Preliminary Review Report

Porter Airlines Runway Extension Proposal Review Coastal Processes and Environments

Prepared for

City of Toronto

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Statement of Limitations and Assumptions

This report outlines the estimated effects of the proposed extension of runway 08-26 at the Billy Bishop Toronto City Airport (BBTCA), as submitted to the City of Toronto by Porter Airlines, to the natural and social environments in the immediate vicinity of the proposed extension. The assessment of effects has been based on data previously gathered for other studies or under other data gathering exercises, and is therefore limited to the information available. This report assesses only the effects of the proposed runway extension, in a cursory and preliminary manner, and does not assess the effects of any works or activities facilitated by or the proposed extension, including the usage of additional or different airplanes at the BBTCA.

Further study and modelling exercises are required to quantify the full effects of the proposed runway extension prior to finalizing design details, and CH2M HILL Canada Limited accepts no liability for decisions made based on the information presented herein. The work is prepared for the benefit of the City of Toronto and there are no third party beneficiaries. All work product is prepared for the sole and exclusive use of the City of Toronto for specific application to the property described in the report and is not for the benefit of any third party. The report may not be distributed, disclosed in any form to, used by, or relied upon by any third party without the prior written consent of CH2M HILL.

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1. Introduction and Background

1.1 Background

In 1939 the City of Toronto (City) opened the Toronto City Centre Airport as the Port George VI Airport. In 1983 the Toronto Harbour Commission, the City of Toronto and Transport Canada signed the Tripartite Agreement outlining terms and conditions for the airport's operation. This Agreement imposed noise controls on flights to and from the airport, banned jet aircraft from using the airport, and disallowed runway extensions. In 2011, City Council granted an easement to the Toronto Port Authority that allowed for the construction of the fixed link pedestrian tunnel beneath the Western Gap to the airport terminal, which is currently under construction (City of Toronto, n.d.). The airport is currently known as the Billy Bishop Toronto City Airport (BBTCA).

In April of 2013, one of two commercial operators at the BBTCA, Porter Airlines Inc. ("Porter Airlines") announced the conditional purchase of Bombardier CS-100 jet-powered aircraft subject the amendment of two provisions of the 1983 Tripartite Agreement (AirBiz, 2013):

1. - The lift of the current prohibition of jet aircraft operations at the airport, and

2. - An authorization to lengthen the runway by 168m at both ends of the airfield.

The announcement of the deal between Porter Airlines and Bombardier was followed by a request by Porter Airlines to the City to review the above-two items. In response to this request, the City has sought review from a number of technical experts on the impacts of the proposed runway extensions and impacts on social, environmental, and technical aspects of the Toronto Harbour and Central Waterfront. The City has commissioned CH2M HILL Canada Ltd. (CH2M HILL) to review the runway extension concept submitted by Porter Airlines to determine, at a conceptual level, the potential effects of the proposed runway extension on the aquatic and terrestrial environments, including

- Document the existing shoreline and coastal environment including bathymetry, marine structures, lake levels, wave climate, currents, ice conditions, nearshore sediments, and regional shoreline characteristics;
- Conduct a cursory level assessment of the shoreline based on site observations, available aerial imagery, bathymetry, geotechnical data, and other available information to provide an understanding of sediment processes and aquatic habitat at the project location and potential impacts of the proposed works on the coastal environment;
- Evaluate the impacts of the proposed runway extension on the surrounding coastal areas and comment on the regulatory implications of the proposal.

1.2 Purpose of the Study

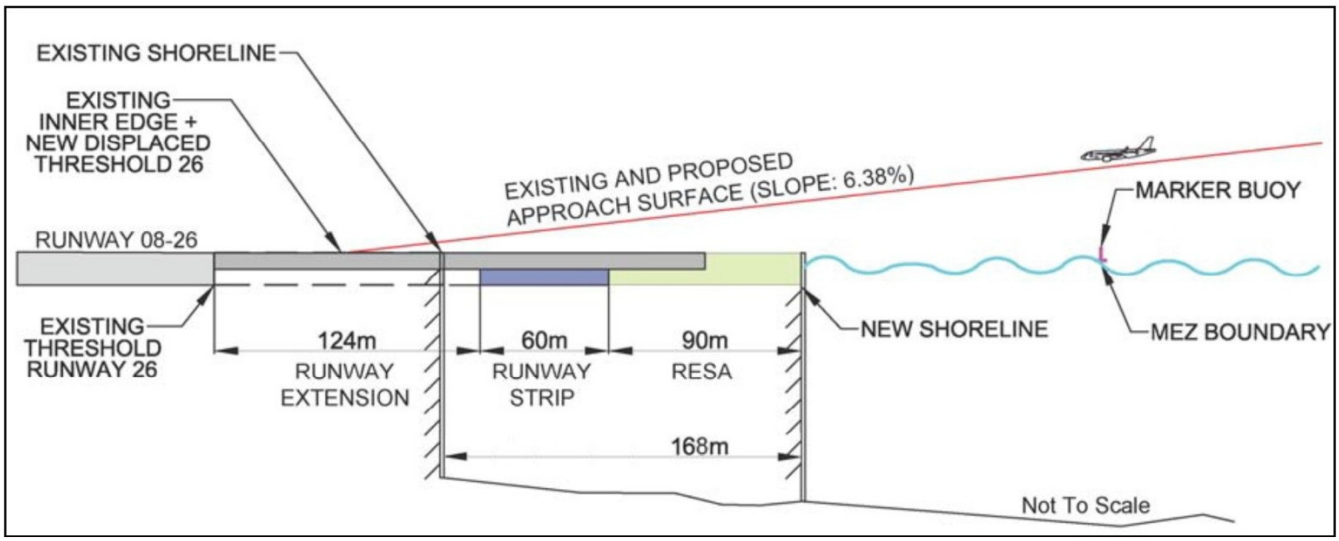
CH2M HILL will examine the aquatic and terrestrial environment in the immediate vicinity of the proposed runway extensions and estimate the likely impacts of those extensions on coastal processes, aquatic and terrestrial habitat, flora and fauna. The aim of this investigation is not to recommend a course of action to the City of Toronto, but to present a factual outline of the existing conditions in the immediate vicinity of both ends of runway 08-26, and an estimate of the changes that may be caused by, and the regulatory requirements for the construction of a 168m extension to both ends of runway 08-26.

1.3 Study Area and Proposed Runway Extension

The City of Toronto is currently reviewing a request from Porter Airlines to permit jet-powered aircraft at the BBTCA. If permitted, extensions of at least 168 metres on both ends of the existing runway, encroaching into the lake waters, will be required. The extension will accommodate a 124 m runway extension from the threshold of

the existing runway, all of which, save 18m, can be accommodated on the existing land, plus a 60m runway safety strip and a 90m Runway End Safety Area (RESA).

Figure 1-1 **Profile of Proposed Runway Extension**
Adapted from: LPS Aviation, 2013

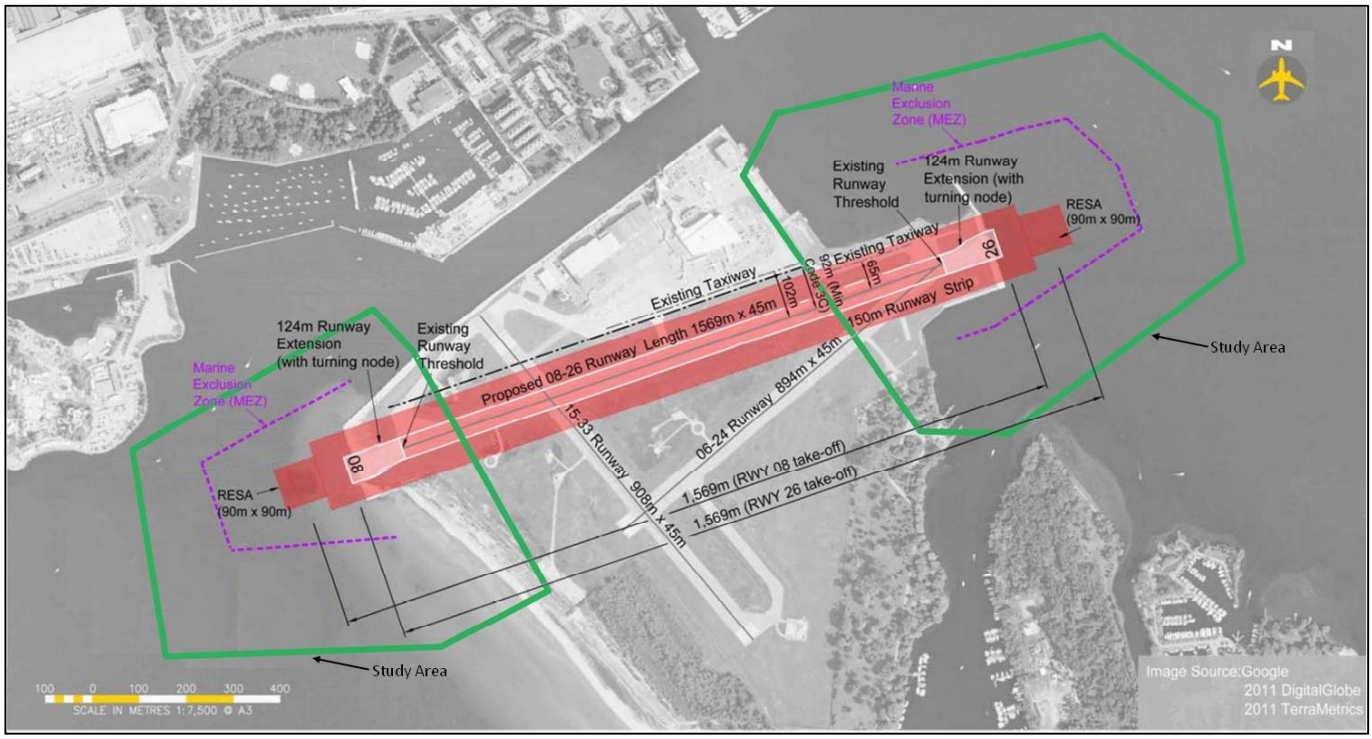


The BBTCA is located near Hanlan's Point on the northwest end of Centre Island, the largest of a group of islands that form the Toronto Islands, just offshore of the city's downtown business and tourism districts. To the east, the airport is bounded by the Inner Harbour, to the west by Lake Ontario, and to the north by the Western Gap, a 120 m wide, 700 m long, NE-SE trending waterway that connects the Inner Harbour with Lake Ontario.

The project site is located within the Marine Exclusion Zone (MEZ) in Toronto Harbour, east and west of the extremities of the BBTCA as shown in Figure 1-2. The footprint of the runway is proposed to extend 168 m into the lake waters on both ends along the 111°-291° N bearing. The total area of the harbour bed to be occupied by the proposed extension would be approximately 38,700m^2.

The runway extension may be constructed on lakefill or on a pile-supported deck structure. To determine the impacts of the proposed runway extension, as described above, CH2M HILL has examined the area of the proposed extension and its immediate vicinity. For appropriate context, existing conditions in the vicinity of the entire BBTCA have been examined as well, where required.

Figure 1-2 **Study Area**
Image adapted from Airbiz, 2013



1.4 Project Team

CH2M HILL has worked closely with the City of Toronto to gather background information, previous studies and reports to facilitate the review of the potential impacts of the proposed BBTCA runway extension. In addition, information was gathered from the Toronto and Region Conservation Authority (TRCA) and the Toronto Port Authority (TPA).

2. Existing Conditions and Effects of Proposed Runway Extension on the Aquatic Environment

2.1 Aquatic Habitat

Water quality in the Inner Harbour and around the Toronto Islands has improved greatly in the past three decades, with the Ontario Ministry of the Environment (MNR) noting a "much healthier open water aquatic community" around the islands (MNR, 2007, p. 4). Populations of aquatic species are strengthening and diversifying, with Tape-grass communities, commonly considered an indicator of relatively clear waters with low disturbance, returning to the open water and coastal regions of the Toronto Islands after declining substantially in the early 1900s. According to the MNR (2007, p. 4) "this species was last recorded on the Islands in 1894, and was not present in [a] 1978 survey... Other aquatic species which have returned include Flat-stemmed Pondweed (last collected in 1899), Perfoliate and Richardson's Pondweed (last collected in 1897), Star Duckweed (last collected in 1947), Common Coontail (last collected in 1926) and Canada Waterweed (last collected in 1913)."

Nonetheless, many other aquatic plants have not returned to the area (MNR, 2007), indicating that the open and coastal waters in the vicinity of the BBTCA may still be in a stressed condition. Although the exact extent of current aquatic vegetation is unknown, if vegetation is located within the footprint of a proposed lakefill runway extension, it will be destroyed by the extension. A deck on piles will reduce the amount of vegetation destroyed in the short term, however it will reduce light penetration through the water column, and may result in longer-term decline of aquatic vegetation in its vicinity.

2.2 Fish and Fish Habitat

A number of fish are present in the vicinity of the BBTCA, spawning and nursing in the coastal marshes of the Toronto Islands. The Coastal marshes of the Toronto Islands are considered significant in the ecodistrict 7E-4, in which they are located (MNR, 2007). According to the Ministry of Natural Resources (MNR, 2007), the fish present at and in the vicinity of the Toronto Islands include Common Carp, Brown Bullhead, Pumpkinseed, Bluegill, Northern Pike, Black Crappie, Longnose Gar, White Sucker, Freshwater Drum, Largemouth Bass, Smallmouth Bass, Rock Bass, American Eel, Bowfin, White Perch, Yellow Perch, White Bass, Walleye, Rainbow Trout, Chinook Salmon, Gizzard Shad, Rainbow Smelt, Alewife, Goldfish, Brook Silverside, Brook Stickleback, Threespine Stickleback, Bluntnose Minnow, Fathead Minnow, Common Shiner, Golden Shiner, Spottail Shiner, Emerald Shiner and Johnny Darter (MNR, 2007). The American Eel is considered endangered by the Ontario Ministry of Natural Resources, and is listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Figure 2-1 **The American Eel Inhabits the Waters of Lake Ontario, amongst other fresh and saltwater habitats, and is listed as endangered under Ontario's *Species at Risk Act***

According to a 2013 Environmental Assessment for the TPA, three aquatic species at risk have the potential to inhabit the area of the runway extension: American Eel, Silver Lamprey, and Eastern Pondmussel (Dillon, 2013).

In the immediate vicinity of runway 08-26, fish habitat is very limited due to the extensive hard surfaces of the cellular and sheet pile walls, and limited submergent and emergent vegetation (Aquatic Habitat Toronto, n.d.). Nonetheless, at both ends of the runway localized shoreline revetments provide limited structural habitat for area aquatic life. Further

underwater surveys are required to determine if additional structural habitat is located within the study area. Runway extensions offer an opportunity to improve habitat through the placement of submerged and emergent structures such as rip rap or root balls to provide cover for foraging fish. The wall of a lakefill runway extension offers more opportunities to place structures such as a shoreline revetment to create habitat than the construction of a deck on piles does. A deck on piles will reduce light penetration below it, affecting vegetation growth.

Submerged, rooted aquatic plants can create good habitat conditions for fish and other aquatic organisms, improve water quality, and stabilize the substrate. A study undertaken by Aquatic Habitat Toronto (AHT) in the summer of 2002 showed submergent vegetation located immediately to the south of the eastern end of the runway (Aquatic Habitat Toronto, n.d.); however, further study should locate the extent of current submergent vegetation. At the time of visiting the site, in early August, when aquatic vegetation usually peaks, no emergent vegetation was visible in the vicinity of the vertical walls or revetment coastline at either end of the runway, and no submergent vegetation was visible in the shallow, sandy lake bed to the south of the eastern end of the runway, or south of the western end of the runway, along Hanlan's Point Beach. Fish will forage and spawn in areas where food and cover are available. While foraging by area fish may be reduced in areas with limited vegetation, a detailed survey of underwater vegetation and structures (boulders, submerged logs, and other sunken debris) is required to ascertain habitat quality and fish activity within the study area.

Figure 2-2 **South of the Western End of the BBTCA Runway, Riprap and Floating Woody Debris Forms Structural Cover for fish species and Protection from Predators**

2.3 Resident/Breeding and Migratory Birds

The BBTCA runway does not host meaningful habitat or nesting grounds for resident and breeding bird populations, nor is it particularly welcoming to migrating birds during stopovers on the way to nesting or overwintering grounds. And although the grassed areas of the airport property can be used by Canada Geese for foraging, and even nesting, the TPA actively manages goose and other bird populations on the site through deterrents and annual removals in cooperation with the Canadian Wildlife Services (Lundy, Personal communication, 2013) as bird populations represent a nuisance to airport operations. Despite the poor habitat found within the BBTCA, very high-quality habitat for resident and migratory birds is found nearby, on Mugg's Island (see Figure 2-3) and other parts of the Toronto Islands and at the Leslie Street Spit/Tommy Thompson Park (TTP). TTP is a globally significant "important bird area" (IBA Canada, n.d.), hosts 316 different recorded species of birds, and contains the largest breeding colonies of colonial waterbirds on the Great Lakes with an estimated population of over 170,000 -

Figure 2-3 **Mugg's Island is Located Immediately to the South of the East End of the BBTCA Runway**

individuals located less than 4km away from the BBTCA (McDonald, Personal Communication, 2013). As a result of the nearby habitat, some of these birds tend to loaf in the waters of the Inner Harbour (MNR, 2007), including in the vicinity of the proposed runway extension.

Unlike resident and overwintering bird populations, which tend to make homes in the vicinity of the BBTCA on a long-term basis, migratory birds stop in the vicinity of the BBTCA to feed, rest, and sometimes wait out inclement weather (City of Toronto, 2009) on a seasonal basis. The greatest diversity of species of migratory birds stopping in the vicinity of the BBTCA can be found in TTP, on the Toronto Islands, and along natural patches of the shoreline (City of Toronto, 2009). Stopovers are typically made in the spring and fall months as migratory birds travel between nesting grounds and overwintering grounds (City of Toronto, 2009). In addition, birds that stopover at TTP, the Toronto Island, and other lakeshore and lakeside locations, may seek food such as water insects and fish in the waters around the BBTCA property. In the Toronto area, of all the threats to migrating birds during migration, the greatest threat is considered to be habitat loss. (City of Toronto, 2009). Although a number of different types of migratory birds stopover in TTP and on the Toronto islands, the birds most likely to be found in the immediate vicinity of the BBTCA runways are those birds that loaf and feed in coastal and wetland environments. The most commonly-observed birds loafing in the vicinity of the BBTCA runways are ducks, geese, and cormorants, of various varieties (see Figure 2-4), however according to the MNR (2007), a number of species of birds can be observed at various times of the year in the waters around the Toronto Islands, including waterfowl, herons and other waders, pelicans, rails, Rusty Blackbirds (a species at risk), Yellowheaded Blackbirds, swallows (many of which are listed as a species at risk), other shorebirds, and American Pipit. The wetlands and open waters of the Toronto Islands and TTP provide stopover for migrating waterfowl such as Gadwall, Bufflehead, Redhead, Canvasback, Green-winged Teal, Blue-winged Teal, Hooded Merganser, Ruddy Duck, American Widgeon, Wood Duck, Mute Swan, Canada Goose, Mallard and Gadwall, many of which also breed at the Toronto Islands (MNR, 2007) and at Tommy Thompson Park (McDonald, Personal Communication, 2013).

A runway extension is unlikely to displace loafing birds, once constructed (using lakefill or a deck on piles), and if habitat improvements are incorporated into the design, may result in more bird feeding and loafing activity. An updated birdstrike assessment should be conducted to detail the effects of existing and increased bird populations on airplane take-off and landing activities.

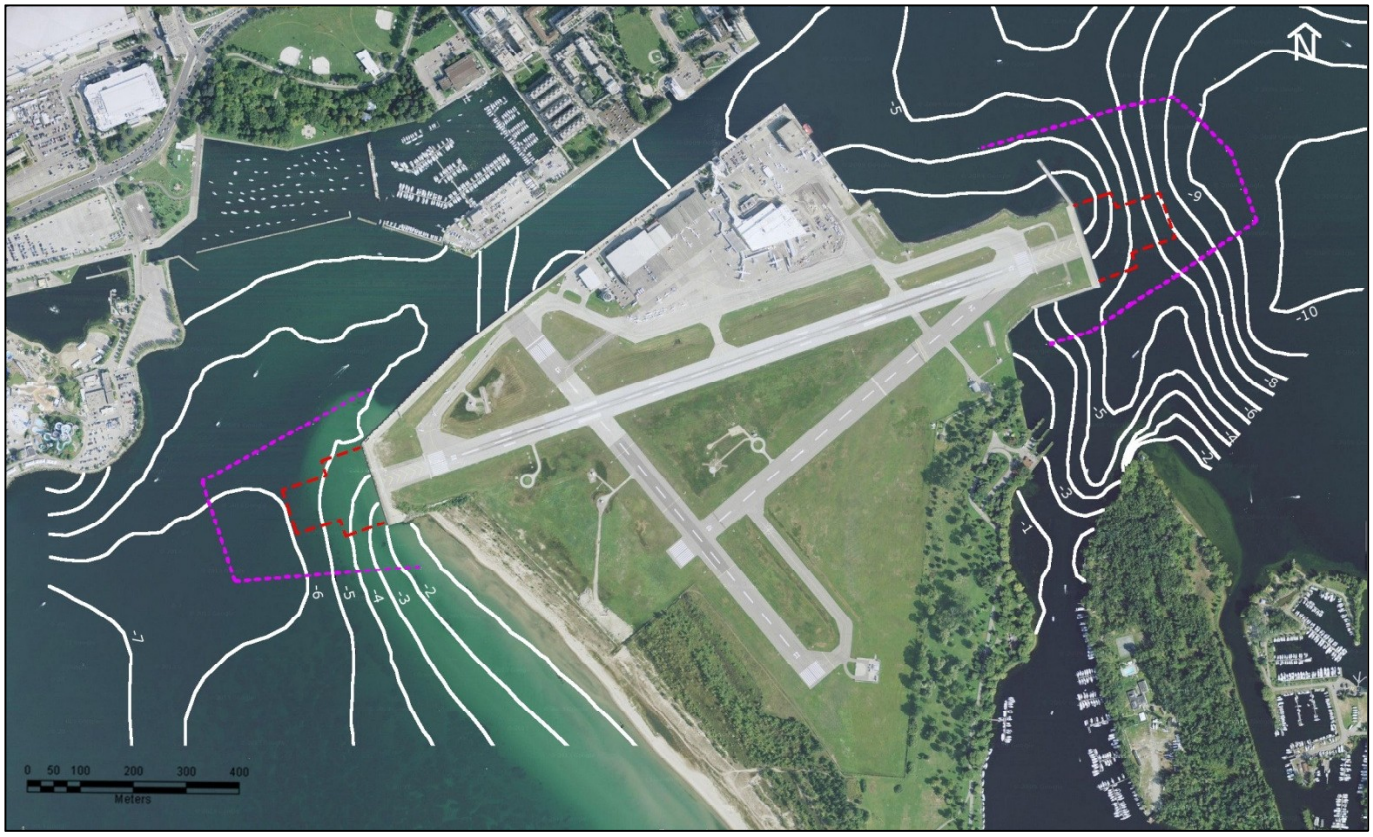
Figure 2-4 **Cormorants and Ring-billed Gulls Sun Themselves on the Eastern BBTCA Breakwater and Loaf in Nearby Waters in Early August 2013**

2.4 Bathymetric Conditions

Depths in the Toronto Inner Harbour vary from 12m in the deepest area, offshore of the eastern side of the runway, to less than 1m along the shores of the Toronto Island. Water depths in the Western Gap are in the order of 7.6 m. To the west of the BBTCA, beyond the MEZ the water depth is approximately 6.7m deep, and reaches 15m in depth within 500m further offshore. All depths are referenced to chart datum, which is 74.2m International Great Lakes Datum (IGLD) 1985.

Figure 2-5 shows bathymetric contours in the vicinity of the BBTCA, created using MIKE 21 CMAP (DHI, 2012a). Contours are plotted on an aerial image from 2009 (Google, 2013). The water depths at the toe of the steel sheet pile wall are 4.5 m and 4.0 m below chart datum at the eastern and western end of the runway, respectively.

Figure 2-5 Local bathymetry around the BBTCA



If a deck structure is selected to extend the runway it will not affect the adjacent bathymetry. If the extension is constructed as lakefill, it is anticipated that the extension will result in decreased depths at the western runway extension where sediments will accumulate along the south side of the extension. No impact is expected on the eastern runway extension if constructed with lakefill or as a deck on piles.

2.5 Seabed Characteristics

As an integral part of the Gibraltar Point Erosion Control project (TRCA, 2008) sediment samples were collected at thirty seven locations in the nearshore area of the Toronto Islands by the TRCA, as shown in Figure 2-6. The sediment samples have been analyzed for grain size distribution in the laboratory. The sample sites 1, 32, and 33 are in close proximity to the western end of the runway in Lake Ontario and these samples are considered herein.

Figure 2-6 Sediment Grab-Sample Locations (TRCA, 2008)

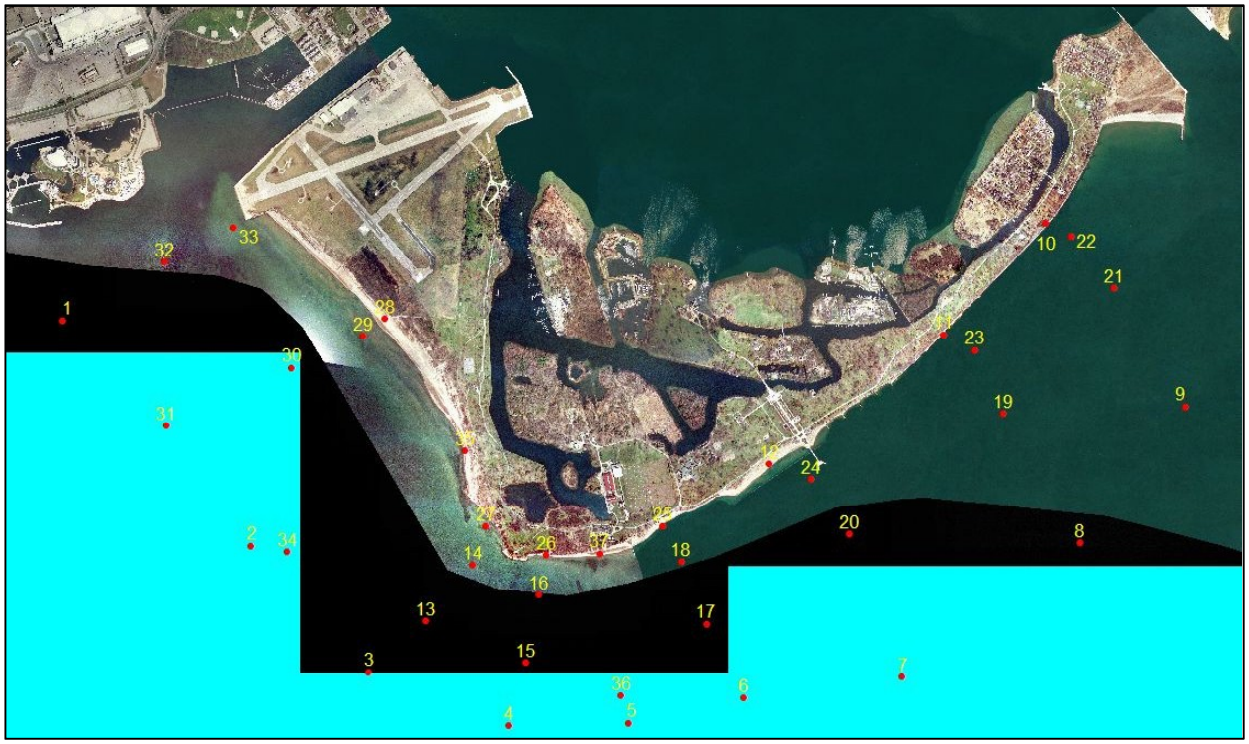


Table 2-1 summarizes grain size characteristics such as D16 (diameter for which 16% of sediment by weight is finer), D84 (diameter for which 84% of sediment by weight is finer) and median grain size D50. The average median grain size for samples collected from the stations 1, 32 and 33 is 0.23mm. Thus the sediment in this region is predominantly fine sand. Figure 2-8 depicts the grain size distribution of each sample in front of the proposed western runway extension.

Table 2-1 Summary of Sand Samples in Front of Western Runway

Station ID	Sample Location (WGS84 UTM Zone 17)		D_{50} (mm)	D_{84} (mm)	D_{16} (mm)	$\sigma_g(=\sqrt{D_{84}/D_{16}})$	$\sigma_\phi=(D_{84}-D_{16})/2$
	Easting (m)	Northing (m)					
1	627883	4831149	0.27	0.68	0.05	3.58	1.98
32	628359	4831422	0.22	0.63	0.16	1.97	1.15
33	628684	4831586	0.20	0.24	0.16	1.22	0.80
Average			0.23	0.52	0.13	2.26	1.31

An indication of the sample's gradation and sorting, which refers to the range of grain sizes present, was also investigated for each sample. A numerical measure of sorting is the standard deviation, σ_ϕ, which is defined by Dean and Dalyrmple (2002) as

$$\sigma_\phi=(\phi_{16}-\phi_{84}/2)$$

The ϕ size is related to grain size by

$$\phi = -\log_2(D)$$

where D is measured in millimetres. A perfectly sorted sand (homogeneous in size) would have the same values for ϕ_{84} and ϕ_{16} where σ_ϕ =0.For realistic sand size distributions on a beach, a $\sigma_\phi \leq 0.5$ is considered well sorted (i.e. poorly graded), whereas a sample with $\sigma_\phi \geq 1$ is considered poorly sorted. The standard deviation σ_ϕ was calculated for each sample (Table 2-1). It was found that average standard deviation σ_ϕ is 1.31 which means the sand is poorly sorted, or very heterogenous in size, at stations 1, 32 and 33.

The geometric standard deviation, σ_g is determined by

$$\text{sqrt}[D84/D16] = 2^{\sigma_\phi}$$

and was calculated for each of these samples (Table 2-1). The average geometric standard deviation σ_g was found to be 2.26 for the three stations.

Recent borehole samples taken in the Inner Harbour show that the lakebed in the harbour consists of sand and silt deposits, varying in thickness from approximately 1m to 10m, overlying bedrock (Ministry of the Environment Canada, 1997). At the eastern end of the proposed runway extension the seabed is characterized by 75% silt and clay and 25 % sand, as shown in Figure 2-8.

Figure 2-7 Grain Size Distribution at Station 1, 32, 33 (TRCA, 2008)

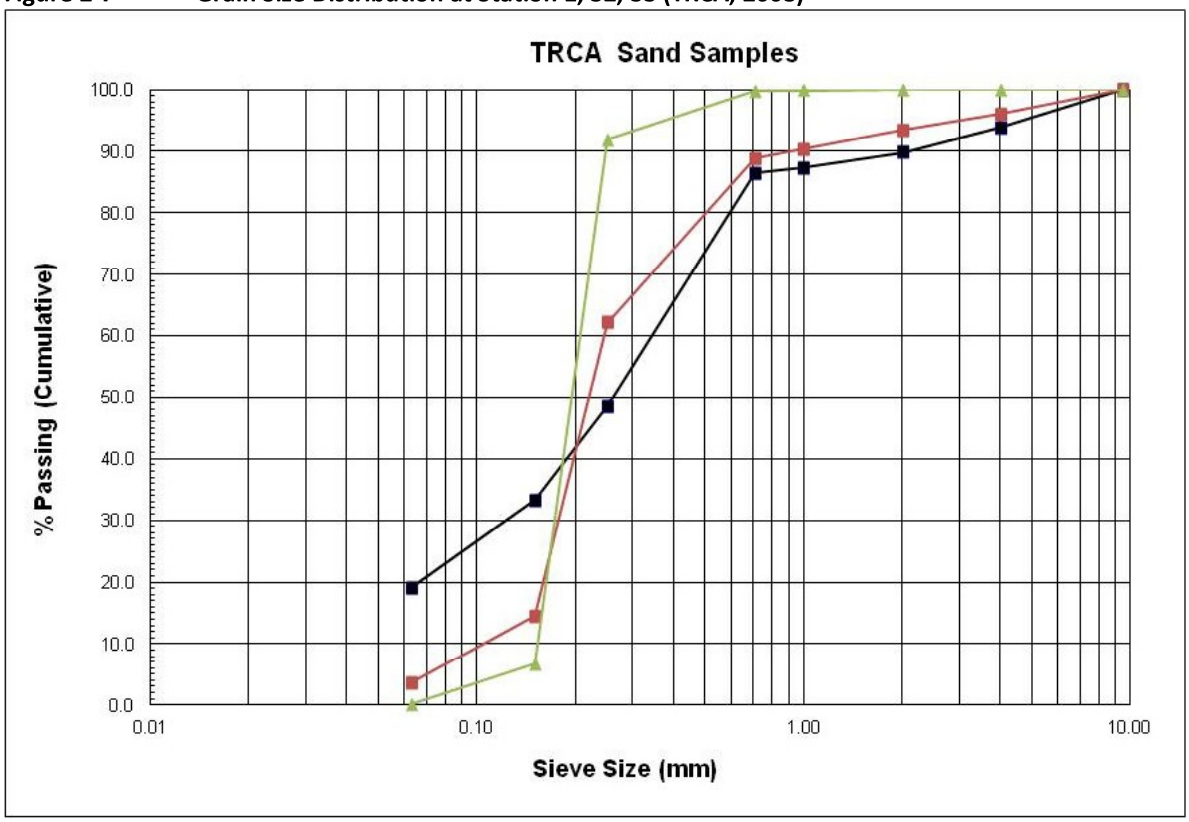


Figure 2-8 Sediment Particle Size Distribution within the Toronto Harbour (MNR, 1997)

Silt/clay can be easily mobilized by construction activities, and will require mitigation measures such as silt curtains to avoid sediment release into the water column outside of the construction area. Bedrock beneath the sediment is unlikely to be negatively affected by the construction of an extension constructed either with lakefill or on piles.

3. Existing Conditions and Effects of Proposed Runway Extension on the Terrestrial Environment

The terrestrial environment within the BBTCA is dominated by paved surfaces and manicured lawns and, as noted in the previous section, offers little habitat for bird species. The property is fenced and generally inaccessible to terrestrial species such as mammals or rodents. This condition will remain unchanged if the proposed BBTCA runway extension is implemented. Beyond the BBTCA, however, dynamic and static shorelines represent existing and potential habitat opportunities, are subject to physical processes, and must be accounted for in the design of a proposed runway extension.

3.1 Historic Shoreline Changes

The coastline to the south of the western end of runway 08-26 features a dynamic dune environment, known as Hanlan's Point Beach. Shoreline changes on the Hanlan's Point Beach were assessed using available aerial images. Historical aerial images with full coverage over the Hanlan's Point Beach were extracted from Google Earth Pro (Google, 2013). Although the exact time stamps of the images used are not known, the historical shoreline positions were digitized from the year 2002, 2003, 2005, 2007 and 2009 aerial images.

Figure 3-1 **Historic Shorelines at Hanlan's Point Beach Overlaid onto Aerial Image 2009**
Adapted from Google, 2013

The shoreline positions were inferred by distinguishing the difference between wet and dry sand. Figure 3-1 shows the digitized shorelines from year 2002 through 2009. The total error due to image placement and shoreline digitization is estimated to be 1.0 m in all images. This error margin should be considered when interpreting the shoreline change results.

Gridlines with 20 m grid intervals, originating from a specified baseline between 630453.87m E, 4830547.97m N, and 629192.24m E, 4831995.27m N (UTM 17) were drawn and perpendicular distances from baseline to the shoreline were measured for all digitized shorelines. Based on measured perpendicular distances to the baseline, shoreline change rates were calculated for approximately a 2km section of the Hanlan's Point Beach between the western end of the runway and Gibraltar Point.

There are several possible methods for calculating an average rate of change within a selected time segment having more than two measurement points. The multiple method approach, first introduced by Foster and Savage (1989) ensures the calculated error is not method-dependent. The first method is called 'the end-point method' which takes the difference between the first shoreline position and the end shoreline position divided by the time between surveys to give an approximate shoreline change per year. The second method applies the least square method to fit a linear trend to the shoreline positions versus time. The slope of the fitted line indicates the rate of shoreline change. The third method, rate averaging, determines the shoreline change rate for each possible survey combination with enough time separation to eliminate possible effects due to digitization error.

The shoreline change rates were calculated using the three methods, based on traced shoreline from aerial images 2002, 2003, 2005, 2007 and 2009 and the average result from the three methods was calculated as the representative shoreline erosion rate for Hanlan's Point Beach. It was found that the shoreline extended into the water through the process of accretion at an average rate of 1.70m/yr between 2002 and 2009 due to northerly longshore sediment transport.

3.2 Present-Day Shoreline Description

A visual reconnaissance of the site was undertaken by CH2M HILL on August 9, 2013. The water level at the time of the visit was approximately 0.84 m above the CD. The description of the shoreline condition is based on the visual reconnaissance only. Geotechnical studies, surveying, sediment sampling, or other detail investigations were not conducted during this visit, but may be required during the detailed design phase of the work, should the runway extension be approved.

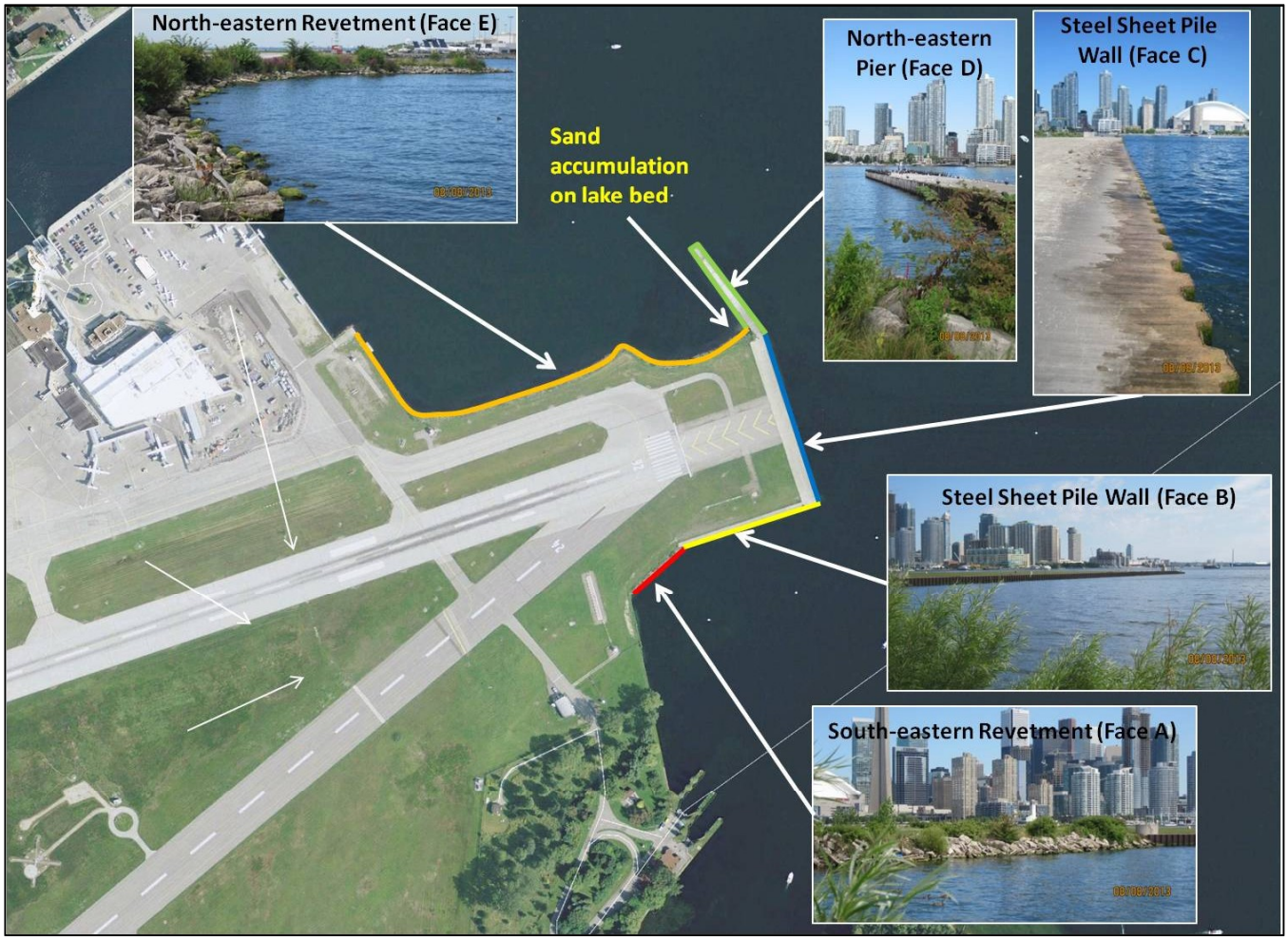
The length of shoreline observed on the eastern and western runway by CH2M HILL are shown in Figure 3-2 and Figure 3-6, respectively. It was observed that the shoreline has been stabilized with shore protection structures including rock revetment (approximately 490 m around the eastern runway and 50 m on the western runway) and steel sheet piles. For discussion purposes, the shoreline has been divided into two reaches, namely the eastern runway and western runway sections.

3.2.1 Eastern Runway

3.2.1.1 Southeastern Revetment (Face A)

The southwestern revetment extends from a steel sheet pile (SSP) wall along the City of Toronto's Hanlan's Ferry docks at the south up to the SSP wall (Face B), as shown in Figure 3-2. The southwestern revetment is a rock armor structure with a front face slope of 1V:1.5H. It is observed that floating debris have accumulated amongst the revetment armor and shrubs and willow whips are growing above and out of the front face, as shown in Figure 3-3. Based on visual inspection revetment appears to be performing and no sign of erosion in the vicinity was observed.

Figure 3-2 Existing Shoreline Conditions on the Eastern Runway



3.2.1.2 Steel Sheet Pile Wall (Face B)

The steel sheet pile wall extends from southern revetment to the next SSP. Its crest elevations seem slightly higher than the southern revetment crest. There are a few localized cracks on the concrete deck of the wall, but it appears the sheet pile wall is in very good condition.

3.2.1.3 Steel Sheet Pile Wall (Face C)

This steel sheet pile protection extends from SSP Face B to the eastern pier. It consists of a steel sheet pile wall with sloping concrete deck in the central portion and a flat concrete deck in the northern and southern portions. The sloping concrete deck slopes down towards the inner port, and occurs over the width of the eastern end of Runway 08-26. The water level was almost at the same level as the crest height of the sheet pile wall during the visit. It is anticipated that this wall shall be overtopped by waves during the higher lake water levels. It is noted that there are few localized cracks between the concrete deck and SSP at the edge of the wall.