due to the scale of the mapping however, the accuracy that can be obtained is limited. The Authorities would be advised to survey the 100 year flood limit in the field when advising property owners. Flood limits are summarized for each reach in Table 7.1.

As discussed in Section 7.1.2, a value of 30 m was added to the flood and erosion limits in beach areas. This is the limit of the regulatory dynamic beach zone as set out in the MNR draft shoreline policy document.

TABLE 7.1 - 100 YEAR SET-BACK AND FLOOD LIMITS

Shoreline Reach	100 Year Erosion Set-back (m)	100 Year Flood Limit (m I.G.L.D)
1	30	77.29
2	40	75.97
3	30	77.29
4	40*	75.97
5	30	77.29
6	30	77.29
7	40*	75.97
8	33	77.29
9	36	77.29
10	40*	75.90
11	67*	75.90
12	40*	75.90
13	66	77.49
14	50	77.49
15	78	77.49
16	40*	76.27
17	36	76.27
18	40	76.27
19	70	77.69
20	33	76.27
21	78	77.69
22	81	77.69
23	33	76.27
24	87	77.69
25	30	76.27

TABLE 7.1 - 100 YEAR SET-BACK AND FLOOD LIMITS
(Cont'd)

Shoreline Reach	100 Year Erosion Set-back (m)	100 Year Flood Limit (m I.G.L.D)
26	123	77.69
27	79	77.69
28	40*	76.63
29	112	77.69
30	48	77.69
31	40*	76.63
32	90	77.69
33	40*	76.63
34	44	78.64
35	40*	78.06
36	49	78.64
37	40*	78.06
38	49	78.64
39	40*	78.06
40	36*	78.06
41	40*	78.06
42	40*	78.06
43	37	77.60
44	36	77.60
45	30	77.60
46	37*	77.31
47	35*	77.31
48	30*	77.31
49	40*	77.31
50	45	78.44
51	45	76.73
52	30*	76.73

TABLE 7.1 - 100 YEAR SET-BACK AND FLOOD LIMITS (Cont'd)

Shoreline Reach	100 Year Erosion Set-back (m)	100 Year Flood Limit (m I.G.L.D)
53	45	76.73
54	45	76.73
55	45	76.76
56	45	76.76
57	35*	75.85
58	35*	75.85
59	35*	76.02
60	35*	75.85
61	35*	75.85
62	35*	76.17
63	35*	76.17
64	35*	76.17
65	35*	76.17
66	35*	76.17

Notes
1. *indicates ΔS which is not a set-back (see Section 7.1.2)
2. For conversion to G.S.C., add D to I.G.L.D. elevation where
   D = 0.08 m at Toronto
   D = 0.07 m at Cobourg
   D = 0.14 m at Kingston

100-YEAR SET-BACK AND FLOOD LIMITS FOR LAKE ONTARIO

(elevations revised to G.S.C.) December 16, 1992

Shoreline Reach	100 Year Erosion Set-back (m)	100 Year Flood Limit (m) I.G.L.D.	100 Year Flood Limit (m) G.S.C. I.G.L.D - 0.06m
45	30	77.60	77.54
46	37*	77.31	77.25
47	35*	77.31	77.25
48	30*	77.31	77.25
49	40*	77.31	77.25
50	45	78.44	78.38
51	45	76.73	76.67
52	30*	76.73	76.67
53	45	76.73	76.67
54	45	76.73	76.67
55	45	76.76	76.70
56	45	76.76	76.70
57	35*	75.85	75.79
58	35*	75.85	75.79
59	35*	76.02	75.96
60	35*	75.85	75.79
61	35*	75.85	75.79
62	35*	76.17	76.11
63	35*	76.17	76.11
64	35*	76.17	76.11
65	35*	76.17	76.11
66	35*	76.17	76.11

Notes

1. *indicates ▲S which is not a set-back (see section 7.1.2 of Plan)
2. Conversion to G.S.C. based upon the following:

~~Add D to I.G.L.D. elevation where~~

~~D = 0.08m at Toronto~~
~~**D = 0.07m at Cobourg**~~
~~D = 0.14m at Kingston~~

Note revised method for Conversion to G.S.C

Subtract 0.06 from I.G.L.D. elevation
(as per telephone conversations with Canadian Hydrographic Service: 416-336-4844)

Source: *Table 7.1 - Lake Ontario Shoreline Management Plan*

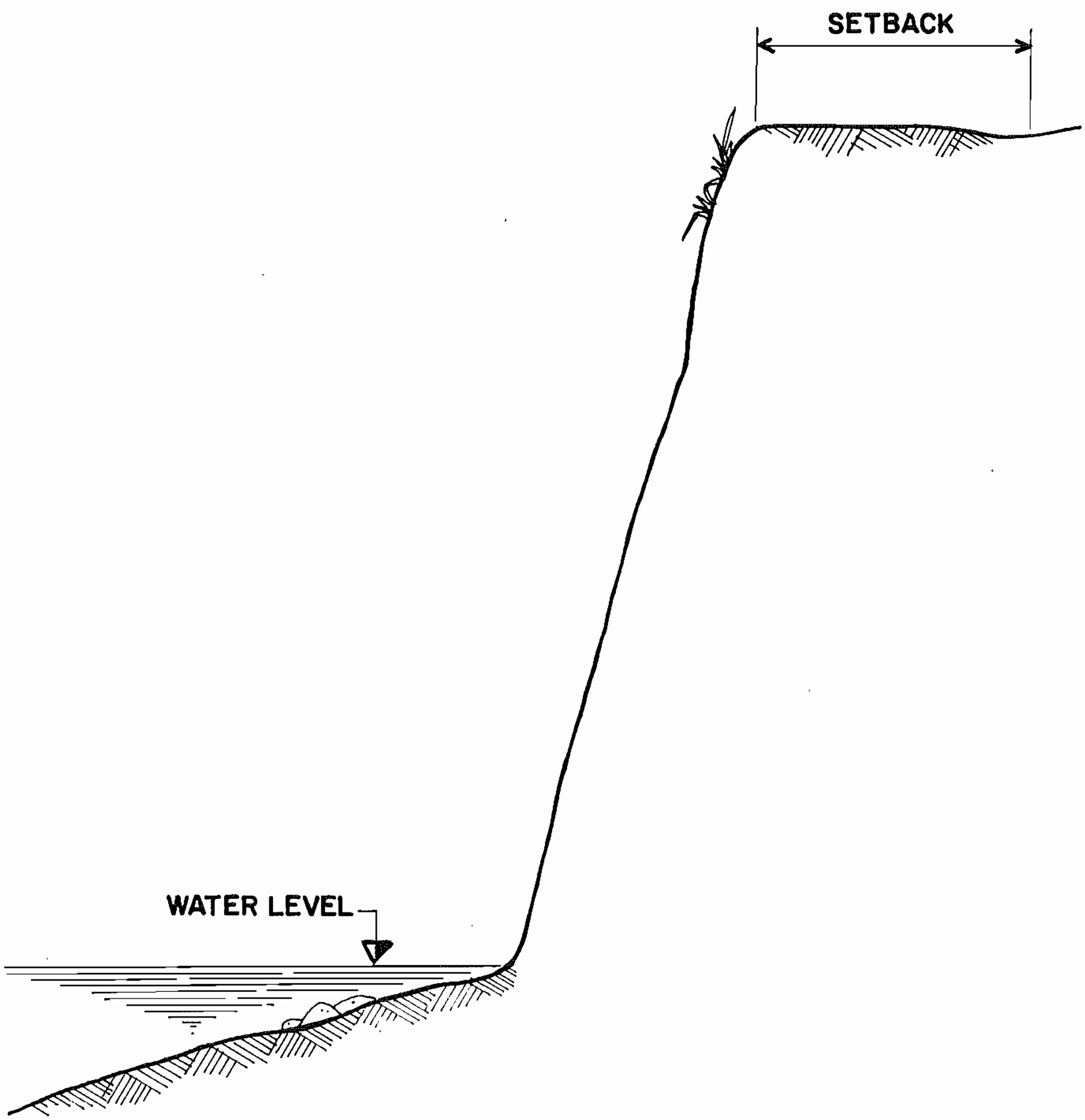


FIGURE 7·1 BLUFF EROSION SET BACK

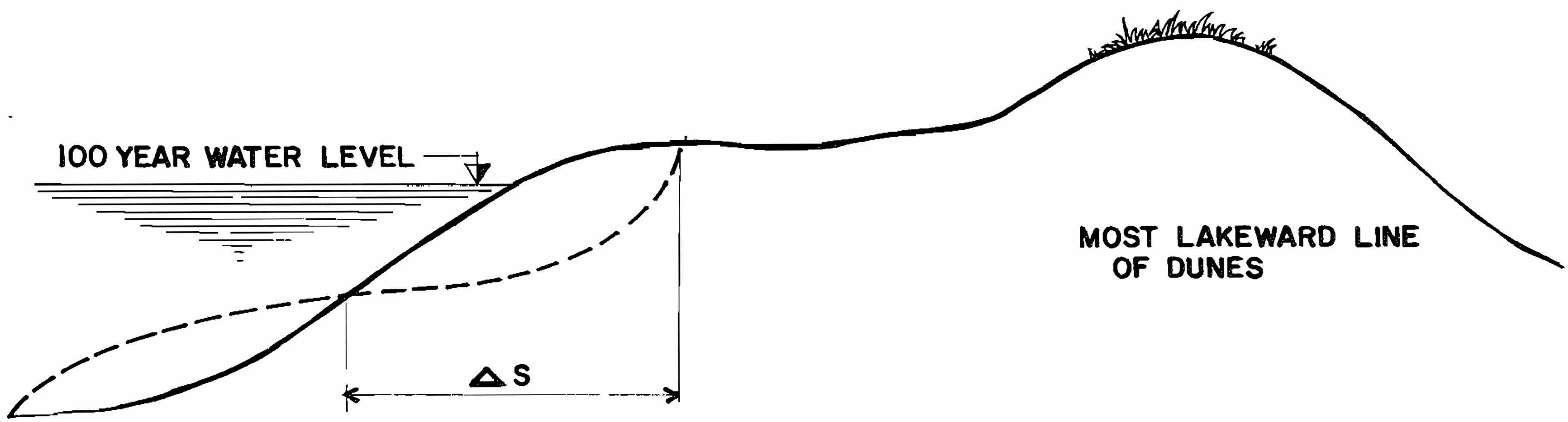


FIGURE 7·2 BEACH EROSION POTENTIAL

8.0 DAMAGE CENTRES AND MONITORING STATIONS

8.1 Damage Centres

Damage centres are defined as areas of high risk due to flooding or erosion potential. They include shorelines subject to high erosion rates, low lying regions prone to flooding and areas where structures are located in close proximity to the shoreline. Seventeen damage centres were identified by the Conservation Authorities for special attention. These sites are described in detail below. In each case, the cause of damage as well as potential for further damage are discussed. Finally, protective measures are recommended.

8.1.1 Town of Whitby Lots 19, 20, 21, Broken Front Concession Damage Centre C1 (Map 2.2) (Reach #6)

This shoreline is characterized by marsh rising in the west to a low bluff. The marsh which is designated as an environmental protection area, is prone to flooding during storm events. The bluff is subject to relatively high erosion rates which threaten a road and a number of houses located near the top of the bluff. Various forms of protection have been used including railway ties, concrete rubble, gabions and concrete walls.

The area is prone to erosion because of its orientation and its close proximity to Thickson's Point which acts as a partial littoral barrier. The shoreline downdrift (east) of the point is therefore starved of sediment.

It is recommended that the marsh be left unprotected in its natural state. Where protection works are required along the bluff and in front of structures, an armourstone revetment such as those shown in Figures 10.1 to 10.3 is recommended.

Many of the existing works may not stand up to severe wave attack or 1 in 100 year wave conditions and the owners may wish to upgrade their shore protection. In particular, vertical walls tend to reflect wave energy and cause scour at the toe of the structure. This can eventually result in undermining. Geotextile and armourstone placed in front of such a wall reduce scour and protect the structure.

8.0 DAMAGE CENTRES (Cont'd)

8.1.2 City of Oshawa Lots 10, 11, 12, Concession BF Damage Centre C2 (Map 2.3) (Reach #9)

This damage centre, located approximately 2 km. west of Oshawa Harbour is a residential subdivision. The shoreline varies from moderately high, actively eroding bluffs to narrow beach in the east. Various forms of protection have been used including old tires, scrap concrete, culverts, oil drums, steel sheet piling, railway ties and concrete cubes filled with sand.

The shoreline at this damage centre protrudes lakeward relative to adjacent shorelines. It is therefore a natural area for wave energy concentration and will continue to erode unless protected. Indeed, the reason that the shoreline protrudes may be because it was protected in the past.

Many of the existing structures are inadequate, ie. precast concrete wall in Lot 11, steel drums in Lot 10. They will be somewhat damaged in normal storm activity and would certainly be significantly damaged during the design storm.

The recommended form of protection for the bluffs is an armourstone revetment such as that shown in Figures 10.2 and 10.3. Where vertical walls protect bluff or bank, geotextile and armourstone are recommended in front of the wall. This will reduce wave reflection and scour.

The protection methods used on the beach at present are totally inappropriate although they offer a short term solution to the erosion problem. Vertical walls will discourage beach formation and aggravate the erosion problem in the long run.

The ideal solution would involve maintaining an artificially placed beach between headlands or behind offshore breakwaters such as the scheme used at Lakeside Park in Oshawa. Such a scheme could cost up to $1,000,000 and is most certainly out of the question for private homeowners. Public acquisition of these properties as they become available should be considered and the area eventually converted to parkland with protection as discussed.

8.0 DAMAGE CENTRES (Cont'd)

8.1.3 City of Oshawa Lot 8, Concession BF
Damage Centre C3 (Map 2.3) (Reach #10)

The shoreline west of Lakeview Park rises to form a steep bluff which protrudes into the lake. A number of houses are located on the headland which extends westward for approximately 100 metres before the shoreline drops off again. Because this feature protrudes into the lake, it is a natural focal point for wave energy.

Some filling has been done in the past and concrete slabs provide some protection. However, unless the shoreline is properly protected, it will continue to erode. It should also be noted that a long-term acquisition program is being pursued by the City of Oshawa subject to budgetary conditions.

8.1.4 Port Darlington Beach
Damage Centre C4 (Map 2.7) (Reach #17)

The beach west of Port Darlington can be described as a sand spit backed by marshland, located at the mouth of Bowmanville Creek and adjacent to Westside Creek. The marshland is a designated environmentally sensitive area. Approximately 50 houses are located on this spit (Cedar Crest Beach Cottage Development) which has a maximum elevation of approximately 76.5 metres IGLD. The area is at risk from flooding of the river as well as from flooding due to wave activity on Lake Ontario.

The major problem with protecting this shoreline is the cost. Because the shoreline must be protected from both sides the cost is at least double what it would normally be and this may be too much for most property owners.

Ideally, the properties should be protected from river flooding by a clay dyke. On the lakeward face, a beach widening scheme should be implemented. This would involve importing and placing sand on the beach and containing the sand between hardpoints or behind offshore breakwaters. Detailed studies would be required to ensure that widening of the beach would not lead to a siltation problem in the harbour approach channel.

There is currently an acquisition plan that covers a part of this beach. The appropriate agency may consider acquisition of the entire beach area.

8.0 DAMAGE CENTRES (Cont'd)

8.1.5 Newcastle

Damage Centre G1 (Map 2.8) (Reach #25)

Low lying land in the vicinity of Newcastle Harbour is prone to flooding. The marina is located at an elevation of 76.5 metres IGLD. Two houses east of the marina are subject to flooding when water levels exceed 76.9 metres IGLD. The shoreline rises to the east where the bluffs reach heights of approximately 15 metres. Lakeshore Road which parallels the river east of the marina is threatened as the shoreline is actively eroding. Different schemes have been considered in the past, including moving the road away from the lake.

8.1.6 Bouchette Point

Damage Centre G2 (Map 2.10) (Reach #26, 27)

The shoreline in the vicinity of Bouchette Point is characterized by high eroding bluffs. The bluffs are broken by a stream which empties into Lake Ontario at the point. At the mouth of the stream, a house located some 12 metres from the shoreline is potentially at risk from flooding and erosion of the low lying area. The owner has protected the property with steel drums. The point forms a natural area of wave energy concentration which will reduce the effectiveness of any shore protection.

The property owner at the river mouth may wish to place armourstone in front of the steel drums to reduce wave reflection and thereby extend the life of the structure. Ideally a low armourstone revetment such as those shown in Figure 10.1a and b would be preferred for this shoreline. As protection of the adjacent bluffs is not recommended, they will naturally continue to recede and the property will eventually experience erosion problems regardless of how well it is protected. Relocation may be a long-term solution. Flooding from the river during storm events is also anticipated to be a problem however recommendations in this regard are beyond the scope of this study.

8.1.7 Port Granby

Damage Centre G3 (Map 2.10) (Reach #29)

Cameco has a low level nuclear waste disposal site located at Port Granby. The settling ponds are set back approximately 120 metres from the top of the bluff at an elevation of 112 metres IGLD. This is well outside the 100 year flood and erosion limits, however, the authorities would be well advised to monitor this site due to the potential environmental risk if the site were to be exposed. The erosion rate of the gullies at the site should also be monitored. There are currently also landfill areas which may be subject to erosion thus threatening the settling ponds.

8.0 DAMAGE CENTRES (Cont'd)

8.1.8 Willow Beach
Damage Centre G4 (Map 2.11) (Reach #31)

This site is characterized by a sandy beach backed by a number of houses as well as a road. Various types of shore protection have been used including a vertical concrete wall, and some armourstone revetment (limited). The concrete retaining wall appears to be on the point of failure and the end of the road which is adjacent to this wall is currently threatened. East of this wall, the beach narrows and trees falling into the lake are to be seen.

As with other beach sites, the optimum erosion protection method, beach filling, is a fairly costly option. A workable solution may be the adoption of a combination of beach filling placed between short groynes or submerged offshore breakwaters or "hardpoints". Failing this approach, the individual properties may be protected by a flexible revetment, although it is likely that the beach will continue to erode unless some form of beach filling is implemented.

8.1.9 Port Britain
Damage Centre G5 (Map 2.12) (Reach #33)

The shoreline at Port Britain is typically beach backed by marsh. It is also designated as an environmentally sensitive area. Several houses are located on the beach at an elevation of 77.1 metres IGLD and are prone to flooding. The shoreline is protected to some degree by concrete cylinders and walls, however this protection is not adequate.

Two alternative protection schemes can be recommended for this shoreline. The first is preferable from a shoreline management point of view however it is more costly and not likely to be possible for the average property owner. This involves placing beach material to widen the beach and installing hardpoints or offshore breakwaters to hold the beach.

The second, less costly alternative is to place a revetment such as that shown in Figure 10.1a or 10.1b. Where vertical walls exist, armourstone should be placed in front of the wall to reduce wave scour.

8.0 DAMAGE CENTRES (Cont'd)

8.1.10 Hope Township Lots 13 and 14.

Damage Centre G6 (Map 2.12) (Reach #36)

The shoreline east of Otty Point is characterized by low bluffs. A number of cottages are located at an elevation of 77.5 metres IGLD and are at risk from flooding. The recommended form of shore protection for this area is similar to that shown in Figure 10.1 a. It should be emphasized that continuity of protection between properties is important and should be encouraged.

8.1.11 Port Hope

Damage Centre G7 (Map 2.13) (Reach #37)

A number of structures in the vicinity of Port Hope Harbour are located below the 100 year flood level. These include the Water Treatment Plant, Cameco, uranium refinery, Port Hope Yacht Club, a building at Madison and Mill Street south and the Port Hope Sewage Treatment Plant. Floodproofing and/or isolation of these structures is an option which should be investigated in greater detail.

8.1.12 Cobourg

Damage Centre G8 (Map 1.16) (Reach #41, 42)

A number of structures within the town of Cobourg are at risk due to flooding and erosion potential. These include:

- erosion and flooding at Pebble Beach
- erosion threatening Monk Street
- three houses on Cedarmere Street
- housing on Durham Street
- Victoria Park
- Bay Street flooding
- Shoreline between Green and Henry Streets.

Erosion protection methods recommended for this area might include a revetment type structure similar to those presented in Chapter 10. Alleviation of flooding problems might be achieved through floodproofing of structures. This however would have to be done on a case-by-case approach.

8.0 DAMAGE CENTRES (Cont'd)

8.1.13 Lakeshore Drive, Cobourg
Damage Centre G9 (Map 2.16) (Reach #43)

This shoreline is characterized by a moderately high, actively eroding bluff. Approximately 33 homes are at risk from erosion. A number of types of shore protection have been used including sandbags, well pipe, a concrete wall and scrap concrete.

The recommended protection along this shoreline is an armourstone revetment such as that shown in Figure 10.2 or 10.3. Continuity of protection between properties should be encouraged. Where vertical walls are in place, the owners may wish to consider placing armourstone at the toe to reduce wave scour.

8.1.14 Lakeshore Pentecostal Camp
Damage Centre G10 (Map 2.17) (Reach #44)

The camp buildings are located approximately 10 metres back from a 3 m bluff. A number of the buildings are within the 100 year erosion limit. At present, the shoreline is protected by fieldstone, rubble, railway ties, concrete walls and small groynes.

The property owners would be advised to place a properly engineered structure along the toe of the bluff similar to those shown in Figure 10.2 and 10.3. Most of the existing protection consists of dumped rubble and stone however geotextile has not been placed and there is the potential for leaching of fines through the existing protection material.

8.1.15 Haldimand Township, Lots 28, 29, 30 and 31, Concession A
Damage Centre L1 (Map 2.18) (Reach #46)

This damage centre is characterized by a low bluff fronted by a 15 metre wide beach. A subdivision known as Grafton Shores was located approximately 50 metres back from the bluff crest in 1980. At the time of construction, this was the 100 year erosion limit. The property between the subdivision and waterline now belongs to the Conservation Authority and is known as Hortop Conservation Area.

The 100 year erosion set back for this reach is 15 metres, which is well within the 50 metre margin created by the Authority. It would therefore seem unnecessary to protect the shoreline at present. If however, a decision is made to introduce shore protection at some future date then an armourstone revetment such as those shown in Figure 10.2 or 10.3 would be recommended. The Authority would be well advised to continue the monitoring of erosion rates at this site.

8.0 DAMAGE CENTRES (Cont'd)

8.1.16 Victoria Beach Loughbreeze
Damage Centre L2 (Map 2.21) (Reach #54)

This damage centre includes Lots 28 and 29 of Cramahe Township. The area was once characteristically seasonal residential and is slowly being converted to year round dwellings.

A creek enters Lake Ontario at the west end of the site, at Loughbreeze. This area is prone to flooding during storm events. The shoreline rises to the east at Victoria Beach where low bluffs are fronted by a shingle beach. The bluffs are subject to erosion particularly during high water levels. A number of different types of shore protection have been used including concrete well heads and armourstone.

The most cost effective protection for this shoreline is an armourstone revetment such as those shown in Figure 10.1. Continuity between adjacent properties should be encouraged. Many of the properties are presently protected by armourstone, however in a number of cases the stone appears to have been dumped without an underlying layer of filter fabric.

During high water levels and storm activity there is a risk that bluff material will leach out from between the stones and the structure will fail. The owners should be made aware of this possibility.

8.1.17 Stony Point to Barcovan Beach
Damage Centre L3 (Maps 2.26, 2.28) (Reach #61, 62, 63, 64, 65)

Located at the east end of the study area this stretch of shoreline is developing as a residential area. The shoreline is characterized by low banks and marshland and it is prone to flooding. Protection efforts of varying size and effectiveness are found including scrap concrete, paved concrete walls, steel caissons and armourstone.

Armourstone revetments such as those given in Figure 10.1a and 10.1b are the recommended form of protection for this shoreline. There are a number of environmentally sensitive sites within the area and these should be left in their natural state wherever possible.

Where flooding is a problem, property owners may consider a number of options. If the structure is a cottage without foundations then the least costly solution may be to raise the cottage on blocks or to move it to a higher elevation. Where the structure is more permanent, dyking may be required.

In all cases continuity of protection between adjacent properties should be encouraged.

8.0 DAMAGE CENTRES (Cont'd)

8.2 Erosion Monitoring Stations

The shoreline erosion monitoring programme for the Great Lakes was initiated in 1973 under the direction of both federal and provincial governments. Profile surveying was carried out on an annual basis from 1973 to 1980 at which time the programme was terminated. Measurements were then taken intermittently between 1980 and 1989.

Twenty three erosion monitoring stations (EMS) lie within the study area. Some are well situated and give representative erosion rates for the adjacent shoreline, however, this is not always the case. A number of EMS have been identified as problem stations because they give misleading shoreline recession rates. Generally, they seem to have been located for the convenience of surveying rather than the purpose for which they were intended. The stations and associated problems are listed following:

Problem Stations and Associated Concerns

Station Number	Problem
06-029	located in a gully
06-035	not perpendicular to shoreline
07-022A	not perpendicular to shoreline
07-040	located in a gully
08-015	located at creek mouth
08-025	not perpendicular to shoreline
08-040	located on a creek bank

It should be recognized that these stations will not give representative erosion rates. Furthermore where stations are not shore perpendicular, this should be corrected.

There are also substantial lengths of shoreline within the study area that are unmonitored. It is recommended that new monitoring stations be introduced to fill these gaps. Suggested sites are given in Appendix C.

8.0 DAMAGE CENTRES (Cont'd)

When locating a new station, it is important that the Authority balance the requirement of easy access for surveying, with the site suitability for erosion monitoring. The following characteristics should be considered:

- the shoreline should be relatively straight on either side
- no EMS should be located in a gully or at a creek mouth
- the survey line should be perpendicular to the shoreline
- a number of permanent bench marks should be well located to facilitate the reliability of annual surveys.

9.0 ENVIRONMENTALLY-SENSITIVE SHORELINE AREAS WITHIN THE STUDY SITE

9.1 Introduction

The environmental sensitivity of a given area of shoreline was evaluated for the physical terrain, forests, wildlife and fisheries within the study area. The criteria used for the evaluations are as follows:

A. Significant Terrain

- Flood-prone areas and wetlands.
- Areas serving groundwater functions.
- Headwater source areas.
- Erosion-prone areas.
- Significant geomorphological landforms.

B. Significant Forests

- Forests serving important environmental functions.
- Forests possessing unusual attributes.

C. Significant Wildlife

- Areas of suitable habitat for important wildlife considerations.
- Areas where rare/uncommon animals have been known to occur.

D. Significant Fisheries

- Suitable spawning areas.
- Conditions suitable for and/or the presence of cold- and warm-water fisheries.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

Important riverine systems are listed following:

Coldwater Stream Fishery	Warmwater Stream Fishery
• Wilmot Creek	• Lynde Creek
• Newtonville Creek	• Pringle Creek
• Port Granby Creek	• Oshawa Creek
• Port Britain Creek	• Harmony Creek
• Ganaraska River	• Robinson Creek
• Gage Creek	• Tooley Creek
• Cobourg Creek	
• Lucas Point Creek	
• Barnum House Creek	
• Shelter Valley Brook	
• Lakeport Creek	
• Bowmanville Creek	
• Soper Creek	
• Fairwell Creek	
• Crysler Point Creek	
• Brook Road Creek	
• Grafton Creek	
• Wicklow Creek	

9.2 Mapping the Sensitive Areas

Sensitive areas within the Lake Ontario shoreline study area are outlined on the mapping in Appendix D. All sensitive areas are indicated by hatching and given a reference number. The specific sensitive areas within the study area are listed in Table 9.1 and discussed below.

TABLE 9.1

LIST OF SPECIFIC SENSITIVE AREAS WITHIN THE LAKE ONTARIO SHORELINE STUDY AREA

Reference No.[1]	Reach No.	Defined Sensitivity[2]
1	2	Le Vay's - Cranberry Marsh
2	2	Lynde Shores
3	4	Whitby Harbour
4	7	Camp X Marsh - Thickson's Woods
5	10	Pumphouse Marsh
6	11	Oshawa Harbour
7	12	Oshawa Second Marsh
8	12	Darlington Provincial Park
9	12	Robinson Creek
10	13	Tooley Creek
11	16	Darlington Creek
12	17	Westside Marsh
13	18	Bowmanville Creek
14	26	Wilmot Creek
15	26	Bond Head Bluffs
16	30	Crysler Point Bluff
17	31	Wesleyville Marsh
18	33	Willowbeach Marsh
19	37	Ganaraska River
20	39	Carr Marsh
21	46	Barnum House Creek
22	47	Lot 25 Haldimand Township
23	48	Shelter Valley Creek
24	48	Wicklow Station
25	51	Colborne Creek
26	54	Loughbreeze Creek
27	55	Salem Creek
28	55	Spencer Point Creek
29	56	Hunt and Beach Woodlands
30	53	Butler Creek
31	57	Presqu'ile Park
32	60	Presqu'ile Bay
33	60	Stony Point
34	61	Shoal Point
35	66	Young Cove

[1] See attached set of maps for relative locations along the shoreline
[2] Details given in the text

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

1. LeVay's-Cranberry Marsh

This highly sensitive wetland receives only local drainage and is not physically connected to any major watercourse or to the lake (as most of the Lake Ontario marshes in the study area). It is an important nesting and feeding area for migratory birds, and is one of the most important nesting locations for many uncommon bird species. Uncommon amphibians and reptiles also occur here.

2. Lynde Shores

This highly sensitive wetland and wooded area occupies the lower extent of Lynde Creek and a western tributary from Highway 401 south to Lake Ontario. The marsh is a stopover area for migratory birds, and uncommon birds nest here. Reports of uncommon amphibians and reptiles exist. Located at the mouth of Lynde Creek, this high quality marsh represents the entrance to upstream spawning beds for migratory rainbow trout from Lake Ontario. Lynde Creek is classified as a warmwater stream fishery. The wetland acts as a regulator of water level variations as a result of Great Lakes water level fluctuations and spring runoff. The extensive wooded area (Lynde Shores Woods) provides wildlife habitat and supports a diverse forest association. It represents the only large stand of black willow in the Central Lake Ontario Conservation Authority area.

3. Whitby Harbour

Whitby Harbour is located at the mouth of Pringle Creek, a warmwater stream fishery, and has some areas exhibiting a moderate sensitivity. The terrain is characterized by wetlands. Disturbance in one part of this physical unit may affect biophysical conditions nearby. Although the harbour provides seasonal shelter to migrating birds, it is not regarded as a significant wildlife area.

4. 'Camp X' Marsh-Thickson's Woods

'Camp X' Marsh-Thickson's Woods occupy the mouth of Corbett Creek in a wetland setting. The small wooded areas along the northwest and eastern margins of the marsh are diverse and constitute significant shoreline forest with rate plants and afford good wildlife habitat. Migratory birds stage in the marsh and uncommon bird species have been reported to breed in this area. The local MNR officials feel this creek has significant fish potential, and local naturalists note the marsh to be an important bird watching area. For these reasons, the marsh and woodlot are highly sensitive.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

5. Pumphouse Marsh

The pumphouse marsh is an important ecological area. The MNR has rated the wetland as a Class 3. The area is known for occupation by trumpet swans, black terns (provincially significant) and a wide variety of other wildlife species. The marsh is also an important passerine staging area. The marsh is frequently used for educational purposes and is slightly disturbed by 'backwash' from the Oshawa Water Filtration Plant.

6. Oshawa Harbour

Oshawa Harbour, located at the mouth of Oshawa Creek, is surrounded by terrain characterized by a high watertable. Wetlands adjacent to the harbour area have become eutrophic due to septic system nutrients and macrophyte growth restricts open water for waterfowl, but many marsh birds nest in the area. Migrating waterfowl use the harbour and adjacent wetlands for shelter.

Some stream-spawning fish from Lake Ontario including rainbow or brown trout enter Oshawa Creek at this point; nonetheless, wildlife utilization is thought to be minor. The immediate harbour and valley bottom lands associated with the area are regarded as having low to moderate sensitivity as a result of physical factors.

7. Oshawa Second Marsh

This unusually large Lake Ontario wetland is highly sensitive to disturbance, owing mainly to significant wildlife and fisheries factors. It is fringed to the north by the Ghost Road bush, which adds to the variety of wildlife habitat available. The marsh supports a substantial number of birds uncommon to the area but which breed here. A large variety of amphibians and reptiles - including uncommon species - along with a diversity of mammals have been recorded here. A variety of migratory birds, including waterfowl, shorebirds and warblers, utilize the marsh as a stopover area. Wildlife management agencies utilize the site for monitoring purposes. These facts, plus the seasonal movement through the marsh of spawning rainbow trout and coho salmon from Lake Ontario, combine to make this one of the most sensitive regions in the study area.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

8. Darlington Provincial Park/McLaughlin Bay

Darlington Provincial Park is an important recreational resource in the study area. The park is particularly utilized for camping and hiking purposes. The McLaughlin Bay marsh is rated by the MNR as Class 3, meaning it is an important ecological area. A very long list of bird species is available, suggesting the marsh and adjacent areas are extensively used by a wide variety of wildlife species. Waterfowl are particularly frequent in the area. The bay is also an important spawning area for carp.

9. Robinson Creek Valley

Acting only as a conveyor of local surface drainage, this stream exhibits a low to moderate sensitivity.

10. Tooley Creek

The upper reaches of one tributary of this stream originates just within the Lake Iroquois Beach. As with Robinson Creek, this stream conveys surface drainage and has a moderately low sensitivity.

11. Darlington Creek or Bowmanville Third Marsh

Bowmanville Third Marsh receives surface drainage from Darlington Creek. The eastern branch of the stream is fed by springs from the western flank of a drumlin. No significant forests nor wildlife areas exist; hence, moderately low sensitivity is exhibited. The Bowmanville Third Marsh provides shelter to migrating birds; its wildlife role is relatively insignificant.

12. Westside Marsh

A very valuable wildlife marsh located at the base of Waverley Road and Westside Beach Road in Bowmanville. The marsh yields an abundant variety of birds, proving to be a very valuable wildlife resource. Forty variety of birds are known to frequent the area. The marsh is also an excellent breeding ground for Canada Geese, and supports a wide variety of marsh birds and wading birds. It is generally a very productive marsh for waterfowl. There is also siginficant shoreline forest and rare plants within this marsh.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

13. Lower Bowmanville Creek

This area includes Bowmanville First Marsh and extends to the Goodyear Dam. This reach is regarded as highly sensitive because of the presence of a warm-water sport fishery and a spring spawning run of rainbow trout to this point. The Bowmanville First Marsh serves as a resting area for migratory birds and supports at least one uncommon species of reptile.

14. Wilmot Creek

Wilmot Creek is environmentally sensitive because it is an area of intensive fish spawning activity and cold water fish runs. Excellent spring runs of rainbow trout and fall runs of brown trout and coho salmon occur in this stream. Wilmot Creek has been targeted as a rehabilitation stream for the reintroduction of Atlantic Salmon into Lake Ontario.

15. Bondhead Bluffs

Bondhead Bluffs are (up to 50 m) high bluffs along the Lake Ontario shoreline from Bond Head to west of Bouchette Point. Portions are vegetated with early successional apple-hawthorne-choke cherry. Willow-white birch-basswood-cedar woods are established in lower stable portions of the bluffs. There is a railway line and agricultural fields to the north. These bluffs are a candidate nature reserve and a provincially significant Area of Natural and Scientific Interest (ANSI). Unusual vegetation species are found in the area (Kaiser, 1987).

16. Crysler Point Bluff

This 4 ha (10 acre) site is situated on top of a 25- to 50-foot steep clay bluff with a sand mantle. It is southwest of Wesleyville and part of the proposed Wesleyville "B" Generating Station site. This feature harbours a large population of fringed gentian (Gentiana crinita). This species was once common on this landform. This is now the only known remaining population in the study area. The west meadow is characterized by grasses, sedges and asters; some areas are reforested with white spruce or silver maple seedlings. Also occurring are dense cedar seedling meadow with regionally rare Balsam groundsel (Senecio pauperculus), Glaucous grass-of-parnassus (Parnassia glauca) and Showy Lady's slipper (Cypripedium reginae).

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

17. Wesleyville Marsh

This 35 ha (85 acre) lakefront marsh is located at the mouth of a creek downstream from Wesleyville. It is an open water marsh with bur-reed-sedge- cattail-bulrush-sweet flag fringe, surrounded by alder carr and cedar-yellow birch-black ash swamp. There are breeding and migrating waterfowl in this marsh. It is separated from Lake Ontario by a sand and cobble beach bar vegetated with willow. It lies within Ontario Hydro's Wesleyville Generating Station property.

18. Willowbeach Marsh

This 15 ha (38 acre) marsh formed at the mouth of the creek, downstream from Port Britain, and is separated from Lake Ontario by a barrier beach bar with one outlet. It is an open body of water with a cattail-bulrush marsh, sedge meadow, marginal alder-willow carr and scrub ash-balsam poplar woods. The north end is dissected by old hydro line on fill. Several homes are adjacent to marsh. There are breeding and migrating waterfowl at present.

19. The Ganaraska River

The Ganaraska River drains through Hope Township into Lake Ontario. The river is an important coldwater stream fishery throughout its length supporting a population of brook trout, rainbow trout, brown trout and pacific salmon. The river is also a siginficant spawning area for these coldwater fish species.

20. Carr Marsh

Similar to LeVay's, Carr Marsh is also fed by surface runoff and is separated from the lake by a low sand and cobble beach bar. Wave action over the bar provides some water exchange with Lake Ontario. Scattered willow seedlings and Potentilla anserina grow sparsely on the bar. Semi-closed bur-reed-cattail marsh, sedge meadow and floating alder carr with some marginal alder scrubland comprise the marsh vegetation. The marsh offers excellent migratory and breeding waterfowl habitat. Alder-cedar swamp and cedar lowland is found on its east side. Situated between Port Hope and Cobourg, it is surrounded by agricultural fields with a railway and three radio towers near its northern edge. Carr Marsh was selected as one of the three candidate nature reserve marshes in Site District 6-13 based on its high quality and present condition. Like LeVay's Marsh (30M/15 630560), it is landlocked and has a small watershed which tends to reduce its susceptibility to pollution/sedimentation from upstream sources.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

21. Barnum House Creek

The Lindsay District of the MNR carried out field investigations and noted this to be an important wildlife resource and coldwater fishery.

22. Lot 25 Haldimand Township

Field work by local conservation authorities denoted this is an important lakeshore marsh formation.

23. Shelter Valley Creek

Studies have found this to be an important trout stream.

24. Wicklow Station

The LTRCA Interim Watershed Plan, MNR (Lindsay District), labelled Wicklaw Station as an environmentally significant area largely because of the important wildlife resource.

25. Colborne Creek

The Environmental Applications Group, in a study for MNR (Napanee District), rated the Colborne Creek as a Class 3 wetland. Provincially, the area is significant as rainbow trout, kokanee, coho salmon and chinook salmon spawning grounds. Regionally, the area is significant for brook trout.

26. Loughbreeze Creek

The creek is provincially significant as rainbow trout, kokanee, coho salmon and chinook salmon spawning grounds.

27. Salem Creek

Salem Creek is provincially significant for brook trout, rainbow trout, kokanee, coho salmon and chinook salmon spawning grounds.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

28. Spencer Point Creek

The creek is provincially significant as a rainbow trout, kokanee, coho salmon and chinook salmon spawning ground.

29. Hunt and Beach Road Wetlands

The Lower Trent Region Conservation Authority has noted this as an important lakeshore marsh formation. These wetlands are too small to be coonsidered provincially significant. As one of the few remaining coastal wetlands along the Lake Ontario shoreline, these formations warrant protection.

30. Butler Creek

Provincially, the creek is significant as a brown trout, rainbow trout and salmon spawning area. There is also a significant brook trout population.

31. Presqu'ile Park

An important recreational area utilized by birders, anglers, campers and sunbathers/swimmers. Historically, user conflicts occurred between these groups. For example, algae mats washed up on beaches are critical for shorebirds (and therefore birders), but sunbathers want the beaches to be "clean". A natural beach is now maintained for shorebird use, thus relieving this conflict. Some sitings of rare and/or endangered birds have occurred in the Park.

There are a number of sensitive geographical features in the Park such as the "fingers and pans" area and a tambolo. It is also the site of one of the largest ringbill gull colonies, and approximately 1,000 double cormorant nests.

32. Presqu'ile Bay

This is a Class 1 wetland, and is provincially significant as a waterfowl nesting area.

33. Stony Point

Given the historical rate of coastal wetland loss along the Lake Ontario shoreline, this marsh formation can be considered environmentally important. Although the marsh is too small to be listed as provincially significant, it represents a portion of a rapidly dwindling coastal resource.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

34. Shoal Point

Given the historical rate of coastal wetland loss along the Lake Ontario shoreline, this marsh formation can be considered environmentally important. Although the marsh is too small to be listed as provincially significant, it represents a portion of a rapidly dwindling coastal resource.

35. Young Cove

Given the historical rate of coastal wetland loss along the Lake Ontario shoreline, this marsh formation can be considered environmentally important. Although the marsh is too small to be listed as provincially significant, it represents a portion of a rapidly dwindling coastal resource.

9.3 Potential Areas of Concern

There are a number of environmentally significant and sensitive areas along the Lake Ontario shoreline study area. These areas include wetlands, erosion-prone shorelines, parklands and unique wildlife habitats. Of particular note is that the study area shoreline has no;

- high forest management potential areas,
- deer concentration areas, or
- woodlands improvement act sites.

This review of environmentally sensitive areas within the study site has resulted in the identification of certain areas where applications to introduce new shoreline works should be examined carefully and the Authority would be encouraged to have the project reviewed by coastal and environmental experts.

Any structures to be built updrift from, or adjacent to the environmentally sensitive areas should be considered in the light of their potential impact on the overall area.

9.0 ENVIRONMENTALLY-SENSITIVE AREAS (Cont'd)

9.4 Summary

Environmentally significant and sensitive areas have been identified for the study area along the north shore of Lake Ontario. Following a survey of the shoreline, three bluff erosion-prevention measures have been recommended. Implementation of these measures in areas of high bluff erosion will likely have minimal environmental impact as long as the identified sensitive areas are avoided. In particular, areas of fish runs, spawning areas and shoreline-sensitive or rare species should be avoided.

It is also strongly advocated that where structural protection methods are recommended, detailed site-specific studies should be undertaken to assess the potential impacts.

Finally, it is recommended that in some areas, such as the Bond Head bluffs, the aesthetic character and nature of the shoreline should be preserved.

10.0 SHORE PROTECTION CONCEPTS

The project shoreline has been divided into 66 shore reach areas each characterized by differing physiographic, wave and sediment related characteristics. Generally however, the project shoreline can be characterized by three main types, low to medium bluffs, medium to high bluffs and by beaches and/or marshes. Generic shore protection methods have been developed for each type. However, while these solutions may be technically feasible, their social or environmental acceptance may only be determined following site specific benefit/cost analyses.

10.1 Low to Medium Bluffs

Preliminary shoreline protection concepts have been developed for this type of shoreline. Because of the construction implications however, this category of shoreline has been divided into two sub-categories, low bluffs between 1-3 m high and medium bluffs between 3-10 m in height. Both of these types are typically fronted by a sand/gravel beach varying in width from 1 m to 7 m (depending on prevailing still water levels).

For the bluffs 1-3 m in height, shore protection in the form of a revetment is recommended. Because of the low height of the bluffs in this category, core material to construct the berm may be end-dumped over the top of the bluff to form the revetment. Two alternative berm types are presented in this category. The first consists of an end-dumped rock berm with material ranging in size from 7 cm. up to 0.7 m. (See Figure 10.1a). This is known as a "shovel-run" material and is obtained from the quarry blast without significant sorting. This type of shore protection is estimated at $300/metre and can be expected to be reshaped somewhat during storms. Because of this reshaping, some maintenance of the berm may be expected on a once per 2 to 5 year basis depending on the specific site and the actual design developed.

The second berm type consists of a sand and gravel core which may be end-dumped over the top of the bluff. A layer of armour stone is then placed on top of the sand/gravel core. (See Figure 10.1b) This placing may also be achieved from the top of the bluff using a backhoe with a sufficiently long reach. This method of protection is estimated at $440/metre.

10.0 SHORE PROTECTION CONCEPTS (Cont'd)

It should be noted that for both of these concepts, a filter fabric must first be placed onto the native bluff material before any dumping of berm material may be carried out. In addition, for the concept showing armour stone, filter fabric must first be placed between the sand/gravel layer and the armour stone layer.

No vertical wall concepts have been considered at this time as these are considered to be less "forgiving" than rubble mound structures. They also reinforce the reflection of wave energy from the shoreline, often with resulting scour in front of the structure. The protection concept with armour stone cover may be expected to be more resistant to reshaping than the rubble mound structure as the armour stone may be sized during the design process to undergo minimal displacement.

For medium height bluffs (these have been defined for this study to be between 3 and 10 m in height), construction may not always be able to be undertaken from the top of the bluff due to the required equipment reach capabilities, etc. For these situations, it becomes necessary to construct a haul road to the base of the bluffs and consequently along the base of the bluff. Two protection alternatives are proposed for bluffs in this category. Both require the construction of an armoured berm some distance away from the toe of the bluff. Initially this berm may be used as a construction road until the armouring is implemented. As the height of the bluff increases, it becomes increasingly important that proper drainage be afforded the face of the bluff, and in particular, the toe of the bluff. For this reason it is recommended that a drainage route be provided along the bluff face into a pervious layer of sand and gravel and out through the rock berm. It is only after the placement of this pervious layer that general fill material and/or native bluff material should be placed behind the berm.

The two alternatives presented in this category differ in that the first assumes that the bluff is mechanically graded back to a stable long-term slope (of the order of 1 vertical to 1.5 horizontal), and that the graded bluff material be placed between the toe of the bluff and the rock berm (i.e on the top of the sand and gravel filter layer, See Figure 10.2). The second alternative by contrast allows for the preservation of the top of the bluff at the start of construction and assumes that clean fill may be obtained at little or no cost (See Figure 10.3).

10.0 SHORE PROTECTION CONCEPTS (Cont'd)

The cost estimate for the first alternative is $2060/m and for the second $2100/m. Both alternatives show an interceptor drain at the top of the bluff which may be led down to a low point in the bluff structure and discharged to the beach area in a controlled manner. The use of a filter fabric is also a requirement for these two alternatives and is to be placed along the face of the bluff (where this is not exposed), between the sand and gravel layer and the rock berm, between the sand and gravel layer and the native fill material and between the rock berm and the native fill material.

10.2 High Bluffs

Sections of shoreline which have high bluffs (i.e greater than 10 m) typically present an engineering challenge in the development of stabilization options. These bluffs may not only be susceptible to sloughing and localized failures of the upper bluff face, but may also be susceptible to deep seated rotational failures. The conditions contributing to this mode of failure is made worse when drainage at the toe of the slope is blocked. This means therefore that bluff erosion and recession, and the subsequent natural deposition of cohesive material at the toe of the slope may occasionally contribute to the decrease in the geotechnical factor of safety of the bluff. This finer material is usually carried away by wave action however and fortunately is not given a chance to block the drainage at the toe of the bluff for a very long time. Overall surface drainage for bluffs in this category is often achieved by the formation of gullies and ravines. These are therefore beneficial natural features, however they often are subject to extensive erosion during times of heavy rainfall or snow melt conditions. Ideally, any bluff stabilization works for these areas should include some gully stabilization works as well.

The protection concept presented here is similar in philosophy to that shown for the medium height bluff. That is, an armoured rock berm is built away from the slope and a sand and gravel filter layer is built behind the rock berm to the toe of the bluff. This layer may also be used as a construction haul road. Drainage fabric should also be placed against the face of the bluff and should extend into the sand and gravel layer. Because of the height of the bluffs under consideration in this category, it is recommended that the bluffs be left to grade naturally back to an anticipated stable profile (1 vertical : 1.5 horizontal). It is our opinion that once wave induced toe erosion has been halted, and the bluff face is allowed to drain properly, the risk of deep seated rotational failures may be expected to diminish as the bluff attains a more stable profile in a natural manner. It is also essential that a drainage swale be provided landward of the anticipated eventual bluff line to intercept surface water run off. These drains may then be led to low points in the bluffs or to existing gullies or ravines. As mentioned above, these drainage features should be stabilized with small rip-rap. (See Figure 10.4)

The estimated unit cost for the construction of this option is $3200/metre.

10.0 SHORE PROTECTION CONCEPTS (Cont'd)

10.3 Sand and/or Gravel Beaches

There are many areas along the project shoreline where sand and gravel beaches occur. In the western section of the project shoreline the beaches that are to be found typically occur at or close to the mouths of rivers and creeks where the adjacent bluffs dip in height. These beaches are typically sandy in nature with some gravel factions to be seen. At the eastern end of the project area (east of the Bond Head bluffs) numerous beaches are to be found and the shoreline is generally lower in nature. These beaches are however typically cobble beaches with a small faction of sand or gravel.

Unlike bluffs which may be stabilized by toe protection works, beaches are dynamic in nature. During storms, beach material may be moved offshore and alongshore, thereby resulting in shallow beach profiles. During times with more normal wave events however, the beach material is usually brought back up on shore and alongshore transport rates are reduced. This cyclical mechanism of beach movement is experienced on both sand and cobble beaches.

Often, individual homeowners put structures on beaches (groynes, breakwaters, etc.) in an attempt to "hold" the beach. This often has deleterious effects on downdrift properties. Another very popular type of shoreline structure is the seawall which often accelerates the loss of beach material during storms.

One type of beach protection mechanism is recommended for this shoreline, and this consists of a series of artificial headlands and filled bays. This type of beach protection work is best suited to a joint effort by homeowners and is not at all suited to implementation by a single landowner. The bays created between the artificial headlands should be filled with a material compatible with the native beach material. This has the advantage of limiting the impact of the headland structures on the alongshore littoral transport regime.

10.0 SHORE PROTECTION CONCEPTS (Cont'd)

The estimated cost of construction of these headland/bay structures are more difficult to quantify on a per metre run basis, however the likely component costs are broken down as follows:

Headlands	$20,000 (each)
Beach Fill	$ 300/m
Mobilization/demobilization	$ 5,000

The actual number of headlands required (i.e the spacing between headlands) may only be determined on a site specific basis.

It should be noted that headland/bay systems are complex structures which should be designed by a qualified coastal engineer, as both their aerial extent and longitudinal profiles must be optimized to reduce or remove any effects on adjacent lands.

TABLE 10.1 - GENERAL RECOMMENDATIONS REGARDING SHORE PROTECTION

Reach No.	COMMENTS
5	Protection of these bluffs should not adversely affect Damage Centre C1.
7	Should be left in their natural state.
8, 9, 10	Protection of bluffs should not adversely affect adjacent shorelines including Damage Centre C2 which is in a low lying area inappropriate for houses.
12	Should be left in their natural state.
13	Avoid further protection as this may adversely affect McLaughlin Bay.
15	Protection would not be detrimental to adjacent shorelines as it is at the downdrift end of littoral cell PLSC 1.
17	Damage Centre C4 is a good candidate for beach nourishment. The beach is starved by St. Mary's Cement pier.
19, 21	Protection of these reaches may starve 18 and 20 of valuable sediment sources.
24	If a residential development occurs in the future, some consideration should be given to including a waterfront park which would provide an additional buffer beyond the set-back. Hard protection would then be avoided.
26	Bondhead Bluffs should be left in their natural state.
27, 29, 30	Bluffs should be left in their natural state.
31	This reach is characterized by low lying flood prone lands and it is therefore not suitable for development. In the long term, the Authority may wish to aquire those properties and utilize the area as some form of parkland.
32	This shoreline is zoned for future development. If a residential development occurs in the future, some consideration should be given to including a waterfront park which would provide an additional buffer beyond the set-back. Hard protection would then be avoided.
33	This reach is characterized by low lying flood prone lands and it is therefore not suitable for development. In the long term, the Authority may wish to acquire those properties and utilize the area as some form of parkland.
34	The sediment source within this littoral subcell is largely riverine. As a result, protection of Reach 34 should not have a serious detrimental effect on Reach 35 and Damage Centre G6.

TABLE 10.1 - GENERAL RECOMMENDATIONS REGARDING SHORE PROTECTION (Cont'd)

Reach No.	COMMENTS
36	Avoid protection, as this bluff is a sediment source for adjacent reaches.
39, 40	This reach is characterized by low lying flood prone lands and it is therefore not suitable for development. In the long term, the Authority may wish to aquire those properties and utilize the area as some form of parkland.
43	There are a variety of shore protection schemes within this reach, some of which are overdesigned and others underdesigned. Future shore protection developments should be more in keeping with those described in Section 10.
44, 45	Protection should be avoided as these bluffs are a source of sediment for Damage Centre G10.
46	The riverine system is contributing a large amount of beach sediment to the littoral zone.
47-49	Development of low lying areas prone to flooding should be discouraged.
53-56	Discourage development of low lying areas and protection of the shoreline as this will impact on the beaches at Presqu'ile.
57-66	Much of the shoreline is low lying and may warrant floodproofing. Littoral barriers should be avoided as they may result in downdrift erosion.

BLUFFS OF 1 - 3 m IN HEIGHT

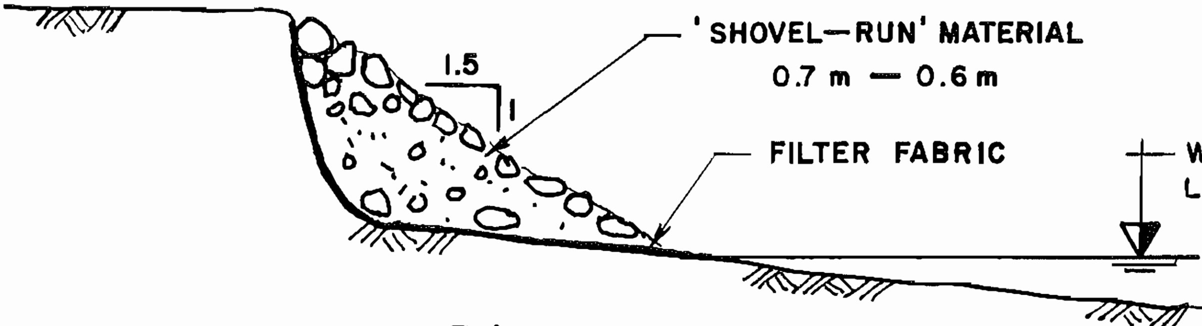
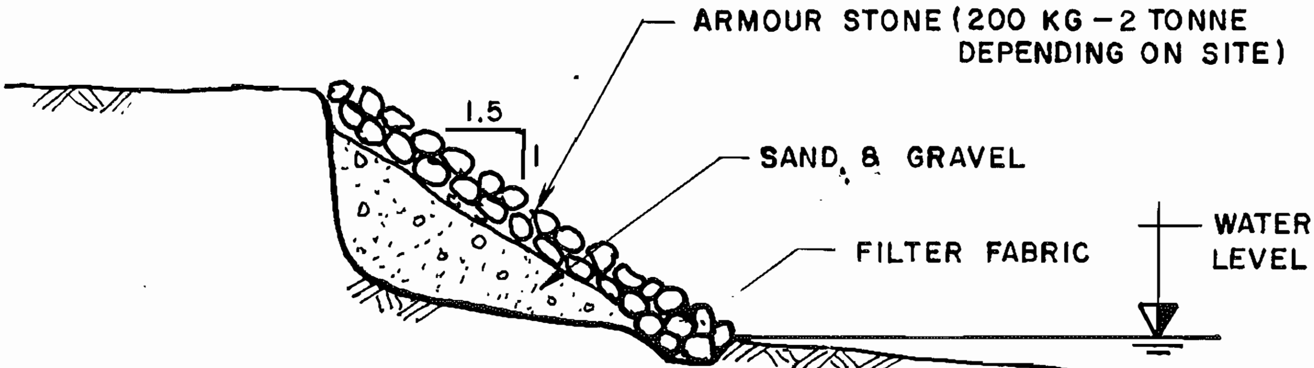


Fig. 10.1a

APPROXIMATE COST = $ 260/m

OR



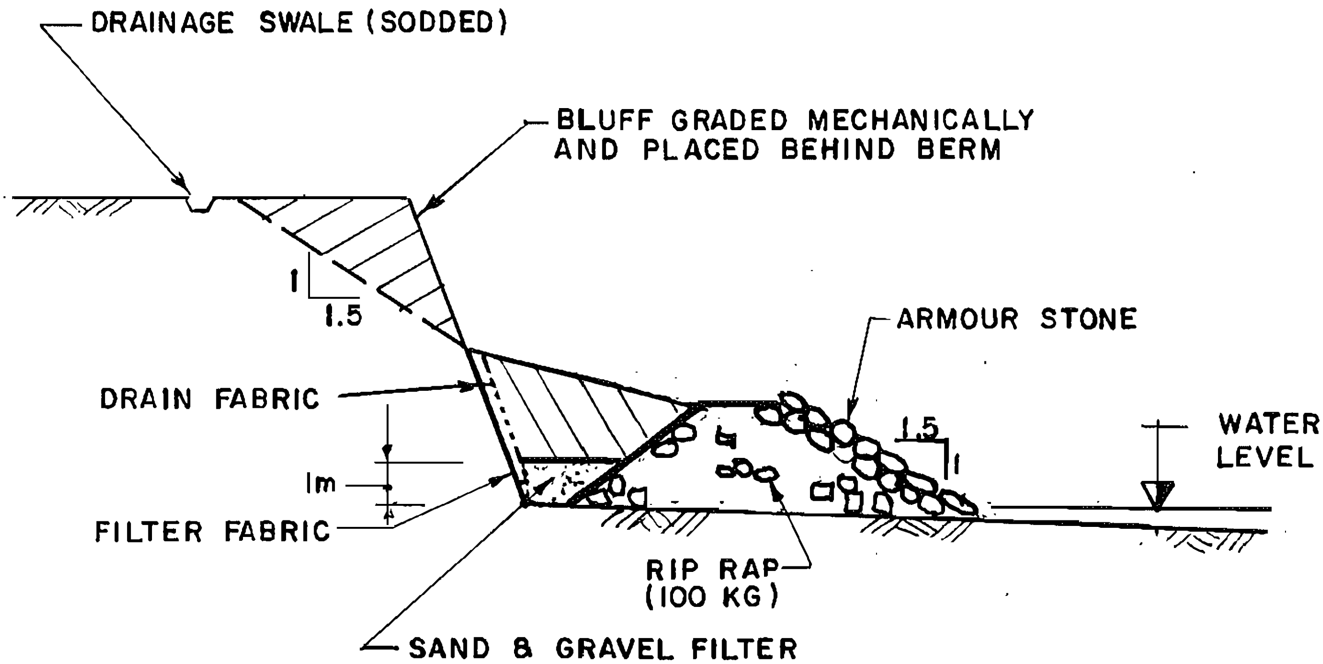
APPROXIMATE COST = $ 440/m

NOTE

THIS IS ONLY A CONCEPT DESIGN. BEFORE SHORE PROTECTION WORKS ARE CONSTRUCTED, THE SITE SHOULD BE VISITED BY AN ENGINEER AT WHICH TIME ARMOUR SIZE AND PROTECTION ELEVATIONS SHOULD BE SPECIFIED FOR THE SITE CONDITIONS.

Fig. 10.1b

BLUFFS OF 3m — 10m IN HEIGHT



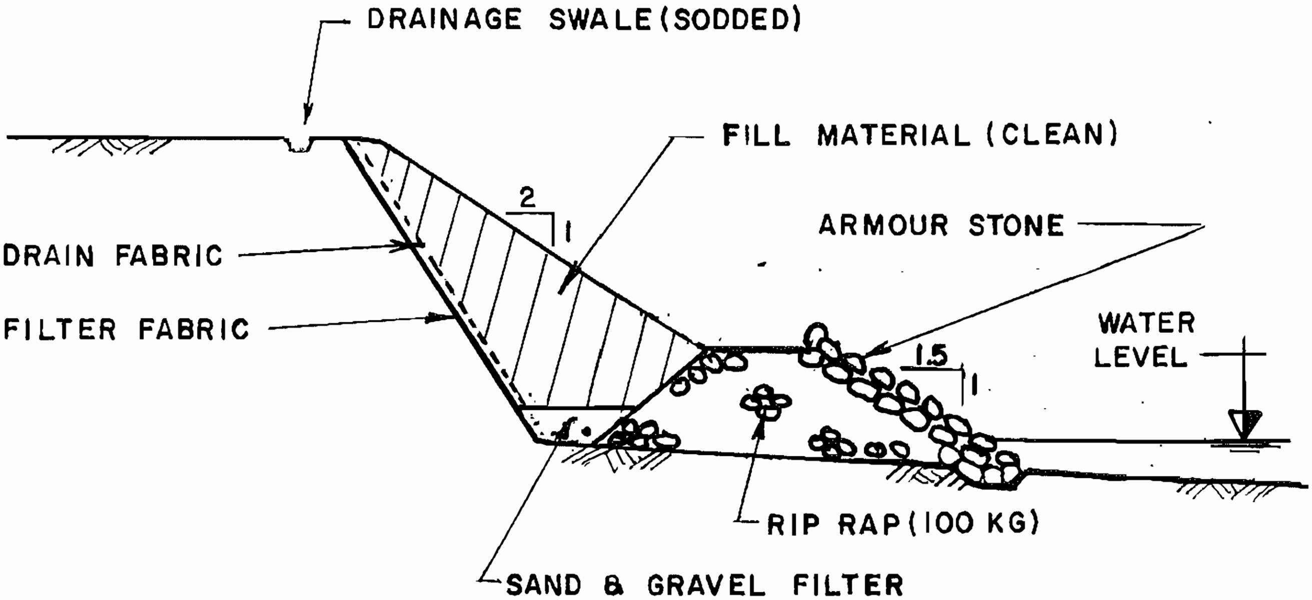
APPROXIMATE COST = $ 2060/m

NOTE

THIS IS ONLY A CONCEPT DESIGN. BEFORE SHORE PROTECTION WORKS ARE CONSTRUCTED, THE SITE SHOULD BE VISITED BY AN ENGINEER AT WHICH TIME ARMOUR SIZE AND PROTECTION ELEVATIONS SHOULD BE SPECIFIED FOR THE SITE CONDITIONS.

Fig. 10.2

BLUFFS OF 3m — 10m IN HEIGHT



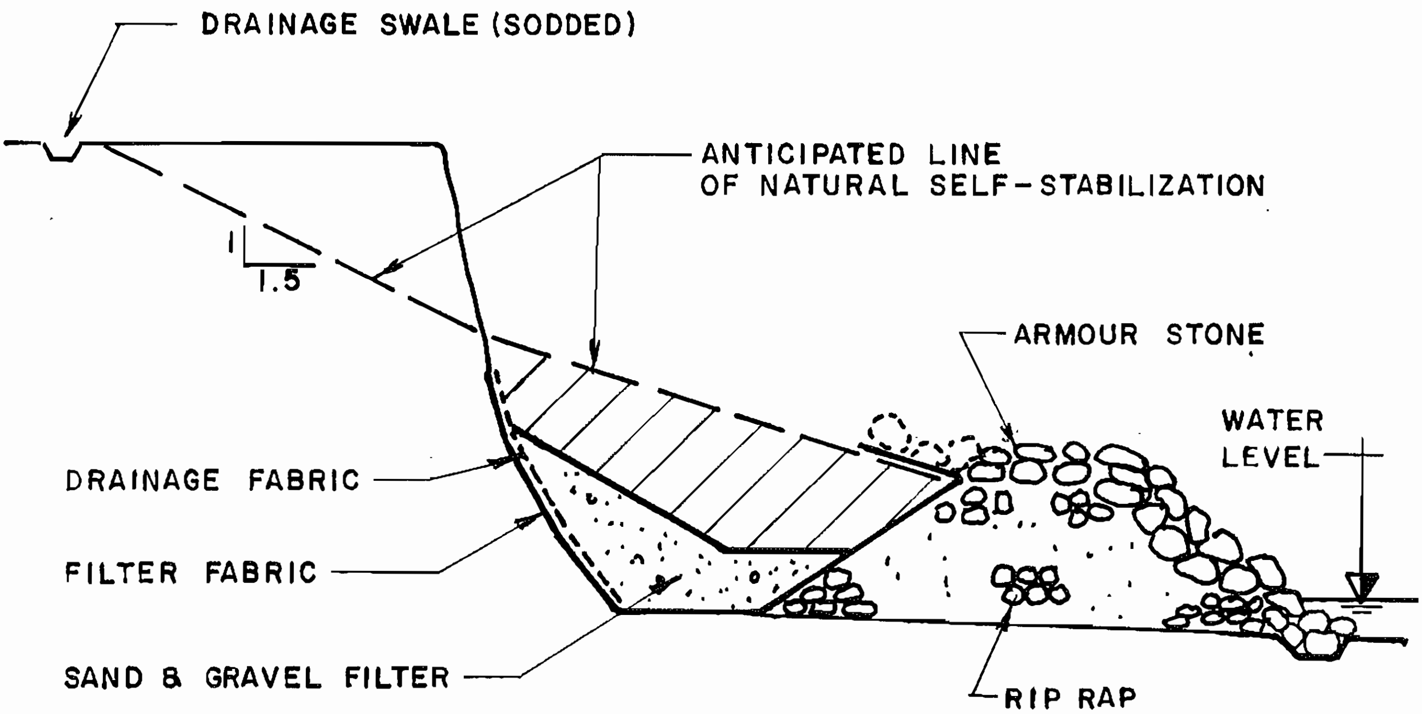
APPROXIMATE COST = $2100/m

NOTE

THIS IS ONLY A CONCEPT DESIGN. BEFORE SHORE PROTECTION WORKS ARE CONSTRUCTED, THE SITE SHOULD BE VISITED BY AN ENGINEER AT WHICH TIME ARMOUR SIZE AND PROTECTION ELEVATIONS SHOULD BE SPECIFIED FOR THE SITE CONDITIONS.

Fig. 10.3

BLUFFS OF HEIGHT GREATER THAN 10 m



APPROXIMATE COST = $ 3200/m

NOTE

THIS IS ONLY A CONCEPT DESIGN. BEFORE SHORE PROTECTION WORKS ARE CONSTRUCTED, THE SITE SHOULD BE VISITED BY AN ENGINEER AT WHICH TIME ARMOUR SIZE AND PROTECTION ELEVATIONS SHOULD BE SPECIFIED FOR THE SITE CONDITIONS.

Fig. 10.4

11.0 LAND USE CONSIDERATIONS

Land use mapping, shown on 1:10,000 maps as Series I drawings in Appendix D, is based on the official plans and zoning by-laws of the various municipalities. Both existing and designated land uses are shown.

The majority of the shoreline within this study area can be described as rural land. Urban centres generally have developed where river mouths have formed ideal locations for harbours. Examples include Whitby, Oshawa, Port Darlington, Newcastle, Port Hope and Cobourg.

The shoreline area has been subjected over the years to varying degrees and types of development. In recent years, development pressures have intensified particularly in the vicinity of existing urban areas, and in those municipalities influenced by the rapid growth of the Toronto area. This trend can be expected to continue in the future.

Due to the aesthetic and recreational characteristics of the shoreline, its hazard land features and the potential demands placed on the shoreline by both industry and new development, a number of municipalities have started to recognize the importance of this resource in their respective planning documents. This has resulted in special land use designations and/or zoning categories for specific reaches of the shoreline within the study area which has promoted coordinated planning and development, and the recognition of various factors that restrict development.

To date, however, detailed hazard land information has not been available to municipalities to aid in this effort. The information provided in this study will be made available to municipalities in order to assist in the identification and incorporation of planning policies specifically addressing the shoreline hazards within their jurisdiction.

Planning controls can be effective in ensuring compatibility of development proposals with hazard land characteristics of the shoreline. However, because of the dynamic nature of the shoreline, land use designations and zoning by-laws must be enacted in such a way that the recession/accretion processes of the lakeshore are recognized. For example, a bluff with a recession rate of .5 m/year will lose 5 m of tableland area during a 10 year period. If a hazard land designation and environmental protection zoning had been placed upon the lands, based upon the 100 year erosion limit in 1990, this land use designation and zoning would have to be extended inland by 5 m in the year 2000 in order to incorporate the appropriate setback. These revisions should be made on a regular basis with the normal updating of official plans and zoning by-laws.

11.0 **LAND USE CONSIDERATIONS (Cont'd)**

Alternatively, the practice of initially designating and zoning sufficient lands can incorporate additional tablelands to accommodate the recession of the shoreline over the years. Municipalities should choose the most suitable method of recognizing the shoreline hazard and incorporate the appropriate measures.

While planning mechanisms can be successful in controlling most development activities along the shoreline, they should be supplemented and reinforced through the implementation of shoreline regulations by the relevant conservation authorities. Some types of proposals, such as shoreline protection works and fill proposals could affect slope stability and littoral transport rates and could be difficult and cumbersome to evaluate through the traditional municipal planning process. Through the enactment of shoreline regulations, the expertise of conservation authorities, and at times the Ministry of Natural Resources, could more appropriately be applied to these situations.

12.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the analysis carried out through this study, a number of conclusions have been drawn and appropriate recommendations are listed below. In total, these recommendations provide policies to be used by the relevant conservation authorities and municipalities in managing the shoreline area.

1. Municipalities should recognize the hazard land characteristics of the shoreline, its aesthetic features and public amenities through appropriate official plan and zoning provisions.

2. Measures should be taken to protect environmentally sensitive areas along the shoreline. In particular, development proposals should not destroy or conflict with the protection of these sensitive features. The impacts of protecting updrift areas on the environmentally sensitive features must be assessed before approving protective works.

3. Acquisition of the shoreline should be considered by the appropriate agencies, where feasible and practical, because it is generally the most effective means of minimizing private property damage and risk to life resulting from shoreline hazards. It can also protect the public amenity and recreational value of the shoreline.

4. As a minimum, when acquisition is utilized as an alternative to shore protection, the area acquired should extend to the limits of the erosion and/or flooding setback of the area in question, with additional bluff lands to be set aside for open space purposes as may be required by the relevant approval agencies.

5. Acquisition of additional lands to protect sensitive areas or for recreational and aesthetic purposes should be considered by appropriate agencies as necessary and as budgets permit.

6. The implementation of shoreline protection structures must be examined on a site specific basis with regard given to potential impacts on adjacent and downdrift areas. Specific recommendations are given for various reaches in Table 12.1.

7. Prior to the implementation of any major shoreline structure, including any where it is proposed that setback limits be reduced, site specific coastal engineering studies must be completed to demonstrate their long term effectiveness and to identify potential impacts on updrift and downdrift properties. These studies must conclusively demonstrate to the satisfaction of the approving agencies that the proposed structure will function as intended.

12.0 **CONCLUSIONS AND RECOMMENDATIONS** (Cont'd)

8. Conservation Authorities through the province should establish "fill" and "construction" regulations for the shoreline which will be structured to allow authorities to control filling and construction within the setback limits and construction of shoreline protection works.

9. Prior to the establishment of any conservation authority capital works programs within the damage centres, further coastal engineering studies should be completed to further refine the design of proposed works.

10. Conservation Authorities should continue to operate the existing shoreline monitoring stations and establish those additional stations as defined in this report.

11. Site specific recommendations as to the applicability, or not, of implementing shore protection structures should be referred to in Table 10.1.

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