Final Report

PORT STANLEY PUBLIC BEACH DUNE MANAGEMENT PLAN

Municipality of Central Elgin

prepared by

Shoreplan
Engineering Limited

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1.0 Introduction

This report presents a dune management plan for establishing new coastal dunes and enhancing existing dunes along the Port Stanley public beach. It includes recommendations for a pilot program to initially develop new dunes near the end of William Street and to maintain the existing dunes between Mackie's and GT's. If the pilot program proves successful additional dunes could be created at the end of William Street and west of GT's. Dunes are a key component of natural beach shorelines and play an important role in sustainable coastal processes.

1.1 Background

This current study is rooted in past studies that have recommended beach management programs for Port Stanley. In the 1989 Shoreline Management Plan that was prepared for the Kettle Creek Conservation Authority the beach shoreline west of the harbour breakwater was divided into 2 reaches (Philpott, 1989). Reach 1 extended from the western limit of the fillet beach to the end of the single dwelling structures, approximately south of Stanley Park. Reach 2 extended from the eastern limit of Reach 1 to the harbour breakwater. The beach was divided into 2 reaches due to the lack of dunes within Reach 2.

The Shoreline Management Plan recommended that a dune management plan be implemented in Reach 1 to promote the growth and stabilization of a dune system lakeward of the line of development as it existed in 1989. It also recommended that new development be restricted until the dune management program was established and that subsequent development be compatible with that program. No dune management program was recommended for Reach 2 because it was felt that the level of pedestrian traffic was too high to allow proper dune formation. Pedestrian traffic must be prevented on both developing and mature dunes and imposing such restrictions at Port Stanley was not considered practical at that time.

In 1992 Shoreplan Engineering Limited carried out a more detailed assessment of wave uprush and flooding on the Port Stanley beach than had been done for the Shoreline Management Plan (SMP). That study used the same mapping as the SMP but carried out wave uprush calculations for a wider range of wave conditions and for a larger number of beach profiles. It was found that the crest of the public beach would be overtopped during design conditions and the western end of the beach would be flooded as far back as Edith Cavell Boulevard. Under design conditions, flooding extends even further inland behind the eastern end of the beach because of the lower backshore elevation.

In 1996 Shoreplan Engineering Limited prepared the Port Stanley Beach Management Study following changes to the Provincial Policy Statement of the Planning Act and publication of guidelines for implementing those policies. Those guidelines proposed new methods for defining the landward boundary of the "Regulatory Dynamic Beach" and recommended

standards to be met for future land use proposals within the Regulatory Shoreline Area. The Beach Management Study focused on delineation of the regulatory beach under the new provincial guidelines and how that delineation would affect future development. It also noted the importance of dunes to all users of the beach and recommended that dunes be developed along both the public and private areas of the beach. Suggestions for the private beach area were similar to those made in the 1989 Shoreline Management Plan and included cessation of the practice of leveling the dunes. For the public beach area it was noted that new dunes could be created on both the east and west sides of William Street and along the crest of the beach fronting the washroom building and picnic shelter west of William Street. This current study provides more detail on how new dunes can be created and how the existing dunes can be maintained and/or enhanced.

2.0 Overview of the Role of Dunes on Beach Physical Processes

Dunes are an important component of the overall beach system and play a key role in the physical, biological and environmental processes that occur on the beach as a whole. Relevant physical processes typically include reducing the extent of inland flooding that occurs during significant storm events at high water levels, acting like a sand reservoir for the formation of breaker bars during storms, and limiting the inland incursion of wind-blown sand.

Dunes are a naturally occurring feature on fully developed dynamic beaches that have a suitable supply of fine grained sand, onshore winds, and vegetation. This applies to both natural beaches and fillet beaches held in place by structures like the Port Stanley west breakwater. Natural dunes have formed along much of the Port Stanley beach although the dunes within the public beach area have mostly been destroyed through intense public use and beach grading and grooming practices. It has long been recognized that natural beaches provide one of the best forms of erosion protection for the backshore area, as long as there is a sufficient supply of sand available to keep the beach nourished.

Sand beaches are highly dynamic with both erosion and deposition occurring on a continuous basis. During storm events sand is transported off the beach to form breaker bars that help protect the beach from severe erosion. The bars force incoming waves to break further offshore, dissipating the wave energy across a wider surf zone and reducing the distance the waves cut into the beach. On a natural beach system it is the dunes that typically supply the volume of sand that is moved offshore to form the breaker bars. Under calmer conditions that sand is transported back shorewards and deposited on the face of the beach. Wind then transports the sand inland where the dunes and dune vegetation trap it, rebuilding the dunes. Sand that is trapped in the dunes is therefore not available for transport landward of the dunes, which is a significant benefit when that sand is causing a problem. The sand that must be removed from the municipal parking lots is an example of a problem caused by sand transported away from a beach.

As the dunes build they increase the elevation of the top of the beach which in turn generally increases the flood protection for inland areas. Dunes do not affect the flood elevation associated with the water level on Lake Erie, but they do limit the inland impact of wave runup and overtopping. During the high water levels of 1985 and 1986 significant portions of Edith Cavell Boulevard were flooded by waves that overtopped the low dunes and flowed inland. Higher dune crest elevations would have reduced the amount of overtopping, particularly towards the eastern end of Edith Cavell Blvd.

While it is generally accepted that the climate changes associated with global warming will eventually lead to lower long-term water levels on Lake Erie it is by no means certain that the water levels which occurred during those flooding events will not occur again. It is also generally accepted that the severity of storms may increase as a result of climate change. The

conservation authority shoreline regulations are based on the same water level analyses used in the 1989 Shoreline Management Plan.

It must be noted, however, that conditions on the beach have changed since the preparation of the Shoreline Management Plan and follow-up flood elevation studies. Those plans were prepared using Flood Reduction Mapping Program (FDRP) mapping produced during the late 1980s. It is our belief that the width and height of the main beach has changed since that mapping was produced, but the extent of that change and how it affects the wave uprush and overtopping elevations has not been quantified. The width of the sub-aerial (above water) beach has increased because the water level has lowered, but we believe it has also increased due to retention of sand by the west breakwater. Most but not all of the littoral drift is likely to be bypassing the breakwater, resulting in a very gradual increase in the volume of the fillet beach near the breakwater.

Both long and short term water level fluctuations greatly influence dune development and dune locations. On natural beaches it is vegetation that traps the wind-blown sand, causing the formation and development of the dunes. That vegetation is generally found above the wave uprush line associated with relatively recent storm events as the uprushing waves will erode the dunes and dune vegetation. Dune erosion is more prevalent during periods of high water levels as the high water levels allow waves to propagate further up the beach. Dune building tends to occur during periods of lower water levels as there is a greater width of beach exposed to wind erosion and fewer disturbances to the dunes by wave uprush. When positioning new dunes adjacent to water bodies subject to long-term water level fluctuations like Lake Erie, consideration must be given to those fluctuations.

3.0 Existing Conditions

There are a limited number of existing dunes on the public beach at Port Stanley. The municipality has allowed dunes to form along a strip of beach between Mackie's and GT's and there is a small dune at the very eastern end of the beach adjacent to the breakwater. There are no other dunes on the public beach because of the grading and grooming that takes places each year. The location of the existing dunes can be seen in Figure 3.1, which is a site plan based on a 2006 aerial photograph of the public beach at Port Stanley.

Photo 1 is a 2009 photograph showing the dunes between Mackie's and GT's and a portion of the graded beach. There are boardwalks to limit pedestrian access to the dune but no physical barriers to keep people off the dunes.

The main beach is graded each spring to smooth out the sand trapped by the sand fences placed on the beach over the winter. It is our understanding that the sand trapped by the fences is redistributed but is not removed from the beach. The beach is groomed on a regular basis during the summer.

Photo 1

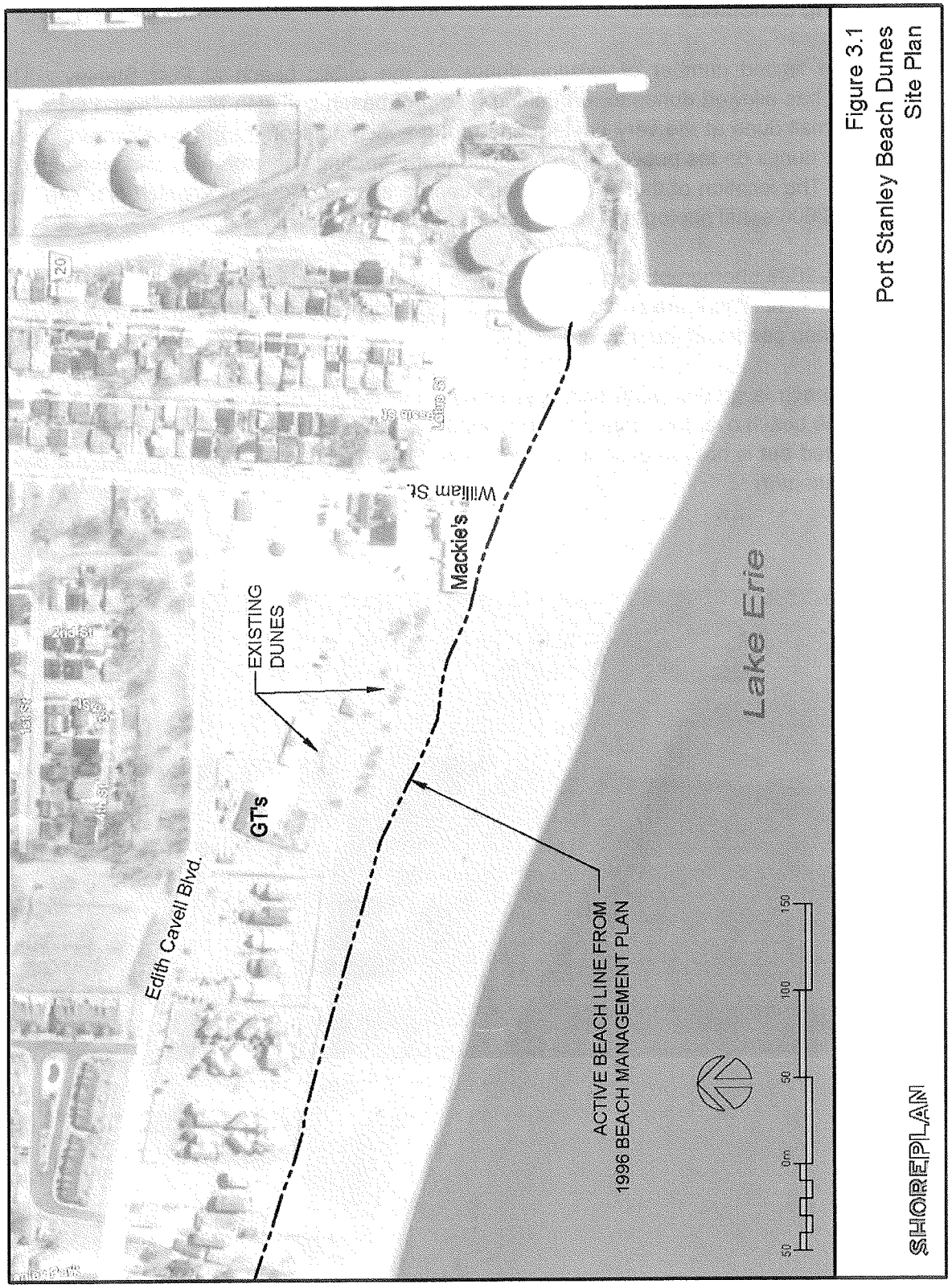

Figure 3.1
Port Stanley Beach Dunes
Site Plan

4.0 Dune Management Plan

This section of the report presents our dune management plan for the public beach at Port Stanley. Our plan describes general locations for potential new dunes and discusses the likely physical processes that will act on those dunes. As there was no survey carried out during this study and the available contour mapping is more than 20 years old our, plan should be interpreted qualitatively rather than quantitatively.

4.1 Ideal Naturalized Dune Management versus Constraints at Port Stanley

Under an ideal naturalized dune management plan, consistent with our interpretation of the intentions of the implantation guidelines of the Provincial Policy Statement, the formation of dunes would be encouraged along the entire length of the public beach. Pedestrian access would be limited to specific corridors through the dunes and the current beach grading practices would be stopped. New dunes would be developed along the boundary of the dune formation zone identified in the 1996 Beach Management Study and those dunes would grow in the lakeward direction because of the current water level. The location of the 1996 dune development zone is shown on Figure 3.1.

Following such a plan would be consistent with the overall concept that dunes are an important component of a beach system and that having a well established beach/dune dynamic is a key component of long-term sustainable coastal processes. Implementing that sort of plan, however, would come at the cost of changing the current public use of the beach. On the other hand, continuing the current public use practices comes at the cost of sacrificing what is considered to be preferred beach management under the ideal naturalized beach management plan.

The authors of this report recognize that there has been considerable local debate about the need for dunes on the main beach and significant pressure has been brought towards maintaining the current beach use practices. We have developed a practical dune management plan intended to advance beach management concepts without excessively impacting the current beach use practices. We provide comment on the costs of our practical plan in terms of the impact on the physical processes associated with our plan when compared to the ideal naturalized plan. Commenting on the significance of the differences in the socio-economic and environmental/biological aspects of the practical plan with respect to the ideal naturalized dune management plan is beyond our area of expertise and beyond the requested scope of this study. Those aspects will need to be considered by council as they decide how to implement the plan.

For the dune management plan we have divided the beach into three reaches: immediately east and west of William Street; from Mackies to GT's; and west of GT's. Each of those reaches is discussed separately below. Figure 4.1 shows the position of the dunes proposed as part of the dune management plan.

4.2 Dune Locations

Reach 1 – Immediately East and West of William Street

Reach 1 of our plan includes the construction of up to 4 dunes around the turning circle at the end of William Street. The dunes, identified as dune 1 to 4, are as shown in Figure 4.1. These dunes will reduce the amount of sand blown into William Street and onto the parking lot on the east side of William Street. They will provide some wave overtopping reduction in the area east of William Street but the reduction will not be as extensive as would be achieved through the ideal naturalized dune management plan described previously. Inland flooding will still occur during design events as water flows around and between the individual dunes. Shoreplan (1989) also noted that flooding in the developed area north of the beach can be caused via the inner harbour and, in a few locations, storm sewer intakes that are located below the flood water levels.

Dune 1 is recommended as part of our dune management plan and is described in more detail below as part of the pilot project. Dunes 2, 3, and 4 are optional dunes that could be developed in the future but are not recommended for construction now. Dune 3 and part of dune 4 are located on private property and cooperation of the property owner would be required to construct those dunes. Developing dunes 2 to 4 would reduce wave overtopping and sand deposition on the end of William Street and the turning circle. They would also be well positioned to provide a sand source for breaker bar formation during design storm events. Previous studies have recommended that the turning circle be relocated further inland and that is still a valid recommendation. If that were to be done the position of all four dunes within in Reach 1 could be adjusted to accommodate a revised turn-around and parking lot configuration.

Dune 1 is positioned near the southern limit of the parking lot to minimize the loss of recreational beach space. However, that places it far enough back that it is not expected to provide sand for bar formation. It will reduce overtopping into the parking lot and will reduce the amount of sand blown off the beach. Dune 1 is essentially in the same position as one of the recommended dunes from the 1996 Beach Management Study. Dune 1 should be developed with a combination of beach grass plantings and sand fencing. More details of how that should be accomplished are included in Section 4. 5.

Dunes 2 to 4 are better positioned in terms of an ideal naturalized dune management program because they are likely to be within the active beach zone. There is some uncertainty as to the position of the active beach zone because the mapping used to determine the limit of that zone in the Shoreline Management Plan and the Beach Management Study is now significantly out of date. Dunes 2 to 4 will, however, cover a significant area of beach that is currently used for public recreation. Whether or not dunes 2 to 4 will eventually be developed will be a council decision made with consideration to more than just the physical processes acting on the beach.

Reach 2 –Mackie's to GT's

Reach 2, which is from Mackie's to GT's already has significant dunes along part of that reach, as described previously. For this section of shore we recommend maintaining the existing dunes without deliberately increasing their overall height, width or length. Access to the dunes should be limited to the existing walkways and any damaged areas should be repaired. The dunes should be monitored on a regular basis to evaluate whether or not the existing walkways and signage are proving effective in limiting access or if more active steps need to be taken. If there are damaged areas where the dune grasses have been trampled they should be repaired with new plantings and the area roped off until the plantings are established.

The existing dunes do not extend over the entire length of Reach 2 (see Figure 4.1), which will leave a gap in front of GT's and a gap west of Mackie's. Those gaps have been left intentionally to avoid disruption of their commercial activities. Extending the dunes in front of GT's would also have impacted the beach volleyball courts and that was viewed as an unacceptable impact.

Growth of the dunes can be limited to some degree through the use of sand fencing, as described in more detail as part of the pilot program (section 4.5.2). The extent to which the dunes can be controlled will be quantified as part of the pilot program. If it found that the fencing cannot adequately control the dune heights then the dunes can be mechanically groomed to reduce their height. The preferred means of reducing the height of an existing dune is to manually remove and save the grasses on the top of the dune, to "shave" the top of the dune with a small dozer or loader, then to re-vegetate the dune by re-planting the saved dune grass.

Municipal staff have reported that the existing dunes have already reduced the volume of sand blown onto the parking lot north of the washroom building. The dunes will also provide some flood reduction during a design event by intercepting the overland flow of waves that overtop the crest of the beach. The dunes do not form a continuous barrier so they will not reduce flooding to the extent that the continuous dunes of an ideal naturalized dune management plan would. This "cost" of our practical dune management plan is not expected to be significant at the current water levels because of the lower risk of experiencing design uprush conditions at the current lake level. At higher water levels the risk of flooding will be greater but the potential consequences of this reduction in flood protection are somewhat mitigated by the fact that the land north of Reach 2 is also susceptible to flooding from water that overtops the beach further to the west. It should also be noted that any development that has taken place since the 1989 Shoreline Management Plan was prepared would have been designed to accommodate the expected flooding.

During a design storm the existing dunes will not contribute significantly to the formation of offshore breaker bars because they are located too far up the beach.

Reach 3 – West of GT's

Reach 3 of the plan includes 2 dunes similar to those previously proposed by the Village. They run parallel to the fence line of the Newport Beach Condominiums and are located approximately 10 metres lakeward of the fence. That 10 metre offset is proposed as a buffer corridor to allow the beach north of the dunes to be groomed to prevent sand depositing against the fence. It is likely that the proposed corridor width could be narrowed once more site specific data about the dune formations is generated from the pilot program.

The proposed dunes run from the western limit of the public beach to the eastern limit of the condominiums adjacent to GT's. That will leave a gap in the dunes immediately in front of GT's. That gap was left to avoid conflicting with the beach volleyball courts and to minimize commercial disruption to GT's.

It is anticipated that the dunes will be in the order of 15 metres wide once they are fully matured. They will be located in a reasonable position with respect to the ideal naturalized dune management plan described previously so they are expected to play a role in the physical processes at this site. They will reduce the extent of inland flooding during a design event by limiting the volume of overtopping water. It is worth noting, however, that the dwellings located north of Reach 3 were all constructed after the Shoreline Management Plan was prepared and have been properly flood-proofed assuming no dunes will be present. While reducing flooding hazards is a general benefit of dunes the fact that the dwellings have been flood-proofed could be viewed as limiting that benefit.

The western dune in Reach 3 should be well positioned to supply sand for breaker bars during severe storms under design conditions. The eastern dune is further back and is not expected to provide sand for bar formation.

4.3 Beach Grading and Grooming

Under an ideal naturalized dune management plan the Village would stop grading and grooming the beach and would allow the dunes to grow lakeward until they reached the limit of the wave uprush zone associated with the current lake levels. However, that would impact the current public use of the beach and is not considered to be practical within the context of this dune management plan. We therefore recommend that the municipality continue with its current practice of grading the beach in the spring and raking or grooming it throughout the summer season. The raking and grooming should take place lakeward of the edge of the dunes and should not encroach into the areas intended for dune development. If the dune grasses need to be raked to remove debris or garbage then it should be done with hand rakes.

Sand retained by the fencing placed at the end of the summer should be re-graded onto the beach, not removed from the beach. As a general principal of littoral material preservation, sand that is removed from behind the dunes should be placed back on the beach if practical.

That includes sand removed from the parking lots and sand removed from behind the dunes in Reach 3, if required. If it is not practical to place the sand back on the beach then an appropriate alternative would be to return the sand to the nearshore littoral regime east of the harbour. That could be done by placing the sand on Little Beach, as long as the sand is clean and uncontaminated. The regulations and policies governing the practice of returning sand to the littoral regime have changed recently so any plans to return sand to either the main beach or Little Beach should be reviewed with the Ministry of Environment to confirm that the sand meets current quality regulations.

4.4 Seasonal Fencing

Grading and grooming in front of the dunes will stop the lakeward migration of the dune vegetation. That migration is a natural process that would not be disturbed within an ideal naturalized dune management plan. Where vegetation migrates new embryo dunes form in front of the established foredunes, allowing the dune system to develop outwards. If that migration is stopped then the dunes tend to increase in height because they trap the beach sand that would have otherwise formed the embryo dune. It is therefore important that the supply of sand to the dunes be limited if the beach is groomed and there is a desire to limit the height of the dunes. Part of the pilot program will investigate if seasonal fencing can be used to limit the growth of the dunes in Reach 2. That experience could then be applied in the other reaches.

Sand fencing can be used to both limit the Aeolian transport of beach sand and to encourage deposition in specific areas. Fencing is most efficient at trapping sand when it is placed perpendicular to the prevailing wind but it will still function when placed at an angle. The greatest sand retention is achieved with a fence with about 50% porosity, such as a wood slat fence with the gaps between the slats the same width as the slat. There is a wide range of fence configurations and spacing that have been used on different projects throughout North America. As a general principal it is suggested that placing parallel rows of fence approximately 10 metres apart provides the most effective erosion control on an exposed beach. Placing fence about 4 to 5 metres apart seems to produce the greatest deposition for a given area and is frequently recommended for dune development.

In the past the municipality has controlled wind erosion on the public beach by erecting sand fences in the late fall and removing them in the early spring. Different fence configurations have been used but it is not clear if those configurations were selected with any specific objective. For example, Figure 4.2 shows the position of sand fencing visible in aerial photographs taken in March 2006. Figure 4.3 shows the approximate configuration reported to have been used since prior to the municipal amalgamation (1998). That information was obtained from a sketch provided by municipal staff. It appears as if there is some variation in where the fencing is placed each year. Subjectively, it looks like the fencing in Figure 4.2 would have reduced erosion over the beach as a whole and the fencing in Figure 4.3 would have produced deposition in key locations where past problems have been experienced. The spacing of the

fences in Figure 4.2 is typically in the order of 40 to 50 metres, which is considerably greater than the most effective spacing of approximately 10 metres.

Overall, the layout of the fences shown in Figure 4.3 seems to be reasonable. We do question the need for the two easternmost north-south running fences located within Reach 2 and suspect they will not be required if a fence is placed in front of the entire dune, as recommended for the pilot program. If too much sand is getting past the fences in any critical areas then two steps could be taken. Parallel rows of fencing could be used in those key areas and an additional row of fencing could be added upwind to halve the upwind length of unobstructed beach. The capacity of a sand fence is related to a number of factors including the length of the unobstructed beach updrift of the fence. Under similar circumstance the volume of sand trapped by the second fence in two rows of fence 50 metres apart will be greater than the volume of sand captured by the second fence in two rows of fence 25 metres apart.

As part of the pilot program we recommend installing seasonal fencing in front of the dunes in Reach 2 to evaluate the effectiveness of the fencing in limiting the supply of sand to the dune. Ideally the fencing should be erected before the fall stormy season and left in place until the end of the spring stormy season. If it is compatible with the public use of the beach we recommend that the fencing be erected in early October (probably after Thanksgiving) and removed in late April or early May.

4.5 Implementing the Dune Management Plan

4.5.1 Constructing New Dunes

Natural sand dunes form on the crests of beaches because fine sand transported off the beach by onshore winds is trapped by vegetation. The four main conditions required for dune formation are suitable topography, a sufficient supply of fine grained sand, onshore winds and vegetation. Where the first three conditions are present, such as at Port Stanley, dunes can be formed by either planting suitable vegetation or erecting sand fences to retain the sand. The most suitable type of vegetation for a newly formed dune is a native dune grass found to grow naturally and locally. We did not investigate the local native plant species as part of this study and recommend that a qualified horticulturist be consulted to identify an appropriate species and source of the dune grass and to identify any local conditions that might affect the planting.

Sand fences will retain a given volume of sand at a faster rate than planted dune grass but a dune initially formed with fences alone must also be vegetated in order to be sustainable in the long-term. Using a combination of fences and dune grass planting is one of the most effective means of mimicking natural processes to create new dunes.

A common type of dune grass is American Beachgrass (Marram). The Ministry of Natural Resources recommends planting Marram grass with a spacing of 45 to 60 cm, on centre with a typical planting depth of 15 to 30 cm. No particular planting pattern is recommended but

uniform rows should be avoided to minimize wind funneling. A random or staggered pattern would suffice. The plantings should cover the target area for the dune

Commercially available standard wooden snow fencing is commonly used for sand fences intended to trap wind-blown sand. Vegetation should generally be planted at the same time the fence is erected unless the expected sand accumulation rate is too high for the vegetation to grow with it. For the dunes developed with fencing during the pilot project we recommend that dune grass also be planted. If the sand accumulation rate is too high new grass will have to be planted once the sand fences become buried.

4.5.2 Pilot Program

We recommend that a pilot program be used to implement the proposed dune management plan. Under the pilot program dune 1 in Reach 1 would be established and monitored prior to establishing the remaining dunes in Reach 1 and Reach 3. Data gathered from the monitoring of the dune development would be used to refine the design of the remaining dunes. The dune should be created by placing sand fence and dune grasses in the location shown in Figure 4.1. We suggest that two rows of sand fence be placed approximately 5 metres apart. The lakeward row of fence should be approximately 2 metres inland of the lakeward edge of the desired dune position. A suitable dune grass should be planted between the two rows of fence, for a width of approximately 8 metres inland of the landward fence, and for a width of 2 metres lakeward of the lakeward fence. That will give a total width of 15 metres for the grass planting. Monitoring the development of the dune will provide data regarding the rate of growth for the use with future dunes. An initial target height of 1.5 metres is recommended for the dune but that target could be re-evaluated as the dune develops.

Growth of the dune should be monitored by measuring the dune height and mapping its footprint. We recommend that those measurements be taken twice annually, at the same time that the seasonal sand fences on the beach are erected and removed. Data obtained from that monitoring can be used to develop an implementation plan for the two dunes recommended for Reach 3. It is our expectation that it will be a number of years before they would be developed.

Our dune management plan recommends that the dunes in Reach 2 be maintained while limiting their growth with the use of sand fences. The degree to which that can be accomplished at this site should be investigated as part of the pilot program. When the seasonal fencing is erected on the main beach a row of fencing should be placed in front of the dunes in Reach 2. We suggest that the fence initially be placed approximately 5 metres in front of the dune but that distance should be modified as determined from observation of its effectiveness. The purpose of the fence is to limit the amount of sand blown onto the dunes during the non-summer season. The sand retained by the fence will be returned to the main beach as part of the spring grading. If the fencing proves capable of limiting the height of the dunes in Reach 2 then it can be assumed that it could also be used to control the height of future dunes in Reach 3. If the sand fence does not retain enough sand and the dune continues to grow higher the dune heights could be controlled with grooming, as described previously.

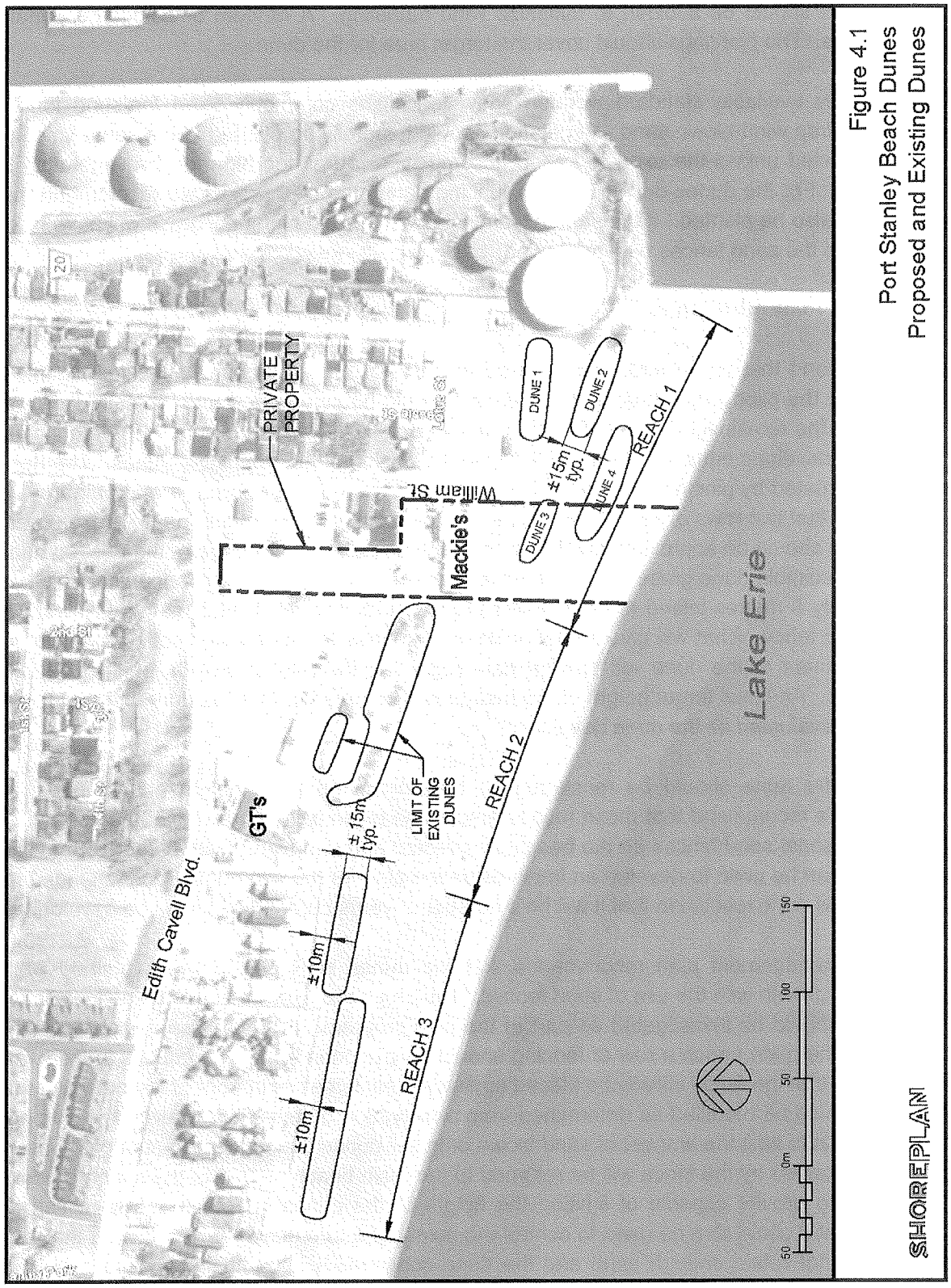

Figure 4.1
Port Stanley Beach Dunes
Proposed and Existing Dunes

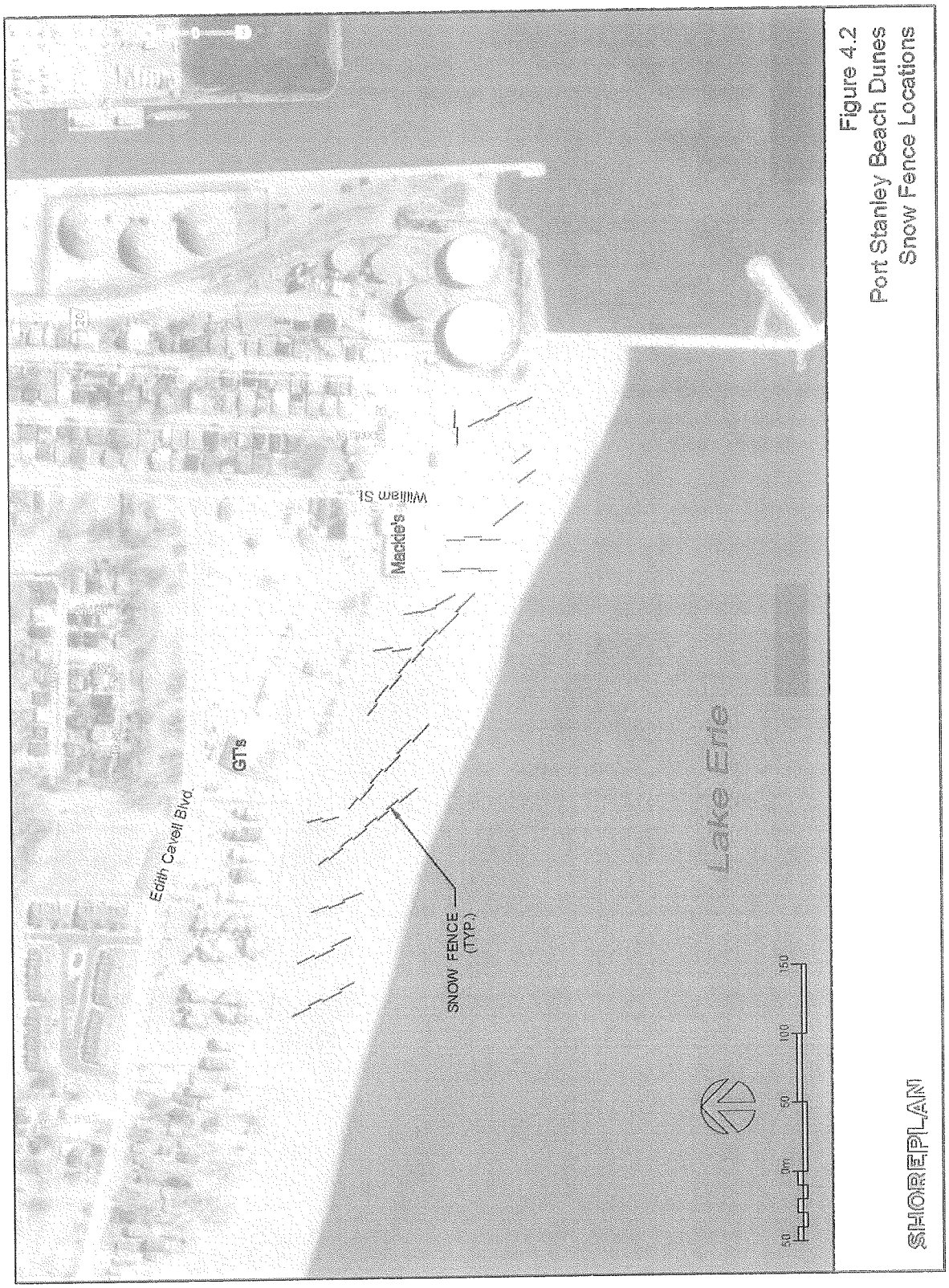

Figure 4.2
Port Stanley Beach Dunes
Snow Fence Locations

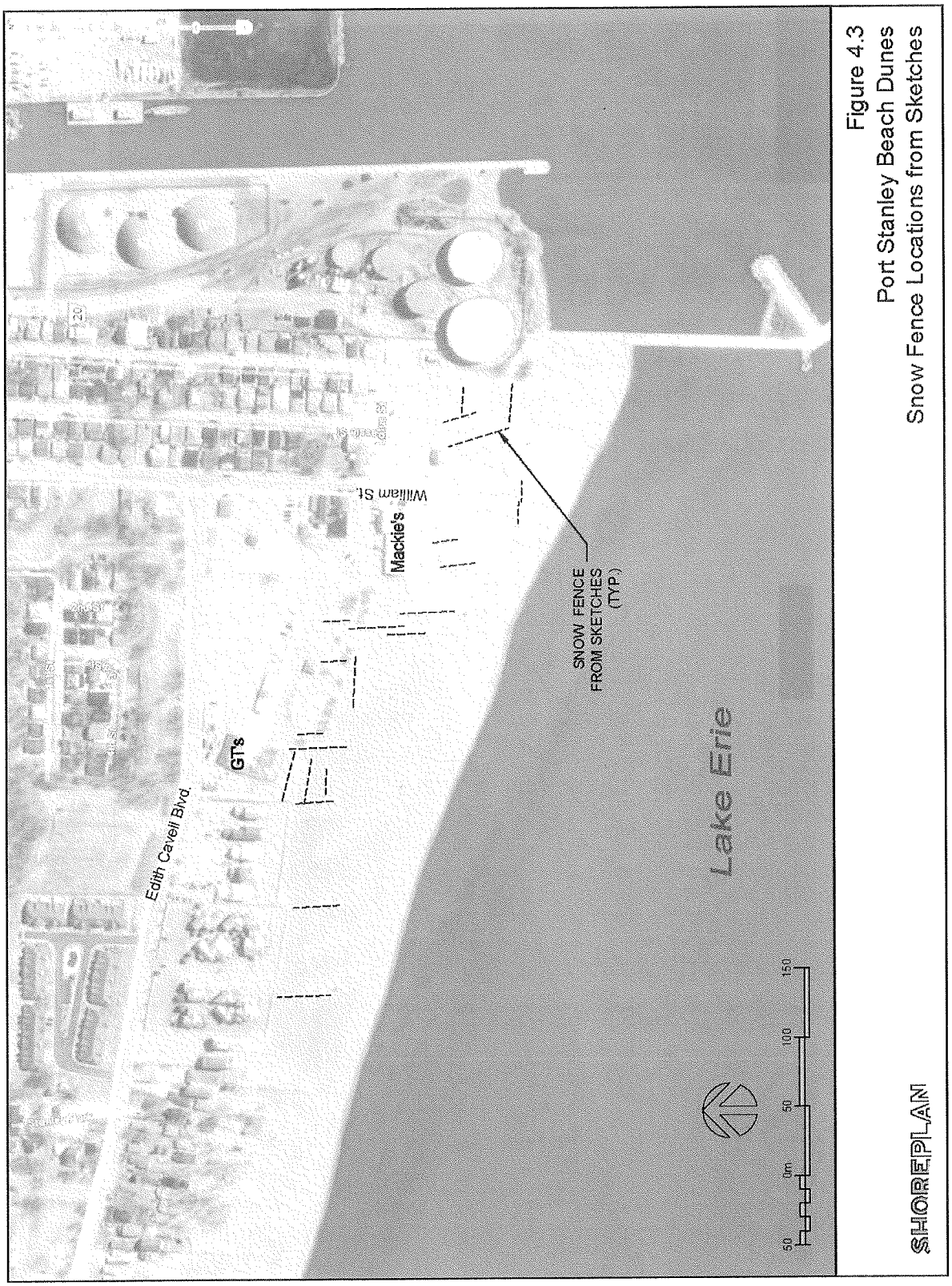

Figure 4.3
Port Stanley Beach Dunes
Snow Fence Locations from Sketches

5.0 Conclusions and Recommendations

We have developed a practical dune management plan intended to advance beach management concepts without excessively impacting the current beach use practices. The public beach was divided into three reaches and specific dune plans were developed for each reach.

In Reach 1, which is immediately adjacent to the end of William Street, we have located four potential dunes. We recommend that only one of those dunes be developed now and that the dune development be carried out as a pilot program. Once the impact of that first dune has been assessed a decision can be made about how to proceed with the other dunes in Reach 1.

In Reach 2, which extends from Mackie's to GT's, we recommend that the existing dune be maintained without intentionally increasing its size. That will leave gaps at either end of the dune where overtopping waves can flood inland and where sand can be blown off the beach. Part of the pilot program will be to determine if sand fences can be used to control the growth of the existing dune.

In Reach 3, which extends from Mackie's to the western end of the public beach, we recommend that two dunes be developed at a future date. Data gathered from the monitoring of the dune developed during the pilot program will be used to refine the design of the dunes in Reach 3.

We recommend that the municipality continue with their practice of erecting seasonal fences to control erosion of the beach during the winter months. When the fences are removed the sand collected should be re-graded. Efforts should be made to ensure that the beach grading and grooming does not disturb the desired positions of the dunes.

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