Credit Valley Conservation

April 2015
(Revised July 2019)

Credit Valley Conservation
Integrated Watershed Restoration Strategy

CVC
CREDIT VALLEY CONSERVATION

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Integrated Watershed Restoration Strategy

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April 2015
(Aquatic Methodology revised July 2019)

To be cited as:
Credit Valley Conservation. 2015 (revised 2019). Integrated Watershed Restoration Strategy

This project was undertaken with the financial support of

Environnement Canada Environment Canada

Acknowledgements

Phil Bird
Bob Morris
Jon Clayton
Neelam Gupta
Phil James
Jaquelyn Keirs
John Kinkead
Aviva Patel
Mike Puddister
Yvette Roy
Scott Sampson
Jacquelyn Saturno (Volunteer)
Janel Sauder
Amanjot Singh
Sherwin Watson-Leung

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1 INTRODUCTION

Credit Valley Conservation (CVC) is legislated under the Conservation Authorities Act (1990) to "*establish and undertake, in the areas over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals*" with powers including but not limited:

- *to study and investigate the watershed and to* ***determine a program whereby the natural resources of the watershed may be conserved, restored, developed and managed****;*
- *to acquire by purchase, lease or otherwise and to expropriate any land that it may require, and, subject to subsection (2), to sell, lease or otherwise dispose of land so acquired;*
- *to control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects thereof;*
- *to alter the course of any river, canal, brook, stream or watercourse, and divert or alter, as well temporarily as permanently, the course of any river, stream, road, street or way, or raise or sink its level in order to carry it over or under, on the level of or by the side of any work built or to be built by the authority, and to divert or alter the position of any water-pipe, gas-pipe, sewer, drain or any telegraph, telephone or electric wire or pole;*
- *to plant and produce trees on Crown lands with the consent of the Minister, and on other lands with the consent of the owner, for any purpose;*
- *to cause research to be done.*

As such, CVC has broad reaching powers to conserve, restore, develop, and manage the natural heritage features and functions within its jurisdiction. However, with limited financial and human resources, the identification of priority areas and actions for restoration and conservation are critical to ensuring that CVC (and other partner organizations) are focusing efforts in a strategic manner to the extent possible.

The corresponding need for an integrated approach to watershed management in CVC's jurisdiction was first identified in the 2006/08 Strategic Plan[1]. That Strategic Plan recognized the dramatic changes in environmental conditions and associated stressors throughout the watershed, and stated that:

> *CVC will develop an* ***integrated watershed restoration strategy*** *that ensures all restoration projects reflect watershed priorities and are coordinated with partners for greater environmental net-benefit.*

[1] http://www.creditvalleyca.ca/wp-content/uploads/2011/02/CREDIT VALLEY CONSERVATION AUTHORITYstrategicplan08-web.pdf

The 2015 Strategic Plan continues to acknowledge the value of multi-disciplinary, integrated, and prioritized approaches including the following relevant goals and directions[2]:

- Plan for an environmentally sustainable future
    - *Complete **integrated multi-disciplinary subwatershed plans** that define existing and future conditions, **identify areas for future management**, particularly in light of climate change, and provide direction for implementation;*
- Safeguard people, property and communities from hazards
    - *Protect, restore, and create natural/naturalized features that reduce flooding and erosion;*
    - *Manage a healthy, resilient environment through protection, restoration and enhancement;*
    - *Develop an **integrated and transparent science-based priority setting process for protection, restoration, enhancement, and securement** projects using monitoring data, the Credit River Watershed Natural Heritage system, watershed studies and related management plans;*
    - *Develop and implement restoration strategies that increase natural cover and improve aquatic, terrestrial and wetland habitat and communities on private, public and institutional lands;*
    - *Connect communities with nature to promote environmental awareness, appreciation and action;*
    - *Work with priority communities to address local environmental concerns through targeted outreach and action.*

Reflecting a systems approach, the *Integrated Watershed Restoration Strategy* (IWRS) aims through its development and implementation, to adopt an integrated approach to addressing threatened or deteriorated ecosystem features and functions. Inherent to this is a need to respond to other identified priorities and to coordinate and promote effective and large-scale environmental restoration efforts that would otherwise be limited in scope (Appendix A). Integration promotes efficiency across ecosystem components and multiple jurisdictions.

1.1 ECOSYSTEM HEALTH

1.1.1 Healthy Ecosystems

There are a wide range of initiatives at various scales that directly or indirectly strive to identify criteria and related directions to conserve and restore ecosystem health, a number of which are summarized in Appendix A. Protection of existing natural heritage features and their functions is the most cost-effective and efficient way to maintain biophysical and chemical characteristics, while restoration and

[2] http://www.creditvalleyca.ca/about-cvc/cvc-strategic-plan/

enhancement approaches are critical to re-establishing desired targets for natural ecosystem composition, structure and function.

The US EPA's Science Advisory Board (SAB – USEPA 2002) identified the following six essential ecological attributes to describe factors that support healthy ecosystems:

1) Landscape condition
   The extent, composition and structure of a landscape influence its ability to support the distribution and diversity of both species and habitat.
2) Biotic condition
   The structure and composition of biota relates to the functional integrity of ecosystems.
3) Chemical and physical characteristics
   The chemical and physical characteristics of air, water, soil and sediment relate to the functional integrity of ecosystems.
4) Ecological processes (e.g. energy and material flow)
   The metabolic functions (energy flow, elemental cycling, and the production/consumption and decomposition of organic matter) influence ecosystem integrity.
5) Hydrologic and geomorphologic condition
   The flow of ground- and surface- water and their interplay with landform characteristics influence the creation and succession of ecosystem conditions and integrity.
6) Natural disturbance regimes
   The frequency, intensity, extent and duration of natural disturbances influence the integrity of ecosystems.

Watersheds are a useful context for managing ecosystems, with subwatersheds and individual catchments allowing for further refinements, since they capture the interacting dynamics of these essential ecological attributes (SAB 2002; MMAH 2014). The SAB also notes that since watersheds are not static, the assessments should incorporate future changes, with climate change and changes in land and water use stemming from population increases identified as the most pervasive influences on changes to watershed condition.

Cairns (2003) suggests that if human society and natural ecosystems are co-evolving then the protection of healthy and the restoration of degraded ecosystems will improve not only ecosystems but, by extension, human health. Healthy watersheds provide various harmonious and sustainable ecosystem services ranging from improved water quality, moderation of climate change effects, and maintenance of healthy natural habitat that contributes to water quality and quantity moderation (Table 1-1). A more detailed discussion related to ecosystem function and health as it relates to ecosystem properties and processes, ecosystem goods, and ecosystem services can be found by referring to CVC (2011).

Table 1-1: Benefits of Healthy Watersheds

Healthy Characteristic	Example Benefits
High Biotic Integrity	Maintains habitat for native plants and animals
Resilient to natural and human disturbances	Vegetation diversity modifies wildfire effects Streams maintain perennial flow during moderate drought
High connectivity across landscape	Flood flows have access to floodplains Riverine habitats area not fragmented by dams
Ecosystem services are provided	Hillslope vegetation lets moderate rainfall percolate into soils rather than eroding them Watersheds produce good-quality drinking water
High long-term productivity	Soils and soil nutrients are not chronically removed by wind or water

Source: Williams et al (1997)

1.1.2 Credit River Watershed Zones

Details concerning the physical and biological conditions in the Credit River Watershed may be found by referring to CVC (2011) and ABL (2006); however, there are three broad physiographic zones and their relative health is discussed below:

1) Upper Credit (above Niagara Escarpment)

   The Upper Credit is generally comprised of moderately to highly permeable soils. Dominant vegetation includes deciduous forests and white cedar swamps and is part of the Great Lakes-St.Lawrence forest region, with the main land use being agriculture/small hobby farms. Settlement areas include Orangeville, Erin, Alton, Caledon Village, and Hillsburgh.

2) Middle Credit (Niagara Escarpment and Oak Ridges Moraine)

   The Middle Credit is dominated by steep slopes, thin overburden, and associated high runoff volumes and velocities. This zone has the highest forest cover of the three and is part of the Great Lakes-St. Lawrence forest region, with the main land use being agriculture. Settlement areas include Inglewood, Cheltenham, Terra Cotta, Ballinafad, Acton, Georgetown, and Norval.

3) Lower Watershed (below Niagara Escarpment).

   Surficial soils in this zone have relatively low infiltration rates, with the sandier soils associated with the Lake Iroquois Plain having higher permeability. This zone has very low natural cover, and includes fourteen watersheds that drain directly into Lake Ontario. Most of these watersheds are highly degraded, and symptomatic of the dominant urban land use. This zone includes an important provincial corridor – the Lake Ontario shoreline, and associated features including shoreline bluff

habitat, coastal wetlands, and nearshore aquatic habitats. The southern part of this zone includes part of the Carolinian life zone with vegetation found in this area that is reflective of a more southern climate. Settlement areas include the western half of Brampton, most of Mississauga and the eastern edge of Oakville.

The following (sub) watersheds are found within CVC's jurisdiction and the above-noted watershed zones (Table 1-2; Figure 1-1 and Figure 1-2):

Table 1-2: (Sub)Watersheds and Forest Regions: Credit River Watershed Zones

Watershed Zone	Subwatershed		Forest Region
	Credit River		
Lower Credit	1	Loyalist Creek	Carolinian
Lower Credit	2	Carolyn Creek	Carolinian
Lower Credit	3	Sawmill Creek	Carolinian
Lower Credit	4	Mullett Creek	Carolinian
Lower Credit	5	Fletcher's Creek	Carolinian Great Lakes-St Lawrence
Lower Credit	6	Levi Creek	Carolinian
Lower Credit	7	Huttonville Creek	Great Lakes-St Lawrence
Lower Credit	8a	Springbrook Tributary	Great Lakes-St Lawrence
Lower Credit	8b	Churchville Tributary	Carolinian
Lower Credit	9	Norval to Port Credit	Great Lakes-St Lawrence/Carolinian
Middle Credit	10	Black Creek	Great Lakes-St Lawrence
Middle Credit	11	Silver Creek	Great Lakes-St Lawrence
Middle Credit	12	Credit: Cheltenham to Glen Williams	Great Lakes-St Lawrence
Middle Credit	13	East Credit River	Great Lakes-St Lawrence
Middle Credit	14	Credit: Glen Williams to Norval	Great Lakes-St Lawrence
Upper Credit	15	West Credit River	Great Lakes-St Lawrence
Upper Credit	16	Caledon Creek	Great Lakes-St Lawrence
Upper Credit	17	Shaw's Creek	Great Lakes-St Lawrence
Upper Credit	18	Credit: Melville to Forks of the Credit	Great Lakes-St Lawrence
Upper Credit	19	Orangeville	Great Lakes-St Lawrence
Middle Credit	20	Credit: Forks of the Credit to Cheltenham	Great Lakes-St Lawrence
	21	**Lake Ontario: West Watersheds**	
Lower Credit		Clearview Creek	Carolinian
Lower Credit		Avonhead Creek	Carolinian
Lower Credit		Lakeside Creek	Carolinian
Lower Credit		Sheridan Creek	Carolinian
Lower Credit		Turtle Creek	Carolinian
Lower Credit		Birchwood Creek	Carolinian
Lower Credit		Moore Creek	Carolinian
Lower Credit		Lornewood Creek	Carolinian
Lower Credit		Tecumseh Creek	Carolinian
	22	**Lake Ontario: East Watersheds**	
Lower Credit		Cumberland Creek	Carolinian
Lower Credit		Cooksville Creek	Carolinian
Lower Credit		Cawthra Creek	Carolinian
Lower Credit		Serson Creek	Carolinian
Lower Credit		Applewood Creek	Carolinian

Figure 1-1: Watershed Zones and (Sub) Watersheds of Credit Valley

No.	Name		
21a	Clearview Creek	21g - Moore Creek	22b - Cawthra Creek
21b	Avonhead Creek	21h - Lornewood Creek	22c - Applewood Creek
21c	Lakeside Creek	21i - Lakeshore East	22d - Serson Creek
21d	Sheridan Creek	21j - Tecumseh Creek	22e - Lakeshore West
21e	Turtle Creek	21k - Lakeshore East	22f - Lakeshore West
21f	Birchwood Creek	22a - Cooksville Creek	22g - Cumberland Creek

Figure 1-2: Watersheds of Credit Valley that drain directly in Lake Ontario

1.1.3 Stressors and ecosystem health

Stressors are defined as *the proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets* (Salafsky et al 2008). Stressors result in impacts and these in turn influence specific ecological attributes and associated ecosystem health. As

such, eliminating and mitigating stressors (and therefore impacts) is key to ameliorating and maintaining ecosystem health across CVC's jurisdiction.

The traditional or historic adverse impacts of stressors on ecological attributes and associated ecosystem health in CVC's jurisdiction are well documented including: habitat conversion, hydrologic alteration, habitat fragmentation, climate change, altered flood regime, turbidity/sedimentation, etc. (CVC 2011; ABL 2006). The SAB identified common stressors and associated relationships with one or more of the ecological attributes, emphasizing that each attribute may be affected by one or more stressors (Figure 1-3).

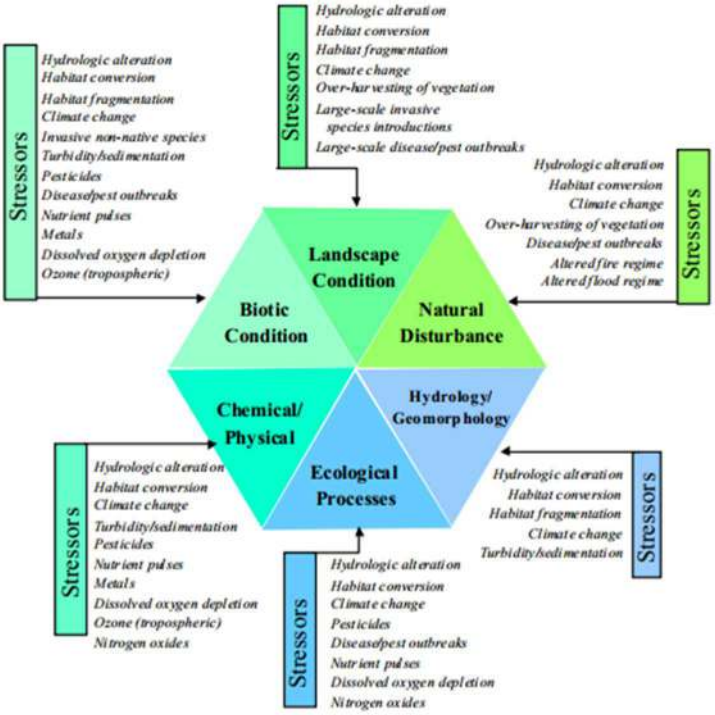

Figure 1-3 Sample stressors and the ecological attributes they affect
(US EPA 2002)

Although this phase of the IWRS does not explicitly identify or address specific stressors influencing individual catchments or (sub)watersheds, exploration of this possibility is included in Section 5: Recommendation #6.

1.1.4 <u>Restoration</u>

As noted in Section 1.1.1, protection of existing features and functions is the most cost-effective and efficient means of ensuring ecosystem health; however, restoration is critical where ecosystem health has been compromised. Restoration may be defined as the *process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed* (SER 2004).

Expanding on this definition, watershed restoration attempts to return an ecosystem to some historic conditions, with the spatial and temporal scales of intervention varying widely from one project to another. Frequently, reference ecosystems are used to guide the planning of the restoration; where the object of the restoration consists of multiple ecosystems, the reference may be referred to as a 'reference landscape'.

Classical management of natural ecosystems has typically focused on historic conditions as a 'reference landscape'; however, in cases where the historic range of variability in both abiotic and biotic drivers no longer exist, these approaches may not always translate to desired outcomes (Seastedt et al 2008; Palmer 2008; Hobbs et al 2014). Consideration of historical or reference conditions is an important starting point; however, restoration may require novel pathways in cases where the dynamics of the degraded system are very different from this desired state.

In the case of the Credit River and the other watersheds found in CVC's jurisdiction, while the pre-settlement vegetation was primarily a forested ecosystem, the majority of woodlands south of the Niagara Escarpment were cleared for agricultural purposes and settlement areas in the early to mid-1800s (CVC 2011). As such, in some instances, the landscape has been altered for close to 200 years and the extent to which the system and associated biota has readjusted is unclear.

These considerations are further compounded by directional shifts resulting from factors such as climate change, fire suppression, enhanced carbon dioxide, or atmospheric deposition of nitrogen, all of which push many systems outside of historical ranges of biophysical conditions (Seastedt et al 2008). Hobbs et al (2014) suggest that in some instances ecosystems may be pushed beyond their historical range of variability to such a degree that it may not be practical to either restore them to or maintain them at prior conditions.

Chapin et al (2006) proposed broad policy strategies to respond to these large directional changes:

1) foster human adaptability – recognizes the central role of human beings in social-ecological dynamics, and promotes learning and innovation to allow for adjustment to changes;
2) enhance resilience – strengthen negative feedbacks that buffer the system against change;
3) reduce vulnerability – increase adaptability and resilience, and make the system less sensitive to stressors; and,
4) enhance transformability – maximize diversity and adaptability, as key components of resilience, to allow for adaptive capacity to respond to anticipated changes.

Changes to one or more of the six ecological attributes identified by the SAB, will influence ecosystem health; however, it is important to recognize that change itself is a natural and important part of successional processes, resulting in the reference to

many systems as being in ‘dynamic equilibrium’. McCann (2000) defines two general categories of stability as: (1) dynamism; and (2) ability to defy change, otherwise known as “resilience” and “resistance”. Resilience is defined as the time required for a system to return an equilibrium following stochastic disturbance, and resistance is a measure of how much the system changes following a disturbance.

Rapport et al (1998) have defined a healthy ecosystem as one that is both ‘stable and sustainable’, and proposed three measures by which to evaluate this:

1) vigour: activity, metabolism, or primary productivity;
2) organization: diversity and number of interactions between system components; and
3) resilience: the capacity of a system to maintain structure and function in the presence of stress.

1.2 OBJECTIVES

Based on the above-noted considerations, the overarching objectives of the IWRS will be to place restoration priorities on those areas and disciplines that maximize both:

1. ecosystem health by reinstating stability in vigour and organization (resistance) and recovery (resilience) (CVC 2011), and
2. human health and safety by mitigating stormwater flows and degraded water quality (ABL 2006).

2 METHODOLOGY

An ongoing dilemma confronting ecosystem managers relates to the planning and prioritization of conservation actions given time and resource constraints as well as multiple (and often competing) goals. The tacit premise that motivates prioritization is the need for a more strategic rather than opportunistic approach, which can be expected to achieve restoration goals in a more efficient and effective manner.

It is important to note that the ecological attributes developed by the SAB are considered essential to supporting healthy (natural) ecosystems, whereas the IWRS is focused on the consideration of both natural and anthropogenic communities. It is acknowledged that human beings are an integral component of individual watersheds, so that a complete return to pre-disturbance levels is both impractical and unrealistic. A primary focus on reconstructing features and functions that falls within a range of greater health than current conditions can help to reconcile biological goals with socio-economic realities (Palmer 2008).

Using the SAB ecological attributes that support healthy ecosystems, four separate metrics were developed as broad surrogates to respond to identified attributes, with

the qualifier that both the water quality and water quantity metrics incorporate both condition and (anthropogenic) stressor indicators (Table 2-1). In giving the highest priority to those areas with the most significant stressors for these two metrics, they are in effect identifying these areas as the highest priority for conservation actions and this will assist in mitigating these stressors. Both Natural Heritage: Terrestrial and Wetland and Natural Heritage: Aquatic give the highest priority to those areas with relatively high existing ecological health, with a focus on preservation first and foremost.

Table 2-1: Metrics and Ecological Attributes

Metric	Ecological attribute (USEPA 2002)
Natural Heritage: Terrestrial and Wetland	Landscape and Biotic conditions
Natural Heritage: Aquatic	Landscape and Biotic conditions
Water Quantity	Hydrologic and geomorphic condition
Water Quality	Chemical and physical characteristics

2.1 METRICS AND CRITERIA

The following attributes were used to develop a ranking system for each of the four metrics:

1. Natural Heritage: Terrestrial and Wetland
2. Natural Heritage: Aquatic
3. Water Quantity
4. Water Quality.

The focus for Natural Heritage: Terrestrial and Wetland and Natural Heritage: Aquatic lies in managing for resilience; as such, the highest weighting is afforded to the conservation and restoration of larger ecosystems and healthier functioning ecological processes. Conversely, the focus for both Water Quality and Water Quantity lies primarily in mitigating effects on human health and safety.

Catchments receive a score for each metric based on the priorities within the catchment. The priorities are weighted to give priority 1 the highest weight and priority 5 the lowest weight.

> Score for catchment = ([(area of priority 1) * 5] + [(area of priority 2)* 4] + [(area of priority 3) * 3] + [(area of priority 4) * 2] + [(area of priority 5) * 1]) /Area of catchment[3]

For all metrics, catchment scores range from 1-5, with 5 being the highest priority numerically and the darker colour depicting the highest priority graphically, and are

[3] For Natural Heritage: Aquatic the score is based on priority lengths and the score is divided by total stream length within each subwatershed.

mapped using ArcGIS Explorer (dynamic mapping tool used for viewing data). All of the data are provided as a separate attachment (MS Excel).

2.1.1 Natural Heritage: Terrestrial and Wetland

The highest priority for terrestrial and wetland habitats includes an abundance of biodiversity, proximity to the Lake Ontario shoreline, and/or high functioning watercourses and water bodies and their buffers. The lowest priority includes all land beyond 120m of the Credit River Watershed Natural Heritage System (CVC 2011) (Table 2-2 and Figure 2-1).

Table 2-2: Natural Heritage: Terrestrial and Wetland Metrics

Natural Heritage: Terrestrial and Wetland	
Priority	Metrics
1	Centres of Biodiversity High functioning valleylands and their buffers High functioning watercourses and water bodies and their buffers Lake Ontario shoreline
2	High functioning woodlands outside those mapped in 1, and their buffers High functioning wetlands outside those mapped in 1, and their buffers
3	Supporting valleylands Supporting woodlands and their buffers Supporting wetlands and their buffers Supporting watercourses Supporting water bodies and their buffers
4	All lands within 120m of the CRWNHS
5	All lands beyond 120m of the CRWNHS

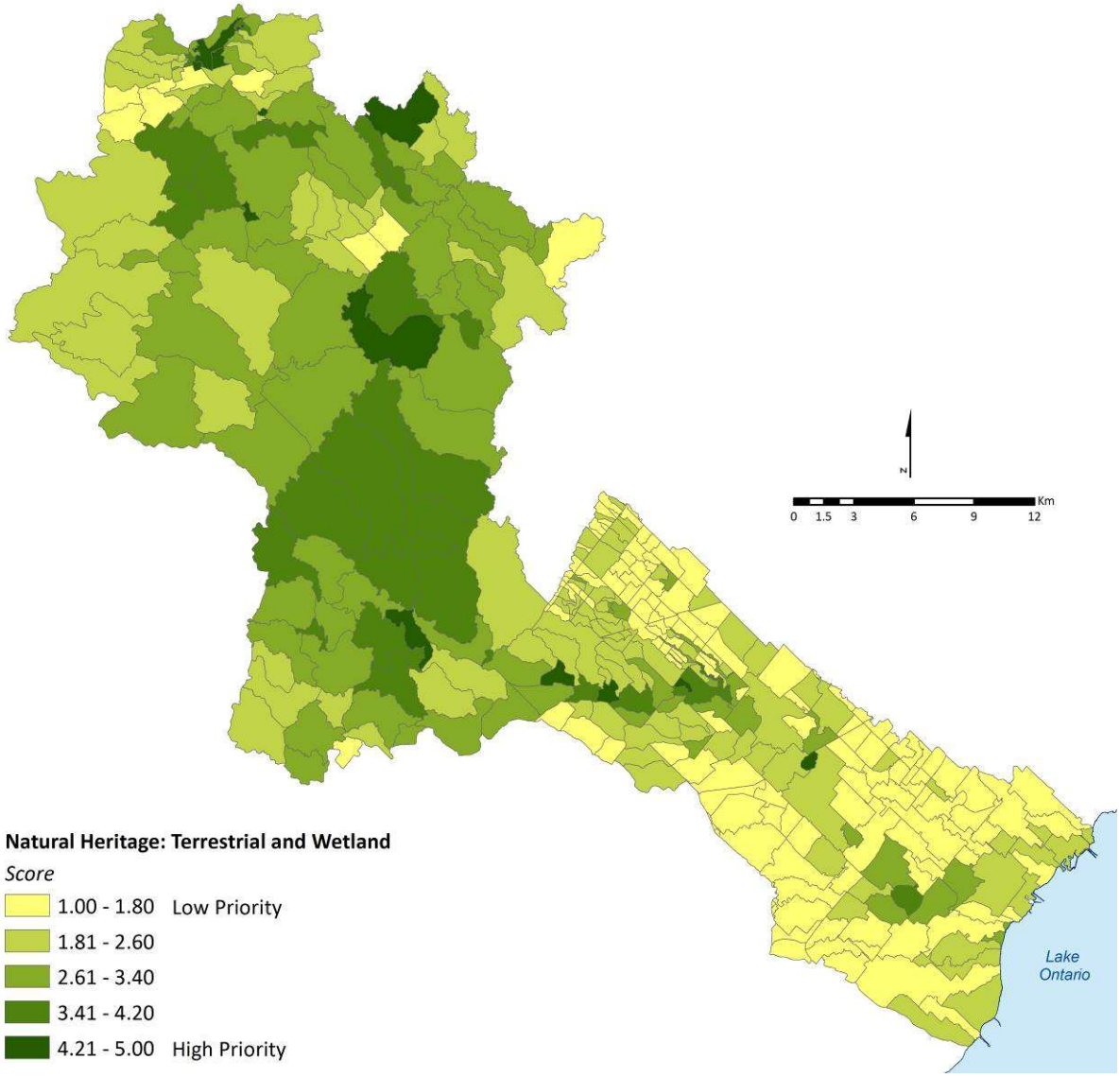

Figure 2-1: Natural Heritage: Terrestrial and Wetland

2.1.2 Natural Heritage: Aquatic

The aquatic metric was derived using a weighted score for each subcatchment. The following CVC datasets summarized below were used to derive the score for each subcatchment. Each of the metrics were normalized to fall within the range of 1-5 to match the IWRS methodology.

Metric by subcatchment	Weighting
Aquatic Health	25%
CVC Fisheries Management Zones	50%
Riparian Planting Priority	12.5%
Dam Mitigation Priority	12.5%

Table 2-3: Natural Heritage: Aquatic Metrics

Natural Heritage: Aquatic	
Priority	Metrics
1	Combined aggregated score between 4.01-5
2	Combined aggregated score between 3.01-4
3	Combined aggregated score between 2.01-3
4	Combined aggregated score between 1.01-2
5	Combined aggregated score between 0-1

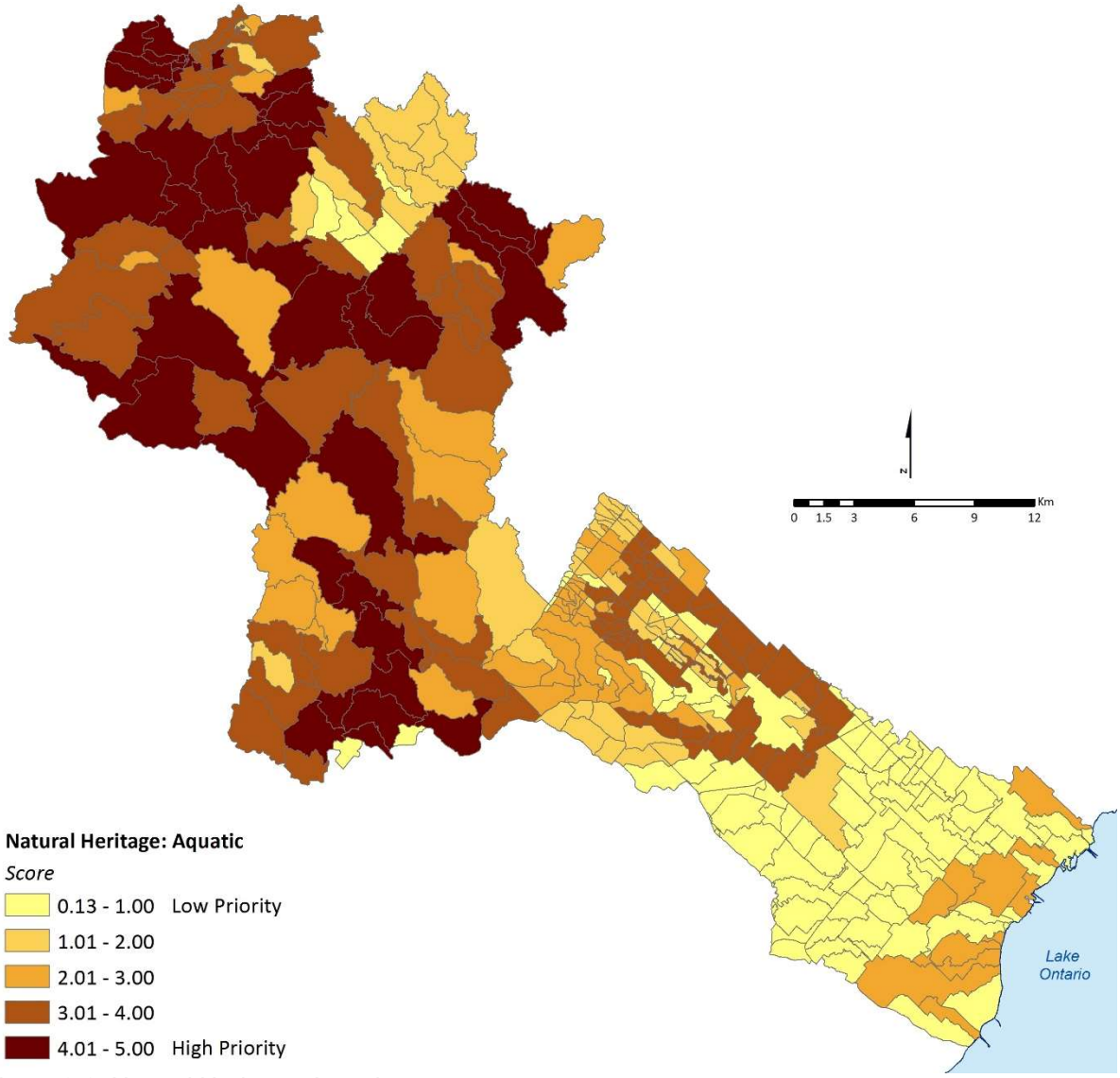

Figure 2-2: Natural Heritage: Aquatic

The highest priorities for aquatic habitats are based on: habitats of excellent health, good health streams adjacent to excellent health, and other good health streams or data deficient sites adjacent to excellent health. The lowest priority includes poor sites adjacent to excellent health, other data deficient or poor health streams (Table 2-3 and Figure 2-2). Segments are delineated based on habitat type and barriers to fish passage.

2.1.3 Water Quantity

Unlike the natural heritage metrics, restoration priorities for water quantity focus on the mitigation of flood and erosion hazards (that pose a threat to public safety) using land use and stormwater treatment as metrics. Urban land uses with no stormwater management ponds (SWMP) are given the highest priority since they will have the greatest impact on flooding and erosion due to higher impervious cover. Higher impervious cover is also well documented to affect baseflow and supported natural heritage features. On the other hand, agricultural land uses, natural areas and wetlands have much lower (or even positive in the case of natural / wetland areas) effects on water drainage; an attribute that classifies these features with lower restoration priorities (Table 2-4 and Figure 2-3; ABL 2006).

Table 2-4: Water Quantity Metrics

Water Quantity	
Priority	Metrics
1	Urban (No SWMP)
2	Urban (with SWMP)
3	Rural
4	Open Space, Agriculture, Aggregate
5	Natural, Wetlands

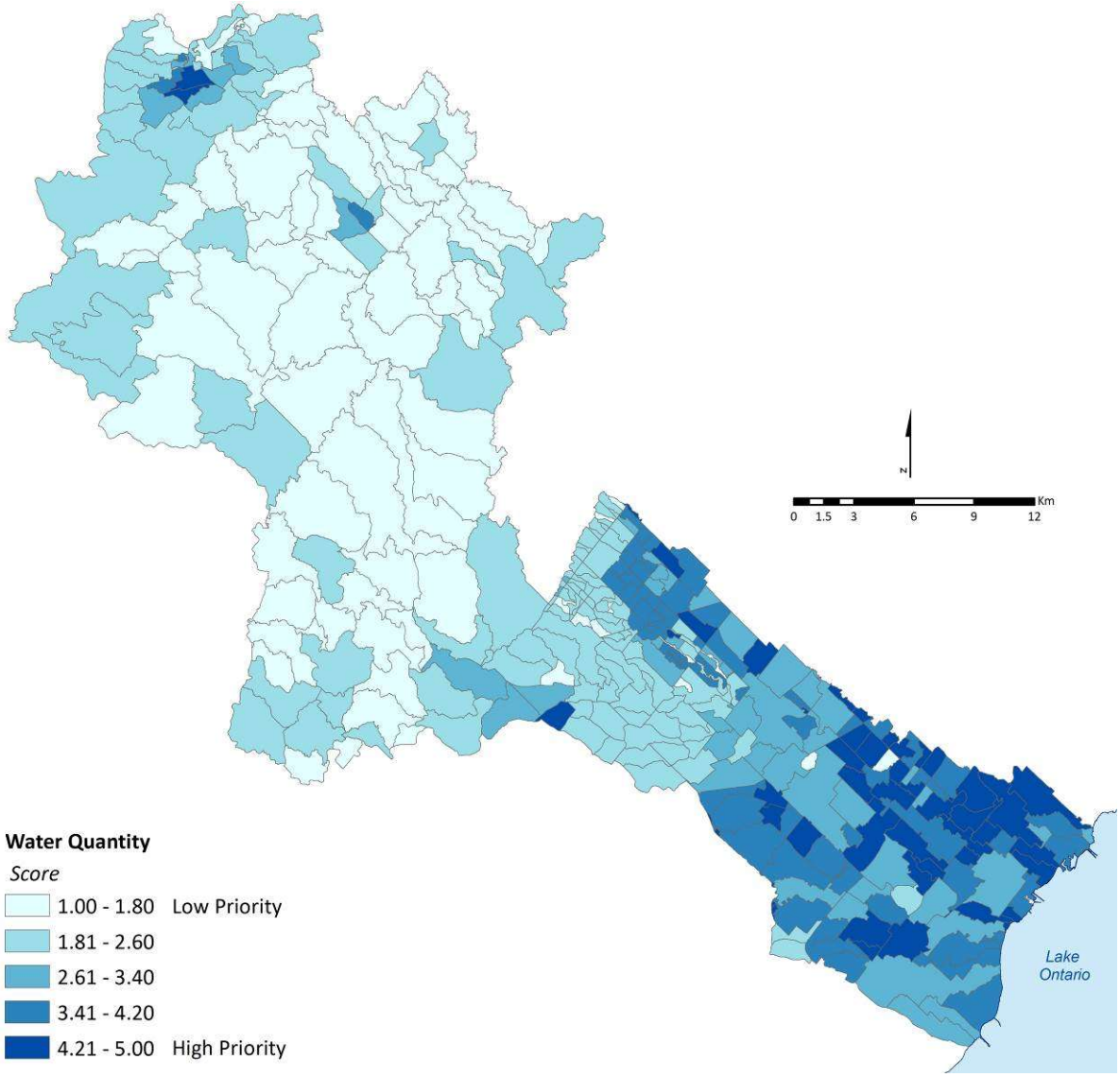

Figure 2-3: : Water Quantity

2.1.4 Water Quality

Restoration priorities for water quality focus on the mitigation of water quality impacts using land use and stormwater treatment as metrics. Urban land uses with no stormwater management ponds are given the highest priority due to direct runoff of associated contaminants resulting from higher impervious cover and lower buffering effects of natural cover. Agriculture is also given a high priority due to associated effects of contaminant runoff into adjacent surface – and ground- water bodies. (Table 2-5 and Figure 2-4; ABL 2006).

Table 2-5: Water Quality Metrics

Water Quality	
Priority	Metrics
1	Urban (No SWMP)
2	Agriculture
3	Urban (with SWMP), Aggregate
4	Open Space
5	Natural, Wetlands

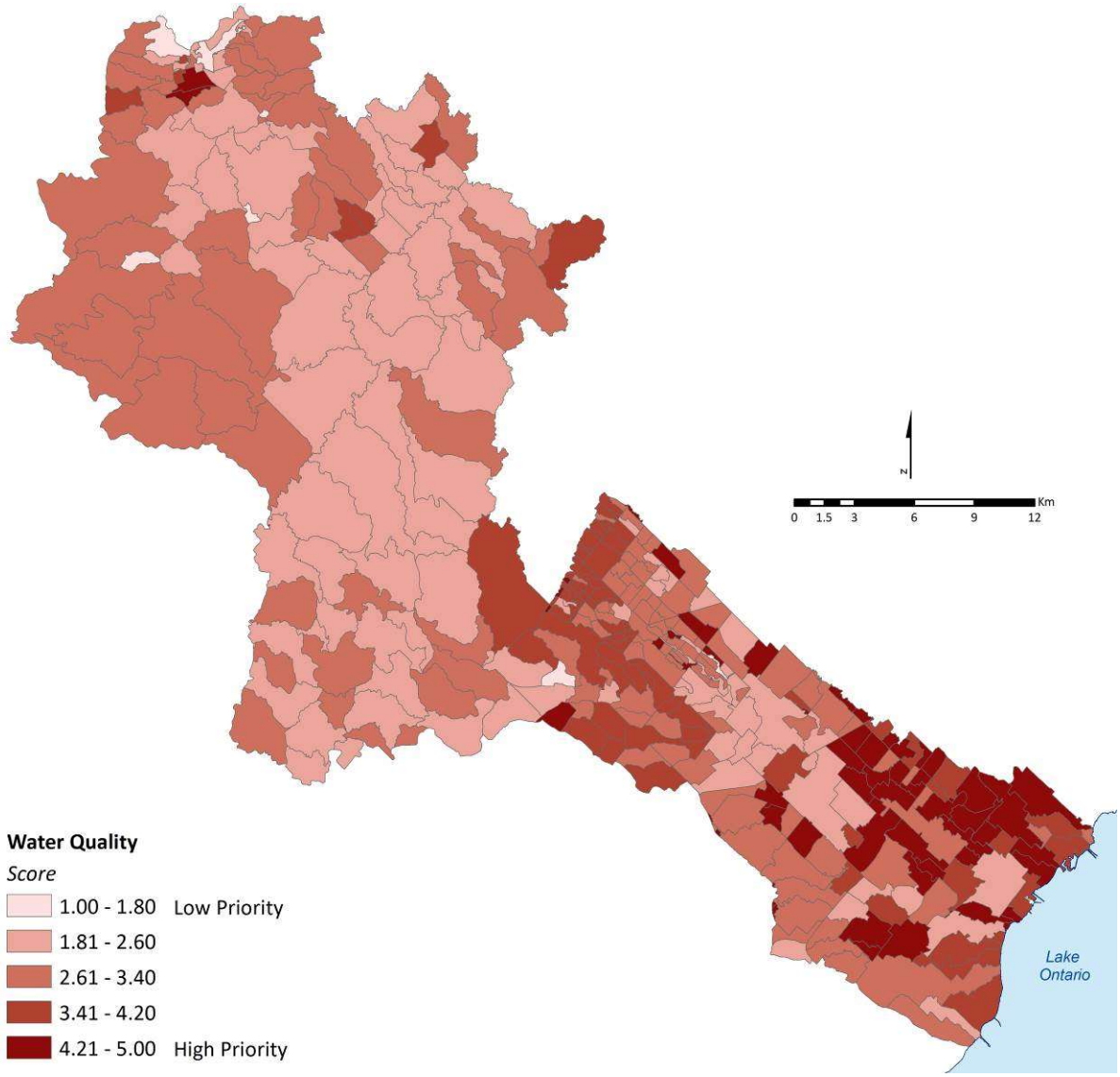

Figure 2-4: Water Quality

3 IMPLEMENTATION

In an ideal scenario, watershed restoration is a comprehensive, long-term, and adaptive process where conservation actions respond not only to identified priority areas and disciplines but also to contributing stressors at both the landscape and site level scales. The IWRS attempts to set out landscape scale priorities; however, decision-making must always factor both site-level and opportunistic considerations (e.g. landowner willingness, specific threats, cost efficiencies, etc).

Conservation actions are defined as:

"*Interventions undertaken by project staff or partners designed to reach the project's objectives and ultimate conservation goals. Actions can be applied to contributing factors, direct threats, or directly to the targets themselves. Conservation actions are roughly synonymous with strategies, interventions, activities, responses and measures"* (Salafsky et al 2007).

There are a large number and range of conservation actions available to improve watershed health, ranging from direct actions such as re-vegetation to land acquisitions to education and engagement, many of which are directly or indirectly undertaken by CVC (Appendix B). Direct conservation actions will assist in restoring and/or preserving healthy ecosystems by addressing declines in one or more ecological attribute, while outreach and education is an example of conservation actions that will address causative drivers and stressors. Ultimately, successful restoration will be contingent not only on mitigating the current degraded conditions, but also on addressing the drivers and stressors (both current and historic) that contributed to the decline.

3.1 SUBWATERSHED STUDIES

Section 2.1 identifies specific priority areas for individual metrics throughout CVC's jurisdiction, with individual subwatershed studies synthesizing more detailed information related to ecological attributes and stressors, and finally identifying priority conservation actions (Figure 3-1; ABL 2006; CVC 2015). Links to both completed subwatershed studies as well as summary priority conservation actions (excel spreadsheet) are embedded within the ArcGIS Explorer IWRS map for ease of reference by the user.

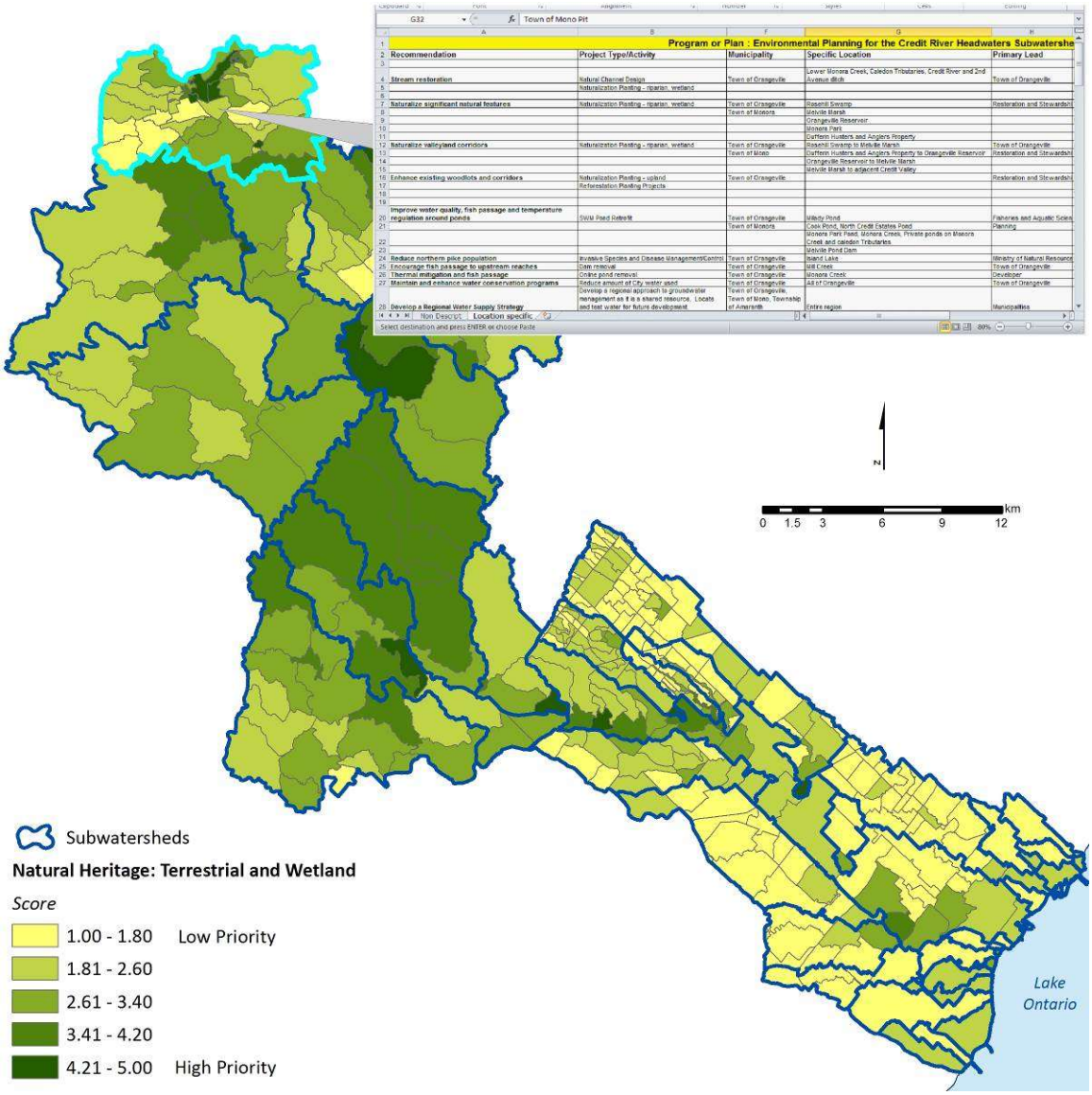

Figure 3-1 Sample Metric and Recommended Conservation Actions [4]

3.2 COMPLETED CONSERVATION ACTIONS

Additional layers of completed conservation actions by CVC are included in the ArcGIS IWRS map and can be activated by the user. This provides a quick indication of where and what types of conservation actions have been completed, and where additional effort is warranted. Figures 3-2 to 3-5 provide examples of the four metrics and related conservation actions, all of which can be selected and overlaid using ArcGIS Explorer.

[4] NB recommended conservation actions provided as sample only – not intended to be legible

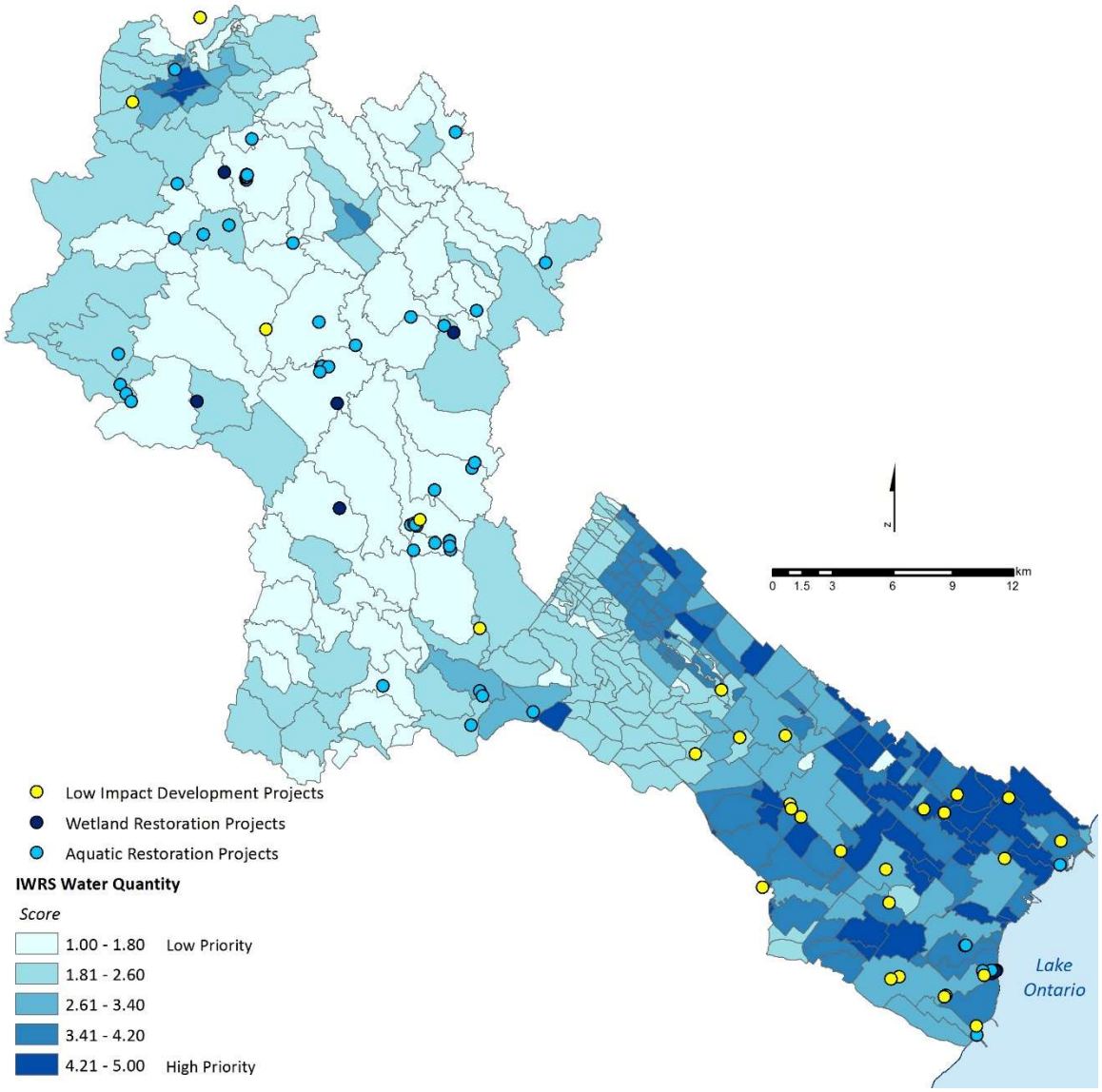

Figure 3-2 Sample (Water Quantity) Metric and Completed Conservation Actions

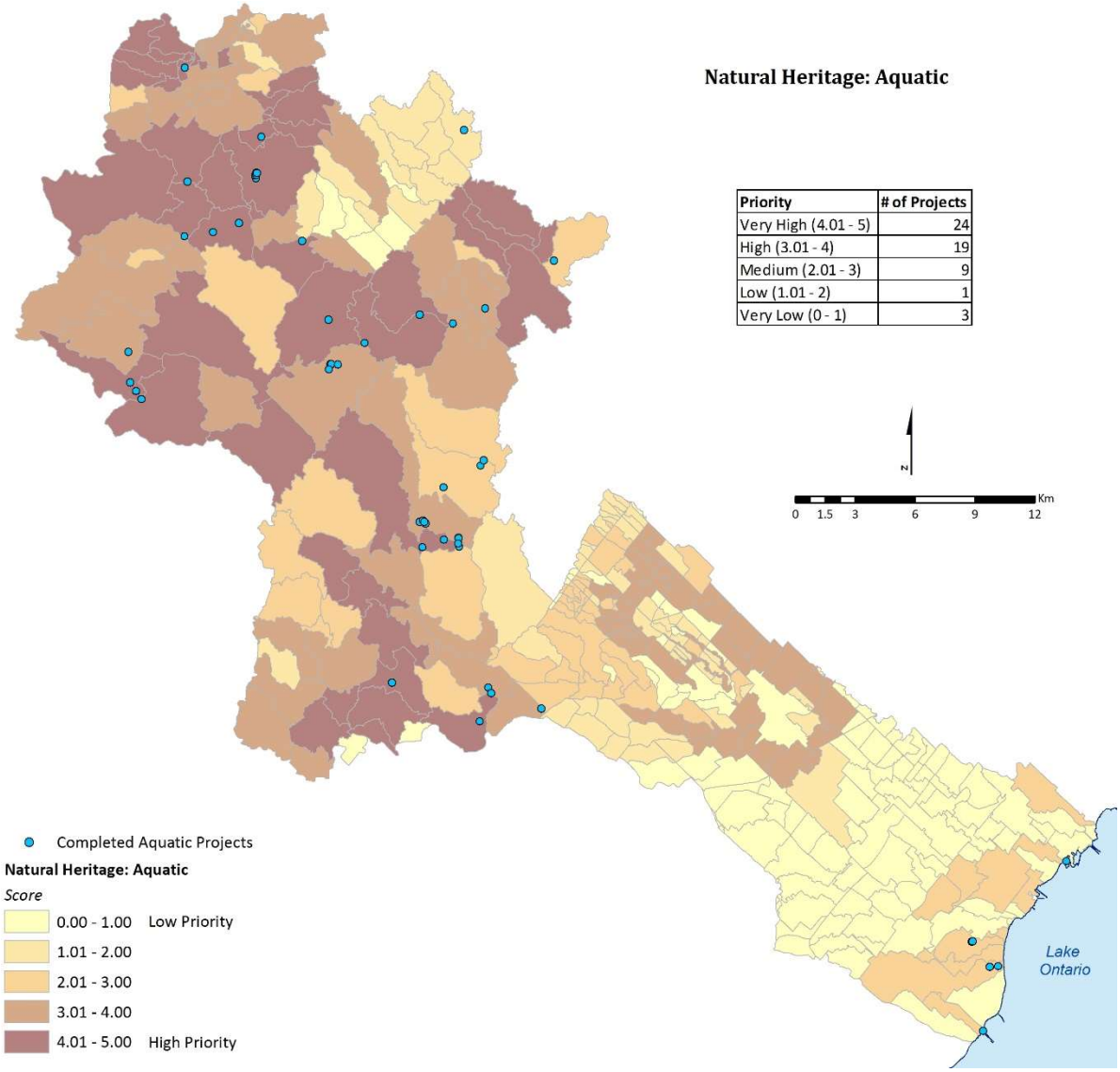

Figure 3-3 Sample (Natural Heritage: Aquatic) Metric and Completed Conservation Actions

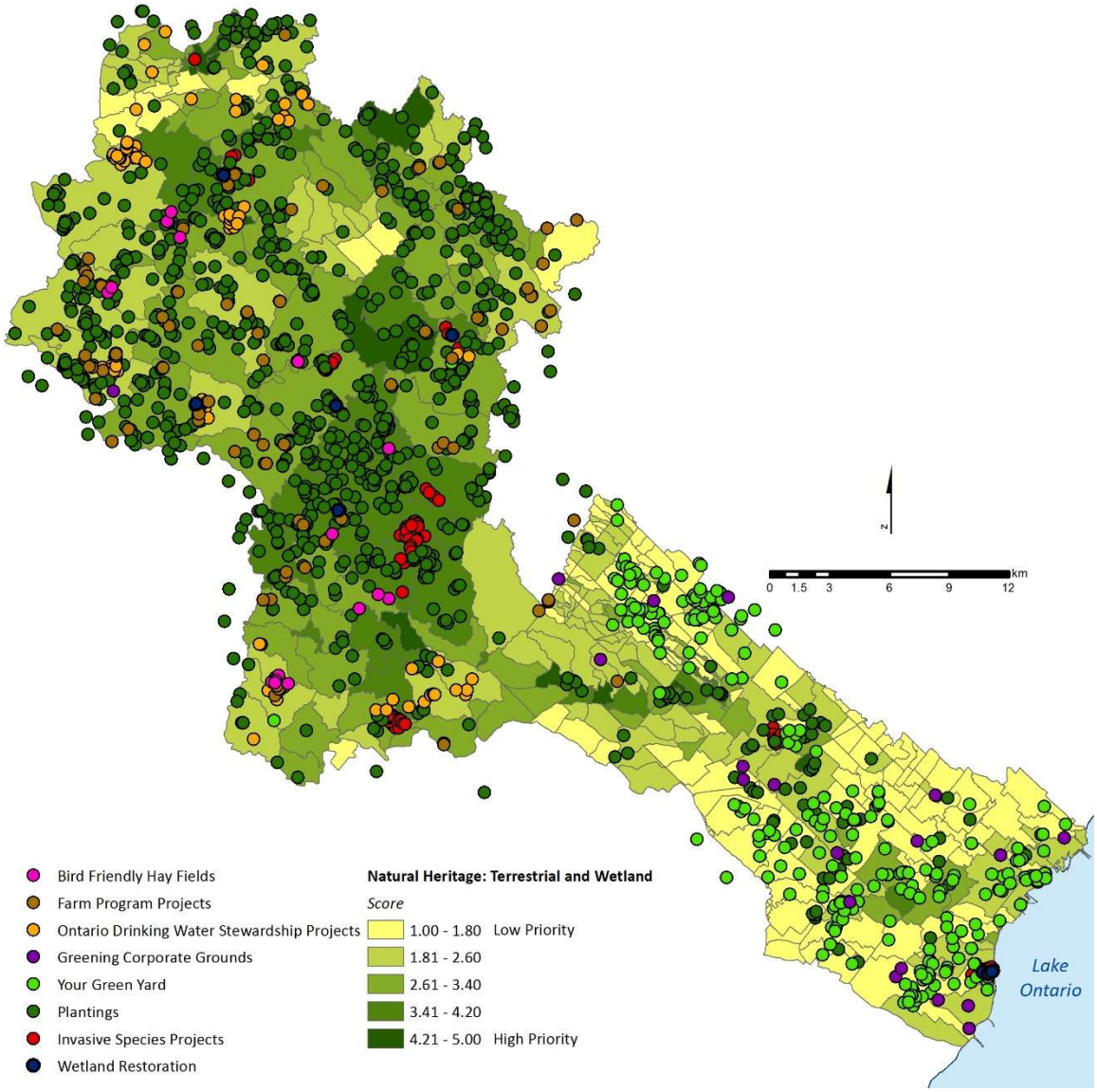

Figure 3-4 Sample (Natural Heritage: Terrestrial and Wetland) Metric and Completed Conservation Actions

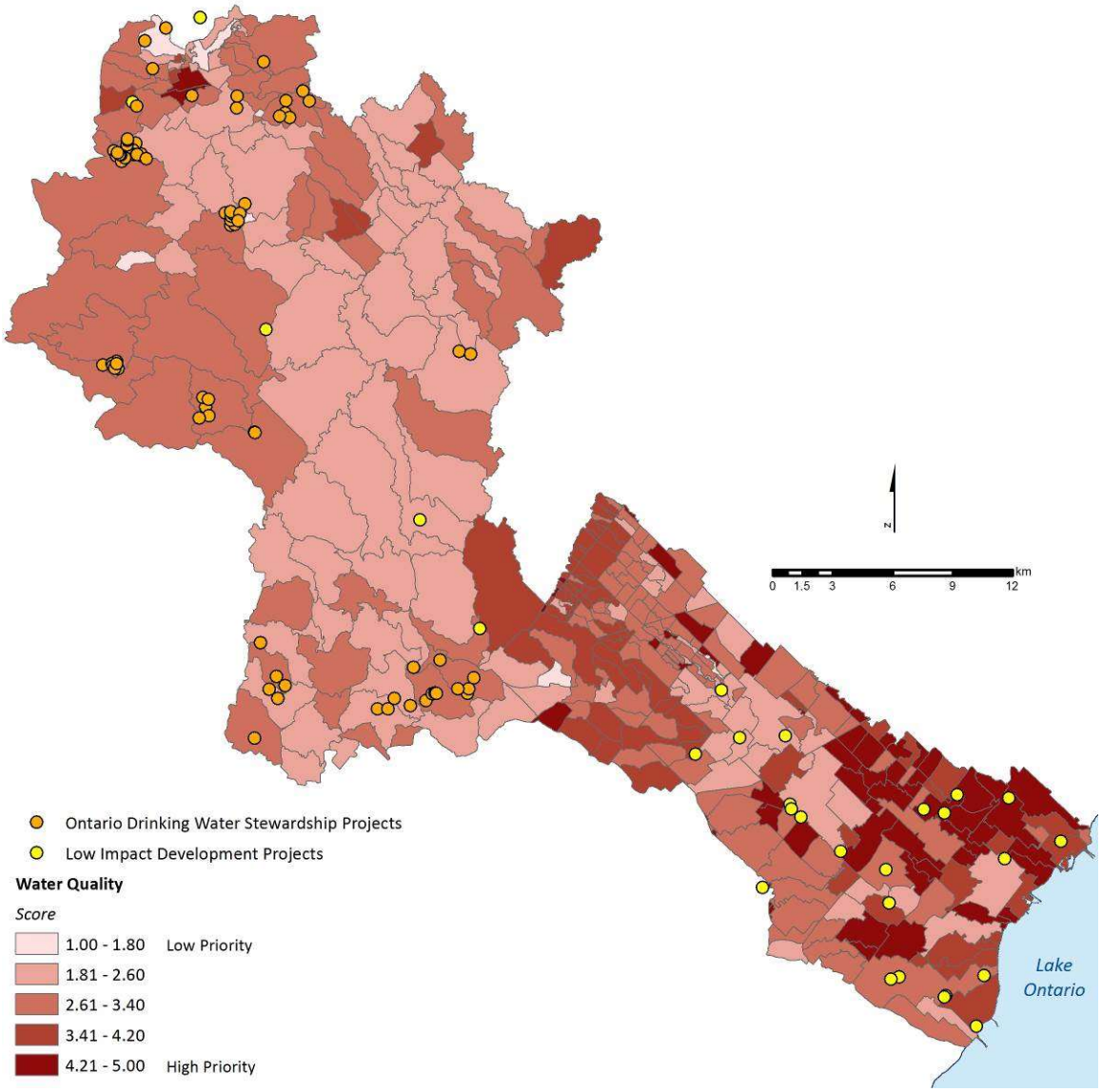

Figure 3-5 Sample (Water Quality) Metric and Completed Conservation Actions

3.2.1 Preliminary Analysis of Completed Conservation Actions

In order to better understand to what extent conservation actions completed by CVC are responding to identified priorities based on the four metrics, both the number and percent of conservation actions relative to metric priorities are summarized in Table 3-2 and Table 3-3. Generally, it can be assumed that the following conservation actions respond primarily to improvements in associated metrics:

Table 3-1: Conservation Actions and Associated Metrics

Conservation Action	Metrics			
	Natural Heritage: Terrestrial and Wetland	Natural Heritage: Aquatic	Water Quantity	Water Quality
Aquatic Projects	√	√	(√)	(√)
Wetland Projects	√	√	(√)	(√)
Bird Friendly Hay Fields	√			
Greening Corporate Grounds	√		(√)	(√)
Invasive Species Projects	√	√		
Ontario Drinking Water Source Protection		(√)		√
Planting (2008 - 2014)	√	√	(√)	(√)
Farm Program Projects	√	√	√	√
Your Green Yard	√		(√)	(√)
Low Impact Development		(√)	√	√

Using Aquatic conservation actions as an example, the majority of the projects are responding to Priorities 3 and 4 for most of the metrics, with a relatively high number responding to Priorities 4 and 5 for Water Quality and Water Quantity, respectively (Figure 3-6), suggesting that additional effort is warranted in targeting Priorities 1 and 2. It is important to consider that the IWRS priority areas are subdivided into catchments, where the Natural Heritage Strategy is more refined in its scoring. Using CVC's Natural Heritage Strategy as a basis, over 75% of Aquatic and Wetland conservation actions respond to highest priorities (Figure 3-7).

It is equally important to recognize that some conservation actions such as those completed under Your Green Yard and Greening Corporate Grounds would not be expected to respond to higher priorities identified for either NH: Terrestrial and Wetland or NH: Aquatic metrics since these programs are primarily undertaken in urban settlement areas with willing private landowners. The extent to which these programs respond to identified priorities may change as Section 5: Recommendation #2 is explored with refinements to the natural heritage metrics closer to the Lake

Ontario shoreline to reflect local scale priorities identified through CVC's Lake Ontario Integrated Shoreline Strategy.

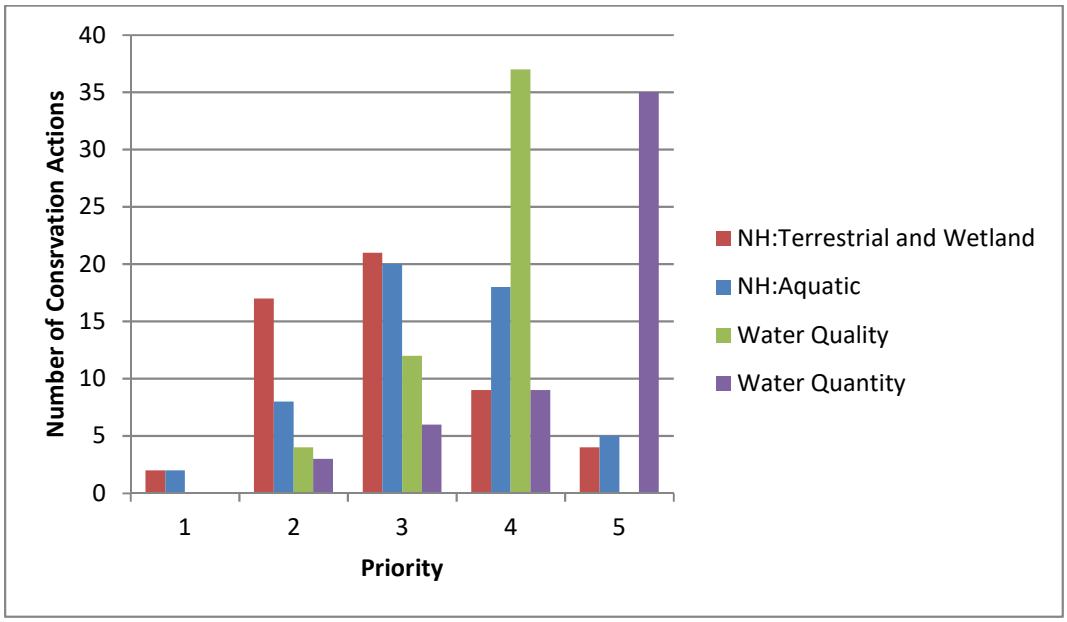

Figure 3-6 Aquatic Conservation Actions vs Metric Priorities

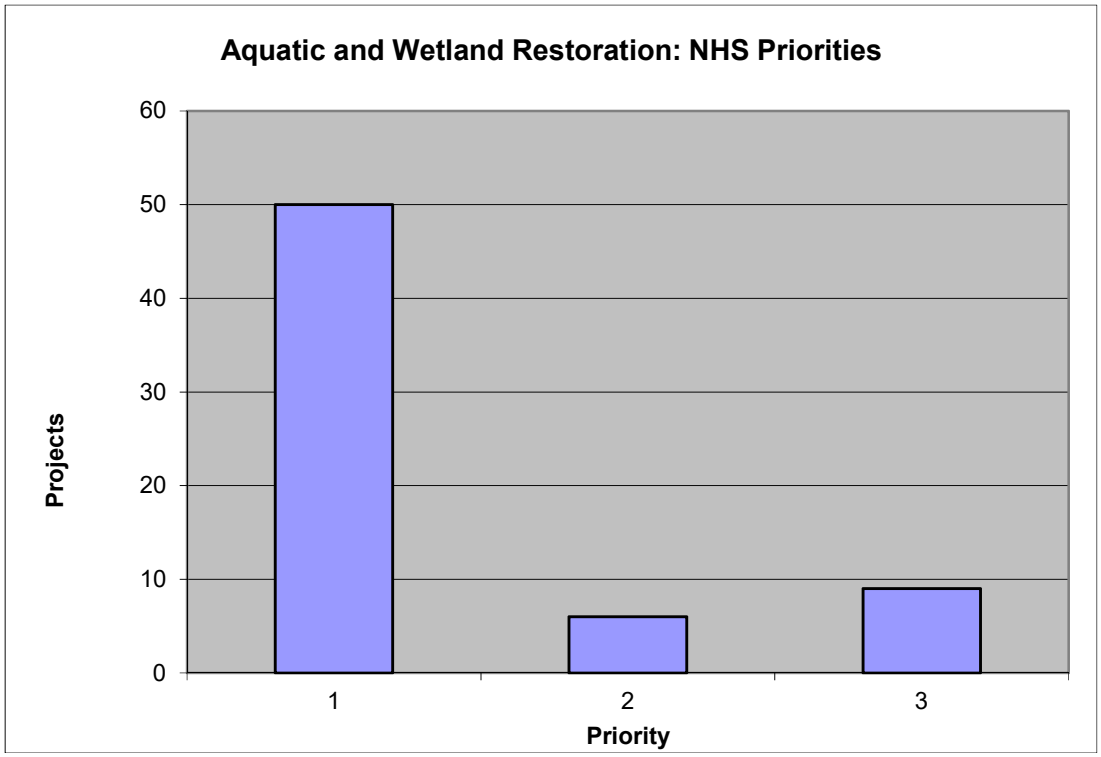

Figure 3-7 Aquatic Conservation Actions vs Natural Heritage Strategy Priorities

While the importance of pursuing opportunistic conservation actions throughout CVC's jurisdiction cannot be overstated in terms of encouraging landowner willingness and addressing broad level restoration and conservation initiatives, as

discussed in Section 1 and reflected in CVC's Strategic Plan, priority setting is critical to maximizing efficiencies and effectiveness. Section 5: Recommendation #7 is aimed at providing some guidance on next steps related to achieving this goal.

Table 3-2: Number of Conservation Actions relative to Metrics

	NH: Terrestrial and Wetland					NH: Aquatic					Water Quality					Water Quantity				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Wetland Projects	0	2	2	1	4	0	1	0	3	5	0	0	5	4	0	0	0	4	2	3
Aquatic Projects	2	17	21	9	4	2	8	20	18	5	0	4	12	37	0	0	3	6	9	35
Bird Friendly Hay Fields	0	6	4	7	0	2	5	1	8	1	0	0	9	8	0	0	0	0	2	15
Greening Corporate Grounds	0	0	0	10	9	0	0	1	3	15	3	7	5	4	0	2	6	9	2	0
Invasive Species Projects	1	25	47	9	17	0	20	17	43	19	0	0	19	80	0	0	0	26	5	68
Ont Drinking Water Source Protection	1	4	25	47	3	26	5	20	28	1	0	0	65	13	2	0	0	5	58	17
Planting (2008 - 2014)	5	65	108	76	24	32	58	42	100	46	9	7	109	151	2	9	14	20	72	163
Farm Program Projects	2	19	44	76	16	9	7	34	87	20	0	21	98	38	0	0	0	0	80	77
Your Green Yard	0	2	20	78	159	0	6	11	37	205	37	28	129	65	0	37	112	101	9	0
Low Impact Development	0	2	4	9	13	0	0	1	9	18	7	5	8	8	0	7	3	11	5	2

Table 3-3: Percent of Conservation Actions relative to Metrics

	NH: Terrestrial and Wetland					NH: Aquatic					Water Quality					Water Quantity				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Wetland Projects	0.0%	22.2%	22.2%	11.1%	44.4%	0.0%	11.1%	0.0%	33.3%	55.6%	0.0%	0.0%	55.6%	44.4%	0.0%	0.0%	0.0%	44.4%	22.2%	33.3%
Aquatic Projects	3.8%	32.1%	39.6%	17.0%	7.5%	3.8%	15.1%	37.7%	34.0%	9.4%	0.0%	7.5%	22.6%	69.8%	0.0%	0.0%	5.7%	11.3%	17.0%	66.0%
Bird Friendly Hay Fields	0.0%	35.3%	23.5%	41.2%	0.0%	11.8%	29.4%	5.9%	47.1%	5.9%	0.0%	0.0%	52.9%	47.1%	0.0%	0.0%	0.0%	0.0%	11.8%	88.2%
Greening Corporate Grounds	0.0%	0.0%	0.0%	52.6%	47.4%	0.0%	0.0%	5.3%	15.8%	78.9%	15.8%	36.8%	26.3%	21.1%	0.0%	10.5%	31.6%	47.4%	10.5%	0.0%
Invasive Species Projects	1.0%	25.3%	47.5%	9.1%	17.2%	0.0%	20.2%	17.2%	43.4%	19.2%	0.0%	0.0%	19.2%	80.8%	0.0%	0.0%	0.0%	26.3%	5.1%	68.7%
Ont Drinking Water Source Protection	1.3%	5.0%	31.3%	58.8%	3.8%	32.5%	6.3%	25.0%	35.0%	1.3%	0.0%	0.0%	81.3%	16.3%	2.5%	0.0%	0.0%	6.3%	72.5%	21.3%
Planting (2008 - 2014)	1.8%	23.4%	38.8%	27.3%	8.6%	11.5%	20.9%	15.1%	36.0%	16.5%	3.2%	2.5%	39.2%	54.3%	0.7%	3.2%	5.0%	7.2%	25.9%	58.6%
Farm Program Projects	1.3%	12.1%	28.0%	48.4%	10.2%	5.7%	4.5%	21.7%	55.4%	12.7%	0.0%	13.4%	62.4%	24.2%	0.0%	0.0%	0.0%	0.0%	51.0%	49.0%
Your Green Yard	0.0%	0.8%	7.7%	30.1%	61.4%	0.0%	2.3%	4.2%	14.3%	79.2%	14.3%	10.8%	49.8%	25.1%	0.0%	14.3%	43.2%	39.0%	3.5%	0.0%
Low Impact Development	0.0%	7.1%	14.3%	32.1%	46.4%	0.0%	0.0%	3.6%	32.1%	64.3%	25.0%	17.9%	28.6%	28.6%	0.0%	25.0%	10.7%	39.3%	17.9%	7.1%

4 MONITORING

CVC's Integrated Watershed Monitoring Program (IWMP, commenced in 1999; CVC 2015a) will continue to be used to assess status and trends across the jurisdiction. A *Monitoring Data Standards Document* summarizing all data collection, processing and management standards for all indicators under IWMP is currently being developed. IWMP will provide the necessary information to adjust future management priorities using the principles of Adaptive Environmental Management (AEM). This approach recognizes that ecosystems are dynamic and also allows for the incorporation of the most current data.

Site- and program- specific monitoring protocols have or are being developed and include protocols developed by:

- Aquatic and Wetland Ecosystem Restoration
    - Stream and Wetland Restoration Performance Monitoring (CVC 2014)
- Terrestrial Ecosystem Restoration and Management
    - Planting Programs: Effectiveness Monitoring
    - Invasive Species Photo Monitoring
    - Grassland Restoration: Effectiveness Monitoring (in development)
- Water Resources Management and Restoration
    - Low Impact Development: Quality Assurance Protocol (in development)
- Various other program-specific protocols are under development to assess program effectiveness.

These data will be used to improve both programmatic approaches to conservation actions as well as enhancing the IWMP dataset using an adaptive approach to management.

5 RECOMMENDATIONS AND CONCLUSIONS

The IWRS is designed to be updated regularly to respond to biophysical, chemical, and socio-political changes in CVC's jurisdiction with the following recommendations from the Steering Committee:

1. Identify individual staff from each section in CVC to create new Steering Committee tasked with ensuring annual updates to the IWRS ArcGIS Explorer mapping product to reflect both state of the science and completed conservation actions;
2. Refine the Natural Heritage: Terrestrial and Wetland and Natural Heritage: Aquatic metrics to reflect local level priorities identified by CVC's Lake Ontario Integrated Shoreline Strategy (LOISS);
3. Refine Natural Heritage: Aquatic metric through the future CVC Stream Rehabilitation and Climate Change Adaptation Strategy which will include

additional analyses and prioritization based on thermal mitigation, dam mitigation and species guild or species at risk.

4. Digitize sewershed mapping and use to refine Water: Quantity metric to reflect local priorities identified by LOISS;
5. Review municipal capital plans to identify additional priorities and partnership opportunities;
6. Explore development of Stressor layer(s) to refine priorities for conservation actions;
7. Undertake more detailed analysis of findings in *Section 3: Completed Conservation Actions* to help inform more targeted approaches to conservation actions that respond to high priorities identified by individual metrics. Ultimately, this exercise could be extended to include the extent to which conservation actions are responding to stressors identified as part of additional recommended conservation actions; and,
8. Compile digital information related to tributary reach treatments building on LOISS criteria and work completed in late 1990s by CVC. Use to inform conservation actions and link to Peel Channel Remediation Study.

As a landscape-scale analysis, the IWRS provides a high level overview of regional priorities; however, decision-making related to conservation and restoration must always take into consideration other factors at the local and broader lakewide level. Coordination with other relevant initiatives such as those outlined in Appendix A and discussed in Section 1 will also promote additional efficiencies.

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APPENDIX A: OTHER RELEVANT SUPPORTING INITIATIVES

Federal - Provincial

Great Lakes Water Quality Agreement

Lake Ontario Lakewide Management Plan (LaMP) – priorities (2013)

- implementing the Biodiversity Conservation Strategy
- 2013 binational Cooperative Science and Monitoring Initiative study
- understanding nutrient cycling in the lake and reducing nutrient runoff

Binational Conservation Strategy for Lake Ontario – Credit Action Site

- targeted land securement
- complete management plans for public lands
- restore stream buffers and wetlands to reduce peak flows
- design standards for new development to restore water balance
- watershed planning for corridors for species movement in response to climate change
- explore 'soft engineering' solutions for shoreline hardening
- reduce phosphorus loadings through BMPs and stream buffers

Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health

- Protecting Waters
  - Nutrients – Improve the health and productivity of the Great Lakes ecosystem and economy by obtaining a sustainable level of nutrients. This long-term goal is attainable with investments in:
    - nutrient related research and monitoring;
    - **green infrastructure**;
    - development in wastewater technologies and facilities; and
    - **improvements in urban and rural land use and land management practices.**
  - Harmful Pollutants – Establish a process to identify Chemicals of Concern in the Great Lakes. Use chemical research, monitoring, surveillance and risk management practices to reduce risk and impacts of environmental degradation caused by contaminated water.
- Improving Wetlands, Beaches and Coastal Areas
  - Areas of Concern (AOCs) – Community members and the local government are putting into effect the Remedial Action Plans (RAPs) to recover beneficial uses within the AOCs. Despite considerable progress, the remaining Canadian and binational AOCs require continued efforts to delist the remaining AOCs by completing priority actions, make significant progress towards reducing microbial and other contaminants and excessive nutrients and implement environmental monitoring.

    - Lakewide Management – advance restoration, protection, and conservation by cooperation between domestic and binational jurisdictions and the Great Lake Community. Through the Lakewide Action and Management Plans, manage lakewide ecosystems conditions and threats. Nutrients, Areas of Concern, Habitat and Species, and Harmful Pollutants are impactful of the health of the Great Lakes; therefore they can help support ecosystem objectives of Lakewide Management.
- Protecting Habitat and Species
    - Aquatic Invasive Species – Provincial regulations are implemented in order to reduce the threat of aquatic invasive species by providing rules and standards in order to improve water quality and ecosystem health. Increase awareness and education within the Great Lakes Community to prevent the spread and new occurrences of aquatic invasive species.
    - **Habitat and Species – Support strategic conservation planning initiatives such as the Biodiversity Conservation Strategies to recognize actions that needed to be taken to recover and protect native biodiversity.** The Lakewide Action and Management Plans are used to report progress and identify the required resources to conserve native species and their habitats.
- Enhancing Understanding and Adaptation
    - Groundwater Quality – Linked to the successful outcome of Areas of Concern, Lakewide Management, Harmful Pollutants, Nutrients, and Habitats and Species. Cooperation with groundwater research and monitoring to enhance understanding of identification and assessment of groundwater stressors and impacts on Great Lake Water Quality and Ecosystem Health**. Identify priority areas where point sources may directly affect the quality of the water and ecosystem of the Great Lakes.**
    - Climate Change Impacts – Affects various aspects of the Great Lakes; physical, chemical and biological. Improving our understanding of climate change impacts can help improve our management practices and strategies in order to help communities take action in reducing the effects of climate change on our ecosystems. Communicating to the public about developments in science and sharing expertise helps promote an understanding in order to advance action.
- Promoting Innovation and Engaging Communities
    - Promoting Innovation – The Great Lakes are a tourist destination where there is an aesthetic appreciation of the diverse landscapes and the National and Provincial Parks. Also, water and wastewater is the largest environmental sector in Ontario and driving 40% of Canadian economy. Promoting

innovation will build the capacity in the water and wastewater sector and improve ecosystem goods and services, and inspire maintainable tourism and recreation.

- Engaging Communities – Very few citizens that reside in the Great Lakes basin are aware of the connections between their actions and the health of the lakes. Canada and Ontario are implementing initiatives to **increase awareness, appreciation and engagement in order to obtain support from the community through various activities pertaining to planning, priority setting, problem solving and stewardship.**

Great Lakes Protection Act (Consideration by Standing Committee)
And *Ontario's Great Lakes Strategy*

- To protect human health and well-being through the protection and restoration of the ecological health of the Great Lakes-St. Lawrence River Basin.
- **To protect and restore wetlands, beaches, shorelines and other coastal areas of the Great Lakes-St. Lawrence River Basin.**
- **To protect and restore the natural habitats and biodiversity of the Great Lakes-St. Lawrence River Basin.**
- **To advance science relating to existing and emerging stressors, such as climate change, that improves understanding and management of the Great Lakes-St. Lawrence River Basin.**
- To enrich the quality of life in communities in the Great Lakes-St. Lawrence River Basin through support of environmentally sustainable economic opportunities, innovation and environmentally sustainable use of natural resources.

Climate Ready: Ontario's Adaptation Strategy and Action Plan

Goal 1: Avoid Loss and Unsustainable Investment and Take Advantage of New Economic Opportunities

- Action 3: Promote Water Conservation
  - Applying proactive solutions that encourage groundwater infiltration of stormwater, such as increasing permeable surfaces in built-up areas
  - The Ministry of the Environment is also proposing to partner with municipalities to develop an approach for sustainability planning for water, stormwater and wastewater taking into consideration projected climate change impacts
- Action 6:Undertake Infrastructure Vulnerability Assessments
  - The Expert Panel recommended the Province undertake vulnerability assessments for representative asset types and geographical locations to better understand the climate change risks to physical infrastructure
- Action 9: Integrate adaptive solutions into drinking water management

        - Stormwater management systems may need retrofitting as storms and heavy rainfall increase
    - Action 10: Develop guidance for stormwater management

    Goal 2: Take all reasonable and practical measures to increase climate resilience in ecosystems
    - Action 16: Conserve biodiversity and support resilient ecosystems
    - Action 18: Build adaptation into the Great Lakes agreements

    Goal 4: Achieve a better understanding of future climate change impacts across the province
    - Action 31: Enhance climate-related monitoring

Ontario Biodiversity Strategy And *Government Plan to Conserve Biodiversity* (2012-2020)
- Mainstream biodiversity by incorporating biodiversity considerations into decision-making across the province, in different sectors and in our homes, workplaces and schools.
- **Protect, restore and recover Ontario's genetic, species and ecosystem diversity and related ecosystem functions and processes.**
- Use Ontario's biological assets sustainably.

Four Strategic Directions identified in OBS with strategic directions identified in Government Plan:
- Engage People
- **Reduce Threats**
- **Enhance Resilience**
    - Promote landscape-level conservation planning
    - Promote and support the development of urban biodiversity and green infrastructure strategies
    - Assess species and ecosystem vulnerability to climate change, and integrate vulnerabilities into decision-making
    - Protect species diversity
    - Develop and implement tools to maintain and enhance habitats and ecosystem services
- Improve Knowledge
    - Establish a long-term biodiversity monitoring system

Planning Act: Provincial Policy Statement
Under the provincial Planning Act, conservation authorities provide input and technical advice, with the Provincial Policy Statement stating that:

> *Planning authorities shall protect, improve or restore the quality and quantity of water by:*
> *a) Using the watershed as a meaningful scale for planning*

b) *Identifying surface water features, ground water features, hydrologic functions and natural heritage features and areas which are necessary for the ecological and hydrological integrity of the watershed*
c) *Maintaining linkages and related functions among surface water features, ground water features, hydrologic functions and natural heritage features and areas.*

Regional - Municipal

Peel Climate Change Strategy

- Proactive and responsive planning and leadership
  - *Address water, natural heritage and land management issues related to climate change through integrated watershed management*
- *Targeted and Proactive Adaptation Actions*
  - *Undertake specific initiatives, such as implementing best practices related to urban forestry, which are intended to maintain and restore natural habitats, trees and naturalized spaces within the urban system*
  - *Work with the farming community to better understand and address climate change impacts*
  - *Building on existing programs, implement additional water quality and water and wastewater conservation strategies and incentives*

Municipal Official Plans
CVC completed a review of existing natural heritage strategy planning policies, with the findings summarized in Usher (2012). General findings were that most NHSs go beyond the minimum requirements of the Provincial Policy Statement, and that lower-tier municipalities tend to be more restrictive with respect to development than upper-tier municipalities.

Credit Valley Conservation

Subwatershed Studies

For several decades, CVC has developed or assisted in the development of a number of watershed and subwatershed scale studies aimed at identifying priority restoration needs (ABL 2006). The Lake Ontario Integrated Shoreline Strategy is following the intent of the subwatershed studies. Recommendations range from tree planting to stormwater pond retrofits, all designed to address identified threats and to restore ecosystem resilience and sustainability. In addition to what might be considered traditional restoration, recommendations also address retrofits to existing infrastructure as well as rehabilitation of damaged sites and enhancement of existing areas. Completed subwatershed studies are found here: http://www.creditvalleyca.ca/watershed-science/our-watershed/subwatershed-studies/

Credit River Water Management Strategy and Update

The *Credit River Water Management Strategy (CRWMS): Phase I* was completed in 1990, with *Phase II* being written in 1992 (Triton Engineering Ltd 1990; Beak Consultants Ltd 1992). Recommendations emerging from Phase II included the development of subwatershed studies.

In 2007, CRWMS was updated to "*develop a management strategy for the watershed to ensure safe, abundant, clean water for environmentally, socially, economically healthy communities within the Credit River watershed*". The CRWMS Update provides a comprehensive summary of watershed related initiatives completed since CRWMS Phases I and II, an overview of existing conditions within the watershed, potential future land use scenarios, and a description of the recommended management alternative and a proposed implementation framework. Potential best management practices in both urban and rural areas are summarized: http://www.sustainabletechnologies.ca/wp/wp-content/uploads/2013/02/crwms07execsum.pdf

Conservation Areas Strategy and Greenlands Securement Strategy

In 1994, a *Conservation Areas Strategy* was developed that set out ambitious targets for land securement and led to the development of the *Greenlands Securement Strategy* in 2004. The *Greenlands Securement Strategy* is science-based and uses prioritized criteria to identify significant conservation lands for protection. The Strategy sets a goal for securement of an additional 5,670 hectares (14,011 acres) of key priority greenlands over a 20 year timeframe. CVC staff have recently identified the need to accelerate the land securement program and to set a new 10 year timeframe for the same goal. This need has been dictated by opportunities and the urgency to secure high priority lands in the Credit River watershed.

The criteria used within the *Greenlands Securement Strategy* ranked all greenlands found within the Credit River Watershed (34,692 hectares) in relation to both terrestrial and water based functions. More specifically, landscape-scale terrestrial and aquatic sensitivity (fisheries), and source water protection (groundwater recharge) measures were used. Credit Valley Conservation (CVC) identified 14,588 hectares of Priority Greenlands for Securement. Greenlands were required to meet high scores for one or more of the following criteria:

1. Representative within their physiographic region
2. Comprise part or all of a major corridor
3. Comprise part of the regional trail system
4. Identified as a key access area to the Credit River fishery
5. Enhance or protect the value of existing public land
6. Comprise part of a bioregional corridor
7. Comprise part of the Credit River valley or Lake Ontario shoreline

8. Maintain or enhance community connections.

Individual Landowners: Conservation Planning

Since 1987, CVC staff have been working with individual landowners to develop site-specific Conservation Plans aimed at assessing existing conditions, and highlighting restoration opportunities. A total of 95 Conservation Plans were developed by CVC on behalf of landowners. In 2007, the Conservation Planning Program was replaced by the "Your Guide to Caring for the Credit" initiative. The guide itself is available by participating in a free workshop that introduces various concepts related to managing a rural property from septic systems to forest management, energy conservation and construction activities.

Conservation Areas: Management Plans

Management Plans are aimed at guiding the development and management of natural and social resources in conservation areas. Detailed information regarding natural heritage features and functions, existing infrastructure, and past and present recreational uses are summarized in the reports. This information is used as a basis for defining goals, objectives, classification, and zoning.

Management Plans must be updated every five years and there are currently two active plans:

1. Terra Cotta-Silver Creek Complex Management Plan (2008)
2. Island Lake Management Plan (1997; addenda 2005).

Three additional management plans are currently being developed in 2015 for:

1. Upper Credit Conservation Area
2. Ken Whillans Resource Management Area
3. Belfountain Conservation Area.

Over the next few years, management plans will be developed for Limehouse CA and Cataract Hills CA (ie. Pinchin Pit).

Wetland Restoration Strategy

CVC's Wetland Restoration Strategy applies to the Credit River watershed and to each its 20 subwatersheds, and to the 14 additional watersheds that drain directly into Lake Ontario and identifies both existing wetlands and priority areas for restoration. The Strategy is aimed at guiding wetland restoration efforts to meet subwatershed and watershed goals and objectives. The report focuses not only on a strategy for wetland restoration and rehabilitation, but also on the sensitivity of wetlands to climate change (Dougan et al 2009).

Water Quality Strategy

The *Water Quality Strategy for the Credit River* was developed to better characterize the effects of land use changes, agricultural uses, and aggregate extraction activities (TSH et al 2003). The study investigated water quality conditions and associated influencing factors, and also proposed various management options. Over thirty parameters of concern were identified, and then shortlisted to a total of 10, based on their relevance to watershed-wide issues, and ability to define cumulative and longterm impacts:

1. flow regime
2. water temperature
3. nitrates
4. total phosphorus
5. dissolved oxygen
6. chloride
7. metals (Ni, Cu, Al, Zn, Fe)
8. organic (representative pesticide or industrial organic)
9. bacteria
10. suspended solids.

Natural Heritage Strategy

The Natural Heritage Strategy (NHS) for the Credit watershed was initiated in 2006. Natural and semi-natural features of the watershed were assessed using a Landscape Scale Analysis (LSA) in terms of their relative importance in contributing to ecosystem functions using a science-based, systems approach.
Future work will focus on developing a NHS that will improve existing conditions by identifying opportunities for stewardship, restoration, protection, or securement that will maintain, restore, and enhance biodiversity and ecosystem functions throughout the watershed.

Integrated Watershed Monitoring Program

The *Integrated Watershed Monitoring Program* (IWMP) monitors water quality, water quantity, biological diversity, and biological productivity of the Credit River watershed. It measures a range of parameters all aimed at better understanding overall trends in ecosystem health. CVC has established over 150 IWMP stations within the Credit River watershed.

Sourcewater Protection

The *Proposed Assessment Report: Credit Valley Source Protection Area* was produced under the direction of the CTC (Credit Valley, Toronto and Region, Central Lake Ontario conservation authorities) Source Protection Region (2014). This draft report identifies the location and nature of potential threats to sources of municipal

drinking water. Four types of vulnerable areas are identified and vulnerability scores are applied to all of the following:

1. intake protection zones (IPZs);
2. highly vulnerable aquifers (HVAs);
3. significant groundwater recharge areas (SGRAs); and
4. wellhead protection areas (WHPAs).

The Source Protection Plan (SPP) will then identify the necessary actions to reduce, manage, or eliminate threats to these vulnerable areas.

Credit River Fisheries Management Plan

The *Credit River Fisheries Management Plan* (CRFMP) was developed to guide the protection and enhancement of aquatic natural heritage features and functions within the Credit River watershed. The following goals and objectives are set out:

Goal
..to have healthy aquatic ecosystems that provide long-term benefits to help satisfy society's need for a high-quality environment, wholesome food, employment and income, recreational activity, and cultural heritage.

Objectives
1. Protect healthy aquatic ecosystems;
2. Rehabilitate degraded ecosystems; and
3. Improve cultural, social and economic benefits form the aquatic resources of the Credit River watershed.

The CRFMP sets out various community zones including: coldwater; mixed cool/cold; mixed warm/cool; and, warmwater, as well as a series of priority strategies and tactics for implementation (MNR and CVC 2002).

APPENDIX B: CVC CONSERVATION ACTIONS[5]

AWER = Aquatic and Wetland Ecosystem Restoration
CO = Community Outreach
CL = Conservation Lands
ED = Education
LO = Landowner Outreach (Urban and Rural)
TRM = Terrestrial Restoration and Management
WRMP = Water Resources Management and Protection

Broad Category	Conservation Action	CVC Program Lead						
		AWER	CO	CL	ED	LO	TRM	WRMP
Conservation Lands	Option to Purchase			x				
	Fee-Simple Estate			x				
	Donation			x				
	Dedication			x				
	Purchase/Sale Back			x				
	Right-of-First Refusal			x				
	Life Estate			x				
	Land Trading			x				
	Management Agreement			x				
	Restrictive Covenant			x				
	Lease			x				
	Conservation Easement			x				
	Will Bequest			x				
Environmental Management: Aquatic	Dam Mitigation: Dam Removal	x						
	Dam Mitigation: Bottom Draw	x						
	Dam Mitigation: Bypass Channel	x						
	Barrier Mitigation: Rocky Ramp or other Structures	x						
	Exclosure: fish	x						
	In-stream structures: Log jam	x						
	In-stream structures: Sweepers and leaners	x						
	In-stream structures: Brush bundles	x						
	In-stream structures: Thalweg changes	x						
	In-stream structures: Digger logs	x						
	In-stream structures: L.U.N.K.E.R.S	x						
	In-stream structures: Boulder placement	x						

[5] In some cases, CVC's role is limited to the provision of guidance and coordination rather than design or construction. In all cases, CVC's role will be contingent on considerations of budget, workload, and staffing considerations.

Broad Category	Conservation Action	CVC Program Lead						
		AWER	CO	CL	ED	LO	TRM	WRMP
	In-stream structures: Sunken reefs	x						
	In-stream structures: Spawning boxes	x						
	In-stream structures: Deflectors	x						
	In-stream structures: Channel narrowing	x						
	Erosion mitigation: bank bioengineering	x						
	Channel Modification: Daylighting	x						
	Channel Modification: Natural channel design, Creek realignment or Fluvial geomorphology alterations	x						
	Channel Modification: Floodplain alterations	x						
	Shoreline: Headland Beach	x						
	Shoreline: Cobble Beach Restoration or Shoreline naturalization	x						
	Shoreline: Beach nourishment	x						
Environmental Management: Wetland	Aquatic planting	x						
	Buffer planting	x						
	Habitat Structures	x						
	Drain removal	x						
	Re-contouring/dredging	x						
Environmental Management: Terrestrial	Brush piles						x	
	Integrated Pest Management						x	
	Invasive Species Management (physical, chemical, biological)	x					x	
	Naturalization (potted trees/shrubs)						x	
	Non-riparian Erosion Control						x	
	Pollinator Patch Creation						x	
	Prairie/Meadow Restoration/Creation						x	
	Reforestation (machine planting)						x	
	Woody debris and logs						x	
	Topographic grading						x	
	Nesting and Roosting structures						x	
	Best Management Practices						x	
	Vegetation Control						x	
	Forest Management (thinning, selection)						x	

Broad Category	Conservation Action	CVC Program Lead						
		AWER	CO	CL	ED	LO	TRM	WRMP
	Understorey planting						x	
	Topographic grading						x	
	Tree preservation plans						x	
	Seed Collection						x	
	Local plant, tree, shrub stock growing						x	
	MFTIP (completion; promotion)						x	
	Hazard tree removal						x	
Outreach and Education	Youth Engagement				x			
	Family/Household Engagement				x			
	Adult Engagement				x	x		
	Social Marketing				x	x		
	Landowner/Resident Workshops					x		
	Fact Sheets					x		
	Guidebooks and Manuals					x		
	Presentations					x		
	Tours					x		
	Festivals/Community Partner events					x		
	Web-based tools					x		
	Commitments program					x		
	Hard copy newsletters					x		
	Electronic newsletters					x		
	Door-to-door visits					x		
	Targeted outreach (by mail, in person or email)					x		
	Workday events (tree planting, garbage pick-up)		x			x		
	Recognition program (signage, events, profiling)		x			x		
	Media releases		x			x		
Water Quality and Water Quantity Management	**Pollution Prevention**					x		
	Barnyard Runoff Control							
	Composting Structures (manure, plant matter)					x		
	LID (Source)							
	Bioretention							x
	LID (Conveyance)							
	Dry swales							x
	Enhanced grass swales					x		
	Thermal Mitigation							
	Cooling trench					x		
	End of Pipe							
	Constructed Wetlands							x

Broad Category	Conservation Action	CVC Program Lead						
		AWER	CO	CL	ED	LO	TRM	WRMP
	Dry detention basin							x
	Operation and Maintenance							
	Cover Crops					x		
	Erosion Control Structures (water and sediment control basins, drop inlet structures, etc.)							x
	Filters							x
	Floating island							x
	Flow restrictors					x		
	Fuel Storage and Handling							x
	Grass Swales							x
	Green roof							x
	Hazardous material storage							x
	Infiltration trenches/basins							x
	Integrated Pest Management (i.e. decision support tools, technology to improve efficiency)					x		
	Irrigation Management					x		
	Lot level controls							x
	Catch basin sumps							x
	Clean Water Diversion					x		
	Non-winter parking lot maintenance							x
	Non-winter road maintenance							x
	Oil/Grit Separators							x
	Parking lot storage							x
	Perforated pipes							x
	Permeable Pavement							x
	Pervious Catch Basins							x
	Pervious Pipe Systems							x
	Pollution Prevention:							x
	Rain Garden							x
	Rainwater Harvest and Reuse					x		
	Reduced Lot Grading							x
	Roof downspout disconnection							x
	Rooftop Grading							x
	Rooftop Leader to Ponding Area							x
	Rooftop Storage							x
	Soakaway, infiltration trench or chamber							x
	Soil Bioengineering							x

Broad Category	Conservation Action	CVC Program Lead						
		AWER	CO	CL	ED	LO	TRM	WRMP
	Super Pipe Storage							x
	Sustainable Stormwater Demonstration:							x
	Winter parking lot maintenance							x
	Winter road maintenance					x		x
	Vegetated Filter Strip					x		x
	Dead Stock Composting					x		
	Conservation Tillage					x		
	Dumpster management							x
	Exclosures: livestock	x				x		
	Fertilizer Handling/Storage					x		
	Landscape maintenance							x
	Landscape naturalization\					x		x
	Manure Storage					x		
	Milkhouse Storage/Treatment					x		
	Nutrient Management Plan					x		
	Nutrient Management Strategy					x		
	Silage storage enhancement and relocation					x		
	Tile drain mitigation					x		
	Wellhead Abandonment					x		
	Wellhead Protection					x		