Flowing Off The Edge

A Strategy to Modernize the Water Science and Water Policies of the Niagara Escarpment Plan

December 2008

Walter & Duncan GORDON FOUNDATION

NIAGARA ESCARPMENT FOUNDATION

COALITION ON THE NIAGARA ESCARPMENT

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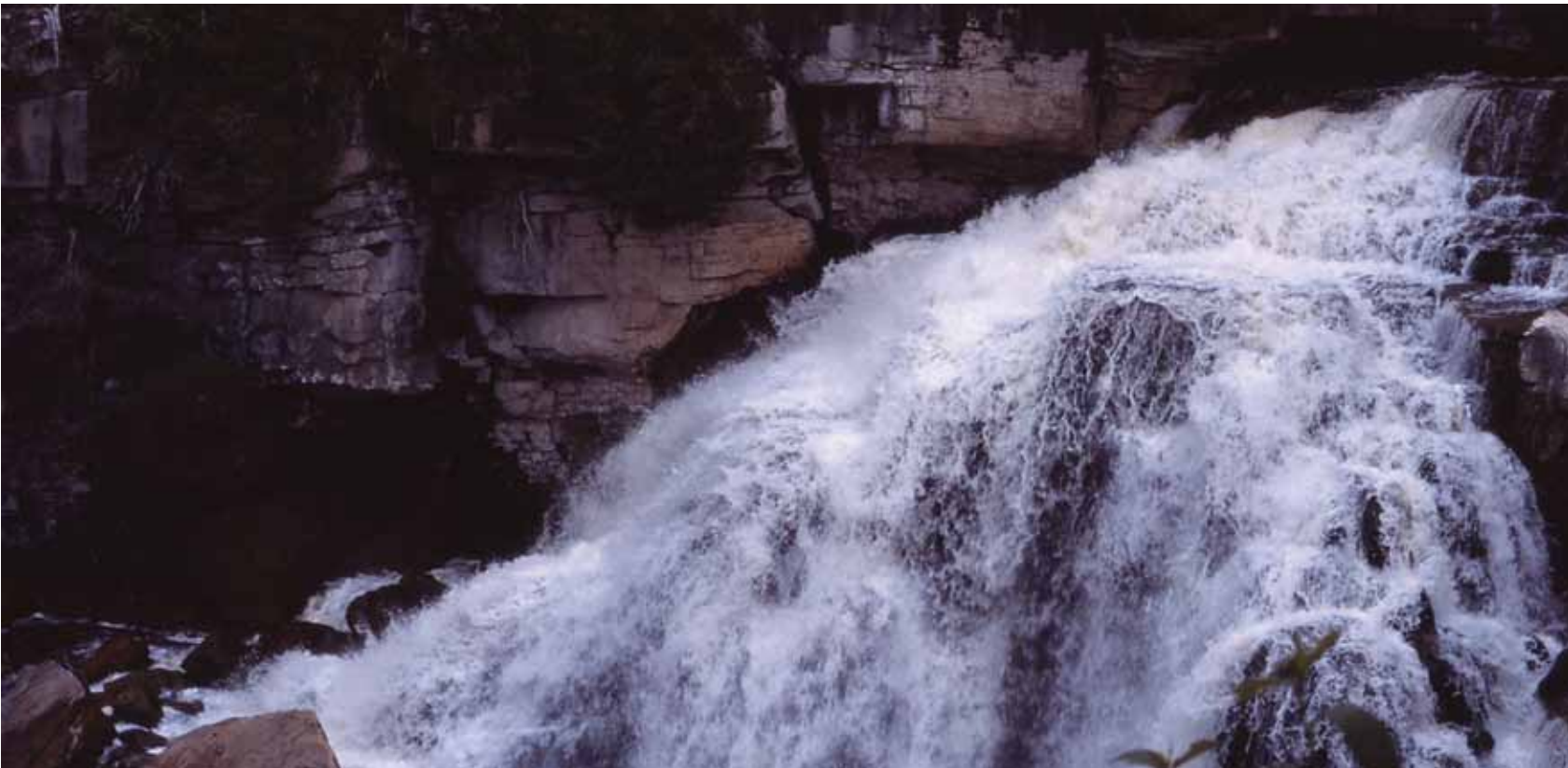

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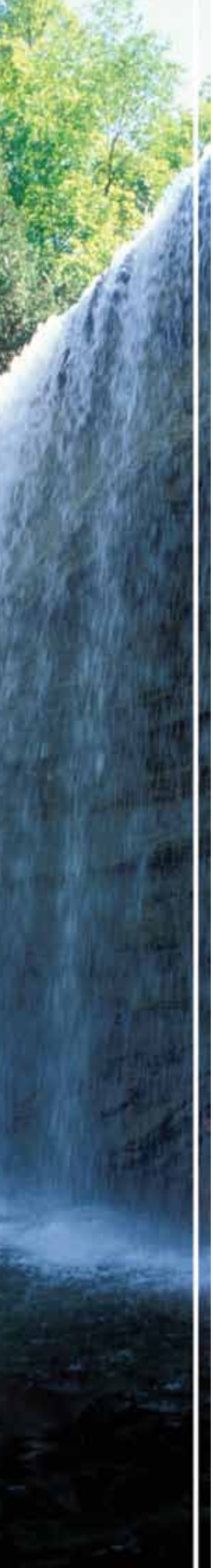

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A Strategy to Modernize the Water Science and Water Policies of the Niagara Escarpment Plan

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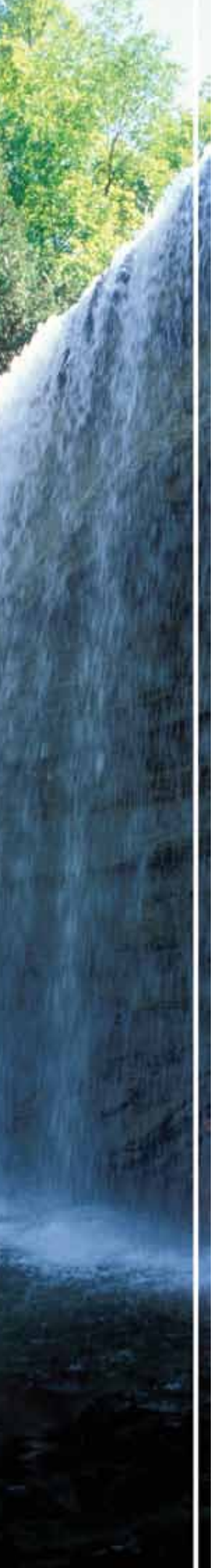


Executive Summary

The policy analysis detailed in this report documents differences between the water policies of the Niagara Escarpment Plan (NEP or the Plan) and the Oak Ridges Moraine Conservation Plan (ORMCP). This report also assesses their comparative protective strengths to identify opportunities to strengthen the NEP's ability to protect the Escarpment's water resources. Research methods included a detailed comparison of the NEP and ORMCP water polices to identify gaps, peer review of the findings by two experts with extensive knowledge of water policy and the Oak Ridges Moraine (the Moraine), and vetting of the results through an expert workshop. Findings indicate that NEP water policies need updating in two main areas:

i. Additional requirements for water technical information and planning to ensure standardized watershed planning, the use of wellhead protection, development of water conservation plans, evaluations of hydrologically sensitive features, aquifer mapping, and water budget planning; and

ii. A variety of changes to water as well as other Plan policies including: the incorporation of recent concepts and thinking on ecosystem integrity (including hydrological function and structure) in the language of the NEP, the renovation of NEP Section 2.6 (New Development Affecting Water Resources), enhanced designation criteria and boundaries to increase the amount of land and water protected, more sophisticated cumulative impact provisions, and more effective monitoring policies.

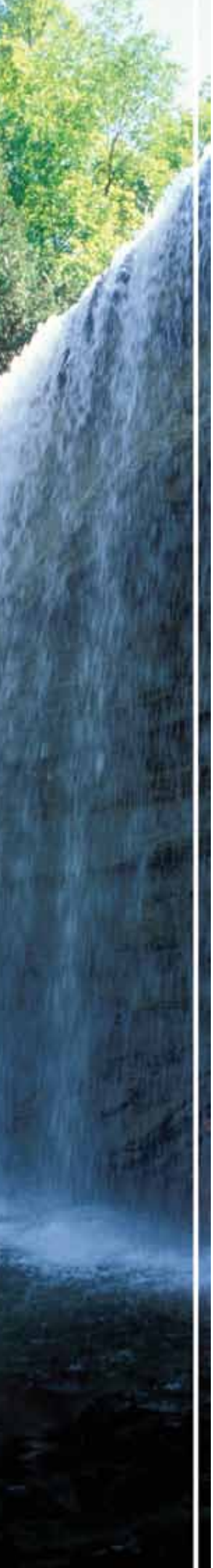
Three approaches to achieving the identified changes are presented. The first involves utilizing the current harmonization process, a process established by the Ontario government to address policy inconsistencies between the ORMCP and/or NEP and the Protected Countryside policies of the Greenbelt Plan (GBP); see Appendix I. This would be a process to achieve changes in the short term and is not meant to change anything related to the purpose and objectives of the NEP (and therefore only housekeeping changes are expected to proceed through this process). Examples would include wording changes to reflect new thinking around "ecological integrity" and "hydrological function."

The second approach involves working with the Niagara Escarpment Commission (NEC) to undertake a Plan Amendment to address water policy updates. This process would focus on policy changes that should be pursued in the mid-term such as making watershed planning mandatory to address the protection of the function and integrity of the hydrological systems of the Niagara Escarpment (the Escarpment) and adjacent lands. This would contribute to preparing for the 2015 GBP / NEP / ORMCP ten-year reviews when more substantive policy changes to the NEP might be made. A second mid-term activity should also include the re-mapping of all NEP land use designations based on existing NEP designation criteria. Advances in science and available information would allow for updates to Plan designations that would have significant impacts on protecting water resources of the NEP and adjacent lands.

The final approach involves using the GBP / NEP / ORMCP reviews starting in 2015 to address substantive changes to NEP water policies including updates to section 2.6 and updating designation criteria based on new science and elements such as source water protection.

A parallel public and media engagement process is also recommended through yearly water celebrations on the Escarpment. This public process will be vital to securing broad support for changes that will strengthen the NEP leading up to and through the 2015 GBP / NEP / ORMCP reviews.

The recommendations outlined in the report are listed below in abbreviated form and the proposed timeframe for achieving the identified changes are sketched out in Table 1. The full recommendations are included throughout the body of the report and are listed in Appendix II.



Recommendation 1
NEP water policies should be updated to be similar to water policies in the ORMCP. NEP policies need to be tailored to the unique hydrological properties of the Escarpment.

Recommendation 2
Two parallel approaches should be initiated to update NEP water policies. The first approach should focus on short, mid, and long-term processes available to update water policies including the existing harmonization process, an NEC-initiated NEP Amendment process and the GBP / NEP / ORMCP review process scheduled to begin in 2015. The second approach should involve an outreach campaign designed to secure public support for stronger protection of Escarpment water resources to begin in 2009 and run through 2015.

Recommendation 3
The environmental NGO community should work with the NEC to secure research, stewardship, and outreach funding through mechanisms that are similar to those used by the Oak Ridges Moraine Foundation and the Friends of the Greenbelt Foundation.

Recommendation 4
At the watershed and subwatershed scales, municipalities, conservation authorities, and the NEC should undertake planning to address protection of the function and integrity of the hydrological system of the Escarpment and lands in the vicinity.

Recommendation 5
Watershed plans should be reviewed periodically. Water budget and water conservation components should be revised if the system has been altered from its original state or if new information should become available. Watershed planning should be designed to be sensitive to changes in climate and adaptive in response to changing conditions.

Recommendation 6
The environmental NGO community should work with the NEC and other Escarpment partners to develop an information management system that can be used for data input, storage, and retrieval to facilitate the coordination, sharing, and updating of Escarpment and related data and information that can be accessed by all partners.

Recommendation 7
Water budget estimates on the Escarpment and adjacent lands should be undertaken at the subwatershed scale. Where the bedrock aquifers show evidence of karst porosity, more detailed investigations should be mandated.

(Note: It is proposed that Recommendations 4 to 7 proceed through an NEP Amendment process. These recommendations could proceed without a Plan Amendment (and therefore earlier), however, if sufficient resources and strong coordination from the NEC is provided.)

Recommendation 8
Water conservation planning similar to that utilized for the Moraine should be required in the development of water policy for the Escarpment.

Recommendation 9
The NEP should have provisions to protect sensitive Escarpment hydrological features. The list of sensitive Escarpment hydrological features would be similar to that of the Moraine and include streams, ponds, lakes, springs, seeps, sinkholes, sinking streams, and conduits.

Recommendation 10
The principle of limiting impervious surfaces and increasing infiltration should be considered for water policy development in the NEP.

Recommendation 11
NEP water policy should address the issue of aquifer vulnerability. It is recommended that areas of high vulnerability be mapped and restrictions placed on activities in that zone such as those outlined in the ORMCP.

Recommendation 12
Water policies in the NEP should provide for the protection of municipal groundwater wells. It is recommended that Escarpment water policy be developed that would require the mapping of wellhead protection areas. Restrictions on activities within these zones should be considered.

Recommendation 13
The wording in the NEP should be adjusted to reflect current thinking on water science, based on ecological integrity and hydrological function, structure, and restoration. NEP definitions related to water policies should be updated and any additional definitions required should be based on the unique nature of the Escarpment landscape.

Recommendation 14
The ORMCP water policies section should be used to guide the updating of NEP water policies.

Recommendation 15
Current permitted uses in Escarpment Natural Areas and Escarpment Protection Areas should be maintained. Implementation of a prohibition on new mineral resource extraction operations should be considered during the GBP / NEP / ORMCP 2015 reviews.

Recommendation 16
The NEP designations should be updated in a two-phased process. The first phase should proceed through a Plan Amendment to update existing designation boundary mapping based on new information. The second phase should involve new designation criteria that need to be developed to reflect the latest terrestrial ecology and water resource science for the purpose of enhancing protection of water resources.

Recommendation 17
Stronger GBP policies through the GBP review starting in 2015 should be pursued in order to ensure that GBP lands adjacent to the NEP area are properly protected with respect to water resources. Similarly, stronger protection is required for lands regulated through municipal official plans adjacent to NEP lands in the northern portion of the Plan area.

Recommendation 18
Continued implementation of the NEP by the NEC and maintenance of the current system of development control should be supported during the GBP / NEP / ORMCP reviews in 2015.

Recommendation 19
Cumulative impact provisions should be retained and enhanced in the NEP.

Recommendation 20
Monitoring provisions in the NEP should be enhanced through specific requirements to monitor water resources.

Recommendation 21
Original research should be incorporated into the monitoring program to address issues related to water resources of the Escarpment, including impacts of climate change and development of a model to assess cumulative impacts of development on water resources.

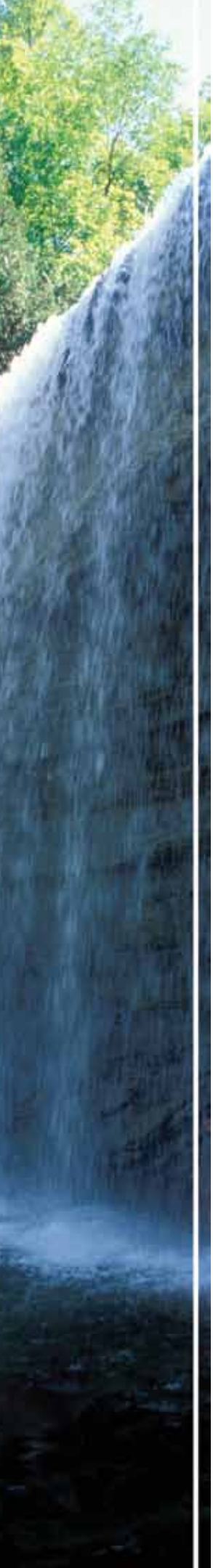


Table 1 – Approaches to achieving the identified changes.

Recommendation	Harmonization (near-term process)	Plan Amendment (mid-term process)	Plan Review (long-term process)	Page
1	X	X	X	14
2				15
3				15
4			X	17
5			X	17
6			X	17
7			X	19
8			X	19
9			X	20
10	X			21
11			X	22
12			X	23
13	X			25
14			X	26
15			X	26
16		X	X	27
17			X	28
18			X	28
19			X	29
20	X	X	X	30
21	X	X	X	30

1.0 Introduction

This report details differences between the water policies of the Niagara Escarpment Plan (NEP) and those of the Oak Ridges Moraine Conservation Plan (ORMCP) and assesses their comparative protective strengths. The Coalition on the Niagara Escarpment (CONE) identified the need for this policy evaluation of landscape level water policies after the ORMCP and Greenbelt Plan (GBP) were approved. The ORMCP and GBP contain policies that were developed based on the best science and understanding of the late 1990s and early 2000s, whereas the policies of the NEP were developed based on the best science and understanding of the mid 1980s. Furthermore, work carried out by CONE on water policy for the Niagara Escarpment (the Escarpment) to evaluate evolving Provincial legislation on source water protection also highlighted the need for improvements to the water policies of the NEP (CONE, 2004).

The NEP has long been recognized to be a leading-edge plan in the field of landscape-level environmental land use planning. From its conception through to its design, implementation and periodic refinement, the NEP has been and remains a highly successful land use plan. The main strengths of the NEP include:

i. the use of objective criteria from which land use designations and permitted uses are determined,
ii. the application of development control, and
iii. the manner in which land use planning policies are developed and decisions implemented.

In addition, the plan is administered by an independent and impartial provincial agency, the Niagara Escarpment Commission (NEC), that is accountable to the provincial government. Operation of the NEC is guided by environmental planning principles with the overall objective of protecting and conserving the natural features and functions of the Niagara Escarpment. **The success of the NEP in maintaining the integrity of the Niagara Escarpment is in large part due to the administrative structure provided by the NEC.** This framework has provided a standardized approach to land use planning across a range of municipalities and conservation authorities.

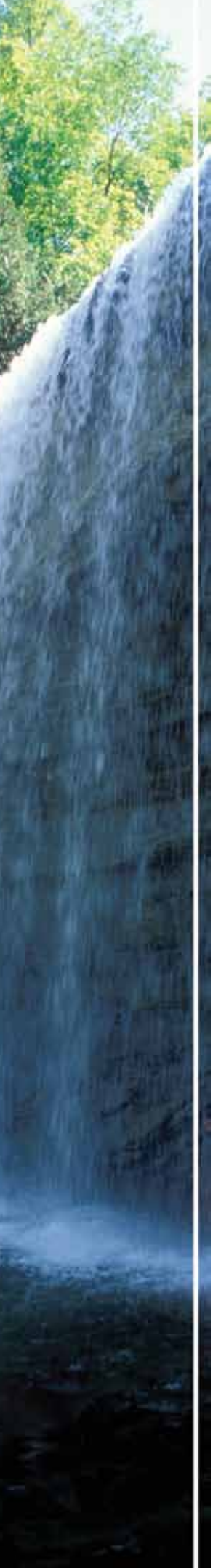
The ORMCP was designed in part to reflect the overall principles of the NEP, with many of the elements of the NEP providing a template for the ORMCP. However, in the area of water resources the NEP has not been comprehensively reviewed and amended specifically with the purpose of updating water planning policies since the Plan was originally approved in 1985. It is clear from the Oak Ridges Moraine (the Moraine) planning processes and outcomes that new approaches have emerged to water planning and management. These new approaches are based on advances in ecosystem science, watershed planning and management, adaptive environmental management, and improved links between water science and land use planning. Examples include the use of water budgets, wellhead protection, improved features mapping, and associated setback and buffer requirements.

Collectively, the water provisions of the ORMCP provide a comprehensive set of procedures that are used to evaluate and protect significant water resources. Water policies and guidelines developed from the plan are some of the strongest in North America. Comparison of the water policies of the ORMCP and NEP provides an opportunity to assess strengths and weaknesses of the NEP in the area of water resources.

The Greenbelt consists of the lands in the NEP and the ORMCP plus the Protected Countryside which was added through passage of the GBP in 2005. (The Greenbelt Plan Area is illustrated in the map provided below; Schedule 1 from GBP, 2005). It should be noted that although the 10-year reviews of the three plans beginning in 2015 will be concurrent and coordinated, the three reviews are nevertheless separate, distinct processes, each pursuant to a different statute. In the case of the NEP, the review is conducted pursuant to the Niagara Escarpment Planning and Development Act.

An initial review of the GBP water policies revealed that policies:

i. were modeled after the ORMCP, but
ii. are less comprehensive, and
iii. are not supported by technical documentation.



Based on this analysis, the majority of this policy evaluation has focused on the ORMCP. However, the lands known as Protected Countryside in the GBP and which are adjacent to NEP lands are substantial in area and comments on the GBP are made in several sections of the text.

Updating NEP water policies is not as straightforward as simply replacing them with the water policies of the ORMCP. There are two reasons for this:

i. Plan policies work in concert, so general policies such as plan designation criteria, permitted uses within designations, and cumulative impact and monitoring provisions combine for strong water planning and management, and
iii. the NEP and ORMCP are structurally different because of when, why, and how they were prepared. (The NEP is administered through a provincial-level Commission, for example, the ORMCP through municipalities. And the NEP uses development control rather than municipal zoning).

Because the Plans are different, simply replacing the water policies in NEP Section 2.6 (New Development Affecting Water Resources) with ORMCP water policies (in the section on Protecting Ecological and Hydrological Integrity) would be inappropriate. Furthermore, and **unlike the geographic area of the ORMCP, the Niagara Escarpment Plan Area is not a logical hydrological planning unit** because it cuts across several major watersheds.

This report does not present a proposed set of Niagara Escarpment water policies. Rather, **this report sets out a series of recommendations for processes that can be used to update water policies** such as harmonization, NEP Amendments, or the 2015 NEP review. Section 2 describes the physical properties of the Moraine and the Escarpment and outlines their hydrological significance and differences. The purpose of this section is to highlight the need for similar but tailored water policies for each Plan.

Section 3 presents a roadmap for modernizing NEP water policies using the following three distinct processes:

i. the current harmonization process to address short-term housekeeping issues such as wording changes to include concepts in the NEP such as ecological and hydrological integrity,
ii. NEC-initiated Plan Amendments to secure changes in the mid-term, and
iii. the ten-year review of the three plans (i.e., the GBP, NEP and ORMCP) that is scheduled to begin in 2015.

A parallel process of public and media engagement is also outlined to build the public and political support that will be needed to underscore the importance that NEP water policies be properly and sufficiently updated.

Section 4 evaluates ORMCP technical water requirements and makes a series of recommendations for similar technical requirements in the NEP.

Section 5 evaluates NEP water and other relevant policies including:

i. water language and definitions,
ii. the water policy sections of both Plans,
iii. designation criteria, boundaries, and permitted uses,
iv. the Niagara Escarpment Commission,
v. development control,
vi. cumulative impact assessment provisions, and
vii. monitoring provisions.

Recommendations are provided throughout the report with an indication of the suggested timeframe—whether actions are appropriate in the short, mid, or long-term. The full recommendations are listed in Appendix II.

2.0 Physical Properties of the Oak Ridges Moraine and Niagara Escarpment

In the sections below, the physical properties of the Oak Ridges Moraine (ORM) and Niagara Escarpment are reviewed. The materials discussed are relevant to water resource issues and water policy. While the Moraine and the Escarpment have markedly different geology, geomorphology, and hydrology, they share some attributes that would favour a harmonization of Plan policies related to water.

2.1 Oak Ridges Moraine: Physical Background

The Oak Ridges Moraine is one of the largest moraine complexes in Ontario and stretches from the Escarpment (east of Orangeville) 160 km eastward to the Trent River. The overall feature is classified as a kame moraine (Chapman and Putnam, 1984) and is comprised largely of ice contact stratified drift and glaciofluvial deposits (Ontario Geological Survey, 2003). The ice contact materials are dominated by sands and gravels with minor occurrences of other glacial deposits, including glaciolacustrine silts and clays (glacial lake deposits) and glacial tills. The glaciofluvial deposits are also largely sands and gravels.

The boundary of the Moraine is most easily defined on the basis of the surficial geology and geomorphology. The moraine stands as an upland comprised of a series of discontinuous hummocky ridges and swales and plateau areas. Based largely on these criteria, Duckworth (1979) placed an elevation boundary at approximately 900 feet above sea level (274.4 metres). For the purposes of the Oak Ridges Moraine Planning Study, an elevation boundary of 275 metres was selected, although in some areas the boundary was placed at a lower elevation. The final boundary of the ORMCP utilizes the 245 metre contour along the southern boundary of the Moraine from the Town of Richmond Hill to the eastern boundary of the Municipality of Clarington (Government of Ontario, 2007). From a hydrological and hydrogeological perspective it should be noted that the boundary of the Moraine does not capture all of the areas that function as important groundwater recharge and discharge zones.

The Moraine was formed during the last glacial event that influenced southern Ontario. During the waning phase of the last glaciation (Late Wisconsinan), the Laurentide Ice Sheet developed a series of lobes near its periphery. Relatively thick glacial ice persisted in the Lake Ontario and Lake Simcoe regions, each forming a lobe. A trough developed between these two lobes, just east of the Niagara Escarpment. A variety of sand and gravel deposits were laid down in the trough between these two lobes. These materials were deposited on a pre-existing upland that was comprised of older Wisconsinan aged glacial deposits. This older surface was a drumlinized till plain that had been incised by large subglacial meltwater channels (tunnel valleys). These older deposits include the Newmarket Till which is a fine-textured glacial diamicton with a relatively low permeability.

The deposition of the sediments that comprise the Moraine was not uniform across the length and breadth of the feature. Deposition occurred in a west to east sequence from the Escarpment to south of Rice Lake as a series of sedimentary wedges. The materials were deposited progressively eastward as a trough between the Ontario and Simcoe glacial ice lobes opened up. Within that trough, a proglacial lake was formed. This lake was bounded to the north, east, and south by the two lobes of glacial ice and by the Escarpment to the west. A multi-phase model proposed by Barnett et al. (1998) describes the complex environments that were present along the moraine during its development. Initially, the deposition of sands and gravels occurred in meltwater channels that were found at the base of the glacial ice. In a second phase, the proglacial lake formed and sedimentation occurred as materials were deposited as subaqueous fans into that lake. This was followed by sand and gravel deposition as deltas were constructed into the proglacial lake. In these latter two phases, fine-grained sediments were deposited on the lake bed. There was also local deposition of glacial diamictons (flow tills) during this period. Finally, on the margins of the moraine there were glacial tills deposited that overlapped portions of the sandy Oak Ridges materials. The entire process was relatively rapid and resulted in the

formation of a thick sequence of sediments dominated by coarse-textured materials. However, within the sediments that comprise the moraine, there are fine-grained proglacial lake sediments and tills that can influence the local hydrogeology and hydrology. These fine-textured materials function as aquitards.

2.1.1 Topography and Drainage

The Moraine is comprised of a series of discontinuous hummocky ridges and swales and plateau areas. There are numerous examples of small enclosed depressions and irregular hill forms (knob and kettle topography). Standing water exists within some of the depressions and significant wetlands are also present. The surface drainage network on the moraine is poorly organized and the drainage density (stream channels per unit area) is low. The sand and gravel deposits have a very high permeability and the soils are typically well drained. Much of the precipitation that falls onto the moraine infiltrates the porous soils and percolates downward into the underlying sediments. There is relatively little surface runoff across the upland areas of the moraine. These upper portions of the moraine constitute one the most important groundwater recharge zones in southern Ontario. On the flanks of the moraine, groundwater springs supply baseflow to headwater areas of approximately 60 streams that drain southward into Lake Ontario or northward into Lake Simcoe, Lake Scugog, Rice Lake, and a variety of other drainages.

2.1.2 Hydrogeology

The coarse-textured materials of the moraine have a high permeability and function as aquifers. There are a series of aquifers that are separated by fine-grained glaciolacustrine materials and glacial tills that operate as aquitards. Hunter et al. (1996) differentiate between four main aquifers in the moraine and surrounding areas that are largely delineated on the basis of their elevation range and the origin and characteristics of the materials. Groundwater flow within the individual aquifers can be locally impeded by fine-grained sediments. The properties of the main aquifers are described below.

The uppermost aquifer is the Upland Aquifer Complex, which is found at elevations above 260 metres. This aquifer is in turn subdivided vertically into units that are separated by discontinuous layers of fine-textured deposits. The Upland Aquifer Complex overlies a regionally extensive glacial till (Newmarket Till) which functions as a significant aquitard. Across much of the ORM, the Upland Aquifer is unconfined. However, at the northern and southern boundaries of the moraine where Halton Till deposits overlie the sands and gravels of the Upland Aquifer Complex, the aquifer is confined. Recharge into the Upland Aquifer Complex is substantial. Hunter et al. (1996) estimate the unit recharge across this area to be approximately 300 mm/yr. Some recharge percolates vertically into the lower aquifers that underlie the Newmarket Till, but much of the groundwater is diverted laterally to the flanks of the moraine due to the low permeability of the Newmarket Till and also by local aquitards within the Upland Aquifer Complex. Groundwater discharge into stream channels through seeps and springs is common at elevations between 280 and 290 metres and this baseflow component is an important source of discharge to the streams draining the flanks of the moraine. Groundwater also may discharge into wetlands and kettle ponds in the upper portion of the moraine.

The Lowland Aquifer Complex (Hunter et al., 1996) occurs between 200 and 240 metres in elevation. It is comprised of glaciofluvial sediments that were deposited where large subglacial meltwater channels (tunnel valleys) cut into, and in some areas penetrated through, the Newmarket Till. Portions of the Lowland Aquifer Complex also extend beyond the morphological boundaries of the moraine. There are hydrological connections between the Upland and Lowland Aquifers. The Lowland Aquifer Complex also contributes substantially to the baseflow of streams that drain the moraine area. In a study of Duffins Creek (northeast of Toronto), for example, Gerber and Howard (2002) determined that 20-25% of the discharge across that watershed originated from the aquifers that underlie the Newmarket Till aquitard. This demonstrates the regional character of the aquifer complexes and demonstrates that the important groundwater discharge area is not confined to the Moraine proper.

There are a large number of wells that extract groundwater from both the Upland and Lower Aquifers, including networks maintained by several municipalities. These wells often yield groundwater of high quality and many of the wells have a high capacity. In total, the aquifers of the Moraine supply groundwater to over 250,000 persons in the areas north of Toronto.

2.1.3 Hydrological Significance of the Oak Ridges Moraine

From a water resources perspective, the Moraine is significant because it:

i. is comprised of aquifers that store significant quantities of groundwater,
ii. represents one of the largest areas of groundwater recharge in southern Ontario,
iii. provides baseflow to the headwater portions of 60 streams that drain the flanks of the moraine, including some significant cold water streams,
iv. supports and maintains significant stream corridors and wetlands that provide habitat for a distinctive range of aquatic and terrestrial organisms, and
v. provides high quality and large quantities of groundwater to municipalities and rural landowners.

The physical properties of the aquifers leave them highly vulnerable. The Upland Aquifer Complex of the Moraine is in large part unconfined and shallow in depth. These qualities leave this aquifer susceptible to contamination from surface infiltration. Due to the nature of the hummocky surface and the non-uniform distribution of sediments in the subsurface, the surface water divides on the moraine may differ from the groundwater divides. These properties substantially complicate water budget estimations and the numeric modelling of groundwater movement and stream flow across the moraine, particularly at the local scale.

Several key water resource issues have been identified on the moraine. In some areas groundwater extraction from the Upland Aquifer Complex is exceeding the local recharge. Portions of the moraine have experienced changes in land use that have had an effect on recharge and surface runoff. This is of particular concern in upper elevation areas of the moraine where recharge rates are relatively high. The aquifer has experienced contamination from a variety of areal and point sources, including seepage from septic fields, as well as infiltration of surface water contaminated with road salt and stormwater from developed areas.

2.2 Niagara Escarpment: Physical Background

The Niagara Escarpment is a cuesta landform that, in southern Ontario, extends more than 700 kilometres from the Niagara River to northern Bruce Peninsula, going under Georgian Bay and emerging again on Manitoulin Island. In its full extent, the feature runs from upper New York State through southern Ontario across the upper peninsula of Michigan and to the Door Peninsula of eastern Wisconsin and has come to be know as the Great Arc. In southern Ontario, the bedrock area exposed along the Niagara Escarpment are sedimentary strata of Ordovician and Silurian age (Johnson et al., 1992). These materials were deposited in a marine environment within two basins: the Michigan and Appalachian Basins. The strata exposed in the eastern Niagara Peninsula are considered part of the Appalachian Basin while those of south-central and southwestern Ontario are of the Michigan Basin. Within each basin, a wide range of clastic and carbonate sediments were deposited, producing laterally extensive sedimentary rocks.

The Michigan Basin experienced very little tectonic disturbance. The only significant change in this region was a tilting of sedimentary strata that was related to subsidence in the central basin area. Due to this subsidence, the sedimentary rocks that rim the Michigan Basin dip gently towards central Michigan. While most of the rocks of the Appalachian Basin were strongly deformed in the Applachian orogeny, the strata of the Niagara Peninsula were on the periphery and were not disturbed. Thus, in southern Ontario, the sedimentary strata dip very gently to the west and south. Some of these bedrock units are exposed in the Escarpment.

The cuesta of the Escarpment was produced through differential erosion. On most areas of the cuesta, the upper surface is a gently dipping slope that corresponds to the dip of the bedrock strata, while the steep scarp face has been developed by differential erosion in the contact zone between resistant and recessive strata. In general, dolostone and limestone strata (carbonate units) tend to be more resistant to a wide range of erosive processes than shale and siltstone units (fine-grained clastics). In the Ordovician and Silurian strata that are found in Ontario, there are thick sequences of fine-grained clastic units and more resistant carbonate units. Since these units are dipping, they may outcrop in close proximity. Where these units outcrop, the more resistant strata tend to form positive relief features while the less resistant features form lowlands.

Along the Escarpment, the bedrock units that are found in the upper cliff bearing sections are resistant carbonate strata while clastic units are dominant in the lower gently sloping areas at the base of the scarp. There is some variance in the stratigraphy of the Escarpment as we move from the Niagara to the Bruce Peninsula (Tovell, 1992). In general terms, the upper units of the Escarpment are dolostone that are typically 20 to 25 metres in thickness, shale units are found at the base, and a mixture of bedrock types are found throughout the middle portion of the feature. The most important units in the upper sequence are the dolostones and limestones of the Amabel, Lockport and Guelph Formations (Abermerle Group), while the principal recessive strata at the base of the Escarpment are the shales of the Queenston Formation. The strata of the Abermerle Group extend down dip (west and south) of the Escarpment, while the Queenston strata extend in the subsurface below (east and north) the Escarpment. The strata that outcrop in the middle portion of the scarp include a variety of formations from the Cataract and Clinton Groups. These units are a mixture of clastic and carbonate units.

The scarp face of the Niagara Escarpment is variable in height from several metres to several tens of metres. In southern Ontario, the Escarpment forms a nearly continuous feature with the exception of regions where it has been buried by thick accumulations of glacial overburden. Along most of the length of the Escarpment, the area that is covered by the Niagara Escarpment Planning and Development Act captures the steep scarp face, the gentle slopes in the older fine-grained clastic units that occur below the Escarpment, and a portion of the dip slope in the upper resistant units.

Surficial materials found below the Escarpment tend to be locally derived glacial tills (from the Queenston Formation) with a fine-grained matrix (e.g., Halton Till). Soils developed on these glacial tills are also fine-grained. Overall these materials have a low infiltration capacity and a low permeability. Due to these characteristics, the drainage density on these materials tends to be high. There is rapid surface runoff and little groundwater recharge. There are few groundwater resources associated with surficial materials derived from the shales of the Queenston Formation, nor are wells that penetrate the formation typically of high capacity or high quality. There are, however, some groundwater resources in the more Recent (Holocene) alluvial deposits that are found along the major streams that cut across the area.

Along much of the length of the Escarpment, bedrock is exposed not only on the face, but also on the dip slope that extends to the west. The area of bedrock outcrop is highly variable at the local scale. There are significant areas on the Bruce Peninsula and on Manitoulin Island where flat 'limestone' pavements (alvars) are present. Across most of the cuesta in south-central Ontario, the dip slope typically shows a flat to gently rolling surface with some areas of undulating relief. This relief is in part controlled by the properties of the strata that comprise the Abermerle Group. Where there are large fossil reefs present in the strata there tends to be more resistant uplands.

There is a discontinuous and variable cover of glacial sediments on the dip slope in some of these areas. At many locations, there is a thin veneer of glacial tills on the bedrock. This veneer typically becomes thicker as one moves away from the scarp face in the down dip direction. There are areas where glaciofluvial materials cover the bedrock and there are locations where the undulating relief is related to hummocky moraine deposits.

2.2.1 Hydrogeology

The strata that are exposed in the Escarpment may also be found in the subsurface mainly to the west and south of the scarp face. A comprehensive review of the hydrogeology of these bedrock units is presented in The Hydrogeology of Southern Ontario (Singer et al., 2003). In the material presented below, the focus is on the units that outcrop in the upper portions of the Escarpment face and occur in outcrop or shallow subcrop to the areas west and south (down dip) of the Escarpment. The important units are the strata of the Abermerle Group. While the emphasis here is given to aquifers in bedrock, it should be noted that locally significant aquifers occur in glacial sediments (mainly glaciofluvial and ice contact stratified drift) that are in close proximity to the Escarpment.

The Amabel, Lockport, and Guelph Formations (Abermerle Group) constitute a high-capacity aquifer from the Niagara Peninsula to Owen Sound (Turner, 1976) and northward to the Bruce Peninsula (Singer et al., 2003). These formations may be treated as a single hydrogeologic unit (Amabel-Lockport-Guelph Hydrogeologic Unit). They are exposed in the upper section of the Escarpment and have an extensive area of subcrop down dip of the Escarpment. Across much of their distribution, the cover of glacial overburden is thin and these units may be accessed through relatively shallow wells.

There are more than 20,000 wells drilled into these strata in southern Ontario. Many of the wells in rural areas have been drilled for domestic use and produce adequate quantities at relatively shallow depths. There are also several well fields maintained by municipalities (e.g., Guelph, Acton, Rockwood) where individual wells typically yield large quantities of potable water. From these units, there is a very small percentage of wells that have a high salt or sulphur content. Water samples tend to have a high hardness, however, and in many wells the iron concentrations are considered elevated. In a small minority of wells, there are high concentrations of nitrate at locations where human activities have locally contaminated the aquifer. Overall, the water quality is particularly good in the Amabel Formation, while the instances of poor water quality are somewhat higher in the Guelph Formation (Singer et al., 2003).

2.2.2 A Fractured and Karstic Aquifer

The strata of the Abermerle Group have highly variable permeability characteristics. Where the bedrock is fractured, and/or where it has been subjected to solution (chemical dissolution), the permeability may be very high. In outcrops of the Abermerle Group, it is common to observe evidence of the process of solution. In precipitation and in soil moisture, carbon dioxide may be dissolved into the water which produces a weak acid (carbonic acid). This acid infiltrates into the bedrock and increases the rate at which the carbonate minerals (calcite and dolomite) are dissolved. Where meteoric (surface) waters are able to infiltrate and circulate through the strata, the process produces a variety of pores and conduits (caverns) that are referred to as secondary porosity. Groundwater may be stored within this secondary porosity or travel along its highly permeable pathways. On the surface, carbonate rocks that have been subjected to solution can be recognized by a variety of small landforms, such as solutionally widened joints (grikes or kluftkarren), pits and runnels, and caverns of variable dimensions. These features are collectively referred to as karst, and aquifers that display such secondary porosity are karstic. Of the units that comprise Abermerle Group, the Amabel Formation is most susceptible to the development of karst. An example of the karstic nature of the Amabel Formation is well expressed at Rockwood along the Eramosa River (Kunert et al., 1998).

2.2.3 Overburden Aquifers

Most of the overburden deposits that occur across and adjacent to the Niagara Escarpment are Late Wisconsinan glacial sediments with glaciofluvial, ice-contact stratified drift, and glacial tills as the principal materials. Glacial tills on the scarp slope and dip slope of the Escarpment tend to be more coarsely-textured and more permeable than tills found elsewhere in southern Ontario. The cover of overburden is highly variable and difficult to generalize, but recent mapping (Goa et al., 2006) provides a baseline, and the hydrogeology of the important aquifers is discussed in Singer et al. (2003).

Overburden in the area of the Escarpment is generally thin, with bedrock being exposed along the scarp face and much of the dip slope, or with bedrock occurring in the shallow subsurface covered by less than a metre or two of sediment. In some areas, the thickness of glacial sediments is more substantial. For example, north of the Forks of the Credit in Caledon, where the Oak Ridges Moraine abuts the Escarpment, there are thick deposits (40-50 metres) of ice contact stratified drift and glacial till. Further north, the Orangeville Moraine complex extends into the Plan Area in the Town of Mono, where the stratified sand, silt and gravel of the kame moraine can also be up to 50 metres in thickness. There are also thick deposits that cover the Escarpment in the Dundas Valley within the City of Hamilton, as well as locally thick deposits across a wide range of sites.

Where the bedrock units are covered by a very thin veneer of sediment, the impact on the bedrock hydrology of the Escarpment is minimal. However, thicker accumulations of sediment may influence the hydrology substantially. A thick overburden reduces the rate of solution in the underlying bedrock by buffering the pH of water that percolates through the soil zone. The porosity of bedrock beneath thick overburden may be less than in areas where bedrock occurs as outcrop. In addition, the sediment can clog pores in the rock and reduce its permeability. Thick accumulations of overburden also behave as aquifers that may or may not be coupled with the underlying bedrock aquifers. For example, there are important overburden aquifers in the Plan Area located within the Orangeville Moraine. Overburden aquifers also exist where glacial meltwater channels either cut across the Escarpment or were formed at the base of the Escarpment during deglaciation. These aquifers occur in sands and gravels—the East and Middle Sixteen Mile Aquifer, for example, is found at the base of the Escarpment and supplies domestic water to portions of Georgetown and Milton.

The overburden aquifers are usually unconfined and many have a hummocky or rolling surface topography. The sediments normally have a high permeability. Thus, there are important recharge zones across areas of higher ground. In valley locations, these aquifers may supply baseflow to perennial cold water streams. In some areas, streams receive baseflow from both overburden aquifers and bedrock aquifers of the Abermerle Group. Black Creek, in the Credit River watershed, and Beaver River are two examples of streams that derive cold water from overburden and bedrock aquifers. Given these properties, the overburden aquifers should be given equal consideration in regions of the Plan Area where they are locally important.

2.2.4 Drainage

Several types of drainage are observed along the Escarpment, including:

i. groundwater seeps and springs on the Escarpment face and at the base of the scarp,
ii. areas of karst drainage on the dip slope near the face of the scarp,
iii. streams that drain toward the Escarpment but sink in the karst zone,
iv. streams that drain over and incise the scarp face,
v. wetlands and ponds on the dip slope, and
vi. streams on the dip slope that drain to the west and south.

Groundwater springs are common along the face and base of the Escarpment at the contacts between the more porous strata and the fine-grained clastic units. Groundwater seeps and springs occur in the contact zone between the low permeability Queenston shales and the overlying Cataract Group. In the Niagara Peninsula, the Cataract Group is mainly sandstone of the Whirlpool Formation, to the north that unit grades laterally into dolostones of the Manitoulin Formation. There are numerous large springs found at the base of the Abermerle Group where the Amabel or Lockport Formations overlie the less permeable Fossil Hill (dolostone), Decew (dolostone and shale) and Rochester Formations (shale and siltstone). These springs can be perennial and yield high quantities of water; they form the headwaters of many small streams that drain the Escarpment face.

Along the upper portion of the Escarpment, on the dip slope, the surface drainage can be poorly organized with a very low drainage density. In this zone, the strata of the Abermerle Group may function as a karst aquifer and small karst landforms are common. Precipitation infiltrates the porous rock and percolates downward through a network of solutionally enlarged fissures, joints, and conduits. This zone is of variable width and is not present across the full length of the Escarpment.

In the Bruce Peninsula, Cowell and Ford (1983) map this as zone of karst (holokarst) that is lacking in surface channels. In that setting, the precipitation that is captured by the karst is thought to supply springs that discharge on the scarp face or at the base of the scarp.

There are several examples of perennial streams that flow along gently sloping areas in the direction of the scarp face but sink in the karst zone. The sinks are either discrete depression landforms or standing water bodies. Cowell and Ford (1983) describe five such fluviokarst basins that occur on the Bruce Peninsula; other examples are known from the Niagara Peninsula and Grey County. These sinking streams and ponds supply discharge to springs that discharge on the scarp face and base.

Also on the dip slope there are extensive areas of wetlands and shallow water bodies that are located where the relief is gentle and the surficial materials are poorly drained. The catchments of these wetlands and water bodies, in turn, are the headwaters of streams that either drain east and north down the scarp face, or southwest in the down dip direction. The larger streams that originate on the dip slope and flow over the scarp face have incised their channels through the Escarpment and take baseflow from the springs and seeps that issue at the contact zones described above. The streams that drain west along the dip slope receive baseflow from shallow aquifers in the strata of the Abermerle Group.

2.2.5 Hydrological Significance of the Niagara Escarpment

The area that is bounded by the Niagara Escarpment Plan Area captures most of the cuesta landform of the Escarpment that is present in southern Ontario. Significant areas of groundwater recharge, transmission, and discharge involving strata of the Abermerle Group, however, do not fall within the boundary of the Plan Area. This is a weakness of the current Plan. This issue was addressed in certain areas with the addition of GBP lands through the Protected Countryside designation.

In the broader sense, the strata that are exposed on the Escarpment also play an important water resource role across areas where the same strata occur in the shallow subsurface. These bedrock units provide abundant supplies of high quality groundwater to municipalities and rural landowners. Also, groundwater circulating through these strata feed a large number of surface water bodies and streams that flow west on the dip slope or across the face of the Escarpment. The individual springs, and the baseflow that is supplied to streams and surface water bodies, are typically of low temperature and with relatively low concentrations of sulphate and nitrate. Thus, the groundwater that is recharged, stored, and discharged from these strata plays a key role in maintaining coldwater stream environments. **Many of the streams that issue from the Escarpment are among the most important and productive coldwater streams in southern Ontario.** Examples on the scarp slope of the Escarpment include Bronte Creek, Black Creek (Credit River), and the Beaver River, while examples on the dip slopes include the Rocky Saugeen River and Spring Creek.

From a water resource perspective, the Escarpment itself is significant because it:

i. contains bedrock and overburden aquifers that recharge, store, and transmit significant quantities of groundwater,
ii. provides baseflow to streams that drain over and through the Escarpment,
iii. supports a diverse set of coldwater streams, each of which constitutes an important and significant stream corridor ecosystem,
iv. serves as the discharge point for springs that issue from the scarp; and
v. provides a route for stream flow and surface waters to move from the dip slope to the base of the scarp.

The physical properties of the Amabel-Lockport-Guelph aquifers leave them highly vulnerable in some regions. Across large areas, these aquifers occur unconfined at the surface or in the shallow subsurface. They are also variable in their thickness (depth) and porosity. Where these units are karstic, the porosity and permeability may be very high. In addition, in karst regions, groundwater flow paths

often do not correspond to surface water divides. Consequently establishing flowpaths, delineating watershed areas, and undertaking water budget estimates in such terrain may present substantial difficulties. Many hydrogeological techniques that are designed to characterize the important physical properties of aquifers (porosity, permeability, hydraulic conductivity, transmissivity) are more difficult to use successfully in karst terrain. In addition, most numerical models that are used in groundwater studies do not perform well for karst aquifers.

Several key water resource issues have been identified with respect to the Escarpment. There have been increases in the demand for groundwater from the Amabel-Lockport-Guelph aquifer for crop and turf irrigation, livestock production, aggregate extraction, and settlement growth. In addition, there are several potential sources of contamination including:

i. the widespread use of road salts,
ii. poorly functioning septic systems,
iii. a real application of fertilizer in agricultural activities,
iv. abandoned water wells, and
v. landfill sites.

2.3 Comparison of the Oak Ridges Moraine and Niagara Escarpment

The materials above provide a very brief overview of the physical characteristics of the Moraine and Escarpment landforms, the nature of the aquifers associated with each, and their role in supplying high quality water to surface water bodies and groundwater users. These are markedly different features. The water resources associated with the Moraine rely on aquifers in overburden, while those of the Escarpment are mainly in aquifers in bedrock. However, there are some attributes that the two regions share in common, including:

i. the primary aquifers are shallow and largely unconfined,
ii. recharge into the aquifers is substantial and rapid, with little surface runoff in the
iii. recharge zones,
iv. groundwater flow paths cannot be easily established due to divergence between the groundwater and surface water divides,
v. the aquifers are highly vulnerable to contamination in local environments,
vi. the aquifers in each area are important sources of baseflow to surface streams, and
vii. the aquifers provide groundwater users with high yields and high quality water.

Recommendation 1

NEP water policies should be updated to be similar to water policies in the ORMCP. Although the Escarpment and Moraine landscapes are markedly different, there are important attributes that the two regions share and water policy should be broadly similar. Updating the NEP water policies is desirable, and the NEP should have similar water policies to the ORMCP, **but they need to be tailored to ensure the unique hydrological properties of the Escarpment are addressed.** Adjacent lands including GBP Protected Countryside lands and lands regulated through municipal official plans in the northern portions of the NEP area should also be included in water policy updating processes.

3.0 Processes for Modernizing Water Policies of the Niagara Escarpment Plan

Two parallel approaches are recommended to achieve the updated water policies identified in Sections 4 and 5 of this report.

The first approach should focus on policy development and changing processes that update technical and other water related policies in the NEP. This includes wording and technical details such as the requirements for watershed planning and updating NEP designation mapping. The latter should be based on re-mapping current designations using existing designation criteria with updated data and new mapping based on additional criteria such as source water protection. Short and mid-term changes should proceed through the existing harmonization process (see Appendix I) and through an NEC-initiated NEP amendment process, respectively. Substantive changes to NEP water policies including re-wording of Section 2.6 and adding new designation criteria should proceed through the longer-term process of the NEP 10-year review starting in 2015. These changes would alter requirements for development, and likely result in changes to plan designation boundaries and influence lands outside the NEP due to the nature of water boundaries. The 2015 review would provide the opportunity for all interested parties to fully participate in these substantial changes.

Each recommendation identified in sections 4 and 5 below includes a discussion of how it might proceed either through the short, medium, or long-term process.

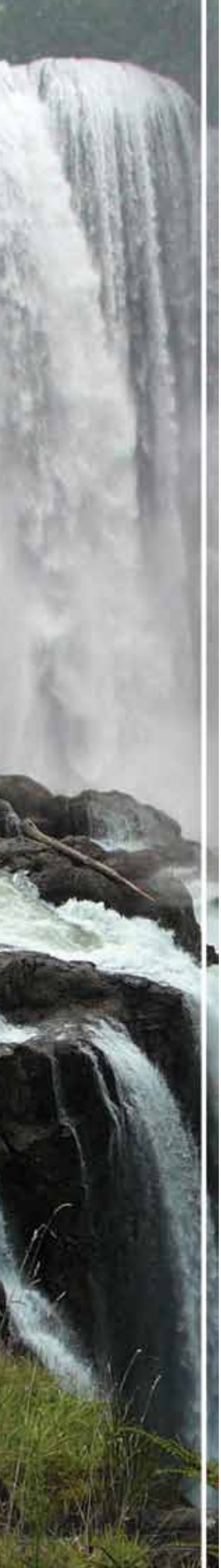
A second parallel approach is recommended to start in 2008 and run through 2015. This would be designed to build support for changes to water policies at the grassroots level through yearly water celebrations in two or three different Escarpment locations. The purpose of these would be to engage residents, civil society, and the media, and to create additional social capital so that there are volunteers to carry out implementation activities associated with water planning and restoration work. These celebrations could also be used to showcase local artists, highlight and generate sustainable ecotourism initiatives, and encourage government and individuals to promote policies that stress minimization of water use, implementation of water conservation, and the importance of limiting inter-basin water transfers. As well, the need for research on karst hydrology should be promoted. This could involve generating support for improving Niagara Escarpment Plan water policies among the academic community, government and the environmental NGO community.

Recommendation 2

Two parallel approaches should be initiated to update NEP water policies. The first approach should focus on short, mid and long-term processes available to update water policies including the existing harmonization process, an NEC-initiated NEP Amendment process, and the GBP / NEP / ORMCP review process scheduled to begin in 2015. The second approach should involve an outreach campaign designed to secure public support for stronger protection of Escarpment water resources to begin in 2009 and run through 2015.

Recommendation 3

The environmental NGO community should work with the NEC to secure research, stewardship, and outreach funding through mechanisms that are similar to those used by the Oak Ridges Moraine Foundation and Friends of the Greenbelt Foundation. These organizations are funded by the Ontario government and can provide non-government groups with the resources needed to carry out research, stewardship, and outreach activities. When compared with the Moraine and Greenbelt, the Niagara Escarpment has been largely excluded from this type of funding over the last 10 years. The NEC, the Minister of Natural Resources, and/or the Minister of Municipal Affairs and Housing may be in a position to promote the establishment of such a fund and then one or more or these agencies could administer it.



4.0 Oak Ridges Moraine Conservation Plan Technical Requirements for Water Planning

The ORMCP is supported by a comprehensive package of technical papers that address implementation of the plan. The NEP has no similar technical support for watershed or hydrological issues. This is considered one of the important areas to address through updating the NEP. **The NEP needs new water policies that are supported by technical information requiring new research methods such as aquifer mapping, watershed plans, and water budgets.** Including such provisions within the NEP will require a complete re-writing of section 2.6 Development Affecting Water Resources.

The technical papers listed below are those that are directly related to water policy and water resource issues on the ORM. The technical papers that operate at the watershed and subwatershed scale are papers #9 through #13, as well as the document on aquifer vulnerability mapping. These papers address essential data needs and management tools required by the watershed plans (e.g., water budget and water conservation) as well as measures that are designed to limit or prevent degradation of water resources (papers #11 to #14 and vulnerability mapping). The balance of the technical papers focus on mitigation related to specific localized water resource issues, such as sewage treatment, recreation use, and stormwater management. The latter papers are not addressed in this report.

Technical Papers

#9 Watershed Plans
#10 Water Budgets
#11 Water Conservation Plans
#12 Hydrological Evaluations for Hydrologically Sensitive Features
#13 Subwatersheds (Impervious Surfaces)
#14 Wellhead Protection
#15 Recreation Plans and Vegetation Management Plans
#16 Sewage and Water System Plans
#17 Stormwater Management Plans
Oak Ridges Moraine Aquifer Vulnerability Mapping

4.1 Watershed Plans (Technical Paper #9)

Municipalities are required to develop watershed plans to be in compliance with the water provisions of the ORMCP. Technical paper #9 outlines and promotes an ecosystem-based approach to integrated watershed management and the use of adaptive environmental management in the implementation of the plan. A watershed plan must include:

i. a water budget and water conservation plan,
ii. land use and water use management strategies,
iii. a framework for the implementation of the watershed plan, including (where and when required) detailed planning and implementation at the local scale—the latter may include the need for subwatershed plans or implementation plans to address specific subjects,
iv. an environmental monitoring plan,
v. specific provisions to guide management practices and programs to address issues related to pollution, such as the use of pesticides and road salt, and
vi. the development of criteria that are used to evaluate the protection of water quality and quantity as well as sensitive hydrological features and functions.

The overall goal of this approach is to contribute to the maintenance, improvement, and restoration of the ecological integrity of the Moraine—of which the hydrological integrity is central. Under this strategy, watershed plans are incorporated into the official plans of the municipalities and the

provisions enforced through by-laws. The requirements of the watershed plan ensure that a series of procedures will be designed to limit or prevent degradation of the water resources, and also to mitigate or restore elements that have been adversely impacted by development or are likely to be impacted by future development.

Technical paper #9 reviews the procedures needed to generate the comprehensive watershed plan, implement the plan, and monitor the efficacy of the plan.

Recommendation 4

At present, there is no comprehensive and consistent watershed planning approach undertaken on the Escarpment. It is recommended that at the watershed and subwatershed scales, municipalities, conservation authorities and **the Niagara Escarpment Commission should undertake planning to address protection of the function and integrity of the hydrological system of the Escarpment and lands in the vicinity.** At a minimum, the plan should include each of the components that are contained within the ORMCP. Those individual components should be specifically designed to address the hydrology of the Escarpment. Attention should be given to the highly variable nature of the bedrock and overburden aquifers.

In addition, watershed plans should include separate language and supporting technical papers that speak to resource issues on the Escarpment that are not observed or may be considered less important on the Moraine. Of particular importance are:

i. the hydrology and hydrogeology of large bedrock quarries located on and adjacent to the Escarpment and the effect of these quarries on the water budget and on sensitive hydrological features, and
ii. the protection of cold water streams and fisheries habitat with attention given to the role of Escarpment aquifers in maintaining those streams.

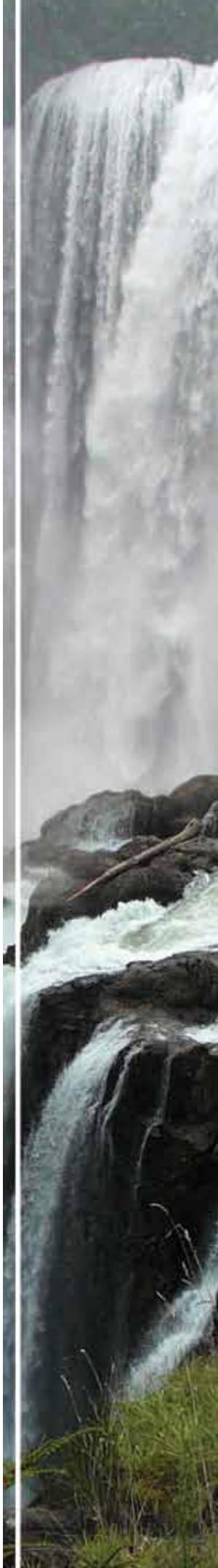
Recommendation 5

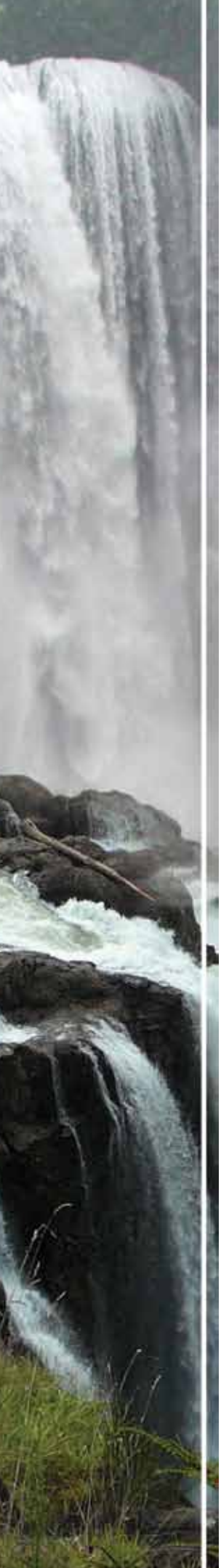
Watershed plans should be reviewed periodically. The water budget and water conservation components should be revised if the system has been altered from its original state (when the initial plans were laid out) or if new information should become available. Of particular concern is the possibility that the water budget will be altered by increases in evapotranspiration that may occur due to warmer drier summers. Under such conditions, reduced summer and fall season stream flows are anticipated. **Watershed planning should be designed to be sensitive to changes in climate and adaptive in response to changing conditions.**

The recommendations that call for the development of watershed plans, including water budget and water conservation planning would require additional staffing resources at conservation authorities and at the NEC. These organizations would need to increase their staffing capacity, particularly in the area of hydrogeology.

Recommendation 6

The environmental NGO community should work with the NEC and other Escarpment partners to develop a information management system that can be used for data input, storage, and retrieval to facilitate the coordination, sharing, and updating of Escarpment and related data and information that can be accessed by all partners.





Recommendations 4, 5, and 6 should proceed in the mid-term through an NEP Amendment process. Establishing a watershed planning provision and creating an information management system will help ensure that water information needed for the 2015 GBP / NEP / ORMCP reviews is collected and available to all interested parties.

4.2 Water Budgets (Technical Paper #10)

The ORMCP requires municipalities to prepare water budgets for every watershed whose streams originate in that municipality. In its most restricted sense, a water budget is a quantitative treatment of the water balance equation. In this equation, discharge from a watershed (output) is a function of gains through precipitation (input), losses from evapotranspiration (output) and any changes in storage that occur over that interval. In the ORMCP, a more comprehensive view is taken of the water budget. The ORMCP requires that a water budget will quantify the components of the water balance equation, including precipitation, evapotranspiration, and changes in storage but also groundwater inflow and outflow, surface water outflow, water withdrawals, and water returns. The ORMCP also stipulates that the surface and groundwater flow systems should be characterized through a modelling process. The budget should identify the availability, quantity, and quality of water sources, set targets to meet the needs of the ecosystem, and provide for monitoring the water budget.

This approach requires that all the components (stores or reservoirs) of the system be identified and the flux of water between these components be measured or estimated through modelling calculations. The rationale behind such a comprehensive treatment is to ensure that the hydrological integrity of the system be preserved as well as the ecosystem services that it provides.

In Technical Paper #10, there is a review of the components of the water budget and a detailed methodology is outlined for undertaking such analyses. In the methodology, the major steps are to:

i. set project goals,
ii. determine the spatial and temporal extent of the system of interest,
iii. collect and analyse data,
iv. develop a conceptual model of the system, and
v. produce a numerical model of the system.

The water budget is calculated from the numerical model. It may then be applied to set watershed targets, and be tested in a variety of scenarios.

The requirements for water budget modelling as set out in Technical Paper #10 are ambitious. The modelling of groundwater aquifers where the subsurface distribution of materials is not uniform requires the use of sophisticated three dimensional approaches. The best performing models have stringent data requirements and are costly. The more commonly used models have limitations to the types of aquifers that can be effectively described.

Unfortunately, hydrological models typically perform poorly in karst areas. Not only may surface and groundwater divides not coincide, but conduits within a karst aquifer provide routes for the rapid movement of high volumes of water. Traditional sampling techniques that are used to characterize the porosity of aquifers may not capture the distribution of cavernous porosity. Where the aquifers of the Escarpment display karst porosity, it is less likely that the traditional models would be effective. There are models available that can be used in karst terrains with some degree of success, but the approaches that are used by karst hydrogeologists are not confined to numerical modelling. Any policy that requires water budget estimates should reflect the unique character of these aquifers.

With increasing pressures on the water resources of the Escarpment, it would be desirable to require approval authorities—Conservation Authorities and municipalities in particular—to undertake water budget calculations as part of a watershed planning process.

Recommendation 7

Water budget estimates on the Escarpment and adjacent lands should be undertaken at the subwatershed scale by approval authorities, in particular Conservation Authorities and municipalities. The expected benefit would be better informed decision making with respect to water taking for a variety of activities while maintaining the ecosystem services of those water resources. Where the bedrock aquifers show evidence of karst porosity, more detailed investigations should be mandated. These examinations should be undertaken using techniques that are consistent with best practices in karst hydrogeology. Due to the cost of such investigations, it is recommended that areas of the Escarpment under increasing development pressure and areas with potentially threatened groundwater resources be targeted initially for such investigations.

Recommendation 7 should proceed in the mid-term through an NEP Amendment process. The establishment of water budget estimates as part of the planning process will help to ensure that water information needed for the 2015 GBP / NEP/ ORMCP reviews is available.

4.3 Water Conservation Plans (Technical Paper #11)

The ORMCP requires municipalities to prepare water conservation plans for every watershed whose streams originate in that municipality. A water conservation plan includes the following components:

i. identification of goals for public education and water conservation,
ii. development of a water use profile and a forecasting of demand,
iii. evaluation of plans for water related facilities,
iv. identification and evaluation of water conservation measures, incentives for water conservation, and promotion of these measures and incentives,
v. analyses of the costs and benefits of water conservation,
vi. a requirement for the use of specific water conservation measures and incentives, and
vii. an implementation plan that reconciles the demand for water with the conservation measures and incentives.

The rationale for undertaking the water conservation plan is to balance the water needs of over 250,000 persons with maintaining the proper functioning of the components of the hydrological system and its overall integrity. On the Moraine, the pressure on resources is sufficient to require conservation measures.

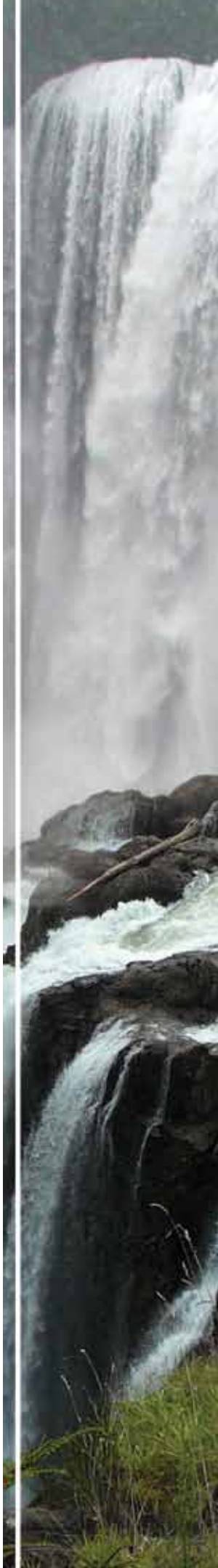
Technical Paper #11 outlines the key steps in formulating a water conservation plan as well as a range of measures and incentives to achieve the goals of the plan. In keeping with other policies on the Moraine there is follow up monitoring to examine compliance with the conservation plan.

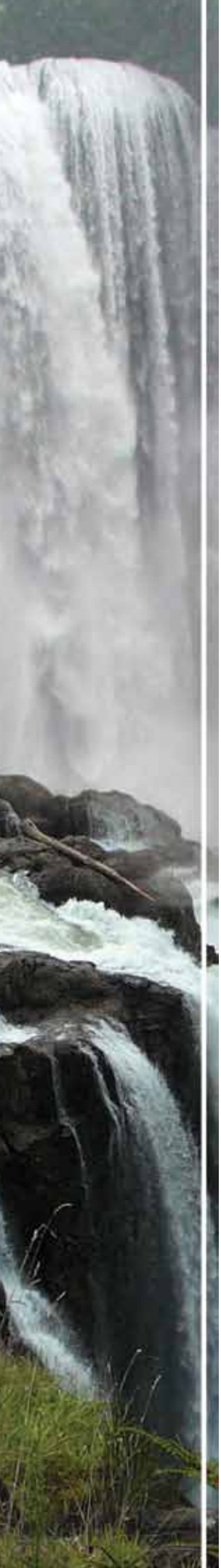
The water conservation plan as outlined in the ORMCP is a powerful tool to address the current and forecast demands at the subwatershed scale. The public involvement, education aspects, and incentive provisions are strong elements of the approach. To be effective, the plan requires good estimates of the components of the water balance that arise from the water budget exercise.

Water taking permits have historically been issued for streams or aquifers that originate or traverse the Escarpment and its adjacent lands without comprehensive knowledge of the water balance or guidance of a conservation plan.

Recommendation 8

Water conservation planning similar to that utilized for the ORMCP should be required of the NEP in the development of water policy for the Escarpment. This should be considered a long-term recommendation and proceed through the GBP / NEP / ORMCP 2015 reviews.





4.4 Hydrological Evaluations for Hydrologically Sensitive Features (Technical Paper #12)

The ORMCP identifies hydrologically sensitive features such as permanent or intermittent streams, wetlands, kettle lakes, and seepage areas and springs. Restrictions are placed on developments or activities that may adversely impact these features. A vegetated buffer zone of not less than 30 metres is established around these features. In addition, a second zone of between 90 to 120 metres surrounds the inner buffer. This latter zone is the called the minimum area of influence. Some activities such as forest, fish and wildlife management, flood and erosion control, transportation and utility infrastructure, and low intensity recreation may be permitted within the feature and its vegetative protective zone. Other developments or activities may be undertaken within the minimum area of influence. In both cases, there is a requirement to undertake a Hydrological Evaluation. These evaluations must:

i. demonstrate there will be no adverse impact on the feature or its function,
ii. identify practises that will maintain, improve or restore the feature, and
iii. assess the adequacy of the vegetation buffer in protecting the feature, and if needed, provide for the maintenance and improvement of that vegetation protection zone.

The rationale to support the protection of these sensitive hydrological features arises from recognition in the ORMCP of the importance of the components of the hydrological system and its overall integrity. These features are critical stores and linkages within that system.

In Technical Paper #12 there are clear definitions of these features and a methodology for undertaking a hydrological evaluation is outlined. The methodology includes a site assessment, a forecast of the likely impacts of the development, the implementation of mitigation techniques, and follow up monitoring. A detailed table is provided that outlines the potential impacts that arise from a range of activities and possible mitigation strategies.

The methodology could be improved by undertaking a Stream Corridor Analyses to define the sensitive areas adjacent stream channels using functional criteria rather than a buffer of uniform width. Through the Natural Channel Systems Initiative, the Ontario Ministry of Natural Resources has developed a series of guidelines on Stream Corridor Analyses. A stream corridor normally includes a channel, floodplain, and riparian zone. When a stream ecosystem is stable and healthy there is an equilibrium among channel form, flow conditions, water quality, habitat, and biodiversity. Using stream corridor analyses it would be possible to identify river reaches that are potentially more sensitive to disturbance and to adjust the boundaries of the sensitive areas accordingly. This analysis could be made part of a hydrological investigation.

Recommendation 9

The NEP should have provisions to protect sensitive hydrological features. The policy should apply to all lands that fall within the Plan boundary. The list of sensitive hydrological features of the Escarpment would be similar to that of the Moraine and should include permanent or intermittent streams, wetlands, ponds and lakes, seepage areas and springs, sinkholes (dolines), sinking stream points, and corridors of high aquifer porosity (conduits). In evaluating sensitive stream corridors, the policy should adopt guidelines similar to those outlined through the Ontario Ministry of Natural Resources's Natural Channel Systems Initiative. Due to the changes to designation criteria and associated mapping, the protection of sensitive hydrological features should be pursued during the 2015 GBP / NEP / ORMCP reviews.

Sinkholes in karst terrain have a wide range of forms. It may be difficult, however, to assess the hydrological importance of a single feature. For example, a sink may appear as a small, shallow dry depression but it may have a relatively large catchment or capture substantial flow intermittently. Criteria would need to be established to define the dimensions and characteristics of these features. Sinking stream points would include all locations where surface streams may enter the bedrock. While the streams themselves would be captured by the first feature in the list, the sink point should be treated as a separate feature and given more meaningful protection. In addition, implementation of

such protection would be less problematic in areas that are designated as Natural, Protection, Rural, Recreation, and Minor Urban Centres (collectively 94% of the Plan Area). In the Urban Areas, the higher density of development would require alternate provisions for protection of sensitive hydrological features. In the Mineral Resource Extraction Areas, protection of hydrologically sensitive features may not be possible within the boundaries of the quarries and pits given the nature of the activity.

4.5 Subwatersheds (Impervious Surfaces) (Technical Paper #13)

In the ORMCP, outside of the Settlement Areas, the proportion of each subwatershed that may be rendered impervious is limited to no greater than 10%. In addition, the plan calls for approval authorities to work to maintain at least 30% of each subwatershed in natural vegetation. Within Settlement Areas, the plan calls for development approvals to be mindful of the need to maintain, enhance, and restore vegetated areas and to limit impervious surfaces. These surfaces include rooftops, roadways, parking lots, driveways, and similar materials that have a very low infiltration capacity.

The main reasons for limiting the extent of these surfaces are to reduce the production of surface runoff and to maintain soil infiltration and recharge to the aquifers. As the percentage of impervious surfaces in a watershed increases, the production of surface runoff also increases. Impervious surfaces have the potential to deliver large quantities of runoff to stream channels in a short period of time. This runoff may be contaminated with a variety of materials such as fertilizer, hydrocarbons, road salt, and sediments. The high flow volumes can cause stream channels to incise and erode their banks at accelerated rates. Where the percentage of impervious surface is high, the recharge to underlying aquifers is reduced. This in turn, lowers the elevation of the water table and the amount of baseflow that moves to surface water bodies drops. The overall impact on surface water bodies is to create a flashy discharge regime, increase the temperature, sediment, and pollutant load, and to stress aquatic biological communities.

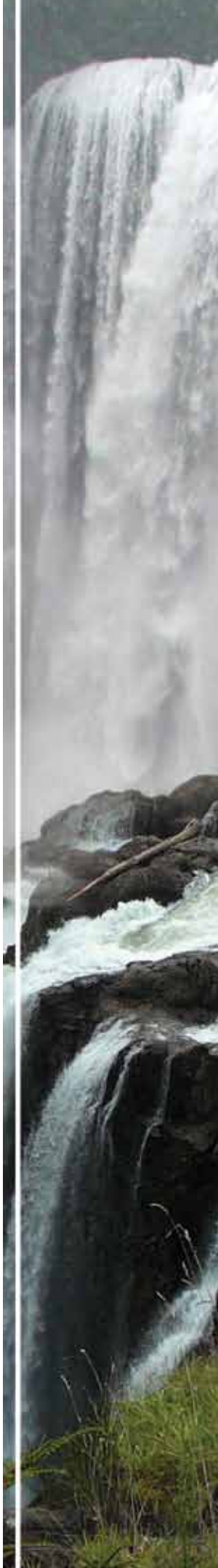
In Technical Paper 13 there is a review of potential procedures that can be used to assess the extent of impervious surfaces in a subwatershed. Of the three techniques suggested, the most robust is mapping using image analyses (remote sensing). In addition, there is a method presented to estimate future changes in impervious cover, as well as guidelines on implementation and reducing the amount of such surfaces.

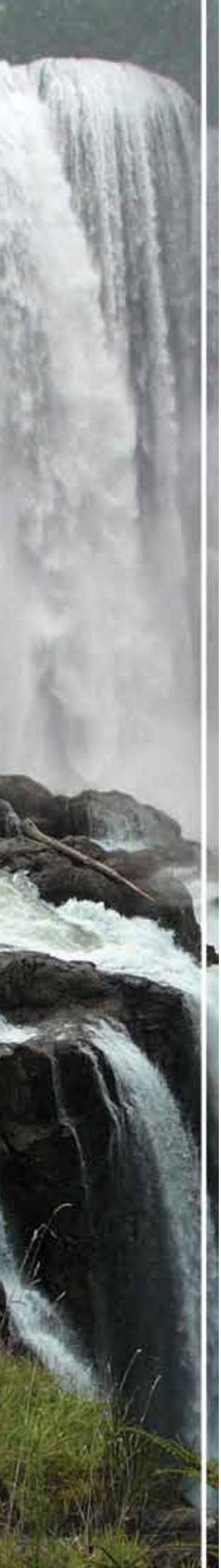
Recommendation 10

The principle of limiting impervious surfaces and increasing infiltration should be considered for water policy development in the NEP. The policy should be applied to the lands that are in the Escarpment Natural Area, Escarpment Protection Area, Escarpment Rural Area, and Escarpment Recreation Area designations. The Minor Urban Centres and Urban Areas should be treated in a manner that is similar to the Settlement Areas of the ORMCP. In the ORMCP Settlement Areas policies, some regard is given through approval requirements for development activities that would increase impervious surfaces. The general model and the procedures outlined for the Moraine could form the basis of a policy, with adjustments needed to address the specific character of the Escarpment. This is a recommendation that should be pursued through harmonization with the GBP.

The expected positive outcomes would be the:

i. maintenance of groundwater recharge,
ii. protection of baseflow to cold water streams, and
iii. maintenance of water quality in streams and other surface water bodies.





4.6 Oak Ridges Moraine Aquifer Vulnerability Mapping

The ORMCP places restrictions on certain activities within areas that are mapped as zones of high aquifer vulnerability. The prohibited uses include:

i. generation and storage of hazardous waste or liquid industrial waste,
ii. waste disposal sites and facilities, organic soil conditioning sites, and snow storage and disposal facilities,
iii. underground and above-ground storage tanks that are not equipped with an approved
iv. secondary containment device, and
storage of toxic contaminants (as per Schedule 3 in the Plan).

Areas of high aquifer vulnerability are recharge zones where an aquifer is typically unconfined and possessing a high permeability. Toxic spills in these areas can produce a plume of contaminants that spread rapidly and have the potential to have an adverse impact on groundwater wells and baseflow to surface water bodies through springs and seeps. The movement of spills to the saturated zone is a function of the depth to the water table and the hydraulic conductivity of the materials in the unsaturated zone. Where the water table is shallow and the materials highly permeable, aquifer vulnerability is high.

For the ORM, the areas of high aquifer vulnerability were mapped using standard techniques that function reasonably well at a broad scale. Data used in the assessment are the water well database (MOE), digital topographic data (MNR) and geological information (GSC, OGS). The confidence in the mapping is high when there are many water wells available to permit proper delineation of the water table and there are good data on the composition of the materials. However, in sensitive areas more detailed investigations are required.

Recommendation 11

NEP water policy should address the issue of aquifer vulnerability. It is recommended that areas of high vulnerability be mapped and restrictions placed on activities in that zone, such as those outlined in the ORMCP. This recommendation should be pursued during the GBP / NEP / ORMCP 2015 reviews. However, background work should start immediately with an assessment of the existing data and the contributions that the ongoing source water protection work by Conservation Authorities and municipalities might make.

Due to the highly variable porosity characteristics of the Amabel-Lockport-Guelph aquifer, and the uneven distribution of glacial cover, the methods used to define aquifer vulnerability would require refinement. Areas that exhibit cavernous porosity would be of the highest vulnerability, however, the types of data used in the Moraine mapping would not capture all of these sensitive areas. Unfortunately, this would require the collection of considerable amounts of new data collected through fieldwork.

Alternatively, the mapping could be undertaken at a general scale using the existing data but with a more stringent conservation threshold in establishing the boundary between vulnerable and non-vulnerable areas. It is recommended that development proposals or activities within the broader vulnerable zone require a site assessment. This would allow for more stringent rules to be applied based on site specific findings. Alternatively, all uses with high contaminant potential could be prohibited within the NEP area.

4.7 Wellhead Protection (Technical Paper #14)

There are provisions in the ORMCP to prevent the potential contamination of groundwater wells by establishing restrictions on the types of materials, substances, and activities that may be stored, utilized, or undertaken in areas that are mapped for wellhead protection. The restrictions do not target the individual landowners personal use of these substances but are rather geared to the commercial sector.

Technical paper #14 outlines the range of materials that are to be excluded from these areas. Schedule 3 of the ORMCP prohibits the storage of hydrocarbon fuels, solvents, agricultural products such as pesticides, herbicides and fungicides, and inorganic fertilizers, road salt, construction equipment, and other toxic compounds as defined in the plan. The generation and storage of hazardous waste or liquid industrial waste is also prohibited, as are waste disposal sites and facilities, organic soil conditioning sites, and snow storage and disposal facilities.

A broader zone is also defined within which there are some restrictions. Within the boundary of the zero to two-year travel time, there is a prohibition on animal agriculture, the storage of animal manure, and the storage of agricultural and construction equipment. The zero to two-year travel time refers to the length of time that it would take for water that infiltrates the surface to move to the wellhead. The rationale for these provisions is to prevent contaminants from infiltrating the ground surface in close proximity to a well. The effects of such events are to reduce the quality of the water supply and potentially spread contaminants to the aquifer.

The prohibitions in the ORMCP do not apply to facilities that were established or were permitted prior to November 15, 2001. Technical Paper #14 outlines, for the operators of these facilities, procedures that are required to implement the provisions in the plan. The operators are required to:

i. establish an environmental policy,
ii. identify the substances that pose a potential risk,
iii. evaluate potential routes to the sensitive areas, and
iv. implement a management strategy designed to limit potential contamination and respond to spills when they occur.

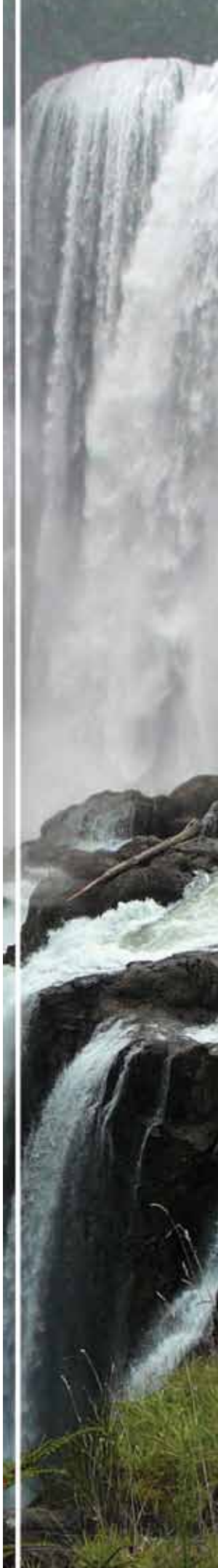
Technical Paper #14 also encourages the use of non-toxic alternatives and outlines practices that help to prevent the release of toxins and highlights the importance of monitoring.

In 2006, the Government of Ontario passed the Clean Water Act (CWA) which has provisions to limit contamination of drinking water supplies including groundwater wells (Government of Ontario, 2006). The Act requires communities to identify drinking water sources and develop strategies to protect those supplies through the creation of Source Protection Plans. The CWA provisions are administered through Source Protection Authorities that cover the same geographic areas as Conservation Authorities. Each of the Source Protection Plans has elements that would address aquifer vulnerability and wellhead protection. The provisions outlined in the CWA and the ORMCP address similar concerns regarding wellhead protection. However, the provisions in the ORMCP cut across municipal and conservation authority (watershed) boundaries and should ensure a more standardized approach across the region. It is recommended that a similar set of provisions be mandated for the NEP and coordinated by the NEC.

Recommendation 12

Water policies in the NEP should provide for the protection of municipal groundwater wells. It is recommended that Escarpment water policy be developed that would require the mapping of wellhead protection areas and the travel times to those wells. Within these zones, restrictions of the type outlined in the ORMCP should be considered. This recommendation should be pursued through the 2015 GBP / NEP / ORMCP reviews.

A potential problem is establishing the zero to two-year buffer. In karst areas, groundwater moves preferentially along conduits and fractures and may not be modelled effectively by the techniques employed in the Moraine study.



5.0 Evaluation of NEP Policies Relevant to Water Resources

This section evaluates NEP policies relevant to water including:

i. water language and definitions,
ii. water policy sections of both Plans,
iii. plan designation criteria, boundaries and permitted uses,
iv. Niagara Escarpment Commission and delegation of development control,
v. development control,
vi. cumulative impact assessment provisions, and
vii. monitoring provisions.

5.1 Water Language and Definitions

The language in the NEP reflects scientific knowledge from the 1980s. The objective in the NEP dealing with water, for example, states:

"To maintain and enhance the **quality** and character of natural streams and **water supplies**."

Wording in section 2.6 (New Development Affecting Water Resources) states:

"The objective is to ensure that new development affecting streams, watercourses, lakes, wetlands, and groundwater systems will have minimum individual and cumulative effect on **water quality and quantity**, and on the Escarpment environment."

In contrast, **the ORMCP contains water science language that reflects current knowledge.** For example the introductory section states that the:

"Plan is… **ecologically** based…"

The vision states that:

"… hills that provide form and structure to south-central Ontario, while protecting the **ecological and hydrological features** and functions that support the **health and well-being** of the region's residents and **ecosystems.**"

This wording captures recent advances in ecosystem science in the areas of ecological integrity bringing into the discussion thinking in terms of hydrologic structure and function. In contrast, NEP language focuses on water supply, quality, and quantity.

Definitions associated with water policies in the NEP are also outdated and need to be updated. A listing of ORMCP water related definitions is included in Appendix I.

Recommendation 13

The **wording in the NEP should be adjusted and modeled after that in ORMCP to reflect current thinking on water science**, based on ecological integrity and hydrological function, structure, and restoration. This wording should be adapted for use in the following sections of the NEP:

Introduction, Purpose, Objectives,
1.3 Escarpment Natural Area,
1.4 Escarpment Protection Area,
1.5 Escarpment Rural Area,
1.6 Minor Urban Centre,
1.7 Urban Area,
1.8 Escarpment Recreation Area,
1.9 Mineral Resource Extraction Area,
2.1 Development Criteria Introduction,
2.6 New Development Affecting Water Resources,
3.1 The Niagara Escarpment Parks and Open Space System,
3.1.1 Objectives, and Definitions (Appendix 2).

Niagara Escarpment Plan definitions related to water policies should be updated based on ORMCP definitions and any additional definitions required based on the unique nature of the Escarpment landscape. This wording update should proceed through the current plan harmonization process.

5.2 Water Policy Sections of the NEP and ORMCP

The ORMCP water policies are organized around the technical issues identified in Section 3 of this report. Part III of the ORMCP, the section on water policy, is structured (and numbered) as follows:

Protecting Ecological and Hydrological Integrity

19. Purpose and application
20. Supporting connectivity
21. Minimum area of influence and minimum vegetation protection zone

Key Natural Heritage Features

22. Key natural heritage features
23. Natural heritage evaluation

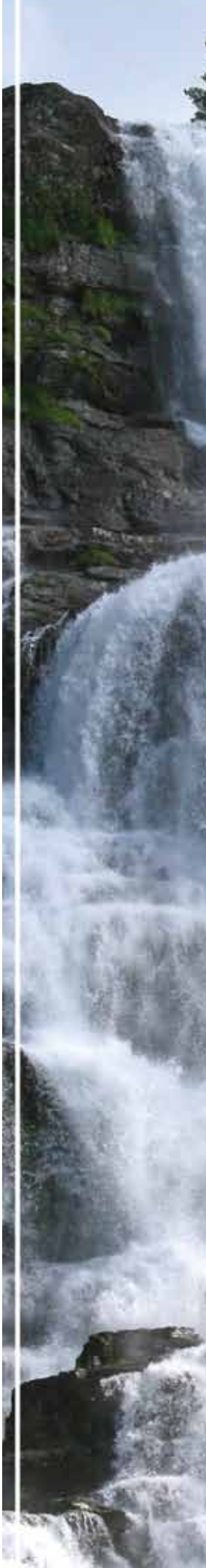
Hydrological Features

24. Watershed plans
25. Water budgets and conservation plans
26. Hydrologically sensitive features
27. Subwatersheds
28. Wellhead protection areas
29. Areas of high aquifer vulnerability

Section 2.6 of the NEP on New Development Affecting Water Resources is organized based on these issues and features:

i. water quality
ii. water quantity
iii. wetlands
iv. fisheries
v. flood plains
vi. ponds

The ORMCP framework reflects our current level of water science. NEP policies are outdated.



Recommendation 14

The ORMCP water policies section should be used to guide the updating of NEP water policies. This recommendation should be pursued through the GBP / NEP / ORMCP 2015 reviews due to significant changes expected to NEP development permit application requirements.

Efforts should be made to discuss the history of success of existing NEP water resource policies with NEC staff and others including academics, consultants, and environmental NGOs to identify those that were helpful in protecting the Escarpment. These should be merged within any new framework developed.

5.3 Plan Designation Criteria, Boundaries and Permitted Uses

The NEP was one of the first land use plans to develop a designation scheme and identify criteria designed to explicitly map protected natural areas or features. This is one of the principal strengths of the NEP. This is the main protective strength of any land use plan, in fact: the ability to delineate on a map a certain land use designation and attached to it permitted uses. Any use not included in the permitted uses list is not allowed. The suite of land use designations included in the NEP—Escarpment Natural and Escarpment Protection in particular—have been the source of the Plan's success over the 23 years of its implementation. **Land use designations and associated permitted uses have done more to protect water resources on the Niagara Escarpment than any other aspect of the NEP.**

In the NEP area, for example, no new subdivision development is permitted in the Escarpment Natural, Protection, or Rural Areas. This means that these areas will remain unpaved—and therefore allowable of water infiltration—and thus provide better conditions for maintenance of hydrological integrity. Similarly, aggregate resource extraction is excluded from Escarpment Natural and Protection Areas and permitted only by Plan Amendment in Escarpment Rural Areas. Excluding aggregate resource extraction from these areas similarly allows the areas to provide better conditions for maintenance of hydrological integrity.

The development criteria policies of Section 2.6 (New Development Affecting Water Resources) apply after development has been approved, setting out criteria for development. Excluding development through permitted uses is a stronger way to protect water resources than through development criteria. With new aggregate extraction permitted only by amendment in Escarpment Rural Areas and subdivision development limited to Urban Areas and some Escarpment Recreation Areas, the NEP has been more successful than most land use plans at focusing development to areas that are less vulnerable to water impacts. Major concerns remain, however, with potential aggregate extraction approvals in Escarpment Rural Areas via Plan Amendment.

Recommendation 15

Current permitted uses in Escarpment Natural Areas and Escarpment Protection Areas should be maintained. **A prohibition on new mineral resource extraction operations should be considered during the GBP / NEP / ORMCP 2015 reviews.** This prohibition would be based on the evident inability of the current NEP policies to prevent any new aggregate operations from being approved and potential ecological impacts of aggregate extraction. (For a discussion of this issue see, for example, the Environmental Commissioner of Ontario's Annual Report, 2006-2007).

ORMCP designations, specifically Natural Core and Natural Linkage, are similar to NEP designations in that they identify permitted uses. These designations were based on both environmental features such as wetlands and traditional mapping such as ESAs and ANSIs, but were also based on conservation biology science. Conservation biology science provided for these designations to capture extensive

areas and create a regional natural heritage system. Conservation biology played a role in the planning and protection of long, wide corridors along the moraine (Whitelaw and Eagles, 2007). Conservation biology science was used to develop various scenarios for the Moraine Advisory Panel, the multiparty collaborative group that made the recommendations on Moraine protection the government used to create the ORMCP. The ORMCP includes 38% Natural Core and 24% Natural Linkage resulting in wide (> 2km) natural corridors across the entire moraine.

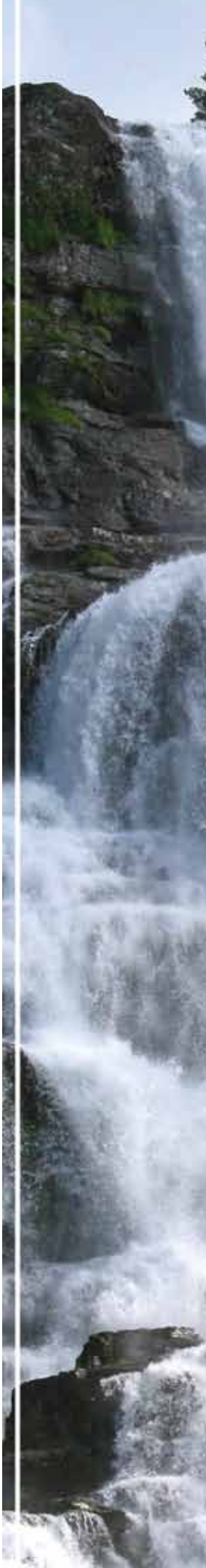
NEP designations are out of date from both a terrestrial and water science perspective. Water and terrestrial ecosystems are closely interrelated and thus terrestrial ecosystem protection must also be considered in any discussion of updating water policies. Designation criteria that protect larger terrestrial areas have greater value in protecting water resources. A number of initiatives have been exploring the need to revise NEP designations. First, Whitelaw et al. (2001) carried out a pilot study in Halton Region applying the 1992 Geomatics International natural heritage system criteria developed for the Oak Ridges Moraine Technical Working Committee (Geomatics International, 1993). Whitelaw et al. (2001) found that these criteria would significantly add to Escarpment Natural and Protection lands through increased core and corridor lands. It should be noted that these criteria were substantially improved upon for the final mapping of the ORMCP core and linkage designations. Second, work by the NEC on the Milton Outlier, in an effort to update the land use designation boundaries (within the existing outer boundary of the NEP Area) indicates that new information (such as additional and updated ESA, ANSI, and wetlands mapping) applied to existing designation criteria for Escarpment Natural and Protection Areas would result in significant increases in size of these land use designations on the Outlier (Niagara Escarpment Commission, 2005). There would be a consequent reduction in the size of the Escarpment Rural Area.

Recommendation 16

The **NEP designations should be updated in a two-phased process** for the purpose of enhancing protection of water resources. The first phase should proceed through a Plan Amendment to update existing designation boundary mapping based on new information (such as ANSI, ESA, and wetland mapping). The second phase should involve developing and presenting new designation criteria to the 2015 GBP / NEP / ORMCP reviews that reflect the most sophisticated terrestrial ecology and water resource science. This means building on the existing designations to include additional criteria that would capture core and linkage areas and water features unique to the Escarpment's karst environment (e.g., sinks and springs).

As already discussed, **the outer boundary of the NEP is inadequate for protecting water resources associated with the geology, geomorphology, or hydrology of the Escarpment.** Although the boundaries of the GBP Area were not established using a single landscape criterion, the addition of the Protected Countryside lands in the GBP created areas adjacent to the NEP. The Greenbelt has the potential to enhance the protection of the water resources of the Escarpment and environs. Of particular note are areas of Niagara, Hamilton, Halton, Peel and Wellington, where the Greenbelt includes regions where the Amabel-Lockport-Guelph aquifers are found in shallow subcrop, and areas below the Escarpment, where the Greenbelt extends along the riparian corridors of major streams that drain into Lake Ontario (Halton and Peel Regions).

Unfortunately, GBP policies have a weaker system of protection. The Plan has one designation, Protected Countryside with three geographically-specific policy areas: Agricultural System, Natural System and Settlement. The Natural System is composed of the Natural Heritage System, Water Resource System and Key Natural Heritage Features and Key Hydrologic Features. The Natural Heritage System is not a designation—it is an overlay, and so it has no permitted uses. Permitted uses are those set out within the Prime Agricultural Areas and Rural Areas of associated municipal official plans. This approach is significantly weaker than the approach used in both the NEP and ORMCP.



Recommendation 17

Stronger GBP policies through the GBP review starting in 2015 should be pursued in order to **ensure that GBP lands adjacent to the NEP area are properly protected with respect to water resources.** Similarly, stronger protection is required for lands regulated through municipal official plans adjacent to NEP lands in the northern portion of the Plan area. This may be accomplished most effectively through participation in Official Plan review processes as they occur.

5.4 Niagara Escarpment Commission and Delegation of Development Control

Despite periods during NEC's long history when it has tilted more in favour of development, the NEC has most often proven to be an adequate—and often superior—mechanism for protecting the Escarpment. This is because the NEC administers the Plan singularly in a consistent manner along the entire Escarpment. This also makes NEC decision-making less complicated to monitor compared to the implementation of the ORMCP by numerous municipalities. There have been several attempts to return development control of the Escarpment to the upper-tier municipalities (e.g., Niagara Escarpment Hearing Office, 1993). Harmonization processes may be an opportunity for delegation proponents to renew their efforts to have responsibility for the Plan's implementation returned to municipalities in an effort to weaken enforcement. The basis for such a call would be the fact the ORMCP and GBP are implemented through municipalities. **The success of the unique combination of NEP implementation through the NEC should be promoted and highlighted.**

The NEP uses a unique system of development control rather than zoning. This system of development control allows landowners, developers, consultants, and NEC staff to design development to fit the local landscape and better protect the local environment rather than be potentially constrained by zoning with rigid side, rear, and front yard setbacks, for example, that can have negative impacts on the natural environment. The ORMCP and GBP are mainly implemented through zoning by-laws associated with lower tier municipalities. Planning responsibilities in the NEP Urban Area designation are the responsibility of municipalities. The NEC should work with its municipal partners to ensure development optimizes the capability of the subwatersheds to store, slow, and retain water on and in the landscape. This would include promotion of limits to impervious surfaces (e.g., maximum percentage impervious cover permitted in each sub-watershed) as well as innovative methods to enhance recharge and better opportunities to manage stormwater in more creative ways. Furthermore, **new adaptive environmental management policies should be included in the development control section of the NEP to ensure that continuous learning occurs through NEP development processes.**

Development control provisions have allowed for the protection of water resources through more innovative and protective site design. There may be an initiative to remove development control by the NEC and replace it with zoning and delegation of planning control back to upper-tier Escarpment municipalities during the 2015 review of the three Plans to streamline all three plans.

Recommendation 18

Continued implementation of the NEP by the NEC and maintenance of the current system of development control should be supported during the GBP / NEP / ORMCP reviews in 2015.

5.5 Cumulative Impact Assessment Provisions

The NEP contains the following cumulative effects assessment provisions:

"2.2 General Development Criteria
The objective is to permit reasonable enjoyment by the owners of all lots that can sustain development.
1. Permitted uses may be allowed provided that:

b) The cumulative impact of development will not have serious detrimental effects on the Escarpment environment (e.g., water quality, vegetation, soil, wildlife, and landscape)."

Although rarely used, these provisions are unique and have significant potential to improve water planning. The ORMCP has no similar provisions and in this one respect, the NEP is more protective than the ORMCP with regard to water resources.

Recommendation 19

Cumulative impact provisions should be retained and enhanced in the NEP. This can be done by linking cumulative impact provisions with the technical issues discussed in Section 4 including watershed planning and water budget analysis, and insisting that development be required to demonstrate no permanent detrimental impact and where possible improve the hydrological integrity within the applicable sub-watershed. This recommendation should be pursued through the GBP / NEP / ORMCP 2015 reviews.

5.6 Monitoring Provisions

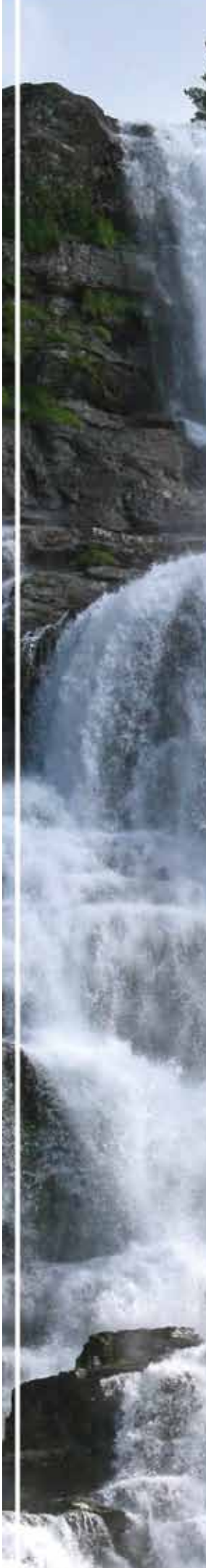
The NEP and ORMCP have monitoring provisions. The NEP introduction states that:

"An environmental monitoring program will be developed and implemented. It will be designed to assess and regularly report upon the effectiveness of policies, decisions and practices throughout the Plan area in meeting the purpose and objectives of the Niagara Escarpment Plan, including the objectives of Part 3 of the Plan especially related to the inclusion of monitoring in Niagara Escarpment Parks and Open Space System master/management planning and monitoring of the Bruce Trail."

Consistent, long-term monitoring of selected indicators allows for analysis of the cumulative response to external influences of all parts of the environment in the Plan Area, including ecosystem and landscape components. These influences include local human activity such as land use practices and changes in land use, as well as regional and global stresses such as climate change. Comparison of indicator values with initial benchmark values or conditions over time will allow evaluation and refinement of management and planning policies and practices. Furthermore, **monitoring is a means of understanding and anticipating environmental changes and avoiding or minimizing deterioration in environmental quality.**

In some cases monitoring will be carried out on a regional, landscape scale; in others it will be on a local or even site-specific scale. The scope and some elements of the broad monitoring program will change over the course of time as stresses on the Escarpment change.

Monitoring information will be used in the day-to-day implementation of the Plan, when considering Plan Amendments, and during periodic reviews of the Niagara Escarpment Plan under section 17 of the Niagara Escarpment Planning and Development Act. Monitoring results and analyses will be disseminated through the NEC's website, conferences, presentations, publications, and regular reports produced as part of the Niagara Escarpment Monitoring Program. The data will be globally available for evaluation and use by interested individuals, organizations, agencies, and the academic community. The monitoring program will also contribute to the United Nations Biosphere Reserve Program in such



areas as managing for biodiversity, education and research, and study of environmentally sustainable development.

A related section of the ORMCP states the following:

"Performance Indicators and Monitoring

a. The Ontario government, in consultation with municipalities, shall over time identify performance indicators for monitoring the effectiveness of the Plan.
b. The Ontario government, in partnership with appropriate stakeholders, shall establish a monitoring network to collect, summarize and evaluate performance indicator data to:
    - assess changes in the ecological integrity of the Moraine;
    - assess the effectiveness of the policies of the Plan in achieving the Plan's vision and objectives;
    - help identify improvements that would address problems encountered in implementing the Plan."

Monitoring has been chronically underfunded in the implementation of both the NEP and ORMCP. The government has been slow to develop monitoring indicators for the ORMCP or to carry out any actual monitoring. Responding to this, the Moraine environmental community has launched its own initiative to develop a multiparty monitoring program with government as a partner. In the case of the Escarpment, the NEC has, despite severe funding constraints, managed to cobble together a monitoring effort focused mainly on terrestrial monitoring.

Recommendation 20

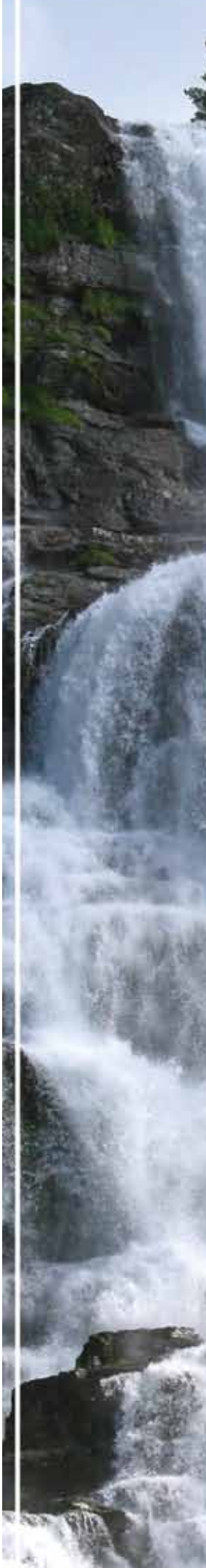
Monitoring provisions in the NEP should be enhanced through specific requirements to monitor water resources.

Conservation Authorities and community groups should be identified as important partners. A Community Based Monitoring program similar to that currently under development on the Moraine should be launched for the Escarpment and tied into NEP monitoring provisions. Monitoring should also be identified in the Plan as an important logistical function of the Niagara Escarpment Biosphere Reserve. Additional monitoring resources should be made available for the NEC to share with the environmental NGO community. Long-term funding should be set aside for a monitoring program, with the funding levels designed to meet the needs of baseline work as well as evaluating specific performance indicators. The monitoring program should be laid out with clear objectives, roles, and responsibilities for the parties.

Recommendation 21

Original research should be incorporated into the monitoring program. Research funding should be made available to the environmental NGO community through a mechanism similar to the Oak Ridges Moraine Foundation and the Friends of the Greenbelt Foundation. This would help to address issues related to Escarpment water resources, including impacts of climate change and development of a model to assess cumulative impacts of development on water resources.

Recommendations 20 and 21 should be pursued across a range of time scales; monitoring work undertaken in the short and medium term could be designed to inform the 2015 Plan review.



References

Barnett PJ, DR Sharpe, HAJ Russell, TA Brennand, G Gorell, F Kenny, and A Pugin. 1998. The origin of the Oak Ridges Moraine. Canadian Journal of Earth Science 35, 1152-1167.

Chapman LJ and DF Putnam. 1984. The Physiography of Southern Ontario. (Third edition.) Ontario Geological Survey, Special Volume 2.

Coalition on the Niagara Escarpment. 2004. Water Policy for the Niagara Escarpment. (Unpublished Report.) Acton, Ontario, Canada.

Cowell DW and DC Ford. 1983. Karst hydrology of the Bruce Peninsula, Ontario, Canada. Journal of Hydrology 61, 163-168.

Duckworth PB. 1979. The late depositional history of the western end of the Oak Ridges Moraine, Ontario. Canadian Journal of Earth Sciences 16, 1994-1107.

Environmental Commissioner of Ontario. 2007. Reconciling Our Priorities. 2006-2007 Annual Report.

Gerber RE and K Howard. 2002. Hydrogeology of the Oak Ridges Moraine aquifer system: implications for protection and management from the Duffins Creek watershed. Canadian Journal of Earth Sciences 39, 1333–1348.

Gao C, J Shirota, RI Kelly, FR Brunton, and S van Haaften. 2006. Bedrock Topography and Overburden Thickness Mapping, Southern Ontario. Ontario Geological Survey, Miscellaneous Release.

Government of Ontario. 2002. Oak Ridges Moraine Conservation Act. Ontario Ministry of Municipal Affairs and Housing.

Government of Ontario. 2006. Clean Water Act. Ontario Ministry of the Environment.

Hunter and Associates and Raven/Beck Environmental Ltd. 1996. Executive summary and technical report, hydrogeological evaluation of the Oak Ridges moraine area, part of Background Report No. 3 for the Oak Ridges Moraine Planning Study. Prepared for the Oak Ridges Moraine Technical Working Committee.

Johnson MD, DK Armstrong, BV Sanford, PG Telford, and MA Rutka. 1992. Paleozoic and Mesozoic geology of Ontario. Pages 907-1010 in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 2.

Kunert M, M Coniglio, and EC Jowett. 1998. Controls and age of cavernous porosity in Middle Silurian dolomite, southern Ontario. Canadian Journal of Earth Sciences 35, 1044–1053.

Niagara Escarpment Commission. 2006. Planning Update Re: Status of harmonization of the Niagara Escarpment Plan with the Greenbelt Plan. Unpublished Staff Report, Georgetown, Ontario, Canada.

Niagara Escarpment Commission. 2005. Niagara Escarpment Plan Amendment PH 143 03 Milton Outlier. Unpublished Staff Report, Georgetown, Ontario, Canada.

Niagara Escarpment Hearing Office. 1993. Report of the Hearing Officers, 1990 Niagara Escarpment Plan Review.

Ontario Geological Survey. 2003. Surficial Geology of Southern Ontario. Miscellaneous Release Data 128.

Singer SN, CK Cheng, and MG Scafe. 2003. The Hydrogeology of Southern Ontario. (Second edition.) Ontario Ministry of the Environment.

Tovell WM. 1992. Guide to the Geology of the Niagara Escarpment. Ashton-Potter Limited.

Turner ME. 1976. Guelph-Lockport Aquifer, Water Resources Map 78-6. Ontario Ministry of the Environment.

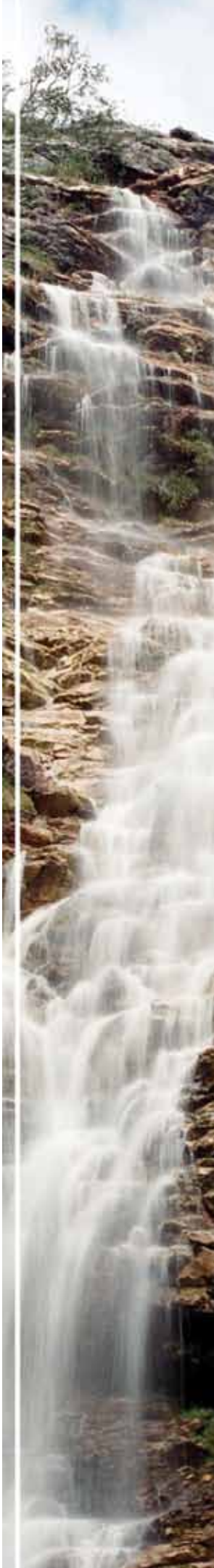
Turner ME. 1978a. Guelph-Amabel Aquifer, Hamilton to Orangeville, Water Resources Map 78-3. Ontario Ministry of the Environment.

Turner ME. 1978b. Guelph-Amabel Aquifer, Orangeville to Markdale Water Resources Map 78-4. Ontario Ministry of the Environment.

Turner ME. 1978c. Guelph-Amabel Aquifer, Markdale to Owen Sound, Water Resources Map 78-5. Ontario Ministry of the Environment.

Whitelaw G, J Hamilton, M Dunkley, and D Ramsay. 2001. Delineating a Natural Heritage System for the Niagara Escarpment. Proceedings of the Fourth International Conference of the Science and Management of Protected Areas Association, (S. Bondrup-Nielsen, NWP Munro, G Nelson, JHM Willison, TB Herman, PFJ Eagles, editors.), Waterloo, Ontario, Canada.

Whitelaw G, and P Eagles. 2007. Planning for long, wide corridors on private lands in the Oak Ridges Moraine, Ontario, Canada. Conservation Biology 21, 675 – 683.



Appendix I – Greenbelt Plan Harmonization Process

Advisory letter concerning proposed criteria for harmonization regulations

May 31, 2006

Honourable John Gerretsen
Minister of Municipal Affairs and Housing
777 Bay Street, 17th Floor
Toronto, Ontario
M5G 2E5

Subject: Proposed Criteria for Harmonization regulations pursuant to Section 22(1)(c) of the Greenbelt Act 2005

Dear Minister:

As anticipated in Section 14b of the Council's terms of reference, the Greenbelt Council has had several fruitful discussions with your staff about a framework for possible regulations to harmonize selected policies of the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan with the Protected Countryside policies of the Greenbelt Plan. The Act stipulates that the purpose of any such regulation will be to help facilitate the effective operation of the Greenbelt Plan.

As your staff develop possible regulations, the Council has worked with them to determine useful criteria for assessing and selecting possible items in the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan for harmonization with the Protected Countryside policies. Accordingly, Council puts forward the criteria set out in the attachment to this letter as advice to you in this matter. We trust that this advice will be useful to you in developing possible regulations and recommending them to Cabinet.

Sincerely,

Dr. Robert Elgie
Chair
Greenbelt Council

Attachment to letter dated May 31, 2006 to Hon. John Gerretsen from Dr. Robert Elgie

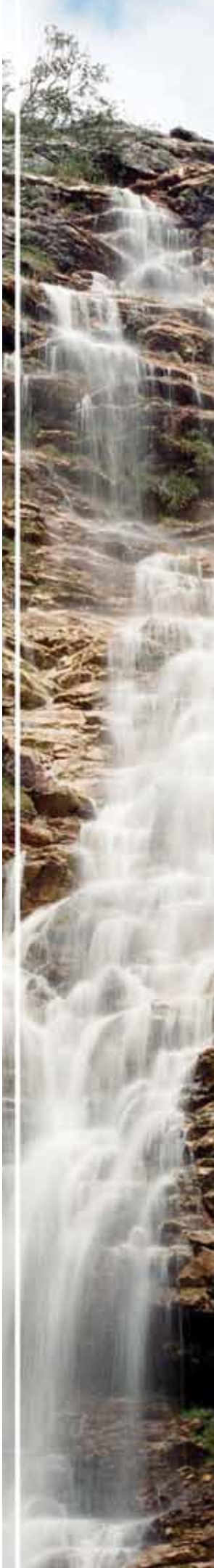
Proposed Criteria for the adoption of regulations to bring the Oak Ridges Moraine Conservation Plan and the Niagara Escarpment Plan into greater harmony with the Greenbelt Plan, pursuant to Section 22(1)(c) of the Greenbelt Act, 2005.

Greenbelt Harmonization Parameters:

1. Only the Oak Ridges Moraine Conservation Plan (ORMCP) and/or Niagara Escarpment Plan (NEP) are candidates for harmonization, not the Greenbelt Plan.
2. Two legislative avenues are available for the harmonization of the Plans
    i. A LGIC regulation initiated by Minister of Municipal Affairs and Housing under the Greenbelt Act, 2005 for ORMCP and/or NEP changes
    ii. A LGIC regulation initiated by the Minister of Natural Resources under the Niagara Escarpment Planning and Development Act (NEPDA) for NEP changes.
3. The Greenbelt Act 2005 imposes no limit on the number of harmonization regulations which may be adopted.

Proposed General Criteria to Assess/Select a Potential Item for Greenbelt Harmonization Regulation(s):

1. Items should not conflict with the Greenbelt Plan objectives in Section 5 of Greenbelt Act, 2005
2. No item should detract from the purpose and objectives of the ORMCP and NEP respectively, nor from any of the unique policies fundamental to the ORMCP and NEP
3. No item should require a substantive change in the purpose, objectives and/or policies of the ORMCP or NEP; such substantive changes should proceed through the regular ORMCP or NEP amendment processes or be subject to 10-year Plan reviews
4. Changes to the NEP or the ORMCP should ensure a common policy base with the Provincial Policy Statement (PPS) and the Greenbelt Plan, where appropriate
5. Items should address policy inconsistencies between the ORMCP and/or NEP and the Protected Countryside policies of the Greenbelt Plan
6. Items should not be the subject of another provincial initiative currently underway (e.g., proposed Clean Water Act).



Appendix II – List of Full Recommendations

Recommendation 1

NEP water policies should be updated to be similar to water policies in the ORMCP. Although the Escarpment and Moraine landscapes are markedly different, there are important attributes that the two regions share and water policy should be broadly similar. Updating the NEP water policies is desirable, and the NEP should have similar water policies to the ORMCP, but they need to be tailored to ensure the unique hydrological properties of the Escarpment are addressed. Adjacent lands including GBP Protected Countryside lands and lands regulated through municipal official plans in the northern portions of the NEP area should also be included in water policy updating processes.

Recommendation 2

Two parallel approaches should be initiated to update NEP water policies. The first approach should focus on short, mid and long-term processes available to update water policies including the existing harmonization process, an NEC-initiated NEP Amendment process, and the GBP / NEP / ORMCP review process scheduled to begin in 2015. The second approach should involve an outreach campaign designed to secure public support for stronger protection of Escarpment water resources to begin in 2009 and run through 2015.

Recommendation 3

The environmental NGO community should work with the NEC to secure research, stewardship, and outreach funding through mechanisms that are similar to those used by the Oak Ridges Moraine Foundation and Friends of the Greenbelt Foundation. These organizations are funded by the Ontario government and can provide non-government groups with the resources needed to carry out research, stewardship, and outreach activities. When compared with the Moraine and Greenbelt, the Niagara Escarpment has been largely excluded from this type of funding over the last 10 years. The NEC, the Minister of Natural Resources, and/or the Minister of Municipal Affairs and Housing may be in a position to promote the establishment of such a fund and then one or more or these agencies could administer it.

Recommendation 4

At present, there is no comprehensive and consistent watershed planning approach undertaken on the Escarpment. It is recommended that at the watershed and subwatershed scales, municipalities, conservation authorities and the Niagara Escarpment Commission should undertake planning to address protection of the function and integrity of the hydrological system of the Escarpment and lands in the vicinity. At a minimum, the plan should include each of the components that are contained within the ORMCP. Those individual components should be specifically designed to address the hydrology of the Escarpment. Attention should be given to the highly variable nature of the bedrock and overburden aquifers.

Recommendation 5

Watershed plans should be reviewed periodically. The water budget and water conservation components should be revised if the system has been altered from its original state (when the initial plans were laid out) or if new information should become available. Of particular concern is the possibility that the water budget will be altered by increases in evapotranspiration that may occur due to warmer drier summers. Under such conditions, reduced summer and fall season stream flows are anticipated. Watershed planning should be designed to be sensitive to changes in climate and adaptive in response to changing conditions.

Recommendation 6

The environmental NGO community should work with the NEC and other Escarpment partners to develop a information management system that can be used for data input, storage, and retrieval to facilitate the coordination, sharing, and updating of Escarpment and related data and information that can be accessed by all partners.

Recommendation 7

Water budget estimates on the Escarpment and adjacent lands should be undertaken at the subwatershed scale by approval authorities, in particular Conservation Authorities and municipalities. The expected benefit would be better informed decision making with respect to water taking for a variety of activities, while maintaining the ecosystem services of those water resources. Where the bedrock aquifers show evidence of karst porosity, more detailed investigations should be mandated. These examinations should be undertaken using techniques that are consistent with best practices in karst hydrogeology. Due to the cost of such investigations, it is recommended that areas of the Escarpment under increasing development pressure and areas with potentially threatened groundwater resources be targeted initially for such investigations.

Recommendation 8

Water conservation planning similar to that utilized for the ORMCP should be required of the NEP in the development of water policy for the Escarpment. This should be considered a long-term recommendation and proceed through the GBP / NEP / ORMCP 2015 reviews.

Recommendation 9

The NEP should have provisions to protect sensitive hydrological features. The policy should apply to all lands that fall within the Plan boundary. The list of sensitive hydrological features of the Escarpment would be similar to that of the Moraine and should include permanent or intermittent streams, wetlands, ponds and lakes, seepage areas and springs, sinkholes (dolines), sinking stream points, and corridors of high aquifer porosity (conduits). In evaluating sensitive stream corridors, the policy should adopt guidelines similar to those outlined through the Ontario Ministry of Natural Resources's Natural Channel Systems Initiative. Due to the changes to designation criteria and associated mapping, the protection of sensitive hydrological features should be pursued during the 2015 GBP / NEP / ORMCP reviews.

Recommendation 10

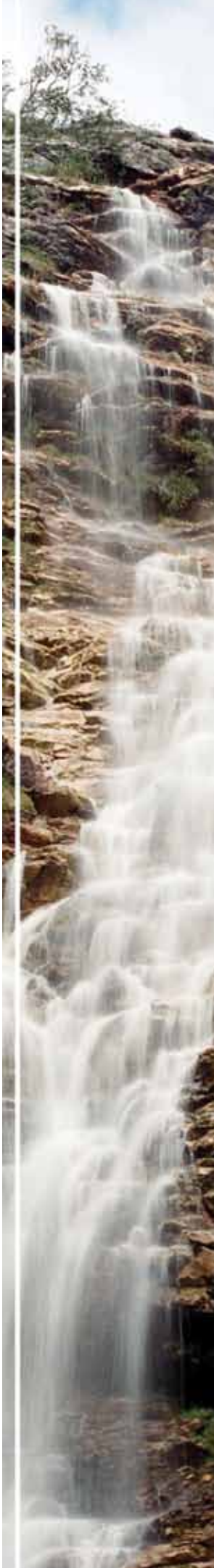
The principle of limiting impervious surfaces and increasing infiltration should be considered for water policy development in the NEP. The policy should be applied to the lands that are in the Escarpment Natural Area, Escarpment Protection Area, Escarpment Rural Area, and Escarpment Recreation Area designations. The Minor Urban Centres and Urban Areas should be treated in a manner that is similar to the Settlement Areas of the ORMCP. In the ORMCP Settlement Areas policies, some regard is given through approval requirements for development activities that would increase impervious surfaces. The general model and the procedures outlined for the Moraine could form the basis of a policy, with adjustments needed to address the specific character of the Escarpment. This is a recommendation that should be pursued through harmonization with the GBP.

Recommendation 11

NEP water policy should address the issue of aquifer vulnerability. It is recommended that areas of high vulnerability be mapped and restrictions placed on activities in that zone, such as those outlined in the ORMCP. This recommendation should be pursued during the GBP / NEP / ORMCP 2015 reviews. However, background work should start immediately with an assessment of the existing data and the contributions that the ongoing source water protection work by Conservation Authorities and municipalities might make.

Recommendation 12

Water policies in the NEP should provide for the protection of municipal groundwater wells. It is recommended that Escarpment water policy be developed that would require the mapping of wellhead protection areas and the travel times to those wells. Within these zones, restrictions of the type outlined in the ORMCP should be considered. This recommendation should be pursued through the 2015 GBP / NEP / ORMCP reviews.



Recommendation 13

The wording in the NEP should be adjusted and modeled after that in ORMCP to reflect current thinking on water science, based on ecological integrity and hydrological function, structure, and restoration. This wording should be adapted for use in the following sections of the NEP:

Introduction, Purpose, Objectives,
1.3 Escarpment Natural Area,
1.4 Escarpment Protection Area,
1.5 Escarpment Rural Area,
1.6 Minor Urban Centre,
1.7 Urban Area,
1.8 Escarpment Recreation Area,
1.9 Mineral Resource Extraction Area,
2.1 Development Criteria Introduction,
2.6 New Development Affecting Water Resources,
3.1 The Niagara Escarpment Parks and Open Space System,
3.1.1 Objectives, and Definitions (Appendix 2).

Niagara Escarpment Plan definitions related to water policies should be updated based on ORMCP definitions and any additional definitions required based on the unique nature of the Escarpment landscape. This wording update should proceed through the current plan harmonization process.

Recommendation 14

The ORMCP water policies section should be used to guide the updating of NEP water policies. This recommendation should be pursued through the GBP / NEP / ORMCP 2015 reviews due to significant changes expected to NEP development permit application requirements.

Recommendation 15

Current permitted uses in Escarpment Natural Areas and Escarpment Protection Areas should be maintained. A prohibition on new mineral resource extraction operations should be considered during the GBP / NEP / ORMCP 2015 reviews. This prohibition would be based on the evident inability of the current NEP policies to prevent any new aggregate operations from being approved and potential ecological impacts of aggregate extraction. (For a discussion of this issue see, for example, the Environmental Commissioner of Ontario's Annual Report, 2006-2007).

Recommendation 16

The NEP designations should be updated in a two-phased process for the purpose of enhancing protection of water resources. The first phase should proceed through a Plan Amendment to update existing designation boundary mapping based on new information (such as ANSI, ESA, and wetland mapping). The second phase should involve developing and presenting new designation criteria to the 2015 GBP / NEP / ORMCP reviews that reflect the most sophisticated terrestrial ecology and water resource science. This means building on the existing designations to include additional criteria that would capture core and linkage areas and water features unique to the Escarpment's karst environment (e.g., sinks and springs).

Recommendation 17

Stronger GBP policies through the GBP review starting in 2015 should be pursued in order to ensure that GBP lands adjacent to the NEP area are properly protected with respect to water resources. Similarly, stronger protection is required for lands regulated through municipal official plans adjacent to NEP lands in the northern portion of the Plan area. This may be accomplished most effectively through participation in Official Plan review processes as they occur.

Recommendation 18

Continued implementation of the NEP by the NEC and maintenance of the current system of development control should be supported during the GBP / NEP / ORMCP reviews in 2015.

Recommendation 19

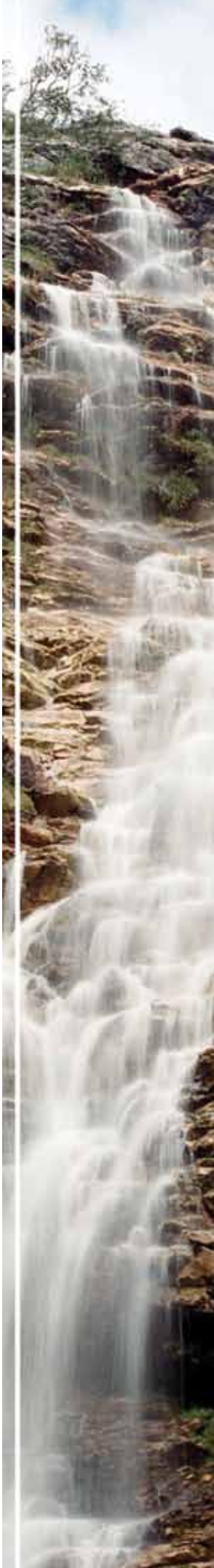
Cumulative impact provisions should be retained and enhanced in the NEP. This can be done by linking cumulative impact provisions with the technical issues discussed in Section 4 including watershed planning and water budget analysis, and insisting that development be required to demonstrate no permanent detrimental impact and where possible improve the hydrological integrity within the applicable sub-watershed. This recommendation should be pursued through the GBP / NEP / ORMCP 2015 reviews.

Recommendation 20

Monitoring provisions in the NEP should be enhanced through specific requirements to monitor water resources.

Recommendation 21

Original research should be incorporated into the monitoring program. Research funding should be made available to the environmental NGO community through a mechanism similar to the Oak Ridges Moraine Foundation and the Friends of the Greenbelt Foundation. This would help to address issues related to Escarpment water resources, including impacts of climate change and development of a model to assess cumulative impacts of development on water resources.



Appendix III – Glossary and Water-Related Definitions from the ORMCP

In this section, a variety of terms that were used in the report are defined. In addition, water related definitions that are used in the ORMCP are denoted.

Alvar
An ecosystem characterized by a discontinuous cover of grassland, open stunted woodlands, lichen and mosses that occur on shallow soils or on exposed carbonate bedrock (limestone and dolostone). Alvars form where flat lying or gently dipping carbonate bedrock units occur as outcrop forming limestone pavements (or dolostone) and the local relief is small. These pavements are often veneered by a very shallow soil.

Aquifer (Confined and Unconfined)
A body of rock or sediment that yields potable (fresh) water in economic (useable) quantities to a well or to a spring. Aquifers are generally comprised of coarse sediments (sands and gravels) or bedrock with a high porosity and permeability (e.g., limestone, sandstone). In a confined aquifer, the water-bearing unit occurs at depth and is overlain by less permeable materials. With an unconfined aquifer, the water-bearing strata or sediments occur at the surface, or in the shallow subsurface where it is overlain by other permeable materials.

Aquitard
A confining body of rock or sediment that does not readily yield water to a well or spring due to its relatively low permeability. An aquitard may store large quantities of groundwater and permit a slow (retarded) movement of groundwater between adjacent aquifers.

Aquiclude
A confining body of rock or sediment that does not yield water to a well or spring due to its very low permeability. Aquicludes are generally comprised of fine-grained sediments (e.g., clay) or fine-textured bedrock (e.g., shale). Due to their low permeability, aquicludes can restrict the movement of groundwater to and from adjacent units.

Area of Natural & Scientific Interest (ANSI)
Areas of land and water that represent significant geological (earth science) and biological (life science) features.

Baseflow
The movement of groundwater, along relatively long and deep flowpaths in the saturated zone, to stream channels and other surface water bodies.

Carbonate
Bedrock and sediment materials that are largely comprised of minerals that contain the carbonate ion (CO_3^{2-}), mainly the minerals calcite ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$). The main carbonate rocks are limestone and dolostone.

Clastic
Sediments comprised a mixture of grains and fragments that are formed from the weathering of pre-existing bedrock. Clastic sediments are described based mainly on grain size and shape. Clastic sedimentary rocks are comprised of cemented clastic sediments and include lithologies such as sandstone, siltstone, and shale.

Confined Aquifer
See Aquifer.

Connectivity
The degree to which key natural heritage features are connected to one another by links such as plant and animal movement corridors, hydrological and nutrient cycling, genetic transfer, and energy flows through food webs. (ORMCP)

Cuesta
An asymmetrical ridge or hill feature that is typically comprised of two components: (i) a steep scarp face (Escarpment), and (ii) gently sloping face called the dip slope. Cuestas usually form where dipping sedimentary rocks outcrop at the surface. Differential weathering processes gradually produce a scarp form where more resistant bedrock strata outcrop. Cuestas may also be produced through tectonic processes.

Dip Slope
See Cuesta.

Doline
A closed topographic depression that occurs in areas of karst topography. These depressions are highly variable in form but are most often conical in shape. The diameter and depth dimensions vary from a few metres to a few hundred metres. The term doline follows from the Slovenian term dolina (valley) and is synonymous with sinkhole. Most dolines form from the localized removal of bedrock by solution or from the collapse of underlying cave passages. Dolines are important recharge points for karst aquifers.

Ecological Feature
Naturally occurring land, water and biotic features that contribute to ecological integrity. (ORMCP)

Ecological Functions
The natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems, and landscapes, including hydrological functions and biological, physical, chemical, and socio-economic interactions. (ORMCP)

Ecological Integrity (which includes hydrological integrity):
The condition of ecosystems in which, (i) the structure, composition, and function of the ecosystems are unimpaired by stresses from human activity, (ii) natural ecological processes are intact and self-sustaining, and (iii) the ecosystems evolve naturally. (ORMCP)

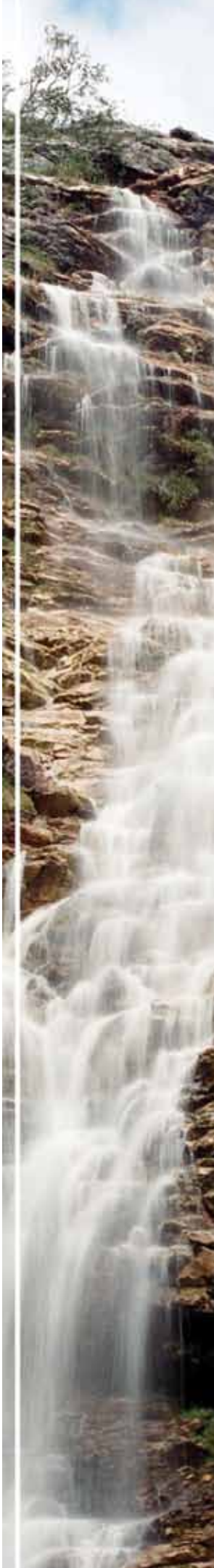
Environmentally Sensitive Areas (ESA)
An area with environmental values that are of local interest. ESAs are designated and managed by municipalities. They may represent the habitat of vulnerable, threatened, or endangered species.

Fish Habitat
The spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out life processes, as further identified by the Department of Fisheries and Oceans (Canada). (ORMCP)

Fluviokarst
A type of karst landscape where surface stream channels and valleys are still present, although a substantial amount of the surface drainage is captured at points such as sinkholes. In a fluviokarst, the capacity of the sinking points may be exceeded during periods of high flow.

Geomorphology
The study of landscapes and the landforms that comprise them, including the processes responsible for their development.

Glaciolacustrine
A glacial depositional environment where sediments are deposited in a deep body of standing water (lake) adjacent to or in close proximity to a glacial ice mass. Sediment characteristics are variable with mixtures of coarse and fine materials deposited on the lake bed near the glacial ice, while farther removed from the glacier, the deposited materials are finer grained, well sorted and stratified (layered).



Glaciofluvial
A glacial depositional environment where sediments are deposited in stream channels and on floodplains. Glaciofluvial sediments are materials that have been transported and deposited by glacial meltwater streams. These materials tend to be sand and gravel, moderately well sorted and stratified. Where the materials are deposited in very close proximity to glacial ice, the term ice contact stratified drift is typically used.

Glacial Diamicton
A diamicton (diamict) is sediment that is comprised of an unsorted mixture of clastic materials, typically with a fine-grained matrix within which coarser materials are suspended. The proportions of matrix to coarse clasts are variable. A glacial diamicton is produced in a glacial environment by a number processes (e.g., glacial till).

Groundwater Recharge
The replenishment of subsurface water resulting from (i) natural processes such as the infiltration of rainfall and snowmelt and the seepage of surface water from lakes, streams, and wetlands, and from (ii) human intervention such as the use of stormwater management systems. (ORMCP)

Glacial Till
Sediment materials that are deposited directly from glacial ice. Till may be deposited beneath an actively sliding glacier through a process called lodgement (lodgement tills) or it may be deposited as the glacial ice melts out producing melt out ills (ablation tills). Till may also be deposited in mass flows, either subglacially or in the supraglacial environment (this produces flow tills). Typically, glacial tills are unsorted to poorly sorted, massive, unstratified, and of low permeability.

Grike (Kluftkarren)
A trench or fissure landform in bedrock that occurs in karst terrain. The fissures develop along joints and other discontinuities in the bedrock and are formed by the process of solution. Grike dimensions are variable with large fissures open to several tens of centimetres. Intersecting grikes form networks and provide routes for surface water to infiltrate into the bedrock. The intervening areas between grikes are Clints. On both clints and grikes there are an array of smaller solution landforms that can develop that are collectively referred to as karren.

Holokarst
A type of karst landscape, where there is the absence of an organized surface drainage network. The terrain is characterized by a variety of closed depression forms such as sinkholes as well as limestone pavements upon which well developed grikes and clints are present and a variety of karren forms. In a holokarst, all of the precipitation infiltrates into the bedrock and recharges the underlying aquifers.

Hydrologeology
The study of the distribution, properties, and movement of groundwater in geological materials including soils, sediments, and bedrock.

Hydrological Cycle
The circulation of water from the atmosphere to the earth and back through precipitation, runoff, infiltration, groundwater flow, and evapotranspiration, including the occurrence, circulation, distribution, and chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things. (ORMCP)

Hydrological Features
Includes permanent and intermittent streams, wetlands, kettle lakes and their surface catchment areas, seepage areas and springs, and aquifers and recharge areas. (ORMCP)

Hydrological Functions
The functions of the hydrological cycle that include the occurrence, circulation, distribution, and

chemical and physical properties of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere, and water's interaction with the environment including its relation to living things. (ORMCP)

Hydrological Integrity
The condition of ecosystems in which hydrological features and hydrological functions are unimpaired by stresses from human activity. (ORMCP)

Hydrologically Sensitive Feature
A hydrologically sensitive feature as described in section 26 of the ORMCP. (ORMCP)

Hydrology
The study of the distribution, properties and movement of water, in all its forms, in the atmosphere and on the surface and subsurface.

Impervious Surface
A surface that does not permit the infiltration of water, such as a rooftop, sidewalk, paved roadway, driveway, or parking lot. (ORMCP)

Kame
A term used to describe an irregular mound, hill, or ridge landform that has a glacial origin and is comprised largely of ice contact stratified drift (glaciofluvial materials).

Karst (karstic)
A type of topography (landscape) that is characterized by a variety of closed depression landforms (e.g., dolines), a range of solution features in bedrock, a poorly developed surface drainage network, and well developed underground drainage. Karst topography may form in areas of highly soluble bedrock (gypsum, limestone, dolostone) through the process of solution. Aquifers in carbonate rocks that have been influenced by karst processes have high porosities.

Overburden Aquifer
In the context of hydrogeology, an overburden aquifer is developed in unconsolidated materials (sediments). In southern Ontario, overburden aquifers are most commonly found in glaciofluvial or alluvial deposits. The term overburden may also be used to denote materials (sediment or bedrock) that overlie a geological unit of interest such as a mineral deposit.

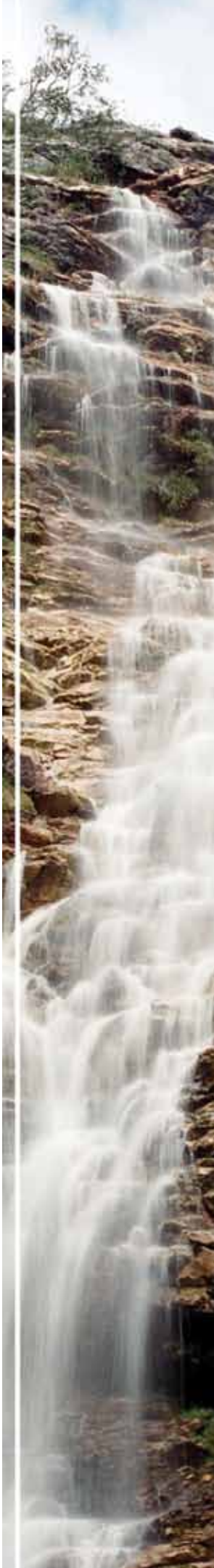
Scarp Slope
See Cuesta.

Sinkhole
See Doline.

Solution
A chemical weathering process in which the constituent ions of a mineral are dissolved in the presence of water. For carbonate minerals, the solution process is enhanced when carbon dioxide dissolves in water which produces a weak acid (carbonate acid).

Stormflow or Stormwater
The movement of surface runoff (overland flow) and shallow subsurface flow (interflow) to stream channels and other surface water bodies. Stormflow in surface streams increases during and following major precipitation or melt events.

Stream Corridor
The channel of a river or stream and its immediate surroundings including its floodplain or confining valley walls and all the hydrologic, geomorphic, and biologic processes that operate within. In a natural ecosystem, a stream corridor normally possess a stable channel form, floodplain, riparian zone, and a diverse array of habitats and biota.



Time of travel
The time that is needed for groundwater to travel a specified horizontal distance in the saturated zone. (ORMCP)

Unconfined Aquifer
See Aquifer.

Valleyland
A natural area that occurs in a valley or other landform depression that has water flowing through or standing for some period of the year. (ORMCP)

Water Resources
The physical, chemical, biological and cultural services rendered by water as it interacts and moves through the landscape.

Watershed
An area that is drained by a river and its tributaries. (ORMCP)

Wellhead protection area
The surface and subsurface area surrounding a water well or well field that supplies a public water system and through which contaminants are reasonably likely to move so as eventually to reach the water well or well field. (ORMCP)

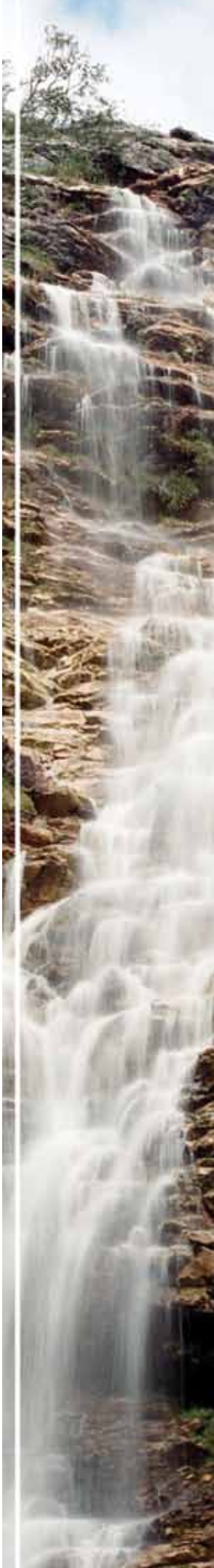
Wetland
Land such as a swamp, marsh, bog, or fen (not including land that is being used for agricultural purposes and no longer exhibits wetland characteristics) that, (i) is seasonally or permanently covered by shallow water or has the water table close to or at the surface, (ii) has hydric soils and vegetation dominated by hydrophytic or water-tolerant plants, and (iii) has been further identified, by the Ministry of Natural Resources or by any other person, according to evaluation procedures established by the Ministry of Natural Resources, as amended from time to time. (ORMCP)

Zone of Contribution
When used in reference to a period of time, means the area within which the water pumped from a well originates during that time. (ORMCP)

Appendix IV – Author Profiles

Graham Whitelaw, PhD,
is an Assistant Professor in the Schools of Environmental Studies and Urban and Regional Planning at Queen's University. His current research is focussed on environmental planning, environmental assessment and First Nations planning, and he teaches courses in environmental planning and management, environmental assessment and sustainability. Dr. Whitelaw has also worked in both the private and public sectors, and his consulting work mainly served government and civil society sectors with a specialization in environmental policy, multi-party monitoring, and facilitation. During the 1990s, he was part of the Ontario Ministry of the Environment's land use policy team working on a variety of files including environmental assessment, brownfields, and the Niagara Escarpment.

James Hamilton, PhD,
is an Associate Professor in the Department of Geography and Environmental Studies at Wilfrid Laurier University. His academic background is primarily in cold regions hydrology and geomorphology, and his dissertation was on karst hydrogeology. Dr. Hamilton has worked at a number of universities and in consulting, and has previous research experience in the areas of climate change and surficial geology. He has worked in collaboration with planners on resource issues related to the Niagara Escarpment and is currently undertaking hydrological research on and adjacent to the Escarpment. He currently teaches courses in physical geography, geomorphology, soils, remote sensing, cartography, and field techniques.



The Niagara Escarpment Plan is the keystone in our ability to, in the words of the Plan, "provide for the maintenance of the Niagara Escarpment and land in its vicinity substantially as a continuous natural environment, and to ensure only such development occurs as is compatible with that natural environment."

The research presented in this report was initiated by the Coalition on the Niagara Escarpment and generously supported by the Niagara Escarpment Foundation and the Walter & Duncan Gordon Foundation.

This report presents a detailed analysis of the relative strengths and weaknesses of the water science and water policies of the Niagara Escarpment Plan in comparison with the Oak Ridges Moraine Conservation Plan. These aspects of the Niagara Escarpment Plan are seriously outdated and inadequate.

The recommendations resulting from this valuable and timely research provide a roadmap for a sophisticated renovation of the Niagara Escarpment Plan to ensure the protection of the Escarpment's hydrological function and integrity.

Download this report at www.niagaraescarpment.org or www.nefoundation.ca.

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