

5. Description, Evaluation and Rationale for Alternative Methods of Carrying Out the Undertaking

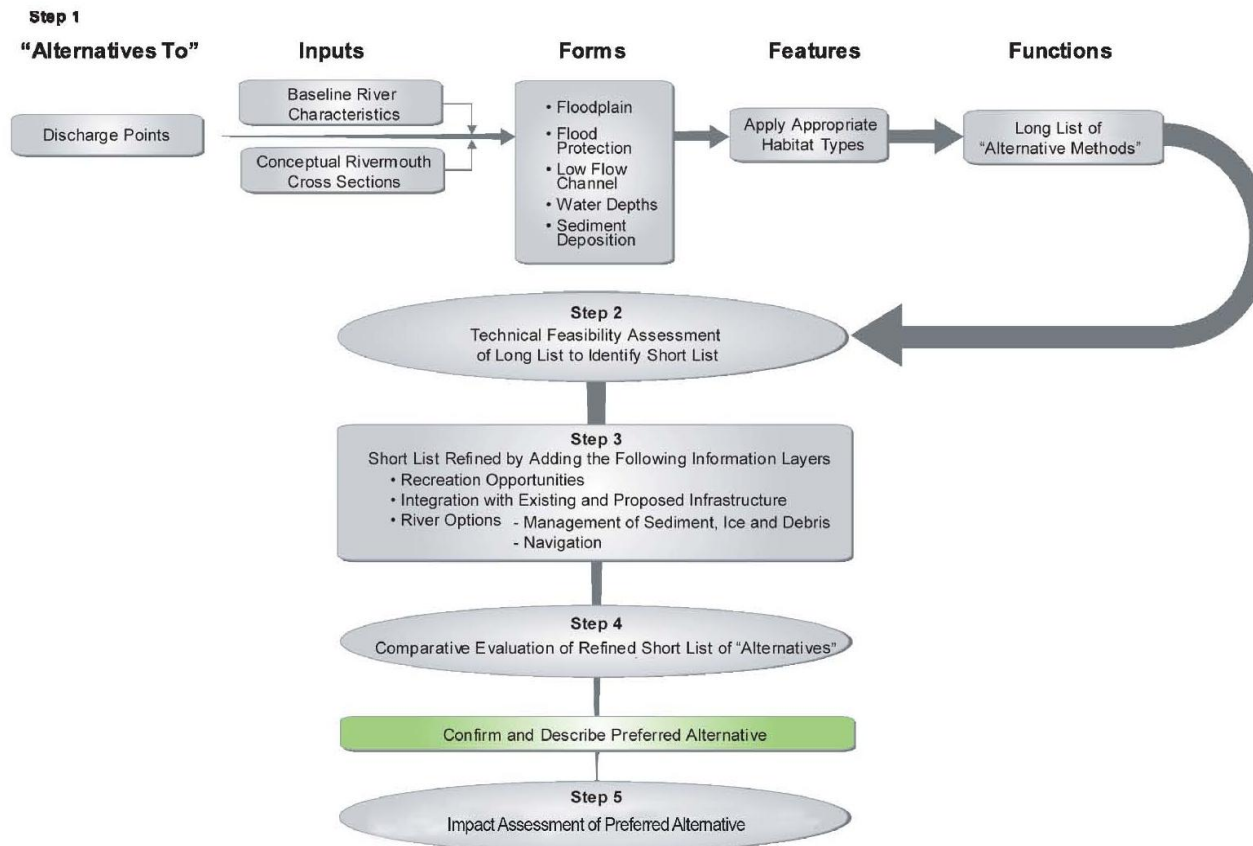
Alternative methods are different ways of doing the same activity or, in other words, functionally similar ways of implementing or designing the river mouth or discharge points described at the end of **Chapter 4**.

For the purposes of the EA, different alternative methods were identified by layering different forms and features required to create the functions of a natural river mouth for each of the discharge points identified in **Chapter 4** (alternative discharge points 2, 3, and 4). The identification of different alternative methods gave prime consideration to the characteristics of the river and the ability to fulfill the naturalization and flood protection objectives in the context of the river conditions. Other project objectives were addressed as subsequent refinements or layers applied to the alternative methods. Additionally, the alternative methods took into account the design elements from the winning Design Competition team.

Scenarios for the naturalization of the Don River mouth could be endlessly diverse. All scenarios are a combination of river mouth forms and features to create river mouth functions.

- **Forms** refer to the shape, size, and physical setting (in terms of soils, physiography, subsurface geology, topography, river channel width, and water depth).
- **Features** refer to components that are characteristic of a natural area (e.g., species of wildlife, plants and vegetation communities, etc.).
- **Functions** are processes, products or services that are created by combining forms and features (e.g., wildlife habitat, sediment storage, flood conveyance). The upstream reaches of the river and the watershed, the shoreline uses, and the lake also influence the river mouth and its functions. Some desirable river mouth functions are:
 - a) Sediment storage/transport;
 - b) Linkages with upstream/downstream;
 - c) Flood conveyance;
 - d) Aquatic/terrestrial habitat (reproduction, nursery, feeding, refuge);
 - e) Nutrient/energy storage and export;
 - f) Biomass export (forage fish, sport fish, birds); and
 - g) Debris capture.

The identification and evaluation of the different alternative methods was carried out in a five-step process illustrated and described in **Figure 5-1**. This process can be thought of as layering of information to develop a comprehensive alternative method. As the identification and evaluation progressed, the level of detail in the data used increased proportionally.



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Figure 5-1 The Identification and Evaluation of Alternative Methods

Additionally, the results of the Design Competition (see **Section 2.2.3.2**) were made known before Step 4 was completed. This necessitated a re-evaluation of Steps 1 to 4 in order to incorporate the competition results into the assessment including the addition of a new alternative. These changes are summarized below, and described in more detail in **Section 5.3.2**.

The following sections provide a general description of the five-step process used for evaluating the alternative methods followed by the results of this evaluation (Steps 1 to 4, **Sections 5.1 to 5.4**), culminating in a final, preferred alternative for the DMNP. This preferred alternative is then refined and evaluated in Step 5 (**Chapters 6 and 7**).

Step 1: Development of Long List of Alternatives

This step involved identifying forms and features which combine to deliver individual functions that meet the naturalization and flood protection objectives for the DMNP. For the purposes of the assessment, each alternative method generally consisted of three elements:

- A discharge point (**form**), as defined in **Chapter 4**;
- A cross-section (**form**); and
- A habitat or vegetation community (**feature**).

The methodology to determine these elements and establish the long list of alternative methods involved:

1. Defining the characteristics of the river mouth;
2. Identifying generic cross-sections and vegetation communities using forms and features from reference sites;
3. Determining the conditions of survival for the vegetation communities; and
4. Combining the cross-sections and vegetation communities with the discharge points to create alternative methods.

No revision of Step 1 was necessary following the Design Competition.

The long list of alternative methods thus included all combinations of discharge points, cross-sections, and vegetation communities, with the hydraulic characteristics determined through modeling scenarios. These alternative methods were advanced to Step 2.

Step 2: Technical Feasibility Assessment of Long List

This long list of different alternative methods was subjected to a technical feasibility assessment to identify the alternatives that had the greatest ability to meet the naturalization and flood protection objectives of the project. This ensured that the project planning was focused on the alternatives with the highest potential to meet the project goal and objectives.

Feasibility assessment criteria were developed to address the ability of each alternative to achieve the naturalization and flood protection objectives given the existing and future river characteristics. Following the Design Competition, these criteria were revisited and revised which is discussed in greater detail in **Section 5.3.2**.

The alternative methods that remained following this step formed the Short List and were subject to further refinement in Step 3.

Step 3: Refinement of Short List

The remaining short list of alternative methods was refined and developed in more detail in order to address the other project objectives. The short list of alternative methods developed in Step 2:

- a) was refined based on the results of the technical feasibility assessment;
- b) addressed issues related to operational management;
- c) addressed issues related to existing infrastructure replacement, relocation or abandonment;
- d) addressed opportunities to influence planned infrastructure and uses through other EAs/ planning processes underway such that the DMNP is improved to the extent possible;
- e) identified opportunities for recreation; and
- f) identified opportunities to enhance cultural and heritage resources.

Key issues that were revised based on the Design Competition concepts and are expanded upon in **Section 5.3.2** include:

- Area available for naturalization;
- Composition and optimization of naturalized areas;
- Area available for development and parkland;
- Location of infrastructure; and
- Location of flood protection features.

The output of Step 3 was a revised and refined set of alternatives to be assessed as part of Step 4. These alternatives reflected the original objectives of the DMNP and the changes brought to the EA process as a result of the Design Competition.

Step 4: Evaluation of Short List Alternatives

A formal evaluation method was used to establish an order of preference between alternatives. The method used evaluation criteria and indicators to structure information and facilitate the comparison of alternatives against each other. The evaluation criteria and indicators were developed to reflect project objectives and refined through public and agency consultation.

Following the results of the Design Competition, the evaluation criteria previously developed for this Step were simplified and revised. Key changes to the evaluation criteria reflected the following issues:

- Revised study area and alternatives;
- Greater integration with built form;
- Incorporation of active recreation components formerly associated with Commissioners Park¹;
- Revised approach to consideration of effects on infrastructure; and
- Naturalization optimization including both wetland and terrestrial opportunities.

Further, the EA team recommended that the width of the floodplain for all alternatives be further refined during this Step by accounting for the roughness coefficient of the proposed vegetation

1. The park was envisioned to include active recreation components such as four regional sports fields, and bike/pedestrian paths.

communities. Similarly, it was pointed out that there might be opportunities during this Step to examine whether adding fill to the developable area for the remaining original EA alternatives would reduce the width of the floodplain further. These changes are further described in **Section 5.4**.

The outcome of Step 4 was the identification and selection of a preferred alternative.

Step 5: Evaluation and Refinement of Preferred Alternative

The final step of the evaluation of alternatives involved five distinct tasks:

1. The identification and resolution of stakeholder issues associated with the Step 4 analysis;
2. Confirmatory studies with respect to hydraulics and sediment management through the river, management of contaminated soil and groundwater, and risk analysis of encroachment on the shipping lane in the Inner Harbour;
3. Development of a conceptual design to refine the preferred alternative (see **Section 5.4**) and add detail to the design;
4. Detailed effects assessment and identification of mitigative measures; and
5. Development of the Monitoring and Impact Management Plan.

The results of Steps 1 to 4 of the five-step process to determine a preferred alternative are presented in the following sections. Step 5 is presented in **Chapters 6** and **7**.

5.1 Step 1: Develop Long List of Alternatives

The methodology for developing a long list of alternative methods involved:

1. Defining the characteristics of the river mouth;
2. Identifying generic cross-sections and vegetation communities using forms and features from reference sites;
3. Determining the conditions of survival for the vegetation communities.
4. Combining the cross-sections and vegetation communities with the discharge points to create alternative methods.

These tasks are described in detail below.

5.1.1 What are the Characteristics of the River Mouth?

The starting point for the development of different conceptual alternatives is an understanding of the characteristics of the river and its sediment transport regime (i.e., the quantity of sediment being transported). This section builds on the baseline characteristics of the river described in **Section 3.1** to show how that information influenced the development of alternatives. The characteristics described here include the:

- flow rate during normal conditions and flood conditions for frequencies up to and including the regional storm events;
- water quality; and
- sediment quantity.

These river characteristics were the basis or first layer on which the alternative methods were created. These river characteristics experience a normal range of fluctuation due to weather and seasonal variations. However, they are also subject to change over time in response to changes in the watershed and changes to the environment, such as climate change.

River characteristics are considered from two different perspectives. First, alternatives must be designed for extreme conditions, being the conveyance of the regulatory flood (1,700 cubic metres per second). Second, there must be an understanding of day-to-day conditions and how those conditions influence the ability of ecological communities to get established and thrive. Thus, river characteristics are described with respect to extreme flooding events and day-to-day conditions, as well as their ability to adapt and function sustainably to changes within the watershed and climate.

5.1.1.1 Flow Rate

Intense, widespread precipitation can produce sudden and drastic changes in discharge, particularly in a watershed as urbanized as the Don River. In fact, even relative minor rainfall events can result in significant and rapid changes in discharge throughout the Don. As can be seen from **Figure 5-2**, any particular alternative at the mouth of the Don River must be able to accommodate a wide range of discharges within a relatively narrow area, while at the same time providing for naturalized, functional and sustainable habitat. The normal flow conditions at the mouth of the Don ranges from 3 to 5 cubic metres per second and represents the flow condition that occurs the majority of time throughout the year.

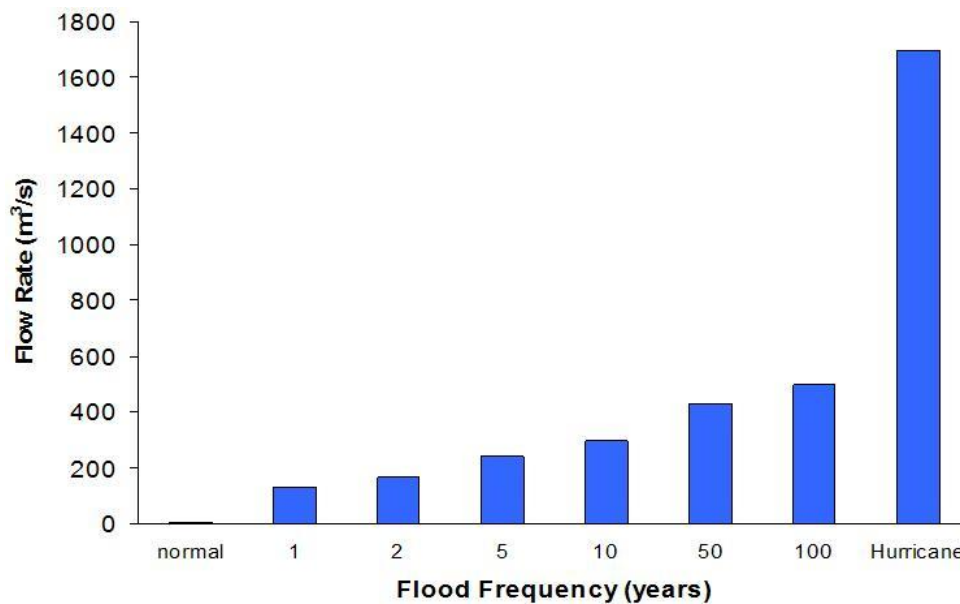


Figure 5-2 Flow Rates during Flood Events

The naturalized mouth of the Don must be designed such that the ecological conditions are sustainable under the normal range of flow conditions, and be able to survive flood events up to the 25 to 50 year event, and ultimately, be able to convey very large floods safely into the Inner Harbour up to Regulatory storm (i.e., 1,700 cubic metres per second).

Equally important to the characteristics of the river mouth is an understanding of the fixed constraints in the Project Study Area. At this stage of the analysis, there is one critical constraint that must be addressed: the constraint is posed by the flood elevation on the downstream side of the CN Rail bridge which cannot be exceeded (78.7 metres above sea level). This elevation is set to ensure the function of upstream flood protection works and the permanent nature of the CN Rail bridge (see **Figure 5-3**). Flood protection south of the elevated railway bridge cannot be provided simply by raising the grades around the existing river, since this would cause water levels to rise upstream, potentially overtopping of the Flood Protection Landform in the West Don lands and/or the CN railway embankment. Given these constraints, solutions south of the elevated tracks must work to lower upstream water levels. This would likely require a combination of lowering and widening the valley in addition to potentially adding some minor fill to create the new containing valley feature.



Figure 5-3 Location of CN Rail Bridge in the Project Study Area

5.1.1.2 Water Quality

For the purpose of screening alternatives, the project team examined water quality from the perspective of its effect on naturalization. Light availability has the greatest influence on the establishment, maintenance and diversity of aquatic vegetation (both floating and submerged) (Hudon *et al.*, 2000). Light availability varies with total suspended solids (TSS), water colour (which can vary independently of TSS), and water depth. Based on data collected by Gartner Lee Limited (GLL) in 2006 and secondary data from the Ministry of the Environment (MOE) from 2000 (Gartner Lee and SENES, 2007), light availability and turbidity in the Don River will limit the vegetation communities to those that can survive in shallow water (less than 0.5 m depth) as there is too little light reaching greater depths.

The concentration of suspended sediment can affect plant growth by inhibiting light penetration through the water column, limiting seed germination in the river bed and inhibiting submergent plants from photosynthesizing. Concentrations of suspended sediment above 20 milligrams per litre impede plant growth.

Above baseflow conditions exist on average approximately 100 days a year in the Project Study Area. As discharge increases above baseflow conditions, so does the capacity of the water to transport suspended sediments and as such, concentrations of suspended sediments increase (50 to 500 milligrams per litre). As the overall suspended sediment load increases, the proportion of clay relative to sand and silt decreases. The 90-degree corner at the mouth of the Keating Channel, combined with the significant increase in depth and width of the Channel, results in an immediate and significant decrease in sediment transport capacity, resulting in the settling out of sand and coarser silts in the Keating Channel. As a result of this self-sorting process, the constituent sediment grain sizes at the mouth of the Keating Channel are the fine silts and clays. It is estimated that approximately 5,000 tonnes per year of clay and 1,000 tonnes per year of fine silt are not currently trapped in the Keating Channel and remain in suspension. The Keating Channel is a very efficient sediment trap for coarse silt and sands. It is anticipated that any sediment management solution will not be as effective as the Keating Channel, and as such, any naturalization solution must be sustainable given the residual suspended sediment loads.

5.1.2 What Generic Cross-sections (Forms) and Vegetation Communities (Features) are Appropriate for the DMNP?

5.1.2.1 Description of Generic Cross-Sections

Forms and features were identified that could work with the river characteristics to create river mouth functions. Given the diversity of river mouth forms and features, reference sites for river mouth and near shore river environments in the Great Lakes-St. Lawrence basin south of the Canadian Shield were identified to provide inspiration for naturalizing the Don Mouth. These reference sites represented broadly defined assemblages of forms and features which create functioning river mouths.

As shown in **Table 5-1**, this methodology led to the development of three different generic cross-sections for the ToR that could be considered individually throughout the length of the river mouth or in combination with other concepts in different reaches of the river mouth. The three cross-sections are:

1. A natural river channel (R);
2. A created wetland river channel/floodplain with riparian vegetation (CW); and
3. A lacustrine environment with associated wetland (L).

Table 5-1 Generic Cross-Sections

Name and Description	Illustration
<p>Natural River Channel (R)</p> <ul style="list-style-type: none"> The natural river channel (R) concept form allows riparian vegetation to be fully exposed and connected to the water and sediment load from the Don River depending on flow and lake level. The channel will flood periodically, resulting in water within the floodplain at or below the soil surface, providing for both aerobic and anaerobic conditions. Based on preliminary hydraulic modelling for Alternatives 2 and 3, a natural river channel configuration would require a channel approximately 80 m wide and a total floodplain width of 300 m (including the river channel) to be able to convey the Regulatory Flood. Under such a scenario, the channel would be required to be several metres deep and flooding would not overtop the riverbank until approximately the 10-year flood event. The preliminary hydraulic modeling for Alternatives 4S and 4W suggest that such a natural river channel configuration would only require a channel approximately 30 m wide combined with up to a 300 m wide primary floodplain and 300 m wide spillway. Modelling suggests that waters would overtop the low flow channel banks under this scenario with a frequency of approximately once every 2 to 5 years. 	
<p>Created Wetland (CW)</p> <ul style="list-style-type: none"> The created wetland (CW) concept form builds upon the natural river channel (R) concept form. In addition to a river channel, it provides a wetland that is separated from the main flow of the river much of the time. The natural river channel carries all of the flow during low flow conditions. The wetland is designed so that it is flooded periodically, thereby allowing certain plant species to grow. This concept provides the ability to manage carp and other invasive species from the wetland as desired. The width of the natural river channel within the CW cross-section is identical to the R cross-section. 	

Table 5-1 Generic Cross-Sections

Name and Description	Illustration
<p>Lacustrine Environment (L)</p> <ul style="list-style-type: none"> The lacustrine environment (L) concept form is like a lake in its shape, thereby allowing the flow to spread across the entire channel. The depth of water level will vary based on lake levels. The channel will always be flooded because the bottom of the channel will remain lower than the anticipated low lake level conditions. Thus, vegetation will be dependent on the average water level in Lake Ontario (the Keating Channel, which is too deep for vegetation, is an extreme example of this concept). Sediment deposition will diffuse throughout the channel. This environment only promotes anaerobic conditions. 	
<p>Lacustrine / Natural River (L/R)</p> <ul style="list-style-type: none"> The combination of a lacustrine environment (L) concept form with a natural river (R) channel provides a section of the floodplain (river channel and lacustrine areas) that is always flooded while the remainder of the floodplain will flood with a frequency dependent on the hydraulic capacity of the river and lacustrine sections. Like the natural river channel, this cross-section provides for both aerobic and anaerobic conditions. 	
<p>Lacustrine / Created Wetland (L/CW)</p> <ul style="list-style-type: none"> The combination of lacustrine environment (L) and created wetland (CW) concept forms separates the created wetland from the main flow in the lacustrine channel much of the time. The lacustrine channel carries all of the flow during low flow conditions. Conditions can vary from primarily anaerobic to a combination of aerobic and anaerobic, depending on the type of offline wetlands that are created. 	

The DMNP team determined that two other cross-sections should be considered based on the combination of the generic cross-sections. These new cross-sections represent river mouth forms not captured by the three original cross-sections which may provide advantages particularly in meeting the naturalization objective. Two hybrid cross-sections were created:

1. Lacustrine and natural river (L/R); and
2. Lacustrine and created wetland (L/CW).

More detailed descriptions of the five cross-sections are provided in **Table 5-1**.

As depicted in **Figure 5-4**, there is no combination of the created wetland and natural river forms because the created wetland cross-section already includes a river channel.

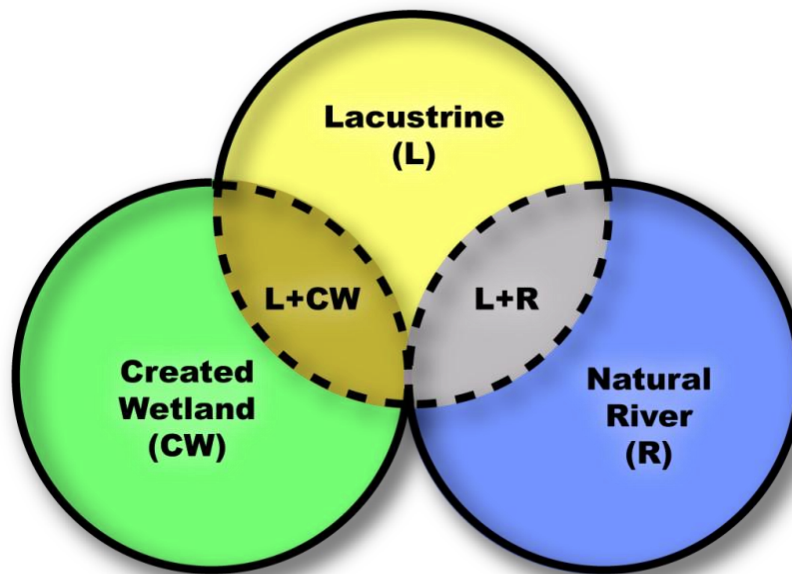


Figure 5-4 Venn Diagram showing Combinations of Cross-sections

The shape or geometry of the river mouth cross-section greatly influences the velocities that are experienced, which in turn influences erosion (areas of high flow velocity), deposition (areas of low flow velocity) and the establishment and maintenance of particular plant communities. For the same volume, very wide, flat cross-sections (i.e., lacustrine) will produce relatively uniform shallow depths with low to moderate flow velocities, while a cross-section with increased topographic and bathymetric complexity and significant planform variation will have a much more complex depth and flow velocity distribution.

The difference between these cross-section geometries becomes most noticeable when comparing day-to-day flow conditions (5 cubic metres per second) to Regulatory Flood conditions (1,700 cubic metres per second). Day-to-day flows in the lacustrine channel will have a very wide water surface with very shallow depths whereas the same flows will be contained within the main channel of the natural river cross-section. Backwater effects produced by Lake Ontario will produce significant impacts on the depth and flow velocity conditions and sustainability of desired vegetation communities for each of the alternatives.

Typically, natural river systems are defined by two physical components. First, a low flow channel with a defined bed and banks conveys the normal low flows and contains runoff from the more frequent runoff events with return frequencies typically in the range of 1.5 to 2 years or a 50 to 70% risk of occurrence in any given year. Second, an overbank area with confining valley walls allows for higher flows that limit the extent of flooding below the top of the river valley. In low-lying non-confined areas which lack a valley feature, the floodplain may be very extensive (such as is currently experienced at the mouth of the Don). Since the second project objective requires the project to greatly reduce the extent of flooding in the area surrounding the mouth of the Don, each viable alternative must have a channel and floodplain system that can contain floods up to and including the Regulatory Flood.

5.1.2.2 Description of Habitat (Vegetation Communities)

Vegetation communities that were considered based on reference sites typical to natural river mouths along the north shore of Lake Ontario are: upland forest and/or thicket; treed swamp; thicket swamp; meadow marsh; emergent marsh; and submergent marsh. A generic description of these vegetation communities, along with the corresponding Ecological Land Classification and photographs, is provided in **Table 5-2**.

Table 5-2 Vegetation Communities



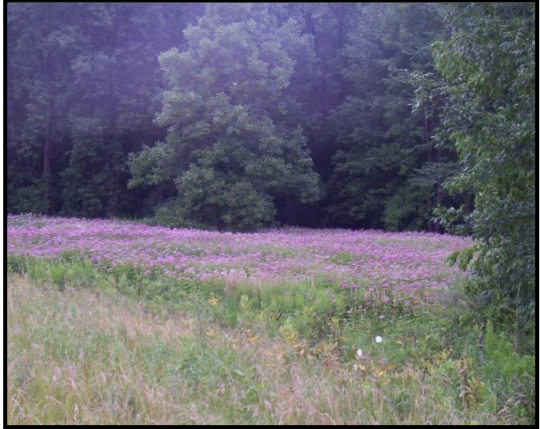

Name and Description	Photograph
<p>Submergent Marsh (SAS)</p> <p><i>A wetland that is permanently flooded and dominated by herbaceous aquatic plants that are rooted or free floating or a combination of the two.</i></p>	
<p>Emergent Marsh (MAS)</p> <p><i>A wetland that is permanently flooded and dominated by grasses and broadleaved flowering plants with less than 25% woody species.</i></p>	

Table 5-2 Vegetation Communities

Name and Description	Photograph
<p>Meadow Marsh (MAM)</p> <p><i>A wetland that is seasonally flooded and dominated by grasses and broadleaved flowering plants with less than 25% woody species.</i></p>	
<p>Thicket Swamp (SWT)</p> <p><i>Wetlands that are flooded in the spring and dry out by August but are dominated by shrubby species with tree cover absent or up to 60% closure.</i></p>	
<p>Treed Swamp (SWD / SWC / SWM)</p> <p><i>Treed areas of wetland (more than 60% canopy closure) that are flooded in the spring and dry out by August.</i></p>	