8.0 MONITORING AND ADAPTIVE ENVIRONMENTAL MANAGEMENT

The LWC Project goal is "to create a new natural park that will establish ecological habitat and public linkages on the eastern Mississauga waterfront". Based on this goal, a series of alternative LWC Project configurations were considered (Chapter 5). The Preferred Alternative was selected based on its ability to best achieve LWC Project objectives and is detailed in Chapter 6 and assessed in Chapter 7. The Preferred Alternative meets the ecological design recommendations[18] that will provide functional naturalization (see Chapter 6 and Table 8.1). The monitoring and adaptive environmental management (AEM) process presented in this Chapter will ensure that recommended design requirements are maintained and work to maximize ecological function of the LWC Project as identified through a set of performance indicators[19] developed during detailed design.

Table 8.1 Recommended Ecological Design Goals for the LWC Project

Habitat Component	Minimum Recommended Ecological Design Goals
Wetlands	Wetland habitat area = 3.5 – 9.5 ha
Forest & Treed Swamp	Forest & Treed Swamp habitat area = 4 ha
Meadow	Meadow habitat area = 10 ha

Given the unique character of the LWC Project, the complexity of ecological interactions and consideration of adjacent planning initiatives that influence and will be influenced by the LWC Project, this EA anticipates the need for a certain degree of flexibility within the outcomes, throughout the life of the LWC Project. The monitoring and AEM process presented in this chapter coupled with the EA amendment mechanism presented in Chapter 9 provides a framework from which designers and project managers can use the flexibility built into the EA to maximize LWC Project benefits and minimize any potential negative effects (see Chapter 7) after this EA has been approved. The monitoring and AEM process will be managed by CVC with input from other LWC Project stakeholders where appropriate.

Section 8.1 describes the monitoring program that informs both the detailed design process and the AEM process for the LWC Project to ensure that the objectives of the LWC Project are achieved. Section 8.2 describes the AEM process as it relates to the LWC Project.

[18] **Minimum design requirements** represent recommended minimum values for the various ecological components of the LWC Project (e.g. minimum wetland area). Wherever possible these values will be maximized through the detailed design, the individual project components can be smaller than these minimum recommendations.

[19] **Performance indicators** will be developed for the LWC Project through the detailed design process to measure the environmental performance of the LWC Project (see Section 8.1.4). Performance indicators relate to the functional ecological attributes of the naturalized system. Performance indicators will be developed based on the monitoring of reference wetlands, baseline monitoring and ecological models.

As a reminder, the objectives of the LWC Project are:

1. **Naturalization** - Establish a diverse range of native terrestrial and aquatic ecosystem habitats and linkages in a degraded area of the eastern Mississauga waterfront.
2. **Access** - Create public linkages for access to and along the waterfront including the Waterfront Trail while allowing for compatible recreational, educational and cultural heritage opportunities.
3. **Compatibility** - Ensure that the LWC is compatible with existing infrastructure.
4. **Coordination** - Coordinate with and inform other local planning and development initiatives.
5. **Fiscal Viability** - Develop an innovative funding approach that maximizes public benefit and value by reusing locally generated fill from existing municipal (regional and local) capital works projects.

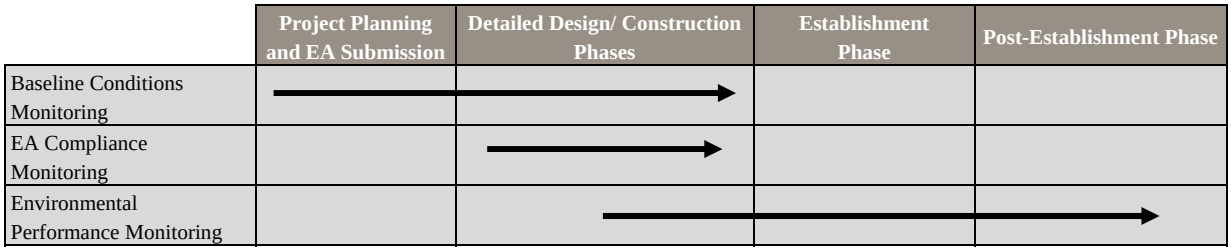
8.1 LWC PROJECT MONITORING PROGRAM

A comprehensive monitoring program is a critical element of the LWC Project from the pre-design phase through to the post-establishment phase. The monitoring program serves several functions throughout the life of the LWC Project:

1. **Baseline conditions monitoring** during the pre-design and design phases will continue to provide data that will inform detailed design elements and identify changes to the existing environment that may affect LWC Project outcomes. Any changes identified through pre-design and design phase monitoring can be incorporated into the detailed design and can inform the potential need for EA amendments if necessary (Chapter 9 presents an EA amendment process for the LWC Project);
2. **EA compliance monitoring** will ensure compliance with EA commitments and ensure that the LWC Project is constructed according to the recommended design requirements and final design elements. This monitoring information will be used to inform the AEM process (see Section 8.2). The AEM process will begin once the LWC Project is constructed (up to this point any LWC Project changes are design related and will be subject to the amendment process described in Chapter 9 if applicable); and
3. **Environmental performance monitoring** will measure if the LWC Project functions as intended during the establishment and post establishment phases.

A standardized data collection protocol will be established for the monitoring program to ensure data consistency. The specific data that is collected will depend on the current phase of the LWC Project so the type of data collected will evolve as the LWC Project progresses. Figure 8.1 shows the relationship between the different monitoring phases and the LWC Project phases.

Figure 8.1 Relationship between Monitoring Phases and LWC Project Implementation



8.1.1 Baseline Conditions Monitoring

CVC, TRCA and other agencies have been monitoring ecological conditions in Lake Ontario for decades providing a baseline of existing conditions (see Chapter 3) which has informed the planning and design of the LWC Project. Descriptions and mapping of existing conditions and aquatic habitat in the Project and Regional Study Areas has been assembled. Research has been conducted by the LWC Project EA Team to identify reference wetland sites along the north shore of Lake Ontario to identify an appropriate range of hydrologic and ecologic function to develop a better understanding of how vegetation communities respond to changes based on wetland bathymetry and topography.

Baseline conditions monitoring allows the study team to identify ecological changes that may occur between EA approval and project implementation, and the changes that may occur throughout the life of the project as external influences exert their pressure on the created landform, including the beaches, islands, creek channels, wetlands and upland areas. There may be a desire for continued baseline conditions monitoring following EA approvals determine whether:

- Significant changes in the existing environmental conditions have occurred that would influence the LWC Project as described in Chapter 6 prior to the detailed design stage and/or during the construction stage;
- The project is performing as anticipated during the establishment period of the project; and
- The completed project is sustainable and functioning under the range of future stressors that cannot be comprehensively defined at this time (i.e. due to climate change, colonization by new invasive species, changes in population and land use, etc.).

The baseline monitoring and modelling work will continue, as required, through the period between EA approval and detailed design to ensure that the most up-to-date and relevant information is used to develop the detailed design for the LWC Project.

8.1.2 EA Compliance Monitoring

EA compliance monitoring is a standard condition of approval for most projects subject to the *EA Act* in Ontario. The purpose of EA compliance monitoring is to ensure compliance with all EA and other commitments made during project planning and ensure that the LWC Project is constructed and operates as described within the range of predicted effects.

EA compliance monitoring will take place during the detailed design and construction period for the LWC Project. EA compliance monitoring will ensure adequate environmental protection through the construction period, document compliance with the EA, and monitor the implementation of the approved design using standard best management practices for construction. The EA compliance monitoring program will be managed by CVC. A detailed compliance monitoring plan will be developed as part of the overall environmental management plan to guide compliance monitoring during the construction phase.

EA compliance monitoring will address the following issues and potential effects:

- Ensure compliance with all commitments made in the EA including the implementation of mitigative measures as identified in the EA;
- Ensure compliance with erosion and sediment control plans;
- Ensure compliance during fish salvage and release activities;
- Ensure the implementation of fisheries mitigation measures (e.g., fisheries windows, maintenance of passage, etc.);
- Ensure compliance with migratory breeding bird periods;
- Ensure the implementation of best management practices during construction (e.g. air quality mitigation measures such as dust suppression and vehicle emissions management, noise management);
- Ensure compliance with all federal, provincial and municipal permits, licenses and approvals (e.g., ECA's, noise by-laws, tree removal by-laws, etc.);
- Ensure compliance with fuel storage and handling and spill response protocols;
- Ensure compliance with waste management plans; and
- Document the as-built features immediately following construction completion.

Table 8.2 below provides a summary of commitments resulting from the LWC Project EA which will be the basis for compliance monitoring.

Table 8.2 Summary of Commitments Resulting from the LWC Project EA

Timing	EA Commitment	EA Report Reference
Detailed Design	Ensure minimum habitat design recommendations are either maintained or enhanced as refinements are made through the detailed design process.	Section 6.1
	Establish site level details and specific habitat components for terrestrial habitat features.	Section 6.1.2.1 and Section 6.1.2.4
	Consider location and design of secondary and tertiary trails.	Section 6.1.3
	Discuss ancillary ecological benefits that could offset HAAT model estimates of compensation requirements with DFO, MNR and Conservation Authority biologists.	Section 7.3.1.1
	Evaluate options for enhancing the ecological function in the area surrounding the remnant treed beach.	Table 7.2
	Establish site level details for aquatic habitat features along the newly created shoreline.	Section 7.3.1.2
	Explore options to provide temporary access to the shoreline for the public viewing, including potential to establish an informal temporary viewing path.	Section 7.3.2.1
	Explore options to further reduce encroachment on the sand beach at Marie Curtis Park West.	Section 7.3.2.2
	Explore options to provide controlled access to wetlands and creeks.	Section 7.3.2.2
	Explore options to mitigate traffic effects at the intersection of Lakeshore Road and the temporary construction access route through the establishment of a right hand turn lane and a merge lane exiting the site.	Section 7.3.3.1
	Develop a fill tracking system to account for and audit all fill coming into the site.	
	Establish performance indicators to guide the Environmental Performance Monitoring program.	Section 8.0
	Establish specific triggers for potential adjustments, refinements or modifications that could occur as part of the adaptive management program.	Section 8.2.2.2
	Explore opportunities for interpretive signage.	Table 10.9
	Work with WWTF to ensure access and maintenance needs to their manholes for the outfall are provided.	
	Develop habitat structure refinements for the permanent rerouting of Serson Creek down the stormwater channel such that it does not impact flood conveyance requirements in the channel.	
Construction	Develop tree removal (include plant salvage and relocation) and compensation/restoration plan.	Section 6.3.2
	Monitoring of environmental site controls and mitigation measures during construction.	Section 8.1.2
	Obtain all relevant Municipal, Provincial, Federal and/or Regional occupancy permits.	Section 6.3.2
	All areas of the site disturbed by the haul road will be restored to original conditions or to an appropriate level of rough grading to match potential future Parks Master Planning conditions for the area, upon completion of LWC Project.	Section 6.3.2
Establishment/ Post-establishment	Monitor environmental performance to measure desired outcomes; determine if they have been achieved; and trigger adaptive management where necessary.	Section 8.1.3

EA compliance monitoring will continue until final grading is completed. Once final grading is complete, the environmental performance monitoring program (see Section 8.1.3) will begin and continue, as required, through the life of the project.

8.1.3 Environmental Performance Monitoring

The purpose of environmental performance monitoring is to measure desired outcomes related to naturalization, flood conveyance and shoreline stability; determine if they have been achieved; trigger adaptive measures where necessary; and inform the refinement of the as-built features. Environmental performance monitoring will commence at the completion of LWC Project construction, following final grading and as-built documentation. Table 8.3 provides examples of environmental performance monitoring that could be conducted for biophysical components of the LWC Project. The specific details and measures to be included in the environmental performance monitoring program for the LWC Project will be developed through the detailed design and construction phases.

Existing monitoring frameworks (e.g. CVC Integrated Watershed Monitoring Program and other targets refined from the Credit River Water Management Strategy Update and Subwatershed Plans) provide examples of performance monitoring that could be adapted specifically for the LWC Project. These existing monitoring frameworks will be augmented with additional performance indicators that address ecological and social aspects of LWC Project objectives. Monitoring results will be compared against the performance indicators developed during detailed design. The comparison of performance indicators against monitoring results is the key driver of the AEM process described in Section 8.2. Monitoring results are compared to performance indicators to determine if AEM measures are required to achieve desired outcomes.

8.2 ADAPTIVE ENVIRONMENTAL MANAGEMENT

To ensure that the Preferred Alternative, as presented in Chapter 6, functions as desired, an approach to ongoing management is required to continually fine tune LWC Project components and ensure long term LWC Project success. AEM provides a clear process for ongoing management of the LWC Project to ensure LWC Project objectives continue to be achieved through positive feedback mechanisms.

8.2.1 What is Adaptive Environmental Management?

The Canadian Environmental Assessment Agency defines AEM as a systematic process for continually improving environmental management practices by learning about their outcomes and applying that knowledge to improve the outcome. AEM allows for flexibility in project management so modifications and refinements can be incorporated throughout the project life cycle. AEM is fundamentally a way of incorporating learning through monitoring into a

feedback loop that enhances project outcomes. Undesirable environmental effects are identified early so that management interventions can be implemented promptly to avoid major problems before they occur and to maximize fulfillment of the LWC Project objectives.

Table 8.3 Examples of Environmental Performance Monitoring for Ecological Components of the LWC Project

Biophysical Component	Environmental Performance Monitoring
Habitat and Species	• identify trends of habitat and species targets through the post establishment phase. • evaluate habitat and species against intended outcomes and functions.
River and Wetland Form and Function	• observe impact of major flow events on river and wetland form and sediment accumulation.
Beach and Shoreline Stability	• evaluate whether beach materials are performing as intended by providing a dynamically stable shoreline. • evaluate whether the hardened nodes are performing as intended by anchoring the beach system and is remaining stable over a range of coastal conditions.
Wave Parameters, Circulation and Sediment Transport and Lake Levels	• document changes in wave parameters, circulation, sediment transport and lake levels over time to inform the need for management adjustments to streams, wetlands and shorelines.
Surface and Groundwater Quality	• Limited parameter water quality analysis for creek and near-shore waters of Lake Ontario to assess changes in water quality.

8.2.2 AEM Strategy for the LWC Project

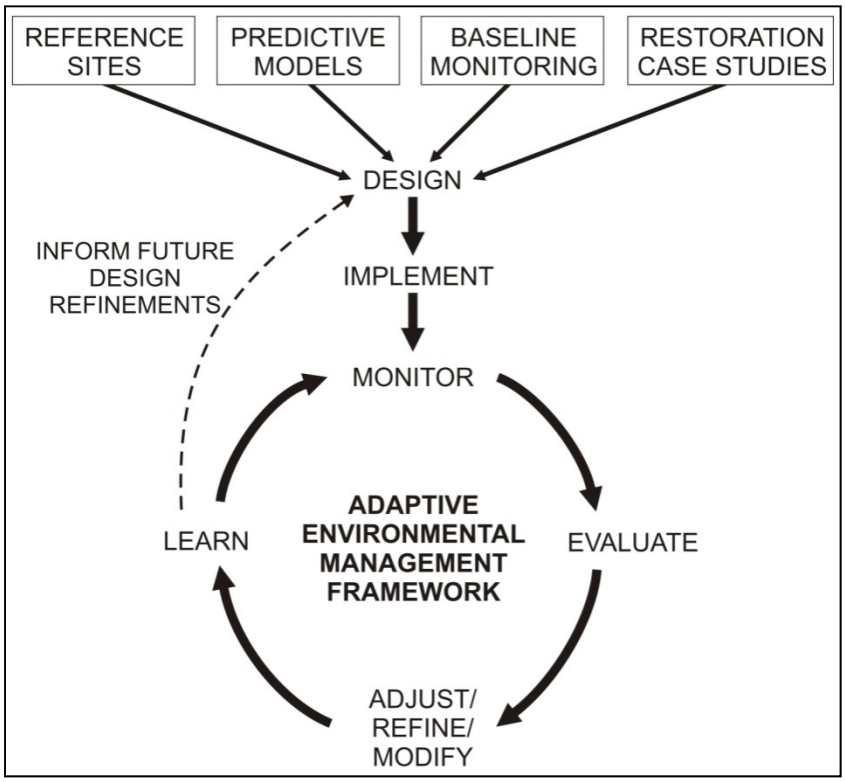
The outcome of naturalization projects depends on the interaction between the biological components with the underlying physical components that are created: terrain, soils, hydrology, and coastal processes which can all be modified by changes in climate; and how people use the LWC Project area and the surrounding areas.

An AEM strategy is desired for the LWC Project for a number of reasons including:

1. The need for a flexible strategy to address ecosystem response to changing environmental conditions and human use stressors during and following LWC Project construction;
2. The need to create the opportunity to maximize LWC Project benefits and minimize negative effects throughout the life of the LWC Project;
3. The need to respond to changes in local weather patterns and long term climate change that may alter lake water levels and the frequency and duration of inundation of the naturalized features, shoreline features; and/or the severity and frequency of extreme storm events; and,
4. The need to respond to changes or benefits related to future projects and planning initiatives (e.g. Inspiration Lakeview, LOISS) in the LWC Project Study Area and elsewhere in the Regional Study Area and to take advantage of enhancements that those projects may provide to this system.

Figure 8.2 outlines the AEM cycle in relation to the pre-design, construction and establishment phases of the LWC Project. The AEM cycle will be applied once the LWC Project is implemented and will inform future projects through a feedback mechanism from lessons learned. AEM is the ongoing cycle of monitoring, evaluation, adaptation and learning.

Figure 8.2 Relationship between LWC Project Design and AEM



The ability to affect the outcome of the LWC Project through monitoring and adaptation in response to stochastic events is of paramount importance. The AEM process offers the best process by which to achieve this flexibility. The purpose of AEM and associated monitoring programs is to increase the likelihood of meeting LWC Project goals despite uncertainty surrounding various LWC Project elements.

8.2.2.1 Monitoring and Evaluation within the LWC Project AEM Process

Monitoring is a key component of the adaptive management framework as it establishes conditions pre- and post- construction and allows the determination of which effects are occurring as a result of LWC Project activities. It identifies environmental changes that are occurring at various spatial scales that may affect LWC Project outcomes. Monitoring allows for the systematic testing of various systems or actions to assess their ability to achieve a desired

function or outcome. The key is to develop an understanding of not only which systems function as intended and which do not, but also which stressors are creating an impact to the system and the reasons for those impacts. The monitoring data that feeds into the AEM process will be robust and scientifically defensible, providing information that will maximize opportunities to achieve desired outcomes.

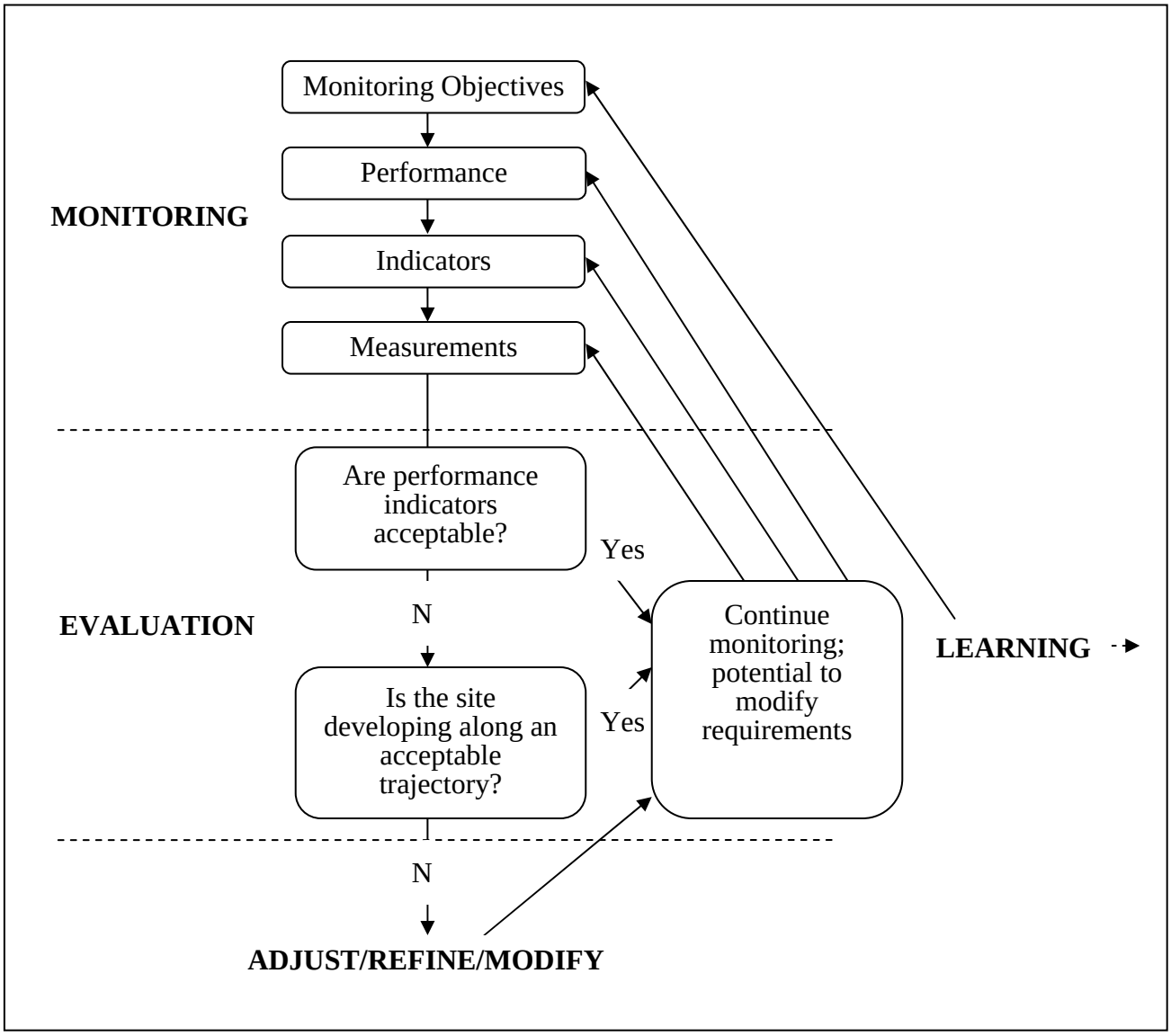
The achievement of LWC Project objectives is assessed by monitoring the system and evaluating the data against pre-defined performance indicators (see Section 8.1.4 and Figure 8.3). If the desired functions or outcomes are not achieved, the LWC Project features may need to be adapted. The objective is to maximize benefits in relation to the performance indicators (i.e. AEM will seek to maximize measured values related to indictors above the standards wherever possible).

The evaluation component of AEM will include specific triggers that will determine when management interventions will be required (see examples in Table 8.4). Evaluation of monitoring data provides the foundation for learning from the LWC Project. These lessons will inform required modifications to the monitoring program (i.e. increase or decrease in monitoring frequency; changes in performance indicators; identification of new objectives or better techniques) and modifications to the ecological models used for LWC Project design.

8.2.2.2 Adjustments, Refinements, Modifications within the LWC Project AEM Process

Adaptation (adjust, refine and/or modify) is about taking action to increase the likelihood of achieving LWC Project objectives. The purpose of an AEM strategy is to identify undesirable environmental effects early so management interventions can be implemented to avoid major problems before they occur. The environmental performance monitoring described in Section 8.1.3 will provide clear evidence of LWC Project outcomes during the establishment phase. Results from monitoring and evaluation will inform the need for adjustments, refinements or modifications to LWC Project design or operations. Table 8.4 provides examples of potential AEM triggers and possible adjustments, refinements, or modifications that could be implemented to address any identified problems. The specific triggers for adjustments, refinements or modifications and the specific management options will be refined during detailed design and included in an AEM work plan.

Figure 8.3 Monitoring and Evaluation within the AEM Cycle



8.2.2.3 Learning within the LWC Project AEM Process

One of the greatest benefits of the proposed AEM strategy is that it will allow for ongoing learning related to the outcomes of the LWC Project and future projects. Learning involves systematically documenting the results of monitoring, evaluation and adaptive measures, and providing lessons learned to a wide audience. CVC, TRCA, academia, other agencies and organizations and the global urban renewal community will benefit from an improved understanding of effective naturalization techniques established through the AEM strategy for the LWC Project. Monitoring programs will determine if predictive models provided accurate

information to appropriately inform design. Where monitoring reveals any inaccuracies within the predictive models, adjustments can be made for future designs.

Table 8.4 Potential AEM Triggers and Adaptive Measures for LWC Project Components

Project Component	Potential AEM Triggers	Potential Adjustments, Refinements or Modifications
Aquatic Habitat and Species	• Underperformance of desirable species recruitment to the area • Undesired spatial distribution of riparian or wetland ELC communities • Impairment of habitat features (sedimentation, ice scour, etc.) that significantly affects performance as intended / designed • Over representation of undesirable species (e.g., carp) • Impacts to created habitat and/or wildlife by people and/or pets	• Adjust / enhance aquatic habitat features and habitats to promote desired species composition • Expand monitoring to identify root causes of low species recruitment • Repair / re-establish habitat features • Refine invasive species (e.g., carp) management program • Adjust public access to habitat areas, bylaw changes, enforcement, etc. • Soil amelioration to improve planting success
Wetland Function	• Undesired hydroperiod in wetlands • Undesired species composition	• Adjust artificial levees (e.g., to avoid excess sedimentation, to retain water in flood events) • Modify flooding frequency, depth and/or duration • Modify vegetation composition using appropriate methods
Terrestrial/Wetland Habitat and Species	• Undesired species composition • Undesired spatial distribution of ELC communities • Inadequate species diversity • Cover not effectively controlling erosion • Recreation/human use causing degradation of habitat • In-adequate species diversity and abundance utilizing habitats as project desired	• Conduct vegetation management (herbicide application, manual removal, re-seeding, etc.) • Re-vegetate or adjust cover management system to control erosion • Reconfigure / manage human use patterns • Adjust / enhance wetland and terrestrial habitats as required to attract desired species or abundance
Shoreline Erosion	• Failure of revetment • Failure of islands • Excessive loss of beach material	• Address shoreline erosion and beach
Water Quality	• *E. Coli* measurements at beaches significantly higher than existing readings	• Source specific adaptive measures

Documentation of the monitoring, evaluation and adaptive measures described in this chapter will be used to inform similar projects that are undertaken in the future. Historically, ecological restoration projects have been poorly documented so the ability to learn from past successes and failures is limited (TRCA 2009). By applying the monitoring and adaptive management process outlined in this chapter, a robust database will be created that can be drawn upon for future projects related to waterfront revitalization and other naturalization efforts in Mississauga and the Greater Toronto Area.

This cycle of monitoring, evaluation, learning and adaptation will be applied to the LWC Project to respond to uncertainties and external influences related to the LWC Project and the environment. Examples of external influences are numerous with a prime example being climate. Climate change is expected to influence management of the LWC Project into the future, considering the duration of the build-out period, and the fact that the LWC Project will establish a new ecological system that will exist and evolve in perpetuity. Climate change may result in lower water levels in Lake Ontario which would influence coastal processes, recharge capabilities or inundation levels in the constructed wetlands, and may alter flow frequency in the creeks upstream. Monitoring the conditions over time following completion of LWC Project phases will allow CVC to respond to change by implementing appropriate AEM measures.

Further complications arise as a result of the build out period for the LWC Project that may extend over a number of years. This may trigger a management response to address changes to the environmental, social or economic context of the LWC Project.