Consultation on growing the size of the Greenbelt
Environmental Registry of Ontario (ERO) 019-3136

Comments from Bruce Peninsula Biosphere Association

ERO Proposal summary

The Ministry of Municipal Affairs and Housing is seeking feedback on ways to grow the size and further enhance the quality of the Greenbelt.

Submission Summary

The Bruce Peninsula Biosphere Association has undertaken work on karst hydrogeological systems on the Bruce Peninsula. The focus of the work is to improve our understanding of the role of karst aquifers in suppling abundant, high quality water to the headwater areas of stream systems that flow into Georgian Bay and Lake Huron. In these systems, groundwater recharge occurs in upland areas, circulates through a body of bedrock, and supplies cold, high quality baseflow to surface stream channels. The quantity and quality of water resources in downstream locations are dependent on preserving the integrity of important karst groundwater recharge and discharge zones. These high quality water resources support surface and groundwater extraction for residential and agricultural purposes, recreation particularly along the coastal zone, and the protection of ecosystem services.

The Biosphere Association completed a study of the karst drainage network that supplies Judges Creek, a cold-water system in the central area of Northern Bruce Peninsula in 2016. This study produced a detailed mapping of groundwater recharge areas, described the flow paths of water in the system, and developed a conceptual model of the flow network. A second study will examine the headwater areas in the watershed of Albemarle Brook, located immediately south of the Judges Creek watershed. To date, preliminary mapping and consultation with karst experts has been completed, with field activities and report writing scheduled for the coming months.

These projects provide a scientific understanding and documentation of the importance of the underground karst drainage systems on the Bruce Peninsula with application to karst-based watersheds that run the full length of the Niagara Escarpment. In a potential expansion of lands into an enhanced Greenbelt, consideration should be given to critical areas of groundwater recharge and

discharge in karst drainage systems. On the Bruce Peninsula, and elsewhere adjacent to the Niagara Escarpment, there are karst systems that are currently situated outside of protected areas. These areas are potentially vulnerable, and development has the potential to compromise their critical hydrological function.

The work of the Biosphere Association supports Greenbelt Plan objectives, vision and goals in that including the lands with potential karst features we propose for consideration would provide permanent protection to the agricultural land base and the ecological and hydrological features, areas and functions occurring on this landscape.

The Biosphere Association presents the following recommendations based on work that has been completed and will make further recommendations based on the ongoing work.

Recommendations

- When growing the Greenbelt, protection of karst-based headwater aquifers is a critical need and should be considered in the Northern Bruce Peninsula and throughout other areas of the Greenbelt Niagara Escarpment Plan area.
- As a candidate area for Greenbelt expansion, the Province should consider the addition of the karst groundwater recharge and discharge zones of the headwater regions of Judges Creek and Albemarle Brook. This area covers 4,775 hectares that is west of the Niagara Escarpment planning area. This candidate area for inclusion is highlighted in this document.
- Similar karst recharge and discharge zones that are elsewhere along the Niagara Escarpment should be considered for Greenbelt expansion to provide increased environmental protection. This practice would reflect the emerging scientific understanding of karst systems and their impact on the quantity and quality of baseflow to surface streams.
- The Province should support research into these systems, particularly the detailed mapping of vulnerable recharge and discharge zones that would permit the identification of important candidate sites for Greenbelt expansion.

Comments Submission

In this submission to the Province's ERO process related to Growing the Greenbelt, we will provide information concerning Discussion Question 4 and Discussion Question 5.

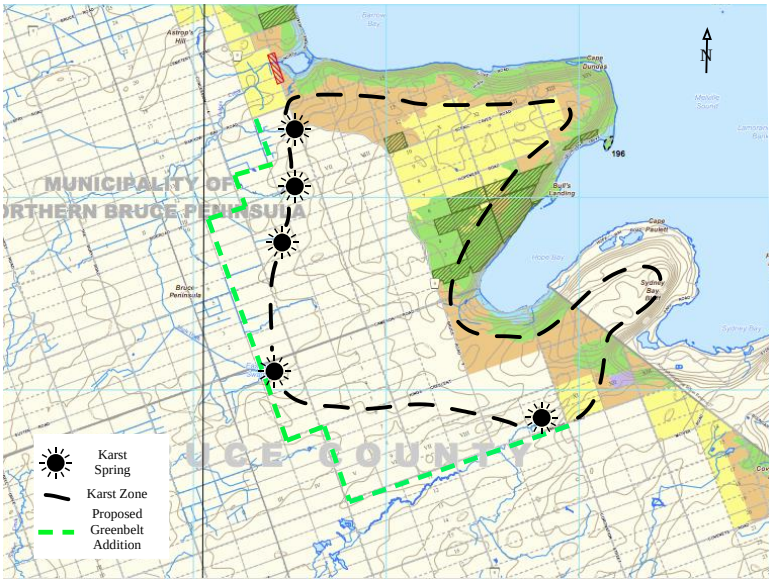
Discussion Question 4:
Do you have suggestions for other potential areas to grow the Greenbelt?

Over the last ten years, the Bruce Peninsula Biosphere Association has been involved in monitoring water quality and quantity in a series of watersheds on the Bruce Peninsula. In this work, sources of contaminants to surface streams have

been identified and actions designed to mitigate the impacts have been undertaken. These initiatives have measurably improved water quality in Bruce Peninsula streams that flow into Georgian Bay and Lake Huron. For example, over 5,000 cattle have been provided alternative watering systems and the installation of 15 km of fencing has kept them from Bruce Peninsula streams, karst springs and wetlands. This experience has developed our capacity to delineate places in need of environmental protection.

Through ongoing environmental work, we have become deeply familiar with the local landscape and the complexity of some Bruce Peninsula watersheds has become more apparent. Two of our study watercourses, Albemarle Brook and Judges Creek have headwaters largely sourced by the outflow of major springs west of the Niagara Escarpment. The flow volumes of these springs are high, the water temperatures are cold, and the water quality is excellent. The origins of these springs is due to their hydrogeologic setting. The springs flow from karst groundwater aquifers that are recharged across extensive areas that are largely in their natural state. Much of the groundwater recharge zone and many of the springs are located outside the Niagara Escarpment Planning area.

The Biosphere Association suggests the inclusion of approximately 4,775 hectares of the Bruce Peninsula, covering the headwater springs and recharge zones of Judges Creek and Albemarle Brook (Map 1). This is an area of recharge and discharge zones of an important karst system and should be offered increased environmental protection through inclusion within an expanded Greenbelt. Support for the inclusion of this area is through the karst hydrologic work of Judges Creek and Albemarle Brook karst systems.



Map 1: Karst zone, springs and area of Judges Creek and Albemarle Brook for Greenbelt inclusion.

As the Greenbelt is meant to be a continuous broad band of permanently protected land, the proposed expansion will build upon the systems approach of the Greenbelt Plan. This area will be directly connected through the Greenbelt's natural heritage, water resource and agricultural systems, as described within the other Provincial priorities:

> *Natural Heritage and **Water Resource Systems** – The Greenbelt Plan and A Place to Grow are aligned with and build on the Provincial Policy Statement to provide policy protection for natural heritage and water resource systems, features and areas, including habitat for endangered and threatened species. Both the Greenbelt Plan and A Place to Grow contain policies supporting and protecting a Natural Heritage System that is made up of these natural features and areas along with the linkages that connect them together. Similarly, policies in these plans protect water resource systems on a watershed basis, with the Greenbelt incorporating significant headwaters, river corridors, wetlands and other features.*

Discussion Question 5:
How should we balance or prioritize any potential Greenbelt expansion with the other provincial priorities mentioned above?

The karst system study being undertaken by the Biosphere Association will provide an enhanced scientific understanding of karst underground systems and their impact on the quantity and quality of the Judges Creek and Albemarle Brook headwaters. The project will involve documentation of the underground drainage networks that comprise karst systems along the Niagara Escarpment, investigation and mapping of the Judges Creek and Albemarle Brook karst system watershed through high-resolution surface imagery, and evaluation of risks through the new GIS-based "Watershed Risk Assessment Tool".

Both the Greenbelt Plan and A Place to Grow contain policies supporting and protecting a Natural Heritage System that is made up of these natural features and areas along with the linkages that connect them. Similarly, policies in these plans protect water resource systems on a watershed basis, with the Greenbelt incorporating significant headwaters, river corridors, wetlands and other features. The Provincial Policy Statement has a strong emphasis on the need to recognize and protect the important linkages between surface water and groundwater. Karst features are such linkages.

In the Biosphere Association's current study of the proposed area of inclusion, Albemarle Brook and Judges Creek have headwaters largely sourced by the outflow of major spring areas west of the Niagara Escarpment. These springs, resulting from thousands of years of water movement through soluble dolostone and limestone, are key to the cold-water sources of central Bruce Peninsula

streams flowing to Georgian Bay and Lake Huron. Both cold-water systems have the potential to return to productive trout streams and we are proposing improvement work to help with the recovery. A starting point for the projects is to define the source area of the karst networks.

Karst is a hydrogeological feature in which the surface water and groundwater regimes are highly interconnected and often constitute a single, dynamic flow system. The presence of karst usually is indicated by the occurrence of distinctive physiographic features that develop as a result of the dissolution of soluble bedrock such as limestone or dolostone. In well developed karst, these physiographic features may include sinkholes, sinking (or disappearing) streams, caves, and karst springs.

The hydrologic characteristics associated with the presence of karst also are distinctive and generally include: (1) internal drainage of surface runoff through sinkholes; (2) underground diversion or partial subsurface interruption of surface streams (sinking streams and losing streams); (3) storage of groundwater within a shallow, perched epikarst zone; (4) rapid, turbulent flow through subsurface pipe-like or channel-like solutional openings called conduits; and (5) discharge of subsurface water from conduits by way of one or more large perennial springs.

Because of these distinctive hydrogeological characteristics, data requirements for the hydrogeological characterization of karst aquifers are more intensive and difficult to obtain than those for aquifers in most other types of hydrogeological settings. Wherever karst features are present, the water resources investigator must anticipate the presence of a flow system that cannot be completely characterized by using conventional hydrogeological methods such as potentiometric mapping or hydraulic tests of observation wells, by numerical modeling, or by using a study approach that treats groundwater and surface water as separate hydrologic regimes.

In karst terrains, a greater emphasis must generally be placed on the identification of hydrologic boundaries and subsurface flow paths, contributions of water from various recharge sources, and the structural and hydrogeological properties of conduits. The acquisition of these data typically requires a multidisciplinary study approach that includes using more specialized investigation methods such as water-tracing tests and the analysis of variations in spring discharge and water chemistry.

Previous Biosphere Association scientific work includes a commissioned report "Karst System of the Judges Creek Watershed" that characterizes the Judges Creek system and high-resolution surface and canopy-level mapping of the watershed. The watershed was found to be an important but poorly understood karst drainage system. Karst system work continues on Albemarle Brook which is fed by similar perennial and ephemeral cold-water springs in its headwater and flows continuously through the year, even in drought periods, providing a source

of water for wildlife, biota, farms and people. Albemarle Brook is distinct in that it is sourced from a single area of springs and much of its aquifer recharge is in a natural state.

Although a conceptual model has been developed to explain the source of the recharge to the karst springs that maintain the base flow in Judges Creek, there are a number of uncertainties and questions that have been raised from the preliminary study. These knowledge gaps include: the exact location and relative importance of each of the springs; the proportion of baseflow that is derived from the karst springs; the relationship between each of the springs and the degree to which they are interconnected; the areal extent and delineation of both the surface watershed and the subsurface spring-shed, particularly on the Cape Dundas promontory; and the nature of the groundwater storage that maintains baseflow throughout the summer and fall.

The issue of watershed complexity emerges in the difficulty in defining these watershed areas. The geographic lines are simple enough but defining the area and extent of drainage through the karst landscape is challenging. We have undertaken some literature review and found that karst drainage systems on the Bruce Peninsula and probably elsewhere in southern Ontario have either been ignored or unknown. The consequence has been an under-consideration of subsurface hydraulic systems, as it is not a simple groundwater system but more like below-grade conduits of streams and tributaries on the Niagara Escarpment and lands influenced by this geological feature.

The impact of this lack of awareness of karst systems became apparent during a proposed quarry application in a karst recharge zone near a major spring sourcing Judges Creek. After being assured that karst conditions were being reviewed as part of the process, we later discovered that potential surface water impact was limited to an area within 120 metres of the quarry. There was no review of karst flow within the proposed quarry geology, the consultant's review detailed just the potential for crevice and cavern industrial hazard during extraction activities, and the hydrogeology comment was limited to well record observations of static ground water elevations with no relation to the karst drainage network.

In the Province of Ontario, legislation and regulations that govern the aggregate industry do not in any meaningful way address the potential impacts of aggregate extraction on karst systems. There is a strong pressure for bedrock quarry development on the Bruce Peninsula.

For application reviews under the Aggregate Resources Act in Ontario, there is no reference to water flow within a karst environment. The review of the environmental suitability of a proposed quarry is based on hydrological evidence of groundwater elevations, generally gained from existing well records from

nearby locations. This may not adequately characterize the permeability variations that can occur within a karst aquifer.
It is probable that the application standards for proposed pits and quarries could be revised to better address the reality of karst drainage networks in the environment.

In quarries that operate on extraction of bedrock no closer than 2 m above the established groundwater table, the area of impact to be addressed in applications is limited to 120 m of the site. The focus in site rehabilitation is on surface water drainage and drainage features on the site with limited attention to groundwater resources. Site assessments have a focus on surface water features on and within 120 m of the site. Any negative impacts on the natural features or ecological functions and proposed preventative, mitigative or remedial measures also focus on the site and within a 120 m buffer area.

In an area in which there are karst aquifers, a quarry operation where the extraction occurs above the water table can result in the removal of surface and near surface landforms in bedrock that are essential to the aquifer recharge and temporary seasonal storage of water. Flow within solution channels is well documented as being distinct from static groundwater elevations and may in many cases have little or no connection. Change in the rock strata, as with removal through quarrying, will completely alter the flow regime occurring within the solution channels.

Water entering the karst system is generally unfiltered and carries with it any contaminants encountered on the surface or elsewhere in the flow path. Quarry site drainage from precipitation or intercepted karst flow is generally directed back into the karst strata from excavated collection sites. This drainage water may bear contaminants and there may be thermal impacts with higher temperatures of drainage water. These altered drainage waters can emerge at a distance in karst springs to impact the quality of headwater streams.

A report by Blackport Hydrogeology and Golder Associates (Applied Research on Source Water Protection Issues in the Aggregate Industry, 2006), prepared for the Ministry of Natural Resources, highlights how karst systems are not yet adequately reflected within the Aggregate Resources Act and other Provincial Policy Statements. Some deficiencies are in addressing (i) the heightened impacts to the ecological functions of stream, lakes, and wetlands by groundwater flow modifications from aggregate extraction activities, and (ii) that karst systems may be the most sensitive environment to impacts from quarrying where dewatering occurs.

A report by Golder Associates Ltd and Ontario Geological Survey (Supplementary Report to Groundwater Resources Study 5: A 3-D Field Investigation of Paleozoic Bedrock and Boreholes in Thin-Drift Limestone-Dolostone Plains of Southern Ontario, 2008) states that areas of carbonate

bedrock (limestone, dolostone) at the surface or in the shallow subsurface are considered to be of high aquifer vulnerability. In these areas there is the strong potential for contamination of the aquifer.

Golder Associates Ltd. was commissioned to undertake field study of limestone and dolostone plains within southern Ontario where varying degrees of surface karst are exposed. The main purpose of the investigation was to test whether surface expressions of karst (for example solution pits, clint and grike features) were reflected, and to what depth, in the underlying sedimentary rock units. The report concluded that the dolostone plains of the Niagara Escarpment had more significant surficial karst expression and that the karst, with its high porosity, was found to a deeper extent. In these areas, there is essentially no attenuation of runoff through interaction with soil. The water would move directly into the bedrock openings, where it can infiltrate to depths, carrying any soluble contamination that may have been contacted, such as nitrates or bacteria. These areas are the major recharge zones, and the Bruce Peninsula contains one of the most significant dolostone karst plains in North America.

These reports and the fact that the findings are not reflected in the application requirements of the Aggregate Resources Act, show that the greatest threat to the integrity of karst-sourced streams like Judges Creek and Albemarle Brook is the apparent lack of policy and legislation specific to karst systems. In this area, there is strong pressure for bedrock quarry development and without addressing the existence and importance of the dynamic nature of the karst environment, these systems face potential impacts of quarry development.

It is apparent that Provincial policy for the review of quarry license applications has little consideration for the potential impact of disruption to karst drainage systems and the diverse ecological systems that they enable. From an environmental perspective, the relevant detail in a karst system investigation is the water: where it enters the system, how far it travels, where it emerges and what ecologies it supports. The Aggregate Resources Act addresses only the stone materials and *surface* water features within 120 metres of the site. Though proposed quarry site hydrology as defined by static ground water elevations is a required assessment, no attention is given to the dynamic nature of conduit flow within the bedded limestone structure of the Niagara Escarpment landform.

Karst drainage areas must be investigated and documented to prevent future impacts to this unusual and sensitive underground feature. It is clear that there are significant knowledge gaps and questions to be asked prior to resource development, and that assessment protocols specific to karst need to be developed. Addressing each of these will be important for developing a more comprehensive understanding of the hydrology of the overall drainage basin and establishing an evidence-based management plan that protects the entire drainage basin.

Judges Creek and Albemarle Brook Karst Systems

The karst system study currently being undertaken by the Biosphere Association will be completed by the end of June 2021. It will build on our preliminary study and provide further documentation of the underground drainage network that comprises karst systems along the limestone and dolostone bedrock of the Niagara Escarpment, additional investigation and mapping of Judges Creek and the Albemarle Brook karst system watershed using high-resolution surface imagery, and evaluation of risks using the new GIS-based "Watershed Risk Assessment Tool".

Specific deliverables include:

- High-resolution surface and canopy-level mapping of the Albemarle Brook watershed;
- A karst landform survey across the entire Judges Creek and Albemarle Brook watersheds, including documenting each of the springs; sinking streams, ponds, and wetlands; and characterizing the karst within the recharge zone on the Cape Dundas and Sydney promontories;
- A karst spring survey along the base of the Niagara Escarpment surrounding the eastern margin of the watersheds (from Barrow Bay to Sydney Bay);
- Further digital analysis and contouring of water elevation data from the Ontario Water Well Records database;
- A report summarizing findings and rationalizing the high-resolution imagery. Recommendations will be made on knowledge gaps and the significance of the karst phenomenon in Niagara Escarpment land-use and planning.

This submission to the Province's ERO system related to Growing the Greenbelt has been to provide science-based comment that when “Growing the Greenbelt”, protection of karst-based headwater aquifers is a critical need and should be considered in the Northern Bruce Peninsula and throughout other areas of the Greenbelt Niagara Escarpment. In June 2021, the Biosphere Association will provide scientific evidence and a greater understanding of the Bruce Peninsula karst to further support protection of headwaters karst-based aquifers as a critical need. The knowledge gap for other areas of the Niagara Escarpment with karst-type hydrogeological systems should also be addressed.

Conclusion

The Greenbelt is meant to be a continuous broad band of permanently protected land and the proposed expansion will build upon the systems approach of the Greenbelt Plan and will be directly connected through the Greenbelt’s natural heritage, water resource and agricultural systems. Expansion of the protected area to include key hydrological features will benefit all Ontarians.

The Biosphere Association appreciates the opportunity to comment on the ERO. We believe that approximately 4,775 hectares in a small karst-shed area of the Niagara Escarpment landform should be offered increased environmental protection through inclusion within an expanded Greenbelt. Karst systems exist along the length of the Escarpment and other additional areas could benefit from Greenbelt inclusion and protection. Further we believe that protocols to assess karst terrain suitability for development need to reflect the inherent differences and vulnerability of these distinct and critical hydrogeological systems.

Respectfully submitted,

Elizabeth Thorn
Chair, Bruce Peninsula Biosphere Association
(519) 377-5166

Neils Munk
Director, Six Streams
Bruce Peninsula Biosphere Association

www.bpba.ca
info@bpba.ca

16 Brock Street
P.O. Box 3
Tobermory
Ontario
N0H 2R0