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LONG-TERM SHORE MANAGEMENT ALTERNATIVES POINT PELEE (EAST), LAKE ERIE

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LONG-TERM SHORE MANAGEMENT ALTERNATIVES POINT PELEE, LAKE ERIE

by

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An aerial view of the study area, April 1976 (1:51,240)

Addendum

On April 11, 1989, the findings of this report were presented by the Project Co-ordinator at a special meeting of Mersea Township Council. Landowners in the study area (Marentette Drainage Scheme) and government agencies having an interest in the management of this reach of shore were invited to attend. The Inland Waters Directorate (IWD) of the Department of Environment addressed an opportunity to undertake the follow-up Feasibility Study for Point Pelee (east) as part of a proposed multi-agency study to develop a Shore Management Plan for the Point Pelee littoral cell. IWD indicated, however, that funding was not yet approved for the study. Township Council expressed an interest in the follow-up study and, as an initial step, would circulate copies of this report for comments from the affected ratepayers, interested government agencies and local drainage scheme commissioners.

At a follow-up meeting of Township Council and government agencies on November 16, 1989, it was agreed to undertake the recommended Feasibility Study as part of the littoral cell Shore Management Plan (providing funds could be secured through IWD).

ACKNOWLEDGEMENTS

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RÉSUMÉ

Le présent rapport a été préparé pour le Service canadien des parcs d'Environnement Canada et pour Agriculture Canada. Il s'agit d'une étude rationnelle des solutions à long terme qui existent pour l'aménagement des rivages de façon à réduire l'érosion des plages et les risques d'inondation au nord du parc national de la Pointe-Pelée.

L'érosion continuelle des plages du parc a des conséquences néfastes sur l'écosystème des marais parce qu'elle change les caractéristiques physico-chimiques des marais d'eau douce. On pense que l'érosion des plages causée par un manque de sédiments le long du littoral, manque qui est lui-même le résultat d'une combinaison de facteurs, notamment la présence de dispositifs de protection du rivage contre les courants, la baisse générale de la quantité de sédiments parvenant aux plages et le niveau anormalement élevé du lac.

L'érosion des plages dans le parc national de la Pointe-Pelée et sur les rivages environnants menace d'inondation jusqu'à 263 ha (650 acres) de terres agricoles drainées. On a jusqu'à maintenant dépensé près de 3 400 000 $ en aménagements visant à réduire les risques d'inondation à ces endroits. D'après les études portant sur ces aménagements et sur d'autres projets d'endiguement du sud-ouest de l'Ontario datant du début des années 70, les coûts des travaux excèdent très probablement la valeur des terres réservées à l'agriculture et ils sont difficiles à justifier sur le plan économique, social ou environnemental.

En vue de la protection contre les dommages dus à l'inondation, on a considéré les solutions faisant appel à des constructions et celles n'en nécessitant pas. De façon que la protection apportée dure aussi longtemps que l'espérance de vie des sols drainés (10-30 années), on a examiné plusieurs options : réaménagement de la plage dans la région nord-est du parc par l'engraissement artificiel en plus de la construction d'un perré à la pointe

sud de la digue nord-sud; construction d'un perré aux endroits les plus sujets à l'érosion des sections nord-sud et est-ouest de l'ensemble de digues, sans protection des plages du parc; transformation en marécages de la partie la plus menacée des terres drainées, sans protection des plages du parc. On a aussi considéré de maintenir le statu quo.

La solution à long terme qui a été recommandée est de convertir le polder sud du projet de drainage Marentette (83 hectares ou 206 acres) en terrains marécageux. Le coût d'acquisition des terres est estimé à 1 030 000 $. On prévoit qu'il y aura des frais supplémentaires pour modifier les digues environnantes de façon à assurer l'endiguement, pour rehausser l'assiette des chaussées et installer un mécanisme de régulation des eaux (estimé à 625 000 $). Rendre de nouveau ces terres marécageuses est la seule option qui permette : une utilisation entièrement compatible avec les risques d'inondation et le recul du littoral; une utilisation et une gestion souples, dans le cas ou des organismes privés désireraient financer, effectuer et appliquer la conversion (avec possibilité d'acquisition); de mettre fin à l'entretien public permanent de terres dont les bénéfices sont d'abord privés. Étant donné que la valeur de ces terres agricoles est en baisse à cause de l'épuisement du sol, la transformation en marécage constitue aussi la seule stratégie qui permette de hausser la valeur des terres et dont la durée dépasse la période d'utilisation agricole.

On recommande aussi de faire une étude de faisabilité complémentaire pour évaluer plus en profondeur la solution à long terme recommandée ainsi que les avantages éventuels qu'il y aurait à ajouter des installations de protection temporaires de façon à maximiser le rendement des récentes dépenses d'aménagement contre les inondations. Pour parer à l'éventualité de risques d'inondation grandissants avant la mise en oeuvre d'un plan de gestion temporaire ou à long terme, il sera nécessaire d'élaborer un plan d'urgence en coopération avec tous les organismes intéressés.

SUMMARY

This report was prepared for Environment Canada, Canadian Parks Service and Agriculture Canada. It provides a conceptual review of long-term shore management alternatives to reduce beach erosion and the risk of flooding north of Point Pelee National Park.

Sustained breaching of the Park beach adversely affects the marsh ecosystem through changes in the physical and chemical characteristics of the freshwater marsh. Erosion at this particular location is thought to be due to a deficit in the littoral sediment supply as a result of a combination of factors including updrift shore protection devices, a general decline of sediment from source areas, and above average lake levels.

The threat of flooding of up to 263 ha (650 ac.) of drained agricultural land stems from beach erosion in Point Pelee National Park and the adjacent shore. Nearly $3,400K have been spent to date for engineering solutions to reduce the risk of flooding in this location. Reviews of this and other southwestern Ontario dyking schemes in the early 1970's conclude that the costs very probably exceed the value of the land for agricultural purposes, and are difficult to justify on economic, social, or environmental grounds.

Both structural and non-structural alternatives were considered in providing flood damage protection. In order to provide protection over the estimated life of the soils in the drained area (10 - 30 yrs), several options were analyzed. These consisted of: rebuilding the beach at the northeast corner of the park using artificial beach nourishment in conjunction with armouring of the south end of the north-south dyke; armouring the most erosion prone areas of the north-south and east-west sections of the dyke system, with no beach protection in the

park; and converting the most threatened section of the drained lands to wetland, with no beach protection in the park. The Do Nothing alternative was also considered.

The recommended long-term solution is to convert the south polder of the Marentette Drainage Scheme (83 ha or 206 ac.) to a wetland environment. The estimated cost of acquiring the land is $1,030K. Additional costs will be incurred for ensuring containment through modifications to the surrounding dykes, raising roadbeds and installing a water control system (estimated at $625K). Converting the lands back to wetlands is the only option that provides: a use that is fully compatible with the flood hazard and shoreline retreat; use/management flexibility, in that private agencies may be willing to fund, develop and operate conversion (and possibly acquisition); and an end to ongoing public maintenance for what is primarily private benefit. Given that these lands in agriculture are of declining value due to soil depletion, conversion to wetlands is also the only strategy that provides a solution that appreciates in value and extends beyond the period of agricultural use.

Recommendations are made for a follow-up feasibility study to provide a more in-depth evaluation of the recommended long-term solution including the need to evaluate any potential benefits of adding interim protection in order to maximize return from recent flood-proofing expenditures. In the event of an escalating threat of flooding prior to the implementation of an interim and/or long-term management plan, a contingency plan needs to be developed in co-operation with all agencies involved.

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1.0 INTRODUCTION

1.1 Description of the Problem

Point Pelee is located in Mersea Township, Essex County, and is the southernmost part of mainland Canada. It is a V-shaped peninsula, bordered by two converging barrier beach ridges, that extends as a sandspit about 15 km into the western basin of Lake Erie, Figure 1.

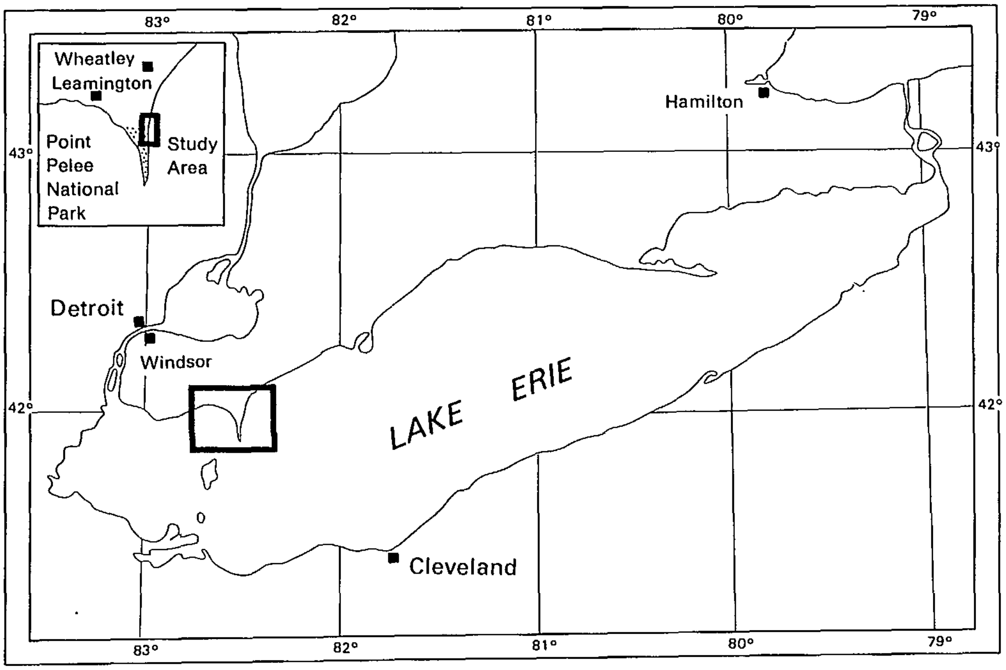

Figure 1. Location of Point Pelee

The stability of the barrier beach ridges is a critical factor to the integrity of the extensive freshwater marsh within Point Pelee National Park, the reclaimed agricultural lands north of the park, and the cottage development along its shores. Although historical accounts indicate shore erosion/deposition is an ongoing process at the Point, there has been very little recovery from the severe erosion that took place along the northeast barrier ridge during and subsequent to the high lake levels of 1973.

Of particular concern to this study, is the excessive erosion that continues to take place at the northeast corner of the park at the interface between the armourstone seawall outside the park and the natural beach inside its boundaries. High rates of recession during the recent high lake level stage (1986/87) produced a breach that in May 1987 was about 260 m long and 160 m wide (Lavalle, 1987). The eroded embayment is illustrated in Figure 2. More significantly, there does not appear to be a sufficient supply of sand in the littoral system for the beach to re-establish itself due in part to the large proportion of the shore north of the park that is protected.

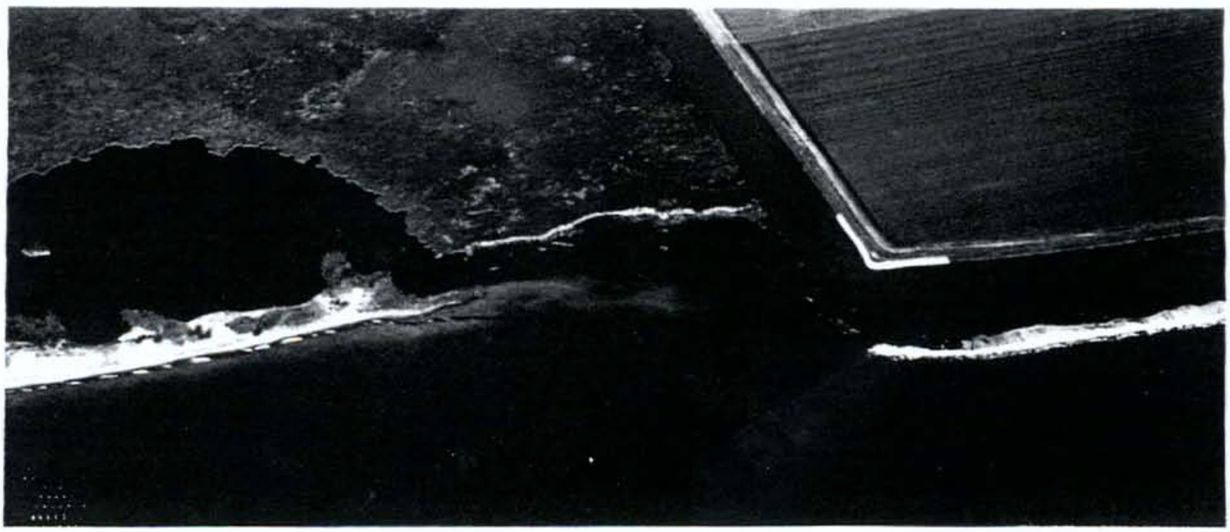

Figure 2. The dykes, Marentette breakwater and embayment at the northeast corner of Point Pelee National Park, July 1986 (photo credit: P.D. Lavalle, Univ. of Windsor)

If no action is taken, it is possible that about 83 ha (206 ac.) of reclaimed farmland within the Marentette Drainage Scheme will be flooded to depths of up to 1.8 m, and that the integrity of the cyclic marsh ecosystem in the park will be adversely effected by changes in the physical and chemical characteristics of the freshwater marsh.

Cottage owners along Marentette Beach also have an interest in the implementation of long-term solutions, as any action to prevent further erosion of the beach and potential flooding of adjacent lands could affect their properties.

1.2 Study Objectives

The need to undertake a study for long-term solutions to the erosion and flood problems at Point Pelee was the outcome of a meeting between Environment Canada (Canadian Parks Service), Agriculture Canada and Mersea Township. Because of its technical expertise in coastal engineering, shore processes and shore management, the Canada Centre for Inland Waters was approached to undertake the study. Recommendations from the study will form the basis for future action by the sponsoring agencies.

The objective of the study is to develop a range of management alternatives using available information that would be effective in the long-term for reducing the risk of flooding of the lands contained in the Marentette Drainage Scheme, reducing beach recession and the further deterioration of the quality of the marsh due to continued exposure to lake processes through the breach. While socio-economic and environmental impacts are recognized and broadly considered at this stage in the development of options, they are not dealt with specifically in this report. More detailed socio-economic and environmental input must be included in a subsequent feasibility study of the preferred option. The information used is adequate for assessing the range of alternatives appropriate for this site and providing an estimate of cost. It is not likely that any additional information would result in a significant change in the options presented at this stage in the evaluation of alternatives, but would help only to fine tune cost estimates.

2.0 ISSUES

2.1 Statement of Interested Parties' Objectives

Agriculture Canada and Environment Canada, Canadian Parks Service are the principle agencies involved. By nature of their respective mandates, their objectives do not mesh perfectly.

Agriculture Canada operates under a broad policy designed to enhance the productivity of prime agricultural land. Canadian Parks Service, through the national park system, has the objective to protect representative natural areas of Canadian significance; this tends to discourage any alterations by human activity.

At Point Pelee, Canada along with Ontario and Mersea Township have invested considerably under joint development programs such as the Agricultural Rehabilitation and Development Administration (ARDA) and the Canada-Ontario Southwest Ontario Dyking Program for ongoing maintenance and protection of large scale drainage schemes, Figure 3.

Although Canadian Parks Service policy (Parks Canada 1982) is to manage shore erosion and flooding as part of the natural process in the evolution of the Point, it is concerned about the effects the present gap in the beach will have on the quality of the marsh, especially if the beach is unable to re-establish itself. As structural solutions are not compatible with park policy , only non-structural alternatives are being considered within the park.

2.2 Risks and Consequences If Not Resolved

There are a number of risks associated with the breach at the northeast corner of the park that range from flooding, in the

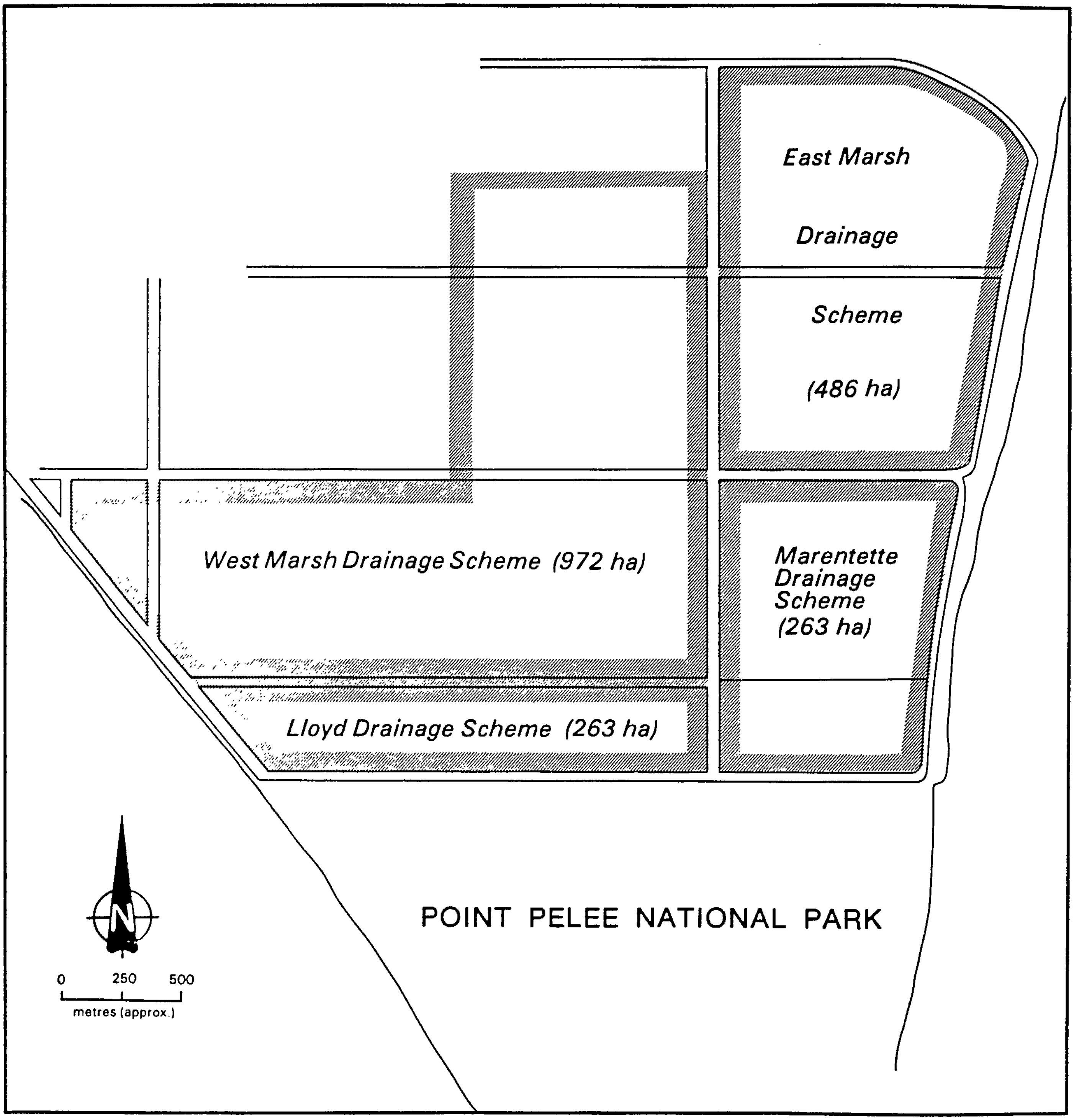

Figure 3. Drainage Schemes at Point Pelee, Mersea Township

short-term, to irreversible impacts to the ecology of the marsh and agricultural production, in the long-term.

The most immediate threat is the sudden failure of the earth dyke due to its exposure to wave action entering through the breach at the northeast corner of the park. This would result in flooding of at least 83 ha (206 ac.) of the south polder to a depth of up to 1.8 m, or possibly the entire area of 263 ha (650 ac.) in the Marentette Drainage Scheme. Depending on the time of year and duration of flood, this could have adverse impacts on those landowners (7) and employees who work the land in terms of financial loss (e.g. crop damage and loss of use) and psychological well-being (e.g. loss of livelihood). Although there are no residences within this floodzone, in a worst case situation, loss of life could also occur where the dyke suddenly fails during a storm-induced breach and mass flooding results. Political and legal implications would certainly arise.

Periodic breaching of the beach in the park is an important process in terms of maintaining the water and nutrient balance of the marsh, especially since the development of the drainage schemes and the effects they have had in diverting the original surface flow pattern from the north. Sustained breaching, however, does present a major threat to the integrity of the marsh/pond complex. Alterations in water quality occur as a result of changes in water depths and temperature, fluctuations in water level, increases in sediment and nutrient loadings, turbidity, and pollution. Conditions generally do not take long to revert back to normal once the barrier beach recovers, but with continuous exposure to Lake Erie, the vegetation communities of the marsh become altered and lake fish species get established which ultimately affect the web of species supported. Some projections of the consequences of an unrepaired breach predict the eventual total loss of the marsh habitat over a relatively short time frame (Schaffer et al. 1987).

Under a sustained flood condition, cottage residences that occupy Marentette Beach between the lands within the drainage scheme and the lake might also be affected. The broad expanse of flood waters would eventually lead to deterioration of the north-south dyke.

3.0 BACKGROUND

3.1 History of Land Use in the Study Area

European agriculturalists began expanding into wetland areas in the early 1800's. Around the beginning of the 20th century, advances in technology and government incentives in the form of funding assistance and Provincial legislation combined to produce large scale drainage schemes which today amount to about 1,980 hectares (4900 acres) of reclaimed land, most of which is below lake level. A more detailed account of the sequence of events leading to the present drainage schemes is provided in Appendix 1. General crop production today includes vegetables and grain crops such as yellow seed onions, wheat, soy beans and corn. Only about 3% of the wetlands originally found in Kent, Essex and Middlesex Counties remain (Environment Canada, Canadian Parks Service, 1987), Figure 4.

Point Pelee National Park was established in 1918 and occupies 1,564 ha (3,865 ac.) at the extremity of the Point. The marsh occupies 1,113 ha (2,750 ac.) of the park in the form of a sandy shored inland coastal marsh and fen and transitional mires. The Park is known for its extensive wetland habitat which supports numerous species of flora and fauna, some of which are rare, threatened or endangered in Canada and Ontario.

The shoreline adjacent to Point Pelee National Park has also been modified over the years with the development of cottages, marinas and harbours. This has been followed by the installation of shore protective works, such as seawalls and groynes, to protect against damage from flooding and beach erosion. As a result, 70% of the east shore of Point Pelee between Point Pelee National Park and Wheatley is now structurally modified. There are no structural modifications on the east shoreline in the National Park itself.

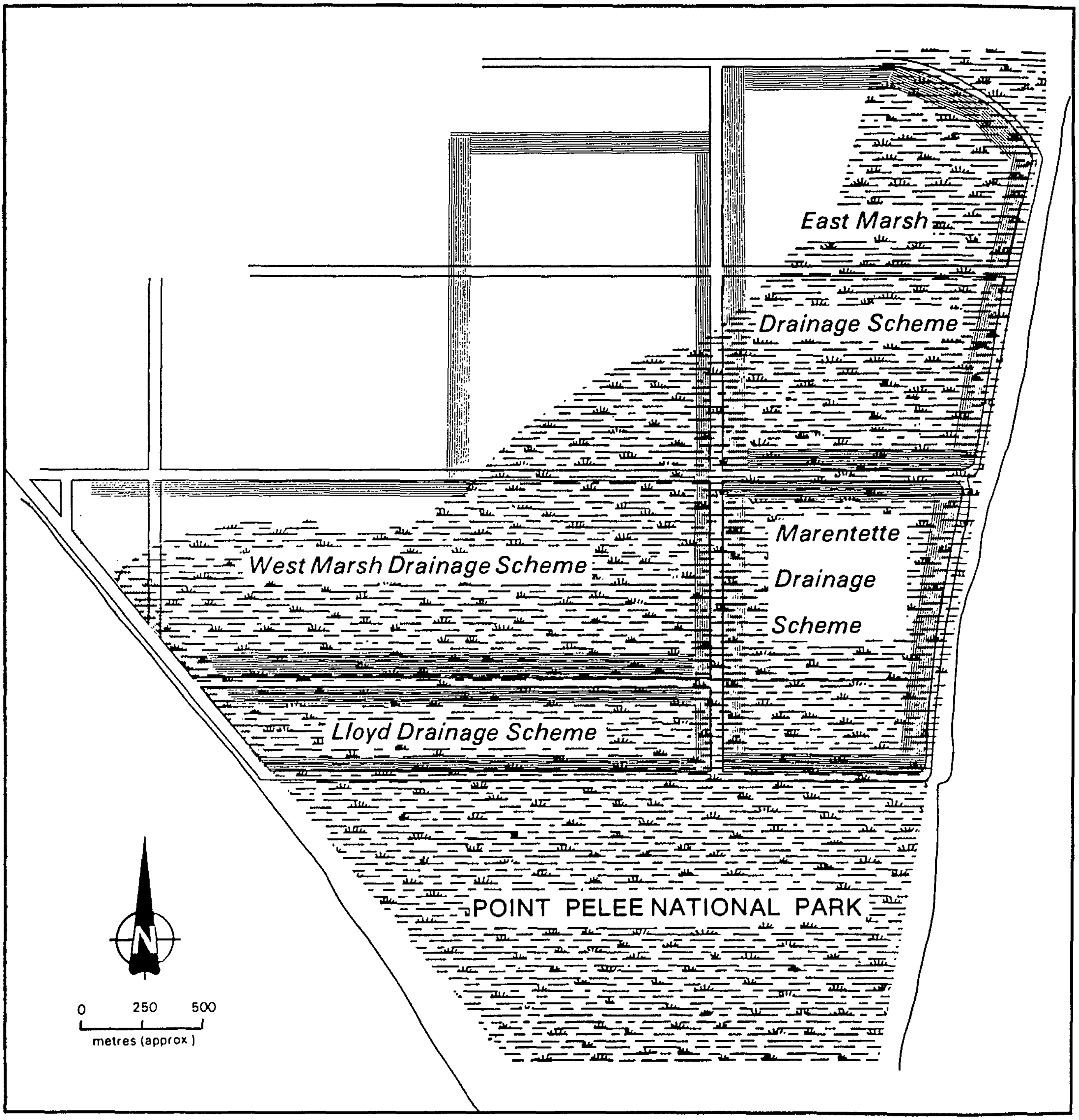

Figure 4. Original extent of wetlands prior to reclamation.

3.2 Values of the National Park

The extent of wetlands in the Great Lakes region has been diminished significantly as development has converted these "wastelands" into what were considered to be more productive uses such as agriculture, landfill sites, harbours and marinas. Perception of their role in the environment, however, has changed as the concern for the quality of the environment and knowledge of marsh ecology and dynamics has increased.

Point Pelee National Park is the only federal park specifically mandated to represent the southern Great Lakes marsh ecosystem. Because of its geographic location and physical characteristics, Point Pelee provides a unique habitat to several hundreds of plant and animal species not found elsewhere in the Canadian national park system. Being at the confluence of North America's Mississippi and Atlantic Flyways, it has long been recognized for its value as a major staging and nesting area with over 347 different species of birds (Environment Canada, Canadian Parks Service 1987). It is also internationally recognized as a major staging area for migrating Monarch butterflies and other invertebrates such as dragonflies. The value of the park is also reflected in the number of visitors it receives annually. In 1986, 463,426 visitors passed through its gates. This number is growing each year as the demand for outdoor recreation (e.g. bird watching) increases. Tourism benefits of the park bolster the local economy as well. For example, non-local visitors to the park spend an estimated $23.86 million annually in the regional area (ADI Ltd., 1986).

Because of its unique quality, and the number of rare and endangered species which it supports, Point Pelee National Park received formal international recognition by the International Union for Conservation of Nature and Natural Resources at the United Nations RAMSAR Convention, 1987, Regina, Saskatchewan.

3.3 Values of Agricultural Land

With some of the prime agricultural lands in Ontario being lost to the development and expansion of urban areas, the preservation of valuable productive land is a concern of provincial and federal agricultural agencies.

Soils in Essex County are generally well adapted to agriculture. The soil capability is classed as 2w which indicates limitation due to excess water. At Point Pelee, soils within the drainage schemes are organic and highly productive, however, depths range from about 2 m to 0 m where the underlying clay is exposed at the surface. Having originated from a former marshland, the soil is particularly suited for market garden crops such as yellow seed onions. Produce is distributed to local markets.

Through oxidation and wind erosion, the value of the land is declining as the soil conditions deteriorate. Ecologistics (1984) report that as a result of soil loss, agriculture in the Marentette Drainage Scheme can only be expected to continue for the next 10 to 30 years.

3.4 Shore Processes

3.4.1 Evolution of Point Pelee

Contrary to conventional theories of spit formation, which generally account for their origin by the incremental accumulation of sediments deposited by converging littoral currents, according to Coakley (1976, 1985), Point Pelee is a relict feature that originated from a much larger landform that was part of the cross-lake Pelee-Lorraine moraine. Its size and shape have been diminished and altered progressively through the action of large scale post-glacial lake level adjustments.

Although longshore transport was not a significant process in the initial development of the Point, Trenhaile and Dumala (1978) report from their analysis of dune and beach sediments, that it became the dominant process during the past 1,000 years.

Recent evidence from preliminary mapping of the quaternary geology of the area to the east of Point Pelee, suggests that the supply of longshore drift has diminished with time during this stage of the formation of Point Pelee. Sato (Geological Survey of Canada, pers. commun.) reports that a sandspit deposit atop the bluff formed during the elevated lake preceding Lake Erie (Lake Warren). Remnants of the spit extend from Erieau to Port Alma along the north shore of the central basin of Lake Erie, Figure 5.

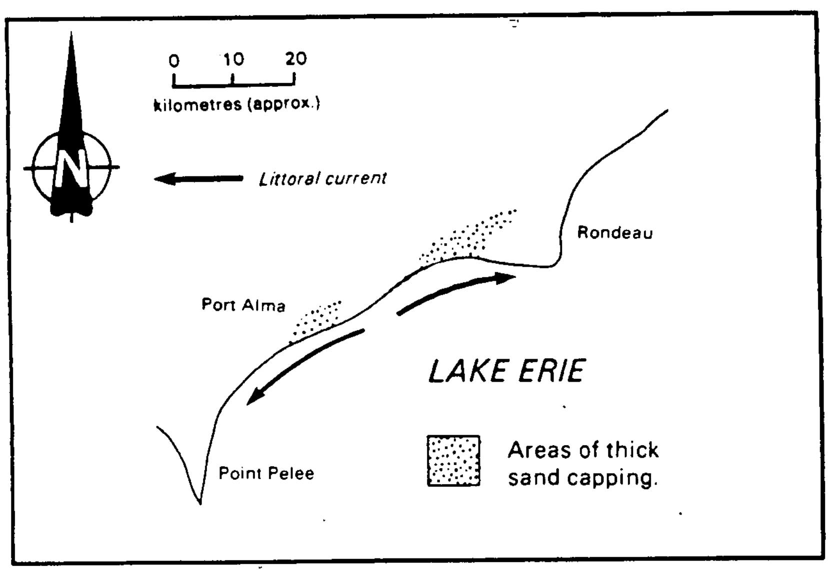

Figure 5. Extent of remnant Lake Warren sandspit.

As the drainage in this area is generally northward, early Lake Erie shorelines probably consisted of higher bluffs having positions hundreds of metres lakeward. Assuming the same composition as today's bluffs, greater amounts of sand and gravel would have been available during the formative period of the east shoreline of Point Pelee. In addition to higher bluff heights contributing more sediment to Point Pelee, more sand would also have been available from the sandspit atop the bluff. Although the relict spit continues to contribute sediments as the bluff face recedes, the breadth of the remnant spit is not as extensive as it was with earlier shoreline positions.

This suggests that the supply of longshore sediment in the past was greater compared to volumes feeding "recent" Point Pelee. In future, supplies of sediment can be expected to continue to diminish as there will be less sand available from the Lake Warren sand spit and central basin bluffs, in general, as well as due to the impacts of man-made diversions described in sections 3.4.2 and 3.4.3.

3.4.2 Ongoing Processes

Beaches change in response to a number of interacting processes such as winds, waves, currents, short-term and long-term lake level fluctuations, offshore bathymetry, changes in sediment budget, and man-made alterations to the shore zone. Less perceptible, but just as important, are the effects of submergence and man's activities in the nearshore and offshore zones.

At Point Pelee, the dynamics of the shore zone have been studied by a number of research agencies since the early 1900's, but especially in recent years in response to the accelerated erosion in the 1970's. A review of shore processes and the impacts of storms effecting Point Pelee is available in much of the literature cited as references. Therefore, it is the intent of this section to focus discussion on the processes affecting the east side, and the northeast corner of the park.

The east side of Point Pelee is particularly vulnerable to erosion under storm conditions because of long fetches and low relief of the beach ridge. A major factor is the magnitude of lake level rise as a result of wind set-up. Under strong easterly winds, the lake level on the east side of the Point may exceed that of the west side by up to 1 m (Shaw 1986). When combined with high lake levels, storm waves overtop the east ridge causing extensive erosion and breaching. Long-term rates of erosion average greater than 3 m/yr (Coakley 1977, Shaw 1986), while losses during a single storm event have been recorded up to 11 m (Coakley et al. 1973). These studies have shown that this material is displaced by overwash into the marsh, or is carried offshore (to greater depths), and alongshore (where it is deposited on the submerged spit and shoal system south of the Point, or as deposition along the west shore of the park).

At the northeast corner of the park, erosion has been most severe since the high lake levels of the early to mid-1970's. Lavalle (1987a) reports recent recession of up to 100-140 m over a two year period (1984-1986), and indicates in a subsequent report (Lavalle 1987b), that this newly eroded embayment is expanding southward. Previous attempts by the Canadian Parks Service to rebuild the beach with a sand berm (at Bush Pond) have been successful, however, as the present gap continues to expand southward, this berm is beginning to erode. Lavalle attributes the high erosion rates to effects of the armourstone breakwater along Marentette Beach and secondly to the ineffectiveness of the park's tetrapod system (due to problems with access).

Although lake levels influence rates of erosion, fluctuations in lake level alone are not the decisive factor, as studies show that erosion continues regardless of lake stage (Jarlan 1966, Coakley 1977, Shaw 1986 and Lavalle 1987a and 1987b). A deficiency in the supply of sediment to the east side of Point Pelee is also thought to be a factor in the recessional trend of the Point. Although the volume of sand actually transported is not well known, Skafel et al. (1985) report that net longshore transport is towards the south and that estimated volumes range from 4,000 m^3/yr to 20,000 m^3/y.

There have been a number of activities undertaken in the past that may have affected the supply of sediment to Pelee. Offshore dredging activities on the shoals to the south of the Point were believed to be affecting the sediment budget balance (Kamphuis 1972, Coakley et al. 1972, Coakley 1977, and Shaw 1978, 1986). Although no direct correlation between dredging and beach erosion could be established, recommendations were made to restrict dredging activity from the main area of accumulation which was established to be within about 1.5 km of the tip (Coakley 1977 and Shaw 1986). Sand extraction has also occurred along the top of the bluffs east of Point Pelee, as well as directly from the beach at Port Crewe and other locations.

Shore structures to the north of the park were also reported to be interrupting the supply of longshore drift. Bayly (1977) provides an account of the progressive erosion of the northeast beach of the park using a series of aerial photographs taken before and after construction of shore protection structures along Marentette Beach, Appendix 2. She concludes that it is the currents from the northeast that are responsible for replenishing the east beach.

The impact of Wheatley Harbour on the supply of littoral sediment to the Point has varied. Until the construction of a new breakwater in 1978, about 4,700 m^3 of sediment had to be dredged annually (Canadian Parks Service Report - PP01:06, 1975). According to Beaulieu et al. (1984), this material is now bypassing as a result of the breakwater and is, therefore, available to nourish downdrift beaches.

The deficiency of sand may also be due to natural changes in the composition and configuration of the eroding bluffs that feed longshore transport to Point Pelee, as discussed under Section 3.4.1.

3.4.3 The Impact of Shore Structures

Breaching of barrier beaches is a natural process and there is evidence from historical records to show that breaches have affected the east side of Point Pelee long before any settlement. From a review of the literature, however, there is an assumption that shore structures north of the park have interfered with natural littoral drift which has resulted in excessive losses at the northeast corner of the park. Although difficult to demonstrate conclusively, it is doubtful that these structures could have helped the situation.

Everts (1983) reports that the formation of headland-bays is common downdrift of coastal structures that impede longshore transport. The plan shape of the northeast breach, which is immediately downdrift of the Marentette Breakwater, resembles the headland-bay configuration as illustrated in Everts, Figure 6.

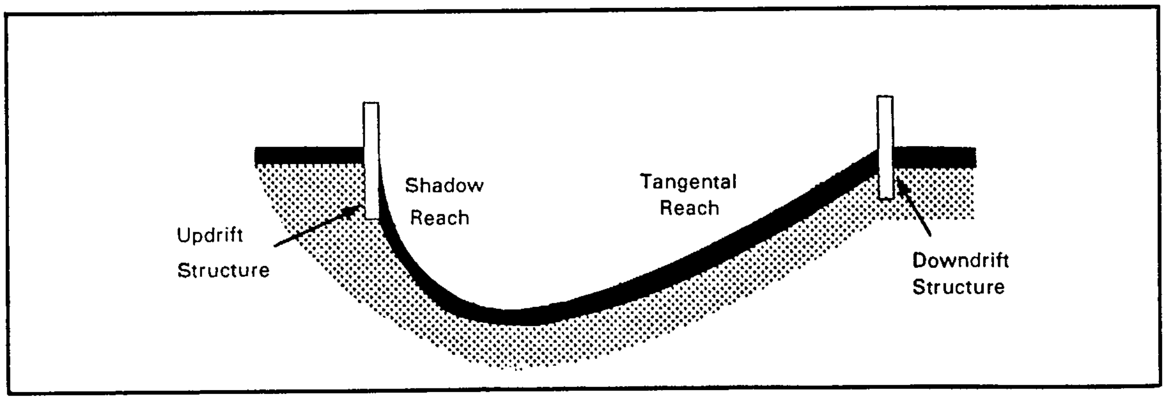

Figure 6. Sketch of Headland-Bay (Everts 1983).

As Bayly, Lavalle and others suggest, it is not coincidence that the northeast corner of the park has eroded at a much greater rate than the remainder of the unprotected park beach. The fact that unprecedented rates of erosion occurred at this location shortly following the installation of the Marentette groyne field and cribs in 1971, and that the breach has not been able to re-establish itself, further suggests unnatural causes. Lavalle's most recent observation that the embayment is enlarging toward the south is also consistent with Everts' observations which indicate that without a downdrift boundary (fixed point), the bay will continue to develop in a downdrift direction. This is in contrast to another breach at Lake Pond, 4.8 km further south. Figure 7 shows the Lake Pond breach which opened in March 1976, and naturally rehabilitated itself by August, 1976. The natural closure of this breach reinforces the idea that the breach at the northeast corner of the park is continuing to erode due to unnatural processes.

Because of alternating directions of longshore transport, the impact of shore structures updrift may not be so much in the direct interception of littoral sediment, but rather in the removal of a former storage area. Of the 8.7 km reach of shore between Wheatley and Point Pelee National Park, 6.1 km or 70% is protected with rock seawalls, wood seawalls and groynes.

Prior to protection, waves could run up the beach and overwash some areas, thereby providing a temporary loss of material from the active littoral system and providing a reservoir for later retrieval as the shore receded. With the installation of shore structures, less overwash occurs resulting in less storage capacity. There is also less erosion along the protected reach of shore which further limits the supply of sand and gravel to downdrift beaches.

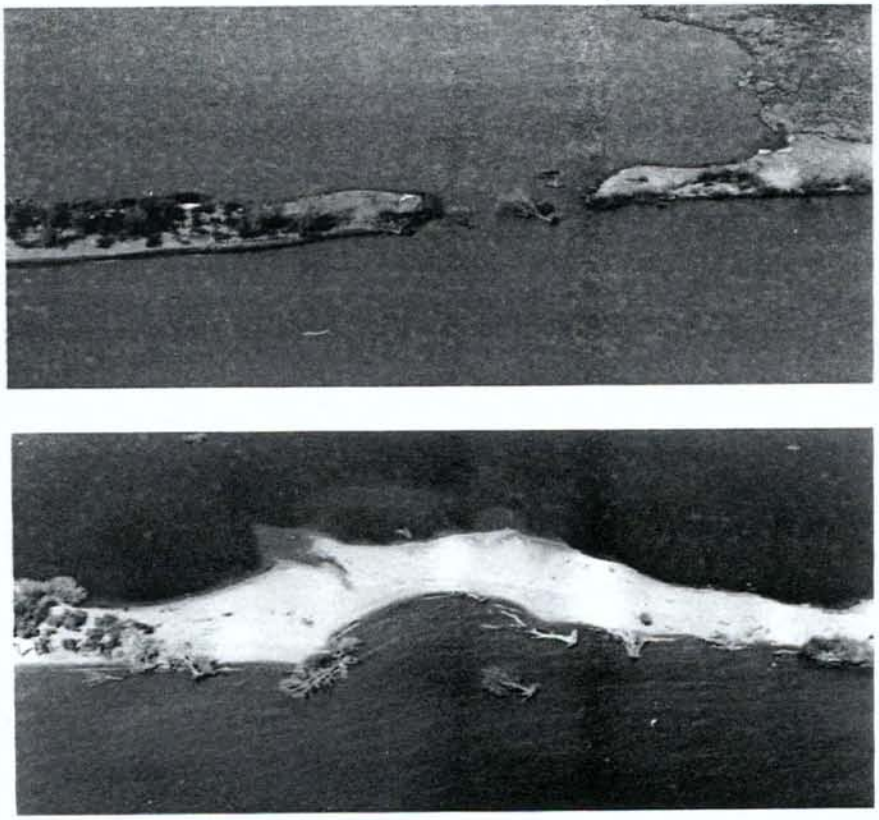

Figure 7. Lake Pond breach opened (Mar/76) and infilled (Aug/76)

The impact of Wheatley Harbour has also been cited in literature concerning erosion at Point Pelee. The popular theory that such structures intercept littoral drift was tested recently by a Federal Court inquiry concerning the Port Burwell shore damage suit. Based on the outcome of this investigation, Rukavina and Zeman (1987) report that the effect of harbours at Port Stanley, Port Bruce and Port Burwell on the extraction of sediments from the coastal zone appears to be both minimal and transitory. Beaulieu et al. (1984) further report that since the installation of a new breakwater in 1978, the dredging requirements are much less and the sediment is bypassing the harbour at Wheatley. Whether this sediment continues downdrift as alongshore transport, remains to be verified.

3.4.4 Future Processes

Erosion on the east side of Point Pelee has been the dominant trend since the 1960's. The Point's long-term evolution also indicates that it has been reduced in size on a continuous basis since deglaciation. Recent rates of erosion are 3 m/y since the early 1900's (Coakley 1977), and during a sustained high lake level period about 4 m/y (Shaw 1986).

When compared to rates of accretion on the west side of the Point, which averaged about 1 m/y since 1974, the future of Point Pelee is not difficult to imagine. By comparing average short-term rates of accretion and recession for the west and east sides of Point Pelee, Shaw (1986) estimated the park would be eroded away in 1,500 years. In fact, it is more likely that the point would not erode away, but rather take on a different configuration comprised of a smaller point, with shoals and islands.

At the northeast corner, given present natural and man-altered processes, it can be expected that the embayment at the Northeast Beach will continue to grow toward the south until some form of equilibrium is established. Further, it is not likely that the beach will re-establish itself given the apparent deficiency in sediment budget. Trends toward lower lake levels may lower the risk of flooding and may help to slow rates of erosion, however, as previously discussed, this reach of shore appears to erode regardless of lake level. The time frame for these changes can be altered by the impacts of shoreline management along the shore.

3.5 Roles and Responsibilities in Shoreland Management

Knowledge of both the extent and limitations of government powers, policies and programs are fundamental to the development of any shore management plan. Although the principal responsibility for shore management rests with Provincial agencies, this section outlines the roles and responsibilities of various levels of government and the private landowner as they apply to the Point Pelee area.

Federal Government

Canadian Parks Service

The Canadian Constitution gives control of lands and natural resources to the provinces, but retains jurisdiction in a number of areas. By virtue of ownership, Environment Canada, Canadian Parks Service manages the shoreline based upon guidelines and objectives set out in the Point Pelee National Park Management Plan (1982). The Plan states that, "erosion and recession should be regarded as natural processes and should be allowed to proceed unimpeded unless public safety becomes a factor, unless major facilities are threatened, or unless actions outside the park boundaries result in negative impacts to park processes". In the latter case, emphasis would be on mitigating the cause rather than reacting to the impact with site management in the park, as the Management Plan specifically calls for integrated regional shoreline management. Legislative authority is provided under the National Parks Act.

Agriculture Canada

Agriculture Canada also has interests in the management of the shoreline in the northeast corner of the park. Their concerns stem from the fact that dykes built to develop and maintain reclaimed farmland may weaken with exposure to the direct wave activity from Lake Erie. Agriculture Canada has contributed $424K from 1985 to 1987 for dyke repair and protection. In this time period, the total investment by ratepayers, provincial and federal governments was $1,043K. While Agriculture Canada prefers to see that dykes are properly maintained, it is not within the Department's mandate, nor is it a federal government responsibility. Both the Municipality and Province have the responsibility for maintaining drainage works under the Ontario Drainage Act.

Other Departments

The Department of Transport has jurisdiction in the shore zone under the Navigable Waters Protection Act. DOT approval is required where alterations to the shore may affect safe navigation.

The Provincial Government

Ministry of Natural Resources

The Ontario Ministry of Natural Resources (OMNR) has the largest role in managing the Great Lakes shoreline. With the recent report of the Shoreline Management Review Committee and the creation of the Shoreline Management Advisory Council, OMNR is taking a number of new initiatives in shoreline management. The report identifies the Ministry as the lead agency for shoreline management and calls for it to establish a plan and guidelines for long-term shore management.

Programs currently in place by OMNR include the Technical Advisory Service that provides technical design advice to individual property owners; the Emergency Repair and Maintenance of Conservation Authority Structures that ensures the integrity of erosion and flood protection structures owned by Conservation Authorities; and assistance to municipalities in providing sandbags for emergency protective work.

Conservation Authorities

Conservation Authorities, which are under the jurisdiction of OMNR, also have a large role in shore management. In addition to having local jurisdiction over shorelines and programs for the construction of remedial works, they are now responsible for implementing and administering shore management plans according to guidelines set by OMNR (1987). Conservation Authorities also provide technical advice to municipalities, and individuals under the Technical Advisory Service. They maintain flood warning systems throughout their watersheds and map their shorelines under the Canada/Ontario Flood Damage Reduction Program.

Under the Conservation Authorities Act, individual C.A.'s have various flood and fill regulations that may influence shoreline construction. The Essex Region Conservation Authority (ERCA) mapped their shoreline areas in 1976 to show flood and erosion risk areas and to document the need for remedial measures. The present study area is included. No flood and fill regulations have been passed for shoreline areas within the ERCA. However, the Authority does intend to establish such regulations in the near future.

Ministry of Agriculture and Food

Under the Ontario Drainage Act, the Ontario Ministry of Agriculture and Food (OMAF) may assist with repairs to dykes and other structures protecting agricultural lands and related drainage systems. Assistance usually consists of a grant covering one-third of the cost of the work. For example, at Point Pelee, $600K of the total $900K worth of shore protection and upgrading was provided to Mersea Township for maintaining drainage schemes in 1985/86 under this program. The Act also provides both the Province and Municipality with the responsibility for maintaining drainage works.

Other Provincial Ministries

The Ontario Ministry of Municipal Affairs (OMMA) has three programs available that could affect shore property interests. Funding assistance is provided to private landowners and municipalities in the form of low interest loans, grants, or on a cost-shared basis depending on the circumstances associated with the damage. Funds are made available through the Shoreline Property Assistance Act, the Disaster Relief Program and the Unconditional Grants Act. Funds assist with the construction and repair of protective works, damages to principal residences and essential furnishings, and the restoration/protection of essential services. Municipalities are also eligible for grants under the Public Transportation and Highway Improvements Act administered by the Ministry of Transportation and Communications for repairs to municipal roads and streets damaged by flooding or erosion.

Municipal/Local Government

In general, Municipal governments commonly control land use and construction through the use of official plans, zoning by-laws and building permits. Specific by-laws may exist for shoreline areas. Under the Ontario Drainage Act, Municipalities have the responsibility for maintaining drainage works, as does the Province.

At Point Pelee, the Township of Mersea Official Plan recognizes the park as federal property and therefore, assumes no jurisdiction over it. Land north of the park is zoned agricultural and residential (Marentette Beach) and is subject to special regulations as a "Lake Erie Flood Prone Area". The regulations specify minimum elevations for lowest openings to buildings and grade levels.

Other roles the municipality may play include administering and implementing provisions/programs of the various ministries such as OMNR's Sandbagging Program and the Shoreline Property Assistance Act of the OMMA.

3.6 Review of Past Management Response to Flooding and Erosion

Traditional response to flooding and erosion in the Great Lakes, in general, has been to control it with engineering structures such as seawalls, groynes and revetments. This is due, in part, to the fact that structures offer visual assurance that something is being done in response to a given situation. Also, decisions have often been made at a time of crisis when those solutions that would reduce the risk of further damage seem more appealing than those that would require more time for the benefits to become obvious, such as public acquisition, zoning and set-back limits.

At Point Pelee National Park, remnants of past attempts to control erosion using various structural measures are evident, some of which are now considerable distances offshore. East (1976) indicates that over $200K was spent on building and repairing shore protection devices in the park from 1910 to 1976. Another $1900K was spent in flood and erosion protection for the adjoining drainage schemes (Nelson et al. 1975).

Since 1976, the Canadian Parks Service has altered its shore management strategy somewhat, as demonstrated in the rehabilitation of the breach at Bush Pond in 1978. Recognizing the ineffectiveness of shore structures, it closed the gap by rebuilding the beach using trucked-in sand. Initial construction cost was about $400K. Another $67K was spent in 1980 for maintenance re-nourishment. This beach has remained intact for the past seven years despite the lack of further renourishment. Its stability is not expected to continue, however, with the present eroded state of the beach immediately to the north.

North of the park, further protection was also required because the integrity of the drainage schemes was once again being threatened by rising lake levels and an eroding Marentette Beach. In 1985-86, an armourstone seawall and dyke were constructed on the southern portion of Marentette beach extending south to the park boundary at a total cost of $798K, funded by the ratepayers, provincial and federal governments. The dyke armouring portion of this work was done at the same time as the seawall at a relatively small cost.

With the closing of the Bush Pond breach in 1978, and armouring of the shoreline protecting the Marentette and East Marsh Drainage Schemes, more than $3.4 million have been directed to maintaining this reach of shore. Other studies undertaken subsequent to these large scale structural adjustments in the early 1970's concluded that such costs very probably exceed the value of the land for agricultural purposes, and are difficult to justify on economic, social, or environmental grounds (Nelson et al. 1975 and Day et al. 1977).

4.0 SHORE MANAGEMENT ALTERNATIVES

A narrow range of alternatives exist for this site. This is due to the deficiency of sediment in the beach budget, a highly dynamic shore zone (e.g. long fetches), Parks' policy restricting the use of structural controls within the national park, and the sensitivity of this reach of shore to the impacts of erosion control structures.

The alternatives proposed are intended to be long-term solutions, however, not without maintenance. Alternatives are considered under two broad categories: non-structural and structural. Non-structural alternatives include Do Nothing, Artificial Beach Nourishment (3 alignments), and Conversion of agricultural land to wetlands. Structural solutions are limited to the north of the park for protection of the Marentette Drainage Scheme dyke. Other structural shore protective methods, such as groynes, seawalls, revetments and perched beaches, were not considered in detail because they were considered by coastal engineers at the Canada Centre for Inland Waters to be unsuitable in terms of probable effectiveness.

In developing management alternatives, the emphasis has been focused on the most eroded section of beach at the northeast corner of the Park. The more detailed follow-up feasibility study will need to address other sections of beach fronting the drainage schemes to determine if protection may be required elsewhere.

4.1 Engineering Constraints

The shore management alternatives examined in this section make use of available information. In order to take some of these alternatives past the conceptual design stage, additional information will be required including the following:

(i) Detailed hydrographic survey at the northeast corner of the park, also to show existing dykes, shoreline and armourstone breakwater.

(ii) Borehole and other geotechnical information to establish bearing capacities, thickness of the peat layer, and depths to the till layer.

(iii) Geotechnical survey of the east-west dyke to establish its structural integrity and the need to upgrade its load-bearing capacity for possible use as a haul road.

(iv) Detailed cost estimates by Public Works Canada.

4.2 Time-Frame Considerations

The immediate threat from a breached dyke has been alleviated temporarily by the recent decline in lake levels and by armouring of the dyke at the corner of the Marentette Drainage Scheme. Therefore, the assessment and selection of an optimum long-term solution can be undertaken without having to make a quick decision that might otherwise occur in a crisis situation. However, given that observations of the east beach indicate that erosion is ongoing and will most likely continue, consideration and selection of long-term solutions should proceed without undue delay. Erosion along the east side of Point Pelee north of the Park may also need to be addressed to ensure against flood hazard (e.g. at the north end of the existing armourstone seawall along Marentette Beach).

As the implementation of a multi-agency long-term solution could take considerable time for final approval, and the fact that Agriculture Canada has expressed a desire to ensure that benefits from recent protection are maximized, interim protection should be considered. It is important to note, however, that any benefits which may result from adding interim protection be considered in the context of the long-term plan and be weighed against the potential economic return from extended agricultural protection.

Timing considerations with respect to the implementation of specific options will require further elaboration at a more detailed level of analysis. For example, if sand nourishment is to be implemented, seasonal shore processes are an important factor in effecting the placement and distribution of material.

4.3 Management Alternatives

4.3.1 Non-structural Alternatives

4.3.1.1 Do Nothing

According to most recent theories and observations of the processes of evolution and erosion at Point Pelee, erosion of the east side of the Point has been a trend since deglaciation. Coakley (1977) indicates long-term rates of recession on the order of 0.25 m/y for the past 4,000 years, and about 3 m/y since the early 1900's. Since the early 1970's, an average rate for the east side is reported to be about 4 m/y (Shaw 1986). At the northeast corner of the park, erosion has been most severe with a complete washout of the beach at Bush Pond in 1975, and again in 1984. Lavalle (1987a) reports rates of up to 100-140 m over a two year period (1984-1986) for this section.

Erosion of the east beach of Point Pelee appears to be related to an overall negative sediment budget. However, in the park, the situation is compounded by the effects of the updrift armourstone seawall. It is unlikely, therefore, that the trend of erosion will reverse. Nor will the beach re-establish itself at the northeast corner of the park, at least in the near future. In fact, according to observations of breach formations elsewhere without a fixed end point (Everts, 1983), the gap will likely continue to expand southward.

The agricultural land to the north is also at risk under the Do Nothing alternative. It is difficult to predict a time frame within which the earth dyke might become weakened to the point of collapse, however, it is certain that an unrepaired gap will eventually lead to flooding of part or all of the Marentette Drainage Scheme. Generally, the greatest risk of this happening would be during spring months under rising lake levels and easterly storms.

Consequences of a flood would vary according to the circumstances causing the flood (e.g. storm induced) and the extent of the area affected. It is recommended that an evacuation plan be developed so as to reduce the risk to life.
Further suggestions in this regard are covered in Section 5.4.2.

4.3.1.2 Artificial Beach Nourishment

Three scenarios for artificial beach nourishment (ABN) have been examined. Each of these provide flood protection, however, nourishment with an updrift headland is expected to provide a more stable beach form, while alignments B-B and C-C rebuild the shoreline at lower cost, but will require more maintenance. Water depths were obtained from the Site Plan of the Southeast Corner of Marentette Drainage Scheme and Northeast Corner of Point Pelee National Park by William Setterington, revised December 16, 1986, Figure 8. The surveys were conducted November and December of 1986. In order to estimate volumes, some basic design information was used from the successful ABN completed at Point Pelee in 1978 by Public Works Canada on the same sand ridge a few hundred metres further south (at Bush Pond).

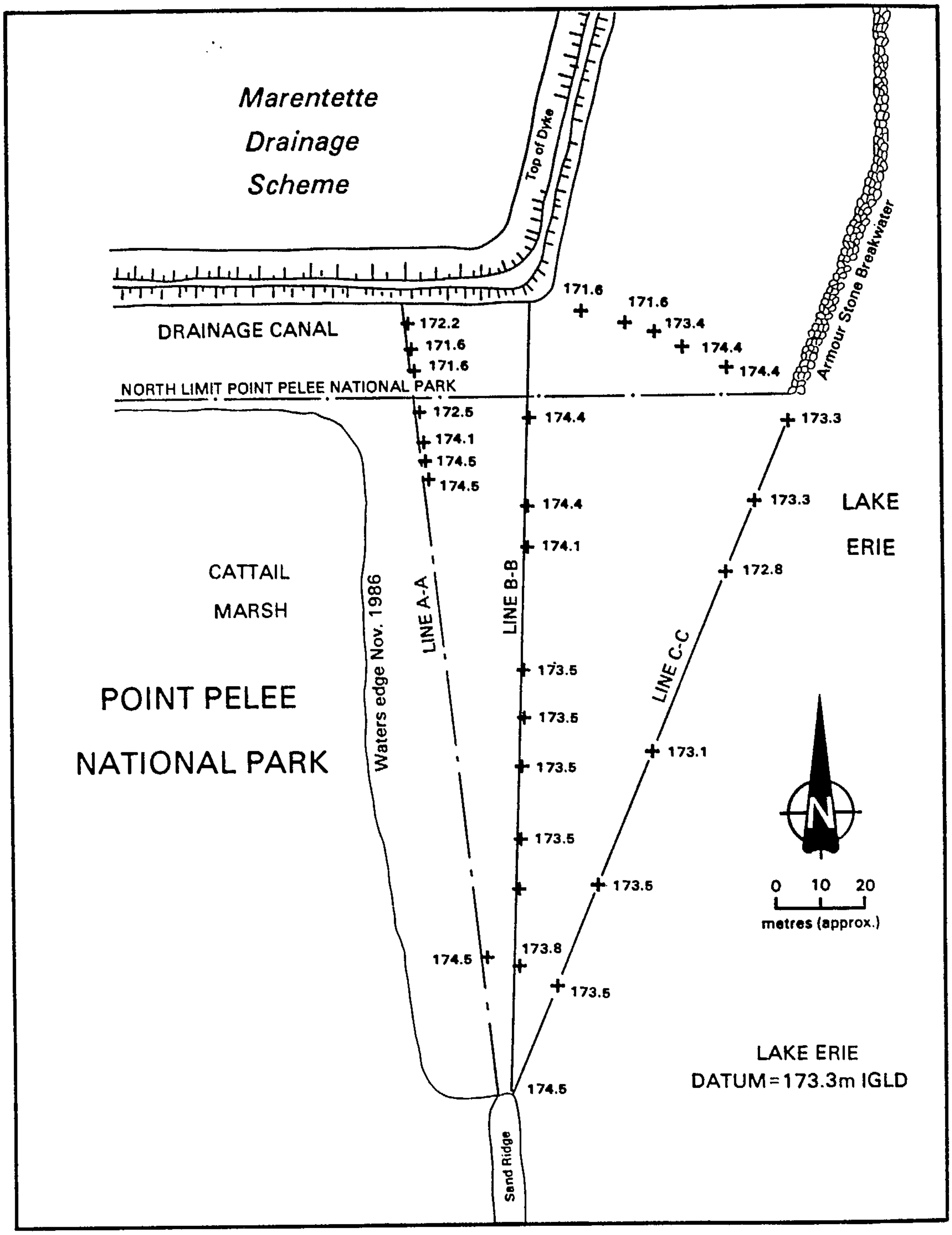

Figure 8. Bottom Elevations and Site Plan From Setterington Survey of December 1986

This information includes the following:

- -top width of nourished beach = 15 m
- -seaward slope of nourished beach = 10:1
- -leeward slope of nourished beach = 3:1
- -sand median diameter of 0.75 mm to 1.0 mm

Based on the top elevation of the subaerial sand ridge further south, the top elevation of the ABN has been assumed to be the same at 176.4 m IGLD (1955); DPW nourished to a top elevation of only 175.93 m, (1978). Cost estimates to supply, haul and place are based on the following:

	$/tonne
-sand (0.75 - 1.0 mm)	10
-crushed limestone (6 - 14 mm)	10
-gabion stone	12
-filter stone (<0.5 tonne)	24
-armourstone (>0.5 tonne)	26

Volumes have not been increased by a factor of safety to allow for handling losses, etc. All construction is assumed to be land based. Assumptions made concerning the gabion stone access road are that it will have side slopes at 1:1, a top width of 4.6 m, a top elevation of 174.4 m and will be removed after construction.

Given past difficulties in gaining road access to the north end of the park, offshore sources of suitable sized sand may also be considered for supplying artificial nourishment. Rukavina (1987) estimates the volume of sediment (>1mm) to be 850,000 m^3 to 40 million m^3 (depending on thickness of sediment deposit) in the area south of the Point. He considers the larger volume to be the more realistic estimate. If an offshore source of sand is to be used, Coakley (1977) and Shaw (1986) suggest mining be restricted to a safe distance from the Point (e.g. 2.5-2.8 km) to avoid detrimental impacts to potential storage areas.

4.3.1.2.1 Nourish Along Line B-B

Line B-B runs from the end of the existing subaerial sand ridge towards the southeast corner of the Marentette Drainage Scheme, Figure 9. Calculations for the ABN are provided in Appendix 3 (with chainage beginning from the top of the existing dyke). The required volume of sand is estimated at 17,500 m^3. Assuming a bulk specific gravity of 2.0 gives a mass of 35,000 tonnes. The volume of gabion stone required for an access road from the dyke across the drainage channel has been estimated at 2100 tonnes (Setterington, Nov. 14, 1986). These volumes translate to a total cost of $375K. Erosion of the artificially nourished beach can be expected to continue. Periodic maintenance would be required (e.g. 2,000 m^3/yr would cost about $40K).

4.3.1.2.2 Nourish Along Line C-C

Line C-C runs from the end of the existing subaerial sand ridge towards the end of the armourstone breakwater, Figure 10; it follows the general position of concrete crosses placed in 1978 by Point Pelee National Park as a means of arresting shore recession. Most of the crosses are now submerged. Calculations for the ABN are provided in Appendix 3 (with chainage beginning at the first sounding south of the tip of the armourstone breakwater).

The required volume of sand is estimated at 24,500 m^3 which gives 49,000 tonnes. The gabion stone access road would have to be about 80 m longer than for alignment B-B, although crossing the drainage channel at the same point, and would require an additional 520 tonnes of stone. These volumes translate to a total cost of $521K. The artificially nourished beach can be expected to erode faster than that of alignment B-B due to a greater exposure,

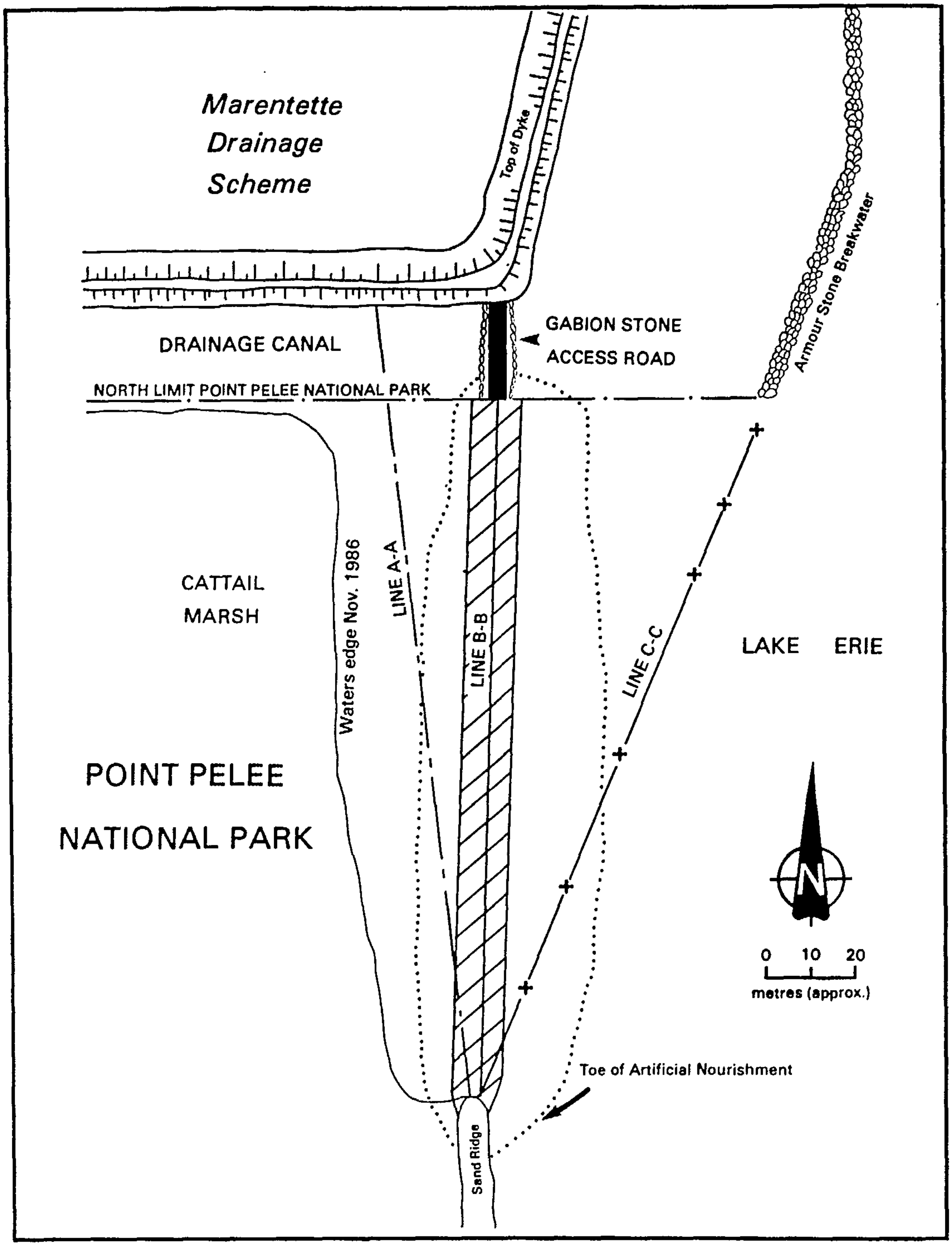

Figure 9. Nourishment Along Line B-B

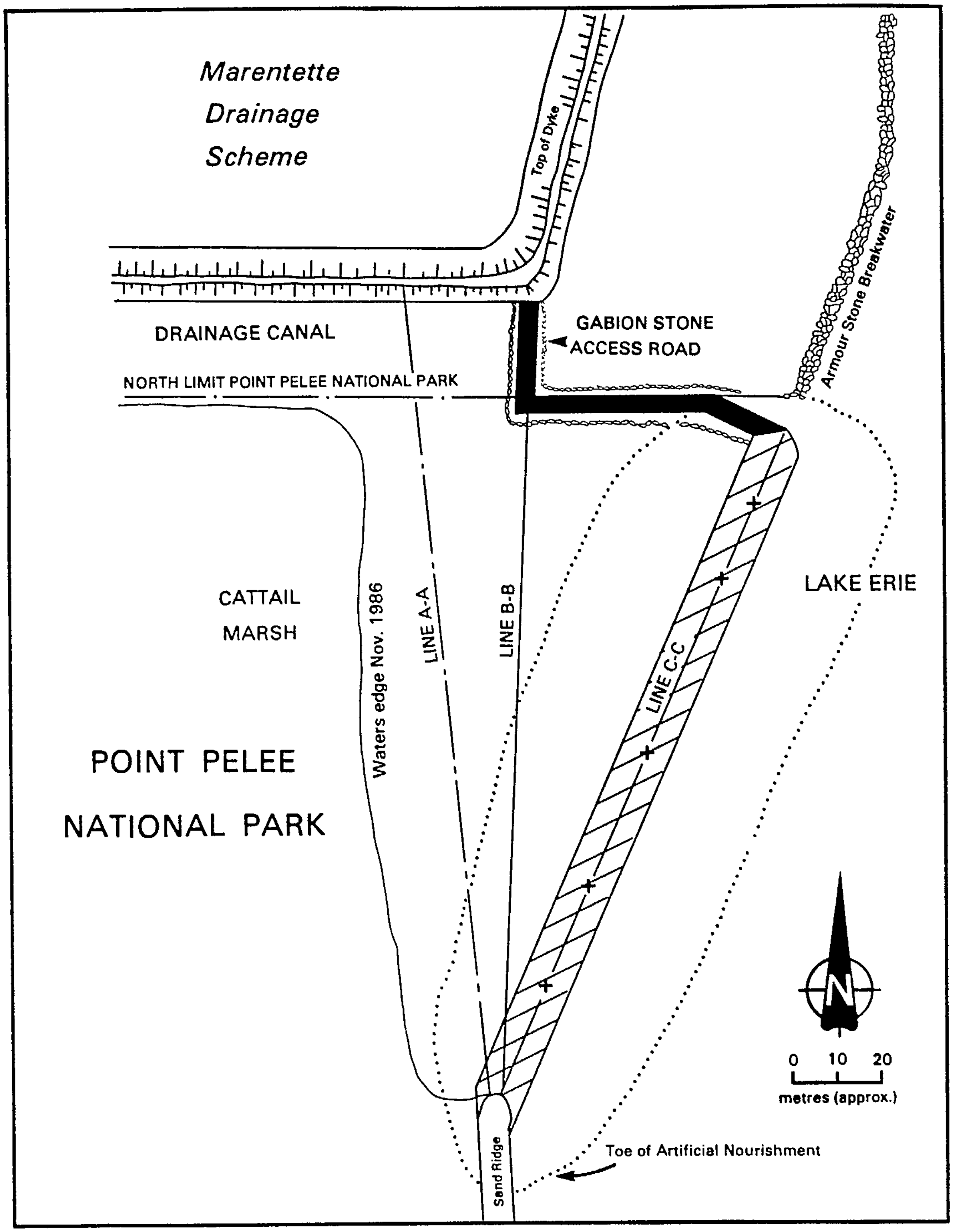

Figure 10. Nourishment Along Line C-C

thereby requiring greater maintenance renourishment (e.g. 5,000 m^3/yr would cost about $100K).

4.3.1.2.3 Nourishment With Updrift Headland

A more stable ABN may be obtained using an updrift headland to anchor the beach. In fact, if both updrift and downdrift headlands could be used, it would be possible to engineer a stable beach shape that no longer has alongshore losses of beach material (Silvester 1976, Bishop 1982). However, at the northeast park boundary, an updrift headland should be able to anchor an ABN solution so that a semi-stable bay develops on its downdrift side, and the downdrift side of the beach is free to shift position along with the remainder of the Point Pelee eastern sand ridge.

A conceptual estimate of the plan shape of such a headland-bay has been deduced from the following assumptions:

- updrift headland has the same alignment as the southern portion of the armourstone breakwater.
- temporary downdrift "headland" is at location of existing subaerial sand ridge on Setterington's plan.
- tangential alignment of downdrift part of quasi-stable headland bay is same as Setterington's line A-A.
- gap between "headlands" is 175 m.

From the preceding assumptions, the angle between a line joining the headlands and the tangential section of the headland-bay beach is about 30 degrees. Results from laboratory tests of stable headland-bay beaches (Silvester et al. 1980) indicate that the maximum indentation of the beach is predicted to be about 60 m. However, a review of field measurements of headland-bay beaches indicates that a more likely value of maximum indentation for a quasi-stable headland-bay is about 45 m (Bishop 1983). Using this latter value, the shape of the headland-bay beach is sketched in Figure 11. The headland consists of a 45 m long dogleg rubblemound breakwater. There is a 30 m gap to the armourstone breakwater to allow drainage and small craft access to the canal behind Marentette Beach. The volume of sand required to nourish this 250 m long headland-bay beach has been estimated from calculations in Appendix 3 to be 22,500 m^3 or 45,000 tonnes. The gabion stone access road would have to be about 65 m longer than for alignment B-B requiring an additional 420 tonnes of stone.

Preliminary estimates of quantities for the 45 m long rubblemound breakwater have been made with the following assumptions:

- bottom elevation 172.0 m IGLD (1955).
- top elevation 178.0 m IGLD (1955).
- 2-layer armourstone with a total thickness of 2 m on seaward slope and top.
- coarse filter layer with a thickness of 0.5 m on top and seaward slope and 1.0 m on leeward slope.
- quarry-run core.
- breakwater top width of 3 m.
- seaward slope of 2:1
- leeward slope of 1:1

This gives quantities of 2,600 tonnes armourstone, 1,000 tonnes filter stone and 2,950 tonnes quarry run core. The cost estimate for the breakwater is $120K. The total cost of this scenario is $600K. As with other alignments, there would be the need for annual maintenance, however, this alignment would require the least (e.g. 1,000 m^3/yr would cost about $20K).

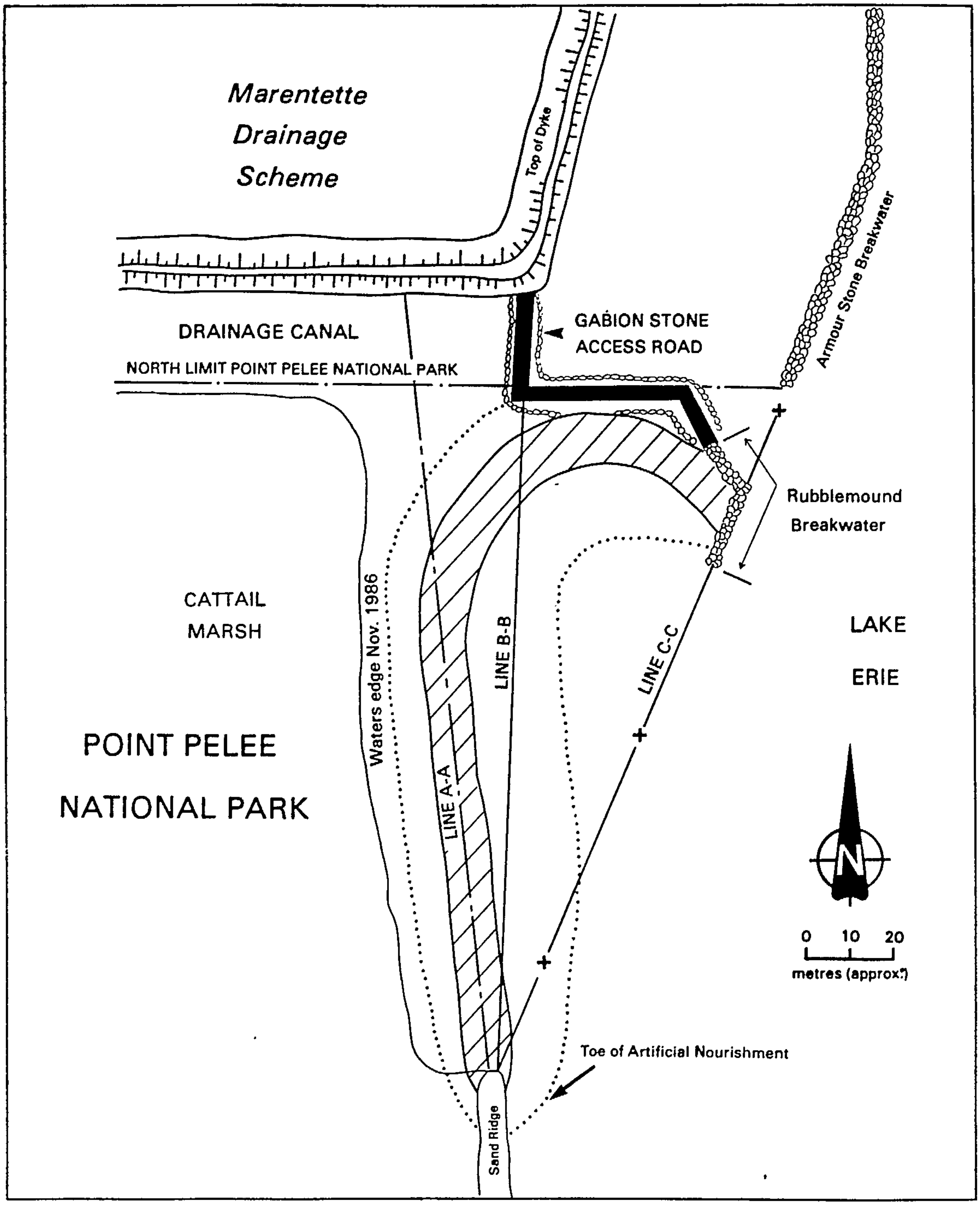

Figure 11. Nourishment Along Headland-Bay Beach

As a variation to this design, the end of the existing armourstone breakwater could be reinforced as a headland, rather than constructing a new one. However, this would not allow for drainage from or access to the drainage channels. Furthermore, the headland would be located on property outside the Park boundary.

Nourishment with an updrift headland is thought to be the more stable of the nourishment options as its shape conforms to the pattern of energy dissipation (e.g. curvilinear) and will therefore require less replenishment. Alignments B-B and C-C also provide flood protection by simply extending the existing beach alignment north to join with the north-south dyke (B-B) or with the south end of the armourstone breakwater (C-C) (approx. 1978 shoreline position). Although their initial construction costs are less than that of the updrift headland configuration, because of their straight-line configuration, they are exposed to more wave action. As a result, maintenance costs will be greater (e.g. 2 -5 times that of the updrift-headland nourishment plan).

4.3.1.3 Conversion of Agricultural Land to Wetland

Restoring part of the Pelee drainage scheme to wetlands is another option to be considered. This option reduces the requirement for ongoing maintenance and protection of the shoreline. It essentially abandons the idea of trying to control a shoreline in a highly dynamic coastal environment at all costs.

The area proposed for rehabilitation to wetlands is the south polder of the Marentette Drainage Scheme which measures 83 ha (206 ac.), Figure 12. According to mapping prepared by Setterington (1984), there are seven different property owners located in this section of the Marentette Scheme.

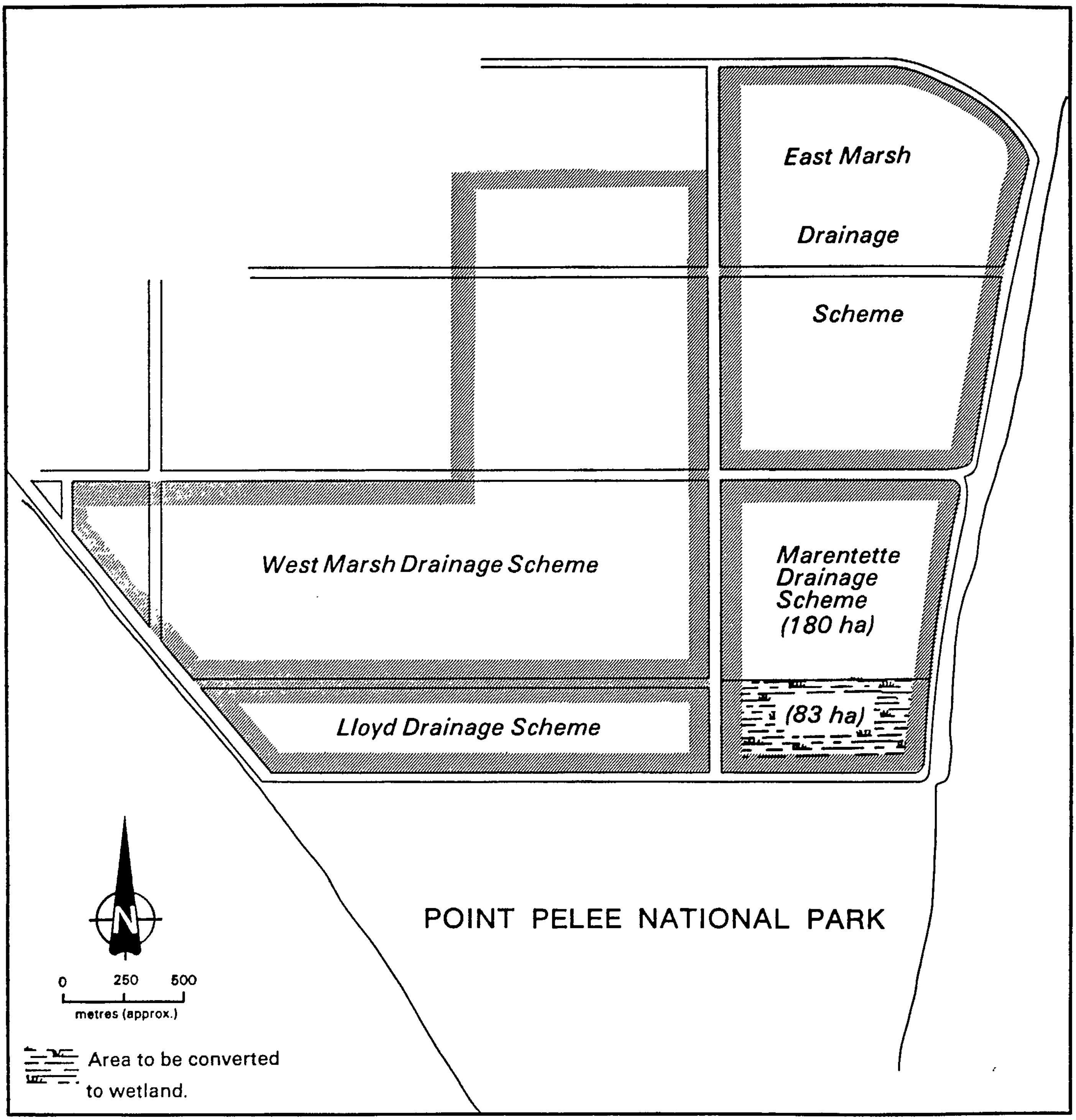

Figure 12. Area proposed to be converted to wetlands.

This land is used mainly to grow yellow seed onions, however, intensive cultivation of these organic soils results in losses due to oxidation and wind erosion. Information pertaining to soil depths and rates of depletion indicates that the soil would be depleted in about 10 - 30 years (Ecologistics 1984). Clay is already exposed in some areas, particulary in the western portion of the drainage schemes as a result of prevailing westerly winds. Setterington (1987) reports land values to be $7.5K to $8.5K per acre within the Marentette Drainage Scheme. However, prices for land drop to about $2.5K per acre where the soil cover has been eroded. It is not certain as to how much of this land has depreciated as a result of soil loss, however, using an average of $5K per acre for the 206 acres, the land has an estimated market value of about $1,030K. It will be necessary to have a detailed land value assessment by a qualified appraiser to affirm its true market value.

Wetland restoration provides a number of use/management options that might include a conservation area, migratory bird sanctuary, demonstration project for the technological development of restored wetlands and scientific research. In any case, it would serve a dual purpose in acting as a natural buffer zone to the park, and with some minor modifications to the surrounding dykes/roadbeds, provide a buffer to the remaining drainage scheme agricultural lands.

Other aspects of any action to create a wetland, which would need to be addressed in more detail, include possible negative reactions by farmers and the general public. Also, consideration will need to be given to maximizing the full benefit from recent expenditures for flood protection. This may mean some form of interim protection providing it is economically feasible. These, and other concerns, will be raised in the more detailed feasibility study.

Initial costs for rehabilitation and its operation would not necessarily be a government responsibility. It could be undertaken by privately funded agencies such as Habitat Canada and Ducks Unlimited that have demonstrated expertise in the development and enhancement of such projects throughout the Great Lakes region.

4.3.2 Structural Solutions

4.3.2.1 Armouring the East-West and North-South Dykes

As an alternative to reinforcing or rebuilding the shoreline, protection from flooding could be provided by armouring the section of dykes in the Marentette Drainage Scheme most threatened by wave action. Temporary protection from wave erosion was provided to the southeast corner of this scheme in 1985-1986 in the form of Gobi-mats. As this was not intended to provide adequate protection in the long-term, additional armouring of the southeast corner of the Marentette Drainage Scheme would be required.

The method used is based on the approach used by U.S. Army Corps of Engineers as outlined in their Shore Protection Manual (1984). Although other variations to reinforcing the dykes are available, such as Setterington's Breaker Bar - Terrafix combination or a "berm" breakwater design, that might afford some cost savings, these have not been examined.

The sections of dyke recommended for armouring at this time extend from the southeast corner 400 m west along the south face of the south dyke, and 100 m north along the east face of the east dyke, as illustrated in Figure 13. Over the expected life of the soils, protection to both dykes may need to be extended as a result of continued erosion in the park and the possible breakup of the armourstone seawall (Phase I) due to undermining (Lavalle 1987b). The armoured section of Marentette Beach and the

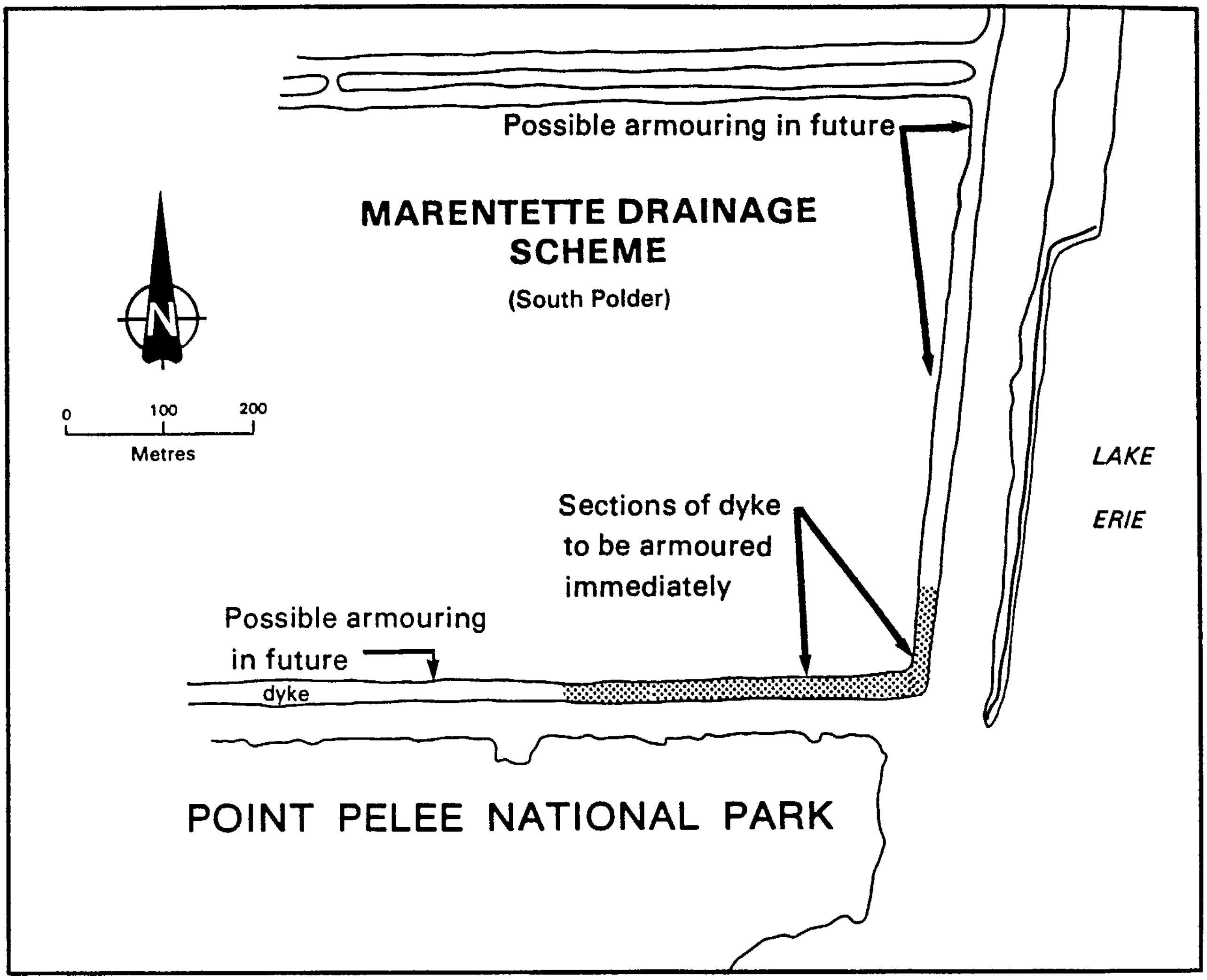

Figure 13. Sections of Dyke to be Armoured

unprotected sections at the north end of Marentette would have to be monitored for any signs of potential breaching. Costs for every additional 100 m of protection are estimated at about $120K. Armouring should consist of a 2 layer revetment of 4-5 ton rough quarry stone placed on a 30 cm filter bed of riprap along the existing dyke face (slope 1:2.5), Figure 14. In addition, the filter bed of riprap would extend onto the roadway as splash protection. Based on costs quoted by Setterington circa 1984/85, the cost per metre for this design is about $1.2K, for a total of $600K.

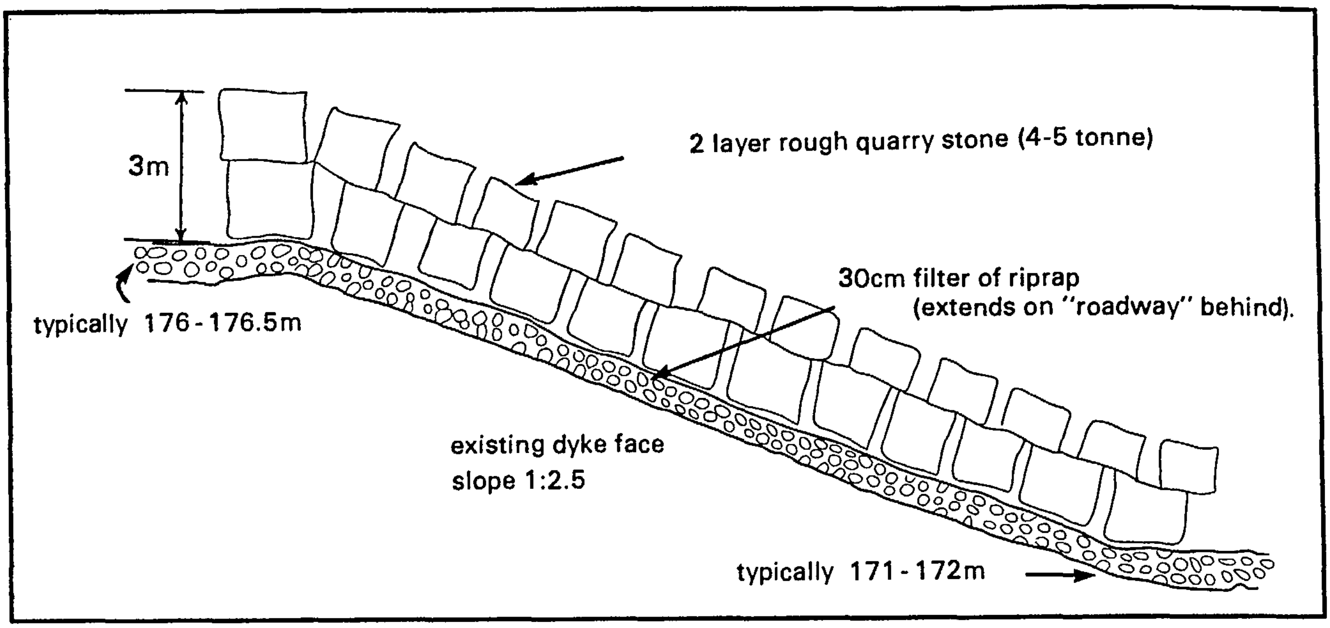

Figure 14. Cross-Section of Riprap Armouring

The design is based on existing information and will require further detailed examination of maximum run-up; integrity of the dyke to support armourstone; depth limitation of waves (assumed 4 m); and inflation costs since 1984/85. As it does not address the problem of continued erosion in the Park, this option would likely also have to be combined with nourishment to prevent breaching from further beach erosion in the park. Nourishment costs are estimated at $375K-$600K plus annual maintenance costs ranging from $20K-$100K as outlined in Section 4.3.1.2.

4.3.2.2 Shoreline Structural Protection

Although extending the rubblemound breakwater to the south is a possibility, further armouring of the shoreline is not recommended based on past performance and effectiveness of structural protection works in this environment, and the potential for extending adverse impacts downdrift. Furthermore, avoidance of structural protection measures is consistent with provisions contained in National Park Management policy regarding shore structures in the park.

5.0 EVALUATION OF MANAGEMENT ALTERNATIVES

5.1 Comparison of Management Alternatives

The options presented are intended as conceptual designs using available information. Further information is necessary for a more detailed analysis of the final management alternative selected. There were a number of factors considered in the development of long-term solutions. Some of the more important factors included the compatibility with shore processes, flood protection, effectiveness of past protection, costs, and duration of the solution. Other shore protection systems such as groynes and perched beaches, that may be effective at other locations in the Great Lakes, were not considered suitable for this site.

A subjective comparison of the relative merits for each of the options (Table 1) provides for an initial screening from which long-term management alternatives can be developed. Reference to "additional" benefits is to indicate which options might have benefits over and above those which provide for continuing agricultural use.

It can be seen that Do Nothing and Artificial Beach Nourishment alignments B-B and C-C are options that provide the least benefit overall. The Do Nothing alternative does not reduce the potential hazards to life and property associated with the risk of flooding. Taking no action will definitely result in flooding. Taking no action also invites the possibility of having to implement a hastily-conceived engineering solution (under crisis circumstances) which past experience has shown to be both costly and ineffective on the long-term. Of the three ABN options, although alignments B-B and C-C are less costly to construct, they are considered to be the least effective on the long-term as they have a shorter life-expectancy and higher maintenance costs.

Table 1. Comparison of Management Options

	Do Nothing	Nourishment B-B	Nourishment C-C	Nourishment Headland	Conversion	Armour Dyke
Initial Capital Cost ($K)	------	375	521	600	1,650	600
Ongoing Maintenance Costs	______	med	high	low	low	high
Duration of Solution	months	yrs	yrs	decade	decades	yrs
Reduces Risk of Flood Damage	no	part	part	part	yes	yes
Replaces Park Shoreline for Short-term	no	yes	yes	yes	no	no
Compatibility With Shore Processes	yes	yes	yes	yes	yes	yes
Compatibility With Fed. Policies	no	yes	yes	yes	yes	yes
Landowners Potentially Affected (Neg.)	yes	no	no	no	yes	no
Additional Public Benefits	no	no	no	no	yes	no
Additional Local Economic Benefits	no	no	no	no	yes	no
Additional Ecological Benefits	no	yes	yes	yes	yes	no
New Opportunities (scientific res./technology devel.)	no	no	no	no	yes	no

The remaining options (Headland ABN, Conversion and Dyke Armouring) provide the level of protection required, but as long-term management strategies, they may need to be combined for a more effective and enduring solution. Benefits associated with the selected option will need to be quantified in a follow-up feasibility study (e.g. net economic analysis).

5.2 Long-term Management Strategies

The ultimate objective is to provide a solution that will eliminate the risk of flood damage to the Marentette Drainage Scheme. While restoration of the Park beach is a concern as it relates to the quality of the marsh habitat, it is viewed more in the context of a flood threat, as was an earlier nourishment project at this site in 1978 (Bush Pond breach). The urgency to restore the beach would not exist were it not for the risk of flood to the Marentette Drainage Scheme. For this reason, there are two versions of the dyke armouring alternative, one which does not restore the beach (A) and the other which does (B). In the non-protection conversion to wetlands option, beach repair is presented as an optional add-on.

There are four components to consider in developing the long-term solution. These relate to the kind of approach taken, either protection or non-protection, and whether the solution is applied only to Marentette, the Park, or both.

The conventional approach to shore management is to modify the cause (e.g. protect the land by armouring the existing dyke system (A), or by combining armouring with rebuilding the park beach (B)). Alternatively, it may be more appropriate to adjust the hazard (e.g. convert the use of the area to something that is more compatible with the natural process of flooding and erosion (C).

Protection

A) Armour Dyke

Don't protect the northeast corner of the park, but protect the southeast corner of the Marentette Drainage Scheme by armouring parts of the south and east Marentette dyke.
Estimated construction cost: $600K

Alternative A) provides flood protection by armouring the most vulnerable sections of the south and east dykes of the Marentette Drainage Scheme (southeast corner). While the objective of reducing the hazard of flooding is addressed, there are very few additional benefits associated with this option.

Under this alternative, it is anticipated that dyke protection along the south boundary of the Marentette Drainage Scheme will have to be extended west an additional 750 m as the breach at the northeast corner of the Park expands allowing wave action to penetrate further inland. There may also be a requirement to extend and reinforce the east dyke if the armourstone wall fronting Marentette Beach is undermined, or if beach erosion increases at the unprotected north end of Marentette Beach. The ecological consequences of not repairing or protecting the park beach will also require further evaluation.

B) **Headland ABN/Dyke Armouring**

Restore/protect the northeast corner of the park and protect the south portion of Marentette Drainage Scheme using the recommended headland nourishment scheme (est. $600K), and armouring of the east Marentette dyke (est. $120K).
Estimated construction cost: $720K

In alternative (B), the northeast corner of the park is restored with artificial beach nourishment. The recommended alignment is the headland configuration, as it will be the most stable of the three nourishment options and as a result will require less maintenance. In preventing further westerly regression of the Park beach, the southern boundary of both the Marentette and Lloyd Drainage Schemes will be protected from direct wave action. Armouring 100 m of the east dyke is also needed at this time to provide protection against storm waves, particularly where it is most vulnerable at the south end of Marentette Beach, as the existing Gobi-mat protection on the dyke and beach protection along this reach of shore are considered to be inadequate. Over the long-term (life of the soils), dyke protection may have to be extended northward if the armourstone wall undermines, or if erosion at the north end of Marentette Beach worsens.

Management alternatives (A) and (B) provide flood protection at an initial capital cost ranging from $600K-$720K. In either case, monitoring and substantial maintenance costs will be required to ensure against flood risk over the next 10 - 30 years, or as long as the soil lasts. This essentially perpetuates the existing situation where private agricultural land is maintained through government subsidy. Normally, there is a major public benefit resulting from food production, however, in this particular case there is little to no public benefit relative to the costs needed for ongoing flood and erosion protection (Nelson et al. 1975, Day et al. 1977, and Muir 1980). In addition, the value of food production from this land is decreasing because of the deteriorating soil conditions (expanding clay exposure). Therefore, any marginal economic benefit that may exist at this time will soon disappear.

Non-Protection

The alternative strategy is to abandon the idea of controlling a dynamic shoreline and convert the high hazard area to a use more compatible with the natural flooding and erosion process.

C) Conversion to Wetlands

Don't restore/protect the northeast corner of the park but convert the south polder of the Marentette Drainage Scheme to wetlands.
Estimated initial cost: $1,650K

Conversion of agricultural land to wetland is an alternative which both eliminates the hazard of uncontrolled flooding of farmland while creating a valuable wetland area more compatible with the flood hazard and gradual shoreline retreat. This approach provides an overall solution to the problem rather than treating symptoms on a piece-meal basis through engineering projects. It does not repair or protect the park beach; this aspect will need to be addressed specifically in any follow-up feasibility study to determine the significance to the quality of the marsh system. Minimum cost for repairing the park beach would be $375K.

Conversion of the land will cost an estimated $1,030K, plus the cost for stabilization of present dykes, construction of water level control structures, and any minor modifications needed to raise roadbeds that together are estimated at $625K.

5.3 Recommended Long-term Management Strategy

Management alternatives that offer flood protection ((A) - Armour Dyke and (B) - Armour Dyke/ABN) are not recommended based on the high construction and maintenance costs, and the possible incremental costs of having to extend protection in the future; the fact that the resource being protected (land in agriculture and food production) is declining in value; there is marginal to no public benefit, and; the protection strategy is only an interim solution while the soil lasts (estimated to be 10 - 30 years).

The recommended long-term strategy is for non-protection, using the conversion management alternative (C). It is a retreat strategy. Conversion to wetlands eliminates hazards of uncontrolled flooding to the most endangered section of the drainage schemes; it changes the expectations of private land owners for continued public funding assistance; and it is a solution that extends well beyond the expected 10 - 30 yr. life of other options.

This alternative offers additional advantages that others do not. For instance, greater use/management flexibility, as there are a number of approaches to acquiring and developing the land to be converted. Other agencies at the provincial and municipal levels, and privately funded groups such as Ducks Unlimited and Habitat Canada that have demonstrated expertise in such projects, may be interested in undertaking such a project outright, or on a cost-shared basis. Uses may vary from an extension of the existing Point Pelee National Park for special activities such as recreational duck hunting, a provincial conservation area, and demonstration project (e.g. OMNR/CWS), to a privately owned and administered waterfowl habitat (Ducks Unlimited). Conversion also provides an opportunity to develop a wetland resource that is in high demand and that will appreciate in value with time, rather than maintaining a declining agricultural resource.

In recognizing the high public costs for maintaining a small number of private operators, others have made recommendations for public ownership. Nelson et al. (1975), for example, indicate that the land within the schemes could continue to be farmed through lease-back or other arrangements, or be maintained for recreational or conservation purposes. East (1976) addressed the "domino effect" associated with the development-protection-downdrift erosion-protection cycle at Point Pelee, and the fact that "continued expenditures for protection are justified more by the amount that has been spent to date than by the primary values which are to be protected". As past experience has shown, the cost to structurally protect this reach of shore continues to escalate while its value and use in agriculture depreciates. Further expenditures of this kind will only lead to a continuation of this pattern. Day et al. (1977) in their assessment of coastal hazard programs also recommend there be more emphasis on long-range non-structural solutions such as land acquisition.

5.4 Future Action

5.4.1 Feasibility Study

In developing and assessing the management options, there were some aspects identified which will require further investigation to substantiate that conversion and habitat development alternative is feasible. The objectives of the feasibility study are to demonstrate confidence and commitment to the recommended management strategy. Elements of the study should address:

- probable habitat productivity and reversion/succession timing and pattern for area to be converted back to wetlands;
- ecological and physical impacts of not repairing the Park beach;
- geotechnical assessment of the surrounding dyke to determine stability and engineering adjustments required (e.g. raising of roadbeds), and details of water control systems;
- economic benefits of public acquisition (if need be) through changes to park use, willingness to pay and increased expenditures in local area by tourists, etc.;
- evaluation of alternate approaches for wetland restoration and operation by other agencies;
- assessment of the impact of removing this area of the drainage scheme from agriculture production;

- evaluation of an interim protection measure to ensure the maximum benefit from recent flood proofing expenditures has been realized. Any benefits that may result from adding interim protection must be considered in the context of the long-term plan and be weighed against the potential economic return from extended agricultural protection.

- socio-economic impact to cottagers, land owners and employees affected;

- land value appraisal to determine fair market price, and;

- a preliminary environmental assessment;

Implementation of the conversion to wetlands management strategy will depend on the outcome of the feasibility study. In the interim, if the threat of an uncontrolled flood should escalate, it is recommended that procedures and solutions be established as a contingency plan.

5.4.2 Contingency Plan

The threat of flooding will increase either by a general rise in lake level, in which case there will be some lead time to assess and organize a flood hazard response, or without warning as a result of storm action. It should be noted that although this study has concentrated on the most obvious flood prone section of the dyke system at the northeast corner of the Park, other sections of unprotected beach also may warrant attention such as at the north end of Marentette Beach.

In either case, the recommended approach to flood proofing should not vary significantly from the protection alternatives presented in this report (artificial beach nourishment, dyke armouring, or a combination of the two). As this would be intended as a short-term measure, the scale of the design could be reduced to cope with the immediate flood risk only. Under a storm induced flood, there may also be a requirement to evacuate the flood prone area. In this regard, it is further recommended that an evacuation plan be prepared in conjunction with Emergency Measures Canada, Emergency Planning Ontario (Ministry of the Solicitor General), Essex Region Conservation Authority and the Township of Mersea.

The evaluation of the perceived risk and assessment/selection of suitable response should be resolved with input from those agencies having direct interest (Canadian Parks Service, Agriculture Canada, OMAF, OMNR, Conservation Authority and the local municipality) as well as those having expertise in coastal engineering (DPW, DOE/NWRI) and coastal processes (DOE/NWRI, DFO).

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APPENDICES

APPENDIX 1

Historical Account of the Events Leading to the Development of the Point Pelee Drainage Schemes

- in 1860's, 1870's and 1880's several financial, institutional and technological changes occurred, permitting large scale drainage projects along north shore of Lake Erie.

- provincial and municipal legislation passed enabling governments and individuals to co-operate in financing drainage schemes; by 1860 clay and brick tile available; by 1880 drainage by dyking and pumping (steam powered) proved practicable and feasible; low lake levels, also this latter approach involved construction of canal along base of high land around marsh, erection of dykes around reclaimed land and installation of pumps to remove water.

- in 1893 W.L. Scott purchased marshland north of naval reserve from South Essex Gun Club; then presented petition for reclamation.

- in 1894 drainage project permitted to proceed.

- completed in 1895; beset with problems, frequent repairs to dykes and pumping equipment; in 1904 few lots in Concession C abandoned; high lake levels.

- by 1905 Point Pelee Drainage Scheme was $46,000 in arrears; bill passed in order to consolidate debts for scheme; repairs completed involved deepening and dredging of canals.

- in 1908 further repairs.

- in 1909 Point Pelee Drainage Scheme divided into two sections, East Marsh Drainage Scheme and West Marsh Drainage Scheme; due to objections from ratepayers.

- continued repairs and higher annual levy.

- in 1914 marshland drained immediately north of naval reserve, e.g. Concession D or Lloyd Drainage Scheme; privately financed and contained some 535 acres.

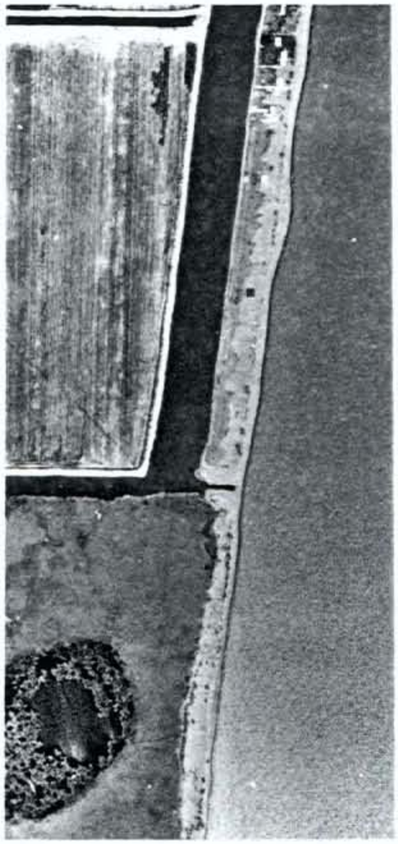
- land owners soon beset by problems and in 1922 Mersea Township became responsible.

- during this time numerous smaller drains constructed within larger scheme to facilitate drainage and agricultural production; land also tiled.

- 1900 - 1901 offers to reclaim part of reserve marsh made; refused.

- 1914 Point Improvement Company applied to drain 2685 acres of reserve marsh for cultivation; denied when official of Ordinance and Admiralty Branch recommended against.
- in 1953 further land reclamation, 656 acre Marentette Drainage Scheme and north park boundary sealed off by dykes.
- flooding always problem; engineering adjustments continue.
- dredging and landfilling on private agricultural land within Point Pelee National Park undertaken in early 1930's; 20 - 25 acres elevated on eastern portion of Lot 8.
- between 1955 - 1963 increased consumer demand; some 80 acres on eastern portions of Lots 7, 11, 12 and 13 created, ditches on Lots 11 and 13 used for irrigation pumps.
- in 1963 government purchased Lots 11 and 13 and dredging and landfill within the park ceased.

APPENDIX 2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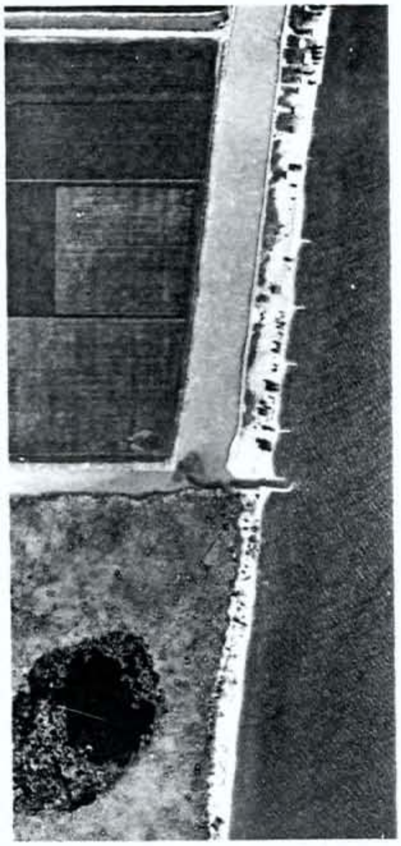
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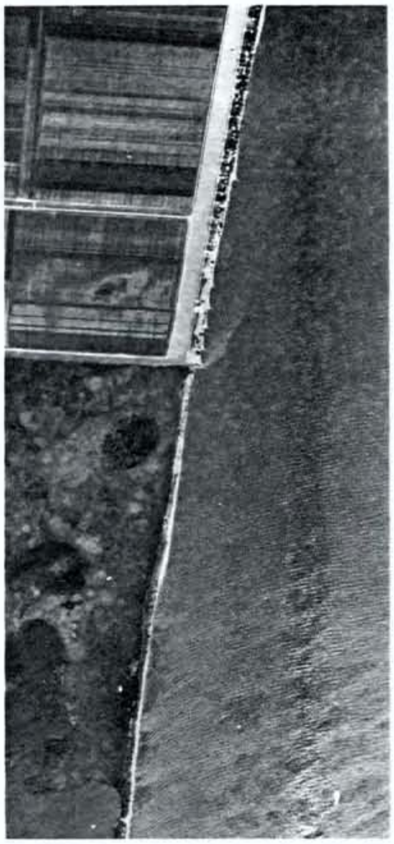
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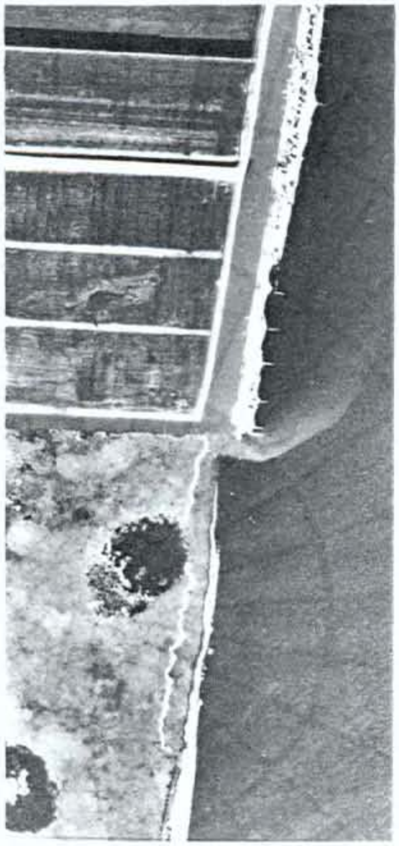
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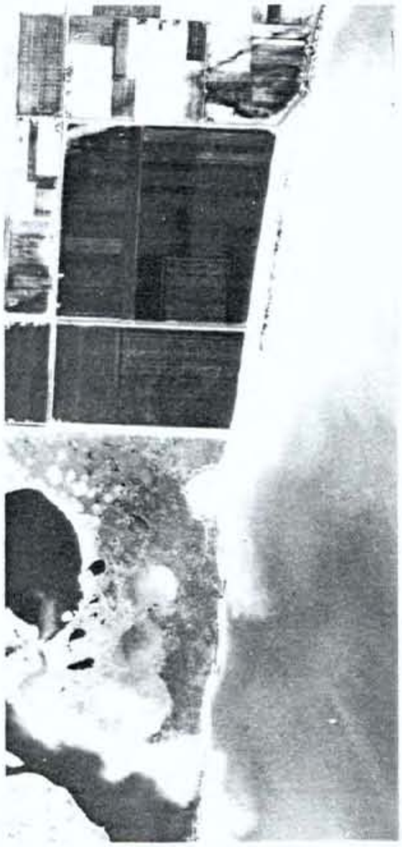
April '76


July '85

APPENDIX 3

Volume Calculations for Alignment B-B

Chainage (m)	Bottom Elev. (ft)	Bottom Elev. (m)	Depth of Fill (m)	Basewidth (m)	c/s Area (m^2)	Vol. (m^3)
43	572.05	174.36	2.04	41.5	57.6	
						1,555
70	572.05	174.36	2.04	41.5	57.6	
						770
82	571.05	174.06	2.34	45.4	70.7	
						3,432
122	569.05	173.45	2.95	53.4	100.9	
						5,247
174	569.05	173.45	2.95	53.4	100.9	
						1,454
189	569.55	173.60	2.80	51.4	93.0	
						2,142
213	570.05	173.75	2.65	49.5	85.5	
						2,869
255	572.55	174.52	1.88	39.4	51.1	
						17,469

Volume Calculations for Alignment C-C

Chainage (m)	Bottom Elev. (ft)	Bottom Elev. (m)	Depth of Fill (m)	Basewidth (m)	c/s Area (m^2)	Vol. (m^3)
0	568.55	173.30	3.10	55.3	109.0	
						2,616
24	568.55	173.30	3.10	55.3	109.0	
						3,060
49	567.05	172.84	3.56	61.3	135.8	
						7,614
109	568.05	173.14	3.26	57.4	118.0	
						4,814
153	569.05	173.45	2.95	53.4	100.8	
						3,528
188	569.05	173.45	2.95	53.4	100.8	
						2,812
225	572.55	174.52	1.88	39.4	51.2	
						24,444