


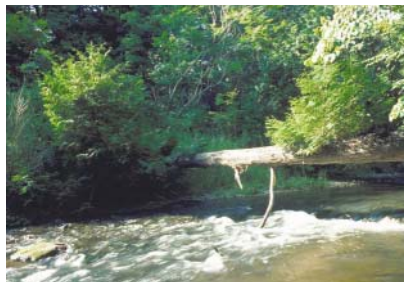

A WATERSHED PLAN

FOR DUFFINS CREEK AND CARRUTHERS CREEK

A Report of the Duffins Creek and
Carruthers Creek Watershed Task Forces

AUGUST, 2003

Duffins and
Carruthers
Watersheds

TORONTO AND REGION
Conservation
for The Living City

ISBN 0-9732764-0-1

5 Shoreham Drive,
Toronto, Ontario M3N 1S4

phone: 416-661-6600
fax: 416-661-6898

www.trca.on.ca

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CARRUTHERS CREEK TASK FORCE MEMBERS

Chair:	Dr. Neil Burnett, resident, Town of Ajax
Vice-Chair:	Regional Councillor Scott Crawford, Town of Ajax
Municipal Representatives:	Councillor Pat Brown (Alternate), Town of Ajax Alex Georgieff (Alternate), Regional Municipality of Durham Regional Councillor Rick Johnson (Alternate), City of Pickering Mayor Steve Parish, Town of Ajax, appointed by the Regional Municipality of Durham Councillor David Pickles, City of Pickering
Residents:	Jane Brooke, Town of Ajax David Clark, City of Pickering Steven Yourt, Town of Ajax
Stakeholders:	Neil Acton, Deer Creek Golf Course, representing Watershed Golf Courses Jackie Fraser, Aggregate Producers Association of Ontario (APAO) Alan Kimble, Urban Development Institute (UDI), Durham Chapter Gordon McKay, Citizens for Carruthers Cindy Mitton-Wilke, Ontario Ministry of Transportation
Supporting Staff Agencies and Municipalities:	Chris Darling, Regional Municipality of Durham, Planning Department Robert Flindall, Town of Ajax, Engineering Department Steve Gaunt, City of Pickering, Planning Department Kevin Heritage, Town of Ajax, Planning Department Tom Melymuk, Division Head, Corporate Projects and Policy, City of Pickering Tim Rance, Ministry of Natural Resources

Duffins and Carruthers Watersheds

DUFFINS CREEK TASK FORCE MEMBERS

Chair:	John Nemeth, resident, Town of Ajax
Vice-Chair:	Councillor Mark Carroll, Town of Whitchurch-Stouffville
Municipal Representatives:	Mayor Wayne Arthurs, City of Pickering, appointed by the Regional Municipality of Durham Councillor Joe Dickson, Town of Ajax Councillor Peter Dobrich (Alternate), Town of Whitchurch-Stouffville Lilli Duoba (Alternate), Town of Markham Alex Georgieff (Alternate), Regional Municipality of Durham Barb Jeffrey (Alternate), Regional Municipality of York Regional Councillor Rick Johnson (Alternate), City of Pickering Councillor Randy Low (Alternate), Town of Ajax Mayor Gerri Lynn O'Connor (Alternate), Township of Uxbridge Regional Councillor Susan Para, Township of Uxbridge Councillor David Pickles, City of Pickering Councillor Erin Shapero, Town of Markham Regional Councillor Tony Wong, Regional Municipality of York
Residents:	Dr. Doug Dodge, Town of Ajax Deanna Fry, Town of Ajax, Environmental Advisory Committee Margie Kenedy, Town of Whitchurch-Stouffville Judy Sullivan, City of Pickering
Stakeholders:	Neil Acton, Deer Creek Golf Course, representing Watershed Golf Courses Jackie Fraser, Aggregate Producers Association of Ontario (APAO) Alan Kimble, Urban Development Institute (UDI), Durham Chapter Patricia Short-Galle, Transport Canada
Supporting Staff Agencies and Municipalities:	Chris Darling, Regional Municipality of Durham, Planning Department Robert Flindall, Town of Ajax, Engineering Department Steve Gaunt, City of Pickering, Planning Department Kevin Heritage, Town of Ajax, Planning Department Tom Melymuk, Division Head, Corporate Projects and Policy, City of Pickering Tim Rance, Ministry of Natural Resources

Duffins and Carruthers Watersheds

EXECUTIVE SUMMARY

The Duffins and Carruthers Creek watersheds lie to the east of Toronto and drain into the north shore of Lake Ontario. These two river systems connect communities across Durham Region and York Region including the City of Pickering, the Towns of Ajax, Markham and Whitchurch-Stouffville, and the Township of Uxbridge. They are among the healthiest of watersheds in the Greater Toronto Region, yet they are also exhibiting signs of stress from land use activities. Although the "footprint" of the proposed Pickering Airport and the Seaton land development was not available during the time this Plan was written, we do know these two watersheds will face pressure from this future urban growth, road widenings, and construction. The Management Actions contained within the Watershed Plan and its associated technical reports provide a watershed perspective and clear direction for these undertakings. However, these watersheds also hold the potential for innovative management associated with their extensive public land holdings and position relative to the protection afforded by the newly enacted Oak Ridges Moraine Act (2001).

This Watershed Plan is a blueprint for action. The Plan includes a brief summary of current watershed conditions and identifies the issues to be addressed and the opportunities that exist. It sets out a vision for the future, a management philosophy, and a framework of management strategies including watershed management goals, objectives, and the required actions. It outlines a set of effective implementation mechanisms, and provides guidance for implementation priorities at a subwatershed scale and areas within the watershed where initial implementation activities should focus.

This Watershed Plan comes from a commitment by Toronto and Region Conservation (TRCA) in its 1989 Greenspace Strategy to guide the preparation of a watershed management strategy for each of the nine watersheds in its jurisdiction. Building upon commitments made in the Greenspace Strategy, and with over 45 years experience in protecting and restoring the environmental health of one of the most rapidly expanding city regions in the world, TRCA has defined a new vision for its work, The Living City:

> *The Living City Vision*
> *The quality of life on Earth is being determined in the rapidly expanding city regions. Our vision is for a new kind of community, The Living City, where human settlement can flourish forever as part of nature's beauty and diversity.*

The Living City is a way of living in city regions that promotes a healthy coexistence between economy and nature. In a Living City, the ecosystem is seen as the foundation for the City Region. Nature is protected and enhanced for its ability to sustain the health of its important functions in the regional ecosystem; a system in which all living things are interdependent and exist in a delicate balance.

The Living City vision has three objectives: healthy rivers and shorelines, regional biodiversity, and sustainable communities. In support of The Living City vision and building upon the experience gained from previous watershed planning initiatives, TRCA has advanced its community-based process and technical approaches in the development of this Watershed Plan.

TWO TASK FORCES AND ONE PLAN

TRCA continued its very successful model for empowering watershed stakeholders and formed two Watershed Task Forces in 2000. Membership of the two Task Forces included elected municipal representatives, watershed residents, and representatives from key stakeholder groups and agencies.

The Task Forces were charged with the responsibility of developing this Watershed Management Plan. Despite their difference in size, the Duffins Creek and Carruthers Creek watersheds are diverse and contrasting landscapes that share many of the same opportunities and challenges. Therefore, the Task Forces prepared one management plan for the two watersheds.

VISION

The Duffins and Carruthers Creek Watersheds Task Forces hold the following vision for the future of these watersheds:

The Vision

Duffins Creek and Carruthers Creek watersheds will be healthy, dynamic, and sustainable watersheds that continue to have clean, safe water. These watersheds will have functioning wetlands and be diverse with self-sustaining communities of native plants, fish and wildlife, where natural and human heritage features are protected and valued. Residents will recognize the watersheds as essential community resources that enhance their quality of life. All stakeholders will participate in the stewardship of the watersheds and growth and development will reflect this vision and the importance of protecting and enhancing this priceless legacy.

MANAGEMENT PHILOSOPHY

The vision for the Duffins Creek and Carruthers Creek watersheds is supported by a management philosophy that promotes five key elements.

Net Gain

- Improve upon existing features and functions throughout the watersheds.
- Use the unique opportunities provided by extensive public land holdings in the watersheds.

Environment First

- Manage the watersheds as a "system," considering the environmental function first.
- Protect and enhance the natural features and functions as a first step in a hierarchy of other management approaches.
- Emphasize prevention over remediation, recognizing that prevention is more cost efficient than remediation.

Balance Land Use

- These watersheds, adjacent to one of the largest cities in Canada, must support a combination of natural, urban and agricultural land uses and systems.
- Apply the principles of Smart Growth.
- Recognize through land use actions, the concept of balance, thus ensuring integrity of watershed functions.

Human Health and Safety

- Recognize linkages between human health and the health of the environment.
- Minimize risk to human health and safety.

Everyone Counts – Ownership, Commitment and Follow Through

- Demonstrate sustainable living and sustainable community design.
- Build upon existing leadership, stewardship, and good decision making practices.
- Strengthen existing and develop new partnerships.
- Make the appropriate lifestyle choices, change behaviours, and encourage innovation in thoughts, words, and actions.

TECHNICAL FOUNDATION FOR THE PLAN

State-of-the-art watershed management today not only addresses a broader range of issues than previous initiatives, but also considers the interrelationships among these issues. Issues are considered in both the current and future planning context, in order to take a more proactive approach to management. Given the rich information base existing within the Duffins and Carruthers Creek watersheds, and the extensive experience of TRCA and its partners with watershed planning, the Task Forces were able not only to employ, but advance, state-of-the-art methodologies for watershed planning.

To understand key functions and issues operating within the watersheds, the Task Forces and the technical support team defined and evaluated three land use scenarios in terms of the effects they would impose on watershed health. The three scenarios included: existing land use, future land use (as per the approved Official Plans), and future land use with enhanced natural cover. These scenarios reflected the primary drivers of change expected in the watersheds, including urban growth and opportunities for natural area protection. The results of the evaluation enabled the Task Forces to benchmark the watersheds' response along a continuum.

Recognizing that the watershed ecosystem is a complex network of interrelated features and functions, the task forces reduced the watershed ecosystems to a set of simpler component systems in order to understand the response to each of the three land use scenarios. Studies were undertaken within the following technical areas:

- surface water quantity;
- groundwater quantity and quality;
- surface water quality;
- aquatic habitat and species;
- terrestrial habitat and species;
- human heritage; and
- public use – outdoor recreation.

An innovative aspect of this work was the degree to which the findings of each technical study component were integrated and interpreted from the perspective of other interrelated components. A watershed response model guided the integration and interpretation of results arising from each individual technical component study. For example, increases in vegetative cover predicted changes in groundwater levels and stream baseflow, which in turn predicted an effect on the aquatic community composition in certain stream reaches. Details of this approach and each of the technical component studies are summarized in the Technical Analysis and Integration Process Summary Report (TRCA, 2003) and in the full set of supporting technical reports. These reports build upon information previously published in the Duffins and Carruthers Creek State of the Watershed Reports (TRCA, 2002).

MANAGEMENT APPROACH

The Task Forces have recommended that the most effective approach for managing the Duffins and Carruthers Creek watersheds involves achievement of an enhanced natural heritage system, together with the application of best management practices in all aspects of land use activities. The concept of an enhanced natural heritage system at a watershed scale is described in the "Future Land Use (as per Official Plans) with Enhanced Natural Heritage Cover" scenario.

Implementation of this management approach will involve a review and realization of opportunities for achieving an enhanced natural heritage system at subwatershed and site scales.

The selection of this approach was based on the following considerations:

- its consistency with the Task Forces' Management Philosophy;
- its effectiveness for meeting multiple watershed management benefits;
- its ability to provide the foundation for a sustainable watershed;
- its feasibility; and
- its consistency with other provincial and federal basin management objectives.

GOALS, OBJECTIVES, AND BASELINE REPORT CARD

A set of eight goals and 25 objectives make up the overall management strategy of this Watershed Plan (Table E-1). A rating has been assigned to each goal and objective, based on an evaluation of the state of current watershed conditions in relation to the management direction provided by the specific goal and objectives. These ratings form a baseline "Watershed Report Card" from which the effectiveness of implementing the Watershed Plan can be measured. Details of the rating analysis are documented in the Ratings Report for the 2003 Duffins and Carruthers Creek Watersheds Report Card (TRCA, 2003).

MONITORING AND REPORTING

A formal, coordinated multi-agency monitoring program is not intended to be the sole form of watershed monitoring in the Duffins and Carruthers Creek watersheds. Many of the recommendations tabled in Chapter Six of this Plan are in fact initiatives that require frequent performance assessments. These performance assessments are considered to be elements of watershed monitoring. It is also recognized that observations of stream and terrestrial ecosystem health by residents, stakeholders, and non-government organizations are important metrics of the effectiveness of this Watershed Plan.

Periodic reviews of this Watershed Plan are an integral component of TRCA's watershed management process and allow for: systematic improvements to the plan, the incorporation of new scientific understandings of the watersheds, and emerging initiatives such as "sustainability". At the same time, the original assumptions of the Watershed Plan can, if necessary, be adjusted. Timing of major reviews should be coordinated with the preparation of a Watershed Report Card, in advance of major land use changes in the watershed.

TABLE E-1: Summary of management goals, objectives and ratings

TOPIC	GOAL	OBJECTIVES		RATINGS	
	Duffins Carruthers			**Duffins**	**Carruthers**
Surface Water Quantity	**Overall Rating: Good Good** To maintain the existing hydrologic function of the watershed.	Objective #1	Maintain the existing water balance within the watershed.	Good	Good
		Objective #2	Maintain or enhance baseflows.	Good	Fair
		Objective #3	Minimize or reduce risks to human life and property due to flooding.	Good	Good
		Objective #4	Maintain or restore natural stream channel stability.	Further study required	Further study required
Groundwater Quality and Quantity	**Overall Rating: Good Fair** To protect groundwater quality and quantity groundwater levels and discharge for watershed functions.	Objective #5	Maintain or enhance groundwater levels and discharge for watershed functions.	Good	Fair
		Objective #6	Protect groundwater quality to ensure provision of safe water supplies and ecological functions.	Good	Good
		Objective #7	Ensure sustainable rates of groundwater use.	Further study required	Further study required

TOPIC	GOAL	OBJECTIVES		RATINGS	
	Duffins Carruthers			**Duffins**	**Carruthers**
Surface Water Quantity	**Overall Rating: Fair Fair** To protect and improve surface water quality.	Objective #8	Manage the quality and quantity of run-off from rural and urban areas to maintain in-stream uses.	Good	Good
		Objective #9	Minimize in-stream sediment associated with construction activity.	Poor	Poor
		Objective #10	Reduce water quality contamination associated with wastewater discharges.	Poor	Not Applicable
Aquatic Habitat and Species	**Overall Rating: Good Fair** To protect aquatic habitat and species.	Objective #11	Protect and restore native aquatic species and communities.	Good	Fair
		Objective #12	Protect and restore the riparian zone and associated functions.	Fair	Fair
		Objective #13	Maintain or restore the natural variability of annual and seasonal stream flows.	Further study required	Further study required

TABLE E-1: Summary of management goals, objectives and ratings

TOPIC	GOAL	OBJECTIVES		RATINGS	
	Duffins Carruthers			**Duffins**	**Carruthers**
Terrestrial Habitat and Species	**Overall Rating: Fair Fair** To protect and enhance terrestrial habitat and species.	Objective #14	Increase the per cent of natural cover to a quantity that provides targeted biodiversity and supports recreational uses.	Good	Fair
		Objective #15	Protect the natural system quality and function from the influence of surrounding land uses.	Fair	Fair
		Objective #16	Protect and restore all native vegetation community types and species to targeted levels.	Further study required	Further study required
Public Use - Recreation	**Overall Rating: Good Fair** To provide appropriate sustainable public use that promotes environmental awareness and enhancement.	Objective #17	Create continuous watershed trails in the greenspace system linking Lake Ontario and the Oak Ridges Moraine.	Fair	Fair
		Objective #18	Manage the greenspace system for sustainable uses and public enjoyment.	Good	Poor
		Objective #19	Improve greenspace accessibility while ensuring compatibility between social benefits and ecological health.	Good	Poor

TOPIC	GOAL	OBJECTIVES		RATINGS	
	Duffins Carruthers			**Duffins**	**Carruthers**
Human Heritage	**Overall Rating: Fair Fair** To preserve and interpret our evolving human heritage resources.	Objective #20	Identify and document human heritage resources for protection.	Fair	Fair
		Objective #21	Increase awareness and appreciation of the inherent value of human heritage resources.	Fair	Fair
		Objective #22	Apply a standardized approach to protecting human heritage resources at all levels of government.	Fair	Further study required
Sustainable Communities	**Overall Rating: Good Fair** To achieve a behavioural shift in lifestyles, community design, and resource use in keeping with the environmental objectives for the watersheds.	Objective #23	Increase awareness of watershed issues and use of available watershed knowledge in decision making to foster sustainability and sustainable lifestyle practices.	Further study required	Further study required
		Objective #24	Promote lifestyles that are ecologically sustainable.	Further study required	Further study required
		Objective #25	Use sustainable urban design approaches to guide urban growth and development.	Fair	Fair

TEN INTEGRAL MANAGEMENT ACTIONS

The Task Forces recommended a detailed set of management activities for the achievement of each objective. A number of these actions are common, in that they contribute toward the fulfillment of numerous objectives. Certain benefits are considered especially important because they can happen well beyond their site of application. These particular management actions are so important that they are integral to the overall health of the watersheds and should be afforded top priority for implementation. The Integral Management Actions are:

1. Protect existing meadows, wetlands, and forests identified in the enhanced terrestrial natural heritage system and secure lands to be restored.

2. Actively restore areas within the enhanced natural heritage system, which contribute multiple watershed benefits, and allow passive restoration to occur in the remaining areas.

3. Provide stormwater quantity and quality controls for new and existing development, including transportation corridors.

4. Manage land uses and water withdrawals to maintain or enhance infiltration patterns, groundwater pathways, and resultant baseflows.

5. Eliminate the remaining point source of pollution (i.e. Stouffville Water Pollution Control Plant) and manage non-point sources of pollution, in particular stormwater runoff and infiltration from urban land uses, transportation corridors, and rural contributions.

6. Enforce stringent erosion and sediment controls for construction and infrastructure maintenance activities.

7. Protect and restore natural streams and stream processes by managing runoff and sediment loss at source, protecting valley and stream corridors, and naturalizing altered streams.

8. Remove and/or mitigate human-built barriers to fish passage and sediment transport, including on-line ponds, where recommended by the Fisheries Management Plan.

9. Maintain self-sustaining, resident/migratory fish and wildlife populations as barometers of a healthy natural heritage system.

10. Identify and raise awareness of past and present human influences on the watersheds and the strong link between human heritage, watershed recreation, and human and environmental health.

MULTIPLE BENEFITS OF NATURAL COVER

The protection and enhancement of terrestrial natural heritage cover through the achievement of the enhanced natural heritage system is central to the Task Forces' management approach. Technical analysis of the watersheds' response to the "Future Land Use (as per the Official Plans) with Enhanced Natural Heritage System" scenario repeatedly demonstrated the multiple watershed benefits that can be realized by achieving an enhanced natural heritage system. In addition to benefits associated with terrestrial habitat and species objectives, a natural heritage system would contribute to the management of hydrological, hydrogeological, water quality, aquatic resource, recreation, and human heritage concerns.

At a watershed scale, the protection of a viable natural heritage system will provide the foundation for a sustainable watershed. By protecting the ability of natural systems to carry out watershed functions, there will be less need for costly maintenance of infrastructure, less risk with unproven technological solutions to watershed management, and cost savings in taking a preventative approach rather than a reliance on remedial or "end-of-the-pipe" solutions. In addition, choices made at the community and site scales within the watershed will contribute to overall watershed sustainability.

IMPLEMENTATION FRAMEWORK

A Tool Kit of Implementation Mechanisms

Common to many watershed plans in Ontario, the key implementation mechanisms include: policy and planning, regulations and permits, stewardship and regeneration activities, land acquisition/securement, and education and awareness.

Both the province, under the Oak Ridges Moraine Act (2001) and Conservation Plan (2002), and Justice O'Connor in his Part Two Report of the Walkerton Inquiry (2002) have endorsed the important role municipal land use planning and other government permitting processes play in implementing a watershed plan. The Duffins and Carruthers Watershed Task Forces have also recognized the importance of developing a model policy framework to assist in the transition between the watershed plan and its implementation through these other planning and policy tools. Initial work has been completed in developing model policy framework; further work is a priority implementation activity.

GIS-based mapping has been prepared for each watershed to identify the areas targeted for active stewardship, regeneration, land acquisition and securement.

Subwatershed Scale Direction

A more detailed identification of key management considerations and actions has been provided at the subwatershed level. For this purpose, the Duffins Creek watershed was divided into six drainage areas including: West Duffins Creek, East Duffins Creek, Ganatsekiagon Creek, Urfe

Creek, Millers Creek, and the Lower Duffins Creek. The Carruthers Creek Watershed makes up the seventh area. Opportunities have been illustrated on a map for each subwatershed.

Community Action Sites

The task forces have identified six sites within the watersheds as potential "Community Action Sites". Sites were selected to demonstrate the implementation of many aspects of the watershed plan; the expected interest, enthusiasm, and support of implementation partners; and the feasibility of design and implementation at the site level. Community Action Sites have been successful in other watersheds as a means of facilitating the transition from plan to ground level action and in providing a sense of early accomplishment for partners implementing the plan.

Roles and Responsibilities

Implementation of the Watershed Plan requires the involvement of everyone, including residents, businesses, schools, and all levels of government. Specific recommendations are provided as to a role for each partner.

TOWARD FULFILLMENT OF NEW PROVINCIAL DIRECTIONS

The release of this report could not come at a better time as it complements recent recommendations of the Walkerton Inquiry, the Oak Ridges Moraine Act and Conservation Plan, and the proposed North Pickering Land Exchange and its principles for development of the Seaton lands. These decisions, combined with planning for the extensive federal government land holdings for a proposed regional airport in the Duffins watershed, suggest that we are at a point in time when critical decisions concerning the protection and enhancement of these areas need to be made.

Walkerton Inquiry Call for Source Protection

The Walkerton Inquiry's Part Two Report, A Strategy for Safe Drinking Water, was released by the Ontario Government in May 2002 and contains 93 recommendations for improved public policy and programs that will ensure the safety of Ontario's drinking water supply. The report focuses considerable attention on the importance of protecting drinking water sources as the first step in a multi-barrier approach to drinking water supply management. Specifically, the report calls for the preparation of watershed-based source protection plans and outlines the role of conservation authorities in this effort.

Drinking water sources within the Duffins Creek and Carruthers Creek watersheds include both lake-based (urban portions of the City of Pickering and the Town of Ajax) and groundwater-based supplies. The regional municipalities of Peel, York, and Durham have been assembling information to address components of groundwater source protection, and TRCA is committed to a program of coordinating the integration of all of this information within an

integrated watershed management and source protection plan.

The preparation of source protection plans for watersheds that are predominantly served by Lake Ontario may require a slightly different approach than areas influenced mostly by local sources. Although the Duffins Creek and Carruthers Creek watersheds affect the nearshore Lake Ontario environment, contaminant sources also arise from upstream in the Great Lakes Basin and from "imported" sources, such as atmospheric deposition.

Toronto and Region Conservation is working with Conservation Ontario and its representatives on the Provincial Advisory Committee that has been established to recommend a framework for the preparation of Source Protection Plans in Ontario.

Oak Ridges Moraine Act and Conservation Plan

After a six month moratorium that froze development on the Oak Ridges Moraine, and during which time a strategy was developed and public consultation undertaken, (Bill 122, The Oak Ridges Moraine Conservation Act) was passed in the Ontario Legislature and received Royal Assent on December 14, 2001. On April 22, 2002 the Oak Ridges Moraine Conservation Plan was approved and filed as a Ministers Regulation (O. Reg. 140/02). The purpose of the Plan is to provide land use and resource management planning direction to ensure the protection and ecological and hydrological integrity of the Oak Ridges Moraine.

The Conservation Plan provides for four land use designations. The first two are Natural Core Areas and Natural Linkage Areas, where very limited new land uses are being permitted. The Countryside Areas are largely identified for agricultural, rural, recreational, and resource areas and, finally, the Settlement Areas are restricted to existing urban or settlement area boundaries.

Municipalities are directed in the plan to recognize these land use designations, setbacks, and further study requirements in their Official Plans and zoning by-laws within set timeframes. In addition, it requires that detailed water management studies (i.e., watershed plans, water budgets, and conservation plans) be completed and their results be incorporated into municipal Official Plans before any major development proposals may be approved.

In summary, the Conservation Plan was written and designed to be implemented by municipal governments. Many of the requirements of the Plan involve tasks or studies that conservation authorities have traditionally undertaken for their member municipalities.

Prior to the enactment of the Oak Ridges Moraine Act and Plan, the nine conservation authorities with watersheds on the Oak Ridges Moraine formed a coalition to advocate for the protection of the Moraine. This Conservation Authorities Moraine Coalition has pre-

pared a proposal to be submitted to its member municipalities outlining the aspects of the Conservation Plan, which could be delivered by conservation authorities. The preparation of watershed plans like this one, water budgets, and mapping of environmental features are among the items being proposed by the coalition.

WORKING TOGETHER FOR THE FUTURE DUFFINS AND CARRUTHERS WATERSHEDS

This Watershed Plan will be successful if it remains a living document, one that is revisited and implemented when and where appropriate. We will know that we have made a difference if we strive to meet multiple objectives during implementation and continue to further understanding of the technical work that supports management strategies and their direction.

What is Success?

As we move forward and evolve with the times and the places that are unique to these two watersheds we should be able to look back and say that we have:

- protected and enhanced the natural systems and sustainability of communities within the Duffins Creek and Carruthers Creek watersheds;
- strengthened foundations for managing the watersheds using a formal monitoring and reporting system in place;
- improved water quality in Carruthers Creek and Duffins Creek for improved habitats and the provision of safe drinking water;
- increased our knowledge of human and natural heritage resources in these watersheds and developed educational and outreach programs that support and apply this new knowledge base in the two watersheds and beyond;
- provided opportunities for watershed residents and stakeholders to have a greater say in how these watersheds are used and managed;
- expanded our knowledge and refined our planning and management practices to sustain these river systems;
- built on existing and established new watershed partnerships that reflect the importance of the Duffins Creek and Carruthers Creek watersheds in the Regional Municipalities of Durham and York and beyond; and
- encouraged private landowners to manage and exercise good stewardship of their lands to promote watershed sustainability.

Good decision making is based on sound science and an accurate, reliable knowledge base. This Watershed Plan identifies a series of actions that are based on sound science. These actions have emerged as a result of detailed analysis and consultation. For practical purposes, these management strategies are to be initiated and monitored over the next five years. Many of these actions will be completed during this time. For those actions that require implementation over a longer time period, significant progress will be made during the next five years and a foundation established for continued action.

Periodic reviews of this Watershed Plan are an integral component of TRCA's watershed management process allowing for systematic improvements to the Plan, and the incorporation of new scientific understandings of the watersheds and emerging initiatives, such as "sustainability". At the same time, the original assumptions of the Watershed Plan, if necessary, can be adjusted. Timing of major reviews should be coordinated with the release of Watershed Report Cards, or advanced, if unanticipated major changes in land use occur.

Many individuals and groups have collaborated to develop this strategy. Many more will be involved in its implementation. But its success hinges on the vigour with which each partner pursues the vision, management philosophy, and accompanying management strategies. Two healthy, dynamic and sustainable watersheds are attainable for Duffins Creek and Carruthers Creek.

CHAPTER

1

1.0 INTRODUCTION

The jurisdiction and work of Toronto and Region Conservation (TRCA) are based on watersheds. A watershed includes all of the lands draining into a river system and, in the greater Toronto region, ultimately into Lake Ontario.

TRCA develops its programs and projects to protect and enhance the natural resource features, functions, and landforms associated with the nine watershed systems within its area of jurisdiction. A key initiative necessary to move toward a watershed based ecosystem approach is the development of individual watershed plans.

In 1999, TRCA began a process to develop a plan for the Duffins and Carruthers Creek watersheds. This initiative continued the TRCA commitment, under its 1989 Greenspace Strategy, to prepare a watershed strategy (or plan) for each of the nine watersheds within its jurisdiction. The Duffins Creek watershed and the Carruthers Creek watershed form the eastern end of the TRCA jurisdiction (Figure 1.1). This planning initiative represented the sixth and seventh management

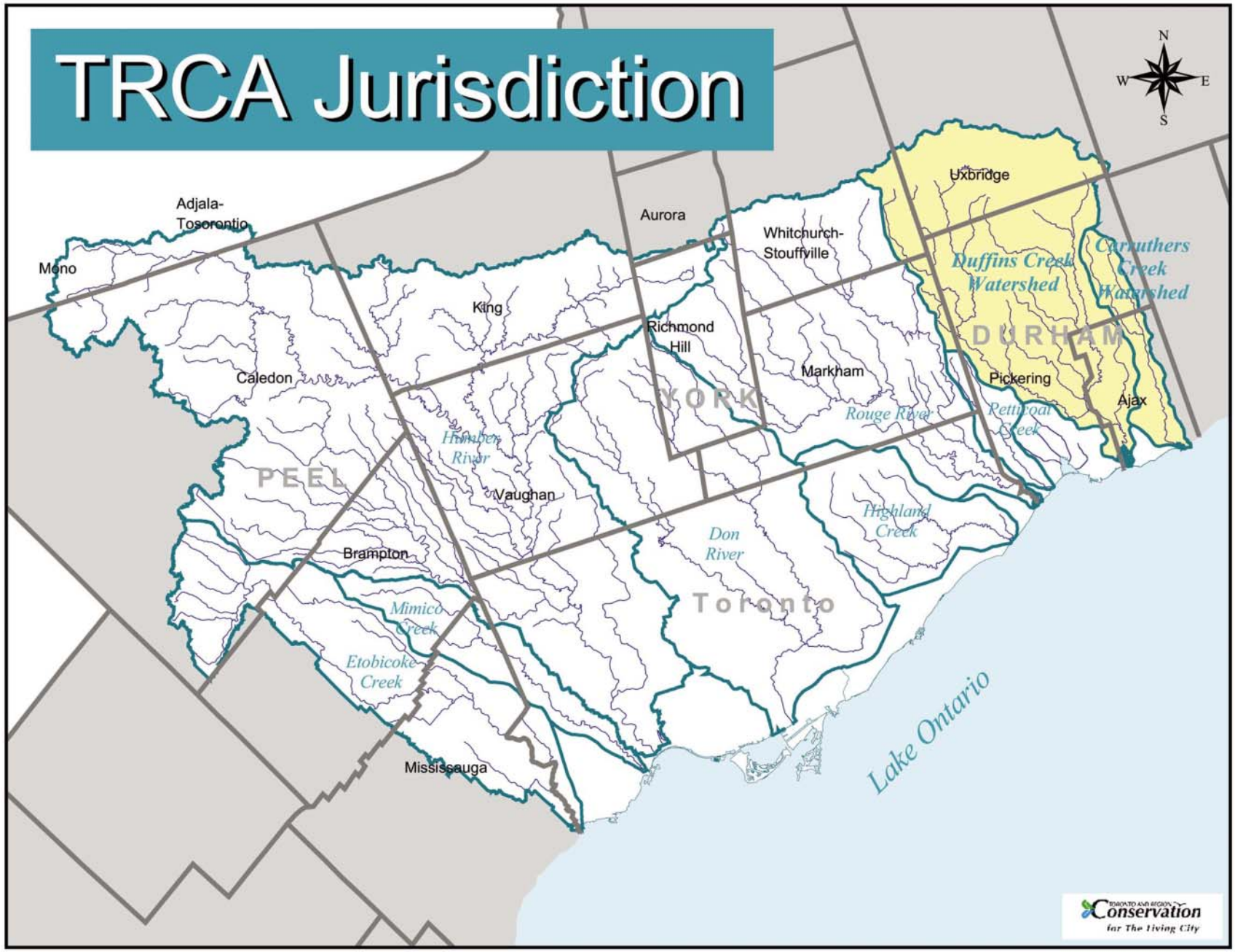

TRCA Jurisdiction
N
W
E
S
Adjala-
Tosorontio
Mono
Aurora
Whitchurch-
Stouffville
Uxbridge
Duffins Creek
Watershed
Carruthers
Creek
Watershed
King
Richmond
Hill
DURHAM
Caledon
Markham
Pickering
Ajax
YORK
Rouge River
Petticoat
Creek
Humber
River
PEEL
Vaughan
Highland
Creek
Don
River
Brampton
Toronto
Mimico
Creek
Etobicoke
Creek
Mississauga
Lake Ontario
Conservation
for The Living City

FIGURE 1.1

plan to be completed out of the nine TRCA watersheds, and as such was designed to build upon the successes and lessons learned from past experiences.

1.1 PURPOSE OF THE WATERSHED PLAN

The purpose of the Duffins and Carruthers watershed planning process was to undertake a thorough study of natural features and functions, human heritage, and public use and the interdependencies among these elements. The Watershed Plan evaluates the potential effects of current and future watershed activities and identifies management actions needed for watershed protection and enhancement.

This process was divided into three phases:

Phase One: An assessment of current watershed conditions and issues that were documented in the State of the Watershed Reports.

Phase Two: Technical Analysis and Integration, an evaluation of the watershed's response to alternative land use management scenarios.

Phase Three: Plan Development, focused on preparing the Watershed Plan with management recommendations, implementation strategies, roles and responsibilities.

All three phases involved watershed residents and other stakeholders through extensive and broad-based public stakeholder involvement.

1.2 THE STATE OF THE WATERSHED REPORTS

To develop a Watershed Plan for the Duffins Creek and Carruthers Creek, TRCA formed a Technical Advisory Committee (TAC) in 1999. The TAC consisted of TRCA staff, scientists, and experts who were familiar with state-of-the-art watershed methods and modelling techniques. The TAC examined groundwater, surface water, terrestrial and aquatic resource information, fisheries, climate change, and land use planning and prepared two State of the Watershed Reports: one for Duffins Creek and one for Carruthers Creek. The two State of the Watershed Reports have been prepared as key reference documents for watershed decision makers. They provide the knowledge base that was used to prepare their companion document, this Watershed Plan.
The Duffins Creek and Carruthers Creek State of the Watershed Reports contain the following 14 chapters:

- Introduction
- Study Area
- Human Heritage
- Greenspace, Trails, and Recreation
- Surface Water Quality
- Surface Water Quantity
- Stormwater Management
- Fluvial Geomorphology

- Land Use
- Air Quality
- Climate
- Hydrogeology
- Aquatic Habitat and Species
- Terrestrial Natural Heritage

Only a limited number of copies have been printed and circulated to municipal planning departments, key interest groups in the watershed and the municipal libraries. The documents can be downloaded from the TRCA website at www.trca.on.ca or are available on a CD from TRCA.

1.3 THE ROLE OF THE TASK FORCES

With a strong base of scientific data, TRCA started a process of developing a Watershed Management Plan for the two watersheds in June, 2000. Two Task Forces were formed, with municipal and federal government representatives, as well as key stakeholders and residents from both watersheds.

As Advisory Boards to TRCA, the Task Forces were charged with the responsibility of developing a Watershed Management Plan for the Duffins and Carruthers watersheds; a watershed plan that would be understood and endorsed by municipal politicians and staff, provincial and federal governments, community groups, business and industry, and watershed residents.

Recognizing the merits of watershed planning, representatives of both the Federal Department of Transportation and the Ontario Ministry of Transportation participated in the study. The provincial ministries of Natural Resources and Environment were invited, but declined to directly participate. Staff from the Ministry of Natural Resources (MNR) assisted the Task Forces in an advisory role on matters relating to the preparation of a Fish Management Plan for the two watersheds. Municipal staff were consulted on a regular basis and in turn they provided technical assistance to the Task Forces, ensuring the relevance of the plan to the watershed municipalities.

The Duffins Creek Task Force consisted of elected representatives from the two regional municipalities and each of the five local municipalities within the Duffins Creek watershed, including the Regional Municipality of Durham, Regional Municipality of York, City of Pickering, Town of Markham, Town of Ajax, Town of Whitchurch-Stouffville and the Township of Uxbridge. Also playing a role on the Task Forces were watershed residents as well as representatives from Transport Canada, Ontario Ministry of Transportation, the aggregate industry, watershed golf courses, the Durham Chapter of the Urban Development Institute, and the agricultural community.

The Carruthers Creek Task Force consisted of elected representatives from the Regional Municipality of Durham, City of Pickering, and the Town of Ajax. Residents from the Carruthers Creek watershed played a significant role along with representatives from the Ontario Ministry of Transportation, Citizens for Carruthers, aggregate industry, agriculture, golf courses, and the Urban Development Institute. In addition, the Town of Ajax appointed a representative from its Environmental Advisory Committee.

1.4 PUBLIC INVOLVEMENT AND CONSULTATION WITH STAKEHOLDERS

Stakeholder consultation began in the spring of 1999 before the two Task Forces were formed. At that time, TRCA staff approached the five local and two regional municipalities in the Duffins Creek and Carruthers Creek watersheds to see if they would provide staff input and financial support toward the development of a Watershed Plan.

Once that commitment was confirmed, TRCA hosted public information sessions in the fall of 1999 to inform the public about the watershed strategy process and to encourage watershed residents to apply for a position on one of the two Task Forces. Concurrently, the Chair of TRCA wrote to the local and regional municipalities and requested Council representation on the Task Forces.

Over the two years (2000-2002) the Task Forces worked, they provided numerous opportunities for public and stakeholder input. Public Open Houses were well advertised and held at "north" and "south" locations across the watershed for the convenience of citizens traveling from all five local municipalities to provide their input. Key milestones that were presented at pubic meetings occurred in November and December of 2001 and June of 2002. At those meetings, feedback was received regarding the watershed issues, vision, and proposed management actions.

In addition to placing ads and hosting public meetings, the Task Forces pursued meetings with those groups who they felt should have a say in the final Watershed Plan. As a result, many meetings and consultations occurred with the Aggregate Producers of Ontario, the Agriculture Industry, the Durham Chapter of the Urban Development Institute (UDI), the Golf Course Industry, the municipal and regional Environmental Advisory Committees (EACs), and active environmental groups in the watersheds such as Uxbridge Conservation, Durham Conservation Association, the Green Door Alliance, Citizens for Carruthers, Uxbridge Naturally, and the Oak Ridges Trail Association.

TRCA staff and the Chairs of the Task Forces kept municipal staff and their councils updated at regular intervals and encouraged participation at regular Task Force meetings, which were open to the public.

CHAPTER

2

2.0 INTRODUCTION TO WATERSHED MANAGEMENT

What is a Watershed?

Everyone lives in a watershed. A watershed is the land area drained by a river/stream system. Rain falling and snow melting from fields, forests, rooftops, lawns, parking lots, and streets flows toward a lake or river and forms a watershed. Smaller drainage areas — the component parts of a watershed — are called subwatersheds. Watersheds are separated from each other by high land elevations called the watershed divide.

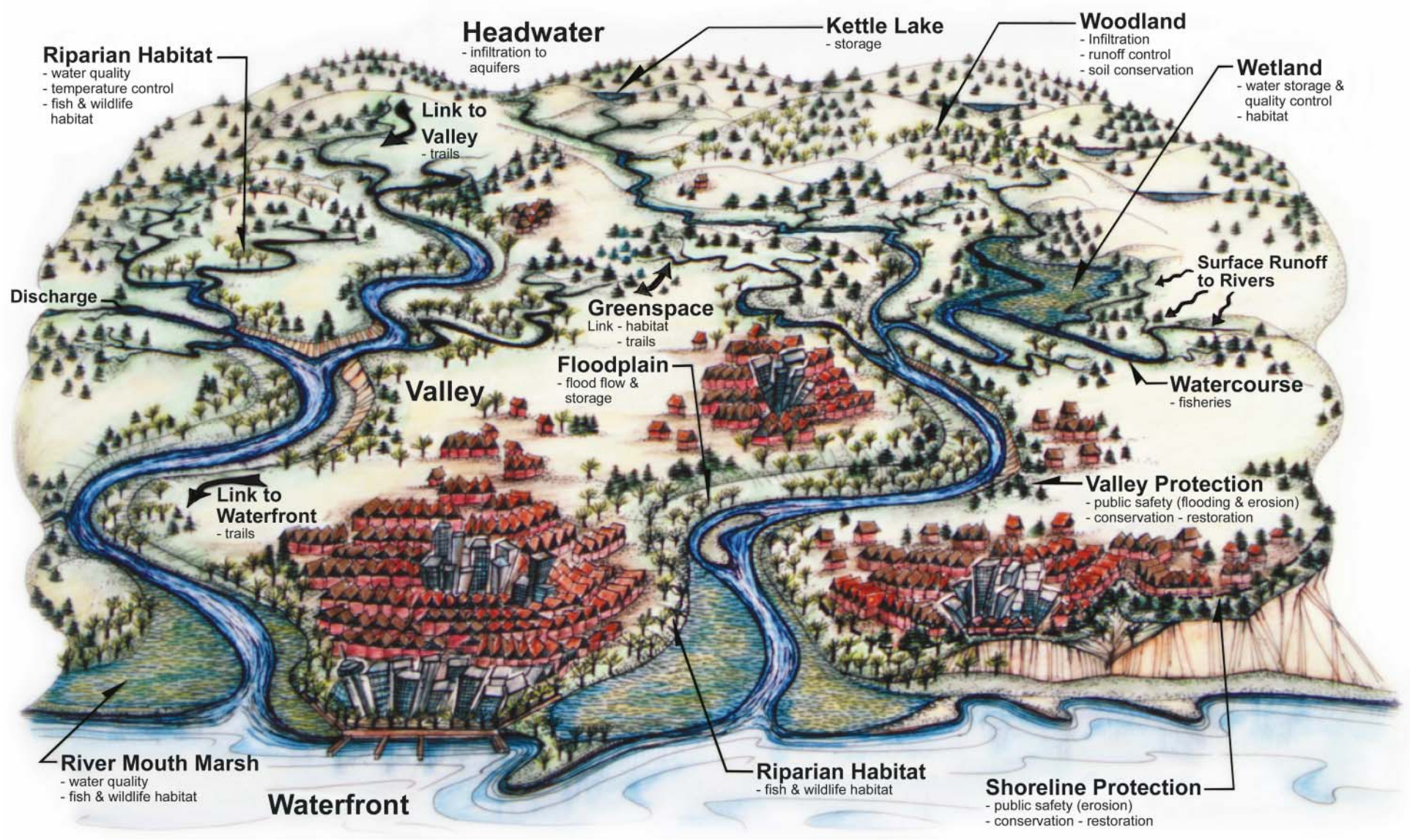
What is Watershed Management?

Human activities on land have a direct and cumulative impact on water and other natural resources within a watershed. Upstream activities influence river flows and water quality downstream. Channelizing rivers, removing riparian vegetation along watercourses, paving recharge areas, filling in wetlands, and consuming groundwater at rates faster than it can be replenished can have severe, and in some cases, irreversible effects on natural systems. These effects in turn

usually impair water quality, degrade aquatic and terrestrial habitat, contribute to a loss of biodiversity, contaminate underground aquifers, and increase risks of flooding and erosion damage.

At the heart of watershed management is the underlying philosophy that "everything is connected to everything else." Watershed components are interrelated and interdependent, like the links of a chain or the spokes of a wheel. Damage to any one watershed component runs the risk of damage to all. The health of upstream components directly determines the health and function of areas downstream. If the headwaters of Duffins Creek and Carruthers Creek are healthy, areas downstream will benefit. If the Duffins Creek and Carruthers Creek Watersheds are well managed then Lake Ontario and the St. Lawrence River Basin will benefit. Our actions affect our neighbours as well as neighbouring communities.

A SAMPLE WATERSHED



CHAPTER

3

3.0 THE VISION

The Duffins Creek and Carruthers Creek watersheds will be healthy, dynamic, and sustainable watersheds that continue to have clean, safe water. These watersheds will have functioning wetlands and be diverse with self-sustaining communities of native plants, fish and wildlife, where natural and human heritage features are protected and valued. Residents will recognize the watersheds as essential community resources that enhance their quality of life. All stakeholders will participate in the stewardship of the watersheds and growth and development will reflect this vision and the importance of protecting and enhancing this priceless legacy.

3.1 THE MANAGEMENT PHILOSOPHY

Preparation and implementation of the Watershed Plan for the Duffins Creek and Carruthers Creek is a continuing commitment to protect the two watersheds. The Plan provides environmental focus and science to guide decisions on balancing diverse interests to ensure the continued health of these important watersheds.

To be successful in managing the watershed, the Task Forces recognized the need to invoke a management philosophy to guide the development of recommended management action approaches.

The management philosophy for the Duffins Creek and Carruthers Creek watersheds promotes five key elements:

- Net Gain
- Environment First
- Balance Land Use
- Human Health and Safety
- Everyone Counts – Ownership, Commitment, and Follow Through

These five key elements can be achieved in the following ways:

Net Gain
- Future decisions and actions will improve upon existing features and functions throughout the watersheds.
- Use the unique opportunities provided by extensive public land holdings in the watersheds.

Environment First
- Manage the watersheds as a "system," considering the environmental function first.
- Protect and enhance the natural features and functions as a first step in a hierarchy of other management decisions.
- Emphasize prevention over remediation, recognizing that prevention is more cost efficient than remediation.

Balance Land Use
- These watersheds, adjacent to one of the largest cities in Canada, currently support a combination of natural, urban and agricultural land uses.
- Apply the principles of Smart Growth.
- Recognize, through land use actions, the concept of balance, thus ensuring integrity of watershed functions.

Human Health and Safety
- Recognize linkages between human health and the health of the environment.
- Minimize risk to human health and safety.

Everyone Counts – Ownership, Commitment, and Follow Through

- Demonstrate sustainable living and sustainable community design.
- Build upon existing leadership, stewardship, and good decision making practices.
- Strengthen new and existing partnerships.
- Make the appropriate lifestyle choices, change behaviours, and encourage innovation in thought, words, and actions.

3.2 THE COLOUR WHEEL

There is always someone downstream. Within these watersheds, there are complementary uses. The following colour wheel (Figure 3-1) illustrates the importance of finding a balance between uses and users. This work is based on Ostwald's colour theory that all colours of the rainbow produce a spectrum of colour that, together, symbolize good quality of life.

Uses in potential conflict appear diametrically opposed around the colour wheel (e.g., agricultural uses and development, irrigation and aquatics, transportation routes, and heritage sites). Complementary uses appear side by side. Effective watershed management promotes a balance between uses and users and takes an integrated approach to managing all resources within the watershed. This wheel is symbolic of that holistic approach.

Over the last 20 years, watershed management evolved from an approach that focused exclusively on hydrologic functions within a watershed to a complex science-based approach that combines planning and decision-making on a watershed scale. Today, watershed management involves integrating numerous water resource priorities and goals, and working in cooperation with residents, stakeholders, and all three levels of government.

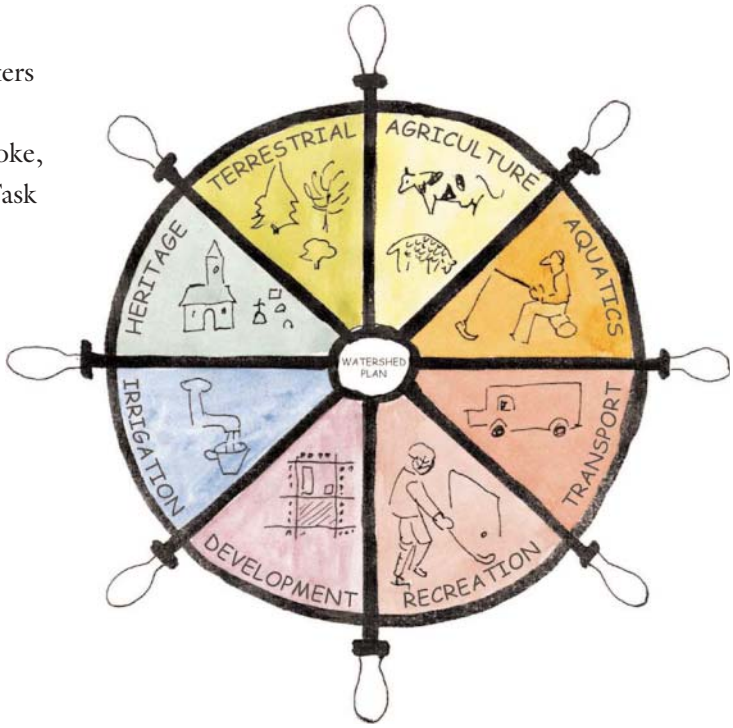


FIGURE 3.1 - Navigating the Waters Complementary Interests (Jane Brooke, Carruthers Creek Task Force)

CHAPTER

4

4.1 THE CARRUTHERS CREEK WATERSHED STUDY AREA

The Carruthers Creek watershed is entirely within the Regional Municipality of Durham and includes the two local municipalities of the City of Pickering and the Town of Ajax (Figure 4.1). Representing the most easterly watershed within the TRCA jurisdiction, Carruthers Creek is not only the smallest watershed (38 square kilometres) in the Greater Toronto Area (GTA), but one of the least studied.

From its headwaters near the community of Mount Zion downstream to Lake Ontario, the Carruthers Creek watershed is 20 kilometres long and three kilometres at its widest point and can be divided into three physiographic regions. From its headwaters on the Halton Till Plain, Carruthers Creek weaves its way toward Lake Ontario over the shoreline of glacial Lake Iroquois and continues south across the Lake Iroquois Plain, where it empties into Lake Ontario through the Carruthers Creek Marsh. Farming was commonplace in the southern reaches until the Second World War when the land was industrialized to support the war effort.

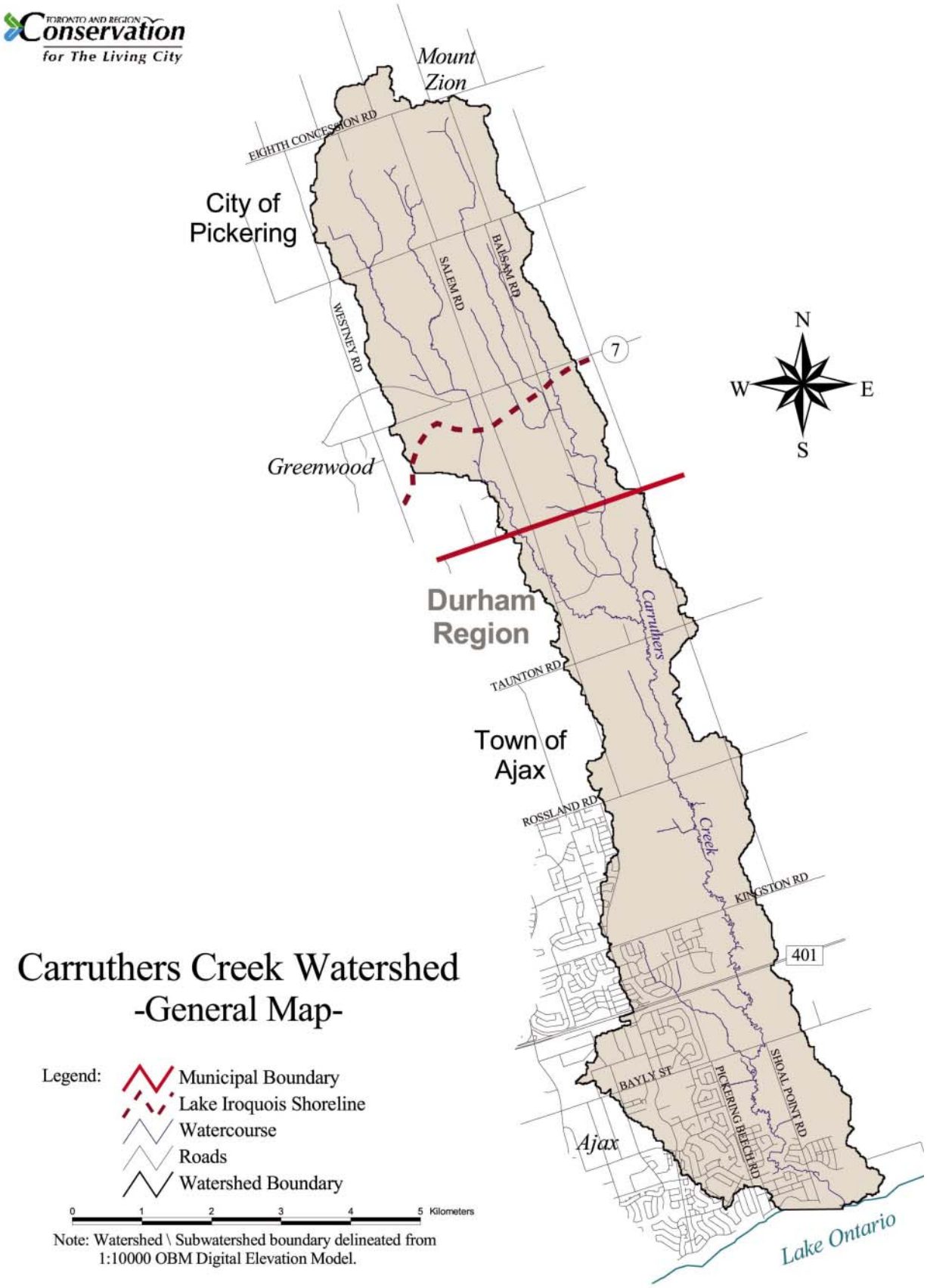

TORONTO AND REGION Conservation for The Living City
Mount Zion
EIGHTH CONCESSION RD
City of Pickering
SALEM RD
BALSAM RD
WESTNEY RD
7
N
W
E
S
Greenwood
Durham Region
Carruthers Creek
TAUNTON RD
Town of Ajax
ROSSLAND RD
KINGSTON RD
401
BAYLY ST
PICKERING BEACH RD
SHOAL POINT RD
Ajax
Lake Ontario
Carruthers Creek Watershed
-General Map-
Legend:
Municipal Boundary
Lake Iroquois Shoreline
Watercourse
Roads
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 4.1

Lands owned by TRCA within the Carruthers Creek watershed (totaling to 25 hectares) are located around the Carruthers Marsh at the mouth of the creek and are predominantly for conservation and recreation purposes.

4.2 THE DUFFINS CREEK WATERSHED STUDY AREA

One of the healthiest watersheds along the north shore of Lake Ontario, Duffins Creek drains an area of 283 square kilometres and is one of the most comprehensively studied watersheds in Canada.

Duffins Creek is in the eastern part of Toronto and Region Conservation's (TRCA) jurisdiction (Figure 4.2). While a major part of the watershed is in the Regional Municipality of Durham, smaller portions fall within the Regional Municipality of York. From its headwaters to Lake Ontario, this watercourse links the communities of Whitchurch-Stouffville, Markham, Uxbridge, Pickering, and Ajax. Duffins Creek has a number of significant tributaries including Reesor Creek, Stouffville Creek, Wixon Creek, Whitevale Creek, Major Creek, Mitchell Creek, Urfe Creek, Brougham Creek, Ganatsekiagon Creek, and Millers Creek.

The headwaters of Duffins Creek rise on the Oak Ridges Moraine. Here, cold-water streams support a diverse aquatic community and large areas of forest, meadow, and wetlands provide high quality terrestrial habitats. From the Oak Ridges Moraine, Duffins Creek winds its way across the Halton Till Plain, the Lake Iroquois Shoreline, and the Lake Iroquois Plain. The middle reaches of the watershed tend to be rural in nature and are characterized by well defined valley lands. From Taunton Road south to the Duffins Creek Marsh and Lake Ontario, the southern reaches of the watershed are more urbanized, consisting of mixed uses and commercial corridors.

A significant portion of the watershed is in public ownership. Lands owned by TRCA totaling 23 square kilometres (eight per cent) are used for education, recreation, forestry, and agriculture. The federal government controls approximately 7,500 hectares (24 per cent of the watershed) and provincial government's land holdings total 28 square kilometres (or 10 per cent of the watershed).

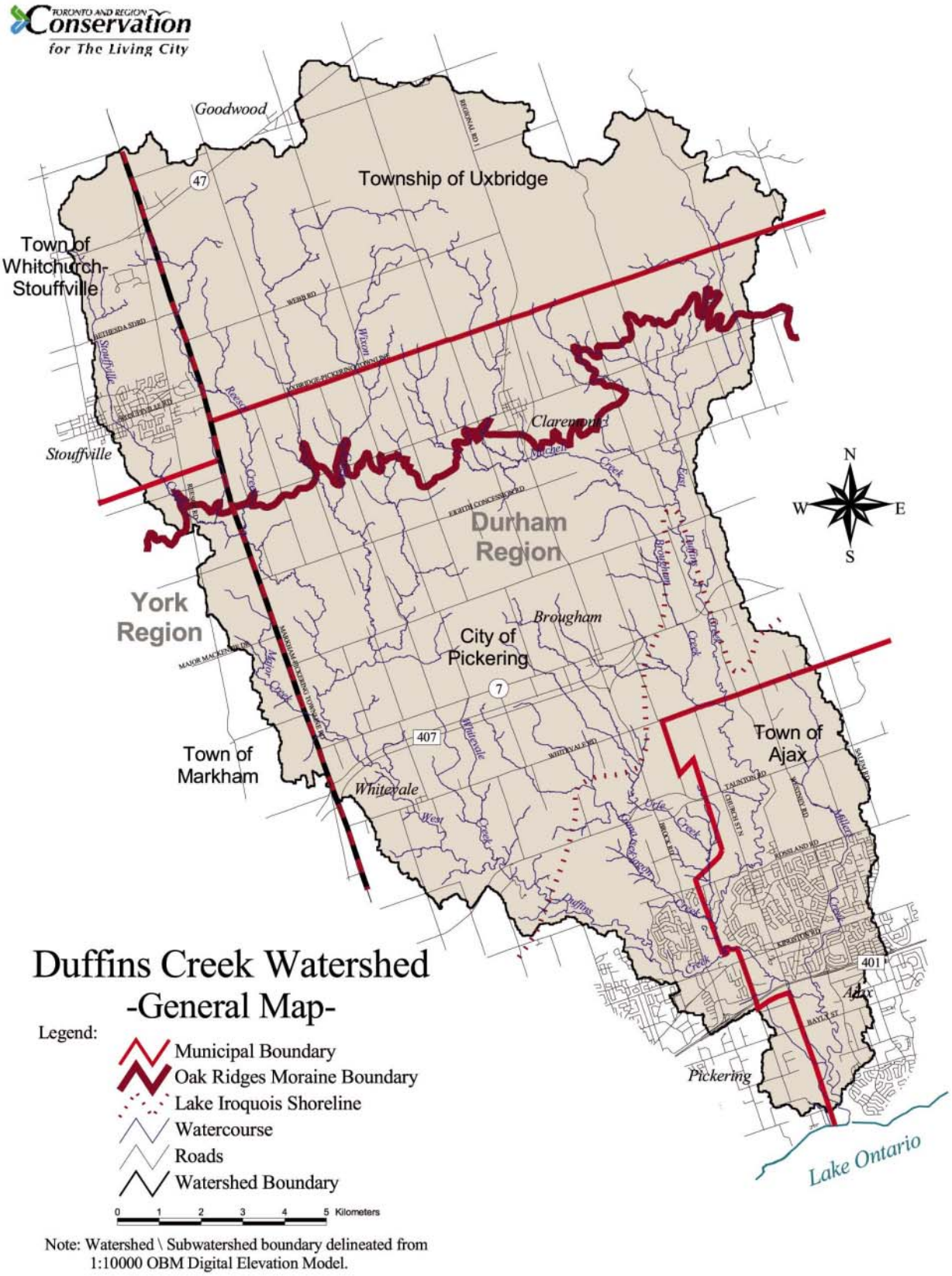

Toronto and Region Conservation
for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
Claremont
Durham Region
York Region
Brougham
City of Pickering
Town of Markham
Whitevale
Town of Ajax
Ajax
Pickering
Lake Ontario
N
W
E
S
47
7
407
401
Duffins Creek Watershed
-General Map-
Legend:
Municipal Boundary
Oak Ridges Moraine Boundary
Lake Iroquois Shoreline
Watercourse
Roads
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 4.2

CHAPTER

5

5.0 THE DUFFINS AND CARRUTHERS CREEK WATERSHEDS – PAST

Human heritage provides a context and background for our management, use, and enjoyment of the watersheds of today. Human heritage features include archaeological resources, architectural resources, and cultural and heritage landscapes. Each of these are critical aspects of the watersheds' past, and together tell of the use of the Duffins and Carruthers creeks waterscapes and landscapes. By uncovering and appreciating the complexities of historic interactions between people and the natural environment, we can inspire a vision for the future where society interacts with the environment in a symbiotic relationship.

For the first 11,000 years of Aboriginal settlement, human impacts on the watersheds were minimal, the result of low population densities and a way of life harmonious with the natural world. Within the first 50 years of European settlement however, the landscape was significantly transformed.

The history of human occupation in the watersheds starts some 12,000 years ago with the retreat of the Wisconsinan Ice Sheet. At that time, this area may have been inhabited by only a few dozen nomadic bands of hunters and gatherers. Not until the climate warmed and horticulture was adopted did people become more sedentary and the population increase. First Nations, and later settlers from the United States and various parts of Europe, were attracted by the natural features and resources of Duffins and Carruthers creeks.

Knowledge of Aboriginal occupation in southern Ontario comes from three sources of data: the archaeological record of their material culture including artifacts, human remains, and traces of campsites and villages; the oral traditions of First Nations, and the historical record that begins in the 1600s including documents, maps, and drawings made by missionaries and other (European) travelers.

For details of First Nations and of 18th to 19th century settlers see Chapter Three: "Human Heritage" in the State of the Watershed Reports.

Augustus Jones, surveyor of the area in 1791, noted that the native name for Duffins Creek was sin.qua.trik.de.que.onk which he described as meaning "pine wood on side." The earliest French name for Duffins Creek was "Riviere au Saumon" named for the Atlantic salmon, which annually migrated upstream to spawn (Rouge, Duffin, Highland, Petticoat Valley Conservation Report, 1956:11).

Carruthers Creek bears the family name "Carruthers" who owned 202 acres along its banks. Richard Carruthers was born in Cumberland, England in 1819. He settled on part of Lots 4 and 5, Concession 1, having purchased these lands in January 1856 and September 1862, as well as purchasing part of the road allowance from the township in June 1875. The land remained in the Carruthers family until at least the 1940s.

Human Heritage Chapter, Appendix D, Duffins Creek and Carruthers Creek State of the Watershed Reports.

5.1 THE DUFFINS AND CARRUTHERS CREEK WATERSHEDS – PRESENT

In June 2002, the Duffins Creek and Carruthers Creek State of the Watershed (SOW) Reports were completed. These two reports, combined with the technical component studies outlined in Chapter Six, provide the knowledge base for preparing this Watershed Plan.

This chapter has drawn on information from the SOWs and summarizes the existing conditions for the Carruthers Creek and the Duffins Creek. Section 5.6 provides a summary of Carruthers Creek current conditions from a land use perspective followed by details under the headings of water, (including groundwater, and surface water quality and quantity), habitats (aquatic and terrestrial), and public use. The same format is followed for Duffins Creek beginning with section 5.7.

5.2 COMMON ISSUES

Climate, climate change, and air quality are reviewed in detail in the SOW reports and a summary is provided below as issues common to both watersheds.

TRCA is currently preparing a Natural Heritage Strategy. This strategy and its components is a significant departure from the Environmentally Significant Areas (ESA) study from the early 1980s. Until such time as the Natural Heritage Strategy is completed, the ESA criteria are used as a planning tool for TRCA plan review comments. The ESA Study and the Natural Heritage Strategy, common elements for both watersheds, are outlined below.

> " Water is life … water binds together the fates of nations with shared watersheds and river basins, and diverse users drawing from common water resources. It also links society with nature, for water is the lifeblood of ecosystems and the wider community of life"
>
> *Tellus Institute, Halfway To The Future: Water In A Thirsty World. 2001.*

Watersheds, like other natural systems, have a capacity to adapt to change. However, like all living systems, watersheds can tolerate only so much stress before detrimental change affects watershed function. It is imperative that the issues facing the watersheds be identified and understood so that collaborative and proactive actions can be taken.

5.3 CLIMATE AND CLIMATE CHANGE

The watersheds of Duffins Creek and Carruthers Creek experience a Great Lakes moderated continental climate typical of southern Ontario. In an average year, approximately 800 to 850 mm

of precipitation falls across the two watersheds. For the most part, there is little variation in monthly precipitation. Only two months, January and February, average less than 60 milimetres, whereas August and September average more than 60 milimetres of precipitation.

Over the last century, mean air temperatures across southern Ontario have increased by approximately 0.5 Celsius. A change likely caused by the release of significant amounts of carbon dioxide and methane gas to the atmosphere. Models used to predict the climate of the 21st century for Southern Ontario forecast air temperature to rise two to five degrees Celsius. The greatest changes are expected in the winter months resulting in a shorter snow season and a longer growing season. With respect to precipitation changes, there is generally less agreement among the models — some predict more and others less. Because higher temperatures will result in increased evaporation, problems arising from moisture deficits are expected to become more frequent and severe, other models predict extra precipitation to occur in extreme events, increasing the risk of flooding and flood vulnerable areas.

5.4 AIR QUALITY

Air quality represents the cumulative effect of contaminants in the atmosphere from human and natural activities and their atmospheric interactions. Air quality in the Duffins Creek and Carruthers Creek watersheds is affected by local, regional, and global factors. The Ministry of Environment (MOE) has three monitoring stations in and around the two watersheds that provide data for assessing air quality conditions. The Stouffville Station is located on Highway 47 just east of Highway 48. The Oshawa and Scarborough monitoring stations are located to the east and west of the watersheds respectively. Although the assessment focuses on these three stations, the "atmospheric region of influence" or "airshed" for the area extends far beyond the watersheds. Long range transport of high levels of pollutants is known to originate Stateside southwest of the Duffins Creek and Carruthers Creek watersheds.

Data from MOE's air quality monitoring network in 1997 and 1998 were studied to represent current air quality conditions in the watersheds. The contaminants evaluated include: ground level ozone, suspended particles, nitrogen oxides, sulphur dioxide, carbon monoxide, and volatile organic compounds. The sources and effects of these pollutants are discussed in greater detail in the State of the Watershed Reports. Air quality assessment also includes information on the Air Quality Index (AQI), which is based on groups of pollutants that have adverse effects on human health and the environment. Trends in the AQI over time were evaluated using data for the most recent ten year period, 1988 to 1997.

Overall, the Duffins Creek and Carruthers Creek watersheds have good air quality conditions most of the time. In 1998, air quality was moderate five per cent of the time and good to very good 94 per cent of the time. Less than one per cent of the time, air quality fell into the poor or very poor range. Recent reports in air quality advisories indicate conditions are not improving.

5.5 ENVIRONMENTALLY SIGNIFICANT AREAS AND TERRESTRIAL NATURAL HERITAGE APPROACH

5.5.1 ENVIRONMENTALLY SIGNIFICANT AREAS (ESA)

TRCA's Environmentally Significant Areas (ESA) study was first initiated in the late 1970s in an attempt to develop a more coordinated and comprehensive approach to land use planning and resource management in the region. Due to the overall size of the jurisdiction and limited resources, the study focussed on the major valley systems, Lake Ontario, and parts of the Oak Ridges Moraine.

Field inventories were used to determine whether an area met at least one of seven designation criteria. The criteria included:

- significant landforms;
- ground water recharge/discharge/storage, linkages between significant systems, or required for a significant population or concentration of species;
- exceptional or high quality habitats;
- habitats with limited representation;
- habitats with high diversity;
- presence of rare species; or
- habitats that were large enough to support species that require extensive blocks of habitat.

The study identified 126 ESAs in 1982. These ESAs were also recognized as priorities within TRCA's land acquisition program.

Inventory work as part of the 1990s ESA Study update highlighted trends in the populations and distribution of species and communities within TRCA's jurisdiction. For, example some species were no longer found within the urban portions of the watersheds even when apparently suitable habitat was available. With ongoing urban expansion in the region there was a concern that these conditions would also extend farther north.

In its Terrestrial Natural Heritage program, TRCA has become more proactive in ensuring that the losses of species and habitats do not continue, and instead are attempting to redress some of the species losses. These species are also indicators of overall environmental health. The shift away from just focussing on rare species and habitats, and instead looking at a preventative approach (taking into account the ecological needs and sensitivities as well as the distribution and abundance of species and habitats), is fundamental to TRCA's Terrestrial Natural Heritage Approach.

TRCA advocates the protection of the ESAs. Figure 5.1 shows the locations of the ESAs within the Duffins and Carruthers watersheds.

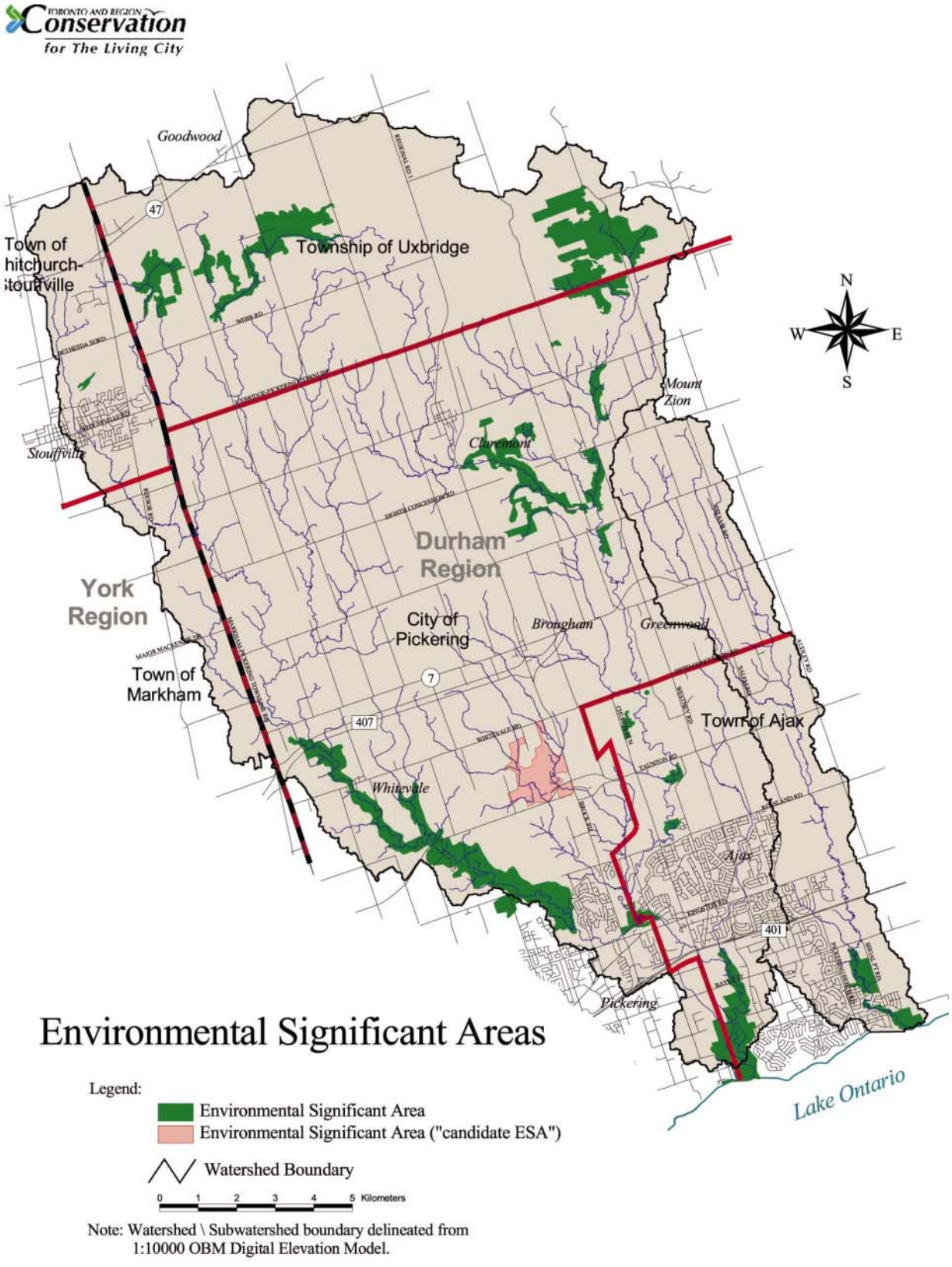

Goodwood
Township of Uxbridge
Town of
hitchurch-
Stouffville
Stouffville
Mount
Zion
Claremont
Durham
Region
York
Region
City of
Pickering
Brougham
Greenwood
Town of
Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
47
7
407
401
N
W
E
S
Environmental Significant Areas
Legend:
Environmental Significant Area
Environmental Significant Area ("candidate ESA")
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 5.1

5.5.2 TERRESTRIAL NATURAL HERITAGE APPROACH

Terrestrial Natural Heritage includes flora and fauna species, community types and the patterns and the interactions of habitat patches across the landscape. Across the Greater Toronto Area, natural areas have been reduced to small fragments. Clearly a new approach – one that maintains biodiversity and ecosystem health – is needed. TRCA is developing the Terrestrial Natural Heritage Approach to address this need.

The Terrestrial Natural Heritage Approach examines the condition of natural cover in the whole watershed and links it to adjoining watersheds. Instead of focussing on natural areas individually (e.g., Environmentally Significant Areas, Areas of Natural and Scientific Interest and Classified Wetlands), the Terrestrial Natural Heritage Approach recognizes the interconnectedness of all parts of the natural system. Therefore, it evaluates the function of the natural cover in the Duffins Creek watershed as one entity which can be conceived of as an "environmentally significant system." Furthermore, the approach is based on the relationship the natural heritage system has with the rest of the watershed. It recommends that decisions at the site level be made according to that premise, considering the whole system and the relationship with its context.

Natural heritage system data is collected at three scales (from large to small): the landscape, vegetation communities, and species scales. At the landscape level, terrestrial habitat patches are mapped according to four broad habitat categories: forest, wetland, meadow, and beach/bluff. Vegetation communities are mapped according to the province's Ecological Land Classification System (ELCS). Species of concern within TRCA's jurisdiction (to prevent rarity) are mapped according to TRCA's field data collection protocols.

Using these data, six indicators and 20 measures were examined to determine the health of the natural system as a functioning unit. Landscape, vegetation community and species data were summarized under each of the six indicators. These indicators are quantity, distribution, size and shape, matrix influence, connectivity, and biodiversity.

5.6 THE CARRUTHERS CREEK WATERSHED – CURRENT CONDITIONS

Land use in the Carruthers Creek watershed is divided between rural and agricultural uses that dominate the northern portion of the watershed, and urban uses that prevail in the southern reaches.

Currently only 20 per cent of the Carruthers Creek watershed is developed. One-third of the watershed is scheduled for urban use. Under the City of Pickering's Natural Areas designation, the headwater streams in the Carruthers Creek watershed are protected as part of the Open Space System. As well, the most northern lands in this area have been protected under a Provincial Minister's Zoning Order to restrict development adjacent to the Pickering Airport lands that are

located to the west. North of Taunton Road, land use is rural with agricultural practices dominating the landscape. Tributaries of Carruthers Creek are surrounded by natural areas (i.e., wetlands located along the Lake Iroquois Shoreline). Between Taunton Road and the 5th Concession, the Town of Ajax has established a permanent countryside dominated by open fields, forest and a functional natural system. From Taunton Road to Kingston Road, most of the land is either vacant or used for agriculture, with lands to the east designated for rural uses. While these lands will remain rural, lands west and north to Taunton Road are designated for residential and employment uses to accommodate future urban expansion.

Major transportation routes (i.e., Highway 401, CNR tracks) cross the watershed between Bayly Street and Kingston Road. Highway 401 is currently being widened with new highway interchanges planned at Carruthers Creek Parkway/Salem Road and Lake Ridge Road.

Almost the entire valley system surrounding the mouth of the creek at Lake Ontario constitutes Provincially Significant Wetlands known as the Carruthers Creek Wetland Complex. Portions of these areas have been designated as Areas of Natural and Scientific Interest and Environmentally Significant Areas (ESA) by the provincial government and TRCA. On the shores of Lake Ontario is the Carruthers Creek Marsh ESA. Approximately 38 hectares in size, this marsh is home to numerous species of mammals, fish, migratory birds, as well as rare birds and plants. Adjacent to the valley system, land use consists of low density residential development with some medium and high density residential areas north of the shoreline.

5.6.1 WATER

5.6.1.1 Groundwater

An understanding of the groundwater flow system is vital to watershed management ranging from the delineation of the sustainable yield for water supply purposes to programs to maintain the flow of groundwater discharge to streams. There is a paucity of data directly relating to the groundwater flow system within the Carruthers Creek watershed. The hydrogeologic understanding of the Carruthers Creek study area, as outlined below, has been applied by using information for the neighbouring Duffins Creek watershed.

5.6.1.2 Geologic Setting

The landforms and geologic deposits of the Carruthers Creek watershed were formed by a succession of glacial periods (when the climate was cooler than present) and interglacial periods (when the climate was similar to the present climatic conditions). The headwaters of Carruthers Creek originate within the South Slope physiographic region, which occurs south of an elevated landform known as the Oak Ridges Moraine. Surficial geologic deposits of the South Slope largely consist of till, which is a mixture of materials ranging in size from clay particles to boulders deposited directly by a glacier. Till deposits are often covered by a thin veneer of sand, silt, and clay deposited in former lakes, and by watercourses within the present day Carruthers Creek

valley. A second prominent landform near the middle of the Carruthers Creek watershed is an escarpment known as the Lake Iroquois Shoreline. This escarpment delineates the shoreline of an ancestral Lake Ontario formed approximately 10,000 years ago when lake levels were up to 60 metres higher than the present lake level. Deposits situated south of the Lake Iroquois Shoreline include till consisting of beach sands, gravels, silt, and clay.

Beneath the surficial deposits, the geologic layering is a series of alternating till and lake (sand, silt, and clay) or river (sand and gravel) units overlying the bedrock surface. The bedrock within the study area is composed of Late Ordovician shales of the Whitby Formation, which were deposited more than 400 million years ago. This till is covered by a thin layer of sand, silt, and clay. The Halton Till is underlain by a more dense, silty sand till known as the Northern or Newmarket Till, which occurs directly above bedrock at these two locations. More geologic units are expected to be present in the northern part of the watershed where the soil thickness above bedrock is greater.

5.6.1.3 Hydrogeology

Aquifer Units and Groundwater Recharge

Aquifers within the Carruthers Creek watershed are designated as upper, middle, and lower aquifer systems, which occur within the unconsolidated sediments lying on bedrock. Groundwater flow within all three aquifer systems is predominantly south to southeast from the highlands toward Lake Ontario. The upper aquifer system and the water table occur within sediments situated above the Northern/Newmarket Till and is largely unconfined. The middle and lower aquifer systems occur within deposits situated beneath the Northern/Newmarket Till and are primarily recharged by vertically downward groundwater flow from the overlying aquifer systems. In the southern part of the watershed, south of the Lake Iroquois shoreline where the sediment thickness is less, groundwater flow from the deeper aquifer systems is vertically upwards coincident with groundwater discharge from these aquifers systems to the river network.

Groundwater recharge rates for the Carruthers Creek watershed have not been determined. It is estimated that direct unit recharge rates to surficial till deposits are approximately 50 to 150 millimetres per year. Recharge areas characterized by surficial sand and gravel will have higher unit recharge rates. In order to define recharge rates it is necessary to prepare a water budget for the Carruthers Creek watershed. A continuous streamflow gauge has been installed south of Bayly Street. Streamflow data will allow for calibrated estimates of groundwater recharge and overland runoff to be conducted for the Carruthers Creek watershed. For preliminary non-calibrated estimates, see the Carruthers Creek State of the Watershed Report.

Groundwater Discharge

Groundwater flows with lower velocities than water flowing overland (runoff). The distribution and amount of groundwater discharging into a stream is important for maintaining annual streamflow, and supporting aquatic life. The groundwater discharge component of streamflow varies gradually in response to long-term changes in the groundwater flow system. In contrast,

the runoff component of streamflow is a short-term response to rainfall or snowmelt events and leads to sharp short peaks of flow.

To determine the spatial distribution of groundwater discharge within a watershed, streamflow was measured at various points throughout the Carruthers Creek watershed during the summer of 2000, after it had not rained for extended periods. Flow within the creek at this time is assumed to be contributed mainly from groundwater sources. Significant discharge was observed along two stream reaches within the watershed. The first area is north of Highway 7; this increased streamflow is expected to represent groundwater discharge mainly from the upper aquifer system. The second area is between Taunton Road and Highway 401 south of the Lake Iroquois Shoreline, in the central part of the watershed. This area of significant groundwater discharge is estimated to represent a significant component of discharge from the lower aquifer system.

Groundwater Quality

The quality of groundwater in the Carruthers Creek watershed is largely unknown. Based on information from the Duffins Creek watershed we found groundwater in the shale bedrock has poor quality, with elevated levels of sodium and sulphate. Groundwater within the unconsolidated deposits above bedrock appears to be of generally good quality for domestic use. Local occurrences of naturally high hardness and iron concentrations have been reported along with locally elevated levels above drinking water criteria for nitrates and chloride. The surface waters associated with the Carruthers Creek marsh indicate impacts from contaminants, such as pesticides, road salt, and fertilizers (Ministry of Environment Provincial Water Quality Monitoring Network (PWQMN)).

5.6.1.4 Surface Water Quality

Water quality data provide a basis for assessing the historic surface water quality in the Carruthers Creek watershed. Current water quality data are not available, since the Provincial Water Quality Monitoring Network (PWQMN) ceased to operate in 1993. For this study, monitoring data from 1983 to 1993 were analyzed. In 2002, with municipal funding support, TRCA has started to monitor water quality in the watershed.

Eight water quality parameters were selected for assessment including: phosphorus, nitrogen compounds, suspended solids, chlorides, bacteria (E.coli and faecal coliform), biological oxygen demand, dissolved oxygen, and temperature. Heavy metals and persistent organic pollutants (e.g., pesticides) were estimated using data from adjacent, similar watersheds. When compared to neighbouring watersheds in the TRCA jurisdiction, water quality conditions in the Carruthers Creek are generally better. However, according to Provincial Water Quality Guidelines and Objectives, some water quality parameters are elevated. To protect aquatic life and ensure safe public use of water bodies, Provincial Water Quality Guidelines and Objectives are very stringent.

High bacterial levels in water can create health risks. Bacterial levels monitored through the PWQMN in Carruthers Creek fail to meet objectives for water recreation 55 per cent of the time.

This estimate is likely low, given that water quality sampling is biased toward dry weather when bacteria levels tend to be lower. During and shortly after rain storms, it is not unusual for bacteria levels to be several orders of magnitude higher, even in pristine watercourses. Bacterial levels in the Carruthers Creek watershed suggest that swimming should occur only at public waterfront beaches. Although Carruthers Creek is generally not deep enough for swimming, it may be inviting to children for wading and streamside playing. Escherichia coli (E. coli) and other faecal coliform bacteria indicate the presence of human and/or animal faecal matter and can also suggest the presence of other bacteria, viruses, or pathogens that could infect humans, pets, and other warm-blooded animals.

Bacterial loadings from Carruthers Creek contribute to high bacterial levels in the nearshore zone of the lake. Pickering Beach is located on Lake Ontario just west of the mouth of the creek and is influenced by the water quality of Carruthers Creek. In 1999, data collected by the Durham Regional Health Department showed Pickering Beach closed 31 per cent of the swimming season (June to September). To the west of Pickering Beach, Rouge Beach and Bluffer's Park Beach were posted unsafe more than 95 per cent of the time during the same year – evidence of the western movement of nearshore currents that result in beach closures along the Lake Ontario waterfront.

This assessment of Carruthers Creek revealed that water quality was not toxic to aquatic communities. Temperature and nutrient enrichment are more likely to be limiting factors affecting aquatic health. Nutrient levels (phosphorus and nitrates) are elevated in the Carruthers Creek watershed. Since the 1970s, phosphorus concentrations have been decreasing in response to lower numbers of agricultural operations, and the adoption of modern agricultural practices. In Carruthers Creek, concentrations of total phosphorus tend to be higher in wet weather conditions and failed to meet the interim provincial guidelines of 0.03 milligrams per litre over two-thirds of the time. These high concentrations result from lawn and garden fertilizers and eroded soil particles coming from construction sites, stream banks, and agricultural activities. High nitrate levels are a concern, since they can contribute to excessive plant growth (nutrient enrichment) and may contribute to aquatic stress. Ammonia, a toxic form of nitrogen, is a component of human and animal sewage and also forms from decomposition of organic matter. Results from 1988 to 1993 suggest that ammonia levels in Carruthers Creek met the Provincial Water Quality Objectives (PWQO) for protecting aquatic life.

Other water quality factors are suspended solids and turbidity (water clarity); these tend to be high in Carruthers Creek during wet weather. Suspended solids find their way into water by suspension of sediment previously deposited on the stream bottom and soil particles transported overland to the creek. While levels of suspended solids in Carruthers Creek do not pose a threat to aquatic life, the highest concentrations occur during March and April when spring rains and snowmelt increase soil erosion. Another concern for water quality is turbidity. Turbidity is a measure of water clarity, and in Carruthers Creek, these levels have been relatively stable over time, with two exceptions. During the 1970s, turbidity levels were elevated because of farming operations and livestock in the creek. Turbidity levels were elevated again in the late 1980s when housing construction expanded in the watershed, leaving soil exposed and subject to erosion.

Other measures of water quality affecting aquatic habitat include Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) in the creek. BOD is a measure of the amount of oxygen-consuming organic materials washed into the watercourse. High measurements of BODs indicate that dissolved oxygen levels in the watercourse are at risk. In natural settings, BOD levels are low, indicating good oxygen levels. Until the mid-1970s, BOD was elevated, resulting from the number of small farming operations and manure running into the creek. Since the mid-1970s, BOD has declined as the landuse changed. In response, DO levels increased and, to date, remain good. While DO fluctuates throughout the year in relation to temperature (i.e., warmer water is capable of holding less dissolved oxygen and, hence, the lowest DO levels in Carruthers Creek occur in July and August), levels remain above the minimum required for either cold or warm water fishery.

Chlorides indicate human disturbance in the watershed. Strong seasonal trends happen because a major source of chlorides is from road salt associated with snowmelt. Over time, chloride concentrations have increased in response to the conversion of rural land (meadows, forest stands, and agriculture) to more urban uses (characterized by more vehicular traffic, paved surfaces, and a dense road network). Currently, chloride levels are around 65 miligrams per litre, with winter concentrations appearing as high as 200 miligrams per litre. Background levels were less than five miligrams per litre.

Persistent toxins were not assessed (pesticides, polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs) or heavy metals) in Carruthers Creek because of a lack of data. The Ministry of Environment (MOE) completed a stream study in 1991-1992 along Toronto's waterfront and a tributary toxics study for Duffins Creek in 2000-2001. While Carruthers Creek was not included in the study, results for this watershed are expected to be similar to, or better than, conditions reported for the Rouge River watershed, where levels were lower than all other Toronto tributaries. Findings from these studies suggest that contaminant concentrations are significantly higher in wet weather conditions for suspended solids, total phosphorus, E. coli, aluminum, iron and most organic compounds. The MOE 2000 – 2001 study for neighbouring Duffins Creek found few traces of organic pollutants and of those that were detected, all occurred in trace amounts – less than a few parts per billion, which is well below aquatic and human health standards.

5.6.1.5 Fluvial Geomorphology

Fluvial geomorphology assesses the shape and form of watercourses and quantifies processes occurring within the stream. This knowledge is used to develop guidelines for watershed management to ensure that processes within stream systems are protected. A number of factors impact the form and function of streams and watercourses. Climate and watershed geology are key factors. Other factors include beaver activity, location, and extent of stream-side vegetation, construction of dams, weirs and channelization, as well as changes in land use.

An analysis of stream patterns at a watershed scale allows us to understand how climate influences the amount and distribution of water, and how watershed geology affects how water is delivered throughout the watershed. Stream assessments are completed, grouping channels into segments (reaches) that reflect their slope and physical characteristics. Reaches are then examined using detailed topographic mapping and historical information to understand rates of erosion and movement patterns. Field studies provide cross-section information about the stream bottom and banks.

Carruthers Creek has a long main branch with a small number of tributaries spaced widely apart. The main channel is fairly straight but south of Highway 401 where the watershed slope becomes relatively flat, the creek meanders.

5.6.1.6 Surface Water Quantity

Water quantity is the movement of surface water through the Carruthers Creek watershed under various dry weather, rainfall, and snowmelt conditions. Many complex factors determine the amount of precipitation that flows into Carruthers Creek. These factors include: soil types (with varying abilities to hold and transfer water), topography, and land use.

Monitoring precipitation, and surface and groundwater levels are essential components of water quantity management. Human uses in the watershed have significant impact on all components of the water cycle, thereby affecting the water budget. Changes in volume and pathways of surface water flowing into Carruthers Creek can alter the size and shape of stream channels, the stability of streambanks, and affect dependent fish and wildlife habitats.

While the Duffins Creek and Carruthers Creek watersheds are very different in terms of drainage area and watershed shape, they respond in a similar way to large storm events. The Duffins Creek watershed is more than eight times larger in area than the Carruthers Creek watershed. Carruthers Creek, by comparison, is long and narrow with a gentle slope, which helps to accommodate flows within the watershed.

Carruthers Creek currently has a "rural watershed response," in that high runoff conditions that pose serious flooding concerns in other urban watersheds do not occur as frequently. This response is attributed to natural and terrain features that promote infiltration and reduce stormwater runoff. Historically, flood damage has been restricted to poor landform drainage issues in the south end of the watershed. Current flood mapping reveals that 12 structures and nine roads are susceptible to flooding within the Carruthers Creek watershed under the Regulatory Flood Standard.

The Regulatory Flood Standard, as defined by the MNR and MMA:

"It is the policy of the Province of Ontario that:
The flood standards used to define flood plain limits for regulatory purposes are:
a) the flood resulting from one of the following storm centred events:
- Hurricane Hazel storm (1954)
- Timmins storm (1961)
b) 100 year flood; and
c) an observed flood event, subject to the approval of the Minister of Natural Resources".

Reference: Flood Plain Planning Policy Statement, Implementation Guidelines, Ministry of Natural Resources and Ministry of Municipal Affairs, October, 1988.

5.6.1.7 Stormwater Management

Stormwater management practices have evolved over the past 20 years in response to advances in technology and a better understanding of the benefits of stormwater management. Prior to the 1980s, stormwater management had one objective — flood control. Management strategies of the day looked at conveying runoff to local watercourses as quickly and efficiently as possible. As a result, watercourses were modified through armouring or concrete lining to accommodate an increase in flow volume and velocity. These measures were largely reactionary and led to a decline in the health of river ecosystems through a reduction in terrestrial and aquatic habitat, reduced water quality levels and increased rates of erosion in downstream watercourses.

When we realized that urban stormwater runoff was a key factor affecting the health of river systems, we changed stormwater management practices. Flood control remains a key objective of stormwater management, but management practices today provide a higher level of protection for the environment, property, and residents by incorporating provisions for water quality, fish habitat protection, groundwater, and erosion controls.

Factors affecting stormwater control include land use designations, flood vulnerable areas, erosion sites, and environmental factors (i.e., baseflow, groundwater resources, terrestrial, and aquatic habitat). Stormwater criteria are usually defined through watershed or subwatershed studies and are applicable to all greenfield development and, to the extent possible, re-development proposals. Management criteria and performance targets, backed by comprehensive modelling studies, need to be straight forward for contractors and developers to implement in their management plans.

In 1991, the Town of Ajax retained the consulting engineering firm of Totten Sims Hubicki (TSH) to develop a Master Drainage Plan for the Carruthers Creek watershed, taking into account both existing and proposed development as outlined in the Durham Region Official

Plan. In 1995 and 1997, the Master Drainage Plan was updated by TSH to consider additional development pressures. The results of these studies are discussed in the Stormwater Management chapter of the State of the Watershed Report. Briefly, the watershed was subdivided into 29 sub-catchment areas. Specific parameters relating to soil conditions, land cover, land use, and slope were calculated and incorporated into the model. A representative rainfall event was distributed over the watershed to determine the stream flow at specific locations or flow points within the watershed. At the time of the study, there were no stream flow gauges in the watershed and the model was not calibrated. A comparison was made between pre- and post-development flows to understand the impact of proposed development on peak flows within the watershed. Based on the study findings, stormwater management criteria were developed to:

- mitigate potential adverse impacts; and, where possible,
- maintain pre-development conditions throughout the watershed.

Stormwater management criteria have been implemented in the Carruthers Creek watershed for both flooding and erosion (water quantity and water quality) control. As described previously, efforts are underway to collect streamflow data needed to update the TSH model. Results from the revised watershed hydrology model will be used to update stormwater management criteria for the Carruthers Creek watershed.

Figure 5.2 illustrates the existing and proposed development, the corresponding level of control, as well as the location of existing stormwater management facilities within the Duffins and Carruthers Creek watersheds. Approximately two-thirds of the urban/developed areas have stormwater controls in place, which meet current TRCA criteria (e.g., quality, quantity, and erosion control). The variation in the level of control indicates the timing of development within the watershed and reflects the change in stormwater management approaches that have occurred to date.

5.6.2 HABITATS

5.6.2.1 Aquatic Habitat and Species

Carruthers Creek is one of the smallest (containing only 61 kilometres of streams) and least studied watersheds in TRCA's jurisdiction. Historically, portions of the Carruthers Creek watershed would have supported coldwater fisheries including brook trout, Atlantic salmon and other species like slimy sculpin and mottled sculpin that are associated with coldwater streams. Other than mottled sculpin, however, these coldwater fish species are now absent. In total, 31 species of fish have been identified from Carruthers Creek. Of these, only two species, rainbow trout and common carp, are non-native. A survey (2000) of the fish community, and the Marsh (2002), found 18 fish species, including rainbow trout and common carp. A lower sampling effort may be one reason that helps to explain the few species found. A key method of determining the health of aquatic communities involves calculating an Index of Biotic Integrity (IBI).

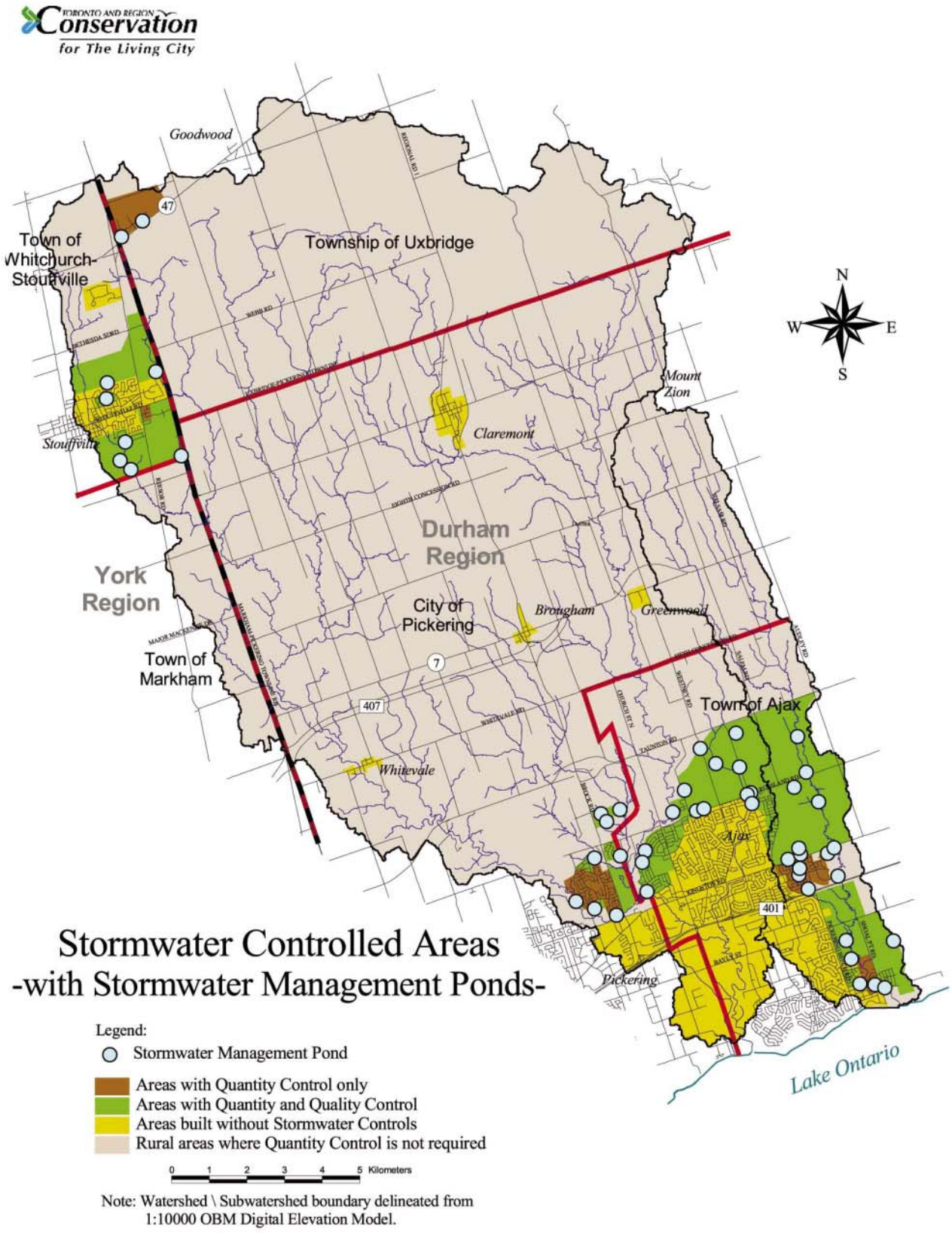

Toronto and Region Conservation
for The Living City
Goodwood
Town of Whitchurch-Stouffville
Township of Uxbridge
Stouffville
Claremont
Mount Zion
Durham Region
York Region
City of Pickering
Brougham
Greenwood
Town of Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
N
W
E
S
47
7
407
401
Stormwater Controlled Areas
-with Stormwater Management Ponds-
Legend:
Stormwater Management Pond
Areas with Quantity Control only
Areas with Quantity and Quality Control
Areas built without Stormwater Controls
Rural areas where Quantity Control is not required
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 5.2

This index is used to determine the ecological condition of fish communities by examining the abundance of fish, the presence of certain "indicator" species, assessments of habitat features, an evaluation of the food chain, and species diversity. Based on six sites surveyed in the watershed, IBI results for Carruthers Creek suggest that the aquatic system is in fair condition.

In-stream barriers to fish movement in the watershed adversely impact the aquatic system by limiting access to feeding and spawning areas, increasing water temperature, and impacting sediment transport. In addition, some in-stream structures increase water velocities to the point where fish passage is prevented. Structures that act as barriers to fish passage include dams, weirs, level crossings, and some culverts. Within the Carruthers Creek watershed most of these occur north of Taunton Road.

An eight-hectare coastal marsh is located at the mouth of the creek. This important transition zone between the lake and river is historically home to 24 fish species. Species found here include warmwater species such as largemouth bass and northern pike as well as lake species, such as white bass, white perch, gizzard shad, and alewife. This area is important to lake and river fish species because it provides spawning grounds and the dense plant growth affords important cover for juvenile fish. Protecting and enhancing this coastal marsh is critical. The health of this wetland is contingent on the condition of the upstream watershed.

5.6.2.2 Terrestrial Natural Heritage

Quantity and Distribution (of Natural Cover)
The Carruthers Creek watershed is in the Great Lakes-St. Lawrence Mixed Forest Zone. Dominant tree species here include sugar maple, American beech, white pine, and eastern hemlock. Historically, the region was cleared of most of its dominant forest cover by European settlers. Clearing of the forest occurred in three stages: the tall white pine was first used for ship masts, and ash from clearing and burning slash was used for potash production. Finally, cleared land was used for agriculture. With commercial and industrial expansion, Carruthers Creek watershed is now starting to feel the pressure of urbanization. Further incremental loss and degradation of natural habitats could result if action is not taken.

Natural cover has increased in the Carruthers Creek watershed over the last 40 years. The Carruthers Creek watershed has 25 per cent natural cover, comprised of 13 per cent forest, 10 per cent meadow and two per cent wetlands. It should be noted that municipal and provincial policies do not afford protection opportunities for meadows. For forested areas and wetlands, a greater level of protection is provided to provincially significant wetlands, ESAs, and regionally significant woodlots.

Consisting of open habitats dominated by grasses and wildflowers, meadows are actually considered old fields (fallow agricultural fields), areas which once were cleared for agriculture but have recently been allowed to naturalize. Meadows support a range of native flora and fauna species, but in a forest bioregion revert back to forest on their own. Beach habitats are found at the

mouth of the Carruthers Creek watershed, some being dynamic sandy beaches with species endemic to the Great Lakes shoreline.

5.6.3 PUBLIC USE

5.6.3.1 Greenspace, Trails, and Recreation

TRCA lands within the Carruthers Creek watershed comprise a total of 25 hectares and are located around the Carruthers Marsh at the mouth of the creek. Although somewhat fragmented, publicly-owned lands in the watershed offer a starting point for connected greenspaces. Linking greenspace areas will improve watershed health and will provide outdoor recreational opportunities for residents.

Two golf courses are currently located within the watershed: Deer Creek (located in the Town of Ajax) and Hawthorne Valley (located in the City of Pickering). For recreational fishing, a variety of fish including white and yellow perch, bass, pike, and carp can be found at different times of the year in Carruthers Creek, although these tend to predominate in the lower reaches of the watershed in and around Carruthers Marsh.

There are a number of existing and proposed trail systems that connect the natural, cultural, recreational, and educational features in the watershed with destinations further afield. One comprehensive trail system has been outlined in the Town of Ajax's Bicycle and Leisure Trail System Plan prepared in 2001. In 2003 the Town of Ajax will be revisiting its Waterfront Plan in consultation with the Waterfront Regeneration Trust and TRCA.

5.7 THE DUFFINS CREEK WATERSHED – CURRENT CONDITIONS

The headwaters of the Duffins Creek arise on the Oak Ridges Moraine in the Township of Uxbridge and the Town of Whitchurch-Stouffville. The Oak Ridges Moraine (ORM) is an ecologically and hydrologically sensitive landform that stretches as a ridge of hilly terrain for 160 kilometres. In 1991, the province recognized the importance of the moraine by identifying this as an area of provincial interest and releasing a set of Interim Implementation Guidelines. Although these guidelines were reflected in local Official Plans and applied to development applications, the provincial position on the ORM was never clarified. In response to growing development pressure on the moraine, the Regions of Peel, York, and Durham collaborated and published a 1999 paper recommending development of a long-term ORM strategy in conjunction with the province.

In response to this regional initiative, and as a result of interest from local groups and the public, the provincial government, in 2001 placed a six-month development moratorium on the ORM to establish a protection strategy for the area. An advisory panel was formed, and in November 2001 the province introduced the Oak Ridges Moraine Conservation Act along with an ORM

Conservation Plan. The ORM Conservation Plan provides for four land-use designations with associated permitted uses: Natural Core Area (38 per cent of the ORM), Natural Linkage Area (24 per cent of the ORM), Countryside Area (30 per cent of the ORM) and Settlement Area (eight per cent of the ORM). The ORM Conservation Plan protects the moraine by allowing new urban growth to occur only within existing settlement boundaries.

A key landowner, the federal government, controls approximately 24 per cent (7,500 hectares) of the land in the Duffins Creek watershed. Located in the City of Pickering, the Town of Markham, and the Township of Uxbridge, lands north of Highway 7 were expropriated by the federal government in the early 1970s and intended as the site of a new international airport within the Greater Toronto Area. Plans for the airport were put on hold in 1975, but federal ownership of these lands has been maintained ever since.

The federal government announced on March 23, 2001, "it will take immediate action to further protect the federally owned portion of the Oak Ridges Moraine and areas around the Rouge Park as green space." The Oak Ridges Moraine – located on the northern portion of the Pickering Lands – will preserve approximately 2,251 hectares. In addition, the alternate Rouge Park Corridor along the western boundary will preserve another 800 hectares (Figure 5.3).

On April 5, 2001, Transport Canada asked the Greater Toronto Airports Authority (GTAA) to conduct, on behalf of the federal government, interim planning setting the stage for a decision on whether to proceed with an airport on the Pickering Lands. Pursuant to this announcement the GTAA is preparing/undertaking:

- examination of the region's aviation supply and demand;
- social and environmental impacts of a possible airport;
- economic viability of an airport; and
- full range of alternatives.

In September 2002, the GTAA released its Financial Assessment Analysis Report. This report provided a framework for the GTAA to begin more detailed work toward a Master Plan that will then be subject to a full Environmental Assessment. Ultimately, the Government of Canada must decide whether an airport is to be built in the Duffins Creek watershed.

The middle reaches of the watershed are defined as those lands between the Township of Uxbridge/City of Pickering Townline and Taunton Road in the south. Current land use in the middle reaches of the watershed is predominantly agricultural. Several rural hamlets are also found here, including Claremont and Balsam as well as the Spring Creek Country Residential area. Areas of high aggregate potential have also been identified along the Lake Iroquois Shoreline and are protected from incompatible development under the Durham Region Official Plan.

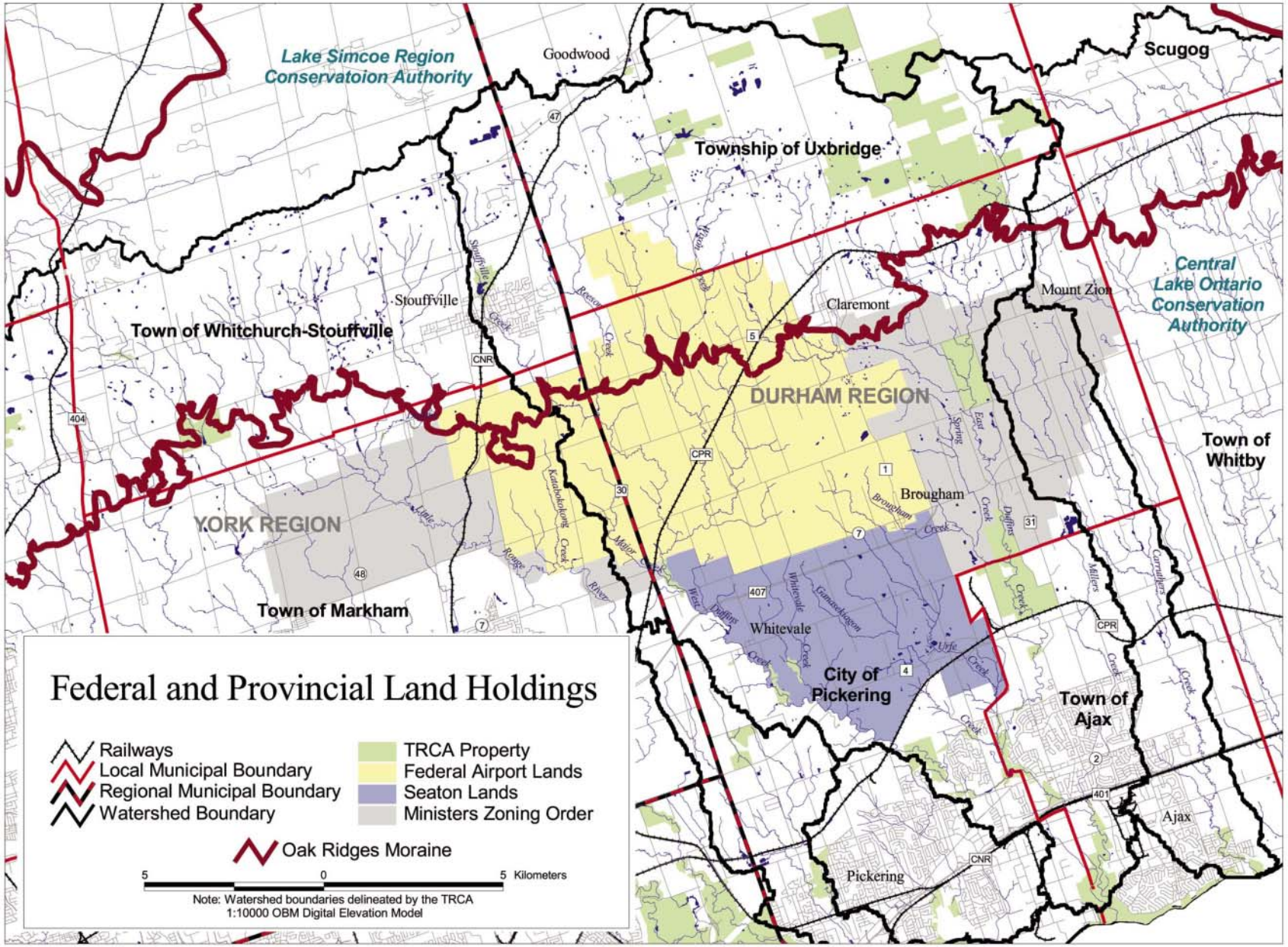

Lake Simcoe Region Conservatoion Authority
Goodwood
Scugog
Township of Uxbridge
Central Lake Ontario Conservation Authority
Mount Zion
Stouffville
Claremont
Town of Whitchurch-Stouffville
DURHAM REGION
Town of Whitby
Brougham
YORK REGION
Town of Markham
Whitevale
City of Pickering
Town of Ajax
Ajax
Pickering
Federal and Provincial Land Holdings
Railways
Local Municipal Boundary
Regional Municipal Boundary
Watershed Boundary
TRCA Property
Federal Airport Lands
Seaton Lands
Ministers Zoning Order
Oak Ridges Moraine
5 0 5 Kilometers
Note: Watershed boundaries delineated by the TRCA
1:10000 OBM Digital Elevation Model

FIGURE 5.3

Along the Highway 7 corridor are the hamlets of Green River, Brougham, and Greenwood. To the south, land uses are mainly rural with a substantial area designated to allow for low - and some medium–density residential uses to accommodate future population growth. Also located in this portion of the watershed are the Seaton lands. The Seaton lands were secured to build a new city of 250,000 residents adjacent to the proposed international airport. To compile these land holdings, 11 per cent of the Duffins Creek watershed was purchased or expropriated by the provincial government in the early 1970s. When plans for the airport were put on hold, the province determined that only lands east of the West Duffins Creek would be considered for urban development for a community of up to 90,000 people and 45,000 jobs. Since the 1980s, development of the Seaton lands has been debated.

The lower reaches of the Duffins Creek watershed are primarily urban consisting of mixed use and commercial corridors. The City of Pickering and the Town of Ajax are located in the lower reaches, defined as land from Taunton Road south to Lake Ontario. Low - and medium-density residential housing and employment areas surround the urban centres and a range of urban-type land uses can be found here. A recent study was completed by the City of Pickering and the Town of Ajax to review and designate appropriate land uses adjacent to Duffins Creek in the Notion Road area.

Drinking water supplies in the urban areas of the Duffins Creek watershed are Lake Ontario based. The Town of Whitchurch-Stouffville is on a municipal well supply for drinking water. An industrial park in the Township of Uxbridge is also on a municipal well. Both of these municipalities are currently preparing a Well Head Protection Plan for these supplies. Hamlets such as Greenwood, Green River, and Claremont, as well as rural residents are all on private wells for drinking water. Protecting groundwater resources from contamination is critical, because Duffins Creek drains into Lake Ontario and groundwater performs a critical water supply function in the rural areas of the watershed.

Development proposals, including the Highway 407 extension, the proposed airport, and the Seaton lands initiative are expected to lead to further urbanization. This area is home to a number of significant natural features, including lands within the Greenwood Conservation Area, valley and stream corridors, Environmentally Significant Areas, wetlands, and groundwater recharge areas. It is also home to several existing and former waste disposal sites (e.g., Brock West Landfill Site, which is designated as a Multi-Use area), the Trans-Canada Gas Pipeline, and CP Rail line.

The Duffins Creek corridor has an Environmental Protection Area designation, which protects natural areas, such as stream and valley corridors and the Rouge-Duffins Wildlife Corridor, that passes through the urban areas. Portions of the developed areas are located within the floodplain and have been designated as "Special Policy Areas" in the City of Pickering Official Plan to allow for continued development in existing communities. Duffins Creek enters Lake Ontario at the Duffins Marsh. The Duffins Marsh and Lake Ontario shoreline consist of publicly-owned lands adjacent to the valley system, which are protected by the Town of Ajax and City of Pickering Official Plans as Environmental Protection Areas (EPA) and Natural Areas (NA), respectively.

5.7.1 WATER

5.7.1.1 Groundwater

An understanding of the groundwater flow system is vital to many aspects of watershed management, ranging from the delineation of the sustainable yield for water supply purposes to programs to maintain the flow of groundwater discharge to streams. The hydrogeologic understanding of the Duffins Creek watershed is one of the most complete for all of Southern Ontario. The information provided below for the Duffins watershed is based on detailed studies conducted by the Ontario Ministry of Environment (MOE), the University of Toronto, the Geological Survey of Canada, Regional Municipality of Durham, and Toronto and Region Conservation.

5.7.1.2 Geologic Setting

In order to assess a groundwater flow system, it is first necessary to determine the extent and thickness of the subsurface rock and soil deposits. This three-dimensional architecture of the subsurface provides a framework within which to incorporate the hydraulic properties of the various geologic formations encountered. The landforms and geologic deposits of the Duffins Creek watershed are all related to a succession of glacial periods (when the climate was cooler than present) and interglacial periods (when the climate was similar to the present climatic conditions). One of the dominant landforms of the watershed is the height of land known as the Oak Ridges Moraine, which is in the northern part of the study area. This ridge of sand and gravel was deposited approximately 12,000 years ago and marks the meeting place of two glacial lobes; one from the north, known as the Simcoe lobe, and one from the south, known as the Lake Ontario Lobe, out of the Lake Ontario watershed.

South of the Oak Ridges Moraine lies the South Slope physiographic region where surficial deposits mainly consist of till, a mixture of materials ranging in size from clay particles to boulders and deposited directly by a glacier. The till deposits are often covered by a thin veneer of sand, silt and clay deposited in former lakes, and by watercourses within the present day Duffins Creek river valleys. A second prominent landform situated near the middle of the Duffins Creek watershed is an escarpment known as the Lake Iroquois shoreline. This escarpment delineates the shoreline of Lake Iroquois, ancestor of Lake Ontario formed approximately 10,000 years ago when lake levels were up to 60 metres higher than the present lake level. Deposits situated south of the Lake Iroquois shoreline include till consisting of beach sands, gravels, silt, and clay.

Beneath the surficial deposits, the geologic layering is a series of alternating till and lake (sand, silt, and clay) or river (sand and gravel) units overlying the bedrock surface. The bedrock within the study area is composed of Late Ordovician shales of the Whitby Formation, which were deposited more than 400 million years ago. The topography of the top of the bedrock surface declines southward from beneath the Oak Ridges Moraine to Lake Ontario.

5.7.1.3 Hydrogeology

Aquifer Units and Groundwater Recharge

Aquifers within the Duffins Creek watershed are designated as upper, middle, and lower aquifer systems that occur within the unconsolidated sediments lying on bedrock. Groundwater flow within all three aquifer systems is predominantly south to southeast from the highlands associated with the Oak Ridges Moraine toward Lake Ontario. The upper aquifer system and the water table occur within sediments situated above the Northern/Newmarket Till and are largely unconfined. The main body of the upper aquifer system is associated with Oak Ridges Moraine deposits in the northern part of the study area. The middle and lower aquifer systems occur within deposits situated beneath the Northern/Newmarket Till and are primarily recharged by vertically downward groundwater flow from the overlying aquifer systems. Note that groundwater flow also occurs across the watershed boundary into and out of the Duffins Creek watershed. In the southern part of the watershed south of the Lake Iroquois Shoreline where the sediment thickness is generally less than 30 metres, groundwater flow from the deeper aquifer systems is vertically upwards coincident with groundwater discharge from these aquifer systems to the river network (Figure 5.4).

Groundwater recharge occurs over most of the area of the Duffins Creek watershed excluding stream reaches and areas of increased topographic gradients generally associated with the south slope of the Oak Ridges Moraine and the Lake Iroquois shoreline. Approximately 25 to 30 per cent of the total annual precipitation (900 milimetres per year) recharges the groundwater flow system. The Oak Ridges Moraine forms the major recharge zone for the study area, covering one-quarter of the total recharge area but contributing greater than 50 per cent of the watershed recharge. Significant recharge also occurs over the till plain situated south of the Oak Ridges Moraine. While this area has a lower unit recharge rate, these deposits cover one-third of the watershed and contribute one-third of the total watershed recharge.

Numerical Groundwater Flow System Analysis

A groundwater flow model developed for the Duffins Creek watershed provides an understanding of the groundwater flow system. Specifically, this model assesses the amount of flow within each aquifer system and explains patterns of groundwater discharge to the various parts of the river system. This model can also be used to calibrate recharge estimates for the watershed.

The model used information from various sources including:

- an existing groundwater monitoring network;
- Ministry of Environment (MOE) water well records;
- historical streamflow data from 17 gauging stations; and
- measurements of low streamflow conditions.

Details and results from this model can be found in the Hydrogeology Chapter of the Duffins Creek State of the Watershed Report.

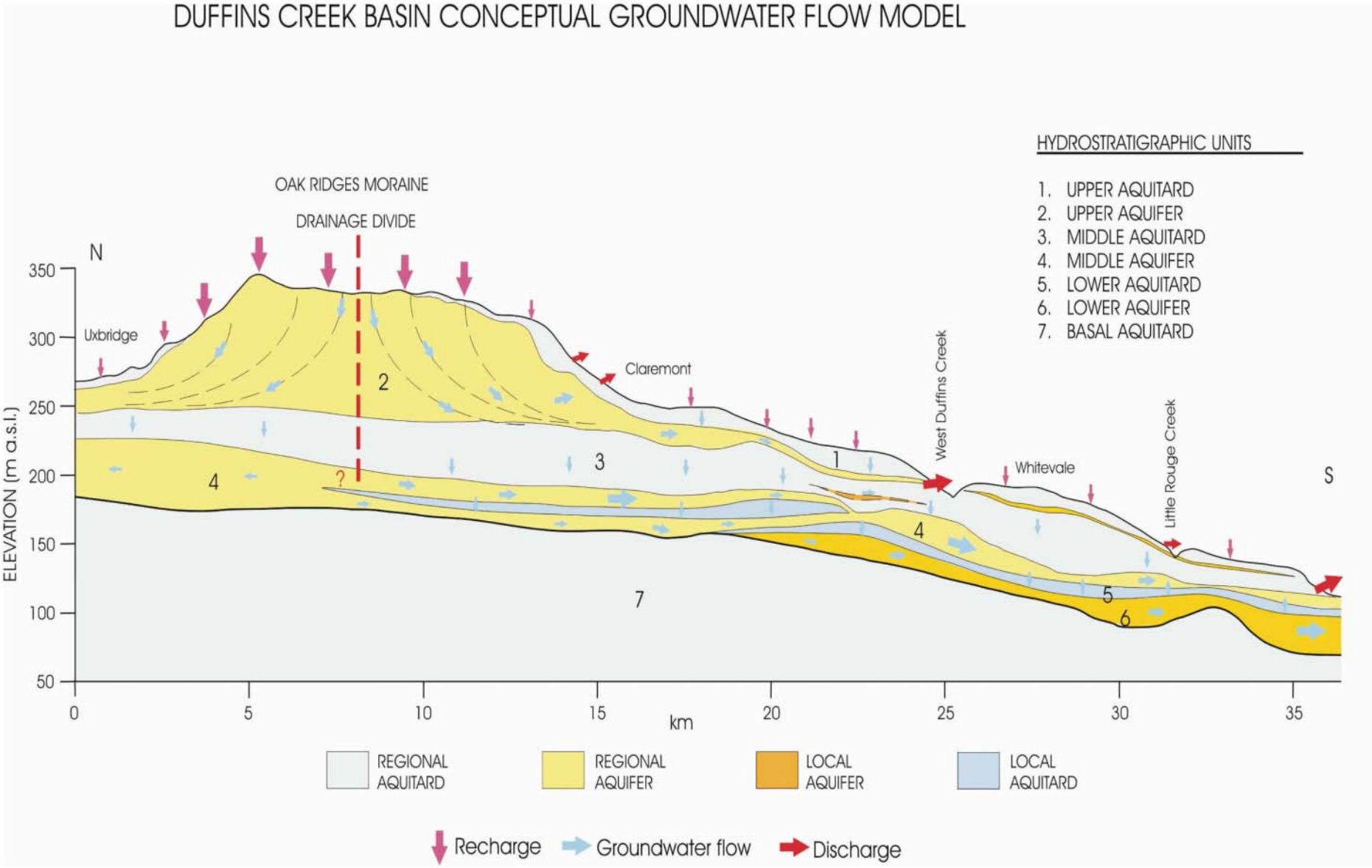

DUFFINS CREEK BASIN CONCEPTUAL GROUNDWATER FLOW MODEL
HYDROSTRATIGRAPHIC UNITS
1. UPPER AQUITARD
2. UPPER AQUIFER
3. MIDDLE AQUITARD
4. MIDDLE AQUIFER
5. LOWER AQUITARD
6. LOWER AQUIFER
7. BASAL AQUITARD
OAK RIDGES MORAINE
DRAINAGE DIVIDE
N
S
Uxbridge
Claremont
West Duffins Creek
Whitevale
Little Rouge Creek
ELEVATION (m a.s.l.)
350
300
250
200
150
100
50
0
5
10
15
20
25
30
35
km
REGIONAL AQUITARD
REGIONAL AQUIFER
LOCAL AQUIFER
LOCAL AQUITARD
Recharge
Groundwater flow
Discharge

FIGURE 5.4

Groundwater Discharge

Groundwater velocities are relatively slow compared with water flowing overland (runoff) to a stream. The distribution and amount of groundwater discharging into a stream is important for maintaining annual streamflow and supporting aquatic life. This groundwater discharge component of streamflow varies gradually in response to long-term changes in the groundwater flow system. In contrast, the runoff component of streamflow is a short-term response to rainfall or snowmelt events and leads to sharp, short peaks on a streamflow hydrograph.

Deposits of the Oak Ridges Moraine include the upper aquifer and form the major recharge zone within the Duffins Creek watershed. A major discharge zone exists to the south of the Moraine where this upper aquifer system thins and is overlain by Halton Till. Groundwater discharge along this topographic break in slope forms headwater streams and accounts for approximately 60 per cent of the entire watershed groundwater discharge. The headwaters of two stream reaches, West Duffins Creek and East Duffins Creek, receive the majority of this groundwater discharge.

Another major groundwater discharge zone is along Duffins Creek south and east of Claremont, associated with, and south of, the Lake Iroquois Shoreline. Groundwater discharge along this reach comes from all three aquifer systems within the watershed, but mainly from the middle and lower aquifer systems. The majority of the groundwater discharge to streams within the watershed is contributed from the upper aquifer system and the water table (75 to 80 per cent). Approximately 20 per cent of the watershed groundwater discharge to streams is contributed to by the middle aquifer system with only two to three per cent of the watershed groundwater discharge coming from the lower aquifer system.

Groundwater Travel Times

Precipitation falling on the ground surface infiltrates to the water table and recharges the groundwater flow system. While most of the groundwater recharge to the Oak Ridges Moraine discharges along the South Slope creating the headwater streams, some of this recharge flows to the deeper aquifer system and takes a longer route before discharging into a stream. Estimated groundwater travel times from recharge to discharge areas ranges from weeks to thousands of years. The shorter estimated travel times represent water that has recharged to and discharged from shallow deposits situated near a stream reach. The longer travel times represent recharge waters that travel through the subsurface to the deeper aquifer systems and discharge to streams in the southern part of the watershed along and south of the Lake Iroquois shoreline. Estimated travel times for water particles that recharge near the moraine crest, which flow to and within the deeper aquifer systems and that discharge in the southern part of the watershed are approximately 2,500 to 3,000 years.

Groundwater Quality

The first extensive study of groundwater quality in the Duffins Creek watershed was conducted by the MOE in 1970 and 1974 and involved the analysis of 44 groundwater samples from the Duffins Creek and Rouge River watersheds. The groundwater within the shale bedrock had poor water quality with elevated levels above drinking water guidelines for sodium and sulphate. This

observation is consistent with subsequent analyses conducted for landfill investigations and by researchers at the University of Toronto.

Groundwater within the unconsolidated deposits above bedrock are generally good quality for domestic use. Local occurrences of naturally high hardness and iron concentrations have been reported along with locally elevated levels above drinking water criteria for the bacteria, nitrates, and chloride (MOE). A subsequent analysis of 260 groundwater samples in the Duffins Creek and Rouge River watersheds (1982 and 1984, University of Toronto) revealed the presence of elevated chloride and nitrate levels, which were attributed to road salt and nitrate fertilizer, respectively. Protocols and suggestions aimed at helping to protect rural water supplies within the Duffins Creek watershed will be provided as part of the 2003 Groundwater Management Source Protection Plan, to be initiated by TRCA in 2003.

5.7.1.4 Surface Water Quality

Water quality data from the Ministry of Environment's Provincial Water Quality Monitoring Network (PWQMN) provide a basis for assessing the surface water quality in the Duffins Creek watershed. Water quality data has been used from six monitoring stations for a 20-year period, baseflow chemistry data (collected at 110 stations during 1995 and 1996 by the Ministry of Environment, and the Geological Survey of Canada), and data from 10 monitoring stations that operated in the watershed from 1975 to 1978, which were evaluated on the basis of stream flow and suspended solids measurements by the Water Survey of Canada.

The tributaries of Duffins Creek have exhibited the best water quality conditions of all streams in the Toronto region. Water quality conditions are described in terms of the implications for swimming, aquatic, and human health. Eight water quality parameters were selected, including phosphorus, nitrogen compounds, suspended solids, chlorides, bacteria (E.coli and faecal coliform), biological oxygen demand, dissolved oxygen, and temperature.

Swimming in Duffins Creek is encouraged only at public waterfront beaches. Duffins Creek is not well suited for swimming or wading given its soft bottom, shallow depth, and naturally cool temperatures. Escherichia coli (E. coli) and other faecal coliform bacteria indicate the presence of human and/or animal faecal matter and can suggest the presence of other bacteria, viruses, or pathogens that could infect humans, pets, and other warm-blooded animals. High bacterial levels necessitate the closure of swimming beaches and can result in health risks. Bacterial levels monitored through the PWQMN in the upper watershed areas (e.g., Stouffville Creek, Reesor Creek, Brougham Creek) fail to meet objectives for water recreation 35 to 45 per cent of the time. Levels increase toward the lower reaches of the watershed, failing to meet water recreation objectives 65 to 75 per cent of the time. These estimates are considered low, given that sampling is biased toward dry weather, when bacterial levels tend to be lower. During and shortly after rainstorms, it is common for bacterial levels to be significantly higher, even in pristine watercourses.

Bacteria loadings from Duffins Creek contribute to high bacterial levels in the nearshore zone of the lake. Rotary Park Beach is located on Lake Ontario near the mouth of Duffins Creek. In 1999, data collected by the Durham Regional Health Department indicated that Rotary Park Beach was closed 55 per cent of the swimming season, which runs from June to September, as a result of excessive bacterial levels. Nearby western beaches including the Rouge Beach and Bluffer's Park Beach were posted unsafe more than 95 per cent of the time during the same year; evidence of the movement of nearshore currents and the impact this has on waterfront bacterial levels.

Phosphorus and nitrates come from lawn, garden, and agricultural fertilizers as well as eroded soils from construction sites, stream banks, and agricultural fields. Phosphorus attaches itself to soil particles and ends up in creeks when soil particles are washed off during storm events. Nutrient levels (phosphorus and nitrates) are elevated in the Duffins Creek watershed during rainfall and snowmelt conditions. When it is not raining, phosphorus concentrations meet the interim provincial total phosphorus guidelines of 0.03 miligrams per litre throughout the watershed, with the exception of Urfe Creek, lower Stouffville Creek, and West Duffins Creek. Around 1980, phosphorus concentrations dropped significantly in the West and Lower branches of Duffins Creek in response to Stouffville Sewage Treatment Plant improvements, improved riparian vegetation, and changes in farming practices throughout the watershed. The decommissioning of the Stouffville Sewage Treatment Plant is planned for 2004 and improvements in water quality are expected to follow.

In the urban areas of the watershed, nutrient levels could once again rise as pollutant loads from stormwater runoff increases unless effective best management practices are applied. In Duffins Creek, concentrations of phosphorus tend to be higher after rainstorms or snowmelt. On a seasonal basis, nutrient levels are generally high from late fall to spring as a function of tillage practices, limited crop cover in the watershed, and spring snowmelt and rainfall. High nitrate levels fuel eutrophication (nutrient enrichment) and may also have an indirect toxicity role by contributing to aquatic stress. Ammonia levels in Duffins Creek usually meet the Provincial Water Quality Objectives (PWQO) for protecting aquatic life, with the only exception from 1988 to 1994 at monitoring sites on the West Duffins Creek, Reesor Creek, and Brougham Creek tributaries.

Other water quality factors are suspended solids and turbidity (clarity). Suspended solids find their way into water by suspension of sediment previously deposited on the stream bottom and the accumulation of particles transported overland to the creek. In the upper reaches of the Duffins Creek watershed total concentrations of suspended solids tend to be low, due to significant forested land area, good riparian vegetation, and stable streambanks. In the lower reaches, streams pass through the Lake Iroquois Shoreline and enter urban areas, which act as sources of sediment. Concentrations of suspended solids tend to be higher during wet weather conditions and in late winter and early spring when soils are exposed (particularly in the agricultural areas). High snowmelt and rainfall combined with low rates of evaporation increase the volume of suspended solids entering the creek. During the summer months, crop cover slows down overland runoff and rates of suspended solids tend to be lower.

Another technique for understanding patterns and trends in water quality is to examine water turbidity. Water turbidity refers to the clarity of the water in the watercourse, and in Duffins Creek these levels have been relatively stable over time.

Other measures of water quality affecting aquatic habitat include Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) in the creek. BOD is a measure of the amount of oxygen-consuming organic materials washed into the watercourse. High measurements of BODs are an indication that dissolved oxygen levels in the watercourse are at risk. In natural settings BOD levels are low, indicating good oxygen levels. BOD levels are elevated in Stouffville Creek and Lower West Duffins Creek relative to other Duffins Creek tributaries. The main reason for the elevated BODs in this part of the watershed is organic loads in effluent from the Stouffville Sewage Treatment Plant (STP). Farm runoff or leaching from septic systems are the primary factors affecting BOD in Ganatsekiagon and Urfe Creeks. Upgrades at the STP to improve effluent quality resulted in a reduction of BOD levels in the early 1980s. As a result of a continued decline in BOD, levels of DO have increased. While DO fluctuates throughout the year in relation to temperature (i.e., warmer water is capable of holding less dissolved oxygen and, hence, the lowest DO levels in Duffins Creek occur in July and August), current BOD and dissolved oxygen levels remain within the acceptable range for aquatic life.

Chlorides indicate human disturbance in the watershed. The major source of chlorides is road salt and, as a result, a strong seasonal pattern exists. Septic fields, sewage treatment plants and landfill leachates also contribute to chloride concentrations found in watercourses. Chloride concentrations have been gradually increasing in the watershed in response to the conversion of rural land (meadows, forest stands, and agriculture) to more urban uses (characterized by greater densities, more paved surfaces, and a more detailed road network). In the rural areas of the watershed, chloride levels remain low, but are elevated above background levels. From 1988 to 1993, levels of chlorides at Bayly Street and in Stouffville Creek (downstream of the STP) exceeded levels of concern for aquatic life two per cent of the time.

Pesticides, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs) are substances not found naturally in the environment. Their detection in water is, therefore, a cause for concern. Heavy metals (e.g., zinc, cadmium, copper) are released at excessive levels as a result of various land use activities. Many pesticides have been banned for use based on their persistence and tendency to bioaccumulate through the food chain. In addition, many of these substances have been linked to chronic health effects on aquatic organisms and humans. Environmental effects in aquatic life include physical deformities, tumors, lesions, and overall population decline. Compounds such as dieldrin and benzo(a)pyrene are believed to be carcinogenic to humans. Some researchers are concerned that exposure to toxic substances at the human embryo stage may affect learning capacity later in life and may disrupt the function of the hormone or endocrine system, which could result in birth defects, depressed immune systems, and behavioural changes.

The MOE conducted a priority pollutant study in 1991-1992 along Toronto's waterfront and found that contaminant concentrations were significantly higher in wet weather conditions for suspended solids, total phosphorus, E. coli, aluminum, iron, and most organic compounds. While Duffins Creek was not included in the study, results for this watershed were expected to be similar to, or better than, conditions reported for the neighbouring Rouge River watershed, where levels were lower than all other Toronto area tributaries.

During 2000-2001, an innovative sampling program was undertaken by MOE to provide data for a number of heavy metals and trace organic contaminants (e.g., organochlorine pesticides, chlorobenzene, PAHs, and volatile organic compounds) in Duffins Creek. An assessment of the presence of pesticides, PCBs, or metals has not been made in the past because of limitations in water quality sampling methods or simply a lack of data. Few traces of organic pollutants were found and, of those that were detected, all occurred in very trace amounts (less than a few parts per billion). Metal concentrations were also found to be within the normal range.

Based on other biological indicators, there is no particular evidence of water quality conditions being toxic to aquatic or fish communities. The Guide to Eating Ontario Sport Fish (MOE, 2001) recommends the minimum restriction on consuming brook trout from the East and West Duffins Creeks. The guide places greater restrictions on consuming fish from the Duffins Creek Marsh; contaminant levels in this part of the watershed could be influenced by conditions in Lake Ontario. Another technique to evaluate the biomagnification potential of pollutants is to test minnows, which are food sources for game fish. In 1997, biomonitoring of minnows found small amounts of PCBs and DDT although levels were well below guidelines. No other contaminants were detected in minnow samples from Duffins Creek. Since these fish spent their entire lives in the marsh, these results suggest the creek has low levels of these pollutants.

5.7.1.5 Fluvial Geomorphology

A number of factors impact the form and function of streams and watercourses. Climate conditions and watershed geology are key factors. Other factors include beaver activity, the location and extent of riparian vegetation, the construction of dams, weirs and channelization, as well as changes in landuse. Fluvial geomorphology assesses the shape and form of watercourses and quantifies processes occurring within the stream. This knowledge is used to develop guidelines for watershed management to ensure that channel processes within stream systems are protected.

An analysis of stream patterns at a watershed scale allows us to understand how climate influences the amount and distribution of water, and how watershed geology affects how water is delivered throughout the watershed. Stream reach assessments group channels into segments (reaches) that reflect their similar slope and planform characteristics. Reaches are then examined using detailed topographic mapping and historical information to understand rates of erosion and migration patterns. Field studies provide cross-section information about the stream bottom and banks.

An assessment of stream pattern was completed for the Duffins Creek watershed. Results indicated that the watercourse has a number of well-branched tributaries. Additional information about Duffins Creek was obtained from data collected at nine locations within the southern portion of the watershed, Highway 7 to Rossland Road. For Urfe, Ganatsekiagon, Whitevale, and Brougham Creeks, various levels of channel degradation were noted. This degradation can be attributed to previous modifications, including channel straightening, loss of riparian vegetation, and the construction of on-line ponds that had occurred previously. Evidence of channel erosion was also observed along portions of the West Duffins Creek south of Highway 7, but geomorphic data for Duffins Creek tends to be limited and somewhat site-specific. TRCA has initiated a fluvial geomorphic assessment and baseline erosion-monitoring program for West Duffins Creek, Whitevale Creek, Ganatsekaigon Creek, and Urfe Creek. The information collected will be used to characterize the existing streams and determine the condition-controlling factors and sensitivity to change.

5.7.1.6 Surface Water Quantity

Water quantity is the drainage of water through the Duffins Creek watershed under various dry weather, rainfall, and snowmelt conditions. Many complex factors determine the amount of precipitation that flows into Duffins Creek. These factors include soil types (with varying abilities to hold and transfer water), topography, and land use. This is one of the last watersheds within the TRCA jurisdiction that exhibits the characteristics of a typical rural watershed. Factors include the small amount of urbanization, the large number of natural features, the predominance of sandy soils, and the extensive forest cover and wetlands, which promote infiltration and reduced stormwater runoff.

Duffins Creek has two main branches, which join approximately one kilometre upstream of Highway 2. The west branch originates northeast of the Town of Whitchurch-Stouffville and drains an area of approximately 135 square kilometres. The east branch originates northeast of Claremont on the Oak Ridges Moraine and drains an area of approximately 143 square kilometres. Both the east and west branches have a number of tributaries:

West Duffins Creek:	Reesor Creek, Stouffville Creek, Wixon Creek. The lower reaches of West Duffins Creek near Highway 401 have been channelized.
East Duffins Creek:	Brougham Creek, Ganatsekiagon Creek, Mitchell Creek, Urfe Creek.

Millers Creek, which originates in the lower eastern section of the watercourse, drains a 17 hectare area and joins the main branch between Highway 2 and Highway 401. The lower reaches of this watercourse in the Town of Ajax have been channelized.

The rural nature of the Duffins Creek watershed is demonstrated by the hydraulic response of the watershed. This response was observed during a large rainfall event that occurred on May 13, 2000, when 50 to 60 milimetres of rain fell in the watershed. The stream flow gauge located on

Duffins Creek, above Church Street, indicated that water levels took 13 hours to peak, with flows ranging from five to 83 cubic metres per second for the beginning of the storm to the peak discharge, respectively. By comparison, the Don River, an urban watershed of similar shape and only a slightly larger drainage area, peaked in approximately four to five hours with flows more than double those of Duffins Creek. While these watersheds have size differences, enough physical similarities exist to demonstrate the different hydrologic response between a relatively rural watershed like Duffins Creek and one that is predominantly urban. Moreover, on an annual basis, Duffins Creek displays the hydrology of a typical rural watershed with annual peak flows occurring solely in the spring. As watersheds urbanize, peak runoff periods are more evenly distributed throughout the entire year, as evidenced by other watersheds in the Greater Toronto Area that are primarily urban, such as the Don River or Highland Creek.

An extensive stream flow monitoring network exists in the Duffins Creek watershed. This network, coupled with low flow investigations and a detailed understanding of the hydrogeology, geology, and geomorphology, provides an excellent position from which to manage the water resources of Duffins Creek.

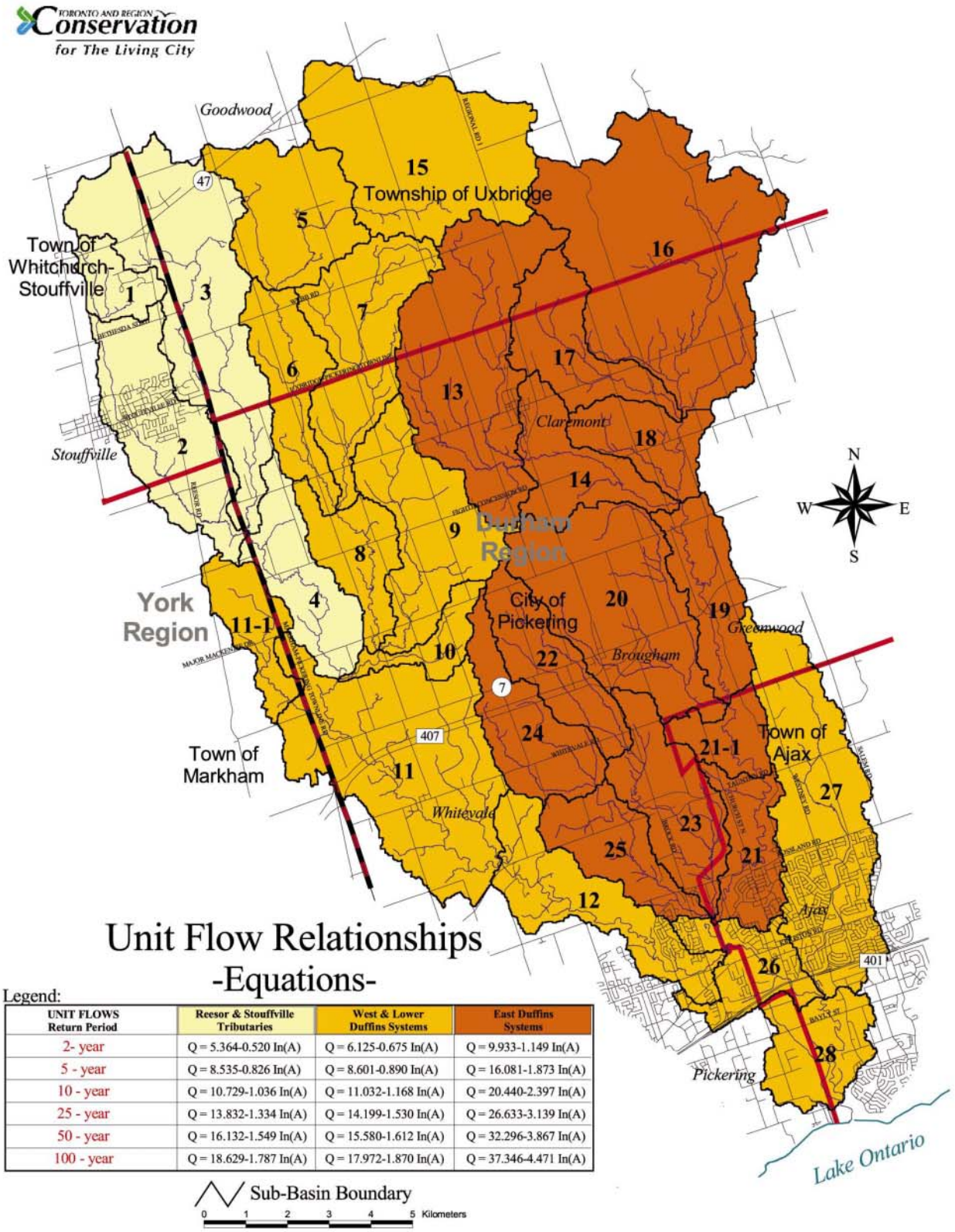
Peak flows associated with existing land uses have been established over 20 flow nodes within the Duffins Creek watershed. The existing flow rates will represent targets to be maintained with future land use change. The "unit flow" concept has been introduced in other TRCA watersheds to provide a consistent means of pre-development peak flow estimation and ensure target peak flows are met within individual sub basins. This approach has been applied to the Duffins Creek watershed to provided pre-development peak flows, which can be determined based on the location in the study area and the drainage area (Figure 5.5).

A hydrology study was undertaken by Aquafor Engineering Limited in 1991, and updated by Aquafor Beech Ltd. in 2002. Both of these studies examined current and future land uses and assessed the hydrologic impact they could have on the watershed. Historical accounts of flooding within Duffins Creek are scattered and rare. Ice jams and large intensive storm events have been the key causes of flooding in the past. Current mapping reveals 64 structures and 55 roads that are susceptible to flooding in the watershed.

TRCA recently developed a water budget model for the entire Duffins Creek watershed. Coupled with the updated hydrology model, these studies were used to establish infiltration targets, flood, and erosion control criteria as well as to establish design targets for stormwater management systems.

5.7.1.7 Stormwater Management

Stormwater management practices have evolved over the past 20 years in response to advances in technology and a better understanding of the benefits of stormwater management. Prior to the 1980s, stormwater management had one objective — flood control. Management strategies of the day looked at conveying runoff to local watercourses as quickly and efficiently as possible. As a result, watercourses, such as Millers Creek, were deepened, made wider, and modified through



Unit Flow Relationships
-Equations-

Legend:

UNIT FLOWS Return Period	Reesor & Stouffville Tributaries	West & Lower Duffins Systems	East Duffins Systems
2- year	Q = 5.364-0.520 ln(A)	Q = 6.125-0.675 ln(A)	Q = 9.933-1.149 ln(A)
5 - year	Q = 8.535-0.826 ln(A)	Q = 8.601-0.890 ln(A)	Q = 16.081-1.873 ln(A)
10 - year	Q = 10.729-1.036 ln(A)	Q = 11.032-1.168 ln(A)	Q = 20.440-2.397 ln(A)
25 - year	Q = 13.832-1.334 ln(A)	Q = 14.199-1.530 ln(A)	Q = 26.633-3.139 ln(A)
50 - year	Q = 16.132-1.549 ln(A)	Q = 15.580-1.612 ln(A)	Q = 32.296-3.867 ln(A)
100 - year	Q = 18.629-1.787 ln(A)	Q = 17.972-1.870 ln(A)	Q = 37.346-4.471 ln(A)

Sub-Basin Boundary

0 1 2 3 4 5 Kilometers

Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 5.5

armouring or concrete lining to accommodate an increase in flow volume and velocity. These measures were largely reactionary and led to a decline in the health of river ecosystems through a reduction in terrestrial and aquatic habitat, reduced water quality levels, and increased rates of erosion in downstream watercourses.

When it was realized that urban stormwater runoff was a key factor affecting the health of river systems, stormwater management practices changed. Flood control remains a key objective of stormwater management, but management practices today provide a higher level of protection for the environment, property, and residents by incorporating provisions for water quality, fish habitat protection, and in-stream erosion controls.

The Duffins Creek watershed is unique in that only seven per cent of the watershed is currently developed. Existing development within the watershed is concentrated within the City of Pickering, the Town of Ajax, and the Town of Whitchurch-Stouffville. A number of scientific studies document the physical, ecological and hydrologic impacts resulting from older forms of urban development. As natural landscapes were modified and paved to accommodate residential, industrial, or commercial development, the health of the local ecosystem declined. Current stormwater management practices are designed to mitigate these impacts.

The most significant change to the natural environment during the process of urbanization is the conversion of natural pervious surfaces to impervious surfaces, which prevent water from infiltrating the soil. Impervious surfaces include roads, sidewalks, driveways, rooftops, and parking lots. Studies in Maryland, U.S.A. reveal that channel instability and habitat degradation begins to occur when the percentage of impervious cover in a watershed reaches 10 to 15 per cent. An increase in impervious cover is associated with increased runoff volume and velocity and a decline in infiltration potential. These in turn lead to increased instream erosion and a reduction in groundwater recharge and annual baseflow within local water courses.

Changes to the hydrologic regime affect not only water quantity but water quality as well. A number of urban non-point source pollutants exist in stormwater, including heavy metals (e.g., zinc, cadmium, copper), pesticides, nutrients (e.g., phosphorous), toxic contaminants, pathogens (e.g., E. coli), and debris. Stormwater management plays a crucial role in removing these pollutants and ensuring a safe and dependable water supply for the millions of GTA residents who rely on Lake Ontario or private wells for water supply.

Best Management Practices

A wide variety of structural and non-structural best management practices are used in the development of stormwater management strategies. For details regarding Best Management Practices, refer to the Stormwater chapters of the State of the Watershed Reports.

Factors affecting stormwater control criteria include land use designations, flood vulnerable areas, erosion sites, and environmental factors (i.e., baseflow, groundwater resources, terrestrial, and aquatic habitat). An updated hydrology model has been developed to reflect changes in land use

designations and analyze various future development scenarios. The new model was recalibrated using rainfall data from Environment Canada and additional data collected at stream flow gauging stations installed within the watershed subsequent to the 1991 hydrology study. Given that the Duffins Creek watershed contains more flow gauging stations than any other watershed in southern Ontario, sufficient data exists to ensure that the new model is an accurate reflection of the watershed and local flow data is available for design purposes. The updated watershed hydrology model was used to revise the current stormwater management criteria for the Duffins Creek watershed.

TRCA criteria for stormwater management (water quality, water quantity, and erosion control) are met in one-third of the Duffins Creek watershed. In the remaining older developed areas that should be treated, only a small percentage has quantity control. These differences in the level of control are indicative of the age of development within the watershed and also reflect the change in stormwater management approaches that has occurred. TRCA, in partnership with the City of Pickering and the Town of Ajax, recently initiated Stormwater Retrofit Studies for the existing urban area that does not meet current water quality and quantity control criteria.

5.7.2 HABITATS

5.7.2.1 Aquatic Habitat and Species

Of all the watersheds in the Toronto region, Duffins Creek has one of the healthiest fish communities and may have the best potential for successful reintroduction of Atlantic salmon. Over the past 50 years, many riparian areas that were once deforested have been left to naturally regenerate. Today, because there has been little development in the middle and upper reaches, the aquatic community is in fairly good condition overall.

Currently, Duffins Creek is dominated by cold water aquatic communities including sculpin, brook trout, and rainbow trout. Based on records there have been 50 riverine species of fish found in the Duffins Creek watershed. From this list, extirpated species include Atlantic salmon, while introduced species include rainbow trout, brown trout, coho salmon, chinook salmon, alewife, common carp, and sea lamprey. In the 2000 survey of the Duffins Creek fish community, 33 species were identified, including three introduced species: chinook salmon, rainbow trout, and brown trout.

The ecological health of a fish community can be estimated through the calculation of an Index of Biotic Integrity (IBI). The IBI determines the health of the fish community by examining the abundance of fish, the presence of certain "indicator" species, trophic balance, and species richness. Based on IBI assessments from the mid-1980s, the aquatic system was in good to excellent condition in many locations throughout the watershed. Surveys in the 1990s had similar results. From the 1950s to the 1990s, there was an increase in the number of species and a general increase in the distribution of trout species throughout the watershed. In 2000, IBI scores were generally fair to good, indicating a relatively healthy aquatic community.

In the upper and middle reaches of Duffins Creek, coldwater streams provide habitat for brook trout, slimy sculpin, and mottled sculpin as well as species of concern, such as redside dace. In the lower reaches of East and West Duffins Creek, coldwater habitat supports a healthy, self-sustaining population of rainbow trout and brown trout. It is suspected that chinook salmon spawn successfully in the lower reaches, as well. Migratory salmon and trout are separated from native brook trout populations by several in-stream barriers that prevent their up-stream movement. Studies suggest that migratory salmonid species would out-compete native brook trout if their distributions were allowed to overlap.

The Duffins Creek coastal marsh of 41 hectares is an Environmentally Significant Area (ESA) as well as a Provincially Significant Wetland because of its importance to fish, plants, and other wildlife species. There are several attributes that make the marsh an important area for fish. First, it serves as a transition zone between Duffins Creek and Lake Ontario. This transition zone provides ideal spawning and rearing conditions for some fish. Low gradient in this part of the watershed creates a wide floodplain that is seasonally covered with water. The marsh historically supported dense aquatic plant growth that provided excellent cover for minnows and juvenile fish, which are a much needed food source for predatory fish. In total, 27 species have been recorded for the marsh including creek and lake species, such as northern pike, yellow perch, gizzard shad, alewife, white bass, and white perch. Eighty per cent of the 27 species found in the marsh use this area for spawning or rearing their young.

5.7.2.2 Terrestrial Natural Heritage: Quantity and Distribution (of Natural Cover)

Historically, the forest cover was cleared by European settlers. Clearing of the forest occurred in three stages: the tall white pine was first used for ship masts, and ash from burning slash was used for potash. Finally, cleared land was used for agriculture. By the end of the 19th century, natural cover was already highly fragmented and, by the early part of the 20th century, sandy areas on the Oak Ridges Moraine were subject to severe erosion and dust-bowl-like conditions. To address the severe erosion issues, much of this area was reforested with conifer plantations. With commercial and industrial expansion, the Duffins Creek watershed is now starting to feel the pressure of urbanization. Further incremental loss and degradation of natural habitats could result if action is not taken.

The Duffins Creek watershed drains an area of 283 square kilometres. Unlike other southern Ontario watersheds, the Duffins Creek watershed has 37 per cent of natural cover (forest, meadow, and wetlands), and only seven per cent urban land use. This is by far the highest percentage of natural and the lowest percentage of urban of any of the watersheds within the TRCA jurisdiction. Agriculture covers about 54 per cent of the watershed and is recognized as having an important local economic role. Natural habitat is more abundant in the northeastern part of the watershed because of the extensive concentration of forest cover in the Glen Major area.

The Duffins Creek watershed is found within the Great Lakes-St. Lawrence Mixed Forest Zone. Dominant tree species include sugar maple, American beech, white pine, and eastern hemlock.

Based on 1999 digital orthophotography, the total forest cover area in the Duffins Creek watershed was approximately 70 square kilometres, which amounts to about 24.5 per cent of the surface area. In comparison to other watersheds in the TRCA jurisdiction, forest cover is more evenly distributed throughout the Duffins Creek watershed, because the east and west branches of the creek are well forested in the middle reaches.

While 24.5 per cent appears high compared with more urbanized watersheds like the Don River (seven per cent) and the Highland Creek (6.2 per cent), it is still small considering that the total area would have been originally close to 100 per cent forest cover. While this suggests that up to 75 per cent of the original forest cover has been lost, the Duffins Creek watershed is in relatively good condition compared to the minimum guideline of 30 per cent forest cover suggested by Environment Canada.

Forest cover could reach or exceed a target 30 per cent coverage if protection and restoration efforts are implemented. In fact, forest cover increased in the 20th century due to reforestation efforts on the moraine and the reduced agricultural intensity there and in the vicinity of the Lake Iroquois Shoreline. This reduction in agricultural use is attributed to the abandonment of marginally productive lands, to improved practices and the acquisition of the Pickering Airport lands in the 1970s.

It is difficult to differentiate swamps from forest, and meadow marshes from meadows in air photos, so reporting on wetland quantity and distribution is contingent upon field data collection. Additional wetland data has been collected for the Duffins Creek watershed. These collections need to be studied to determine an accurate evaluation of wetland quantity and distribution. Most of the wetland areas are associated with forest cover, including headwater areas on the Oak Ridges Moraine as well as groundwater discharge areas associated with the Lake Iroquois Shoreline. Kettle wetlands are well distributed on the moraine. Abandoned quarries on the Lake Iroquois Shoreline leave behind meadow marshes with many plant species of concern as well as emergent marshes. Duffins Creek mouth holds an estuarine wetland with a coastal character. Other wetlands, such as kettle marshes and thicket swamps, are scattered throughout the watershed.

Consisting of open habitats dominated by grasses and wildflowers, meadows are actually considered old fields (fallow agricultural fields), areas that were once cleared for agriculture, but have recently been allowed to naturalize. Meadows support a range of native flora and fauna species, but in a forest bioregion revert back to forest on their own. Meadows cover 4.1 square kilometres (406.6 hectares) and successional areas cover 5.3 square kilometres (529.4 hectares) of the Duffins Creek watershed. Together, these areas account for 3.3 per cent of the watershed and have short-term restoration potential. Beach habitats are found in two zones in the Duffins Creek watershed: along the modern Lake Ontario shoreline at the mouth of the creek, and along the ancient glacial Lake Iroquois Shoreline. Some of the modern beaches are dynamic, sandy beaches with species endemic to the Great Lakes shoreline. The remnant beaches from the glacial lake are composed of sand and gravel and, in certain areas such as the Whitevale Corridor and the Seaton ESA, substantial bluffs mark this habitat along the West Duffins Creek branch.

5.7.2.3 Habitat Size and Shape

Size and shape of habitat patches significantly influence the diversity of plant and animal species. Generally speaking, the larger a habitat patch, the more diverse the vegetation and animal species found within. Larger habitats generally mean larger and more resilient populations. Within the entire TRCA jurisdiction the headwaters of the Duffins Creek watershed is one of the few places where many of the most sensitive flora and fauna can achieve sustainable populations.

Habitat shape is also significant. Large habitat patches, particularly those that tend to be more circular than linear in shape, have more interior habitat. Forest interior, an increasingly rare habitat in the Greater Toronto Area, is found in many of the larger forest patches in the watershed. Forest interior refers to that area of the forest considered to be free from negative external influences or "edge effects." The combination of several edge effects, including wind damage, invasion of exotic plant species, songbird nests being taken over by parasitic bird species (such as the brown-headed cowbird) and the prevalence of fauna species that use both forest and human-dominated landscapes, has the ability to influence the unique make-up of forest interior areas. The degree to which these edge effects can penetrate a patch determines how a forest can be divided into edge or interior. A minimum 100 metres from the outside edge of a patch is a widely accepted figure for defining where interior habitat begins. Cowbirds can penetrate over 400 metres; hence, forests with interior beyond this point are clearly more desirable but rarely occur in a fragmented landscape.

Within the Duffins Creek watershed, numerous forest patches containing interior forest habitat exist beyond 100 metres. There are several with more than 300 metres of forest interior and parts of the Glen Major complex exceed even 400 metres interior. Species associated with these patches reflect the quality of this habitat. Red-shouldered hawk, scarlet tanager, Canada warbler, and black-and-white warbler, as well as forest interior species including veery, black-throated blue warbler, and ovenbird all occur here.

Size and shape are also significant in terms of wetland habitat although even small, linear wetlands can contribute significantly to ecological health and biodiversity, particularly if they are connected to other natural habitat. Small wetlands were part of the original forested landscape and native wetland species have adapted to them. Habitat size and shape should be considered after total habitat cover. Where natural cover falls below 30 per cent, as is often the case at the subwatershed scale, habitat patches remain valuable, no matter what size and shape they are, even if they lack interior.

Natural System Connectivity

Natural habitats that are well linked, or in close proximity, support more biodiversity and more viable populations than those that are widely separated. A cluster of smaller individual patches close together may support viable populations, which could not occur in individual, isolated fragments. This is particularly important for certain species with low mobility. Linkages between forest and wetland are important for certain amphibians (e.g., wood frog, red-spotted newt) that

breed in wetlands and spend part of their life cycle in forests. Many species that find too many perils to move through urban areas can disperse and migrate across agricultural areas.

Most forest in the Duffins Creek watershed is directly connected to valley and stream corridors. Across the watershed, there is a level of connectivity via these natural corridors, but also a lack of tableland forest, evident for that section of the watershed below the Oak Ridges Moraine on the south slope. An exception is the East branch of Duffins Creek, which provides an almost continuous wooded corridor along most of its length. The West branch of Duffins Creek also has continuous habitat over a large area (the Whitevale Corridor).

Another interesting feature is the east-west corridors between the branches of the Duffins Creek across the Oak Ridges Moraine and along the old Lake Iroquois Shoreline. These corridors extend west to the Rouge River, and east to Carruthers Creek and the Heber Downs conservation lands under the jurisdiction of the Central Lake Ontario Conservation. The high level of connectivity in the Duffins watershed is reflected in the fact that ruffed grouse, a sensitive species of low mobility, is found along most of the valley right down to the lake.

Matrix Influence

Matrix influence is a measure of the effects that the surrounding environs exert on a habitat patch. The Terrestrial Natural Heritage Approach defines the matrix as anything within two kilometres from a patch's edge and is divided into three types of land uses: natural, agricultural, and urban.

Matrix influence ranges from edge effects to beneficial influences. In urbanized areas, edge effect impacts on forested areas include trampling, dumping of garbage, impacts from pets, raccoons and the like. Adjacent urban development can degrade a habitat, even if the site is "protected" from development and from direct elimination.

Habitat patches are the building blocks of the natural system. The health of the natural system is determined by the combined influence of the matrix on these individual patches. Matrix influence is at the core of the Terrestrial Natural Heritage Approach, which examines the relationship of the natural system to the rest of the watershed. The relationship between habitat patches and the surrounding urban, agricultural, and natural land uses is complex. A natural system that is protected is not necessarily guaranteed to have high habitat quality and biodiversity, because these characteristics are influenced by the surrounding land use. At the same time, certain features in a watershed can overwhelm the health of its natural system and its ability to perform ecological functions. That depends on the ratio of natural, agricultural, and urban areas. If the ratio is in balance, the urban heat island effect is reduced and runoff is reduced in favour of infiltration, resulting in more groundwater and less flooding. Air quality is also improved and there is less competition for quality recreational open space.

5.7.3 PUBLIC USE

5.7.3.1 Greenspace, Trails, and Recreation

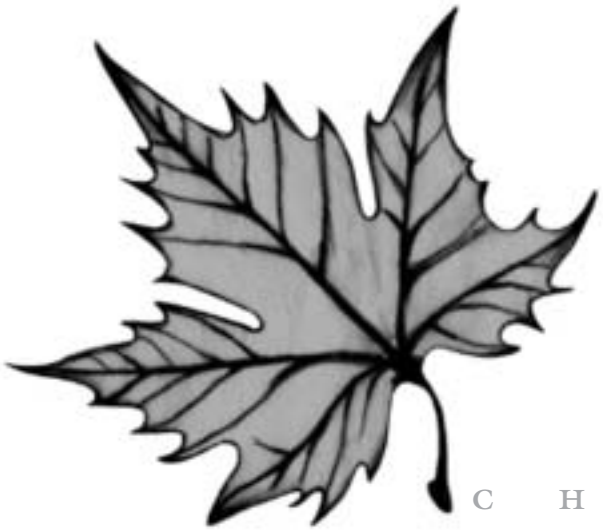
TRCA properties have been acquired over the years to protect Environmentally Significant Areas, and Areas of Natural and Scientific Interest, as well as those properties with strategic ecological watershed attributes, public use functions or the potential to connect greenspaces. Conservation Area Management Plans are being prepared to ensure sustainability of these resources into the future for both public use and to protect ecological functions. The development of management plans for the Duffins Creek Headwaters, Duffins Marsh and the Greenwood Conservation Area are underway by TRCA in partnership with local municipalities and residents. Future initiatives that may help to link these areas include proposed extensions to the Trans Canada Trail, the Oak Ridges Moraine Trail, the Waterfront Trail, and trail planning proposed by local municipalities. There are a number of existing and proposed trail systems that connect the natural, cultural, recreational, and educational features in the study area with one another and other designations outside of the watershed. The following trails are located within the Duffins Creek watershed and are described in more detail in the State of the Watershed Report. Efforts are underway to link these trails providing a loop system within the two watersheds with connections to the neighbouring Rouge Park.

- Waterfront Trail
- Inter-Regional Trail (proposed)
- Trans Canada Trail (proposed)
- Oak Ridges Moraine Trail
- Great Pine Ridge Equestrian Trail
- Seaton Hiking Trail

Duffins Creek is well known as a recreational fishing spot and it is recognized for its excellent aquatic habitat. South of Highway 7, Duffins Creek has large runs of migratory rainbow trout and salmon. The headwater areas contain brook trout, while the mouth and marsh areas of the watercourse are popular for warmwater species fishing. There has also been a report of a run of walleye south of Highway 401, although it has not been officially documented. A variety of fish can be found in the creek at different times of the year including white perch, yellow perch, bass, and carp.

There are a number of elementary and secondary schools within the watershed that contribute to public uses through their outdoor sports facilities and fields, playgrounds, open spaces, and linkages to other greenspace areas. Often schools are clustered with other public facilities and are located adjacent to valley and stream corridors. The Claremont Field Centre (residential) and the Duffins Creek Environmental Education Centre (day use) are outdoor education centres located within the watershed. These field centres offer environmental programming and dormitory facilities for students.

Due to the rural nature of the northern two-thirds of this watershed, perhaps the most enjoyable recreational activities involve cycling or hiking to the rolling hills on the Oak Ridges Moraine. Hamlets and villages scattered throughout the watershed contain beautiful historic buildings and cemeteries. Self-guided walking tours of historic downtown Stouffville or the Whitevale Heritage Conservation District, for example, are enjoyable and educational. Within these areas, trails and fishing spots provide focal points for outdoor recreation. In other areas of the watershed, recreational facilities, golf courses, and ski resorts allow for more active recreational pursuits.



CHAPTER

6

6.0 MANAGEMENT STRATEGIES

6.1 INTRODUCTION

While the Duffins and Carruthers watersheds are in relatively good condition today, they are not static systems. Despite the good watershed management efforts to date by various stakeholders, the watersheds are exhibiting signs of stress that can be attributed to current land use. Furthermore, future pressures from urban growth, road widenings, and construction (e.g., Highway 401 and 407), proposed airport development, and associated impacts are anticipated in these watersheds over the next 20 years. With these anticipated pressures in mind, the Task Forces and the technical support team defined and evaluated alternative land use scenarios, in terms of the effects they would have on watershed health. To guide this evaluation and to assess the effectiveness of various management approaches, the Task Forces identified watershed management goals and objectives necessary to realize the vision for the watersheds. Based on findings of technical studies and in keeping with the Management Philosophy, the Task Forces have formulated a set of management strategies for the watersheds.

Section 6.2 provides an overview of the extensive technical studies that form the scientific foundation for the management strategies and the chosen targets to measure implementation. Section 6.3 summarizes the recommended management approach. Section 6.4 defines the overall framework used to present the management strategies. The section also describes the methodology employed for assigning ratings of current watershed health, according to the long range objectives and associated targets. Sections 6.5 to 6.12 present the complete set of management strategies that form this Watershed Plan. Section 6.13 identifies a set of "Integral Management Actions," which is a summary of the management actions that are integral to the overall health of the watersheds. These management actions contribute to the fulfillment of numerous objectives, presented in sections 6.5 to 6.12, and often have benefits upstream and downstream of their site-specific application. The Integral Management Actions are Top Priority for implementation.

The leadership and partnerships demonstrated to date by watershed residents, businesses, municipalities, provincial and federal governments, and TRCA will be a sound basis for implementing these management strategies. Subsequent chapters in this watershed plan provide more detailed recommendations for specific roles and responsibilities.

6.2 TECHNICAL ANALYSIS AND INTEGRATION PROCESS

State-of-the-art watershed management today not only addresses a broader range of issues than previous initiatives, but also considers the interrelationships among these issues. Issues in this Report are considered in both the current and future planning context, in order to take a more proactive approach at management. Given the relatively rich information base existing within the Duffins and Carruthers Creek watersheds, and the extensive experience of TRCA and its partners with watershed planning, the Task Forces were in a good position to not only employ, but advance, state-of-the-art methodologies for watershed planning.

To understand key functions and issues operating within the watersheds, the Task Forces and the technical support team defined and evaluated three land use scenarios in terms of the effects they would impose on watershed health (See Figures 6.1 to 6.6). The scenarios reflected the primary drivers of change expected in the watersheds, including urban growth and opportunities for natural area protection. The results of the evaluation enabled the Task Forces to benchmark the watersheds' response along a continuum.

The three scenarios were:

- **Existing Land Use**
  The "Existing Land Use" scenario assumed maintenance of existing land use conditions and associated land cover characteristics (i.e., areas of imperviousness, vegetation, etc.). Mapping was developed by interpreting 1999 Digital Ortho Aerial Photography at a scale of 1:4000.

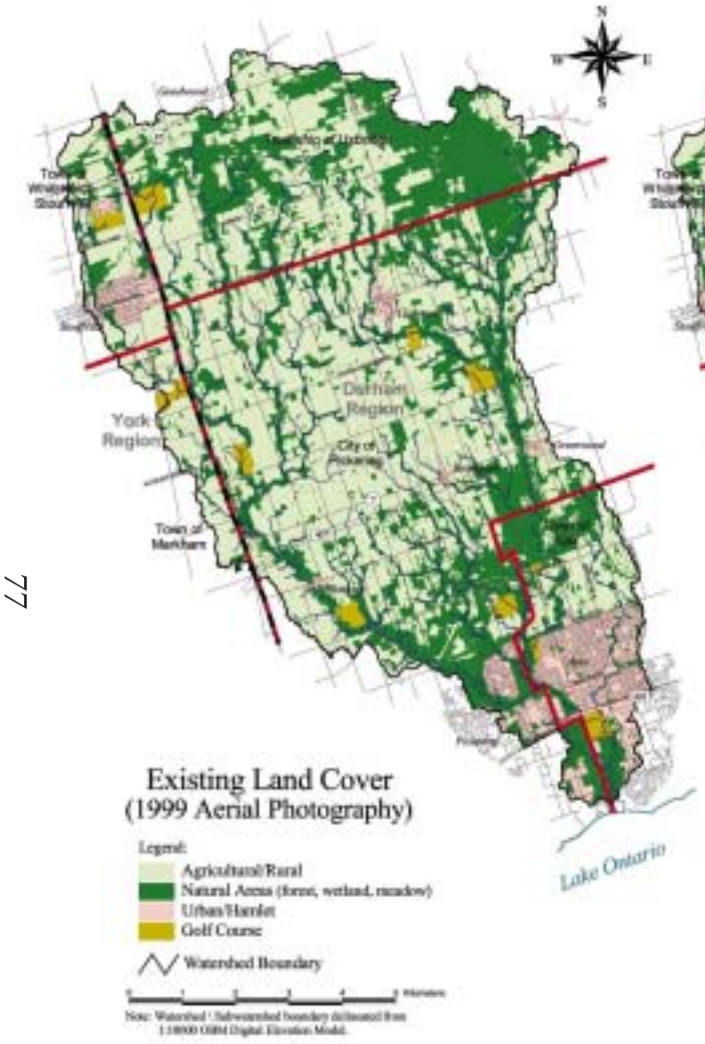


FIGURE 6.1

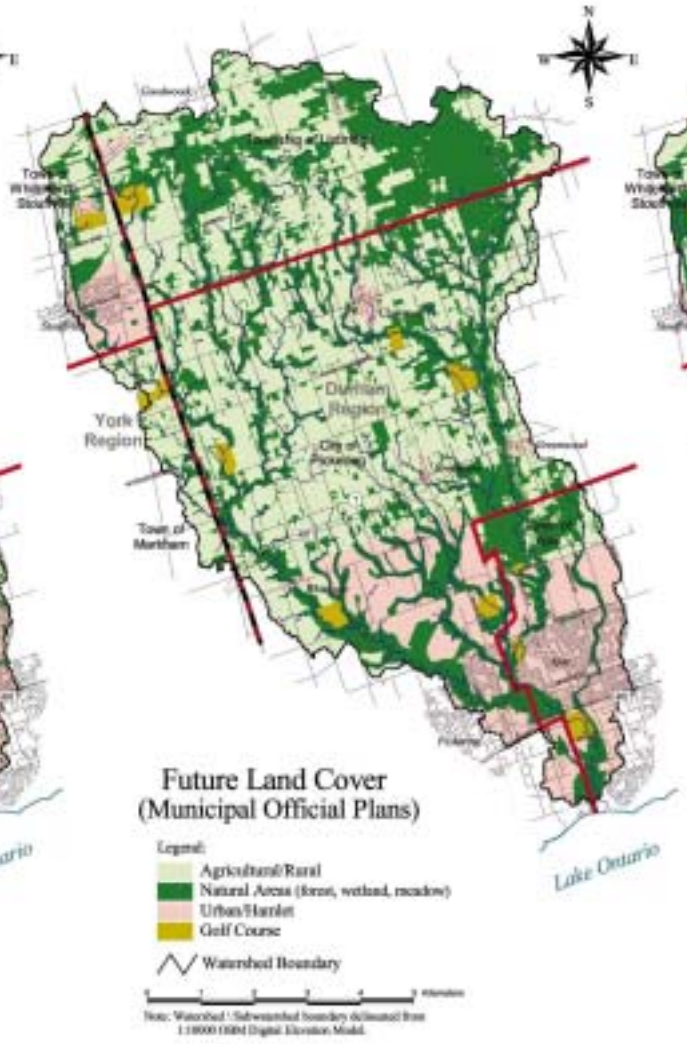


FIGURE 6.2

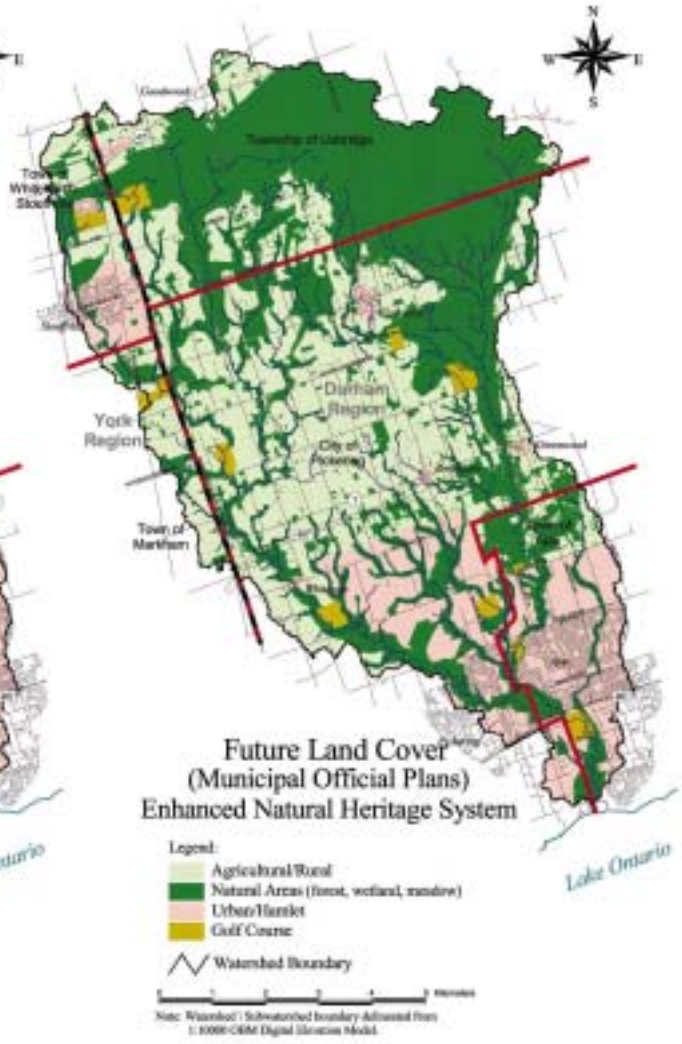


FIGURE 6.3

Note: The urban lands outlined in Figures 6.2 and 6.3 were evaluated as part of the modeling exercise and do not represent the Pickering urban boundary as outlined in the Durham Region and City of Pickering's Official Plans. The actual urban boundary extends north to Highway 7.

The "Enhanced" Natural Heritage System, as depicted in Figure 6.3, is a concept only. It illustrates the benefits of an increase in natural cover. It does not define the exact locations for the increase or limit the increase in natural cover to only those areas identified in dark green.

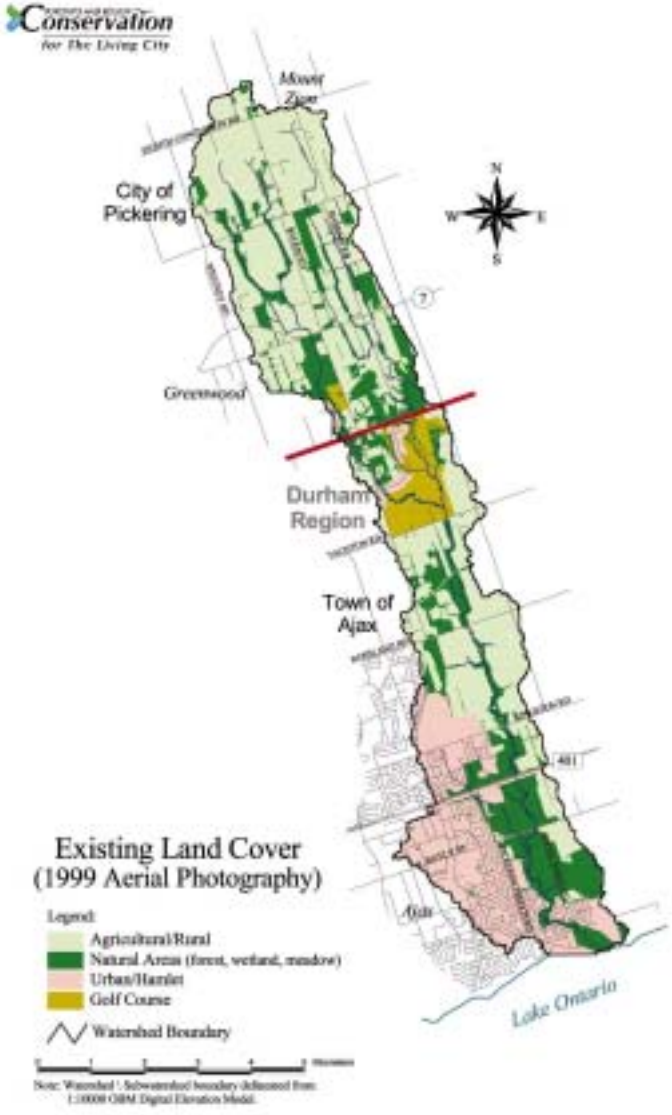


FIGURE 6.4

FIGURE 6.5

FIGURE 6.6

Note: The urban lands outlined in Figures 6.5 and 6.6 were evaluated as part of the modeling exercise and do not represent the Ajax and Pickering urban boundary as outlined in their Official Plans.

The "Enhanced" Natural Heritage System, as depicted in Figure 6.6, is a concept only. It illustrates the benefits of an increase in natural cover. It does not define the exact locations for the increase or limit the increase in natural cover to those areas identified in dark green.

Analysis of this scenario would provide a benchmark to describe current watershed conditions, and to identify healthy elements to be protected and existing problems to be addressed.

- **Future Land Use**

  The "Future Land Use" scenario assumed full build-out of the approved Regional and Local Municipal Official Plans, which projected watershed land use up to the year 2020. Mapping was developed by digitizing municipal official planning schedules. When applying the land cover classifications, associated with future designated urban growth areas, it was assumed that the TRCA Valley and Stream Corridor Policies would be implemented, and therefore vegetated land cover was applied to all valley and stream corridors, as defined under the TRCA program. Modeling exercises assumed no best management practices would be incorporated with the urban development, in order to demonstrate the response of watershed systems under a "worst case" scenario.

Defining Valley and Stream Corridors

Valley and stream corridors are distinguished from other physiographic features or resources by their connectivity to the river system as a whole.

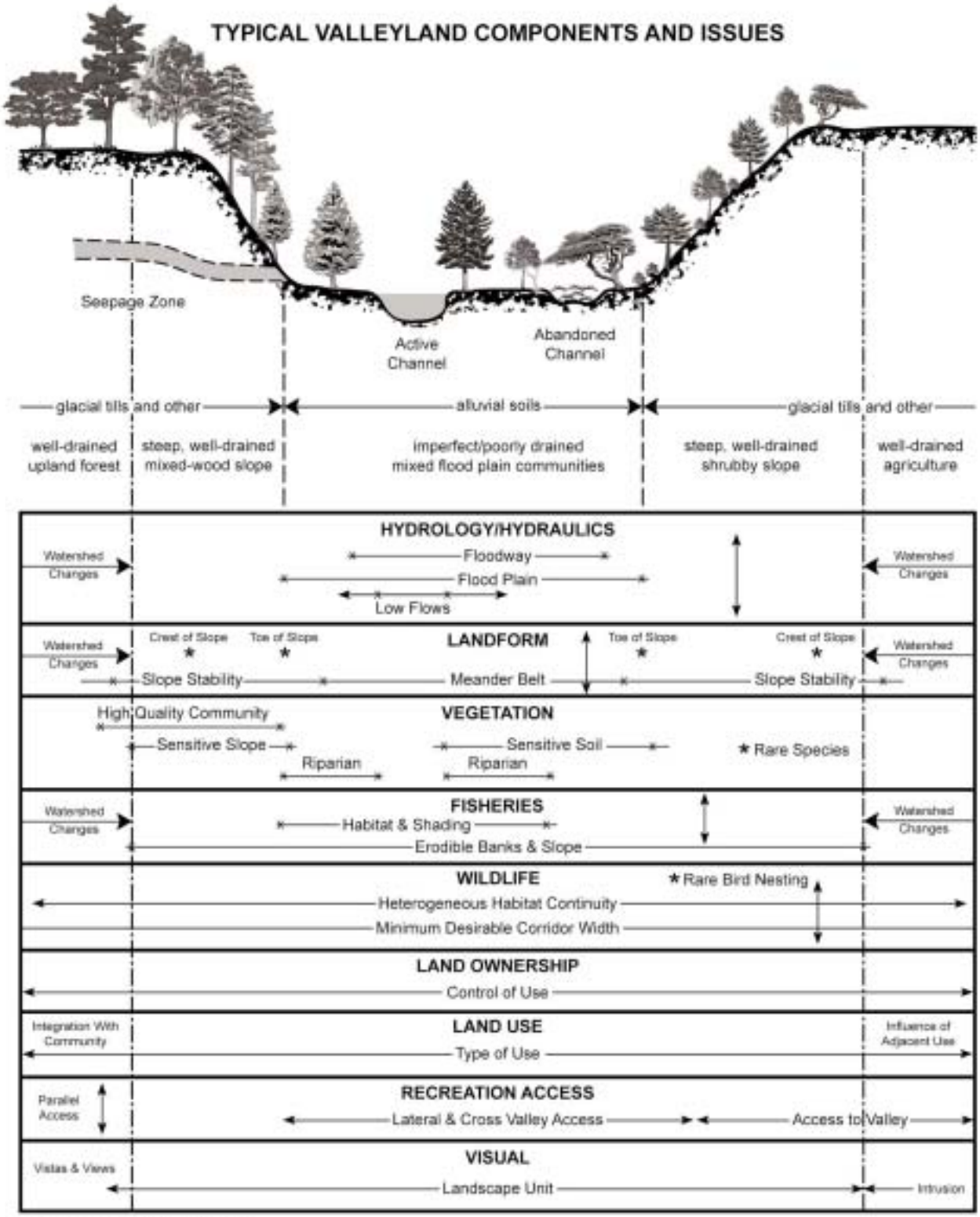
The physical landform of a valley corridor can visually be identified from its surrounding landscape (it is well defined). The physical landform of a stream corridor cannot be visually identified from its surrounding landscape (it is ill-defined). Therefore valley corridors are distinguished from stream corridors by the presence of a distinct landform.

Valley corridors may or may not have a defined watercourse channel. Stream corridors will typically have a defined watercourse channel.

Valley and stream corridors are valued landscape units providing diversity and contributing to environmental quality and the provision of open space. These corridors hold rich archaeological resources and natural heritage areas. Figure 6.7 illustrates typical valleyland components and issues.

Taken from MTRCA Valley and Stream Corridor Management Program, October 28, 1994.

The Durham Region Official Plan assumes urban development within the provincially owned Seaton lands, so results of the modeling exercises provided some indication of the potential impacts associated with the development of "Seaton," although the exact density and type of the future urban land cover is not known. This information is especially timely, in consideration of an April, 2002 provincial government decision to facilitate a "land swap" in the Seaton area with private land owners in Uxbridge Township and Richmond Hill, in order to remove sensitive Oak Ridges Moraine lands from development (MMAH, 2002). Under the agree-



Toronto and Region Conservation
Valley and Stream Corridor Management Program, October 28, 1994

FIGURE 6.7

ment, these lands will be brought into public ownership and the landowners will be compensated with land deemed more suitable for development in Seaton.

Durham Region's Official Plan identified a future regional airport, but did not show any details with respect to an airport on the federal lands. Even the future prospect of an airport was questionable when this watershed study began. Therefore, the federal lands were classified as rural and assigned the same land cover classifications as in the Existing scenario.

When the Duffins and Carruthers Task Forces started to work on the Watershed Plan in 2002, there were no plans in place for a federal airport and the Provincial Seaton Lands were scheduled for development at some future time. The Oak Ridges Moraine was an emerging issue and the Province had not initiated preparation of protective legislation for the moraine. Over the two year timeframe necessary to complete this Plan, the province passed The Oak Ridges Moraine Act and Conservation Plan, arranged a land swap between ORM lands and lands in Seaton, and the federal government indicated an interest in studying the feasibility of building an airport in Pickering.

- **Future Land Use with Enhanced Natural Heritage Cover**

Analysis of the "Future Land Use with Enhanced Natural Heritage Cover" scenario examined the multiple benefits of increased terrestrial natural cover. This scenario assumed full build out of the approved regional and local Official Plans, as in the previous scenario, but also assumed revegetation of lands, where such opportunities were expected to exist and where other watershed management objectives were likely to be realized. The resulting scenario represented an increase in area of natural cover from 37 per cent (existing) to 49 per cent in the Duffins Watershed and from 25 per cent (existing) to 30 per cent natural cover in the Carruthers Creek Watershed. Gains in the natural cover in the headwaters of the Carruthers Creek under the "Future Land Use with Enhanced Natural Heritage Cover" scenario were offset by losses in the urban portions of Ajax.

This land use scenario inherently incorporates the Task Forces' "environment first" and "net gain" management approaches, which are premised on the understanding that natural systems provide a long term, sustainable first step in an integrated management plan. It also recognizes that any management benefits derived from the protection/enhancement of natural systems would still need to be augmented by mitigative measures and best management practices (BMPs) associated with land use activities. However, for the purposes of the modeling, no BMPs were assumed in order to demonstrate the watershed response associated only with the enhanced natural cover. The management philosophies represented by this scenario are consistent with trends in water management approaches from the early 1980s to late 1990s, as identified by Heathcote, 1998 and summarized in Table 6-1.

TABLE 6-1: Trends in Water Management Approaches

SHIFT FROM	TO
End of pipe	→ Control at source
Remediation	→ Prevention
Point source focus	→ Point and non point source focus
Site focussed solutions	→ Regional and watershed approaches
Trust of technology	→ Understanding the limits of technology

Adapted from Heathcote, 1998

The formulation of this scenario preceded detailed Terrestrial Natural Heritage modeling conducted by TRCA as part of its Terrestrial Natural Heritage Program, and thus applied a similar but alternative approach. The lands targeted for enhanced natural cover were delineated according to the following considerations:

- opportunities to improve size, shape, and connectivity of existing habitat patches;
- opportunities to rehabilitate riparian vegetation;
- likelihood of benefiting other watershed management objectives (i.e., groundwater infiltration, floodwaters detention, recreational use enhancement, etc.);
- compatibility of adjacent land use and likelihood of implementing enhanced natural cover;
- assumption that aggregate operations would be naturalized;
- private landowners in the watershed have expressed an interest in conservation easements;
- public lands provide an opportunity to implement enhanced natural cover, including the Transport Canada's Green Space Lands; and
- provincially owned Seaton lands were assumed to be urbanized according to the provisions of existing legislation and policies for natural heritage, and therefore, typical of privately developed lands, no revegetation opportunities were assumed beyond the protection of existing natural heritage features.

These considerations went beyond those factors that might be associated solely with terrestrial habitat management objectives, in recognition of the other benefits of natural cover, such as hydrological benefits and enhanced public recreational use experiences. Most of the opportunities for enhanced natural cover were concentrated in the headwater areas, particularly in the East Duffins Creek subwatershed.

The development of this scenario preceded the release of the Oak Ridges Moraine Conservation Plan (ORMCP) and its protective land use designations. When compared, the TRCA enhanced natural heritage cover scenario would address all of the lands protected under the ORMCP, and go further in a few areas.

The resulting scenario, representing 49 per cent natural cover in the Duffins Watershed and 30 per cent natural cover in the Carruthers Watershed, was intended for study purposes and was not intended to limit revegetation to these specific geographic areas.

Technical Studies

Recognizing that the watershed ecosystem is a complex network of interrelated features and functions, it was necessary to take it apart and reduce it to a set of simpler component systems in order to understand each one and its response to each of the three alternative land use scenarios. For the purpose of the Duffins and Carruthers watersheds, the following technical component studies were undertaken:

- **Surface Water Quantity** – surface water budget analysis, watershed hydrology modeling, baseflow monitoring, and review of surface water withdrawals. Concurrent and ongoing work has included hydraulic modeling, flood plain mapping, and stream morphology field studies.

- **Groundwater Quantity and Quality** – geological mapping, groundwater flow modeling, review of groundwater withdrawals, and a review of available groundwater chemistry data.

- **Surface Water Quality** – non-point source pollutant modeling for rural and urban runoff, assessment of pollutant sources attributable to the wastewater discharge, and a review of available information on sediment loads related to construction activity.

- **Aquatic Habitat and Species** – a review of fish and benthic invertebrate collections, calculation of metrics (i.e., Index of Biotic Integrity), mapping of instream barriers and riparian habitat conditions, and a review of the baseflow contributions to total flow and their implications for habitat.

- **Terrestrial Habitat and Species** – application of TRCA's Terrestrial Natural Heritage Approach, which involved a GIS-based calculation of habitat scores under various scenarios, and a review of field inventory data for flora and fauna species and communities.

- **Human Heritage** (archaeological and built heritage) – review of mapping of known built heritage sites and archaeological sites, modeling for potential areas of archaeological sites, and consideration of potential impacts and opportunities for human heritage management under various scenarios.

- **Public Recreational Use** (primarily trails and other passive use opportunities) – mapping of existing and proposed trail routes, review of availability of various recreational use opportunities, and consideration for recreational use challenges and opportunities under various scenarios.

An innovative aspect of this work was the degree to which the findings of each technical study component were integrated, and interpreted, from the perspective of other interrelated components. Figure 6.8 illustrates the sequential order in which changes occur in the condition of each watershed system in response to a given change in land cover. This watershed response model guided the integration and interpretation of results arising from each individual technical component study. For example, increases in vegetative cover were associated with predicted changes in groundwater levels and stream baseflow, which, in turn, were predicted to have an effect on the aquatic community composition in certain stream reaches. Details of this innovative approach and each of the technical component studies are documented in the Technical Analysis and Integration Process Summary Report (TRCA, 2003). Key findings are described in the remaining sections of Chapter Six.

6.3 OVERALL MANAGEMENT CONTEXT

Based on the results of the technical studies, the Watershed Task Forces have recommended that the most effective approach for managing the Duffins and Carruthers Creek watersheds would involve achievement of the enhanced natural heritage system, together with the application of state-of-the-art management practices that would be employed in all aspects of land use activities. The concept of an enhanced natural heritage system, at the watershed scale, is depicted in the "Future Land Use (as per Official Plans) with Enhanced Natural Heritage Cover" or Scenario #3 (Figure 6.3 and Figure 6.6). The scenario was not intended to limit revegetation to these specific geographic areas. Implementation of the watershed plan would involve a review of opportunities for enhancing the natural heritage system at subwatershed and site scales. The technical studies have recommended guidelines and criteria for the design and application of best management practices that would contribute to maintaining the function of the natural heritage system. The information available will also assist in exploring opportunities for innovative urban form and servicing approaches that will contribute to the protection of these watersheds.

The selection of this preferred management approach was based on a number of considerations:

6.3.1 CONSISTENCY WITH TASK FORCE MANAGEMENT PHILOSOPHY

The Task Forces composed a management philosophy to be used to guide in achievement of their vision for the watersheds. The management philosophy consists of five elements:

- Net Gain
- Environment First
- Balance Land Use
- Human Health and Safety
- Everyone Counts - Ownership, Commitment, and Follow Through

The establishment of a natural heritage system, together with sustainable agricultural and urban land uses, is consistent with this Management Philosophy.

WATERSHED RESPONSE MODEL – HIERARCHY OF CHANGE

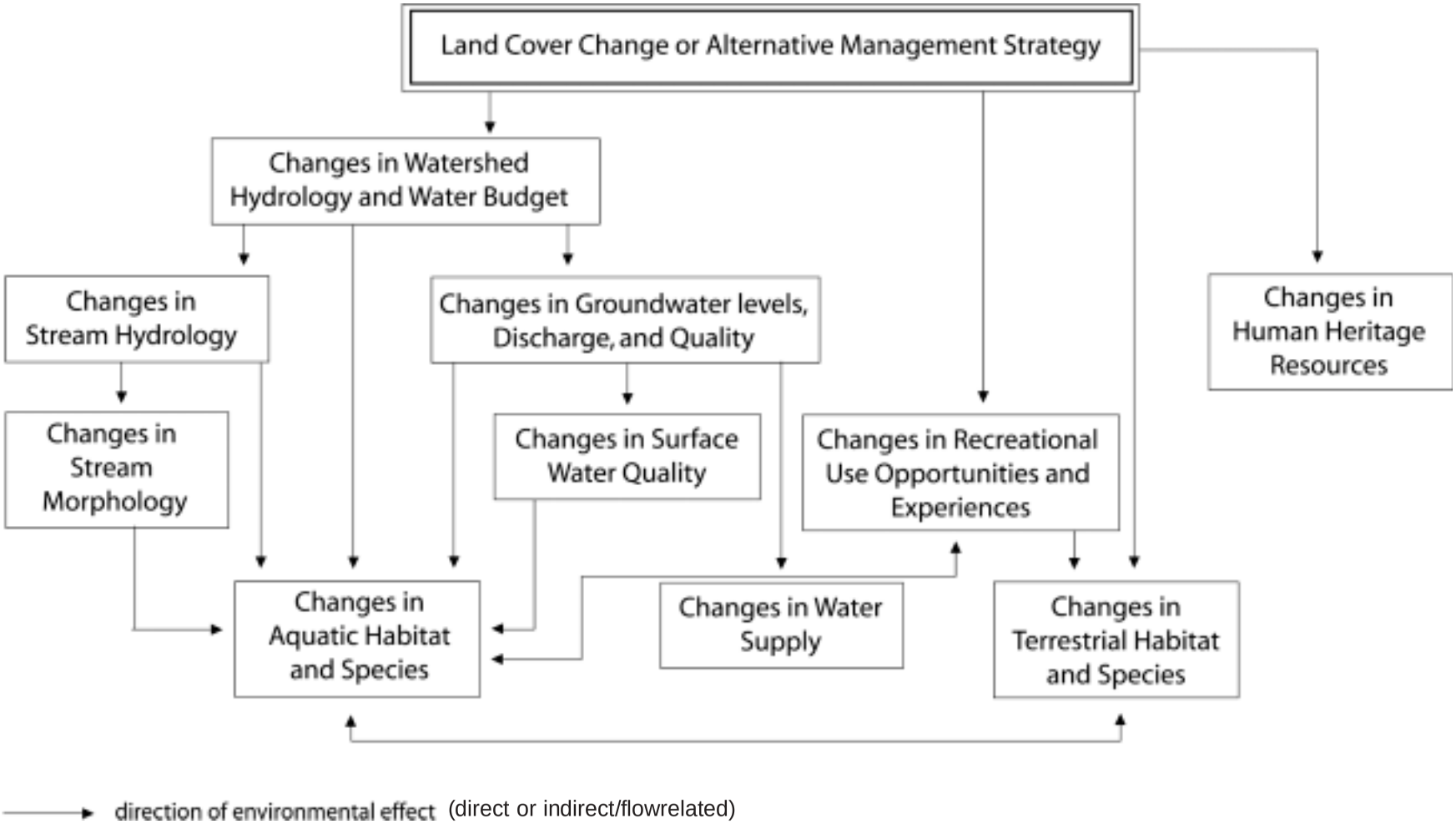


FIGURE 6.8

6.3.2 EFFECTIVENESS

Technical analysis of the watersheds' response to alternative land use and management scenarios enabled the Task Forces to establish benchmarks of watershed condition, which were used as a guide in formulating and justifying this management plan. Results from the analysis of Scenario #3 repeatedly demonstrated the multiple watershed management benefits that can be realized by achieving an enhanced natural heritage system. In addition to benefits associated with terrestrial habitat and species objectives, a natural heritage system was shown to contribute to the management of hydrological, hydrogeological, water quality, aquatic resource, recreation, and human heritage concerns.

6.3.3 LONG-TERM SUSTAINABILITY

At a watershed scale, the protection of a viable natural heritage system will provide the foundation for a sustainable watershed. By protecting the ability of natural systems to self-regulate, there will be:

- less need for costly maintenance of infrastructure;
- less risk involved with unproven technological solutions to watershed management; and
- cost savings in taking a preventitive approach rather than a reliance on remedial or "end-of-pipe" solutions.

Wise choices regarding "backyard practices", urban form, and transportation design, made at site and community scales within the watershed, will complement the level of protection provided by natural systems and contribute to overall watershed sustainability.

6.3.4 FEASIBILITY

Due to unique opportunities in the Duffins and Carruthers Creek watersheds, the Task Forces deemed the achievement of an enhanced natural heritage system to be feasible in these watersheds. Unique opportunities in these watersheds include:

- Provincial legislation – Since the Task Force began its work, the Ontario Government passed the Oak Ridges Moraine Act and Conservation Plan, which effectively protects a significant area of land for a natural heritage system in the headwaters of the Duffins Creek.

- Public land holdings – Federal, provincial, and municipal governments and TRCA own significant lands in these watersheds and expect to be able to realize watershed plan objectives with public support. For example, in March 2001, Transport Canada identified lands surplus to its needs for an airport and announced that these lands would be protected as greenspace in perpetuity. There may be further lands deemed surplus as airport planning and political decision making proceeds.

- Private landowner willingness to participate in environmental programs in these watersheds, as has been demonstrated by the significant number of conservation easements that have been established since the watershed planning process began.

6.3.5 CONSISTENCY WITH GREAT LAKES BASIN MANAGEMENT OBJECTIVES

The Canada-Ontario Agreement on Great Lakes Water Quality (2002) commits Canada and Ontario to increase natural areas and practice sound watershed management as a means of protecting coastal wetlands and the overall health of the Great Lakes.

6.4 MANAGEMENT STATEGY FRAMEWORK AND RATINGS

The Task Forces have identified management strategies in eight theme areas, detailed in sections 6.5 to 6.12. Each "strategy" is composed of a goal and a set of objectives, which identify the approach necessary to address the key issues. Management strategies were identified by the Task Forces in two workshops and verified through extensive public and stakeholder consultation. Management actions are mechanisms recommended to achieve the objective and may include: policy, planning, and regulatory tools; stewardship, regeneration, and education/awareness activities; land securement; monitoring; and/or further study needs. Policy, planning, and regulatory tools represent the central mechanisms for achieving this Plan's objectives, as they guide many other implementation initiatives. An important part of policy development and implementation is the ongoing requirement for monitoring and enforcement. Overall, the implementation of all management actions will be the responsibility of multiple partners.

In addition to setting management directions, the Task Force has reported on the current watershed conditions, according to each of the management objectives, thus providing a baseline "Report Card" from which progress can be measured. In order to facilitate meaningful and replicable reporting, indicators, measures, and targets were defined for each objective. An indicator is a fact or device that provides specific information about the objective of interest. Measures are quantitative or qualitative ways to measure the state of the indicator. Targets represent a numerical threshold or directional aim, associated with each measure, and were chosen as the minimum (or maximum) state necessary to achieve the desired objective. To the extent possible, the actual numerical target has been included in this chapter. However, in cases where the target varies throughout the watersheds or under various conditions, such as flow rates, and where presentation of this information would have required the inclusion of oversized tables or figures, the source report has been fully referenced so that this target information can be readily located.

For each goal, objective, and measure, a rating has been assigned, which represents an evaluation of current watershed conditions. Ratings of current watershed conditions are based on both quantitative and qualitative analyses. Details of the rating analysis are documented in the Ratings

Report for the 2003 Duffins and Carruthers Creek Watersheds Report Card (TRCA, 2003), such that the same methodologies may be repeated in future years.

The rating system, particularly as applied to quantitative measures, is defined as follows:

Rank	Target Per cent Achieved
Excellent	better than 80
Good	between 70 and 79
Fair	between 60 and 69
Poor	between 50 and 59
Fail	below 50
Further study required	baseline data not available or insufficient at this time

For some objectives, the associated indicators and measures are not amenable to quantitative evaluation, so the respective targets are based on a qualitative condition or directional aim. Ratings were assigned based on the best professional judgement of TRCA staff following a review of all pertinent, available information.

In some cases, quantitative measures and targets have been established for the objective, but the amount of information available is insufficient for the purpose of evaluating the level of achievement of the target. Further data collection and analysis is required to fill information gaps. Therefore, no ratings have been assigned in this reporting period and the need for further study has been indicated.

On-going data collection to monitor progress toward the achievement of goals and objectives of this watershed plan will be coordinated through the Regional Watershed Monitoring Network (RWMN). This monitoring work will address many of the remaining information gaps and will contribute to the information needed to complete the establishment of "baseline" conditions and adjust targets when deemed necessary. Information from the RWMN will be presented in Annual Progress Reports and future Watershed Report Cards.

6.5 SURFACE WATER QUANTITY

The volume of water and its movement through the watershed under various dry weather, rainfall, and snowmelt conditions is important in watershed management, because it affects and is affected by virtually every other natural system and many human activities. The overall distribution of water through different pathways within the watershed affects both ground and surface water levels and has implications for water supply and habitats. Too little water in the form of stream baseflow can affect a stream's aquatic habitat potential and limit its viability as a water supply. Too much water in the form of peak flow volumes can pose potential human safety concerns associated with flooding. The frequency and duration of intermediate ("bankfull") stream flows,

coupled with local geology, influence the stability of the watercourse and its susceptibility to erosion. Just as these hydrologic conditions influenced settlement decisions of the past, watershed managers today must continue to direct land use decisions and human activities such that these vital hydrologic functions are protected and flooding hazards are minimized.

Issues

Based on the findings of a water budget analysis (Clarifica, 2002) and hydrological modeling (Aquafor Beech, 2002) within the Duffins Creek watershed and other available information for both the Carruthers and Duffins watersheds, the Task Forces have determined the implications of future, uncontrolled urban growth and the relative effectiveness of alternative management strategies.

The increased area of impervious surfaces (e.g., asphalt, concrete, roof) associated with urbanization under the Regional Official Plans is predicted to reduce groundwater recharge by four per cent (nine milimetres per year) overall in the Duffins Creek watershed and increase overland runoff by 17 per cent (25 milimetres per year), if no management steps are undertaken (See Figures 6.9 and 6.10). This impact will be greater in areas experiencing a greater proportion of urban growth. For example, in the lower Urfe Creek subwatershed, where the urban area is planned to expand from 21 hectares (three per cent of the area) to 412 hectares (51 per cent), with an estimated increase in imperviousness of 0.8 per cent to 22 per cent, the hydrologic changes will be much more pronounced: infiltration to groundwater will be reduced by 30 per cent (66 milimetres per year) and runoff will increase by 137 per cent (185 milimetres per year) (Clarifica, 2002). Although similar estimates are not yet available for the Carruthers Creek watershed, the effects are expected to be comparable or greater. These changes have implications for reductions in local water table elevations, changes in local stream baseflow, scouring of stream channels, degradation of water quality, loss of habitat, and alterations in aquatic communities, as discussed in the following chapters.

Figure 6.11 depicts locations in the Duffins and Carruthers Creek watersheds where baseflow measurements have been taken. Under present conditions, more than half (57 per cent) of the total baseflow of Duffins Creek is contributed to by the East Duffins Creek (Figure 6.12). A large portion of that baseflow is derived from the Oak Ridges Moraine area. Baseflow within Carruthers Creek is more evenly distributed, with increases in flow of 15 to 25 per cent at most flow points along the Creek (Figure 6.13). Reductions in baseflow in the vicinity of the 4th Concession are attributed to a recharge area located on the glacial Lake Iroquois shoreline, and the marked increase in baseflow at Rossland Road is coincident with discharge from the middle aquifer at the lower edge of the Iroquois shoreline (TRCA, 2003).

Under the future land use conditions, expected to occur with the implementation of the Regional Official Plans, the reductions in baseflows by subwatershed are expected to range from one to 17 per cent overall within the Duffins Creek watershed. These changes are based on analysis of water budget and groundwater flow modeling results (TRCA, 2003). Little change would be anticipated within the east or west branches, which generate the bulk of the overall system baseflow, therefore no significant impacts would be expected within the lower reaches of Duffins

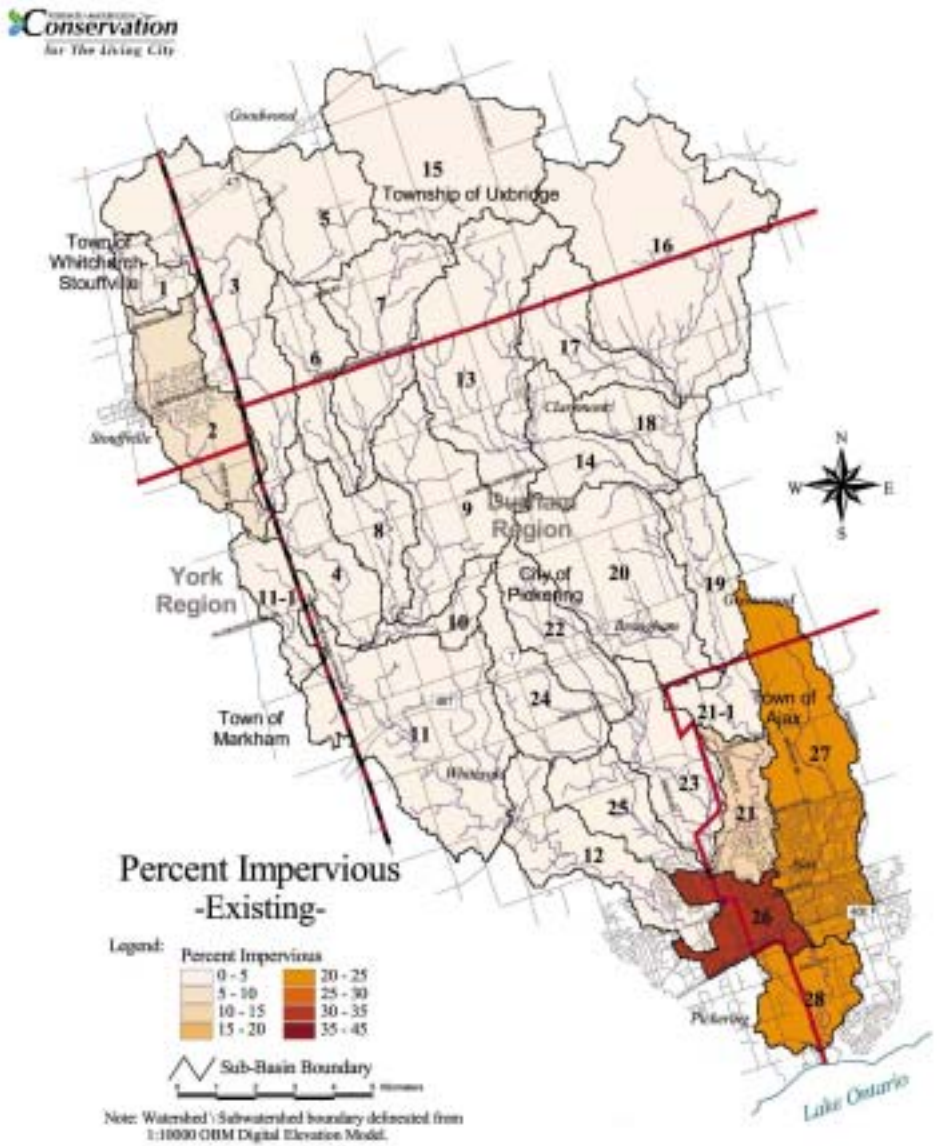


FIGURE 6.9

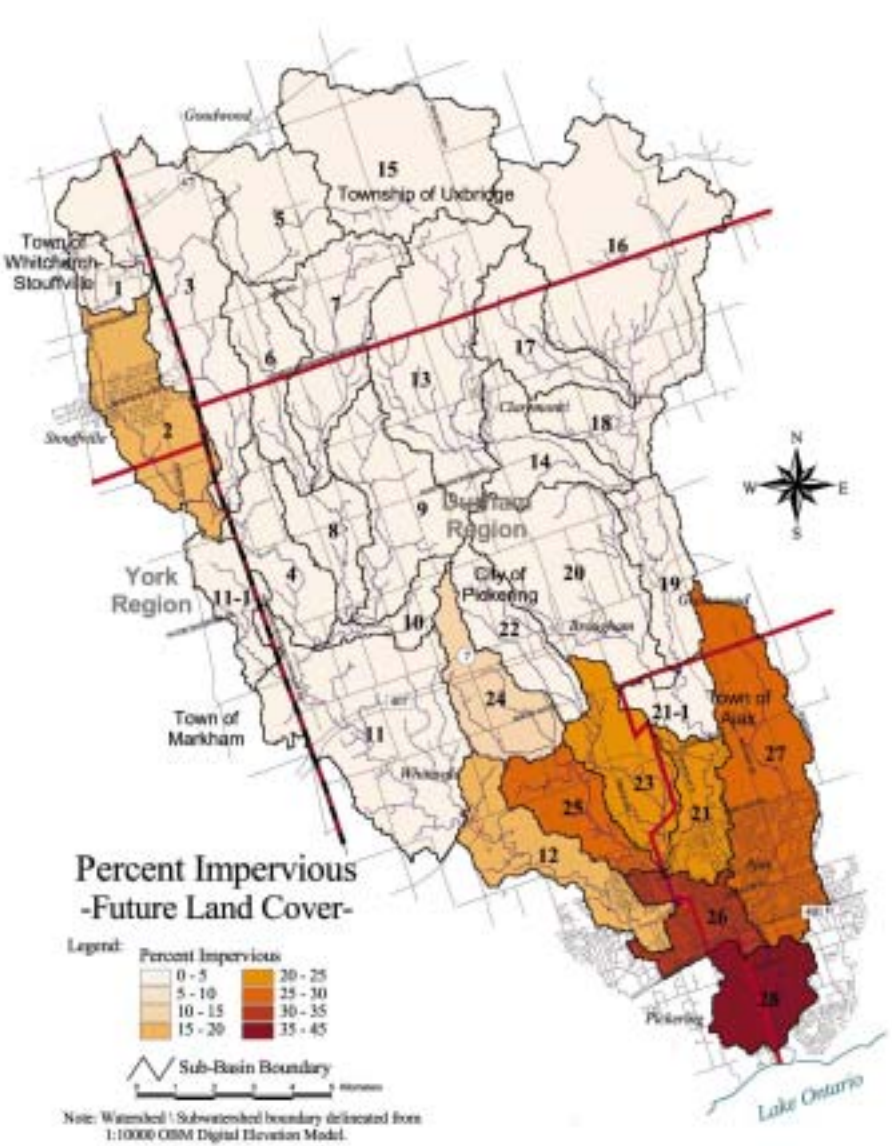
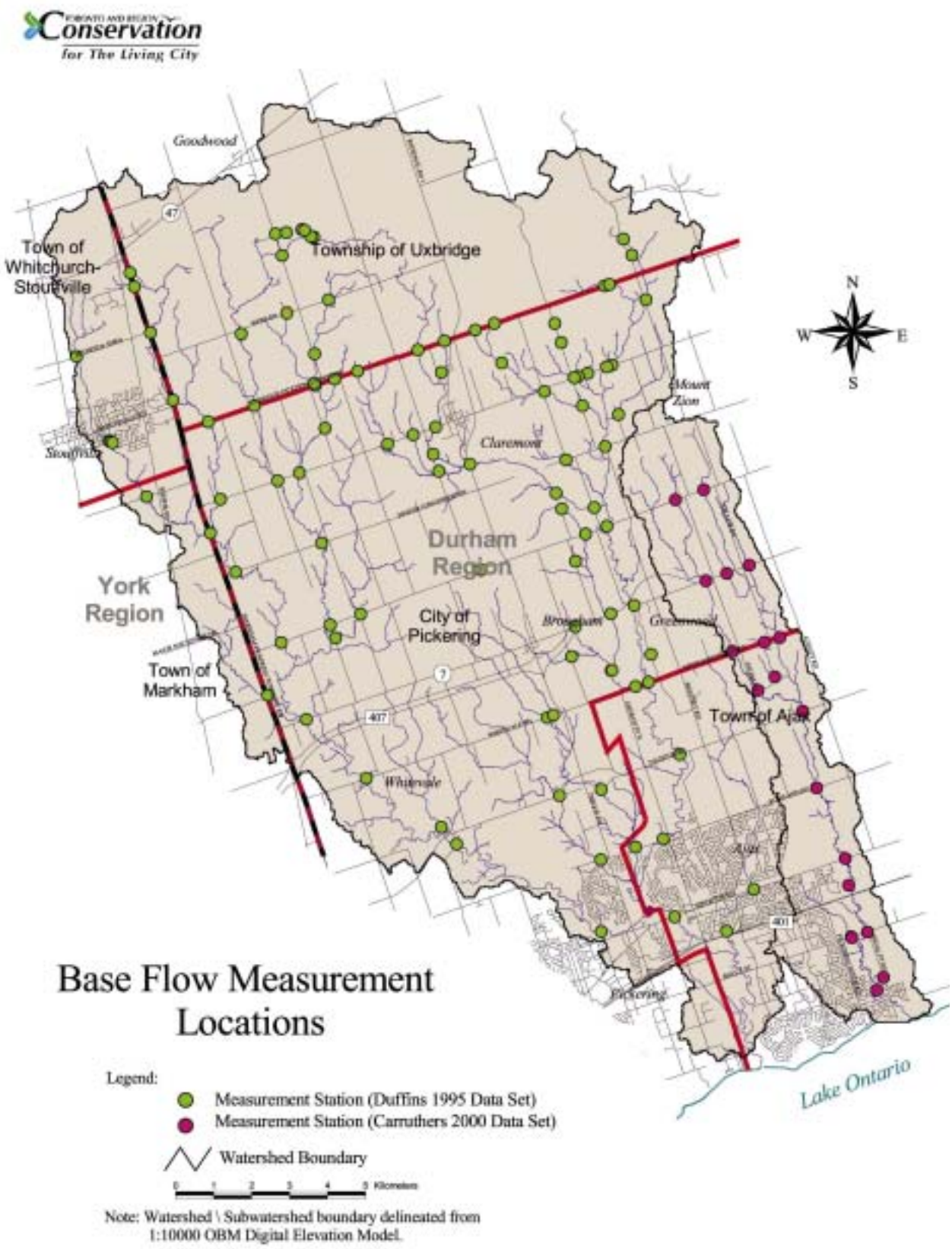


FIGURE 6.10


Conservation
for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
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Mount Zion
Durham Region
York Region
City of Pickering
Broughm
Greenwood
Town of Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
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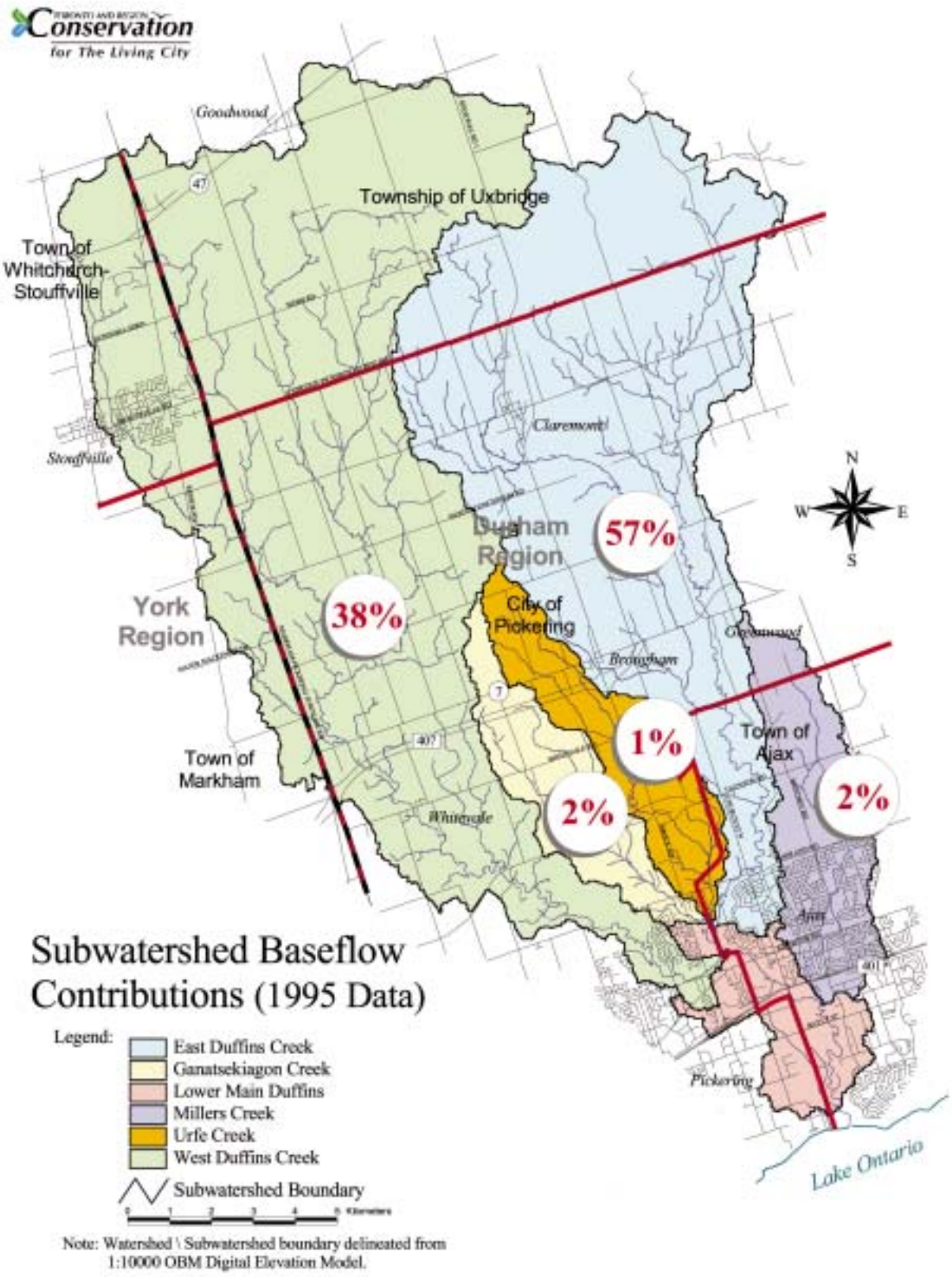
Base Flow Measurement Locations
Legend:
Measurement Station (Duffins 1995 Data Set)
Measurement Station (Carruthers 2000 Data Set)
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.11


Conservation
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Claremont
Durham Region
57%
York Region
38%
City of Pickering
Brougham
Town of Ajax
1%
2%
2%
Town of Markham
Whitevale
Ajax
Pickering
Lake Ontario
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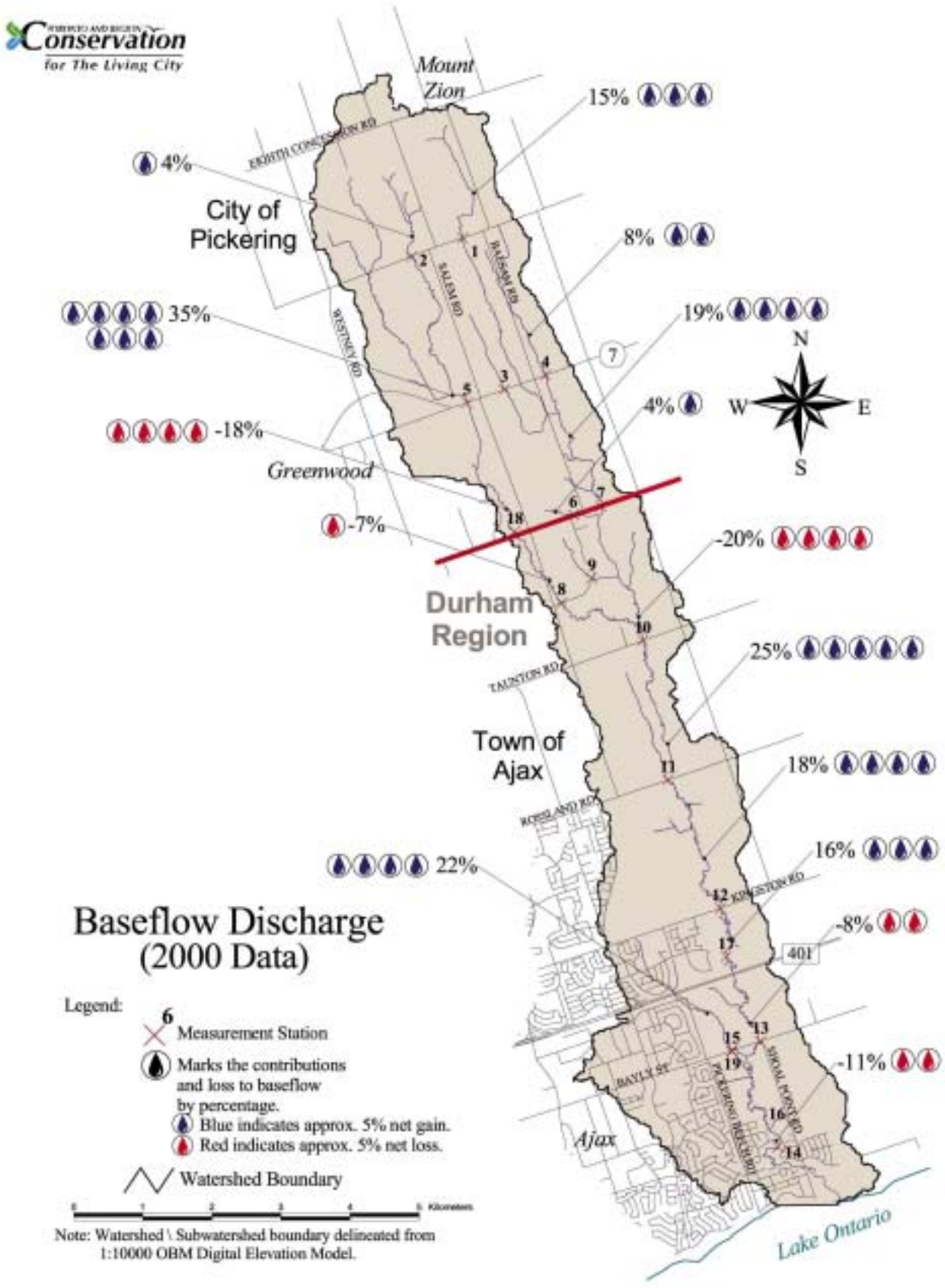
Subwatershed Baseflow Contributions (1995 Data)
Legend:
East Duffins Creek
Ganatsekiagon Creek
Lower Main Duffins
Millers Creek
Urfe Creek
West Duffins Creek
Subwatershed Boundary
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.12


Conservation
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City of Pickering
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Ajax
Lake Ontario
15%
4%
8%
35%
19%
4%
-18%
-7%
-20%
25%
18%
16%
22%
-8%
-11%
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Baseflow Discharge
(2000 Data)
Legend:
6
Measurement Station
Marks the contributions and loss to baseflow by percentage.
Blue indicates approx. 5% net gain.
Red indicates approx. 5% net loss.
Watershed Boundary
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.13

Creek. Baseflow within the Ganatsekiagon, Urfe, and Millers Creeks would be most impacted with a potential reduction of 17 per cent, 14 per cent, and four per cent, respectively, due to the concentration of urban growth in these areas. These localized impacts are of particular concern to aquatic communities reliant on groundwater upwellings for reproduction.

In keeping with the "Environment First" management philosophy of the Task Force, a future land use scenario with an enhanced area of natural heritage cover, such as meadows, wetlands, and forests, was evaluated and shown to play a key role in the maintenance of hydrologic function. This is not a new concept, as it is consistent with protocols established by conservationists in the last century to reduce flooding and erosion in the Ganaraska River Watershed. Their efforts demonstrated the effectiveness of large scale reforestation in managing flood and erosion concerns. These practices were transferred to the Duffins watershed, starting as early as the 1940s, with the eventual creation of the Durham Regional Forests and private and TRCA headwaters reforestation programs.

The impacts of reforestation are difficult to quantify as discussed by Clarifica Inc. (May 2002), and examples from the literature predict both increases and decreases in recharge following reforestation. In a report for the Ganaraska watershed, Richardson (1946) suggested that replanting should be beneficial to increasing groundwater recharge. Richardson based this opinion on inverse reasoning after observing the differences in streamflow on the Oak Ridges Moraine following extensive deforestation. Carman (1941) also documents changes to the flow system following deforestation of the moraine within Durham County.

Richardson argued that when the upper part of the watershed was heavily timbered, springs were more numerous, and the streams commenced farther up the slope compared to stream headwater areas following deforestation. It was felt that with replanting, the summer flow in streams would be increased and there would be more deep seepage through the moraine gravels for water supply to the wells in the area. Other quotes on the topic provided by Richardson, are as follows:

"The influence of tree growth on the stream flow is emphasized also by the fact that on old maps of the area, notably Tremaine's Map of Durham County, 1861, and the Historical Atlas of the Counties published in 1878, the headwater streams extend much farther up the morainic slope, which at that time was well wooded. Many of these dried-up water courses can still be followed, and these probably help to increase the rate of run off on this part of the watershed at certain seasons of the year." (p. 58)

"But the function of the roots does not end with giving support and nourishment to the tree, since in the act of extending themselves for food they open up the soil and make thousands of small channels in to the ground, which greatly increases its porosity."(p. 65)

> "This assistance which the forest floor gives to the absorption of moisture by the soil is partly responsible for the feeding of springs and underground storage.... No one, who has lived in wooded areas of Ontario and has watched the forest being cut down over large areas, will gainsay the fact that the water supply in springs has been changed." (p. 66)

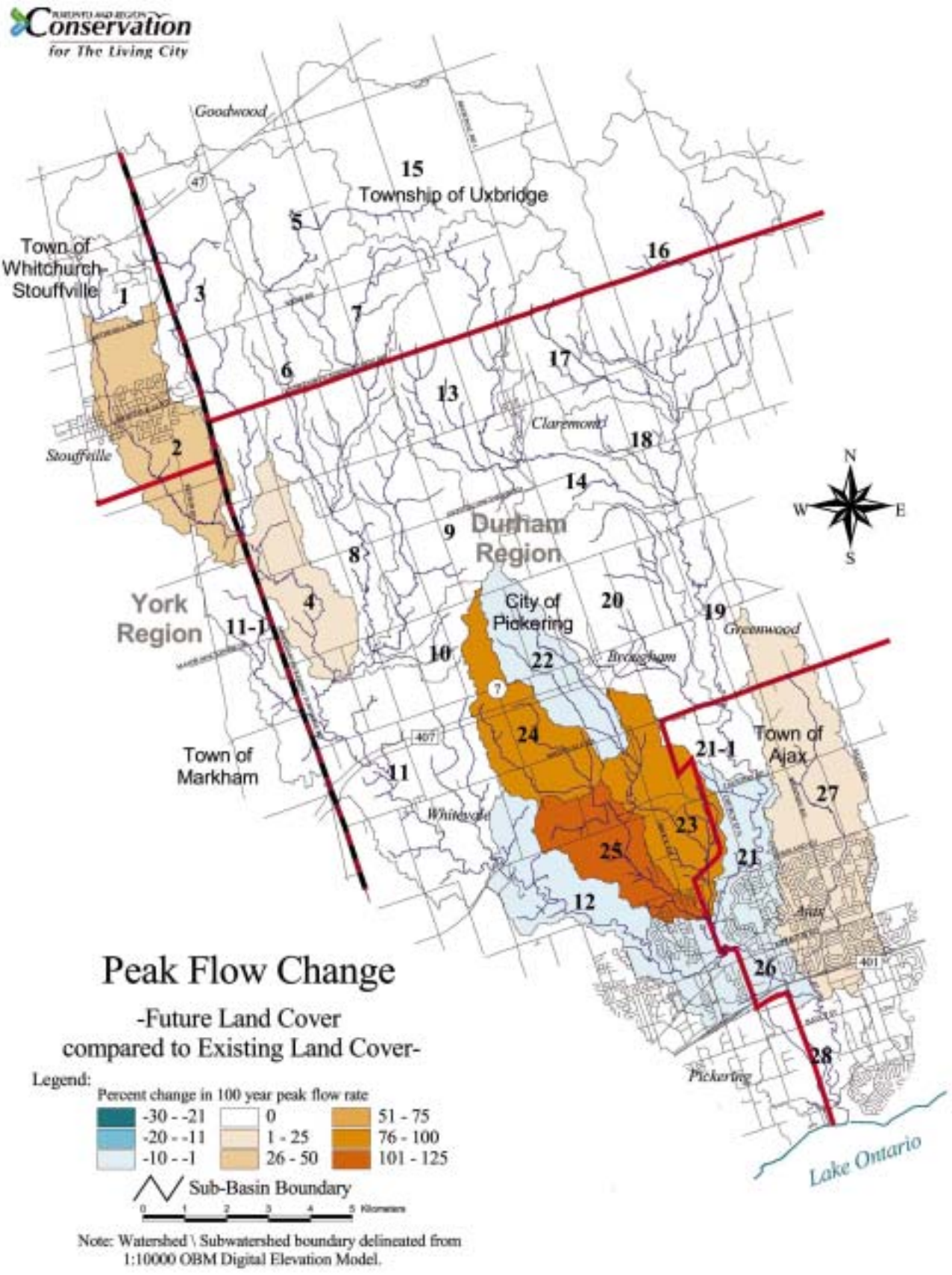
Modeling carried out in support of this Watershed Plan has shown that a future land use scenerio would increase peak flows by 15 per cent to 120 per cent greater than existing flows for the 100-year event (Figure 6.14). These increases occur only in areas that will be impacted from future development. Therefore, stormwater management measures are essential in these areas to ensure that pre-development peak flows are maintained. The future scenario also results in a number of subcatchments having no change in peak flows and a few having peak flows that are marginally less than existing peak flow rates for the 100-year event.

Based on the future Natural Heritage scenario, peak flow increases are expected to be approximately 10 per cent to 110 per cent greater than existing flows for the 100-year event, which are slightly less than the increases expected with the future scenario (Figure 6.15). As with the future scenario, these peak flow increases occur only in future development areas. The future Natural Heritage scenario also results in a number of subcatchments having peak flow decreases that are expected to be approximately zero to 25 per cent less than existing flows for the 100-year event.

Similar benefits would be expected in the Carruthers Creek, if the area of natural heritage cover were increased in that watershed. Further hydraulic studies and floodline mapping updates will be undertaken for certain portions of the Duffins Creek in 2003 (Figure 6.16). Complete hydrologic, hydraulic and mapping updates for the Carruthers Creek Watershed will begin in 2004, in order to provide a similar level of management direction for that watershed.

The practice of protecting natural features continues to have potential for wider application in the Duffins and Carruthers watersheds, as an effective means of sustainably maintaining hydrologic function. Other important approaches in support of water quantity management objectives include the protection and management of flood plains and valley and stream corridors (Figure 6.17), the protection of recharge and discharge functions, the incorporation of stormwater management practices in new and existing developments, and careful management of water withdrawals.

Updated hydrological modeling in the Duffins Creek watershed has shown that a more stringent level of stormwater management for flood control, "Regional storm" control, may be required in the Whitevale, Urfe, and Ganatsekiagon Creek subwatersheds, in addition to the normal two - to 100-year post - to pre-development flood control required in most other reaches, in order to maintain existing levels of flood risk (Figure 6.18). This will ensure that new developments have a current standard of flood risk and that existing flood vulnerable areas and flood vulnerable roads are not flooded to a higher level or with greater frequency.


Conservation
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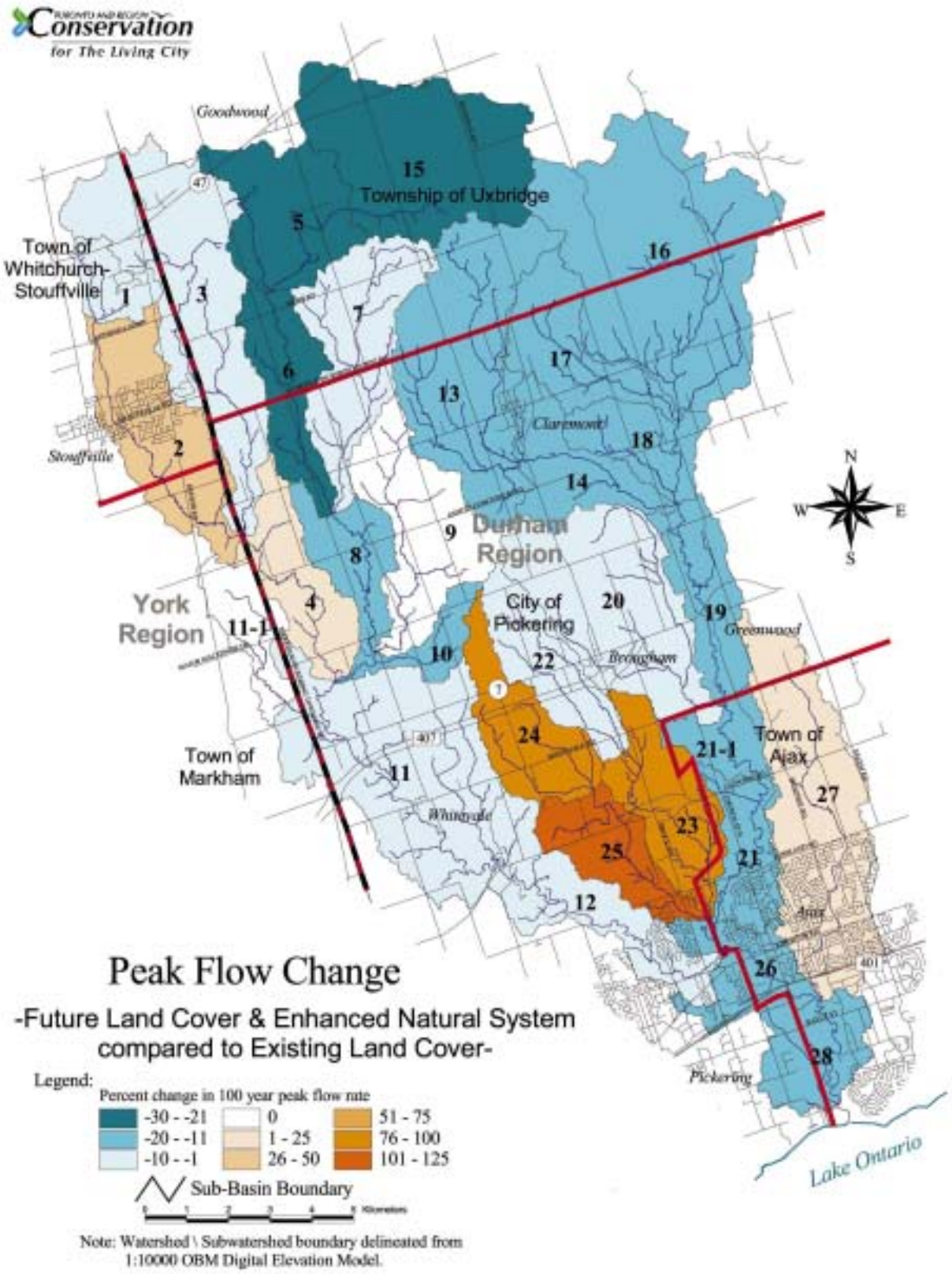
Peak Flow Change
-Future Land Cover
compared to Existing Land Cover-
Legend:
Percent change in 100 year peak flow rate
-30 - -21
-20 - -11
-10 - -1
0
1 - 25
26 - 50
51 - 75
76 - 100
101 - 125
Sub-Basin Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 6.14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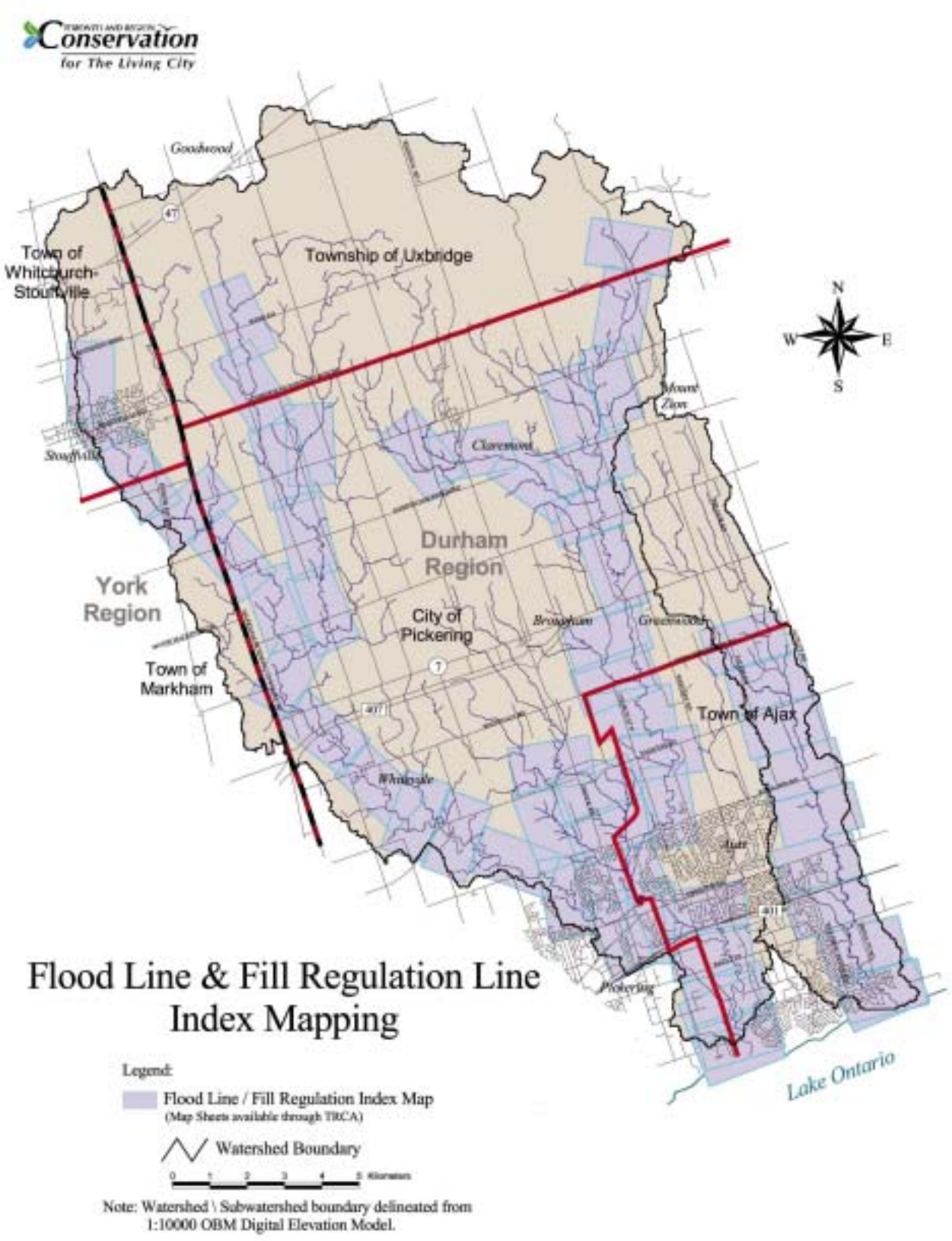
Pickering
Lake Ontario
Peak Flow Change
-Future Land Cover & Enhanced Natural System
compared to Existing Land Cover-
Legend:
Percent change in 100 year peak flow rate
-30 - -21
-20 - -11
-10 - -1
0
1 - 25
26 - 50
51 - 75
76 - 100
101 - 125
Sub-Basin Boundary
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 6.15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Brougham
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Town of Ajax
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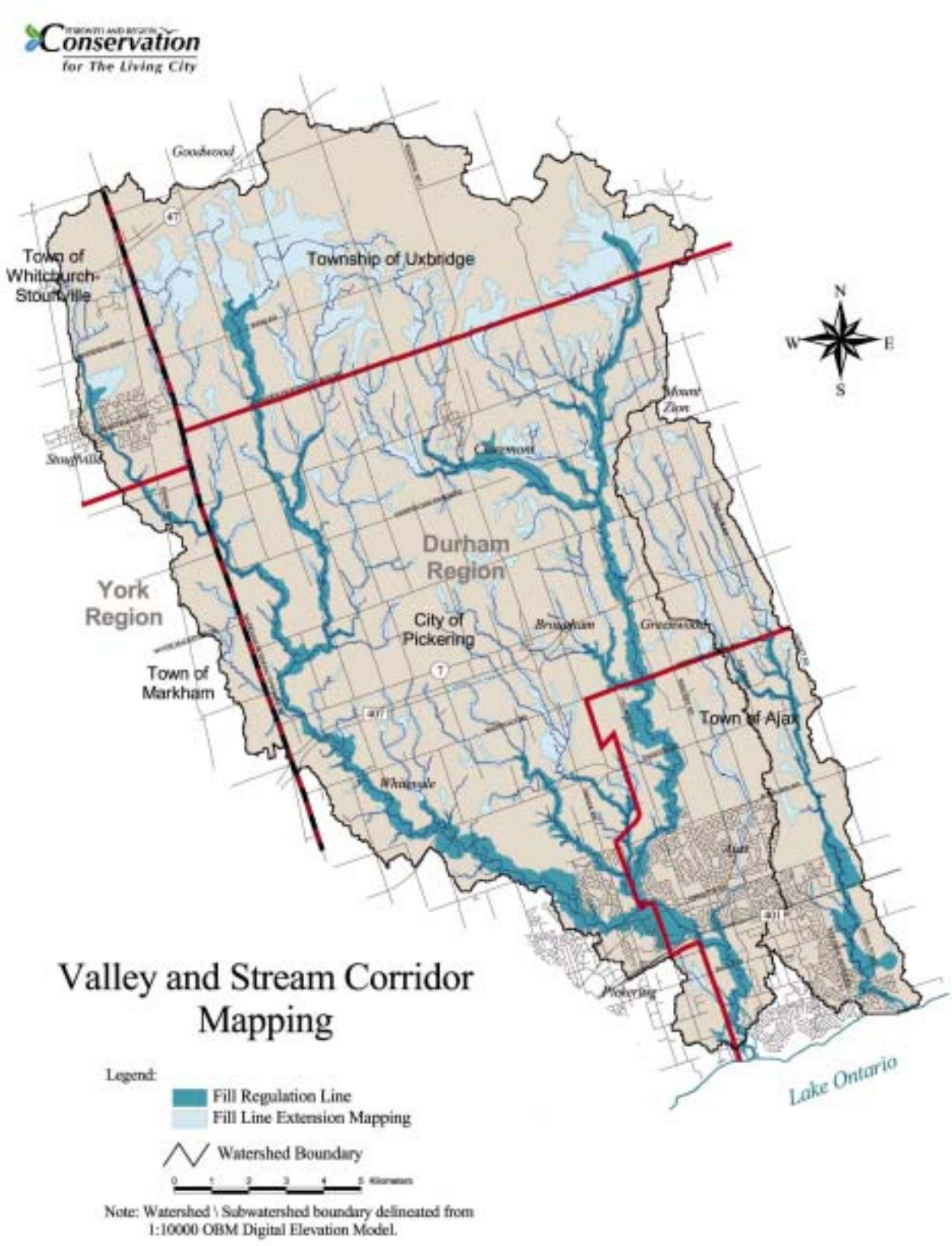
Flood Line & Fill Regulation Line
Index Mapping
Legend:
Flood Line / Fill Regulation Index Map
(Map Sheets available through TRCA)
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 6.16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York Region
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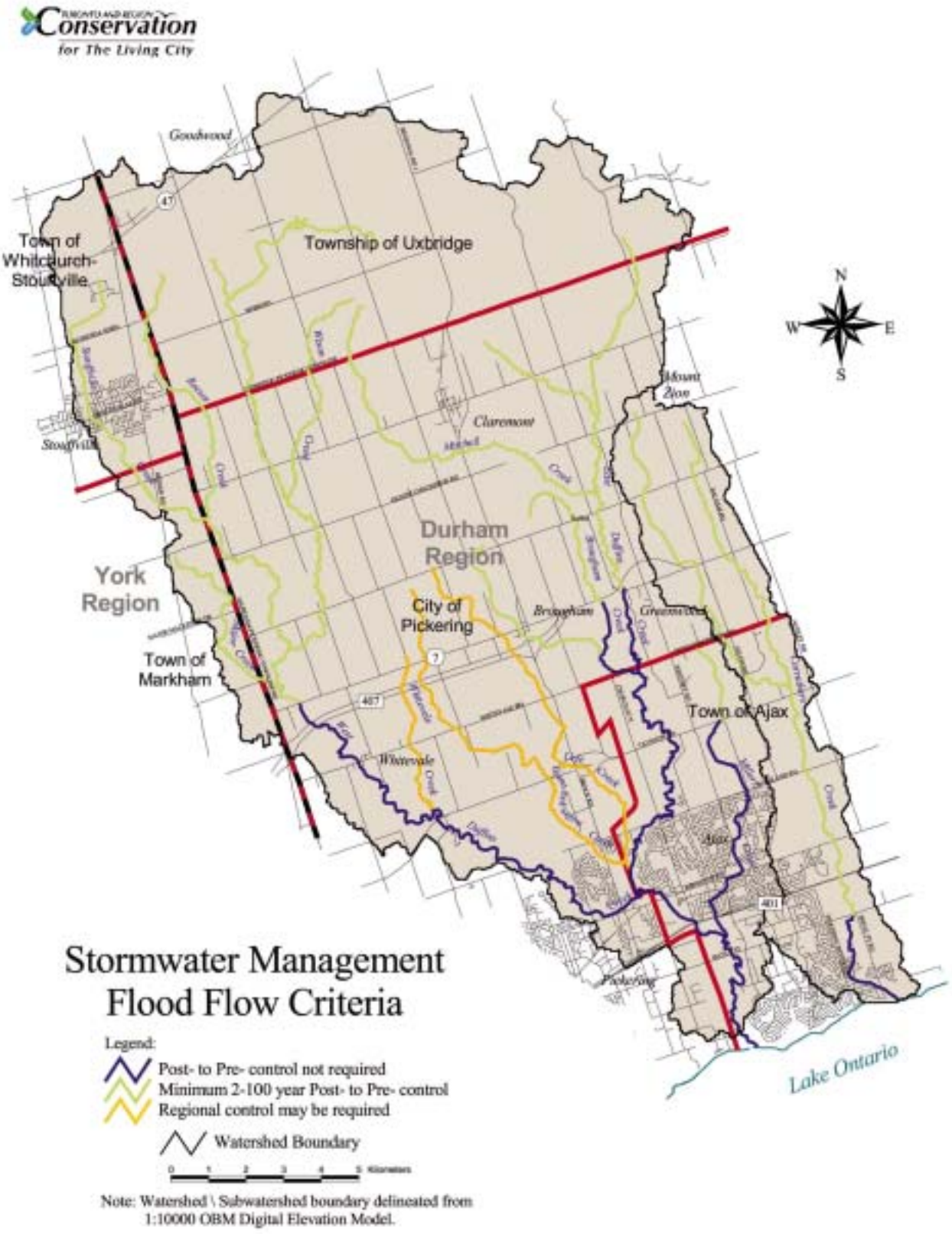
Brougham
Greenwood
Town of Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
Valley and Stream Corridor Mapping
Legend:
Fill Regulation Line
Fill Line Extension Mapping
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.17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Durham Region
York Region
City of Pickering
Brougham
Greenwood
Town of Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
Stormwater Management
Flood Flow Criteria
Legend:
Post- to Pre- control not required
Minimum 2-100 year Post- to Pre- control
Regional control may be required
Watershed Boundary
Note: Watershed \ Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 6.18

Aside from control of flood flows, another objective of stormwater management is to regulate the frequency and duration of erosive flows that affect downstream channel form. Further work to characterize the existing channel form, classify the stability of the active channel, establish erosion thresholds, and determine stormwater management requirements, is underway in the subwatersheds that are expected to experience urban growth in the near future. These subwatersheds include West Duffins, Whitevale Creek, Ganatsekiagon Creek, and Urfe Creek. These types of studies have already been carried out in Carruthers Creek and Millers Creek by private developers.

The significance of existing surface water withdrawals was evaluated by reviewing the maximum permitted annual withdrawals in relation to total annual baseflow volume (TRCA, 2003). Within the Duffins Creek watershed, known surface water withdrawals represent approximately five per cent of baseflow. At a subwatershed scale, the most significant water use is within the Reesor, West, and East Duffins Creeks, where withdrawals may represent up to 19 per cent, 12 per cent, and 14 per cent of baseflow volume, respectively. Permit applications are currently being reviewed within the Duffins and Carruthers Creek watersheds.

Information on surface water withdrawals for the two watersheds is incomplete. This is a significant limitation to an assessment of impacts associated with current levels of water use and the acceptability of future water taking proposals. There is an urgent need to address this deficiency.

DEFINITIONS

Water Budget Analysis: Based on the components of the hydrologic cycle, the purpose of this exercise is to estimate changes in overland runoff and infiltration values due to the various land use scenarios.

Hydrology Model: This model is used to estimate peak flow rates for different sized storm events as an indication of where changes in flooding risk may occur and to evaluate the effectiveness of alternative flood control approaches.

Alternative Design Standards: Flexibility in the application of municipal design standards for such site features as: building setbacks, grading requirements, minimum street gradient and turning radius, width of internal streets, locations of site services, provision of street boulevard areas, etc. Alternative design standards reduce development costs, promote compact urban form, and facilitate creative approaches at mitigating environmental impacts (MOE, 1999).

Alternative Development Forms: Innovative building forms, densities, and site layout, designed to reduce the extent of disturbance to the site and the overall development footprint. Implementation of alternative development forms may require allowance for alternative design standards.

GOAL

TO MAINTAIN THE EXISTING HYDROLOGIC FUNCTION OF THE WATERSHED

Duffins	Carruthers
Good	Good

#1

OBJECTIVE #1

Maintain the existing water balance within the watershed

Duffins	Carruthers
Good	Good

MANAGEMENT ACTIONS

- Achieve the enhanced natural heritage system as the primary means of maintaining the watershed water budget (i.e., groundwater infiltration, runoff, and evapo-transpiration rates) and ensure that any development or resource use proceeds only if in accordance with the water budget.
- Explore alternative design standards and development forms, together with the use of stormwater management practices, in new and existing developments as a means of attenuating runoff volumes and peak flow rates and maintaining infiltration to specified levels.
- Review municipal engineering standards and make revisions, where necessary, to ensure that the standards are compatible with the water budget and associated stormwater management objectives (e.g., road drainage measures).
- Provide incentives and educate watershed residents, businesses, and agencies regarding the benefits of implementing lot level source control measures.
- Implement active and passive revegetation programs to compensate for changes in imperviousness of the watersheds.
- Continue to monitor on a long-term basis streamflow in the Duffins and Carruthers watersheds.
- Evaluate the implications of climate change on the water balance of the watersheds.

INDICATORS	MEASURES	TARGETS
watershed hydrology (as measured by sub-catchment)	total annual infiltration rate (mm/year)	maintain or enhance baseline infiltration rates and distribution†
	runoff volume (m^3/year)	maintain or reduce baseline runoff volume†
	seasonal and annual baseflow (m^3/year) at indicator sites	maintain or enhance baseline seasonal and annual baseflows*

References:

† Clarifica Inc. 2002, Water Budget in Urbanizing Watersheds: Duffins Creek Watershed (Table 20, p. 41)

* TRCA 2003, Duffins and Carruthers Creek Low Flow Study and Management Plan (Appendix A and B)

#2

OBJECTIVE #2
Maintain or enhance baseflows

Duffins	Carruthers
Good	Fair

MANAGEMENT ACTIONS

- Achieve the enhanced natural heritage system as the primary means of protecting groundwater recharge and discharge.
- Ensure that any development or resource use proceeds only if it can maintain existing groundwater infiltration volumes, distribution, and flow direction.
- Encourage MOE to use the Duffins-Carruthers watershed knowledge base when reviewing permit-to-take-water (PTTW) proposals, to ensure the maintenance of baseflows necessary for aquatic habitat functions.
- Work with MOE to ensure all water users have a valid PTTW, where required, and that applications for permit renewals are reviewed for consistency with the watershed plan directions.
- Evaluate the impacts of climate change on baseflows and revise the management recommendations and criteria of this watershed plan as necessary.
- Continue to work with the Regions of Durham and York Low Water Response Teams to implement Provincial Low Water Response procedures.
- Establish a long-term baseflow monitoring program, as part of the Regional Watershed Monitoring Network.
- Coordinate and direct the above-noted actions through the implementation of a Low Flow Management Plan.

INDICATORS	MEASURES	TARGETS
baseflow	seasonal and annual baseflow (m^3/year) at indicator sites	maintain or enhance baseline seasonal and annual baseflows*

References:

*TRCA 2003, Duffins and Carruthers Creek Low Flow Study and Management Plan (Appendix A and B)

#3

OBJECTIVE #3
Minimize or reduce risks to human life and property due to flooding

Duffins	Carruthers
Good	Good

MANAGEMENT ACTIONS

- Achieve the enhanced natural heritage system as the primary means of attenuating stormwater runoff volumes and peak flows.
- Ensure that any development or resource use proceeds only if it does not increase flood risk.
- Continue to implement TRCA fill and floodplain regulations as further described by TRCA's Valley and Stream Corridor Management Program and other municipal programs used to meet the provincial policy statement regarding the prevention of flood hazards.
- Ensure that development form, together with the use of stormwater management (SWM) practices in new and existing developments, can attenuate runoff volumes and peak flow rates to specified levels.
- Continue to operate the flood forecasting and warning program and develop a flood site database response model to guide municipal emergency response.
- Update the hydraulic studies (HEC Model), floodline maps, and Flood Vulnerable Roads and Flood Vulnerable Areas databases for the Duffins Creek Watershed, assuming reforestation in all valleylands, except for existing engineered channels and manicured parks.
- Update hydrology modeling and associated hydraulics studies, floodline mapping and Flood Vulnerable Roads and Flood Vulnerable Areas databases for the Carruthers Creek watershed.
- Develop and implement a Flood Remedial Works Plan based on priority risk assessment.
- Educate homeowners regarding the flood risks associated with improper lot level practices (i.e., backyard dumping, hydraulic impediments).
- Implement active and passive revegetation programs to promote attenuation of flood flows (e.g., no mow zones, riparian plantings, grass swales), and mitigate the residual impacts of development after stormwater management practices have been applied.
- Investigate opportunities for implementing quantity controls in urban areas developed prior to any requirement for control through stormwater retrofit studies.

INDICATORS	MEASURES	TARGETS
number of flood vulnerable areas (FVAs) and flood vulnerable roads (FVRs)	peak flow rate (unit flows)	maintain baseline peak flows (two- to 100- year and regional control if required)*
	water level (flood lines)	maintain baseline water levels†
	number of flood vulnerable areas (FVA) and flood vulnerable roads (FVR)	reduce or, as a minimum, maintain the existing number of flood vulnerable areas and flood vulnerable roads (and the design storm frequency at which they flood)‡
	ice jams (frequency and location)	develop and maintain documentation of the number of sites and frequency of ice jams

References:

*Aquafor Beech Ltd. 2002, Duffins Creek Hydrology Update

†Marshall Macklin Monaghan Ltd., 2002, Duffins Creek Watershed Hydraulic Modeling and Flood Plain Mapping Project

‡TRCA 2000, Flood Vulnerable Areas Database

TRCA 2002, Duffins Creek State of the Watershed Report (Figure 7)

TRCA 2002, Carruthers Creek State of the Watershed Report (Figure 4)

#4

OBJECTIVE #4
Maintain or restore natural stream channel stability

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Protect natural stream form and establish development limits, using TRCA's Valley and Stream Corridor Management Program as a minimum standard.
- Undertake a detailed erosion analysis for priority subwatersheds (i.e., Ganatsekiagon, Urfe, Whitevale, and Lower West Duffins Creek) to determine baseline conditions, erosion thresholds, and the necessary stormwater management (SWM) requirements.

- Adopt a stormwater management policy, which ensures that development form together with the use of stormwater management practices in new and existing developments can attenuate runoff volumes and flow rates to specified thresholds.
- Complete the development of a stormwater retrofit strategy and implementation plan for existing developments, including regional and local roads.
- Review municipal engineering standards and make revisions, where necessary, to ensure that the standards allow adequate flexibility to meet stormwater management objectives (e.g., road drainage measures).
- Educate watershed residents, businesses, and agencies regarding the benefits of lot level source control measures.
- Protect and regenerate riparian vegetation.
- Increase natural cover as a means of protecting channel stability.

INDICATORS	MEASURES	TARGETS
in-stream erosion	erosion index	maintain the baseline erosion index*
	per cent of developed area that has adequate erosion controls in place (according to 2003 criteria)	100 per cent of developed area with adequate erosion controls in place
	rate of erosion at indicator sites	maintain or reduce the baseline rate of erosion†

References:

* Cosburn Patterson Mather Ltd., 2001 (1997), Stormwater Management Study - A8 Secondary Plan (OPA 48), Town of Ajax, 2001 Addendum to May 1997 report

Ecotech International Systems Inc., pending approval, Functional Servicing Study - Northeast Quadrant OPA 101 Community of Stouffville, Town of Whitchurch-Stouffville

Parish Geomorphic Ltd., pending review, Erosion Assessment and Fluvial Geomorphic Update for Portions of West Duffins, Whitevale, Ganatsekiagon and Urfe Creeks

Planning and Engineering Initiatives Ltd., 2002, Green Space Project Lands Fluvial Geomorphology Study - Duffins Creek Watershed, Transport Canada, November 2002

URS Cole Sherman Ltd., pending approval, Functional Servicing Study - Southeast Quadrant OPA 101 Secondary Plan, Town of Whitchurch-Stouffville

†To be defined through the Regional Watershed Monitoring Network

6.6 GROUNDWATER QUALITY AND QUANTITY

Groundwater plays a significant role in the watershed by providing baseflow for the streams and rivers and serving as a source of water supply for potable uses and irrigation. Groundwater supported baseflow is not only important in terms of flow volume, but is vital in maintaining cool stream temperatures needed by certain aquatic species, such as brook trout. For many rural residents and businesses, groundwater provides an essential and economical source of water.

The essence of a watershed management plan from the groundwater perspective is to protect the quality and quantity of the resource. Protection strategies must then reflect the unique character of the flow system. An understanding of the groundwater flow system is vital to the development of a watershed or groundwater management plan.

Issues

Impacts associated with projected urban growth represent a primary groundwater management issue. An assessment of the effects that urban growth will likely have on the groundwater system was carried out using a Duffins watershed water budget analysis (Clarifica, 2002) and groundwater flow model (Gerber Geosciences, 2003).

The increased area of impervious surface associated with urbanization under the Regional Official Plans is predicted to reduce groundwater recharge by four per cent (nine milimetres per year) overall in the Duffins Creek watershed, with much greater reductions of up to 30 per cent in subcatchments experiencing more pronounced urban growth, if no management measures are undertaken. This loss of recharge is expected to cause a decline in the water table elevation of one to three metres in parts of the lower West Duffins, Ganatsekiagon, and Urfe Creeks (See Figures 6.19 to 6.21). It is also predicted that there will be a three per cent reduction in daily discharge to streams in the basin overall. Again, subwatersheds experiencing a greater proportion of the urban growth are expected to suffer greater impacts. Ten per cent reductions in discharge are predicted in Stouffville Creek and the lower East and West Duffins Creeks, and about 20 to 25 per cent loss of discharge is likely to be experienced in the lower Urfe, Ganatsekiagon, and the lower Duffins Creek subcatchment itself. Within the Duffins watershed, the areas most sensitive to a recharge reduction include the south slope till plain. The predicted water table drop over this area is greater than for areas of sand and gravel because of the lower effective porosity and permeability of the till, silt, and clay deposits.

To maintain the existing groundwater flow regime, recharge rates for the post-development land use configuration must be sustained at pre-development levels. The protection and enhancement of natural features, such as forests, wetlands, and meadows will assist in achieving this objective by promoting infiltration. Due to limitations in current state-of-the-art water budget tools, the modeling exercise estimates only minor benefits of enhanced natural cover on groundwater infiltration rates. However, there are a number of historical accounts of more numerous springs and permanently flowing streams that extended further up slope when the upper watershed was more heavily forested, suggesting that natural cover was influential in maintaining a higher water table elevation.

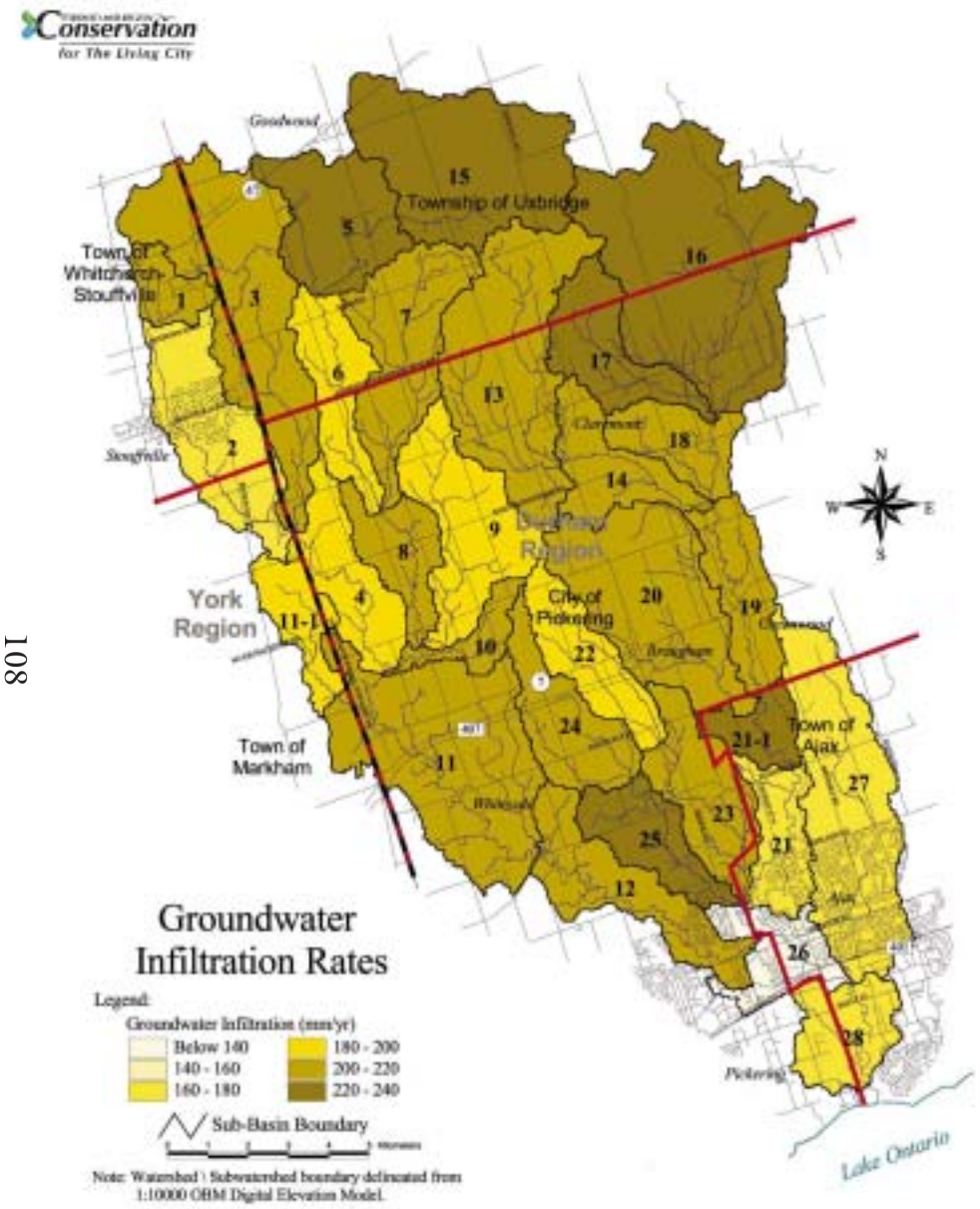


FIGURE 6.19

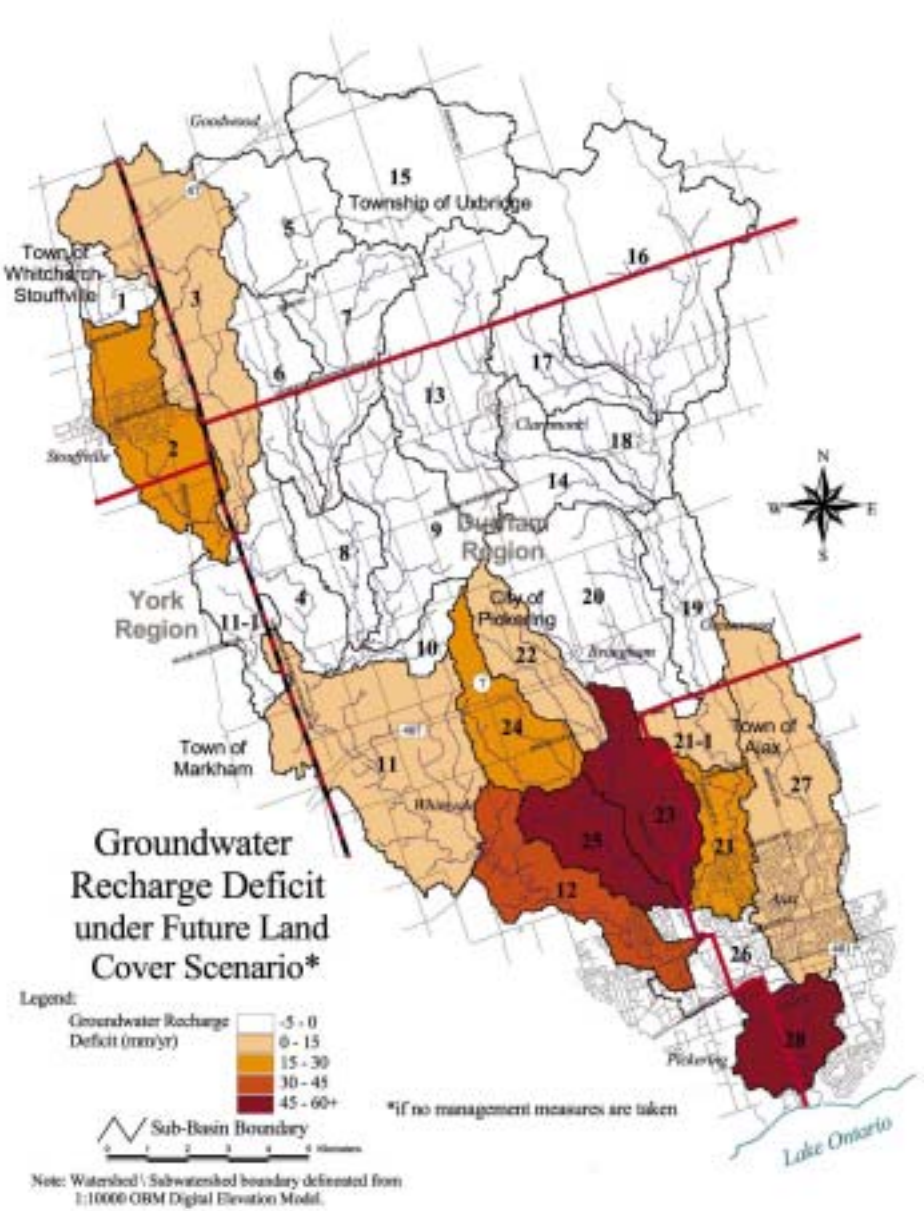


FIGURE 6.20

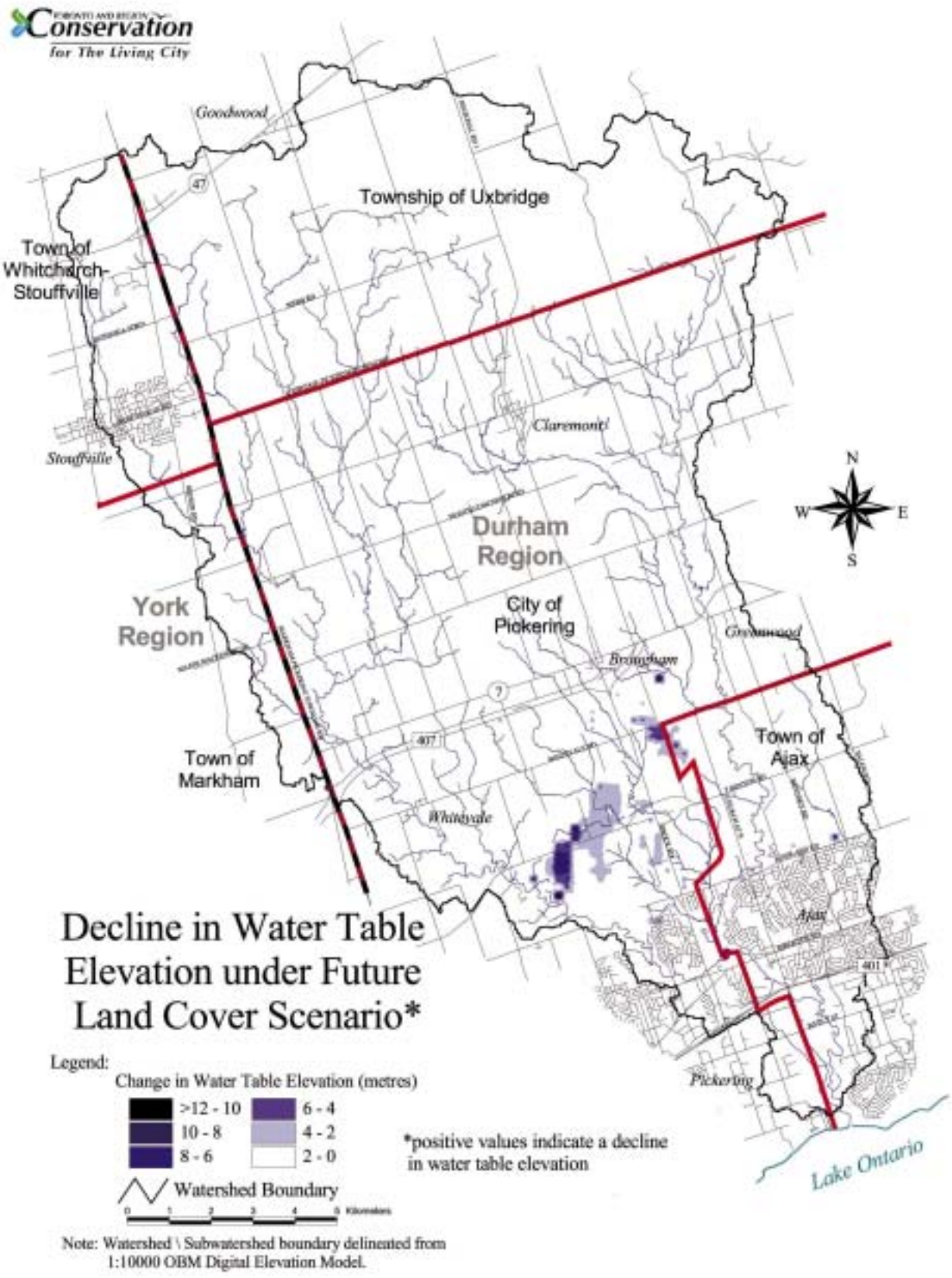

Conservation
for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
Claremont
Durham Region
York Region
City of Pickering
Brougham
Town of Markham
Whitevale
Town of Ajax
Ajax
Pickering
Lake Ontario
N
W
E
S
Decline in Water Table Elevation under Future Land Cover Scenario*
Legend:
Change in Water Table Elevation (metres)
>12 - 10
10 - 8
8 - 6
6 - 4
4 - 2
2 - 0
Watershed Boundary
*positive values indicate a decline in water table elevation
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.21

Groundwater studies undertaken in support of this plan have not recommended that groundwater recharge enhanced above the existing recharge quantities in proposed urban developments over the till plain, or areas of lacustrine silts and clays, due to the limited presence of a shallow water table and the infiltration capacity of these soil areas. These studies have also acknowledged that while the south slope till plain area is most sensitive to recharge reduction, it will also be an area where the siting of engineered recharge facilities will encounter relatively more difficulty in attempting to maintain pre-development recharge rates. Areas with potential for recharge enhancement lie on the sands and gravels associated with the Oak Ridges Moraine. However, recent land use designations have removed the development pressure from this terrain except for near existing urban centres such as Stouffville (Gerber Geosciences, 2003).

Other key groundwater management issues include:

- additional groundwater extraction for potable water supplies;
- dewatering of quarries for aggregate extraction below the water table;
- sourcing and disposition of wash water by aggregate producers;
- infrastructure installation, including municipal (i.e., buried pipelines and other services), industrial, agricultural (i.e., drainage tiles and residential (i.e., foundation drainage, services);
- potential risk to groundwater quality from inland fill operations; and
- groundwater source area protection.

Data regarding groundwater withdrawals is incomplete across the watershed. Figure 6.22 identifies the locations of known surface and groundwater withdrawals. Since this 2001 data was compiled, a number of applications have been submitted for permits-to-take-water (PTTW) including a number of golf courses in the watershed. These data are critical to the assessment of potential effects from both current and proposed future water usage. The MOE has recognized the urgency of the need to address this deficiency, as demonstrated by the proposed amendments to Ontario Regulation 903 and the PTTW process.

Water conservation is an important ethic to be considered, particularly for the Municipal and Regional Study partners, who are actively involved in this initiative. Without conservation, the groundwater requirements may outstrip the available supply. This has been recognized by the Province of Ontario, since the development of Water Conservation Plans is required by both the Oak Ridges Moraine Act and Conservation Plan.

Source protection has been endorsed by the Walkerton Inquiry as a fundamental element in an overall water supply management strategy. While current groundwater quality conditions are generally good in both watersheds, there are reports of local nitrate and bacterial contamination, possibly due to failed septic systems or agricultural influences, and increasing trends in chloride levels attributed to road salting practices. Many of the rural residents in the upper parts of the watersheds rely on the shallow aquifer system, and therefore their wells are more susceptible to contamination.

The Duffins Creek watershed groundwater study has identified that the till plain is more sensitive to groundwater quality changes than areas of sand and gravel. While contaminant plumes will generally move more slowly (disregarding fracture flow) than sand aquifer settings, the assimilative capacity of the till plain is lower, as lower unit recharge rates will lead to less dilution of potential contaminants (Gerber Geosciences, 2003). It should be noted that the mass of stormwater related contaminants entering the groundwater flow system will be lower on the till plain, where the majority of the contaminants are transported by overland flow.

Development of a source protection plan for the watersheds will begin in 2003. It will involve the identification of potential contaminant sources, and assessment of the vulnerability of groundwater systems, and a management plan, which will especially benefit the rural water users on private well systems. The Regions of Durham and York have already begun the preparation of wellhead protection plans for their Uxville (industrial park in Uxbridge) and Stouffville wells.

DEFINITIONS

Groundwater Flow Model: This model is used to understand the relative rates and locations of groundwater recharge and discharge areas, groundwater levels, direction of flow within the subsurface both laterally and vertically between different aquifers. The model can then be used as a tool to understand the effects the changes in recharge due to various land use or climate change scenarios may have on the groundwater system.

Review Process for Permits to Take Water (PTTW).

The Ministry of the Environment, proclaimed guardian of Ontario's ground and surface water supply by authority of the Ontario Water Resources Act (OWRA), manages a water-taking permit program for the province which spells out in detail regulations under which this precious natural resource may be used and by whom.

Who needs a Permit?
Any water taken from a well, lake, stream, or storage pond that is in excess of 50,000 litres per day requires a permit. Exceptions include water for emergency fire fighting, water for livestock or poultry, and water for domestic use (home gardens and lawns).

Ontario's municipalities (half of all municipal water supplies in the province are from groundwater sources) must apply to the ministry for a PTTW to supply their water treatment facilities and they face strict limits on how much water they may draw from a source.

Applications for permits have been received from a variety of purposes including crop irrigation, drinking water supply, golf course watering, cooling, and processing water for industry

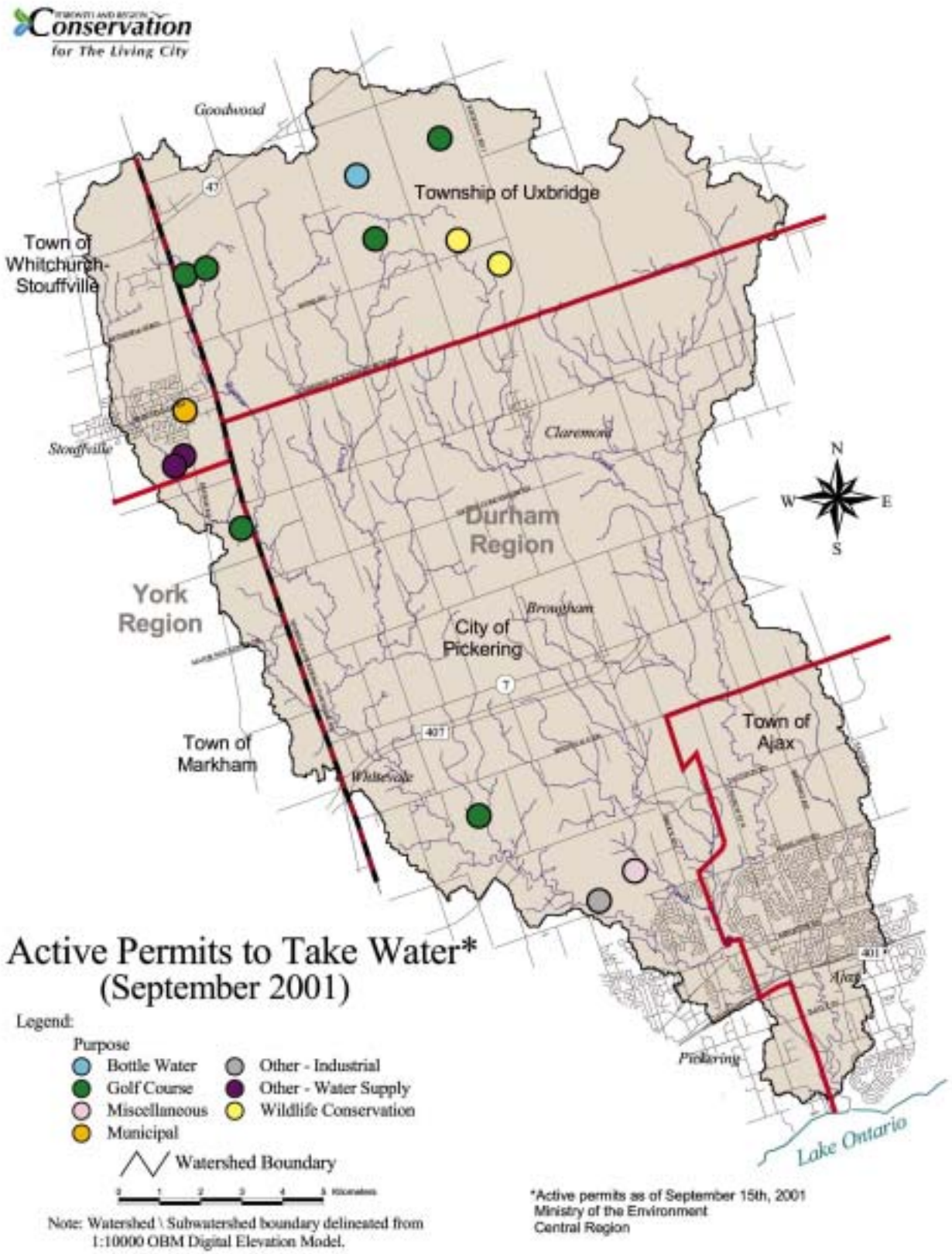

Conservation
for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
Claremont
Durham Region
York Region
Brougham
City of Pickering
Town of Markham
Whitevale
Town of Ajax
Ajax
Pickering
Lake Ontario
N
W
E
S
Active Permits to Take Water*
(September 2001)
Legend:
Purpose
Bottle Water
Golf Course
Miscellaneous
Municipal
Other - Industrial
Other - Water Supply
Wildlife Conservation
Watershed Boundary
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.
*Active permits as of September 15th, 2001
Ministry of the Environment
Central Region

FIGURE 6.22

and fish farming. These uses have to be balanced against the overriding goal – the protection of the natural functions of our aquatic systems.

Most PTTWs carry conditions that require the holder to perform certain monitoring functions and/or maintain a record of water use that the ministry can review upon request.

Environmental Bill of Rights
Permit applications must be posted on the Environmental Bill of Rights (EBR) environmental registry for a 30-day public comment period. Some exceptions for EBR posting include agricultural irrigation of crops, most municipal water takings and those sought for a specific reason for less than a year. The website for reviewing postings is www.ene.gov.on.ca/envision/ebr.

Text extracted from:
In Brief, Ministry of the Environment, Queens Printer for Ontario, January 2000

GOAL

TO PROTECT GROUNDWATER QUALITY AND QUANTITY

Duffins	Carruthers
Good	Fair

#5

OBJECTIVE #5
Maintain or enhance groundwater levels and discharge for watershed functions

Duffins	Carruthers
Good	Fair

MANAGEMENT ACTIONS

- Achieve the enhanced natural heritage system as a means of maintaining or increasing groundwater recharge.
- Implement the recommendations of the Walkerton Inquiry Report(s) and the Oak Ridges Moraine Act.
- Explore alternative design standards and development forms, together with the use of stormwater management (SWM) practices to meet specified requirements for infiltration, maintenance of groundwater flow paths, and the protection of groundwater quality.
- Encourage MOE to use the Duffins-Carruthers watershed knowledge base when reviewing permit-to-take-water (PTTW) proposals, to ensure the maintenance of groundwater levels and baseflows necessary for water supply and habitat functions.
- Continue to coordinate with extra-regional groundwater management activities under the York-Peel-Durham Groundwater Management Program.
- Establish long term groundwater and stream flow discharge monitoring programs as part of the Regional Watershed Monitoring Network.

INDICATORS	MEASURES	TARGETS
water table level	water table level at indicator sites	establish and maintain baseline water table levels*
aquifer water level	piezometric surfaces at indicator sites	maintain baseline piezometric surfaces†
discharge	seasonal and annual discharge	maintain or enhance baseline seasonal and annual discharge‡

References:

*Conservation Authorities Moraine Coalition 2003, York-Peel-Durham-Toronto MODFLOW Groundwater Flow Model - Core Area

†Gerber Geosciences Inc. 2003, Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System (Appendix C)

‡ TRCA 2003, Duffins and Carruthers Creek Low Flow Study and Management Plan (Appendix A and B)

#6

OBJECTIVE #6

Protect groundwater quality to ensure provision of safe water supplies and ecological functions

Duffins	Carruthers
Good	Good

MANAGEMENT ACTIONS

- Achieve the enhanced natural heritage system as a means of protecting aquifer water quality.
- Complete the development of a groundwater management plan including a source protection plan to provide specific guidance for:
  - naturalization of recharge areas
  - land use planning and policy
  - stormwater management
  - Best Management Practices for land use practices
  - abatement actions by municipalities or MOE.
- Apply the Duffins-Carruthers watershed knowledge base when reviewing proposals for new septic systems to avoid impacts in areas having a high risk of groundwater contamination.
- Develop a mechanism for the regular inspection and maintenance of septic systems (e.g., requirement for the regular submission of a certificate of septic system inspection/maintenance).
- MOE and Region of Durham Health Department should continue to evaluate the impact of land application of biosolids, including sewage and paper sludge.

- Develop provincial guidelines and adopt and enforce municipal Fill Control Bylaws and/or Erosion and Sediment Control Bylaws to ensure inland fill operations minimize the risk of groundwater quality impairment.
- Request the MOE to develop inland fill quality guidelines/protocols and undertake regular inspection of approved inland fill sites.

INDICATORS	MEASURES	TARGETS
groundwater chemistry	Chlorides Nutrients Total Organic Carbon (TOC) Phenols Conductivity Metals pH Bacteria parameters in MOE Ontario Drinking Water Standards	MOE Ontario Drinking Water Standards (mg/L)*

References:

*Ontario Regulation 459/00

www.env.gov.on.ca for up-to-date information

#7

OBJECTIVE #7

Ensure sustainable rates of groundwater use

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Encourage MOE to use the Duffins-Carruthers watershed knowledge base when reviewing proposals for new or renewed PTTWs, to ensure the maintenance of groundwater levels for water supply.
- Prepare and implement water conservation plans, as required under the Oak Ridges Moraine Conservation Plan.
- Consider water supply requirements and ensure sustainability of supplies during the development review process.
- Promote water conservation through use of water efficient technologies and practices, such as low flow technologies, rain barrels, cisterns, and planting native ground covers.

- Continue the monitoring of surface and groundwater levels on a long-term basis as part of the Regional Watershed Monitoring Network, with support from all levels of government.

INDICATORS	MEASURES	TARGETS
water table level	water table levels at indicator sites	establish and maintain baseline water table levels*
aquifer water level	piezometric surfaces at indicator sites	maintain baseline piezometric surfaces†
groundwater discharge	seasonal and annual groundwater discharge	maintain or enhance baseline seasonal and annual groundwater discharge‡
groundwater withdrawals	maximum annual volume of groundwater withdrawals permitted by active MOE permits- to-take-water (PTTW)	sustainable rate of groundwater use TBD pending further study

References:

*Conservation Authorities Moraine Coalition 2003, York-Peel-Durham-Toronto MODFLOW Groundwater Flow Model - Core Area

†Gerber Geosciences Inc. 2003, Duffins Creek Watershed Hydrogeology and Assessment of Land Use Change on the Groundwater Flow System

‡ TRCA 2003,. Duffins and Carruthers Creek Low Flow Study and Management Plan (Appendix A and B)

6.7 SURFACE WATER QUALITY

Water quality conditions have implications for various water uses, including recreation, aquatic habitat, potable supply, and irrigation. Although the Duffins and Carruthers Creeks themselves are not well suited for swimming, recreational pursuits near the creeks are bound to result in occasional contact with water, and therefore the maintenance of low bacteria levels is of interest. Of greater concern are swimming water quality conditions at Lake Ontario waterfront beaches, which are influenced by bacteria loads discharged from the watersheds.

A number of water quality parameters, such as phosphorus, suspended sediment, and chlorides, affect aquatic species by impairing physical habitat conditions or, in the case of chlorides, presenting toxic effects. Although water from the creeks is not used as a source of potable water supply, the creeks drain into Lake Ontario, which is the source of municipal water supplies for the southern portion of the watersheds. Therefore, there is an interest in maintaining levels of pesticides,

PCBs, polynuclear aromatic hydrocarbons, and other substances below detectable limits so that they pose no human health concerns. Golf courses, nurseries, and some farms draw water from the creeks as a source of irrigation water. They have a strong interest in protecting and enhancing instream water quality.

Water quality may be considered a local watershed concern, however the Duffins and Carruthers Creek watersheds are also a part of the Lake Ontario basin, which is the subject of international agreements regarding Great Lakes Water Quality. Therefore, the ongoing protection of water quality within these watersheds from point and non-point sources of pollution is also a responsibility of senior levels of government.

Issues

Extensive areas of natural vegetation, sandy soils, and significant groundwater discharges to stream baseflow in Duffins Creek and in localized parts of Carruthers Creek play a big role in maintaining the relatively good water quality conditions that exist in these watercourses. From a water quality perspective, it will be important to protect these natural features and their hydrologic function as outlined in the surface water quantity and groundwater management strategies.

Water Pollution Control Plant Effluent

The most noteworthy form of water quality impairment in the two watersheds is the phosphorus level found in West Duffins Creek, due to effluent from the Stouffville Water Pollution Control Plant (also referred to as the Sewage Treatment plant). It is suspected that aquatic biota in reaches immediately downstream of the plant are stressed by chlorine and ammonia levels associated with the effluent. This plant represents the only remaining known point source of pollution in the watersheds, and is scheduled to be decommissioned in 2003. Currently, during low flow conditions, phosphorus levels attributed to plant effluent exceed the Provincial Water Quality Objectives in the Reesor Creek tributary and West Duffins Creek at least as far downstream of the plant as Taunton Road, a distance of about 16 kilometres (TRCA, 2003). During wet weather conditions, effluent from the plant is overshadowed by pollutant loads from non-point sources. Water quality in the stream is expected to improve following the plant's decommissioning, although stormwater management measures will be integral to mitigating the effects of runoff from the new urban growth in that subwatershed.

Stormwater Runoff

Elevated phosphorus, suspended sediments, and bacteria levels throughout the watershed, particularly during wet weather periods, are attributed to various urban and rural non-point sources. Suspended sediment concentrations in the Duffins and Carruthers Creeks can be an order of magnitude higher in wet weather conditions as compared to dry weather baseflow. The total wet weather sediment load is about 13 times higher than the dry weather load from the Duffins watershed and about twenty times higher from the Carruthers watershed.

Stormwater runoff from many existing urban areas contributes to degraded water quality conditions. Sixty two per cent of existing urban areas in the Duffins Creek watershed and 29 per cent

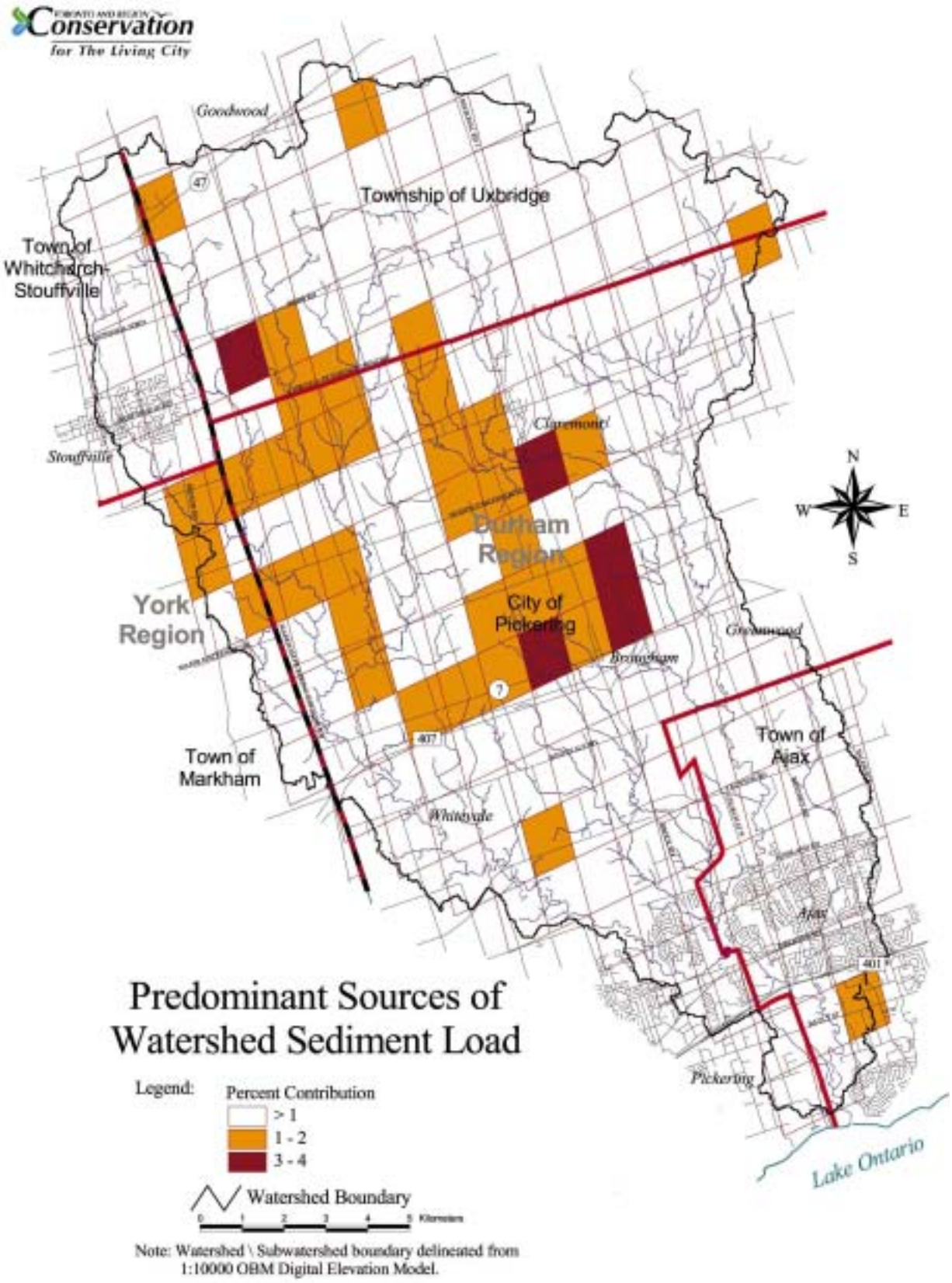
of urban areas in the Carruthers watershed have no stormwater treatment measures in place. Seven percent of the developed areas in both watersheds have only stormwater quantity control measures, which may provide only limited water quality benefits. There is a need to complete and implement stormwater retrofit plans for these areas that guide in the application of stormwater management measures along the entire treatment train from "backyard practices" at the lot level, to innovative designs along the conveyance system, to facilities at the end-of-pipe.

Urban growth in the watersheds is predicted to cause an increase in pollutant loads due to the increased volume of stormwater runoff. The short-term increase in sediment loads, which will occur during the construction of new developments, should be mitigated through improved erosion and sediment control practices. Several municipalities, such as the Town of Markham and the Town of Ajax, are developing new Erosion and Sediment Control Bylaws to strengthen their ability to manage this pollution source. With the urban growth projected under the Regional Official Plans, wet weather sediment loads may increase by up to 13 per cent in the Carruthers watershed and up to 25 per cent in the Duffins watershed (TRCA, 2003; Stantec and Aquafor Beech, 2003). Stormwater management measures, incorporated into all new developments, must be able to maintain an acceptable level of water quality conditions for the protection of aquatic life. Performance of erosion and sediment control practices must be demonstrated through site-specific monitoring programs and, if necessary, retrofits undertaken.

Rural non-point sources of pollution should be the subject of ongoing rural stewardship programs. Technical analyses undertaken as part of this Watershed Plan provide guidance as to the primary source areas of sediment and nutrient generated in the watersheds during rain storm events (i.e., storm event loads), based on consideration for existing land uses, natural soil erodibility, and topography. These priority areas should be the focus for stewardship/management initiatives (See Figures 6.23 and 6.24). Further predictive modeling studies have evaluated the effectiveness of alternative management approaches (TRCA, 2003). The studies found that expanded vegetative cover throughout the watershed, as modeled under the future land use with enhanced natural heritage cover scenario, appears to be able to compensate for the negative impacts of urban growth by at least maintaining water quality conditions in most subwatersheds. Focusing the initial revegetation efforts on priority source areas of sediment and nutrient generation has been shown to be an effective approach at addressing water quality concerns, and can realize other watershed management benefits, such as habitat enhancement.

Other Pollution Sources

There are a variety of other non-point pollution sources. The presence of major highways, including the 401 and 407, and anticipated extension and widening of these roads will increase the potential incidence of spills, as spills tend to occur in association with transportation corridors and industrial land uses. Spills and illicit discharges to sanitary and storm severs, while difficult to detect can be managed through pollution prevention and awareness programs, regular inspections, and enforcement under a municipal Sewer Use Bylaw. On a regular basis, both York and Durham Regions update their Sewer Use Bylaws.


Conservation
for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
Claremont
Durham Region
York Region
City of Pickering
Town of Markham
Whitevale
Town of Ajax
Ajax
Pickering
Lake Ontario
N
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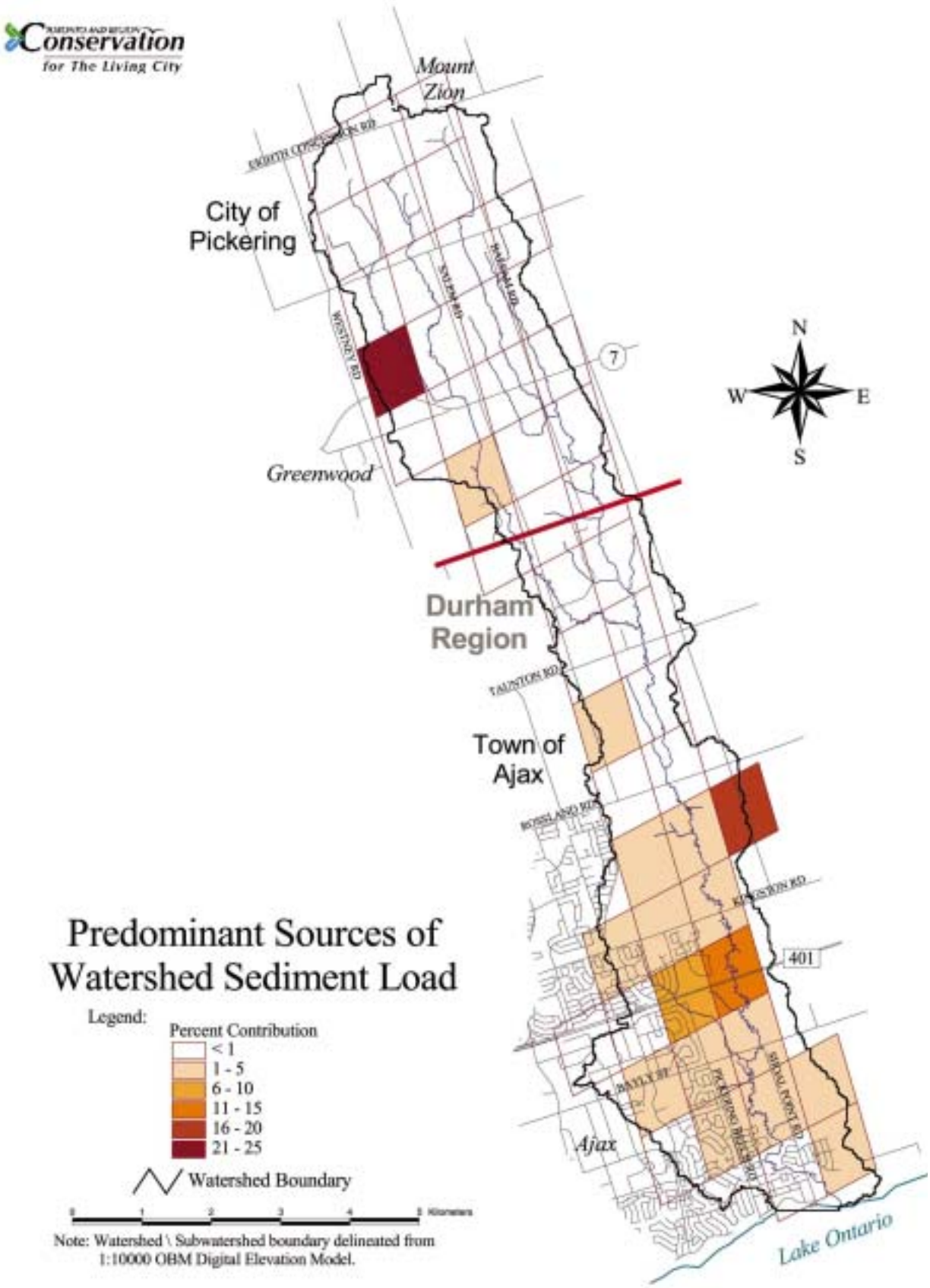
E
S
Predominant Sources of Watershed Sediment Load
Legend:
Percent Contribution
> 1
1 - 2
3 - 4
Watershed Boundary
Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.23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for The Living City
Mount Zion
City of Pickering
Greenwood
Durham Region
Town of Ajax
Ajax
Lake Ontario
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Predominant Sources of Watershed Sediment Load
Legend:
Percent Contribution
< 1
1 - 5
6 - 10
11 - 15
16 - 20
21 - 25
Watershed Boundary
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.24

Improperly maintained septic systems can be a threat to both surface and groundwater quality conditions. Land disposal of biosolids, paper sludge, and inland fill operations are activities that require more study and careful management. These issues require the cooperation of many stakeholders.

Stormwater Management Concepts

A combination of stormwater management measures are designed to treat stormwater before it enters the creek by reducing both the sources of pollutants, and the flow volume and velocity. Adopting a "treatment train" approach (pollution prevention practices, together with lot level, conveyance, and end-of-pipe controls) is considered the most effective method of managing urban run off because it provides a number of opportunities to implement protection measures. An ongoing maintenance program helps to ensure the system continues to function as intended.

The most effective use of best management practices requires the participation of a greater number of stakeholders, in order to keep the water as clean as possible from the moment it falls to the ground (at the source) to the time it enters Duffins and Carruthers Creeks. Keeping the water clean at the source will help to alleviate liability and financial strain on municipalities for operations and maintenance, reduce development costs related to engineering structures, and ultimately result in improved watershed health. These efforts will require all stakeholders to make changes in their day-to-day management practices, development standards, operating procedures, and lifestyle choices.

Erosion and sediment control is also an important aspect of stormwater management as it applies to the control of runoff during construction activities, a time when natural erosion rates can increase anywhere from 100 to 1,000 times (MTRCA, 1994) and water quality is at its worst. A number of provincial guidelines currently exist, which are well known to the development industry. Information contained in these documents includes an overview of the problems associated with erosion and sediment control, a review of the existing legislative framework, and descriptions and illustrations of proper installation techniques for a number of protection measures.

A comprehensive stormwater management strategy needs to incorporate monitoring (at various scales) to assess individual performance capabilities and to determine the overall benefit of stormwater management practices on a watershed scale. It is important to verify whether or not best management measures are operating as designed and that maintenance is being carried out. Where problems are identified, control measures can be modified accordingly or additional measures put in place to ensure improvements to the level of control. Watershed monitoring programs like TRCA's Regional Monitoring Network can be used to assess the benefit of stormwater management practices in the context of the subwatershed or watershed.

At this scale, monitoring results can be used to track the biological responses of urban construction to assess the cumulative benefits within the stormwater control system.

Stormwater management guidelines are available from the Ministry of the Environment: "Stormwater Management Planning and Design Manual" (1994; Updated Draft 1999) and "Stormwater Pollution Prevention Handbook" (2001). Additional information is found in the TRCA publication: "An Evaluation of Roadside Ditches and Other Related Stormwater Management Practices, Second Edition" (J.F. Sabourin and Associates Inc. for TRCA, 2000).

Great Lakes Water Quality Agreement Non-Point Source Pollution

Progress in non-point source pollution reduction was significant through the 1980s but has lagged over the past decade. In part, this may be because other issues, such as concern for persistent toxic organics, became prominent in the environmental agenda and eventually took precedence over issues that were generally believed to have been "solved."

Phosphorus continues to be a major source of concern in the Great Lakes basin, both because of persistent eutrophication in some areas and because control strategies have been less effective than anticipated.

Similarly, soil erosion (leading to high sediment loadings to watercourses) remains a significant problem in some areas.

The impacts of urban drainage on receiving waters are significant and must be included in any attempt to address non-point source pollution. Significant improvements in urban drainage impacts may be achievable through modest land use planning changes coupled with appropriate and well-maintained structural measures, such as infiltration trenches and stormwater retention ponds.

Although trace metals and trace organic chemicals, including PAHs and pesticides, remain of concern in the urban and rural environments, they are relatively minor in mass and impact compared to phosphorus, sediment, and microorganisms.

We appear to be approaching the limits of acceptance and/or effectiveness of available soil conservation technology in some regions where non-point source pollution is still not adequately controlled. In these areas, more aggressive measures, for instance using emerging technologies drawn from industrial and municipal systems, may be necessary.

In all cases, measures must be planned and managed on a local basis, in response to the needs of the local system.

Both in the urban and in the rural environment, future progress must depend on a combination of technology and land use planning on a watershed or subwatershed basis.

Nevertheless, it became apparent during the workshop that non-point sources of pollution to the Great Lakes basin remain a serious issue, and that phosphorus levels are far from under control.

Source: Extracted from Workshop Proceedings regarding Non Point Sources of Pollution to the Great Lakes Basin, held in Toledo, Ohio, Sept. 1998 and published by the Great Lakes Science Advisory Board, February 2000.

GOAL

TO PROTECT AND IMPROVE SURFACE WATER QUALITY

Duffins	Carruthers
Fair	Fair

#8

OBJECTIVE #8

Manage the quality and quantity of runoff from rural and urban areas to maintain instream uses

Duffins	Carruthers
Good	Good

MANAGEMENT ACTIONS

Rural Actions

- Continue to develop and implement a rural water quality stewardship program to address priority contaminant sources and support nutrient management standards under Bill 81; program elements will include:
  - riparian corridor and natural heritage protection and rehabilitation
  - Best Management Practices for rural land uses, including environmentally sustainable agricul tural practices that are also economically feasible
  - establishment of a local clean water advisory committee with the mandate to oversee the implementation of rural water quality improvements. Progress of this committee will be reported to local and regional municipalities
  - public agency leadership in addressing rural water quality improvements (i.e., as major andowners, the federal and provincial Governments and the TRCA should demonstrate opportunities for improvement on their own lands)
  - reclamation of wetlands to attenuate nutrients and eroded soils

Urban Actions

- Ensure that stormwater management (SWM) practices in all new developments, including the Pickering airport lands, provide the specified level of water quality treatment.
- Complete the development of the City of Pickering and Town of Ajax stormwater retrofit strategies and implementation plans for existing developments, including regional and local roads. Develop a retrofit strategy for the Town of Whitchurch-Stouffville.
- Develop and implement municipal stormwater management facility operation and maintenance plans. Continue to implement the Town of Markham maintenance plan.
- Educate residents, businesses and agencies regarding the benefits of source control measures (i.e., pollution prevention, proper disposal techniques, runoff reduction/infiltration measures, etc.).
- Ensure Sewer Use By-laws are up-to-date to include application to storm sewers and regional roads, requirements for the preparation of pollution prevention plans, and provisions for the establishment of an inspection program.

Watershed Wide Actions

- Achieve the enhanced natural heritage system as a means of maintaining water quality through the attenuation of runoff and maintenance of baseflow.
- Implement active and passive revegetation programs in areas that contribute significantly to the total pollutant load.
- Develop a snow disposal and road salt management plan, with special consideration for roads on the Oak Ridges Moraine.
- Encourage municipalities to provide routine staff training for spills prevention and control programs.
- Recommend an Integrated Pesticide Management (IPM) Program for golf courses and cemeteries.
- Promote educational programs to limit the use of pesticides.
- Recommend the provincial government develop a regulation for the application of pesticides within the municipalities and encourage the municipalities and residents to lobby the provincial government to complete the regulation in a timely manner.
- Promote stewardship opportunities associated with the operation and maintenance practices of recreation facilities (e.g., golf courses, ski hills), roads, education centres, cemeteries, etc.
- Develop provincial guidelines and adopt municipal Fill Control Bylaws for inland fill operations to ensure acceptable fill quality and site location.
- Investigate the implications of climate change on water quality and make recommendations for improved management practices.
- Explore opportunities to reduce the area of impervious surfaces to enhance stormwater management.

INDICATORS	MEASURES	TARGETS
in-stream water chemistry	concentrations of nutrients (phosphorus and nitrogen), suspended solids, bacteria, chloride	concentration targets (based on PWQO or other guideline): -total phosphorus <0.03 mg/L* -nitrite < 0.06 mg/L† -suspended Solids < 30 mg/L† -bacteria < 100 counts/100 ml* -chloride < 250 mg/L‡ -un-ionized ammonia <0.02mg/L*
	annual loads of suspended solids and phosphorus	maintain annual loadings at or below the targeted "background annual load": Duffins‡‡: -suspended solids - 2,670 tonnes -total phosphorus - 2.67 tonnes Carruthers: TBD
stormwater management (SWM)	per cent of developed area within watershed having adequate stormwater controls in place (both quantity and quality control)	one hundred per cent of area having Level one water quality control (80 per cent total suspended solids removal) for all new and retrofitted development

References:

* Ontario Ministry of Environment and Energy (OMOEE), 1994, revised in 1999, Water Management: Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy, Queens Printer for Ontario

† Canadian Council of Ministers of the Environment (CCME), 1999. Canadian Water Quality Guidelines (CWQG), Canadian Council of Ministers of the Environment, Winnipeg

‡ Environment Canada and Health Canada, 2001. Road Salts: Priority Substances List Assessment Report Prepared for the Canadian Environmental Protection Act, 1999 Priority Substances List. Internet Publication

‡‡ To be reviewed prior to next Report Card

#9

OBJECTIVE #9

Minimize in-stream sediment associated with construction activity

Duffins	Carruthers
Poor	Poor

MANAGEMENT ACTIONS

- Update TRCA's Model Erosion and Sediment Control By-law due to changes to the Municipal Act.
- Adopt the updated Model Erosion and Sediment Control By-law.
- Monitor the effectiveness of current construction sediment ponds.
- Develop improved design criteria for temporary construction sediment ponds.
- Develop technical standards for erosion and sediment control measures.
- Define roles and responsibilities of all stakeholders related to the review of erosion and sediment control plans and the inspection and enforcement of erosion and sediment control measures.
- Provide training sessions for contractors, consultants, and municipal staff.
- Limit, to the maximum extent possible, the exposure of soils during construction by staging. development.
- Monitor the sediment accumulation rate in construction and sediment ponds to determine the sediment pond maintenance requirements.

INDICATORS	MEASURES	TARGETS
compliance with Municipal Erosion and Sediment Control By-laws	per cent of construction permits found to be in compliance with Municipal Erosion and Sediment Control By-laws	100 per cent compliance with approved permits under Municipal Erosion and Sediment Control By-laws
	per cent of sediment ponds checked annually	100 per cent of sediment ponds checked annually
	per cent of sediment ponds maintained when required	one hundred per cent of sediment ponds maintained when required

References:

TRCA, Greenland International Consulting Inc., 2001, Urban Construction Sediment Control Study, Toronto and Region Conservation, April 2001

Clarifica, Inc., 2002, TRCA Model By-law for Erosion and Sediment Control, Litter and Debris Control and Dust Control Relating to Urban Development Activities in the TRCA Jurisdiction, Toronto and Region Conservation, April 2002

Ryerson University, TRCA, 2003, Sediment Control Pond Monitoring Study Toronto and Region Conservation, March 2003
TRCA, Clarifica, 2003, Preliminary Assessment for an Improved Design Criteria for Construction Sediment Control Ponds Toronto and Region Conservation, March 2003

#10

OBJECTIVE #10
Reduce water quality contamination associated with wastewater discharges

Duffins	Carruthers
Poor *	Not applicable†

MANAGEMENT ACTIONS

- Support the Region of York in its decision to decommission the Sewage Treatment Plant on Stouffville Creek and ensure that stormwater management measures are incorporated into any new developments supported by the replacement pipe.
- Develop a mechanism for the regular maintenance and inspection of septic systems (e.g., requirement for the regular submission of a certificate of septic system inspection/maintenance).
- Ensure Durham and York Region sewer use by-laws are up-to-date.
- Durham Region Health Department and the MOE should continue to evaluate the impact of land application of biosolids, including sewage and paper sludge.

INDICATORS	MEASURES	TARGETS
in-stream water chemistry	in-stream phosphorus concentrations due to sewage treatment plant	in-stream phosphorus concentration due to sewage treatment plant should meet PWQO (0.03 mg/L) for all flow levels upon leaving sub-catchment (i.e., Reesor Creek at 8th Concession)
effluent quality	sewage treatment plant effluent quality	sewage treatment plant effluent quality meets Certificate of Approval
sewage treatment plant bypasses	number of sewage treatment plant bypasses	zero sewage treatment plant bypasses

References:

*The Stouffville Sewage Treatment Plant is scheduled to be decommissioned in 2004, which will result in significant improvement in this rating

†There are no point source discharges of Sewage Treatment Plant effluent in Carruthers Creek

6.8 AQUATIC HABITAT AND SPECIES

Fish and benthic invertebrates and their habitat make up the aquatic community. For the purposes of this watershed plan, wetland and amphibian issues are addressed under the Terrestrial Habitat and Species section. While aquatic communities are a natural component of the watershed ecosystem, contributing to the ongoing management of the in-stream nutrient cycle, providing a food source for other wildlife including people, and creating sporting opportunities, they also act as a barometer of overall watershed health. In any watershed, land use activities such as urban development, agricultural practices, or the removal of woody riparian vegetation, if not properly controlled, will cause changes in water quality and flow regimes that will directly influence the type and diversity of the aquatic community. It is for this reason that aquatic species are often used in monitoring programs as indicators of environmental health. In the development of the Duffins and Carruthers Watershed Plan, the predicted impacts of future land use scenarios on the aquatic community were regarded as a significant indication of the acceptability of the expected level of change.

Issues

A variety of factors affect the condition of the aquatic community, including the presence of native versus non-native species, natural variation in flow regime, water quality and temperature, presence of riparian vegetation, degree of physical alteration of stream channels, and the presence of in-stream barriers to fish movement.

A Fisheries Management Plan has been prepared for both watersheds (TRCA, 2003). This plan provides a detailed guide of the targeted fish community management zones and the management requirements for the protection and regeneration of these communities (See Figure 6.25). Directions in the Fisheries Management Plan meet the three objectives for Ontario fisheries, which are as follows:

- to protect healthy aquatic ecosystems;
- to rehabilitate degraded aquatic ecosystems; and
- to improve cultural, social, and economic benefits from Ontario's fisheries resource.

Principles For Fisheries Management

The Duffins and Carruthers Fisheries Management Plan is consistent with principles for Fisheries Management, as defined by the Ministry of Natural Resources in its Strategic Plan for Ontario's Fisheries:

> Sustainable development requires that adverse impacts on air, land, and water, be minimized to ensure the aquatic ecosystem's overall integrity.

There is a limit to the natural productive capacity of aquatic ecosystems, so there is a limit to the amount of fish that can be harvested from them.

Naturally reproducing fish communities, based on native fish populations, provide predictable and sustainable benefits with minimal long-term cost to society.

Good fisheries management is scientifically based and relies on the acquisition and use of the best available knowledge.

Resource management decisions shall be based on ecological, social, cultural, and economic benefits and costs to society, both present and future.

Protect and rehabilitate aquatic ecosystems.

Involve the public in decision making.

Ensure resources are appropriately valued.

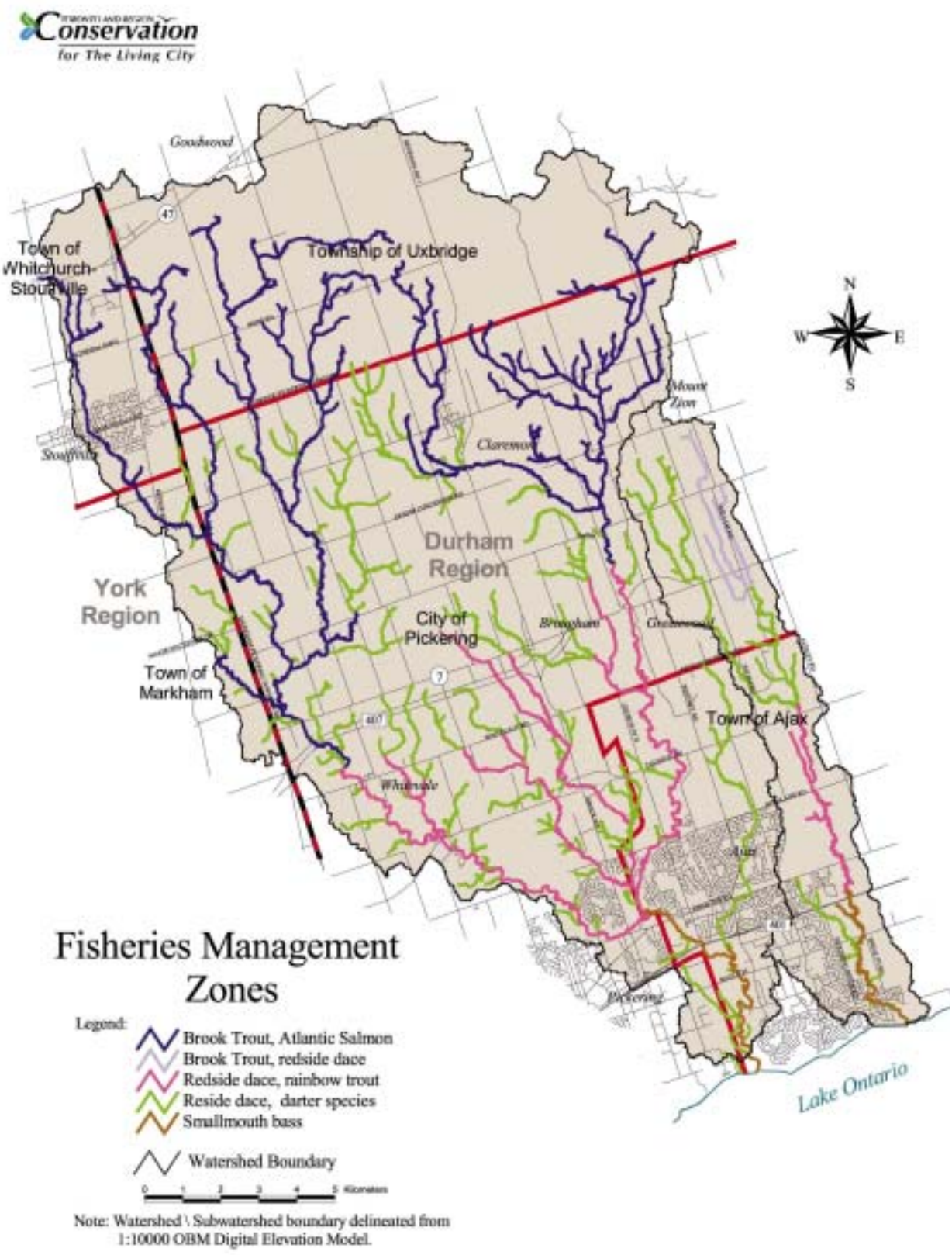
Improve program management and co-ordination.

Acquire and communicate knowledge.

Enforce firmly and effectively.

Aquatic communities depend on stream bank vegetation cover to reduce warming of the water, slow down erosion and stream flow, add organic material to the food chain, and provide needed cover for fish and other wildlife species. In the rural areas, the creek ecosystem is most directly affected by loss of woody vegetation from the riparian zone (the area next to the watercourse). In many areas, particularly the headwaters of the Carruthers Creek and the mid reaches of Duffins Creek, woody vegetation has been removed and the land is cropped very close to the stream bank. Over the past 40 years however, improvements have been made to the riparian zone, and today, there is more woody riparian vegetation in the watershed than what existed in 1958. While these improvements are encouraging there is still much room for improvement.

One of the most significant issues in managing the aquatic community actually relates to the management of land use practices that affect the hydrologic regime. From a land use and development perspective, the headwaters of Carruthers and Duffins Creeks are identified in the Official Plans to remain in rural/agricultural use or natural states. It is widely understood that the headwaters are important from an aquatic habitat perspective, because these areas serve as water detention, evaporation and groundwater recharge areas — all functions that maintain the natural flow regime of the stream. Maintenance of these headwater land uses will be important in protecting and enhancing the functions necessary to maintain the existing surface and groundwater flow regime.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York Region
City of Pickering
Brougham
Town of Markham
Town of Ajax
Whitevale
Ajax
Pickering
Lake Ontario
Fisheries Management Zones
Legend:
Brook Trout, Atlantic Salmon
Brook Trout, redside dace
Redside dace, rainbow trout
Reside dace, darter species
Smallmouth bass
Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.25

Under the Regional Official Plans, urban growth will initially occur south of Highway 7 in both watersheds and around the Village of Stouffville in the Reesor Creek subwatershed. The increased volume and rate of stormwater runoff associated with urbanization can increase bank erosion, causing streams to be wider, shallower and susceptible to warming. Organic debris such as fallen trees and branches can also be swept away during storms, destroying critical in-stream habitat. Stormwater runoff carries additional pollutant loads to the stream, which also contribute to the impairment of habitat.

Implications of Impervious Cover

Urbanization and associated runoff from the increased area of paved surfaces, referred to as impervious cover, can have significant effects on aquatic life. In Maryland, studies have shown reductions in stream aquatic insect diversity begin with as little as two per cent impervious cover. More than 15 per cent impervious cover conditions for aquatic species were determined to be fair to poor. When the impervious cover reached 25 per cent, species diversity was significantly reduced.

Urbanization also typically reduces the opportunity for groundwater recharge, and subsequently the discharges necessary to support stream baseflow are affected. Groundwater is cold (eight to 10 degrees Celsius) year-round and when it mixes with the warm surface water in the creek it moderates the temperature of the stream. The more groundwater discharge into a watercourse, the greater the potential for cold water habitat to exist.

The comparison of the amount of baseflow to total annual flow in a watercourse can be a useful indicator of the likelihood of a watercourse supporting cold water species, such as trout. Watercourses where this ratio is greater than 50 per cent are considered excellent for trout production; between 25 per cent and 50 per cent is considered fair to good, and less than 25 per cent is considered poor. Projected urban growth in the Duffins Creek watershed is expected to cause reductions in this ratio in the Lower West Duffins, Urfe, Ganatsekiagon, Stouffville Creek, and Millers Creek sub-basins. It is likely that trout populations will be impacted by this change, particularly in the Urfe and Ganatsekiagon subwatersheds, where the ratio is expected to decrease by as much as 27 per cent (Figures 6.26 and 6.27).

Baseflow in the upper Urfe and Ganetsekiagon creeks is primarily reliant on shallow groundwater supplies that are recharged from local sources within the subwatersheds. Baseflow in the lower reaches of these creeks is augmented by groundwater discharges from deeper aquifers, which may not be as susceptible to changes in local recharge. Due to the sensitivity to changes in baseflow in these subwatersheds, stringent controls will be required to maintain local recharge volumes, flow directions, and groundwater levels in the upper and middle aquifers.

The rising trend in in-stream chloride concentrations may at some point in the future prove to be limiting for certain life stages of aquatic organisms in headwater streams, particularly the smaller

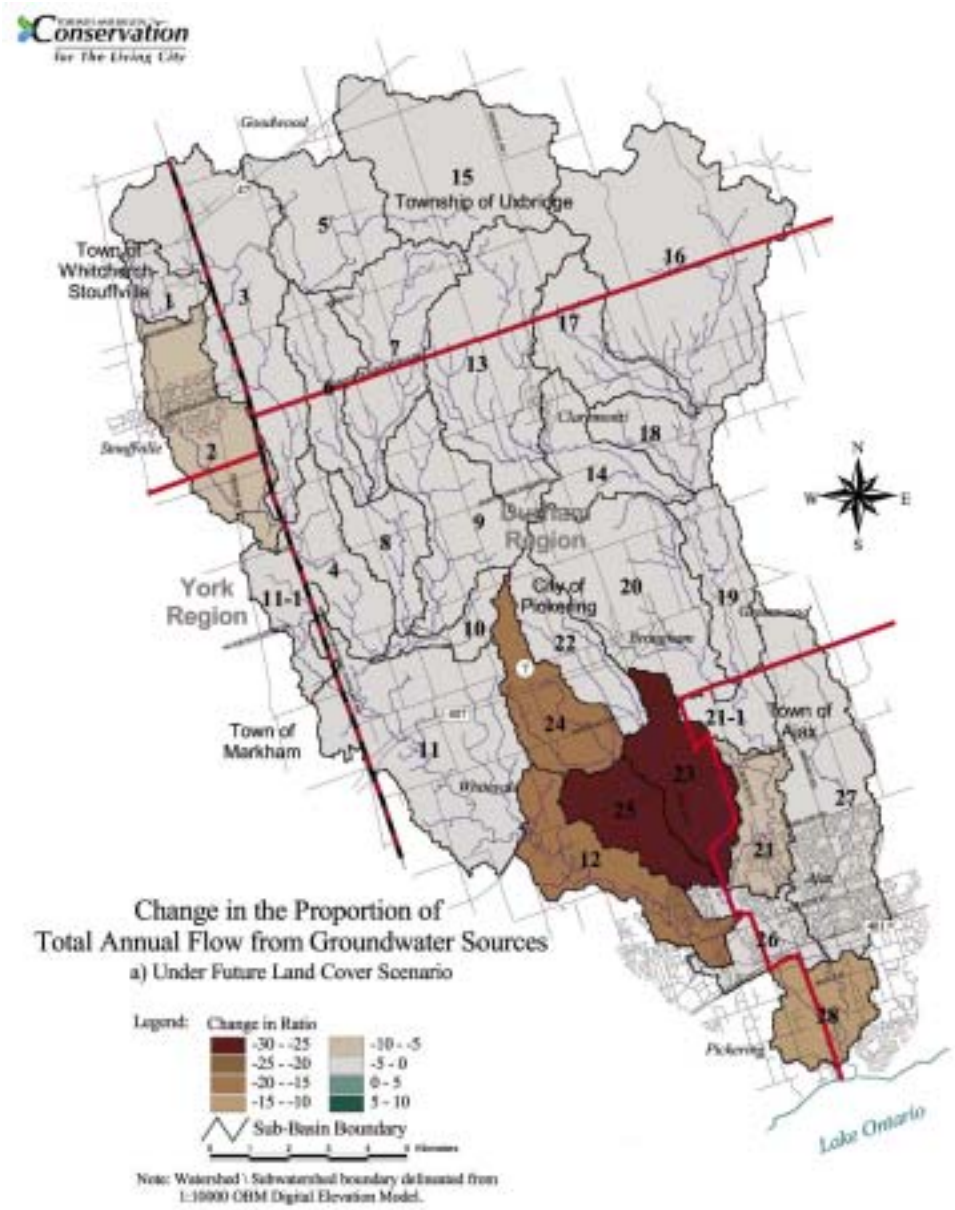


FIGURE 6.26

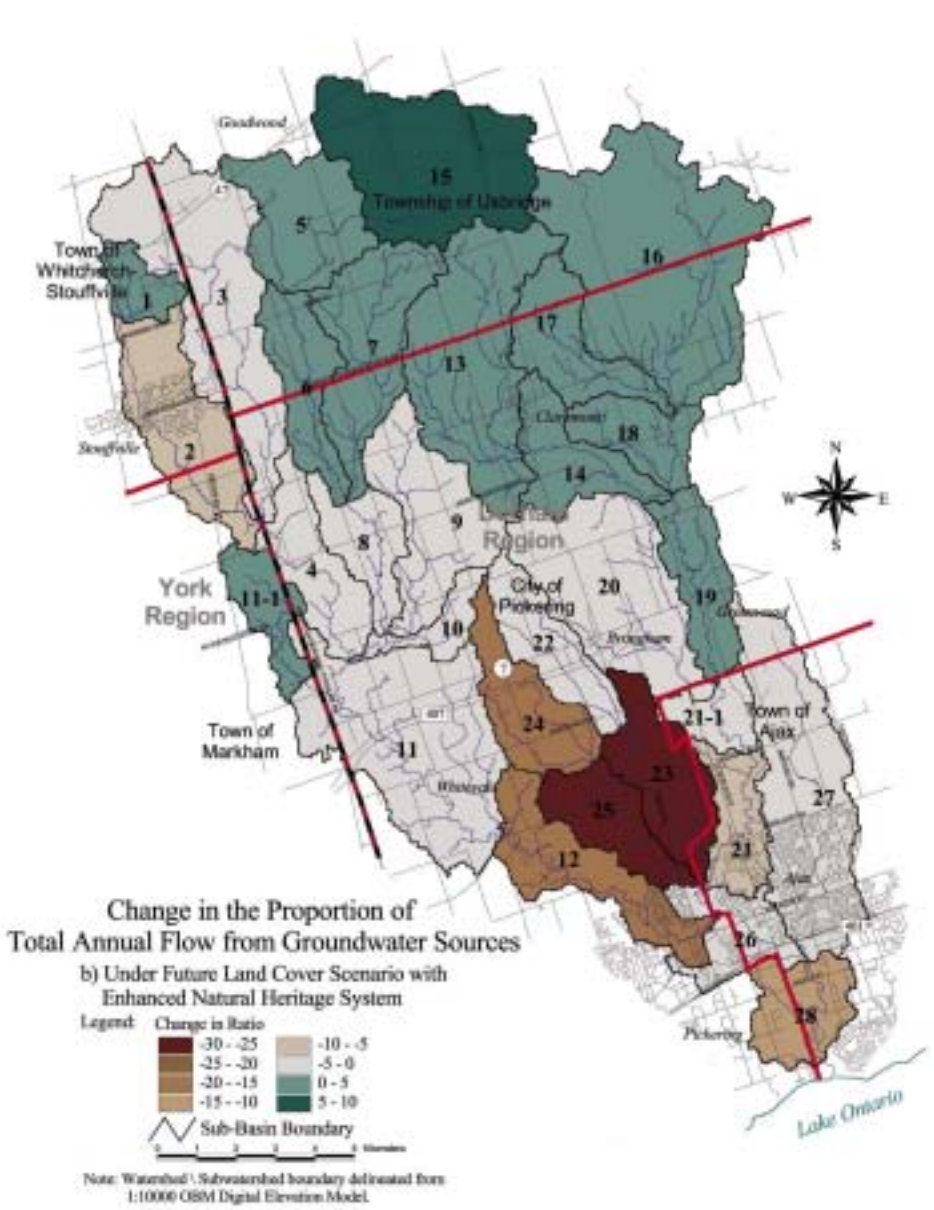


FIGURE 6.27

and more urbanized tributaries including the Ganatsekiagon, Urfe, Millers, and Carruthers creeks. Elevated nutrient and suspended sediment loadings in these same creeks will create eutrophic conditions that will alter the aquatic community, unless effective water quality management programs are in place.

Strategies to maintain the hydrologic regime and water quality within the watersheds will be integral to the protection of the aquatic community. Other key management activities must involve the protection and restoration of the riparian zone, mitigation of in-stream barriers, and maintenance of barriers limiting the movement of non-native species.

GOAL

TO PROTECT AQUATIC HABITAT AND SPECIES

Duffins	Carruthers
Good	Fair

#11

OBJECTIVE #11

Protect and restore native aquatic species and communities

Duffins	Carruthers
Good	Fair

MANAGEMENT ACTIONS

- Promote the adoption and implementation of the Fisheries Management Plan (FMP)
  - Prepare screening maps for land use planning based on the vulnerability of aquatic communities using a risk assessment approach.
  - Promote the incorporation of aquatic community vulnerability mapping into Official Plans.
- Promote "catch and release" within recreational angling community.
- Limit the movement of invasive exotic species (e.g., maintain lamprey controls).
- Mitigate in-stream barriers to fish passage and the impacts of on-line ponds, where possible.
- Work closely with angler groups to undertake litter clean-ups, fish rehabilitation projects, and creel surveys.
- Manage the headwaters of Duffins Creek for native Brook Trout and streams south of Highway 7 for migratory salmon and trout.
- Request the MNR to provide an update on plans to re-introduce Atlantic salmon into Duffins Creek.
- Increase awareness of stream ecology/recreational opportunities in order to foster awareness and to encourage public interest in the management of the aquatic communities.

INDICATORS	MEASURES	TARGETS
fish and invertebrate communities	invertebrate indices Index of Biotic Integrity (IBI) presence and abundance of indicator species	to be determined pending further study minimum IBI of "Good" maintain or achieve historical distribution of targeted indicator species as specified for reaches in the Fisheries Management Plan*
in-stream habitat	per cent in-stream woody cover per cent riffle substrate ratio of baseflow to total annual flow	to be determined pending further study as specified for reaches in Fisheries Management Plan*
water chemistry	water temperature total suspended solids phosphorus chlorides	as specified for reaches in Fisheries Management Plan*
fish passage to critical habitat (breeding, rearing, foraging grounds)	presence of in-stream barriers	only strategic barriers for fisheries management to remain

References:

*TRCA 2003, Duffins and Carruthers Creek Watersheds Fisheries Management Plan

#12

OBJECTIVE #12

Protect and restore the riparian zone and associated functions

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Recommend the province complete the development of a policy and supportive guidelines for the protection and management of riparian zones.
- Apply the Valley and Stream Corridor Management Program and Duffins and Carruthers Creek Fisheries Management Plan policies and recommendations for protecting riparian zones and associated functions.

- Restore woody riparian zones.
- Protect the function of the riparian zone from impacts associated with agriculture, recreation, and other uses (e.g., livestock access, trail, and infrastructure alignment).

INDICATORS	MEASURES	TARGETS
riparian zone vegetation	per cent of total stream bank length with riparian vegetation cover	100 per cent coverage with riparian vegetation
	per cent of total stream bank length with woody riparian vegetation cover	minimum of 75 per cent coverage with woody riparian vegetation

#13

OBJECTIVE #13

Maintain or restore the natural variability of annual and seasonal stream flow

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Develop a wetland protection and restoration program to promote recharge, manage flow, and provide habitat.
- Support the MOE in the development of a protocol for water takings that establishes a baseflow threshold below which no surface water may be drawn from a watercourse.
- Develop targets for identifying and monitoring the achievement of a natural range in variation of flow regime (e.g., baseflow to average annual flow ratio).
- Monitor on a long-term basis stream flows, groundwater levels, and precipitation in the two watersheds.

INDICATORS	MEASURES	TARGETS
stream hydrograph (annual and seasonal variation in hydrological regimes)	flow events (timing, duration, frequency, and rate of change) ratio of baseflow to total annual flow ratio of seasonal baseflow to total seasonal flow	to be determined with consideration for maintaining or restoring historical variability of the hydrograph, and consideration of the timing of low flows with respect to sensitive life-cycle requirements of aquatic communities

6.9 TERRESTRIAL HABITAT AND SPECIES

The terrestrial natural heritage system includes forests, wetlands, meadows, and beaches/bluffs. It also includes the plant and animal communities and species associated with them and consideration for the patterns and interactions of habitat patches across the landscape. But, the natural heritage system is not just habitat! Forests, wetlands, and meadows have been shown throughout this Watershed Plan to play a significant role in maintaining the watershed's hydrologic function, in terms of surface and groundwater quantity. These natural features also address water quality concerns, contribute to aquatic habitat needs, help preserve human heritage resources, and enhance public recreational use experiences. While respecting the multiple roles of natural heritage cover, this section focuses on its habitat role. For more details regarding Terrestrial Habitat and species refer to the Duffins and Carruthers State of the Watershed Reports.

Across the Greater Toronto Area, although to a lesser degree in the Duffins and Carruthers watersheds, natural areas have been reduced to small fragments, with declining biodiversity and overall health. In response to these concerns, TRCA is developing a Terrestrial Natural Heritage Approach, which examines the condition of natural cover in the whole watershed and links it to adjoining watersheds. Instead of focusing on natural areas individually (e.g., Environmentally Significant Areas, Areas of Natural and Scientific Interest, and Classified Wetlands), the Terrestrial Natural Heritage Approach recognizes the interconnectedness of all parts of the natural system. Therefore, it evaluates the function of the natural cover in the Duffins and Carruthers creek watersheds as one entity, which can be conceived of as an "environmentally significant system." Furthermore, the approach is based on the relationship the natural heritage system has with the rest of the watershed. It recommends that decisions at the site level be made according to that premise, considering the whole system and the relationship with its context.

From a habitat perspective, key factors influencing the condition of the natural heritage system include the area of natural cover; its distribution; patch size, shape, and connectivity; matrix influence; and the type of communities and species.

Issues

Using the Terrestrial Natural Heritage Approach, TRCA will be completing a Regional Terrestrial Natural Heritage Strategy for its jurisdiction by the end of 2003. This strategy will give TRCA and its partners a much needed plan for the protection and regeneration of a natural heritage system, and will provide for a more coordinated and effective review of planning applications, land securement programs, and regeneration efforts.

The Terrestrial Natural Heritage Strategy will reflect an enhanced network of natural heritage cover within the Duffins and Carruthers watersheds, as developed for this Watershed Plan. The enhanced natural heritage system builds upon the existing patches of natural cover and enhances those patches with consideration for improvements in patch distribution, size, shape, and connectivity coupled with potential feasibility and landowner willingness. This system represents an

increase in natural cover from 37 per cent to 49 per cent in the Duffins watershed and from 25 per cent to 30 per cent in the Carruthers watershed.

One of the challenges for this Watershed Plan is to protect meadow, successional, and beach/bluff habitat patches. In the case of the Carruthers watershed for example, meadow habitat patches make up a significant proportion of the natural cover (as shown in Figure 6.28). In order to achieve the target of 30 per cent natural cover for the Carruthers watershed, not only will additional forest cover need to be established in the headwaters, a concerted effort will be required to protect meadow habitats in the Town of Ajax during the development process. It is recognized that both provincial and municipal natural heritage policies and procedures afford a greater degree of protection for wetlands and forest in urbanizing watersheds.

Calculated scores for patch size and shape improve under this targeted scenario (See Figures 6.29 and 6.30). Patch distribution, as measured by the centroid, tends to move farther north in the watersheds under the scenario of increased natural cover in the headwaters, but there may be opportunities to address this weakness by incorporating additional lands for regeneration in the Seaton developments.

Meadow as Natural Cover

Old field is classified as "cultural meadow," in the Ontario Ecological Land Classification System. This is in contrast to natural grassland habitats, such as tallgrass prairie or savanna, both of which are rare in southern Ontario. The figures for meadow used here are approximate, based on aerial photo interpretation. Although they typically refer to oldfield, it is possible that ground-truthing could identify a few of these as natural wet meadow (meadow marsh) habitat, or in extremely rare cases, as prairie or savanna.

Since old-field habitats are the result of past agricultural use, it can be argued that, unless they are supporting species of concern, their greatest value in the TRCA region may be their restoration potential. Left alone these areas would naturally go through the process of succession, eventually reverting to forest, since the watershed lies within a forest bioregion. The ecological result would be an overall increase in forest cover and connectivity between forest patches. In addition to many other values of forests, this would enhance the viability of wildlife populations, many of which have been long suffering from the impacts of fragmentation. This process of increasing forest cover in meadow areas can be aided by tree and shrub planting projects. Moist or lowland meadow areas present opportunities for wetland restoration.

Duffins Creek and to some extent the Carruthers Creek are unique, in that there are a variety of mechanisms available to protect and secure the enhanced terrestrial natural heritage system, many of which do not exist elsewhere. The Oak Ridges Moraine Act provides a strong mechanism to protect natural areas within the Oak Ridges Moraine. Federal and provincial land holdings offer an opportunity for these governments to go beyond the normal provisions of their legislation,

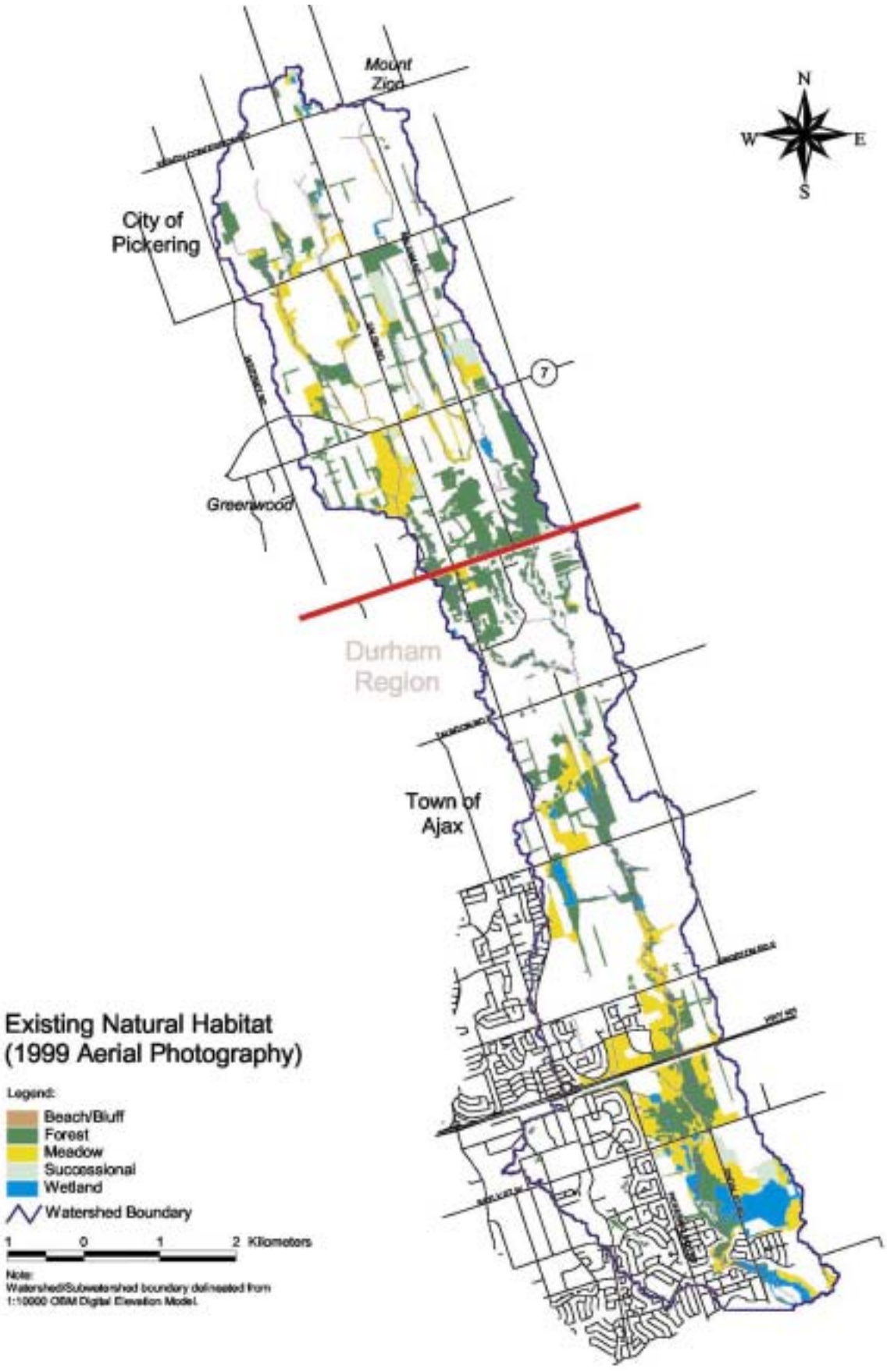

Mount Zion
City of Pickering
Greenwood
Durham Region
Town of Ajax
N
W
E
S
Existing Natural Habitat
(1999 Aerial Photography)
Legend:
Beach/Bluff
Forest
Meadow
Successional
Wetland
Watershed Boundary
1 0 1 2 Kilometers
Note:
Watershed/Subwatershed boundary delineated from
1:10000 OBM Digital Elevation Model.

FIGURE 6.28

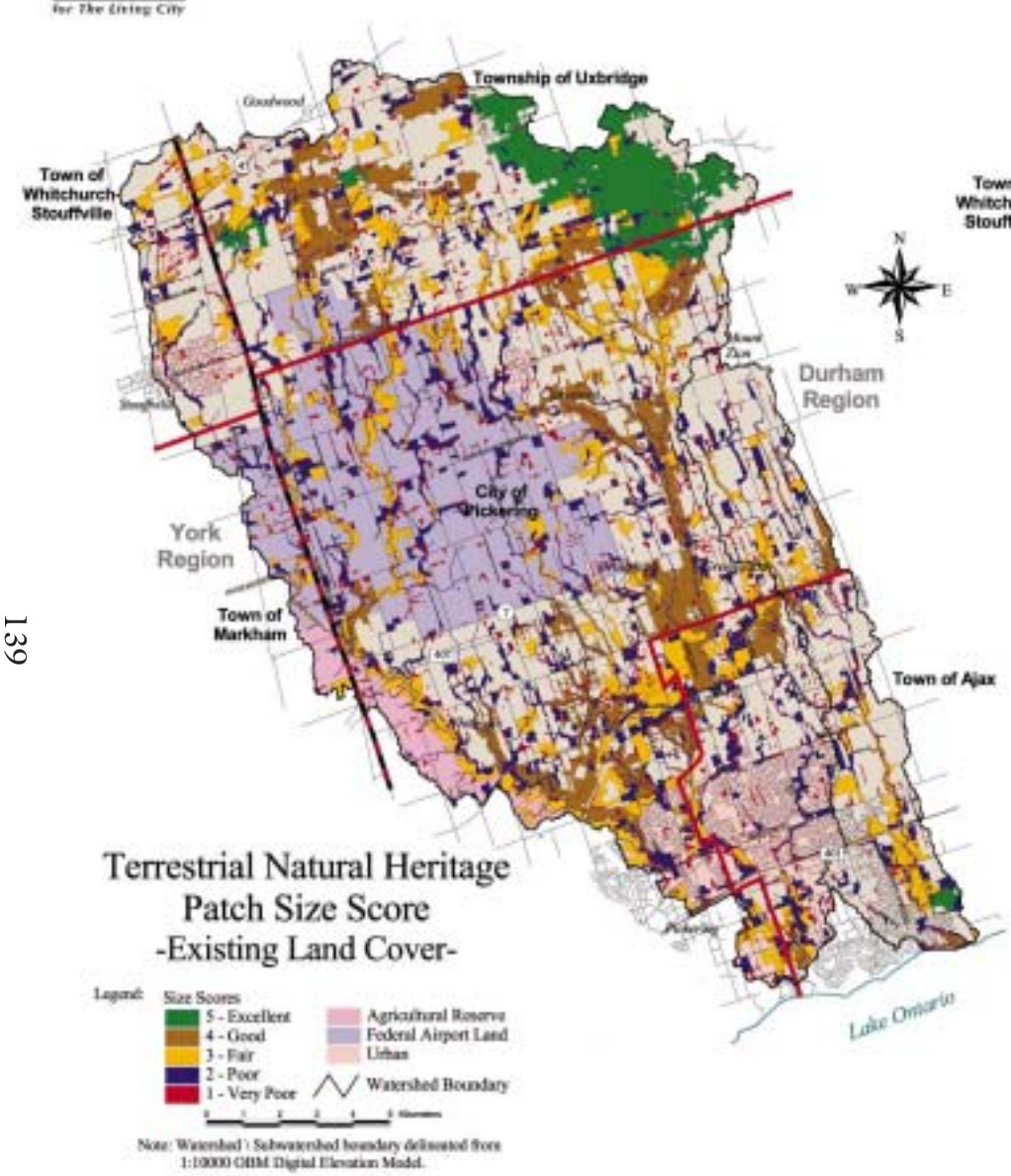


FIGURE 6.29

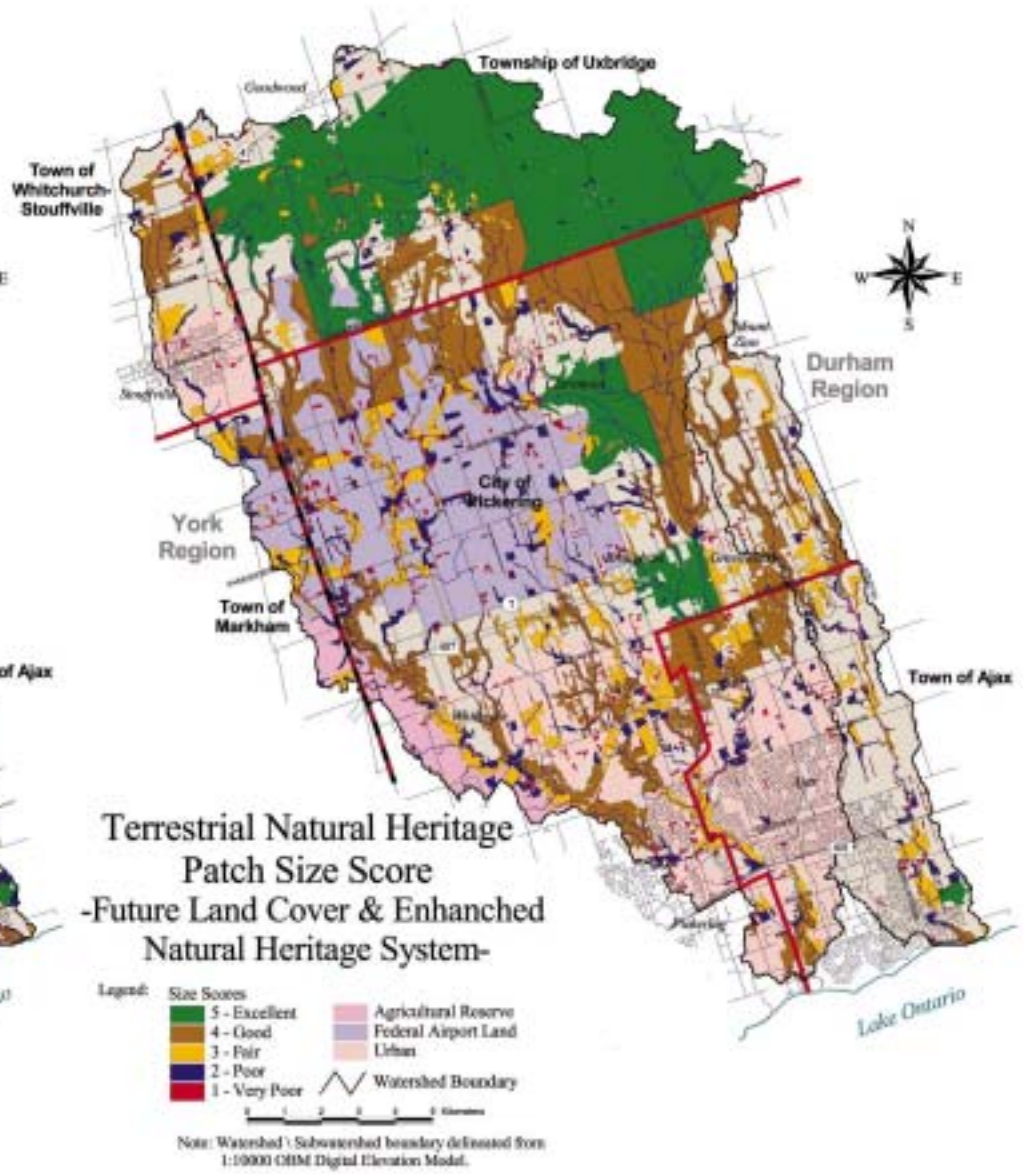


FIGURE 6.30

which usually allows them to protect only natural features that are deemed to be of federal or provincial significance. Regional and local municipalities can designate lands for protection in their Official Plans and can pass Tree Cutting By-laws and Fill By-laws, however these tools have sometimes proven to be too weak.

Private landowners within these watersheds have demonstrated a strong willingness and commitment to watershed management by establishing conservation easements on their lands, which should facilitate the securement of additional lands by the same means. New funding sources are required to assist these landowners in managing their easement lands through stewardship practices and naturalization programs.

Fewer mechanisms are available, however, for the protection and securement of lands identified for natural area regeneration. This poses a significant management challenge, which will require the full support of government, community leaders, and landowners.

Matrix influence is expected to increase as urban growth proceeds as provided for under the approved Regional Official Plans. The public is not always aware of the sensitivity of natural areas to disturbance. Hikers, dogs, and bicycles can cause a great deal of damage to the understorey and ground cover plants within forests. Encroachment of private gardens or the dumping of material into the forest or valley can also be a threat to natural open spaces. Public outreach and education about good land stewardship practices are important activities.

Canadain Biodiversity Strategy

A Tradition of Conservation…

Canada's natural wealth is the envy of many nations, and is supported by a strong tradition of conservation and sustainable use. An important component of this wealth is Canada's biodiversity — the variety of genes, species, and ecosystems, and the ecological processes of which they are a part. Biodiversity is our life support system. It can be seen in the wetland ecosystems that clean our water, the insects that pollinate our crops, the micro-organisms that contribute to medical research, and the forests that cleanse our air. Biodiversity provides enormous economic, cultural, and spiritual benefits, and its decline worldwide is one of the most serious crises facing humanity.

Canada is committed to protecting its own biological diversity, and to working with others to help conserve the biodiversity of the planet. In 1992, Canada took new steps on its journey to protect this natural wealth by becoming the first industrialized country to ratify the United Nations Convention on Biological Diversity.

DEFINITIONS

Habitat Patch: a contiguous part of the landscape, 0.5 hectares or more, supporting either forest, wetland, or meadow. In the Duffins and Carruthers watersheds, the patches range from 0.5 hectares to greater than 700 hectares, some being compact in the headwaters, others more linear and associated with valley corridors.

Matrix Influence: "matrix" refers to what is around a habitat patch; matrix influence is the influence that a patch receives from surrounding land uses. Habitat patches tend to receive negative impacts from an urban matrix, but positive impacts from a natural matrix. An agricultural matrix is somewhere in between, allowing for better movement of species and representing less impacts to a habitat patch. Sustainability of a watershed is largely defined by the ratio of natural, agricultural, and urban cover, thus the sum of the matrix of each habitat patch.

Connectivity: landscape connectivity from a terrestrial natural cover perspective refers to the ability of species to travel safely to different parts of an area, such as a watershed. This can be achieved chiefly in two ways, generally in combination, by increasing the size of habitat patches (adding more connected hectares of habitat) and by promoting a more benign matrix (generally favouring agriculture over urban). Connectivity is necessary for preventing in-breeding by allowing species to mix the gene pool and increase their resilience to the diversity of diseases and unpredictable weather patterns.

Centroid of Patch Distribution: this centroid, geographically speaking, is the center of where the habitat patches (or all of the natural cover) lays on the landscape. By its location in a watershed, the centroid summarizes if the patches are uniformly distributed or concentrated to one part of a watershed. Even distribution of natural cover in a watershed means even distribution of its benefits to flora and fauna, water management, aesthetics, and recreational opportunities.

GOAL

TO PROTECT AND ENHANCE TERRESTRIAL HABITAT AND SPECIES

Duffins	Carruthers
Good	Fair

#14

OBJECTIVE #14

Increase the per cent natural cover to a quantity that provides targeted biodiversity and supports recreational uses

Duffins	Carruthers
Good	Fair

MANAGEMENT ACTIONS

- Adopt and implement the Regional Terrestrial Natural Heritage Strategy, which provides for:
  - Protection and enhancement of a combination of habitat types, including forest, wetland, meadow, and beach/bluff.
  - Distribution of habitat and species throughout the watersheds to maximize genetic variation, public use opportunities, and benefits for other ecological functions.
  - Improvement of individual habitat patches to provide for species needs, promote population viability, and achieve the targeted level of natural system biodiversity.
  - Improvement of opportunities for native species to travel safely across the landscape and promotion of population viability.
- Adopt policies that protect lands for the natural heritage system, including lands supporting existing vegetation and land for restoration.
- Undertake land securement and stewardship of the enhanced natural heritage system.
- Allow for passive succession of properties within the enhanced natural heritage system.
- Actively restore areas within the enhanced natural heritage system, starting with those areas where natural cover would achieve multiple watershed management benefits (e.g., riparian zones, significant source areas of water quality contamination, vulnerable recharge areas, etc).
- Use native species in restoration efforts.
- Promote the use of TRCA's Terrestrial Natural Heritage Strategy approach in neighbouring watersheds.

INDICATORS	MEASURES	TARGETS
quantity	per cent natural land cover	≥ 49 per cent in Duffins Creek and ≥ 30 per cent in Carruthers Creek
distribution	distribution of the natural cover in relation to total watershed area (as measured by distance to centroid)	≥ 2350 metres for Duffins Creek and ≥ 1,750 metres for Carruthers Creek
size	average patch size scores	≥ 4 in Duffins Creek and ≥ 3 in Carruthers Creek
shape	average patch shape scores	≥ 3 in Duffins Creek and ≥ 2 in Carruthers Creek

Reference:

TRCA Terrestrial Natural Heritage Strategy (under development)

#15

OBJECTIVE #15

Protect the natural system quality and function from the influence of surrounding land uses

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Adopt and implement the Regional Terrestrial Natural Heritage Strategy.
- Promote awareness about the impacts of urbanization and recreation on natural habitats.
- Promote stewardship practices (e.g., pet control, access control) and impact mitigation options (e.g., lighting and noise controls).
- Enhance enforcement programs that deal with property standards, tree cutting, flood plain filling, etc.

INDICATORS	MEASURES	TARGETS
matrix influence	compatibility of surrounding land uses within two kilometres of the edge of each natural cover patch	targeted ratio of urban, natural, and rural/agricultural land cover surrounding each natural cover patch, as defined by the Regional Terrestrial Natural Heritage model matrix influence scores (four in the Duffins Watershed; three in the Carruthers Watershed)

#16

OBJECTIVE #16

Protect and restore native terrestrial communities and the flora and fauna found within them

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Complete the inventory of flora and fauna species and vegetation communities.
- Develop a plan to achieve the enhanced natural heritage system.
- Adopt and implement the Regional Terrestrial Natural Heritage Approach and promote its use in neighbouring watersheds.

- Adopt policies which protect lands for the natural heritage system, including lands supporting existing vegetation and land for restoration.
- Undertake land securement and stewardship of the enhanced natural heritage system.
- Allow for passive succession of properties within the enhanced natural heritage system.
- For active restoration, select desired vegetation communities based on a model of site conditions, TRCA community rankings, and trends of community types across the watershed.
- Use native species in restoration work.
- Monitor restoration projects for natural succession of fauna and flora species over time.
- Initiate and expand outreach and invasive species control programs.
- Continue to support the Regional Watershed Monitoring Network including remote sensing, biological field inventories, and community volunteer-based monitoring.

INDICATORS	MEASURES	TARGETS
vegetation type diversity	number of vegetation types represented	to be determined
species diversity	number of species represented	to be determined

6.10 PUBLIC USE AND OUTDOOR RECREATION

Public greenspaces are highly valued for their aesthetic, social, recreational and spiritual value. They provide opportunities to pursue recreational and leisure opportunities ranging from hiking, bird watching, cycling, camping and picnicking, to swimming, fishing and a variety of other active and passive activities. It is a well documented fact that active lifestyles promote a sense of well being and an overall healthier population, which over time will lessen the burden on our health care system.

Outdoor recreation is one way people of all ages and all cultures can interact with the environment. Through greater interaction with the natural environment, people gain an appreciation for their natural surroundings and are more likely to participate in and support efforts to enhance and protect these watersheds.

Issues

The Duffins and Carruthers creek watersheds already have a significant amount of publicly owned greenspace, when all land holdings of the provincial and federal governments, TRCA, and the municipalities are considered. The existing public greenspace network, the master plans that are prepared by the municipalities for phased implementation, and management plans prepared by TRCA serve well as models to build upon when implementing the public use and outdoor recreation components of this Watershed Plan.

Public use facilities have been developed to varying degrees throughout the watersheds. With the significant amount of public land holdings in the Duffins Creek watershed many opportunities exist for public use and recreation opportunities including TRCA headwater properties, valley and stream corridors, the Lake Ontario waterfront and their associated trail networks. Other destinations include the Greenwood Museum, Greenwood Conservation Area, and enjoying an evening stroll along the Lake Ontario waterfront. Although the amount of land in public ownership is much less in the Carruthers Creek watershed, the opportunities for exploring the outdoors and vistas are not limited by its size. The Carruthers Creek has always provided biking and hiking opportunities and scenic drives along rural roads dotted with century farms. Expanding the amount and availability of outdoor recreation opportunities in these two watersheds can also be explored through partnerships with existing outdoor recreation providers such as golf course owners, municipalities, and privately run parks and ski facilities.

The Duffins Creek is well known as a recreational fishing spot with excellent aquatic habitat. It has the strongest run of migratory rainbow trout (up to Whitevale), and the mid-section north of Whitevale is abundant with brown trout. The headwater areas contain brook trout while the mouth and marsh areas are popular for pike fishing. There are two private fishing clubs in the headwaters of Duffins Creek in addition to the public lands along the watercourse that provide good to moderate fishing.

A variety of lake fish, including white and yellow perch, bass, and carp, can be found at different times of the year in Carruthers Creek. Fishing opportunities are mainly restricted to the lower portions of the watershed, in and near the Carruthers Creek Marsh.

Over time, informal trails have been blazed very close to or right along side the creek by anglers. This does not present a concern when they are used infrequently by weekend hikers or anglers. However, as the number of individuals who use these trails increases, and if the types of activities become more aggressive, such as mountain biking, then the trail would start to erode into the watercourse and impact water quality and, in turn, fish habitat. The Watershed Plan presents the opportunity to review the appropriateness of a range of recreation opportunities that currently exist, identify those inappropriate uses or locations and redirect users in order to protect the watershed functions.

Projected increases in the population of urban centres within the watersheds and in adjacent centres, such as Toronto and Oshawa, will create increased demand for public use opportunities and present a number of challenges from a land management perspective. If adequate public use facilities are not provided, this pressure could lead to environmental damage from the development of informal trails, conflicts associated with trespassing on private lands, and overuse of existing publicly accessible areas. With increasing population and increasing public use, there will be greater personal safety risks, the potential for accidents in greenspace areas and problems of increased unacceptable and/or criminal activity, which planning and management must address. Whether it be Toronto and Region Conservation, local municipalities or another government agency responsible for publicly owned lands, there is a responsibility to provide additional areas

of publicly accessible and safe greenspace and associated venues that do not negatively impact the environment.

Although currently fragmented, trails in the Duffins and the Carruthers creek watersheds will be linked together over time (Figure 6.31). The objective of this plan is to create a continuous trail system that will allow individuals to move across the watersheds from east to west and from the Oak Ridges Moraine to the Lake Ontario Waterfront, as well as to seek out opportunities to sinificantly increase the value of individual areas by linking them into a continuous, integrated greenspace system. Trail routing, monitoring, and maintenance is a financial and safety issue for land managers. Partnerships between agencies, municipalities, and community representatives will assist in developing a sustainable and financially viable trails system.

Although there is a cost, and maintenance is required, signs used in public parks and along trails are an excellent medium for providing the users with directions and educational facts about the environment and the cultural heritage of the area.

The use of valleylands for active recreation can sometimes conflict with natural heritage objectives. In the older communities of Pickering, Ajax and Stouffville, active recreation facilities such as soccer fields, baseball diamonds, and play equipment are occasionally located in valleylands as a result of all the table lands being occupied by residential development. What we know today, is that the ecological features of the valley system function best when they remain in vegetative cover. In planning new communities, it will be beneficial to explore the options for locating these active recreation fields outside of the valley system to ensure that their environmental value and ecological functions continue undisturbed. It will be important that all existing public greenspaces be managed using an environmental management system to minimize the impacts of activities.

Many of the issues and opportunities outlined above are reviewed and provided for in the preparation of Management Plans for large tracts of public-owned lands. For many years, the TRCA has been developing management plans for the lands in their ownership. In the Duffins Creek watershed, a Headwaters Management Plan will be completed in 2003 that includes seven TRCA properties, including the Secord Forest and Wildlife Area, Clubine Agreement Forest, Goodwood Resource Management Tract, Glen Major Resource Management Tract, Walker Woods, Timber Brothers Gravel Pit, and the Claremont Field Centre lands. A Restoration Action Plan was completed in 2002 for the Duffins Creek Marsh and a Greenwood Conservation Area Management Plan was initiated by the Town of Ajax in 2002. Through the implementation of the recommendations in this Plan it is hoped that a Management Plan for the Carruthers Creek Marsh can be developed and implemented.

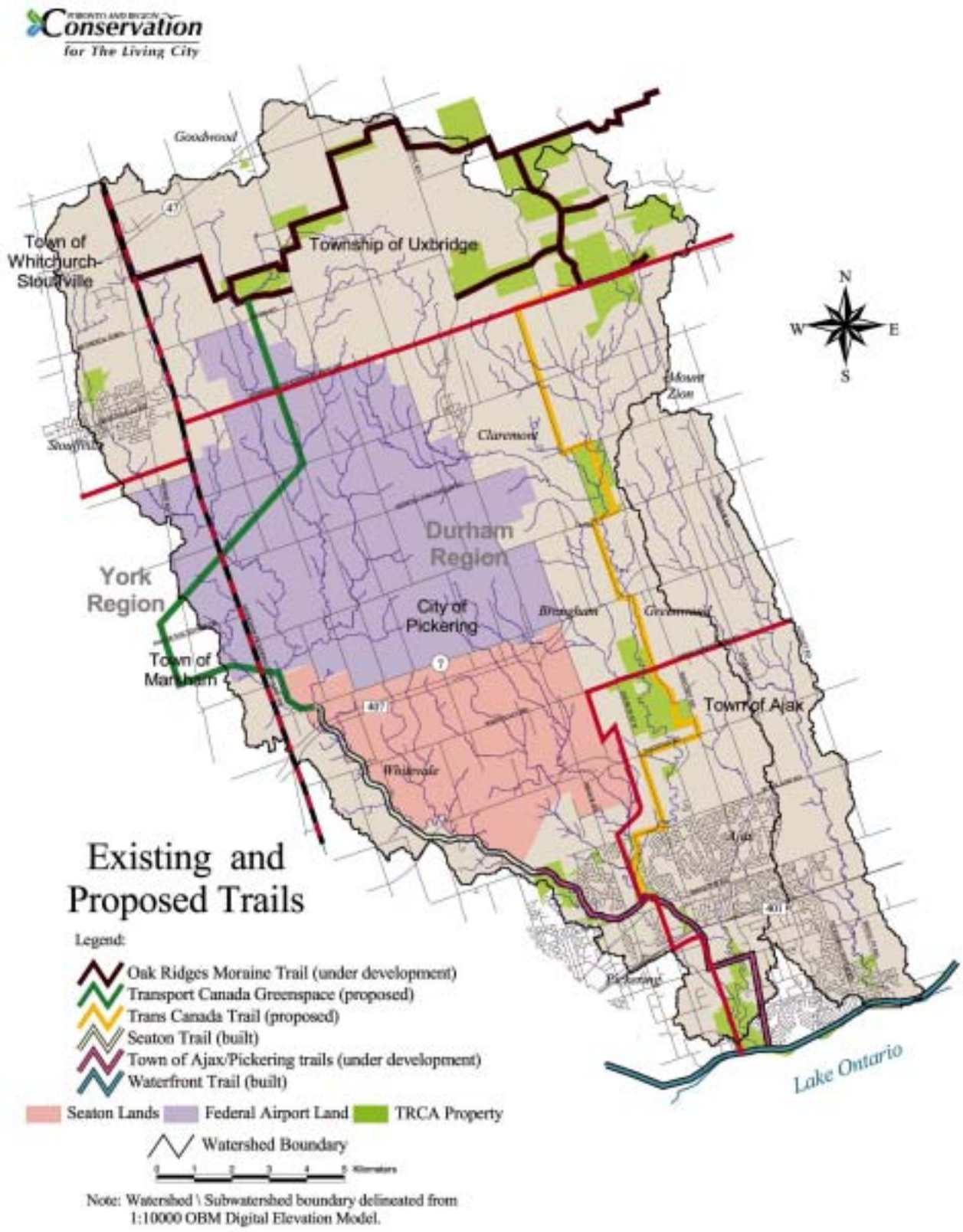

Conservation
for The Living City
Goodwood
Town of Whitchurch-Stouffville
Township of Uxbridge
Stouffville
Claremont
Mount Zion
Durham Region
York Region
City of Pickering
Brougham
Greenwood
Town of Markham
Town of Ajax
Whitevale
Pickering
Lake Ontario
N
W
E
S
Existing and Proposed Trails
Legend:
Oak Ridges Moraine Trail (under development)
Transport Canada Greenspace (proposed)
Trans Canada Trail (proposed)
Seaton Trail (built)
Town of Ajax/Pickering trails (under development)
Waterfront Trail (built)
Seaton Lands
Federal Airport Land
TRCA Property
Watershed Boundary
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 6.31

DEFINITIONS

Open space: is a land use designation used by municipalities, which generally refers to existing and planned natural areas (e.g., forests, valley, and stream corridors), and active and passive recreational areas (e.g., municipal parklands, soccer fields, etc.). Hydro/utility corridors and other privately owned lands that are open to the public for passive recreational uses are not usually included under this land use designation, but for the purposes of public recreational uses may be considered as part of public use planning within this strategy.

Greenspace: a term used by TRCA to refer to areas that may have the potential to form part of a public use recreational system. Greenspace includes conservation lands owned or managed by TRCA, municipal parklands located in valley and stream corridors and on tablelands, and other government or privately owned lands that are open to the public for passive recreational uses (e.g., picnic areas, trails).

GOAL

TO PROVIDE SUSTAINABLE PUBLIC USE WHICH PROMOTES ENVIRONMENTAL AWARENESS AND ENHANCEMENT

Duffins	Carruthers
Good	Poor

#17

OBJECTIVE #17

Create continuous watershed trails in the greenspace system linking Lake Ontario and the Oak Ridges Moraine

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Inventory existing trails and access points and identify current ownership and management.
- Plan and develop a continuous trail network.
  - Work with existing trail groups and residents who have been "Gate Keepers" of the Duffins and Carruthers trail systems to determine trail use objectives.
  - As a priority, establish greenspace connections in areas where linkages between existing trail systems are needed.
  - Plan routes with consideration for opportunities to promote awareness of natural and human heritage features.
  - Establish greenspace connections to the Rouge watershed to the west and Lynde Creek to the east by working with neighbouring jurisdictions.
- Prepare website and printed materials for watershed trails, using the same logo or design standards for access and information signs. Material should include trail maps and lengths, access points,

roads, parks, amenities, names of tributaries, and natural and human heritage points of interest.
- Work with existing trail user groups, residents, and ratepayer associations to assist with raising public awareness, addressing linkage issues, fundraising, and undertaking general maintenance activities.
- Complete the Trans Canada Trail plan, registration, and implementation.
- Where trails may cross private lands, such as golf courses, seek easements or other agreements with the owners, or route the trail around the private property to ensure continuity and safe passage.

INDICATORS	MEASURES	TARGETS
designated interregional trail network	per cent completion of the interregional trail network	one hundred per cent completion

#18

OBJECTIVE #18
Manage the greenspace system for planned sustainable uses and public enjoyment

Duffins	Carruthers
Good	Poor

MANAGEMENT ACTIONS
- TRCA and its municipal partners should continue to work together to identify areas within the greenspace system (e.g., Carruthers Creek Marsh) that require a Management Plan to guide current uses and future needs.
  - Ensure the recreation carrying capacity of watershed greenspace systems is not exceeded.
  - Coordinate the preparation of management plans for public-owned greenspace systems through consultation with residents and formalized user groups.
  - Integrate resource and public uses with public safety.
  - Include community and private sector interests in the Management Plan planning process.
  - Include elements of conservation, restoration, environmental, and human heritage education in each plan.
  - Ensure that the public use and outdoor recreation opportunities presented in the management plans are financially viable on a long-term basis.
- Complete, finalize, and implement the following Management Plans with existing and new partners:
  - The Duffins Marsh Restoration Action Plan.
  - Carruthers Marsh Restoration Action Plan for the marsh and associated wetland complexes.
  - The Headwaters Management Plan for the Duffins Creek Watershed.
  - The Greenwood Management Plan with the Town of Ajax and project partners.
- Incorporate public use strategies into the Master Plan for Transport Canada's greenspace lands, where appropriate.

- Work with privately owned outdoor recreation providers (golf courses, ski operators) in the watersheds to continue to improve upon the environmental components of their operations.
- Continue to develop and implement an environmental management system for all TRCA, municipal, provincial, and federally owned lands.

INDICATORS	MEASURES	TARGETS
sustainable public use and enjoyment	participation in planned uses as defined in the Management Plan	increase in participation in planned uses and decrease in participation in unplanned uses
Management Plans	number of Management Plans completed for areas identified	one hundred per cent completion

#19

OBJECTIVE #19

Improve greenspace accessibility, while ensuring compatibility between social benefits and ecological health

	Duffins	Carruthers
	Good	Poor

MANAGEMENT ACTIONS

- Inventory and develop a plan to expand the existing greenspace system and its accessibility.
  - Explore opportunities to secure greenspace lands within the enhanced natural heritage system.
  - Through municipal planning and recreation, master plans and their associated budgets provide parking, washrooms, and other public services at major nodes throughout the watershed where possible.
  - Make greenspace entrance points accessible by public transit, where possible, and accessible to handicapped individuals.
  - Develop and implement a public use safety plan.
- Work with stakeholders in the watershed to understand user needs, implementation mechanisms, stewardship, and promotional opportunities.
  - Produce a guide that identifies existing public greenspaces, their access points, permitted uses, and interpretive information on natural and human heritage.
  - Promote the active participation of golf courses in watershed management issues through on-site signage, member newsletters, articles in golf magazines, and newspaper articles.
  - Continue relationships with hiking and trail associations to understand the patterns and issues related with trail use and maintenance.

– As horseback riding continues to grow as a recreational use in the watersheds, meet with horseback groups and associations to exchange information about their experiences and the sustainable use of the trail systems.

- Work with public agencies to recognize greenspaces in planning documents to ensure that they are not impacted in the future by municipal servicing and the expansion of transportation networks.
- Complete a comprehensive watershed signage plan, which includes creek names at major road crossings and natural and human heritage information where appropriate.
- Implement the public use components of the completed Management Plans.

INDICATORS	MEASURES	TARGETS
accessible greenspace	number of access points to publicly owned greenspace as identified in Management Plans	one hundred per cent completion of the development of all planned access points

6.11 HUMAN HERITAGE

Human heritage provides a context and background for our management, use, and enjoyment of the watersheds of today. Human heritage features include archaeological resources, architectural resources, and cultural/heritage landscapes. Each of these are critical aspects of the watersheds' past, and together tell of the use of the Duffins and Carruthers creeks waterscapes and landscapes. By uncovering and appreciating the complexities of historic interactions between people and the natural environment, we will use this foundation to inspire a vision of the future where society interacts with the environment in a positive symbiotic relationship.

Issues

There are many issues that affect the protection and understanding of our human heritage resources. A comparison of the present watershed with that of the past might provide a focus for future recognition of what has been retained as well as target those areas in need of regeneration.

The principle issue inhibiting the appreciation of, and desire to, protect human heritage resources is the sense of identity or the lack of connection between individuals and within communities, and the history of the local landscape. Through identifying with the watershed and the past relationships between humans and the natural environment, those who live and work in the watershed will develop the motivation and sense of stewardship necessary to participate in activities that enhance their local environment. Awareness and appreciation of local history may be achieved through public celebrations and descriptive signage or plaques, or by taking advantage of resources in the community, such as local museums, the local history sections at libraries, collections of old photographs and maps, and genealogical and cemetery records. A comparison of the present watershed with that of the past might provide a focus for future recognition of what has been retained as well as target those areas in need of regeneration.

DEFINITIONS

Archaeological Resources are defined as: The remains of any building, structure, event, activity, place or cultural feature or object that, because of the passage of time, is on or below the surface of the land or the water and is associated with Aboriginal history (pre-A.D.1608) or the historic period (post-A.D.1608) in Ontario.

Architectural Resources are defined as: Buildings, structures, or remains built by people, which reveal some of the broad architectural, cultural, social, political, economic, or military patterns of Ontario's Euro-Canadian history or are associated with specific events or people that have shaped Euro-Canadian history. These would include resources, such as individual buildings, groups of buildings, historic settlements, foundations, cemeteries, barns and other outbuildings, fences, bridges, roadways, etc. Architectural Resources of outstanding historical or architectural character can be protected under the Ontario Heritage Act by being "designated". This procedure requires the passing of a By-law by the local municipal government. Architectural Resources considered as potential or candidates for this protective measure are defined as "listed".

Cultural/Heritage Landscapes are defined as: Any discrete aggregation of features made by people where the arrangement of the features that exist in conjunction with one another is representative of distinct cultural processes in the present, and historical development and use of the land within the watershed. Cultural landscapes include any scenic/heritage or contemporary area perceived as an ensemble of culturally derived landscape features, such as a neighbourhood, a townscape, landscape, or waterscape that illustrates noteworthy relationships between people and their surrounding environment.

For practical purposes historic landscapes may be considered as part of, or a subset of, the cultural landscape but are differentiated by their historical merit. They can be remnant or existing landscapes but have a specific association to historical events, people, heritage building(s)/structures or archaeological sites. They can be clearly identified as providing an important contextual and spatial relationship necessary to preserve, interpret, or reinforce the understanding of important historical resources, settings, and past patterns of land use.

GOAL

TO PRESERVE AND INTERPRET OUR EVOLVING HUMAN HERITAGE RESOURCES

Duffins	Carruthers
Fair	Fair

#20

OBJECTIVE #20
Identify and document human heritage resources for protection

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Ensure the identification of new resources in view of a changing watershed.
- Establish minimum standards for documentation to ensure that evidence of the resource is not lost.
- Strengthen and expand TRCA and Local Architectural Conservation Advisory Committee (LACAC) human heritage inventories.
- Manage existing resources (considering best management practices).
- Develop probability models for prehistoric archaeological sites as an aid for responsible planning.

INDICATORS	MEASURES	TARGETS
number of human heritage resources	number of registered archaeological sites	maintain or increase the number of registered archaeological sites
	number of designated structures (i.e., built heritage)	maintain or increase the number of designated structures
	number of listed structures (not yet designated)	

#21

OBJECTIVE #21
Increase awareness and appreciation of the inherent value of human heritage resources

Duffins	Carruthers
Fair	Poor

MANAGEMENT ACTIONS

- Develop additional community-based human heritage projects to educate the public, such as programs offered at the Pickering Museum Village in Greenwood.
- Encourage the development of a community-based plan to incorporate human heritage values and themes into the local community fabric (e.g., signage for historic communities, streets and public buildings with historic names or descriptions, as well as trail guides/maps).

- Promote the link between human and natural heritage resources (e.g., interpretive signs placed at rehabilitation sites, which describe the past environment and human presence/influence in the area).
- Promote/foster partnerships between human heritage organizations and environmental groups (e.g., self-guided heritage tours combined with birding opportunities).
- Encourage local media to include stories on human heritage issues.
- Provide opportunities for pre-1615 and local Euro-Canadian history in the school curriculum.
- Build partnerships between human heritage organizations, municipal agencies, funding partners, and community interest groups.
- Promote the economic benefits of human heritage resources; for example, incorporate historic buildings into new subdivision plans as businesses or as local community centres rather than demolishing every one.
- Establish an integrated tourism plan involving human heritage resources in coordination with existing eco-tourism opportunities.
- Develop active revenue-producing human heritage facilities and programs that can assist in sustaining non-revenue producing programs.

INDICATORS	MEASURES	TARGETS
awareness and appreciation	per cent of population that places value on human heritage	net increase of awareness and appreciation of human heritage

#22

OBJECTIVE #22

Apply a standardized approach to protecting human heritage resources at all levels of government*

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Resolve legal uncertainties and inconsistencies with respect to human heritage resources among municipalities, developers, and other stakeholders.
- Develop criteria for priority setting (i.e., best management practices) for built heritage (i.e., historic buildings and other structures).
- Develop a standardized approach for built heritage site identification and protection.*
- Achieve cooperation by all local Architectural Conservation Advisory Committees in using the standardized approach for identifying, recording, and managing built heritage resources.
- Maintain the use of standardized Ministry of Culture approach as a minimum in identification and protection of archaeological sites and, where possible, enhance to TRCA standards.

INDICATORS	MEASURES	TARGETS
standardized approach	number of agencies that agree to apply a standardized approach	one hundred per cent agreement and application

* as for identified archaeological sites in Archaeological Resource Management Procedures: Guidelines (TRCA, 2002)

6.12 SUSTAINABLE COMMUNITIES

The Task Force's Management Philosophy for the Duffins and Carruthers watersheds recognizes that sustainable watersheds located adjacent to Canada's largest city must support a balance of natural, urban, and rural agricultural land uses to insure the integrity of watershed functions. This balance can be achieved at three levels: the regional scale, the watershed scale, and the community scale by identifying opportunities to enhance and integrate natural functions.

Appropriate provisions must be established to ensure that each land use and its associated activities remains a healthy and viable component of the watershed.

Sustainable living involves the behaviours, lifestyle choices and approaches of everyday life that cumulatively affect our natural environment. New information and new ways to define sustainable communities and sustainable living continue to evolve.

This chapter is intended as a starting point in capturing the key concepts, definitions, and practices of sustainable communities and how they can be incorporated into the implementation of this Watershed Plan.

Some of the following wording builds off of Chapter 7, City and Countryside Strategy, of the TRCA's publication entitled Greening Our Watersheds: Revitalization Strategies for Etobicoke and Mimico Creeks.

What is Sustainability?
Sustainability provides a new way of seeing challenges and opportunities by using an integrated approach or a "sustainability lens". The sustainability lens requires us to consider economic, social, and environmental interactions to look for multiple long-term benefits, fundamental to a watershed's form and function.

In the context of land management, the basis for an integrated approach is described in Chapter 10 of Agenda 21 as follows:

"Land resources are used for a variety of purposes which interact and may compete with one another; therefore, it is desirable to plan and manage all uses in an integrated manner. Integration should take place at two levels, considering, on the one hand, all environmental, social, and economic factors (including for example, impacts of the various economic and social sectors on the environment and natural resources) and, on the other, all environmental and resource components together (i.e., air, water, biota, land, geological, and natural resources). Integrated consideration facilitates appropriate choices and tradeoffs, thus maximizing sustainable productivity and use. Opportunities to allocate land to different uses arise in the course of major settlement or development projects or in a sequential fashion as lands become available on the market. This in turn provides opportunities to support traditional patterns of sustainable land management or to assign protected status for conservation of biological diversity or critical ecological services."

Tools to Envision Sustainable Communities

Agenda 21 is the global blueprint for action signed by the 179 heads of state at the United Nations Conference on Environment and Development (Earth Summit), held in Rio de Janeiro, Brazil in 1992, and reinforced in 2002 at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa. It provides a guide to socially, economically, and environmentally sustainable issues related to growth and development.

At the recent WSSD, local government representatives from around the globe tabled a statement to world leaders, calling for a shift from agenda to action for sustainable development.

The Earth Charter and the Melbourne Principles were identified as tools to help communities envision healthy, vibrant, and sustainable cities where people respect one another and nature, to the benefit of all. Durham Region, the City of Pickering, and TRCA have all endorsed the Earth Charter (visit www.earthcharter.org).

The Melbourne Principles along with the report on the workshop can be downloaded from the United Nations Environment Program (UNEP/IETC) website: http://www.unep.

In his 2001-2002 Annual Report entitled Developing Sustainability, the Environmental Commissioner for Ontario stated that we have the wealth and the knowledge in Ontario to do things properly. The challenge he identified was to think about the broad impacts of our decisions on all of society. Sustainability compels us to consider and address what environmental economists call the "external costs" of our actions and technologies, such as damage to our ecological systems. It implores us to think about long-term consequences of our decisions and our lifestyle choices for future generations such as damage to our ecological and social systems.

Perhaps some of the confusion over sustainable development lies in the perceived contradiction between sustainability and development. Development has been largely understood as economic growth, whereas sustainable development means finding the balance between the economic, soci-

etal, and environmental aspects of development in order to leave a good legacy for our children and grandchildren.

This Watershed Plan allows us to consider and plan for how development will proceed, in a manner that protects and restores the natural environment while improving the quality of life for watershed citizens. The real challenge is to develop, test, and apply approaches and policies to advance the goal of sustainability.

Sustainable Development Strategies

In 1997, the Canadian Parliament directed all federal departments to create and implement sustainable development strategies, to be reviewed every three years.

Environment Canada's Sustainable Development Strategy focuses on four priority areas: knowledge for decision making, incentives, partnerships and sustainable communities, and managing for sustainable development.

In November of 2002, the Prime Minister's Caucus Task Force on Urban Issues released "Canada's Urban Strategy: A Blueprint for Action", with its vision of urban sustainability, which includes economic competitiveness, social harmony, a sustainable environment, urban revitalization, and education skills. These strategies at various levels of government confirm that sustainable development is a consistent priority and that local applications (as in the Duffins and Carruthers creek watersheds) are needed for implementation and to demonstrate progress.

Smart Growth and Sustainable Community Planning

Sustainability provides the principles and integrated framework to guide land use planning and urban design. At many government levels, there is a growing recognition of the need for a new approach to land use planning and urban design.

In Canada, smart growth has its precedent rooted in programs such as The Ontario Healthy Communities Coalition (founded in the early 1990s), The Ontario Round Table on the Environment and the Economy (1989 to 1995), and The Conservation Council of Ontario, in support of the Green Ontario Campaign (1996 to present).

Smart Growth Principles

- Create a range of housing opportunities and choices
- Create walkable neighbourhoods
- Encourage community and stakeholder collaboration
- Foster distinctive, attractive areas with a strong sense of place
- Make development decisions predictable, fair, and cost effective
- Mix land uses
- Preserve open space, farmland, natural beauty, and critical environmental areas

- Provide a variety of transportation choices
- Strengthen and direct development towards existing communities.

Taken from Smart Growth Online, www.smarthgrowth.org, A Service of the SmartGrowth Network, May 2003

At the provincial level, the Smart Growth Secretariat, part of the Ministry of Municipal Affairs and Housing, oversees Ontario Smart Growth. The Secretariat's vision of Smart Growth is based on three principles: a strong economy; strong communities; and a clean, healthy environment. Its purpose is to develop comprehensive growth-management plans shaped by comments provided through public consultation. In the Central Ontario Smart Growth zone the vision addresses thriving, livable, safe, and productive urban and rural areas; the coordination of broad level infrastructure planning, including an integrated transportation network; and a healthy natural environment. Core concepts to achieving smart growth are the importance of preserving high-quality agricultural lands as well as compact urban settlement.

Local initiatives applicable to sustainable watersheds are specific and well defined. The review panel for the North Pickering Land Exchange, for example, developed principles to promote an innovative, sustainable community in Pickering on the Seaton lands. The City of Pickering's Growth Management Study outlines principles, which have a focus that reflect a shift in land use planning toward sustainability.

Sustainable communities are designed with nature and community in mind. They are to be compact, mixed in land uses, support transit use and pedestrian orientation and use green infrastructure and building technologies. Drawing from the principles of integrated water management, the "Green Development Approaches" identified below are aspects of sustainable community design that are critical for realizing our vision of healthy and sustainable watersheds.

Green Development Approaches

(Modified from Tetra Tech, 1996)

- Flexible zoning and subdivision resolutions
- Management of growth through agriculture and natural resource preservation
- Comprehensive and integrated site planning
- Reduction in imperviousness
- Restoration of site hydrologic regime to mimic predevelopment condition
- Maintenance of surface water and groundwater quality
- Minimization of the generation and the off-site transport of pollutants
- Enhance riparian habitat functions

There are many good sources of information to guide the components of sustainable community design, those resources most frequently used by TRCA are listed in Table 6-2.

TABLE 6-2: Sustainable Community Design Resources

DESIGN COMPONENT	RESOURCES
ecological/landscape design urban patterns follow natural features and processes of the watersheds.	Hough, M. 1995. Cities and Natural Processes. Van der Ryn, Sim & Cowan, S. 1996. Ecological Design. Wackernagel, M. & William Rees. 1996. Our Ecological Footprint: Reducing Human Impact on the Earth.
compact communities including transit and pedestrian-oriented developments.	Ontario Round Table on the Environment and Economy. 1995. Sustainable Communities Resource Package. King, Lisa. 1999. Sustainable Community Planning. Roseland, Mark et al. 1998. Toward Sustainable Communities; Resources for Citizens and their Governments.
green infrastructure including transportation, communications, energy, water, and waste systems.	Sheltair Group Resource Consultants Inc. 2001. City Green; A Guide to Green Infrastructure for Canadian Municipalities. Federation of Canadian Municipalities.
green building design and standards.	Natural Resources Canada. C-2000 Integrated Design Process. www.buildingsgroup.nrcan.gc.ca. US Green Building Council. 2000. Green Building Rating System. Version 2. TRCA. 2003. Green Design Criteria.
policies and legislation: overcoming barriers.	Peck & Associates. 2000. Implementing Sustainable Community Development: Charting a Federal Role for the 21st century. CMHC. Pim, Linda & Joel Ornoy. 2002. A Smart Future for Ontario. Federation of Ontario Naturalists.

Carrying Capacity: Our Ecological Footprint

Carrying capacity is a term that addresses the extent and types of development a watershed can sustain before an unacceptable amount of social and environmental degradation takes place. The amount of resources available, the size of the population, and the amount of resources each individual consumes determine carrying capacity.

Collectively, all of the strategies contained in this document provide the technical framework for achieving ecological sustainability in these watersheds. This Watershed Plan and its supporting reports are intended to provide technical data and guidance to the local and regional municipali-

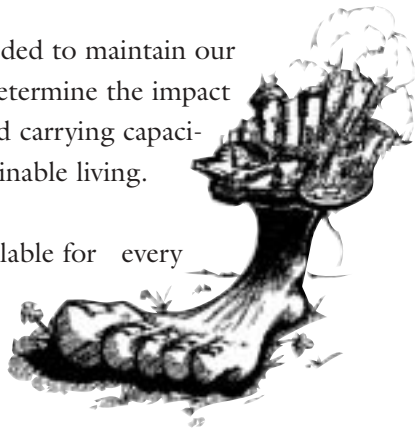
ties, and senior levels of government so they can make informed land use decisions that are within the carrying capacity of the Duffins and Carruthers creek watersheds.

On the following pages, objectives 23-25 prescribe actions that can be taken in the areas of education and awareness for sustainable living and sustainable community design, and to begin to monitor progress toward sustainable watersheds.

Our actions in these watersheds have impacts globally, they are designed to reduce our ecological footprint and thus live within the carrying capacity of the Earth.

How Big is your Footprint?

The Ecological Footprint is a calculation of the land area needed to maintain our current lifestyles. It is an education and accounting tool to determine the impact of people on nature. The footprint tool help us to understand carrying capacity and to identify simple steps that we can take towards sustainable living.



There are approximately two hectares of productive land available for every person on our planet, whereas the average citizen worldwide has a footprint of 2.7 hectares and the average Canadian footprint is 7.7 hectares.

To take the ecological footprint test, and for more information, see the Redefining Progress website at www.redefiningprogress.org.

Every Effort Counts

A commitment to sustainability must be made at all levels where major planning decisions occur. Change also occurs through individuals and community sectors making adjustments in all aspects of their daily lives — in recreation, business, and home practices – as much as through good governance. The forces that make sustainable choices more attractive and feasible for individuals are as important as public awareness and action.

Each stakeholder has a different level of interest, awareness, and involvement with the watersheds. Each will be motivated to learn differently, some through formal programs and others through informal means. Each will have a unique cultural and societal perspective and a different capacity to affect change. Reaching such a diverse range of stakeholders requires a variety of outreach methods.

Through awareness programs, we may overcome the common perception that small actions are insignificant. We need to promote the message that, while they may be immeasurable on their own, all efforts count. Cumulatively, every effort contributes to achieving our goal of sustainability in the management of these watersheds.

GOAL

TO ACHIEVE A BEHAVIOURAL SHIFT IN LIFESTYLES AND RESOURCE USE IN KEEPING WITH THE ENVIRONMENTAL OBJECTIVES FOR THE WATERSHEDS

Duffins	Carruthers
Fair	Fair

#23

OBJECTIVE #23

Increase awareness of watershed issues and use of available watershed knowledge in decision making to foster sustainability and sustainable living practices

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Integrate Duffins and Carruthers watershed knowledge into the delivery of the formal education curriculum and promote local and global environmental education in the classrooms.
  - Continue formal education at the Claremont Residential Field Centre, where students and youth are immersed in two-to five-day experiential learning programs.
  - Continue the Watershed on Wheels Outreach Education Program, which brings learning opportunities directly to schools and communities.
- Use watershed community activities such as stewardship/regeneration projects, municipal parks and recreation programs, stream clean-ups, and other community-led events as a venue to disseminate watershed information and promote life-long learning for all citizens of the watershed.
- Make all watershed information from this and future studies readily available through a variety of ways including public libraries, websites and CD-Rom.
- Place signs at all road crossings of the Duffins and Carruthers creek watersheds, identifying the watercourse by name.
- Complete a public opinion poll to increase watershed resident's awareness that they live in the watershed, and gather input into the perceived issues and problems in the watershed.
- Promote sustainable living practices by supporting innovative education and awareness campaigns in the watershed communities.

INDICATORS	MEASURES	TARGETS
awareness	per cent of surveyed population having awareness of watershed issues	increased level of awareness of watershed issues
outdoor environmental education	number of students participating in outdoor education programs	increased number of students participating in outdoor education programs

#24

OBJECTIVE #24
Promote lifestyles that are ecologically sustainable

Duffins	Carruthers
Further study required	Further study required

MANAGEMENT ACTIONS

- Make sustainable choices in every aspect of our lifestyles including housing, food, transportation, gardening, consumption of goods, and production of waste.
- Promote a backyard stewardship program.
- Promote water conservation.
- Recognize, celebrate, and promote sustainable practices through Recognition Awards for residents, businesses, agencies, and institutions.
- Encourage transit use, walking, cycling, and other alternatives to the private vehicle to reduce air pollution.

INDICATORS	MEASURES	TARGETS
water efficiency	amount of water used per capita	reduce the amount of water used per capita
materials and resources	degree of waste generation/diversion	reduce degree of waste generation and increase diversion
energy efficiency	non-renewable energy consumption	decrease non-renewable energy consumption
renewable energy	number of homes and industries using green power	increase proportional use for renewable green versus non-renewable energy

INDICATORS	MEASURES	TARGETS
urban forests	hectares of urban canopy	increase urban canopy
naturalization on private lands	hectares of naturalized lawns and gardens	increase hectares of naturalized lawns and gardens
stewardship initiatives	participation in stewardship initiatives	increase participation in stewardship activities

#25

OBJECTIVE #25
Use sustainable urban design approaches to guide urban growth and development

Duffins	Carruthers
Fair	Fair

MANAGEMENT ACTIONS

- Promote the Watershed Plan and its supporting technical reports as the framework for achieving ecological sustainability as development proceeds in Duffins and Carruthers creeks.
- Promote the use of innovative community designs, such as eco-villages, transit-oriented compact communities, eco-housing, and new urbanism.
- Advocate for designing new communities with consideration for ease of transit use and walking or cycling routes.
- Promote full cost water pricing and other full cost accounting practices (e.g., for development or capital works proposals) that have consideration for long-term environmental, social, and economic costs.
- Encourage universities and community colleges to focus graduate research on the Duffins Creek and Carruthers Creek watersheds to advance our understanding of sustainable urban growth.

INDICATORS	MEASURES	TARGETS
sustainable communities	application of sustainable community principles	increased per cent of land developed or redeveloped using sustainable community principles
development type/form/location	public transit opportunities	increase public transit opportunities

INDICATORS	MEASURES	TARGETS
development type/form/ location	neighbourhood mixture of jobs, shops, and housing	increase percentage of neighbourhoods offering a mixture of jobs, shops, and housing
	density	increase percentage of urban areas that are high density

6.13 INTEGRAL MANAGEMENT ACTIONS

Sections 6.5 to 6.12 presented detailed lists of management actions that are necessary to achieve the Watershed Plan's objectives. A number of these actions are repeated, in that they contribute toward the fulfillment of numerous objectives, or are considered important because they often have benefits that are realized upstream, downstream, or well beyond their site specific application. These particular management actions are considered to be so important that they are integral to the overall health of the watersheds. These integral management actions should be afforded top priority for implementation.

INTEGRAL MANAGEMENT ACTIONS

1. Protect existing meadows, wetlands, and forests identified in the enhanced terrestrial natural heritage system and secure lands to be restored.

2. Actively restore areas within the enhanced natural heritage system, which contribute to multiple watershed benefits, and allow passive restoration to occur in the remaining areas.

3. Provide stormwater quantity and quality controls for new and existing development, including transportation corridors.

4. Manage land uses and water withdrawals to maintain or enhance infiltration patterns, groundwater pathways, and resultant baseflows.

5. Eliminate the remaining point source of pollution (i.e., Stouffville Water Pollution Control Plant) and manage non-point sources of pollution, in particular stormwater runoff and infiltration from urban land uses, transportation corridors and rural contributions.

6. Enforce stringent erosion and sediment controls for construction and infrastructure maintenance activities.

7. Protect and restore natural streams and stream processes by managing runoff and sediment loss at source, and protecting valley and stream corridors, and naturalizing altered streams.

8. Remove and/or mitigate human-built barriers to fish passage and sediment transport, including on-line ponds, where recommended by the Fisheries Management Plan.

9. Maintain self-sustaining, resident/migratory fish and wildlife populations as barometers of a healthy natural heritage system.

10. Identify and raise awareness of past and present human influences on the watersheds and the strong link between human heritage, watershed recreation, and human and environmental health.

CHAPTER

7

7.0 THE SUBWATERSHEDS

In developing this Watershed Plan, the Task Forces deliberated regarding the appropriate level of detail and the best format to convey information to those people who would embrace and endorse its implementation. They recognized that there was a need to divide the work into manageable pieces, and to identify its application at the local level in order to ensure clarity and direction for implementation. In other words, the steps required to implement this plan had to be presented at the "ground level".

In order to address implementation opportunities at the local level, the study area was divided into seven components. Duffins Creek was divided into six drainage areas or subwatersheds. These subwatersheds are outlined in Figure 7.1 and include West Duffins Creek, East Duffins Creek, Ganatsekiagon Creek, Urfe Creek, Millers Creek, and Lower Duffins Creek. The Carruthers Creek watershed makes up the seventh drainage area (Figure 7.2).

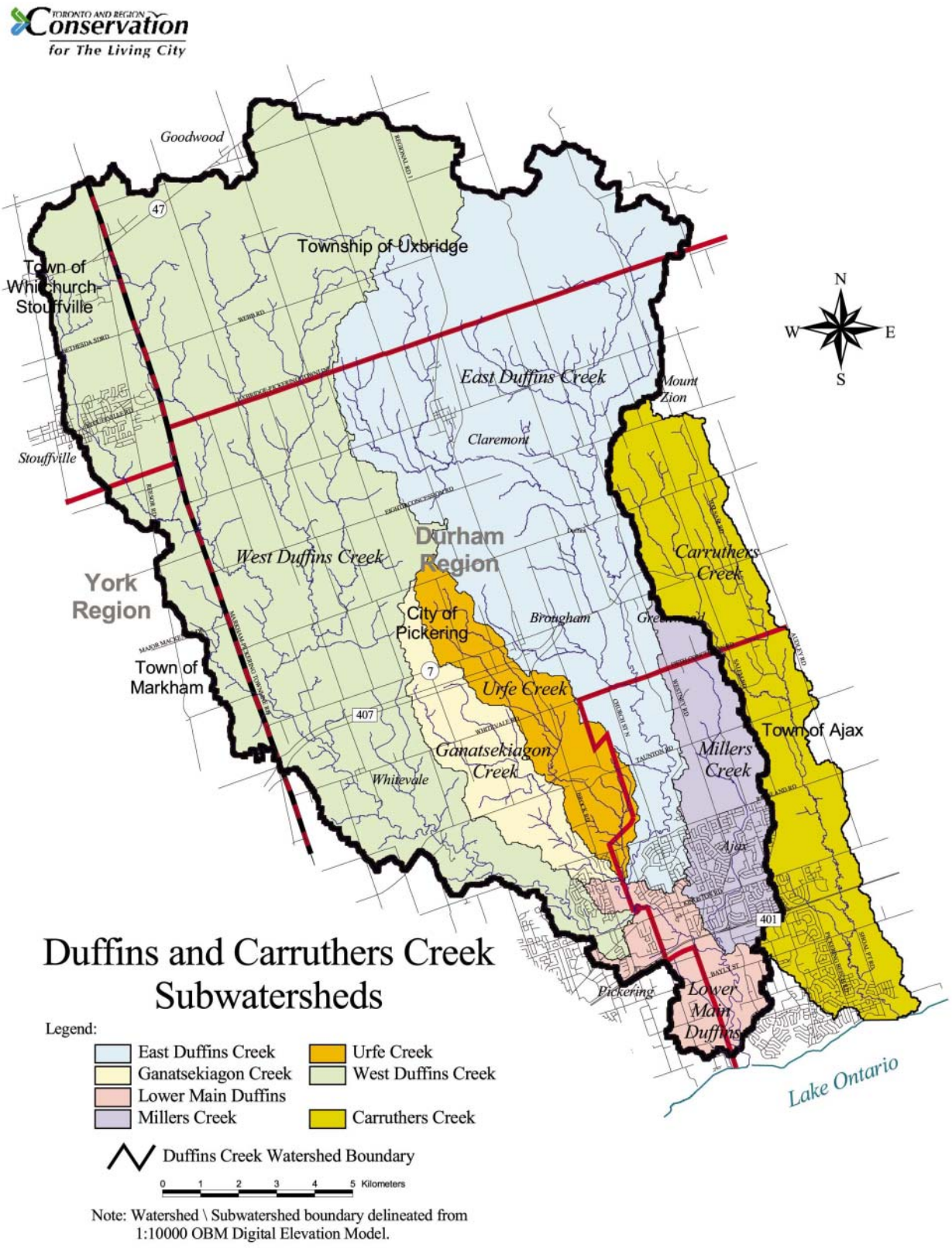

TORONTO AND REGION Conservation for The Living City
Goodwood
Township of Uxbridge
Town of Whitchurch-Stouffville
Stouffville
East Duffins Creek
Mount Zion
Claremont
West Duffins Creek
Durham Region
York Region
Carruthers Creek
City of Pickering
Brougham
Town of Markham
Urfe Creek
Town of Ajax
Ganatsekiagon Creek
Millers Creek
Whitevale
Ajax
Pickering
Lower Main Duffins
Lake Ontario
N
W
E
S
47
7
407
401
Duffins and Carruthers Creek Subwatersheds
Legend:
East Duffins Creek
Ganatsekiagon Creek
Lower Main Duffins
Millers Creek
Urfe Creek
West Duffins Creek
Carruthers Creek
Duffins Creek Watershed Boundary
0 1 2 3 4 5 Kilometers
Note: Watershed \ Subwatershed boundary delineated from 1:10000 OBM Digital Elevation Model.

FIGURE 7.1

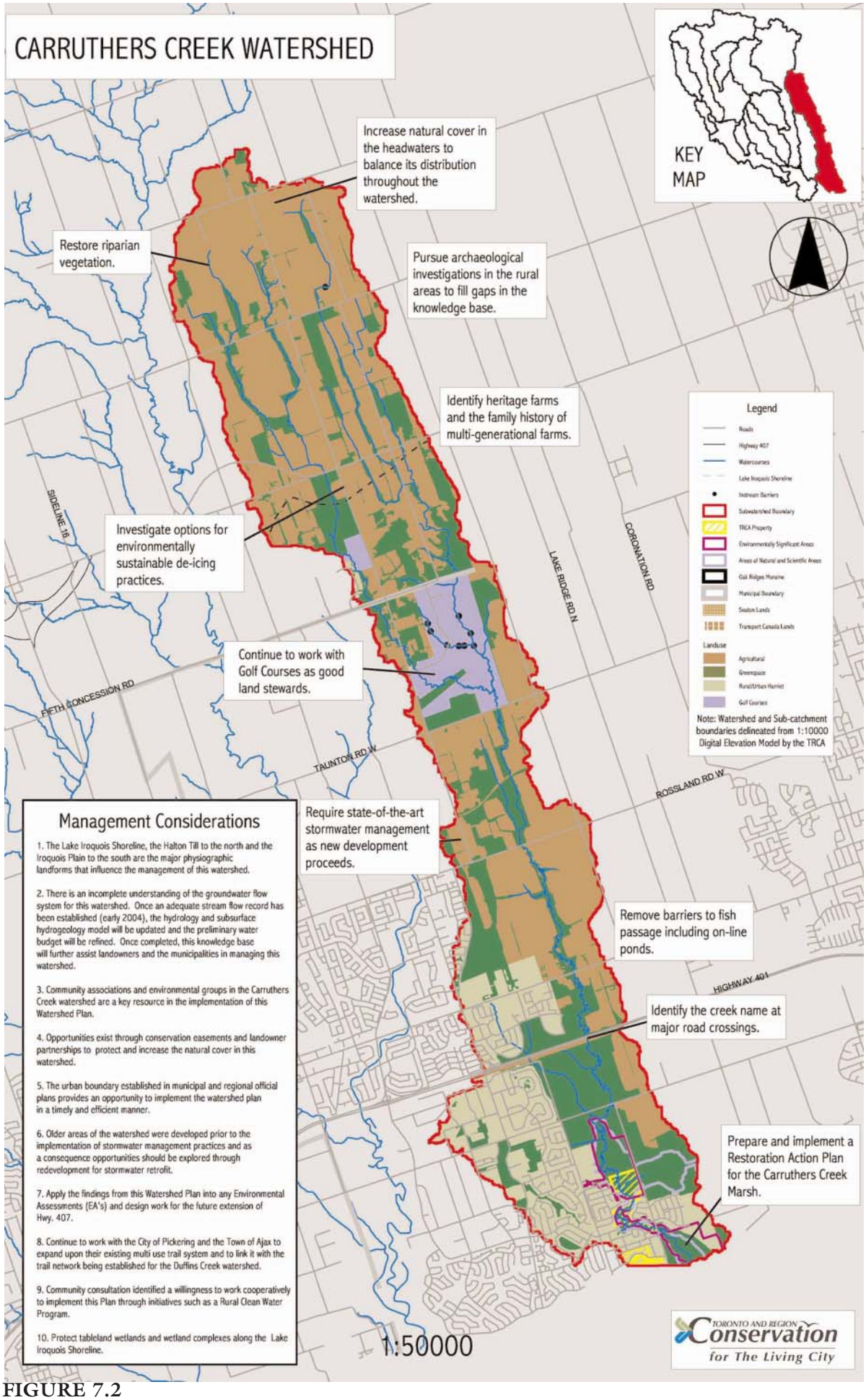

CARRUTHERS CREEK WATERSHED
KEY MAP
Increase natural cover in the headwaters to balance its distribution throughout the watershed.
Restore riparian vegetation.
Pursue archaeological investigations in the rural areas to fill gaps in the knowledge base.
Identify heritage farms and the family history of multi-generational farms.
Investigate options for environmentally sustainable de-icing practices.
Continue to work with Golf Courses as good land stewards.
Require state-of-the-art stormwater management as new development proceeds.
Remove barriers to fish passage including on-line ponds.
Identify the creek name at major road crossings.
Prepare and implement a Restoration Action Plan for the Carruthers Creek Marsh.
SIDELINE 16
FIFTH CONCESSION RD
TAUNTON RD W
LAKE RIDGE RD N
CORONATION RD
ROSSLAND RD W
HIGHWAY 401
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
Management Considerations
1. The Lake Iroquois Shoreline, the Halton Till to the north and the Iroquois Plain to the south are the major physiographic landforms that influence the management of this watershed.
2. There is an incomplete understanding of the groundwater flow system for this watershed. Once an adequate stream flow record has been established (early 2004), the hydrology and subsurface hydrogeology model will be updated and the preliminary water budget will be refined. Once completed, this knowledge base will further assist landowners and the municipalities in managing this watershed.
3. Community associations and environmental groups in the Carruthers Creek watershed are a key resource in the implementation of this Watershed Plan.
4. Opportunities exist through conservation easements and landowner partnerships to protect and increase the natural cover in this watershed.
5. The urban boundary established in municipal and regional official plans provides an opportunity to implement the watershed plan in a timely and efficient manner.
6. Older areas of the watershed were developed prior to the implementation of stormwater management practices and as a consequence opportunities should be explored through redevelopment for stormwater retrofit.
7. Apply the findings from this Watershed Plan into any Environmental Assessments (EA's) and design work for the future extension of Hwy. 407.
8. Continue to work with the City of Pickering and the Town of Ajax to expand upon their existing multi use trail system and to link it with the trail network being established for the Duffins Creek watershed.
9. Community consultation identified a willingness to work cooperatively to implement this Plan through initiatives such as a Rural Clean Water Program.
10. Protect tableland wetlands and wetland complexes along the Lake Iroquois Shoreline.
1:50000
TORONTO AND REGION Conservation for The Living City

FIGURE 7.2

7.1 CARRUTHERS CREEK

Despite their difference in size, the Duffins Creek and Carruthers Creek watersheds are diverse and contrasting landscapes that share many of the same opportunities and challenges for the future. Based on this point, and the fact that they both flow at different points through the Region of Durham, including the City of Pickering and Town of Ajax, and are subject to the land use planning decisions made by these municipal governments, it seemed logical to prepare one Management Plan for the two watersheds.

It is necessary in the context of this plan to bring forward specific management actions for this watershed that address local issues and opportunities and recognize and incorporate the partnerships, interests, and existing non-government organizations who pioneered efforts to protect and enhance this watershed.

7.2 DUFFINS CREEK

As noted above, the Duffins Creek watershed, for the purpose of this chapter, has been divided into six subwatersheds (Figures 7.3 to 7.8). The East Duffins Creek and West Duffins Creek subwatersheds cover a very large land area. Although implementation actions are not identified at the tributary level on the following maps, it should be noted that significant local tributaries exist within these two large drainage areas. When discussions begin and implementation actions occur in these two subwatersheds, it will be necessary to work at the tributary level of detail using their local names and taking into consideration their ecological functions within the larger basin.

The tributary names are as follows:

WEST DUFFINS CREEK TRIBUTARIES	EAST DUFFINS CREEK TRIBUTARIES
Stouffville Creek	Mitchell Creek
Reesor Creek	Brougham Creek
Wixon Creek	Spring Creek
Major Creek	
Whitevale Creek	

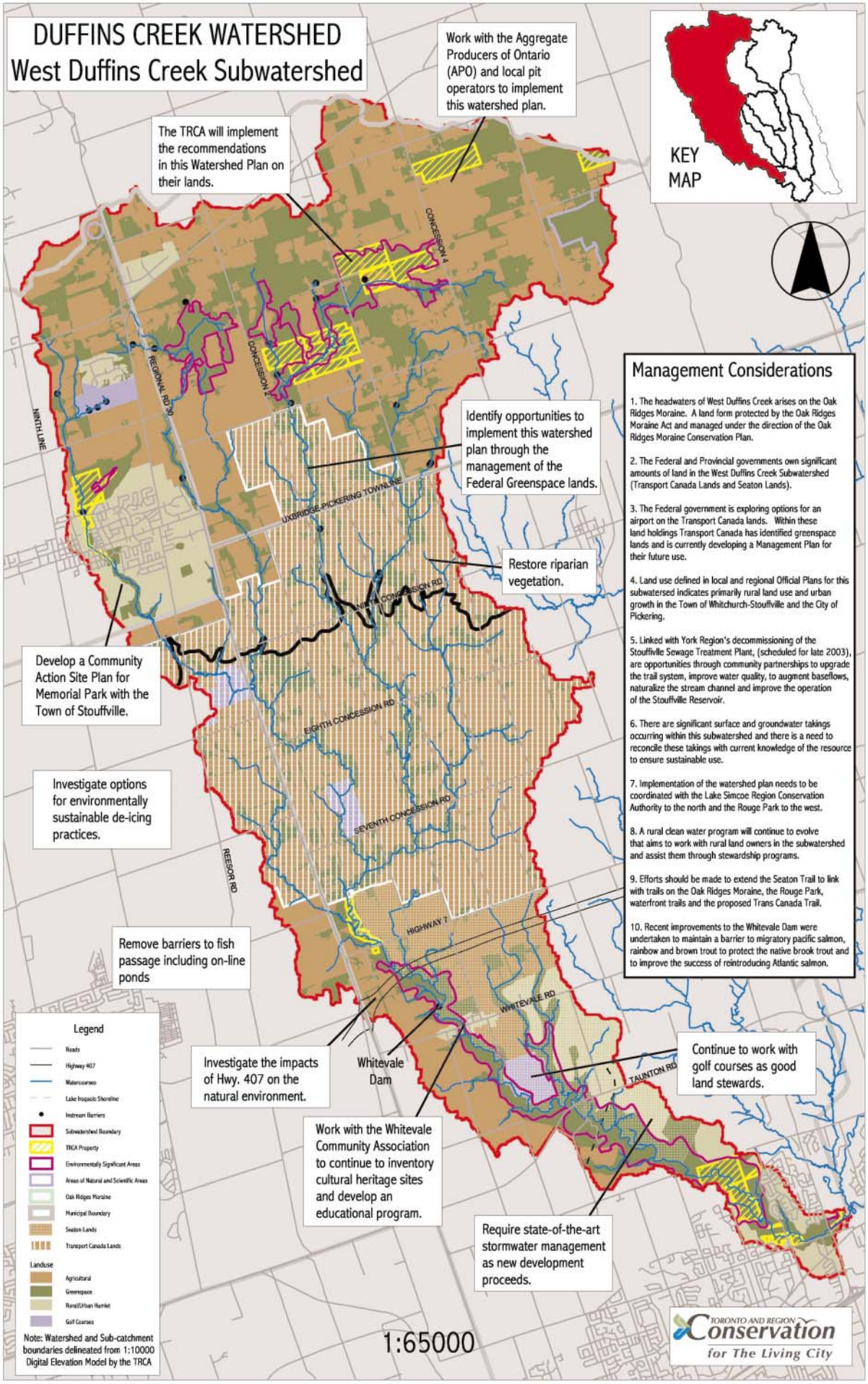

DUFFINS CREEK WATERSHED
West Duffins Creek Subwatershed
Work with the Aggregate Producers of Ontario (APO) and local pit operators to implement this watershed plan.
The TRCA will implement the recommendations in this Watershed Plan on their lands.
KEY MAP
Management Considerations
1. The headwaters of West Duffins Creek arises on the Oak Ridges Moraine. A land form protected by the Oak Ridges Moraine Act and managed under the direction of the Oak Ridges Moraine Conservation Plan.
2. The Federal and Provincial governments own significant amounts of land in the West Duffins Creek Subwatershed (Transport Canada Lands and Seaton Lands).
3. The Federal government is exploring options for an airport on the Transport Canada lands. Within these land holdings Transport Canada has identified greenspace lands and is currently developing a Management Plan for their future use.
4. Land use defined in local and regional Official Plans for this subwatersed indicates primarily rural land use and urban growth in the Town of Whitchurch-Stouffville and the City of Pickering.
5. Linked with York Region's decommissioning of the Stouffville Sewage Treatment Plant, (scheduled for late 2003), are opportunities through community partnerships to upgrade the trail system, improve water quality, to augment baseflows, naturalize the stream channel and improve the operation of the Stouffville Reservoir.
6. There are significant surface and groundwater takings occurring within this subwatershed and there is a need to reconcile these takings with current knowledge of the resource to ensure sustainable use.
7. Implementation of the watershed plan needs to be coordinated with the Lake Simcoe Region Conservation Authority to the north and the Rouge Park to the west.
8. A rural clean water program will continue to evolve that aims to work with rural land owners in the subwatershed and assist them through stewardship programs.
9. Efforts should be made to extend the Seaton Trail to link with trails on the Oak Ridges Moraine, the Rouge Park, waterfront trails and the proposed Trans Canada Trail.
10. Recent improvements to the Whitevale Dam were undertaken to maintain a barrier to migratory pacific salmon, rainbow and brown trout to protect the native brook trout and to improve the success of reintroducing Atlantic salmon.
Identify opportunities to implement this watershed plan through the management of the Federal Greenspace lands.
Restore riparian vegetation.
Develop a Community Action Site Plan for Memorial Park with the Town of Stouffville.
Investigate options for environmentally sustainable de-icing practices.
Remove barriers to fish passage including on-line ponds
Investigate the impacts of Hwy. 407 on the natural environment.
Whitevale Dam
Work with the Whitevale Community Association to continue to inventory cultural heritage sites and develop an educational program.
Continue to work with golf courses as good land stewards.
Require state-of-the-art stormwater management as new development proceeds.
CONCESSION 4
CONCESSION 2
REGIONAL RD 30
NINTH LINE
UXBRIDGE-PICKERING TOWNLINE
EIGHTH CONCESSION RD
SEVENTH CONCESSION RD
REESOR RD
HIGHWAY 7
WHITEVALE RD
TAUNTON RD
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
1:65000
TORONTO AND REGION Conservation
for The Living City

FIGURE 7.3

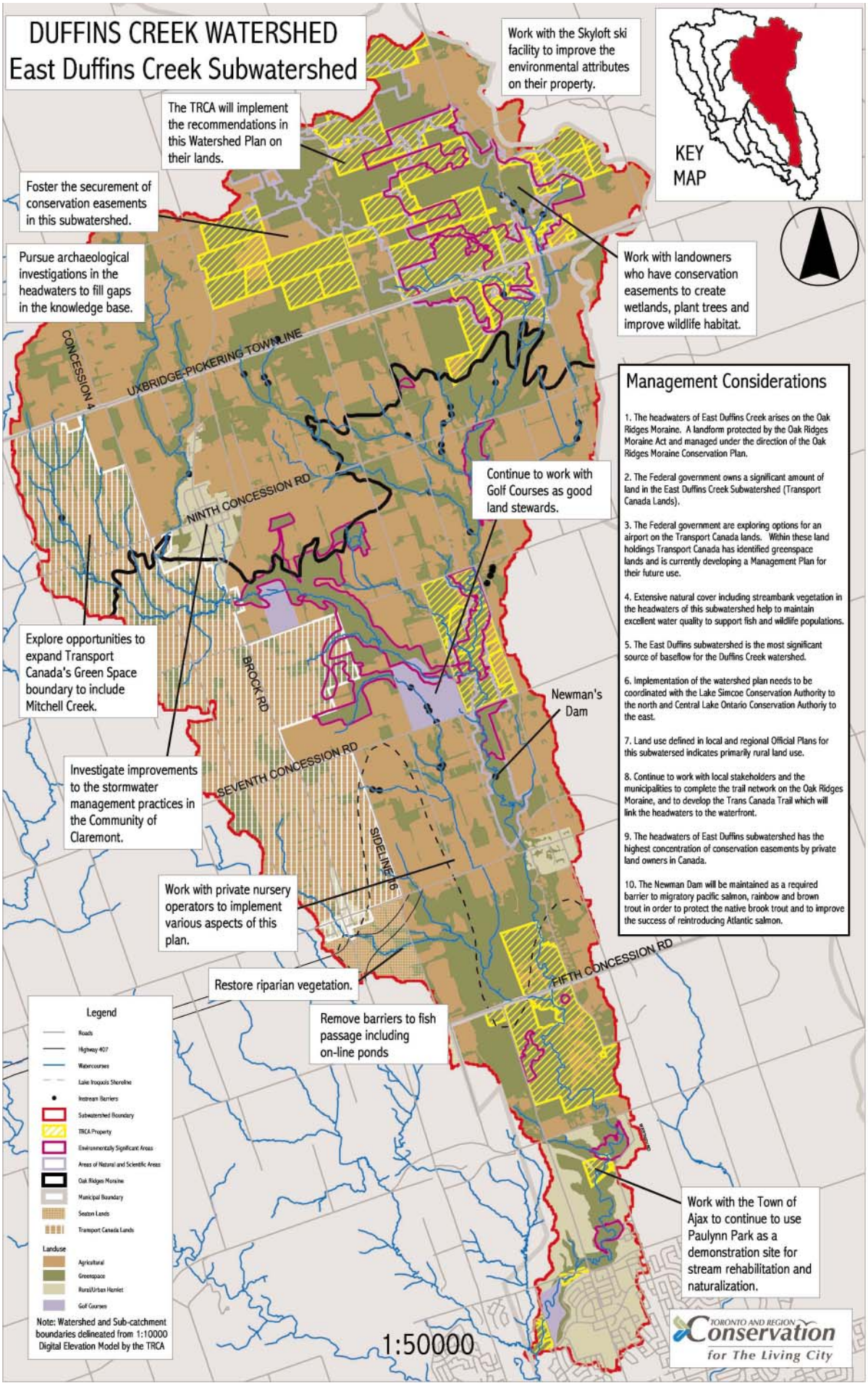

DUFFINS CREEK WATERSHED
East Duffins Creek Subwatershed
Work with the Skyloft ski facility to improve the environmental attributes on their property.
The TRCA will implement the recommendations in this Watershed Plan on their lands.
Foster the securement of conservation easements in this subwatershed.
Pursue archaeological investigations in the headwaters to fill gaps in the knowledge base.
Work with landowners who have conservation easements to create wetlands, plant trees and improve wildlife habitat.
KEY MAP
CONCESSION 4
UXBRIDGE-PICKERING TOWNLINE
NINTH CONCESSION RD
Continue to work with Golf Courses as good land stewards.
Management Considerations
1. The headwaters of East Duffins Creek arises on the Oak Ridges Moraine. A landform protected by the Oak Ridges Moraine Act and managed under the direction of the Oak Ridges Moraine Conservation Plan.
2. The Federal government owns a significant amount of land in the East Duffins Creek Subwatershed (Transport Canada Lands).
3. The Federal government are exploring options for an airport on the Transport Canada lands. Within these land holdings Transport Canada has identified greenspace lands and is currently developing a Management Plan for their future use.
4. Extensive natural cover including streambank vegetation in the headwaters of this subwatershed help to maintain excellent water quality to support fish and wildlife populations.
5. The East Duffins subwatershed is the most significant source of baseflow for the Duffins Creek watershed.
6. Implementation of the watershed plan needs to be coordinated with the Lake Simcoe Conservation Authority to the north and Central Lake Ontario Conservation Authority to the east.
7. Land use defined in local and regional Official Plans for this subwatersed indicates primarily rural land use.
8. Continue to work with local stakeholders and the municipalities to complete the trail network on the Oak Ridges Moraine, and to develop the Trans Canada Trail which will link the headwaters to the waterfront.
9. The headwaters of East Duffins subwatershed has the highest concentration of conservation easements by private land owners in Canada.
10. The Newman Dam will be maintained as a required barrier to migratory pacific salmon, rainbow and brown trout in order to protect the native brook trout and to improve the success of reintroducing Atlantic salmon.
Explore opportunities to expand Transport Canada's Green Space boundary to include Mitchell Creek.
BROOK RD
Newman's Dam
SEVENTH CONCESSION RD
Investigate improvements to the stormwater management practices in the Community of Claremont.
SIDELINE 16
Work with private nursery operators to implement various aspects of this plan.
FIFTH CONCESSION RD
Restore riparian vegetation.
Remove barriers to fish passage including on-line ponds
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
Work with the Town of Ajax to continue to use Paulynn Park as a demonstration site for stream rehabilitation and naturalization.
1:50000
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FIGURE 7.4

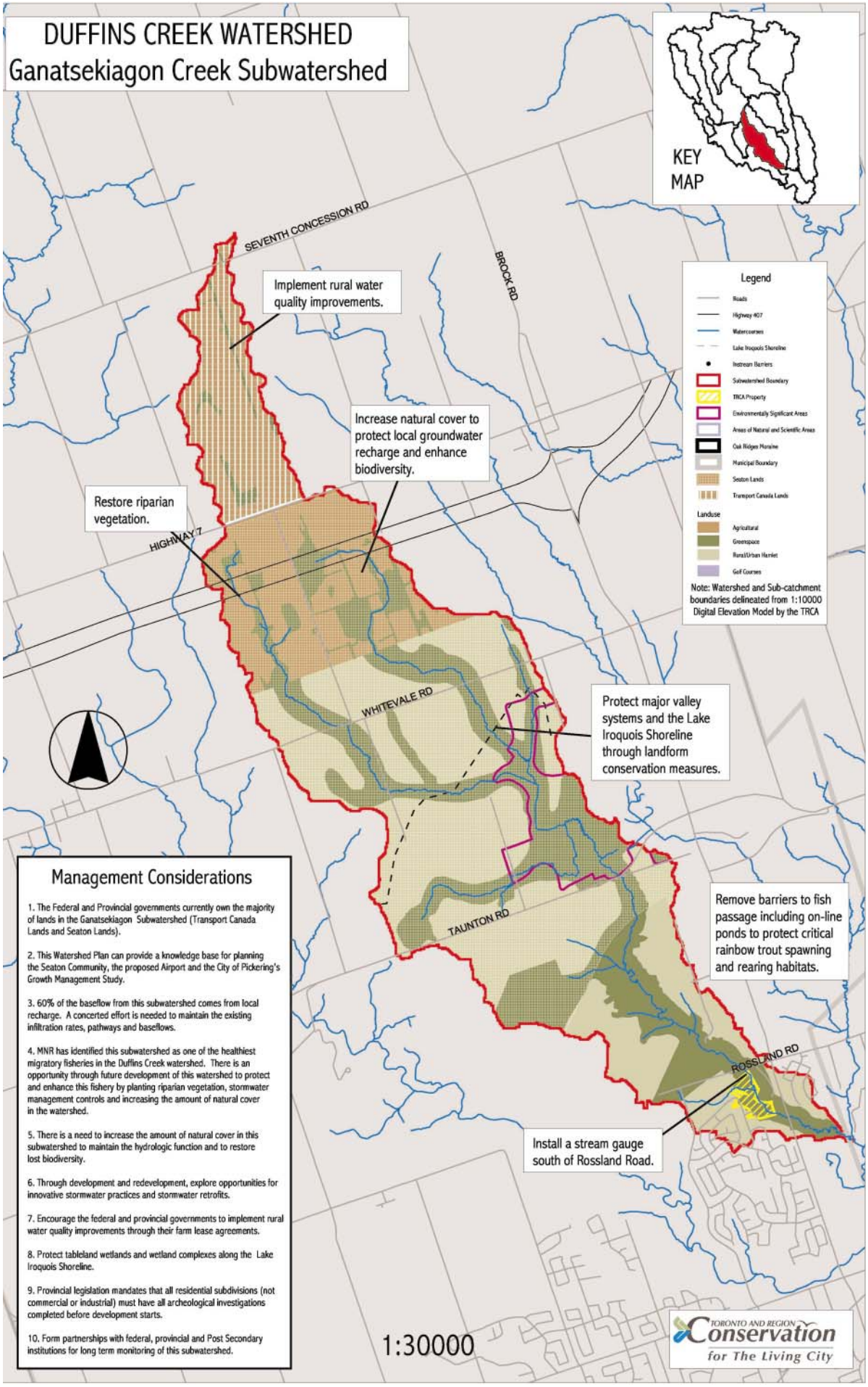
DUFFINS CREEK WATERSHED
Ganatsekiagon Creek Subwatershed
KEY MAP
SEVENTH CONCESSION RD
BROCK RD
HIGHWAY 7
WHITEVALE RD
TAUNTON RD
ROSSLAND RD
Implement rural water quality improvements.
Increase natural cover to protect local groundwater recharge and enhance biodiversity.
Restore riparian vegetation.
Protect major valley systems and the Lake Iroquois Shoreline through landform conservation measures.
Remove barriers to fish passage including on-line ponds to protect critical rainbow trout spawning and rearing habitats.
Install a stream gauge south of Rossland Road.
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
Management Considerations
1. The Federal and Provincial governments currently own the majority of lands in the Ganatsekiagon Subwatershed (Transport Canada Lands and Seaton Lands).
2. This Watershed Plan can provide a knowledge base for planning the Seaton Community, the proposed Airport and the City of Pickering's Growth Management Study.
3. 60% of the baseflow from this subwatershed comes from local recharge. A concerted effort is needed to maintain the existing infiltration rates, pathways and baseflows.
4. MNR has identified this subwatershed as one of the healthiest migratory fisheries in the Duffins Creek watershed. There is an opportunity through future development of this watershed to protect and enhance this fishery by planting riparian vegetation, stormwater management controls and increasing the amount of natural cover in the watershed.
5. There is a need to increase the amount of natural cover in this subwatershed to maintain the hydrologic function and to restore lost biodiversity.
6. Through development and redevelopment, explore opportunities for innovative stormwater practices and stormwater retrofits.
7. Encourage the federal and provincial governments to implement rural water quality improvements through their farm lease agreements.
8. Protect tableland wetlands and wetland complexes along the Lake Iroquois Shoreline.
9. Provincial legislation mandates that all residential subdivisions (not commercial or industrial) must have all archeological investigations completed before development starts.
10. Form partnerships with federal, provincial and Post Secondary institutions for long term monitoring of this subwatershed.
1:30000
TORONTO AND REGION Conservation for The Living City

FIGURE 7.5

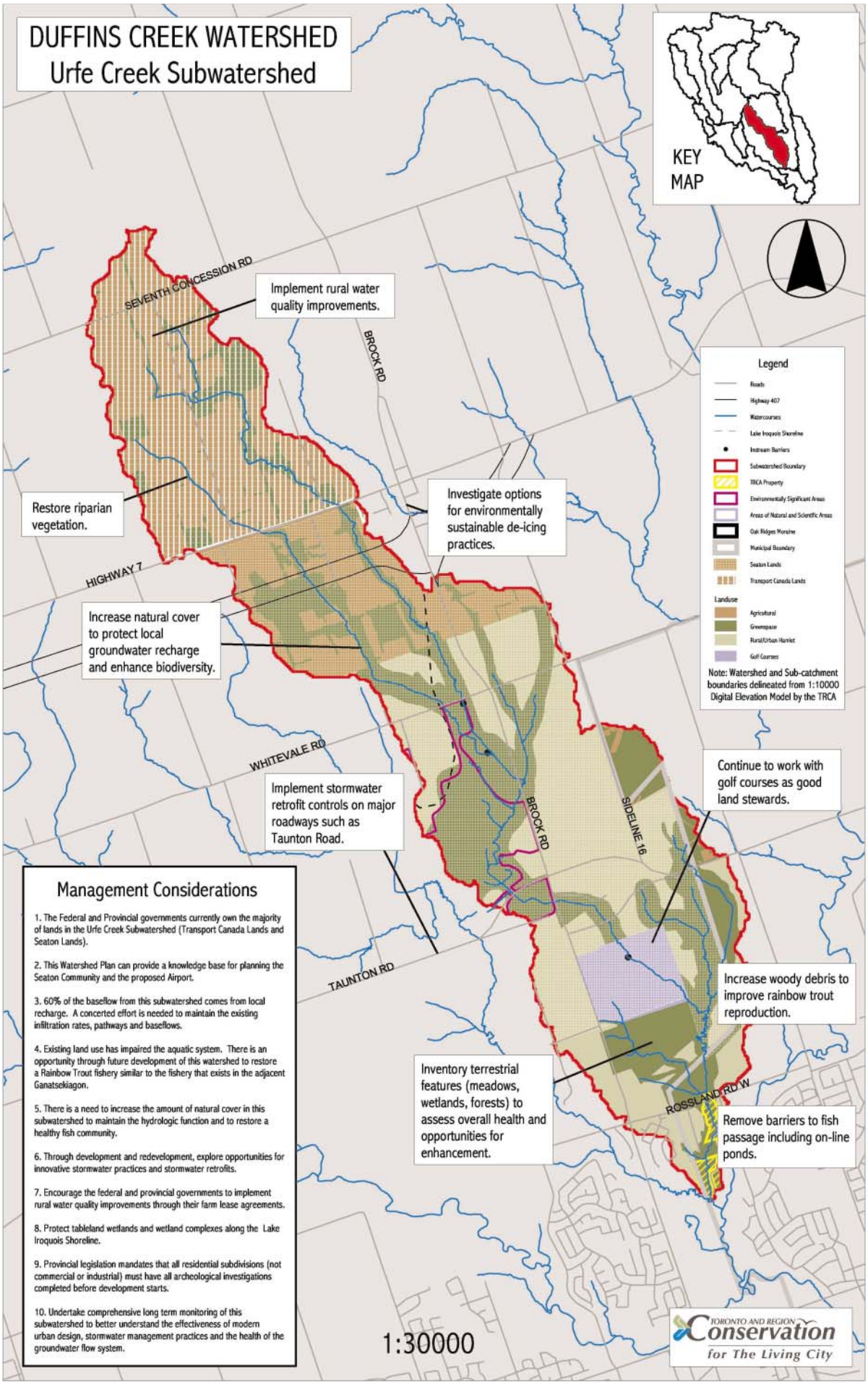
DUFFINS CREEK WATERSHED
Urfe Creek Subwatershed
KEY MAP
SEVENTH CONCESSION RD
Implement rural water quality improvements.
BROCK RD
Restore riparian vegetation.
Investigate options for environmentally sustainable de-icing practices.
HIGHWAY 7
Increase natural cover to protect local groundwater recharge and enhance biodiversity.
WHITEVALE RD
Implement stormwater retrofit controls on major roadways such as Taunton Road.
BROCK RD
SIDELINE 16
Continue to work with golf courses as good land stewards.
TAUNTON RD
Increase woody debris to improve rainbow trout reproduction.
Inventory terrestrial features (meadows, wetlands, forests) to assess overall health and opportunities for enhancement.
ROSSLAND RD W
Remove barriers to fish passage including on-line ponds.
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
Management Considerations
1. The Federal and Provincial governments currently own the majority of lands in the Urfe Creek Subwatershed (Transport Canada Lands and Seaton Lands).
2. This Watershed Plan can provide a knowledge base for planning the Seaton Community and the proposed Airport.
3. 60% of the baseflow from this subwatershed comes from local recharge. A concerted effort is needed to maintain the existing infiltration rates, pathways and baseflows.
4. Existing land use has impaired the aquatic system. There is an opportunity through future development of this watershed to restore a Rainbow Trout fishery similar to the fishery that exists in the adjacent Ganatsekiagon.
5. There is a need to increase the amount of natural cover in this subwatershed to maintain the hydrologic function and to restore a healthy fish community.
6. Through development and redevelopment, explore opportunities for innovative stormwater practices and stormwater retrofits.
7. Encourage the federal and provincial governments to implement rural water quality improvements through their farm lease agreements.
8. Protect tableland wetlands and wetland complexes along the Lake Iroquois Shoreline.
9. Provincial legislation mandates that all residential subdivisions (not commercial or industrial) must have all archeological investigations completed before development starts.
10. Undertake comprehensive long term monitoring of this subwatershed to better understand the effectiveness of modern urban design, stormwater management practices and the health of the groundwater flow system.
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FIGURE 7.6

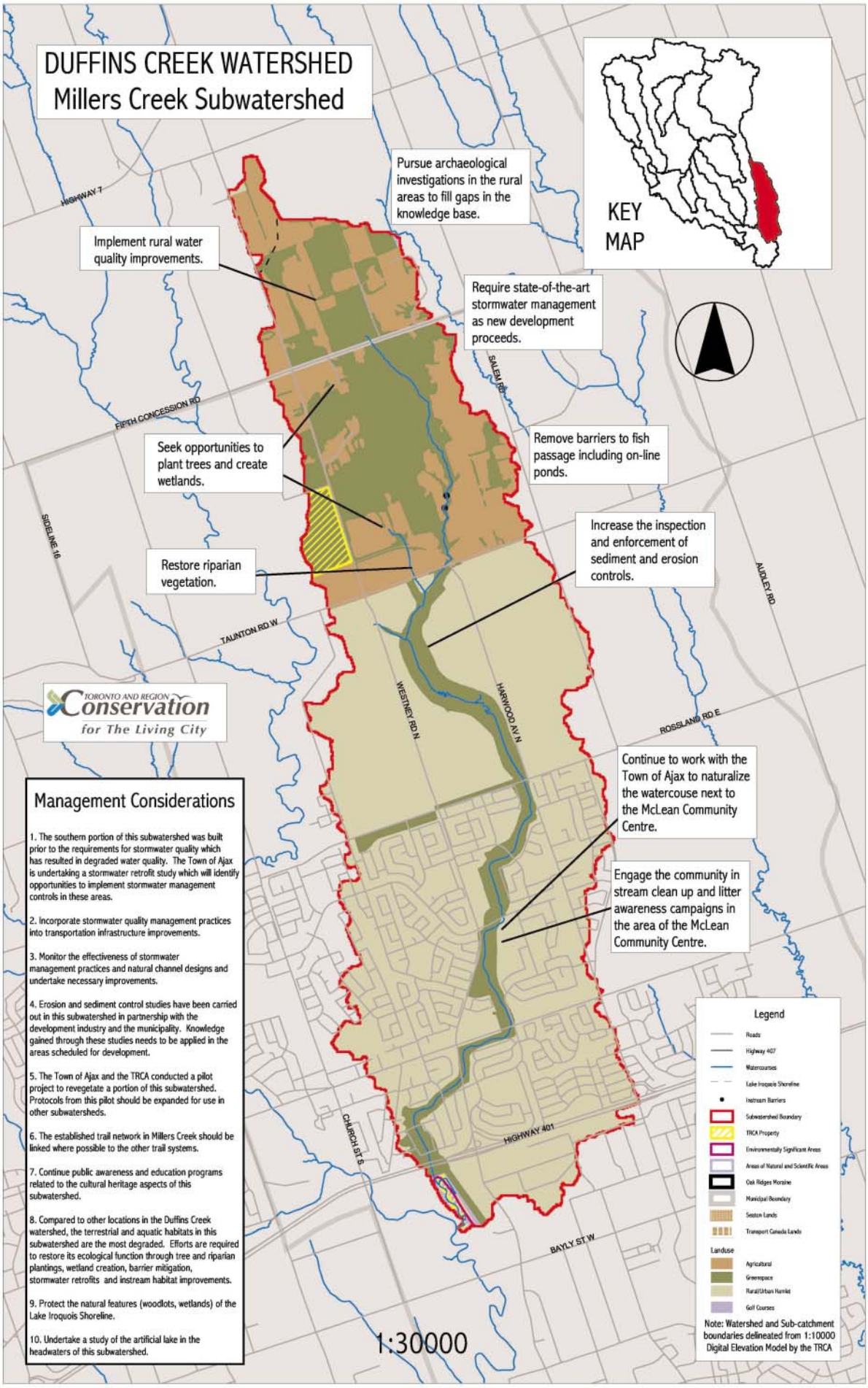
DUFFINS CREEK WATERSHED
Millers Creek Subwatershed
KEY MAP
Pursue archaeological investigations in the rural areas to fill gaps in the knowledge base.
Implement rural water quality improvements.
Require state-of-the-art stormwater management as new development proceeds.
Seek opportunities to plant trees and create wetlands.
Remove barriers to fish passage including on-line ponds.
Restore riparian vegetation.
Increase the inspection and enforcement of sediment and erosion controls.
Continue to work with the Town of Ajax to naturalize the watercouse next to the McLean Community Centre.
Engage the community in stream clean up and litter awareness campaigns in the area of the McLean Community Centre.
HIGHWAY 7
FIFTH CONCESSION RD
SIDELINE 16
TAUNTON RD W
SALEM RD
AUDLEY RD
WESTNEY RD N
HARWOOD AV N
ROSSLAND RD E
CHURCH ST S
HIGHWAY 401
BAYLY ST W
TORONTO AND REGION Conservation for The Living City
Management Considerations
1. The southern portion of this subwatershed was built prior to the requirements for stormwater quality which has resulted in degraded water quality. The Town of Ajax is undertaking a stormwater retrofit study which will identify opportunities to implement stormwater management controls in these areas.
2. Incorporate stormwater quality management practices into transportation infrastructure improvements.
3. Monitor the effectiveness of stormwater management practices and natural channel designs and undertake necessary improvements.
4. Erosion and sediment control studies have been carried out in this subwatershed in partnership with the development industry and the municipality. Knowledge gained through these studies needs to be applied in the areas scheduled for development.
5. The Town of Ajax and the TRCA conducted a pilot project to revegetate a portion of this subwatershed. Protocols from this pilot should be expanded for use in other subwatersheds.
6. The established trail network in Millers Creek should be linked where possible to the other trail systems.
7. Continue public awareness and education programs related to the cultural heritage aspects of this subwatershed.
8. Compared to other locations in the Duffins Creek watershed, the terrestrial and aquatic habitats in this subwatershed are the most degraded. Efforts are required to restore its ecological function through tree and riparian plantings, wetland creation, barrier mitigation, stormwater retrofits and instream habitat improvements.
9. Protect the natural features (woodlots, wetlands) of the Lake Iroquois Shoreline.
10. Undertake a study of the artificial lake in the headwaters of this subwatershed.
1:30000
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA

FIGURE 7.7

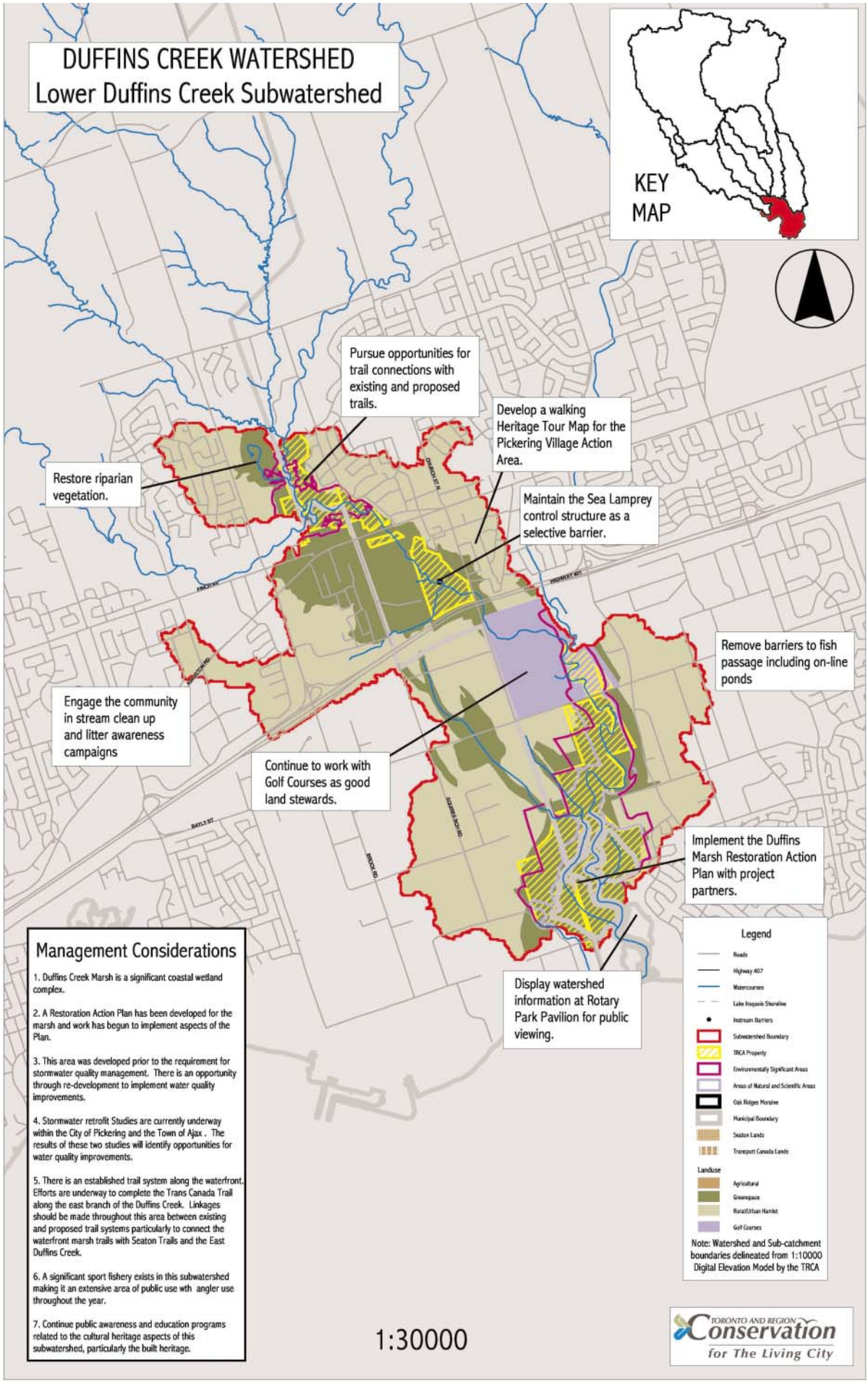
DUFFINS CREEK WATERSHED
Lower Duffins Creek Subwatershed
KEY MAP
Pursue opportunities for trail connections with existing and proposed trails.
Develop a walking Heritage Tour Map for the Pickering Village Action Area.
Restore riparian vegetation.
Maintain the Sea Lamprey control structure as a selective barrier.
Remove barriers to fish passage including on-line ponds
Engage the community in stream clean up and litter awareness campaigns
Continue to work with Golf Courses as good land stewards.
Implement the Duffins Marsh Restoration Action Plan with project partners.
Display watershed information at Rotary Park Pavilion for public viewing.
Management Considerations
1. Duffins Creek Marsh is a significant coastal wetland complex.
2. A Restoration Action Plan has been developed for the marsh and work has begun to implement aspects of the Plan.
3. This area was developed prior to the requirement for stormwater quality management. There is an opportunity through re-development to implement water quality improvements.
4. Stormwater retrofit Studies are currently underway within the City of Pickering and the Town of Ajax . The results of these two studies will identify opportunities for water quality improvements.
5. There is an established trail system along the waterfront. Efforts are underway to complete the Trans Canada Trail along the east branch of the Duffins Creek. Linkages should be made throughout this area between existing and proposed trail systems particularly to connect the waterfront marsh trails with Seaton Trails and the East Duffins Creek.
6. A significant sport fishery exists in this subwatershed making it an extensive area of public use wth angler use throughout the year.
7. Continue public awareness and education programs related to the cultural heritage aspects of this subwatershed, particularly the built heritage.
Legend
Roads
Highway 407
Watercourses
Lake Iroquois Shoreline
Instream Barriers
Subwatershed Boundary
TRCA Property
Environmentally Significant Areas
Areas of Natural and Scientific Areas
Oak Ridges Moraine
Municipal Boundary
Seaton Lands
Transport Canada Lands
Landuse
Agricultural
Greenspace
Rural/Urban Hamlet
Golf Courses
Note: Watershed and Sub-catchment boundaries delineated from 1:10000 Digital Elevation Model by the TRCA
1:30000
TORONTO AND REGION Conservation for The Living City

FIGURE 7.8

7.3 MANAGEMENT CONSIDERATIONS

For the Carruthers Creek watershed and each of the subwatersheds of Duffins Creek, specific management considerations and key management actions have been identified.

Management considerations set a direction and priority to achieve the watershed functions articulated in the Management Plan. They are considerations that should be "kept in mind" as implementation progresses. They provide insight into local considerations, such as the percentage of urbanized land in the area, gaps in data for decision making, public or private land ownership, significant features such as the Oak Ridges Moraine, and how the subwatershed area is influenced by upsteam activities.

Paulynn Park and the Duffins Creek Marsh are just two examples of the opportunities that exist for implementation at the local level that involves community and government partners coming together to choose a location for a "Community Action Site" that can showcase a number of implementation actions, and their collective benefits to the environment.

7.4 MANAGEMENT ACTIONS

The key management actions are action oriented opportunities. They identify opportunities for improvement, such as where stormwater retrofits may be appropriate, barriers that are restricting fish passage, cultural heritage features, recreational opportunities, and potential stream bank and other rehabilitation sites. The combination of the key management actions and the actions outlined in supporting studies, such as the Fish Management Plan, Duffins Marsh Plan, and the Headwaters Management Plan, will provide clear direction on how to improve the existing and future health of Duffins and Carruthers creeks at the local level.

Figures 7.2 to 7.8 illustrate the key management considerations and key management actions for each of the six subwatersheds and the Carruthers Creek watershed. The purpose of these detailed maps is to provide a visual concept and to set the stage for further discussion, groundtruthing, refinement and to develop the details for implementation with local municipalities and community stakeholders.

7.5 COMMUNITY ACTION SITES

Other watershed plans in the Greater Toronto Area have defined the next "local" level of detail, referred to as "Community Action Sites". This model of a Community Action Site has been very successful in the Don River and the Humber River watersheds, where it has provided multiple benefits to the environment and has included cultural heritage and public use components. The most successful Community Action Sites are those that have been community driven, high-profile, and visible to passers-by. They have included multiple partners and met a number of the

objectives identified in their Watershed Plan, with both measurable benefits on-site, and downstream as well. The Caledon East Wetland Community Action Site Opportunities Map is an example of a successful project being implemented in the Humber River Watershed (Figure 7.9).

These Community Action Sites are usually implemented in phases over a number of months, and sometimes years, as partnerships develop and as timing and funding permit. A selected site can include a number of integrated components, such as trails, to encourage public use and recreation, interpretive signage to educate and inform the users about natural and cultural heritage, wetland creation, and stream bank restoration works to improve terrestrial and aquatic habitats and provide water quality benefits.

A number of regeneration activities have been implemented in the Duffins Creek watershed while this Watershed Plan was under development. In July of 2002, TRCA, Town of Ajax, and the Pickering-Ajax Rod and Gun Club carried out instream works along a section of the Duffins Creek in Paulynn Park to prevent continued erosion of the banks and create aquatic habitat. Paulynn Park will continue to be a demonstration site for aquatic and terrestrial habitats.

TRCA along with a number of partners has developed a comprehensive Marsh Restoration Action Plan for the Duffins Creek Coastal Marsh. A combination of land use changes, high water levels, flooding, abundance of carp, poor water clarity and the colonization of purple loosestife have all accounted for the overall degradation of habitat in this valuable waterfront wetland. The Plan is focused on five areas of improvement, including wetland restoration and expansion, meadow enhancement, forest enhancement, fish and wildlife habitat enhancement, and a trails and public use component. Work-to-date has focused on marsh monitoring, waterfowl banding, development of a wildlife corridor along Bayly Street, and the deployment of a test scale carp barrier in the north east lagoon.

The following sites have been suggested as possible Community Action Sites for future consideration and implementation. This list will evolve and be updated as implementation progresses, opportunities arise, and as new partnerships are formed. They include:

- **Memorial Park**, in the Town of Whitchurch-Stouffville, is being considered as an opportunity to demonstrate stream rehabilitation improvements

- **Millers Creek**, in the Town of Ajax, is an example of a degraded urban watercourse; an ideal demonstration site for measurable water quality improvements

- **Duffins Creek Headwaters**, in the Township of Uxbridge, make an incredible contribution to groundwater resources and terrestrial resources in the Duffins Creek

- **West Duffins Creek Valley Lands**, in the City of Pickering, present a number of implementation opportunities and include the Whitevale, a Heritage Conservation District

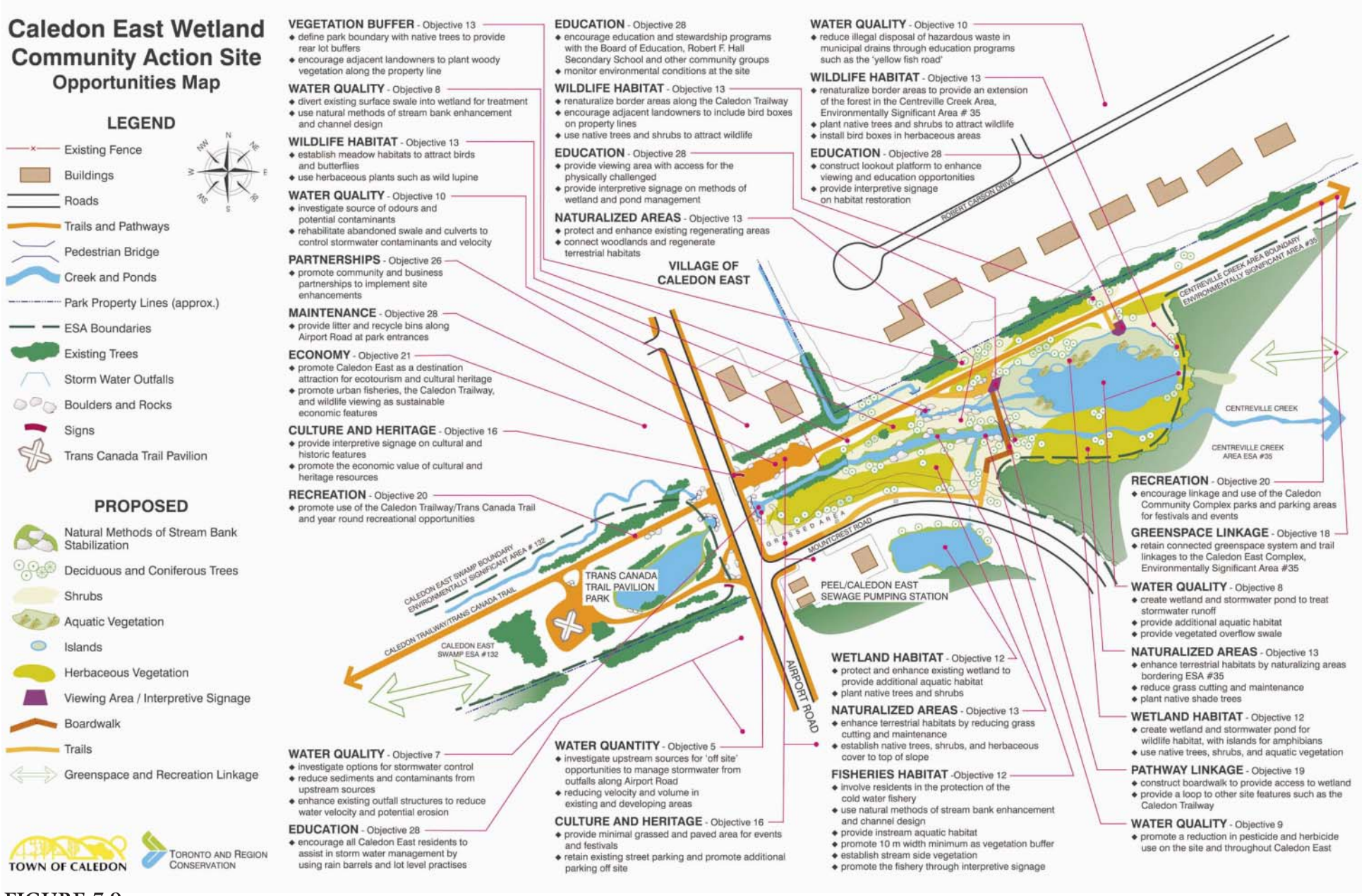
Caledon East Wetland
Community Action Site
Opportunities Map
LEGEND
Existing Fence
Buildings
Roads
Trails and Pathways
Pedestrian Bridge
Creek and Ponds
Park Property Lines (approx.)
ESA Boundaries
Existing Trees
Storm Water Outfalls
Boulders and Rocks
Signs
Trans Canada Trail Pavilion
PROPOSED
Natural Methods of Stream Bank Stabilization
Deciduous and Coniferous Trees
Shrubs
Aquatic Vegetation
Islands
Herbaceous Vegetation
Viewing Area / Interpretive Signage
Boardwalk
Trails
Greenspace and Recreation Linkage
TOWN OF CALEDON
TORONTO AND REGION CONSERVATION
VEGETATION BUFFER - Objective 13
◆ define park boundary with native trees to provide rear lot buffers
◆ encourage adjacent landowners to plant woody vegetation along the property line
WATER QUALITY - Objective 8
◆ divert existing surface swale into wetland for treatment
◆ use natural methods of stream bank enhancement and channel design
WILDLIFE HABITAT - Objective 13
◆ establish meadow habitats to attract birds and butterflies
◆ use herbaceous plants such as wild lupine
WATER QUALITY - Objective 10
◆ investigate source of odours and potential contaminants
◆ rehabilitate abandoned swale and culverts to control stormwater contaminants and velocity
PARTNERSHIPS - Objective 26
◆ promote community and business partnerships to implement site enhancements
MAINTENANCE - Objective 28
◆ provide litter and recycle bins along Airport Road at park entrances
ECONOMY - Objective 21
◆ promote Caledon East as a destination attraction for ecotourism and cultural heritage
◆ promote urban fisheries, the Caledon Trailway, and wildlife viewing as sustainable economic features
CULTURE AND HERITAGE - Objective 16
◆ provide interpretive signage on cultural and historic features
◆ promote the economic value of cultural and heritage resources
RECREATION - Objective 20
◆ promote use of the Caledon Trailway/Trans Canada Trail and year round recreational opportunities
WATER QUALITY - Objective 7
◆ investigate options for stormwater control
◆ reduce sediments and contaminants from upstream sources
◆ enhance existing outfall structures to reduce water velocity and potential erosion
EDUCATION - Objective 28
◆ encourage all Caledon East residents to assist in storm water management by using rain barrels and lot level practises
EDUCATION - Objective 28
◆ encourage education and stewardship programs with the Board of Education, Robert F. Hall Secondary School and other community groups
◆ monitor environmental conditions at the site
WILDLIFE HABITAT - Objective 13
◆ renaturalize border areas along the Caledon Trailway
◆ encourage adjacent landowners to include bird boxes on property lines
◆ use native trees and shrubs to attract wildlife
EDUCATION - Objective 28
◆ provide viewing area with access for the physically challenged
◆ provide interpretive signage on methods of wetland and pond management
NATURALIZED AREAS - Objective 13
◆ protect and enhance existing regenerating areas
◆ connect woodlands and regenerate terrestrial habitats
WATER QUANTITY - Objective 5
◆ investigate upstream sources for 'off site' opportunities to manage stormwater from outfalls along Airport Road
◆ reducing velocity and volume in existing and developing areas
CULTURE AND HERITAGE - Objective 16
◆ provide minimal grassed and paved area for events and festivals
◆ retain existing street parking and promote additional parking off site
WATER QUALITY - Objective 10
◆ reduce illegal disposal of hazardous waste in municipal drains through education programs such as the 'yellow fish road'
WILDLIFE HABITAT - Objective 13
◆ renaturalize border areas to provide an extension of the forest in the Centreville Creek Area, Environmentally Significant Area # 35
◆ plant native trees and shrubs to attract wildlife
◆ install bird boxes in herbaceous areas
EDUCATION - Objective 28
◆ construct lookout platform to enhance viewing and education opportonities
◆ provide interpretive signage on habitat restoration
VILLAGE OF CALEDON EAST
ROBERT CARSON DRIVE
CENTREVILLE CREEK AREA BOUNDARY ENVIRONMENTALLY SIGNIFICANT AREA #35
CENTREVILLE CREEK
CENTREVILLE CREEK AREA ESA #35
RECREATION - Objective 20
◆ encourage linkage and use of the Caledon Community Complex parks and parking areas for festivals and events
GREENSPACE LINKAGE - Objective 18
◆ retain connected greenspace system and trail linkages to the Caledon East Complex, Environmentally Significant Area #35
WATER QUALITY - Objective 8
◆ create wetland and stormwater pond to treat stormwater runoff
◆ provide additional aquatic habitat
◆ provide vegetated overflow swale
NATURALIZED AREAS - Objective 13
◆ enhance terrestrial habitats by naturalizing areas bordering ESA #35
◆ reduce grass cutting and maintenance
◆ plant native shade trees
WETLAND HABITAT - Objective 12
◆ create wetland and stormwater pond for wildlife habitat, with islands for amphibians
◆ use native trees, shrubs, and aquatic vegetation
PATHWAY LINKAGE - Objective 19
◆ construct boardwalk to provide access to wetland
◆ provide a loop to other site features such as the Caledon Trailway
WATER QUALITY - Objective 9
◆ promote a reduction in pesticide and herbicide use on the site and throughout Caledon East
WETLAND HABITAT - Objective 12
◆ protect and enhance existing wetland to provide additional aquatic habitat
◆ plant native trees and shrubs
NATURALIZED AREAS - Objective 13
◆ enhance terrestrial habitats by reducing grass cutting and maintenance
◆ establish native trees, shrubs, and herbaceous cover to top of slope
FISHERIES HABITAT -Objective 12
◆ involve residents in the protection of the cold water fishery
◆ use natural methods of stream bank enhancement and channel design
◆ provide instream aquatic habitat
◆ promote 10 m width minimum as vegetation buffer
◆ establish stream side vegetation
◆ promote the fishery through interpretive signage
CALEDON EAST SWAMP BOUNDARY ENVIRONMENTALLY SIGNIFICANT AREA # 132
CALEDON TRAILWAY/TRANS CANADA TRAIL
CALEDON EAST SWAMP ESA #132
TRANS CANADA TRAIL PAVILION PARK
DRESSED AREA
MOUNTCREST ROAD
PEEL/CALEDON EAST SEWAGE PUMPING STATION
AIRPORT ROAD

FIGURE 7.9

- **The Waterfront Marshes**, both located in the Town of Ajax, can profile public use activities, including trails and human heritage educational components. Aquatic habitat restoration works are underway in the Duffins Creek Marsh

7.6 PARTNERSHIPS IN THE SUBWATERSHEDS

Partnerships will be key to the success of making meaningful changes at the subwatershed and tributary level. The Task Force members and the future members of the "Implementation Team" will need the support and experience of the following groups for successful implementation:

- Non government agencies, such as Durham Conservation, Uxbridge Naturally, Uxbridge Conservation, Rouge-Duffins Coalition, Green Door Alliance, and Citizens for Carruthers
- Environmental Advisory Committees from Whitchurch-Stouffvile, Ajax, and Durham Region
- Ratepayers groups from across both watersheds
- Service clubs and community groups
- Uxbridge Township Watershed Committee

Small Streams: Time for Some Respect

Scientists who study rivers refer to small tributaries as first- or second-order streams. In a natural watershed setting, these make up about two-thirds of the total stream and river length. These small watercourses are not simply lesser versions of large river channels. They have very important and unique roles to play in the ecology of healthy running water environments.

Small, even temporary, streams provide breeding grounds for a wide range of insects, amphibians, and fish, offering protection from larger predators that cannot access these shallow channels. Like vernal ponds, these tiny aquatic habitats are there when they are most needed, even if they are smaller, or even dry, later in the summer. As well, because the water is often moving slowly and has long contact with stream bottoms and banks, small streams are a major source of exchange for nutrients, organic matter, minerals, and gases. All of these processes are vital to downstream ecological communities, since in the larger portions of the river, water moves faster, and there is proportionately less contact with the soils and vegetation of the river's bed and banks.

An analogy can be made with the human body, where veins and arteries carry bulk blood to and from the heart and lungs. However, it is in the many tiny capillaries that penetrate to every organ and tissue where oxygen and nutrients are delivered, while carbon dioxide and metabolic wastes are removed, cell by cell. Certain diseases, including diabetes, can cause degradation of the capillaries, often resulting in diminished eyesight and loss of extremities. The same can be said of rivers, where the loss of the ecological function of the kilometres of small streams will reduce the water quality of downstream portions of the river with respect to fish and wildlife production, water quality, and general environmental quality. It is important that land use planning recognizes the vital functions played by small watercourses, and develops policies to enhance and protect these processes.

The ecological well being of a watershed cannot be assured unless the importance of small streams, swales, and even temporary flows is recognized. Water is an opportunity, not a problem, and with modern methods of stream restoration and enhancement, today's ditch can become tomorrow's hatching and rearing area.

Text extracted from an article entitled "Small Streams: Time for Some Respect", Connections newsletter, Fall 2002 by Lewis Yeager, General Manager, Rouge Park.

CHAPTER

8

8.0 IMPLEMENTATION

In Conservation Ontario's submission to the Walkerton Inquiry on Drinking Water Protection, a variety of tools that are administered by several agencies at the provincial and local level were identified for the implementation of watershed plans. According to Conservation Ontario, these tools can be categorized under the headings of land use planning, water and waste water master planning, water resources regulations, land and water stewardship programs, public land acquisition, infrastructure development and maintenance, and remedial measure programs.

Experience has shown that the province, municipalities, and conservation authorities will implement a watershed plan if they have been involved in developing the plan. Conservation Ontario identified opportunities or venues for participation in watershed studies, including education, information exchange, private-public sector partnerships, and to a lesser extent, regulatory and enforcement approach. Watershed plans that employ a broad range of opportunities to get involved, result in a broader base of support. These factors were considered in the design of the community-based process followed in the development of this Watershed Plan, and therefore, it is hoped that the foundation has been laid for active involvement of all stakeholders in the Plan's implementation.

This Watershed Plan has defined eight goals, 25 management objectives, and management actions necessary to achieve each objective. Ten management actions have been identified as being integral to the achievement of the overall vision for these watersheds. The protection and enhancement of terrestrial natural heritage cover through the achievement of the enhanced natural heritage system is central to the Task Force's approach, together with the application of state-of-the-art practices that should be employed in all aspects of land use activities.

In an effort to facilitate implementation of this Plan by multiple partners, the specific management directions presented in this Watershed Plan are in several user-friendly formats. The implementation framework consists of:

- a summary of key implementation mechanisms, as presented in this chapter;
- a model policy framework to be developed as an Addendum to this Plan;
- a suite of technical models, databases, targets, and criteria;
- maps illustrating areas where the protection and enhancement of natural cover would achieve multiple watershed management benefits and maps illustrating areas targeted for active stewardship, regeneration or securement;
- the subwatershed maps, contained in Chapter Seven; and
- the proposed Community Action Sites, listed at the end of this chapter.

8.1 GOVERNMENT INITIATIVES IN THE WATERSHEDS

Federal, provincial, and municipal governments and TRCA own significant lands in these watersheds and, through the management of these lands and future decisions, may be able to realize watershed plan objectives with public support.

During the 24 months that this Plan was being prepared, a number of land use related initiatives by various levels of government have been made public. The following list represents additional opportunities for municipal and senior government agencies to utilize the information contained within the State of the Watershed Reports, supporting technical documents and to implement the Watershed Plan:

- Proposed development of an airport on the Transport Canada Lands in Pickering
- Oak Ridges Moraine Act and Conservation Plan
- Proposed extension of the 407 highway to the east of Brock Road
- Development of the Seaton lands in Pickering
- the Provincial Government Smart Growth Initiative
- Durham Region Official Plan updates
- City of Pickering Growth Management Study
- Transport Canada's Greenspace Project

Implementation of a Watershed Plan cannot occur in isolation of other planning initiatives or regulatory roles and responsibilities. It is important that local, regional, provincial, and federal decisions that will influence existing and future land use changes in the Duffins and Carruthers creeks consider the recommendations of the Watershed Plan and its supporting technical documents when and where appropriate.

8.2 IMPLEMENTATION MECHANISMS

Common to many watershed plans in Ontario are key implementation mechanisms, including policy and planning tools, regulations and permits, stewardship and regeneration activities, land acquisition, and education and awareness campaigns. Monitoring and reporting are essential activities that complement and provide feedback to the implementation program.

8.3 PLANNING AND POLICY

Watershed planning has been recognized by all levels of government as an "effective means of evaluating and developing water-related resource management strategies and practices". These governments have further endorsed the important role that the municipal land use planning process and other government regulatory and permitting processes play in implementing a watershed plan (MOEE, 1993, Conservation Ontario, 2001, Walkerton Inquiry Part II, 2002, ORCMP. 2002).

The development of watershed management plans provide context and recommendations for natural systems protection, restoration, environmental education, recreation, and human heritage planning activities. Yet a large part of implementing a watershed management plan depends on how well the vision and goals can be reflected in the municipal land use planning process. To do this, adequate linkages must be established between the direction provided by watershed plans and the development of land use planning policies and practices.

In recognizing the importance of this transition between the direction provided by the Watershed Plan and its reflection in planning and policy documents, the Duffins and Carruthers Task Forces intended to develop a watershed policy framework as a component of the Watershed Plan. A number of initiatives that are currently underway will provide valuable input into preparing a watershed policy framework, including the completion of TRCA's Terrestrial Natural Heritage Strategy, the evolving Oak Ridges Moraine Conservation Plan policies, provincial responses to Part II of the Walkerton Inquiry, and watershed initiatives such as the City of Pickering's Growth Management Study and the Province's Seaton Land Swap. All of these initiatives present valid reasons for continuing the policy framework as an initial part of the Watershed Plan's implementation. This approach will allow for input from these external planning/policy initiatives, and a peer review with municipal planning staff with the objective of harmonizing approaches across the entire study area.

In developing this Plan, the Duffins Creek and Carruthers Creek Task Forces established a Land Use and Policy Working Group to investigate municipal policies (from current Official Plans) to identify "State of the Art" policies for 11 environmental topic areas that the watershed municipalities are currently being challenged on. The following environmental issues were identified by the working group as important policy elements for successful watershed management:

- Headwater Streams
- Stormwater, Flooding, Erosion
- Woodlands
- Buffers
- Sustainable Communities
- Environmental Targets
- Fisheries
- Groundwater
- Riparian Corridors
- Connections and Linkages
- No Net Loss

Through a policy review exercise, the Working Group prepared a policy matrix that was presented to the Task Forces in November 2001. Copies of this matrix are available from TRCA. Subsequent to this meeting, TRCA and municipal staff assessed the policy directions in the Oak Ridges Moraine Conservation Plan (ORMCP). The detailed and comprehensive requirements in the ORMCP provide approaches that the municipalities may want to consider as a means to strengthen policy elements related to watershed management. The same tools that are used to achieve the protection of the natural heritage features and the ecological health of the Oak Ridges Moraine are some of the same tools that could be used for the rest of the lands in the Duffins Creek watershed and in the Carruthers Creek watershed.

To date, a draft policy framework has been developed for the Duffins and Carruthers watersheds, including policy concepts in the areas of protection and management. This provides a substantial base upon which to build. Technical tools have been developed to support the implementation of policy directions at the watershed scale and as a significant contribution to further studies and planning activities at subwatershed and site scales. These include:

Models

- water budget model
- groundwater flow model
- hydrology model
- water quality models

Criteria and guidelines

- stormwater management criteria for:
    - groundwater infiltration targets
    - flood flows
    - water quality
    - erosion control
- floodline and regulation mapping
- fisheries management zones

- enhanced terrestrial natural heritage system and associated databases

Integrated Management Mapping

- maps illustrating areas where the protection and enhancement of terrestrial natural heritage cover will meet multiple watershed management benefits
- maps illustrating areas targeted for active stewardship, regeneration, and acquisition, particularly as achieved through the protection and enhancement of terrestrial natural heritage cover

When this management plan is presented to the regional and local watershed municipalities, it is envisioned that the councils will agree to work cooperatively with TRCA and other agencies to find opportunities to implement the Watershed Plan, agree that an advisory committee be designated to guide implementation of the Plan with input from the municipalities, and finally, that consultation with the public and other key stakeholders in the community continue as the implementation phase evolves.

Examples of Municipal Implementation Actions

At the regional level, the Region of Peel incorporated the management directions from both the Humber River watershed strategy and the Credit River Subwatershed 19 Plan into their planning process through a resolution of council. Through these resolutions, regional council endorsed the Watershed Plan as a framework for guiding future municipal planning and directed staff to use the Watershed Plan as a basis for providing comments in the development review. Further, staff were authorized by resolution to participate on an implementation committee.

In the Grand River Watershed, the City of Waterloo passed a resolution requiring secondary plans, plans of subdivision and stormwater management plans that demonstrate how they meet the objectives of the Laurel Creek Subwatershed Plan.

In a more local example, in 1997 the Township of Uxbridge passed a By-law that formally adopted the Uxbridge Brook Watershed Plan as a guiding document to provide direction to ensure the health of the watershed is maintained and enhanced.

8.4 STEWARDSHIP AND REGENERATION

Stewardship and regeneration programs serve an important role in delivering projects and fostering the sustainable behaviour and practices that contribute to watershed protection and enhancement. These programs are an important enabler of action, because they raise awareness of priority issues and bring willing partners together with the knowledge, tools, and resources necessary to undertake the projects. The products of these programs apply to both private and public lands.

There are many excellent examples of existing stewardship and regeneration programs, delivered by community groups, municipalities, provincial and federal governments, and TRCA that apply to these watersheds. These programs can easily be tailored to assist in addressing the stewardship and regeneration priorities of the Duffins and Carruthers Creek Watershed Plan.

Public agencies with land holdings in the watershed have an additional role to play in setting an example for others by acting as model stewards of their own properties. They also have the opportunity to undertake demonstration projects that could assist in informing others on best practices.

While stewardship and regeneration activities can be linked to every one of the 25 objectives of this Watershed Plan, several key activities are identified that should be considered for special focus:

- protection and enhancement of terrestrial natural heritage cover;
- lot-level best management practices, for example those that contribute to the prevention of flood risk, promote sound stormwater management, protect water quality, promote water conservation, prevent groundwater contamination, and prevent impacts on stream and valley corridors or surrounding habitat;
- retrofit of existing urban areas lacking stormwater management;
- erosion and sediment controls at construction sites;
- road maintenance and de-icing practices;
- rural water quality;
- septic system maintenance;
- "catch and release" practices within the angling community;
- removal of identified in-stream barriers to fish movement;
- restoration of woody riparian vegetation; and
- invasive and exotic species control.

TRCA Stewardship and Regeneration Programs

The TRCA Private Land Stewardship Program engages landowners in land and water resource protection and restoration through education and action. TRCA seeks to increase partnerships with landowners in projects that focus on improving water quality, re-establishing native plant communities, enhancing wildlife habitat, and reconnecting natural areas through planting.

Free educational conservation seminars are offered to residents on a variety of topics including wildlife, land stewardship, and habitat restoration. The Stewardship Resource Centre, located in Woodbridge, houses a variety of books, videos, and other printed material relating to nature, stewardship, and the environment.

In addition to the seminar series, TRCA also offers a number of programs that promote private land stewardship opportunities including, but not limited to, forest management, water resources, and aquatic plants.

The Managed Forest Program involves qualified forestry staff preparing and/or approving plans for submission into the Managed Forest Tax Incentive Program. A properly managed forest can provide excellent wildlife habitat, as well as income generation opportunities and property tax savings. Technical assistance is also provided to landowners through the Private Land Tree Planting Program to evaluate their reforestation objectives. Qualified staff perform site assessments and provide recommendations for plant materials and placement, as well as site preparation.

The Rural Clean Water Program offers financial grants to rural landowners for projects that improve stream water quality on their property. Grants may be provided for septic system repairs, livestock restriction around streams, manure management, milkhouse wastewater disposal, tree planting, and erosion control.

The Aquatic Plants Program offers people of all ages the opportunity to grow native aquatic plants for planting in local wetland restoration projects. This is a seasonal program offered from February to June each year. TRCA supplies the necessary equipment and instructions, as well as information on wetlands. An in-class presentation is available upon request. In June, volunteers join TRCA at a local wetland for guided tours and planting.

Under private land stewardship, landowners are encouraged to protect natural areas on their land, through oral or written agreements with government agencies or other management bodies. Private owners agree to do such things as:

- maintain and protect natural areas;
- notify appropriate agencies about planned changes in land use; and
- notify appropriate agencies about the intent to sell.

In exchange, TRCA, or another organization involved in private land stewardship programs, can provide certain benefits or initiatives, such as:

- management advice;
- plaques or certificates of appreciation; and
- financial incentives where appropriate (such as Conservation Land Tax Rebates).

8.5 LAND SECUREMENT AND ACQUISITION

Land securement is another important means of protecting the natural and human heritage features that are recognized for their vital contribution to overall watershed health. In general terms, land securement refers to the act of bringing lands into public ownership and/or otherwise securing the assurance of their protection through private landowner agreements. Land securement tools include:

Planning/Policy – Securing land through legislation (acts and regulations) including the Planning Act and the Conservation Authorities Act;

Stewardship – Protecting natural or human heritage features through landowner agreements and education; and

Acquisition – Securing land through title, easements, and covenants on title.

In the past, acquisition was seen as a primary mechanism for protecting natural heritage features in the watershed. More recently, the Oak Ridges Moraine Conservation Plan and the Watershed Plan suggest redirecting the limited public funds available for acquisition toward other proactive securement mechanisms, such as through planning/policy tools and stewardship programs that would have the same environmental benefits as acquisition. These planning, policy, and stewardship tools were discussed under previous sections. However, there is still a need for acquisition for certain features, which perform vital roles in maintaining watershed health, where public use requirements necessitate public ownership of lands, or where no other mechanism would provide adequate protection. The focus of this section is on land acquisition.

The protection and enhancement of terrestrial natural cover through the achievement of the targeted natural heritage system is integral to the management of this watershed. While a range of implementation tools will be needed to address all areas of the targeted natural heritage system, land acquisition programs should be considered as a key mechanism to address areas within the watershed where the protection and enhancement of natural cover would achieve multiple watershed management objectives.

Three main systems in our natural environment would benefit from the implementation of land securement practices including the natural heritage system, the water resource system and the landform conservation system. Land securement also allows for protection and, where possible, enhancement of a resource, to ensure its biological integrity and sustainability for future generations.

Protection of the natural heritage system enhances the health and diversity of plant and animal species and their associated habitats with special emphasis on native species. The water resources would benefit by providing clean, abundant water to maintain baseflow in streams, to maintain storage in wetlands, and to provide for the sustainable use of water resources by residents in the watersheds. Landform conservation ensures the form, character, and variety of landscapes within the watershed will be maintained to minimize disruption to natural processes, to maintain visual character and attractiveness, and to retain the educational and interpretive value of its landforms.

Land acquisition priorities identified in this Watershed Plan should be coordinated with ongoing implementation programs of groups, such as the Oak Ridges Moraine Land Trust, the Conservation Foundation of Greater Toronto, and the regional municipalities.

Many private landowners in the Duffins and Carruthers creek watersheds have demonstrated their willingness to participate in environmental programs through actions such as conservation easements, bequests, and an overall involvement in good land stewardship practices. Conservation easements are especially effective means of land securement, because they reduce the need for public agencies to acquire lands for environmental protection and public use.

Ecogifts in Ontario

Each donation of a property or conservation easement must be individually certified as ecologically sensitive before it can be included under the Ecological Gifts Program. To be qualified, a property must meet one or more of a set of criteria developed specifically for Ontario. The following list includes 19 specific categories of qualified lands (the "A" list):

A) Specific Categories of Qualified Lands

Lands, easements, or covenants relative to such lands, which fall into one or more of the following categories shall be deemed to be ecologically sensitive lands in Ontario:

A1 Sensitive portions of the habitat of species determined to be endangered, threatened or vulnerable in Ontario, as specified in a recovery plan or other biological study.
A2 Areas designated as Provincially Significant Wetlands.
A3 Provincial or regional Areas of Natural and Scientific Interest.
A4 Designated Areas of Concern for biodiversity purposes as identified in Forest Management Plans.
A5 Areas qualifying for the Conservation Land Tax Reduction Program.
A6 Areas managed for wildlife habitat conservation purposes that qualify under the Managed Forest Tax Reduction Program.
A7 Areas promoting the conservation of natural heritage and biodiversity that are identified within a regional or watershed plan or strategy developed by a recognized conservation organization.
A8 Areas designated as a World Heritage Site for biodiversity conservation purposes, a core area of the UNESCO biosphere Reserve, or a Wetland of International Importance under the Ramsar Convention.
A9 Areas of biodiversity significance identified in a Canadian Heritage Rivers Management Plan or Strategy.
A10 Areas designated in the Niagara Escarpment Plan as an Escarpment Protection Area or an Escarpment Natural Area.
A11 Areas designated as Natural Core, Natural Corridor, Sensitive Hydrological Feature, Regional Recharge, Regional Discharge or Significant Landform within the Oak Ridges Moraine Strategy or Guidelines.
A12 Areas designated Core Area Corridor or Restoration Area in the Lake Ontario Greenway Strategy.

A13 Areas designated for biodiversity conservation purposes within Management Plans or Strategies for Trent-Severn or Rideau Waterways.

A14 Areas within a municipal official plan or zoning by-law under the Planning Act (Ontario) designated as an Environmentally Sensitive Area, Environmentally Significant Area, Environmental Protection Area, Restoration Area, Natural Heritage System, or other designation for similar purposes that is comparable with the conservation of the biodiversity, ecological features, and functions of the site.

A15 Areas within or adjacent to a Provincial Park, Provincial Park Reserve, Conservation Reserve, Conservation Area, Wilderness Area, Provincial Wildlife Area, National Wildlife Area, Migratory Bird Sanctuary, National Park, National Park Reserve, or Ecological or Natural Reserve managed by a government or non-government agency.

A16 Municipal parks or other protected areas designated or managed for biodiversity conservation purposes.

A17 Areas identified as Carolinian Canada sites or alternate sites.

A18 Areas identified as Core Natural Areas, Natural Area Buffer, Natural Area Link, or Valued Ecosystem Component in the National Capital Greenbelt Master Plan by the National Capital Commission.

A19 Areas designated for biodiversity purposes by regional agencies, such as the Niagara Parks Commission, St. Clair Parkway Commission, St. Lawrence Parks Commission, and the Waterfront Regeneration Trust.

Taken from The Ontario Ecogifts handbook 2001, Environment Canada, Ontario Region.

8.6 EDUCATION, AWARENESS AND ADVOCACY

All implementation partners have a role to play in raising awareness of watershed issues and promoting the Watershed Plan. The outdoor classroom of the Duffins and Carruthers creek watersheds is one of the most effective venues for learning. Many existing programs and resources can be used as vehicles for this purpose, including:

- curriculum of the formal education system;
- outdoor environmental education programs at the Claremont Field Centre and Greenwood Conservation Area;
- Watershed on Wheels Outreach Education Program;
- municipal parks and recreation department programs;
- programs of Scouts, Guides, and many other community groups;
- industry association programs (e.g., Urban Development Institute, Aggregate Producers of Ontario);
- museums; and
- privately owned outdoor recreation and tourism providers (e.g., golf courses, ski resorts).

It will be important to build on existing resources, share materials, and coordinate the delivery of key messages. While specific education and awareness programs should be designed for individual aspects of the plan, key watershed messages include:

- multiple benefits of achieving the enhanced terrestrial natural heritage system;
- role of sustainable living practices;
- role of overall watershed management in protecting human health;
- relative cost-effectiveness of protection/prevention versus remediation;
- contribution of Duffins and Carruthers creek watershed management to the overall management of the Great Lakes Basin; and
- what individuals can do.

Certain management actions are beyond the direct control of watershed stakeholders. Therefore, there is a need to advocate to federal and provincial governments and adjacent municipalities and conservation authorities on the responsibilities they have in managing transboundary issues that impact the health of the Duffins and Carruthers creek watersheds. These transboundary issues include air quality, groundwater, the demand for transportation infrastructure, and the demand for water supply and wastewater servicing.

Furthermore, there is a need to advocate for ongoing research into improved methods for watershed management, particularly in the areas of:

- the science and support tools for integrated watershed management;
- sustainable living practices and sustainable community planning;
- climate change; and
- road salt management in the Oak Ridges Moraine.

8.7 MONITORING AND REPORTING

For its size, the Duffins Creek watershed was one of the most intensively studied watersheds in Canada. For example, the Ontario Ministry of Environment's Provincial Water Quality Monitoring Network (PWQMN) was active in the Duffins Creek watershed for the period 1965 to 1993. Water samples were collected at monthly intervals, to provide data for the assessment of water quality conditions downstream of the Stouffville Sewage Treatment Plant, urban centers, and rural land use practices. The PWQMN has sampled some 50 locations in the Duffins Creek watershed, for periods ranging from one year to more than 30 years. The majority of these stations were sampled in the 1970s and early 1980s to provide baseline water quality data for the planning of the federal airport and the proposed Seaton Community. With the decision to cancel the federal airport and the community of Seaton in the late 1970s, water quality monitoring efforts in the 1980s and early 1990s was less extensive (five to 10 locations sampled on a monthly basis). Typical for most southern Ontario watersheds, the MOE sampled only one location in the Carruthers Creek watershed during the period 1965 to 1993. In 1993, the MOE stopped

water quality sampling in the Duffins Creek and Carruthers Creek watersheds. In 2002, water quality sampling was initiated in the Duffins and Carruthers watersheds through partnerships with the City of Toronto (stream and waterfront routine water chemistry monitoring) and the Ministry of the Environment.

In the summers of 1995 and 1996, the MOE and Geological Survey of Canada, as part of a collaborative research project, sampled the Duffins Creek to determine patterns in groundwater discharge and the chemical composition of the watershed under baseflow (dry weather conditions) at more than 100 locations. For the purposes of their study, a more extensive list of parameters were analyzed than the PWQMN.

At one time, the federal and provincial government operated as many as 13 streamflow gauges in the Duffins Creek watershed. With the cancellation of plans to build the international airport in the mid 1970s and the funding base declined, the number of gauges in the watershed was reduced from 13 to two. Since 1994, TRCA along with municipal and provincial partners have installed six additional gauges in Duffins Creek and one in Carruthers Creek for a total of nine.

Groundwater levels have been monitored at a number of locations within the Duffins Creek watershed since the late 1970s on a discontinuous basis. This monitoring was initiated by the MOE and continued by the University of Toronto (U of T) in the mid 1990s. Two of these locations have been included in the MOE/TRCA monitoring program.

The first extensive study of groundwater quality in the Duffins Creek basin was conducted by the MOE in 1970 and 1974 and involved the analysis of 44 samples from the Duffins and Rouge watersheds. A subsequent study by the U of T between 1982 and 1984 sampled 260 locations in the Duffins and Carruthers watersheds. In the 1990s M.M. Dillon Ltd. monitored groundwater quality as part of the Interim Waste Authority landfill studies in the Duffins Creek watershed.

While not continuous, various fisheries and stream assessment studies were undertaken by the Ministry of Natural Resources (MNR), U of T, and TRCA in the Duffins Creek over the past 50 years. These inventories provide a comprehensive knowledge base for the design of TRCA's aquatic monitoring program, described below.

In 2000, TRCA developed the Regional Watershed Monitoring Program, in partnership with the City of Toronto, and the regional municipalities of York, Peel, and Durham. It is widely recognized that long-term monitoring is a critical step in the process of understanding the condition of the Duffins Creek and Carruthers Creek watersheds. The establishment of this monitoring program fills a gap that existed since the mid 1990s, when the federal and provincial governments reduced their monitoring programs across the province. Monitoring of aquatic and terrestrial systems has been formalized into a systematic long-term program. This reflects a shift from an "ad hoc" inventory approach described above.

The Regional Watershed Monitoring Network is a partnership between agencies and organizations who cooperate in a monitoring program based on their individual and collective monitoring needs. Each participant in the network is responsible for some aspects of collecting, storing, analyzing, distributing, and reporting on data and information that is required by themselves or other partners in the network. By cooperating in a monitoring network, participants make more efficient use of resources by focusing their efforts on their expertise, and eliminating overlap by relying on other partners.

The spatial and temporal assessment of condition, and causes of change in that condition, at the scales of the Remedial Action Plan (RAP) area, watersheds, the waterfront, and subwatersheds in TRCA's jurisdiction are the focus of this program. The intent is to be able to answer the question of how healthy these areas are and how they are changing through time. It is not the intent of this program to be a substitute for monitoring associated with implementation projects or reach specific sampling to trace sources of disturbance or contamination. It is the intent of the program to be able to track the overall cumulative impacts of both positive and negative changes at the broad RAP, watershed and subwatershed scales. Additional "site specific" monitoring activities can be undertaken in order to address questions at a smaller scale.

Key objectives for this program are:

- To provide a scientific knowledge base for the assessment of the ecosystem health of watersheds, subwatersheds, the Lake Ontario waterfront, and the Toronto RAP area.

- To build upon existing monitoring activities, and avoid duplication between agencies, municipalities, and organizations.

- To identify ways to engage and involve the general public, interest groups, and school groups in meaningful monitoring activities.

- To establish protocols for the collection, analysis, storage, and distribution of monitoring data on the key indicators that are identified for the assessment of ecological health.

The monitoring program collects data on six major components: Aquatic Habitat and Species, Fluvial Geomorphology, Terrestrial Natural Heritage, Surface Water Quality, Water Quantity and Climate, and Groundwater. Table 8.1 provides a summary for each component of the monitoring program and the key indicator used to evaluate the health of the Duffins and Carruthers watersheds. Included in this table is a brief description of the principal monitoring activities and the program partners who have primary responsibility.

TABLE 8.1 - Program Components of the Regional Monitoring Program

COMPONENT	INDICATOR	MONITORING ACTIVITIES	AGENCY
Aquatic Habitat and Species	Invertebrates, Fish, Algae, Geomorphology, Habitat, Substrate, Macrophytes.	Fish surveys every three years and benthic invertebrate surveys annually. Twenty-five Duffins sites, five Carruthers sites.	TRCA
Fluvial Geomorphology	Bank stability; Erosion rates.	Surveys every three years. Number of sites to be determined.	TRCA
Terrestrial Natural Heritage	Habitat patch, Vegetation communities, Species.	Ecological Land Classification System. Air photo analysis.	TRCA
Surface Water Quality	Basic water chemistry, Organics/ metals, Tissue contaminants, Aesthetics.	Monthly water quality sampling. Six sites in Duffins and one in Carruthers.	TRCA MOE City of Toronto
Flow and Precipitation	Stream flow, Precipitation, Snow.	Eight (plus one proposed) stream gauges in Duffins, one (plus one proposed) stream gauges in Carruthers. Three snow course sites in Duffins. Three (plus three proposed) precipitation gauges in Duffins and one proposed precipitation gauge in Carruthers.	TRCA Env. Canada MNR
Groundwater	Groundwater quantity, quality.	Monthly levels and annual water quality analysis at seven Duffins Creek sites.	TRCA MOE

Aquatic Habitat and Species

Aquatic organisms are adapted to the many interacting physical, chemical, and biological factors that surround them, and are dependent upon these factors for the maintenance of their health. Such factors include water temperature, water flow, nutrients, sediment, or contaminants carried in water, channel form, and types of in-stream cover, to report a few. When a watershed becomes degraded, often the first clue is a change in the aquatic biotic community from a diverse robust community to one dominated by tolerant species. The aquatic biotic community should also respond positively to management actions, such as increased natural cover, riparian plantings, and the decommissioning of the Stouffville Sewage Treatment Plant. By comparing sampling results

from Regional Reference Sites, the ecological integrity of the Duffins Creek and Carruthers Creek will be established. Fish communities and habitat within the watersheds will be monitored on a three-year cycle.

Fluvial Geomorphology

Fluvial geomorphology is a science that assesses the shape and form of watercourses. A key component of the science is identifying the processes responsible for the characteristics of the stream channel. There are many different processes that may be at work within stream channels. The most important of these are physical, namely the movement of sediment (e.g., silt, sand, gravel) and water. Monitoring of fluvial geomorphology characteristics is beneficial to watershed studies as the processes at work within the channels can be identified and quantified. This provides a better understanding of the form (shape and pattern) and function of the stream system. This understanding can be used along with knowledge from other disciplines to assess the implications of land use change and response to watershed management actions. Fluvial geomorphology will be monitored on a three-year cycle. Sites that were set up and monitored in 2003 will be revisited, and measured for change in 2006.

Terrestrial Natural Heritage

Terrestrial monitoring surveys are designed to describe vegetation communities, and map flora and fauna species distribution. To date, approximately 45 per cent of the natural cover in the TRCA jurisdiction has been surveyed. A volunteer monitoring component has been developed to facilitate volunteer monitoring of 66 fixed sites within the TRCA jurisdiction, (eight of which in the Duffins Creek and two in the Carruthers Creek watershed). Field work will continue in 2003 in order to further map and digitize natural cover in the watersheds.

Surface Water Quality

According to the schedule outlined in the Regional Monitoring Plan, the MOE programs (Tributary Toxics Monitoring, Young-of-the-Year Biomonitoring, Sport Fish Contaminant Monitoring) will be undertaken in the Duffins and Carruthers creek watersheds. As a component of implementing this Watershed Plan, a community-based program will be established to provide opportunities for volunteers to participate in stream aesthetic monitoring activities. Monthly water chemistry sampling will continue at a total of 35 sites in the TRCA jurisdiction, (six of which are in Duffins Creek watershed and one in the Carruthers Creek watershed) and will include basic water chemistry and trace metals analysis.

Water Quantity and Climate

The monitoring activities undertaken under the water quantity and climate component of the watershed monitoring network provide both direct information about the state/condition of water quantity in the Duffins and Carruthers watersheds as well as supportive information to aid in understanding the current biological conditions of aquatic habitat and species. The activities and monitoring carried out as part of the Regional Watershed Monitoring Program are designed to augment TRCA's existing network of flow, precipitation and snow gauging locations throughout the region.

The monitoring efforts described above for the Duffins Creek and Carruthers Creek watersheds is not intended to be the only form of monitoring in the watershed. Many of the recommendations tabled in Chapter Six are, in fact, initiatives that require frequent performance assessments. These performance assessments are considered to be elements of watershed monitoring. It is also recognized that observations of stream and terrestrial ecosystem health by residents, stakeholders, and non-government organizations are important metrics of the effectiveness of this Watershed Plan and the two watershed responses to change.

Groundwater

In 2001 and 2002, TRCA entered into partnership with the MOE under the Provincial Groundwater Quality Monitoring Network. Under this partnership, TRCA will be maintaining and monitoring groundwater wells. Monitoring of groundwater at these sites will include monthly water level measurements, and the annual collection of water samples for laboratory chemical analysis. TRCA hydrogeologists will be reviewing the existing partnerships and data needs in order to determine the potential for expanding the groundwater monitoring network.

Other Monitoring Initiatives

The following list outlines other monitoring initiatives that contribute toward the health of the watershed. These activities take place within the TRCA jurisdiction and beyond, and for the most part are normal business functions of TRCA, the municipality, province, and federal government.

TRCA

- Landscape analysis of terrestrial vegetation to evaluate progress in achieving the targeted natural heritage system (on a five-year basis).
- Engage universities and other research institutions to undertake research on these watersheds.
- Prepare reports on stream erosion analysis studies and make recommendations for future actions.
- Continue to seek the cooperation of watershed residents to participate in volunteer terrestrial monitoring.
- Monitor and report on the success of land securement and stewardship programs on an annual basis.

TRCA in partnership with the MOE

- Undertake lowflow monitoring as outlined in the 2003 Duffins and Carruthers Lowflow Management Plan.
- Prepare updates to mapping of water takings on an annual basis for both surface and groundwater sources.

Municipalities

- Update stormwater mapping in urban areas of the two watersheds to track progress in implementing stormwater management retrofits.

Municipalities and TRCA

- Request that the MOE undertake and report on a 10-year basis tributary pollutant loads.
- Review site specific performance of stormwater management facilities, sediment, and erosion control plans.
- Review other site specific monitoring requirements established through Environmental Assessments.
- In York Region, monitor West Duffins Creek's response to the decommissioning of the Stouffville Sewage Treatment Plant.
- Municipalities undertake an analysis and report on the findings of the recommended inspections of the septic systems in the two watersheds.
- TRCA and MNR survey and report on angling effort and harvest in the Duffins Creek watershed as a method of evaluating trend through time responses to the implementation of the Watershed Plan and the Fish Plan.
- Request that the federal and provincial governments share outcomes of site specific monitoring undertaken as part of Environmental Assessments or baseline studies of the federal airport and Provincial Seaton Lands.
- In cooperation with the watershed residents and stakeholder groups, monitor and evaluate trends in:
  - amount of litter in the valley lands, illegal dumping, and vandalism of public greenspace trail use;
  - patterns in water clarity following snow melt or rain events downstream of urban construction sites; and
  - the health of rural watercourses in response to riparian plantings and an increase in natural cover.

TRCA and MNR through monitoring

- Evaluate the distribution and abundance of fish species to determine whether the target fish community has been achieved.

Municipalities, Transport Canada, and TRCA

- Inventory and report on surveys of public use in public greenspace with the objective of demonstrating patterns in use.

Reporting

Periodic reviews of this Watershed Plan are an integral component of TRCA's watershed management process, and allow for systematic improvements to the Plan, the incorporation of new scientific understandings of the watersheds, and emerging initiatives such as "sustainability". At the same time, the original assumptions of the Watershed Plan can, if necessary, be adjusted. Timing of major reviews should be coordinated with the preparation of a Watershed Report Card, in advance of major land use changes in the watershed.

8.8 WHAT CAN YOU DO?

If we implement the Duffins and Carruthers Creek Watershed Plan and fulfill all of the management actions and recommendations we can pass along two healthy watersheds to future generations.

To accomplish this we will need the help from watershed residents, businesses, schools, and all levels of government. Here are some ways that you can help make a difference in the continued health of the Duffins and Carruthers Creeks:

What you can do as a Conservation Authority
- Be accountable for the implementation of the Watershed Plan.
- Provide leadership in watershed wide management issues and opportunities.
- Contribute technical knowledge and experience to other watershed related initiatives.
- Work with political representatives in the watershed to initiate action and change.

What you can do as a Watershed Resident
- Explore the watershed and enjoy its rich resources.
- Implement backyard stewardship activities.
- Participate in Community Action Site events.

What you can do as a Landowner
- Plant native trees and shrubs on your property.
- Take part in private land stewardship programs.
- Consider a conservation easement on your property.

What you can do as a Business Owner
- Make your employees aware of the Duffins and Carruthers Creeks.
- Encourage employee participation in community events that enhance the natural environment.
- Consider naturalizing the grounds surrounding your business location.

What you can do at your School
- Get involved in monitoring projects (rain gauges, etc.).
- Establish a demonstration site on school grounds.
- Take part in the Yellow Fish Road and Watershed on Wheels programs.

As an elected official, you have an unparalleled ability to make things happen. Here are some actions you can take to help make a healthy Duffins and Carruthers Creek watershed!

What you can do as a Municipal and Regional Councillor
- Ask council to support and promote community action sites and their implementation.
- Be accountable for the implementation of the Watershed Plan.
- Engage local business, non government organizations (NGO's), and residents to become active partners in implementing the actions for the subwatersheds.

What you can do as a Member of Provincial Parliament (MPP)

- Support the Watershed Plan and its implementation.
- Ensure that the supporting technical studies, State of the Watershed Reports, and this Plan, are considered in provincial planning initiatives.

What you can do as a Member of Parliament (MP)

- Support the Watershed Plan and its implementation.
- Ensure that this Plan, the supporting technical studies, and State of the Watershed Reports are considered in federal planning initiatives related to the federal airport lands and greenspace lands.

Roles and Responsibilities

The following roles and responsibilities are included in order to position the senior governments to become partners to implement this Watershed Plan:

Great Lakes Water Quality Agreement

In the 1972 Great Lakes Water Quality Agreement, the governments of the United States and Canada agreed "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." Under the terms of the agreement, the two federal governments agreed "to make a maximum effort to develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem and to eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System."

Annex 13 of the Great Lakes Water Quality Agreement deals with pollution from non-point sources. This Annex identifies binational commitments to abate and reduce pollution from land-use activities. The parties are required to identify land-based activities contributing to Great Lakes Water Quality problems and to develop and implement watershed plans.

The Canada-Ontario Agreement (COA) on Great Lakes Water Quality

The Canada-Ontario Agreement (COA) on Great Lakes Water Quality (Renewed in March, 2002) commits Canada and Ontario, through a five-year commitment, to increase natural areas and practice sound watershed management as a means of protecting coastal wetlands and the overall health of the Great Lakes.

The Agreement establishes four Annexes that address environmental issues or management functions that will benefit from cooperation and coordinated action. Three of these Annexes are relevant to our efforts to manage the Duffins and Carruthers Creek watersheds.

X Areas of concern (AOC)
√ Harmful Pollutants (whose sources could be watersheds)
√Lakewide Management (healthy Lake Ontario=watershed health=role of Duffins and Carruthers)
√Monitoring and Information Management (knowledge base to manage)

X *Areas of Concern: Refers to 16 remaining Canadian areas along the shoreline of the Great Lakes that require clean-up. Duffins and Carruthers watersheds are not included in the Toronto Area of Concern.*

While not restating all the details within the agreement, key COA statements follow:

Result 1
Reductions in the release of harmful pollutants on a lake-by-lake basis.
- Implement actions for Binational Lakewide Management Plans
- Identify point and non-point sources of pollution to each lake and its contributing watersheds
- Develop methods and provide support for Watershed Management

Result 2
Rehabilitated, conserved, and protected fish and wildlife habitats and protected areas.
- Advance implementation efforts related to fish and wildlife habitats identified in Lakewide Management Plans
- Implement measures to address erosion and pesticide use in priority watersheds
- Use conservation easements and other tools to secure ecological significant lands and areas requiring protection
- Implement the Great Lakes Wetland Conservation Action Plan
- Monitor water quality changes in the Great Lakes to determine their ecological impact

Result 3
Reduced entry and spread of non-native invasive species.
- Implement the Sea Lamprey Control Program

Result 4
Reduced human health risk from contaminants in the Great Lakes.
- Develop and deliver education and outreach materials to communicate to the public, especially high risk populations the method of minimizing exposure to harmful pollutants

Result 5

Collaboration between government, organizations, and basin residents.

- Provide technical support to improve stormwater management and nutrient management
- Produce outreach materials and use technology transfer tools to encourage environmental citizenship initiatives, such as rehabilitating fish and wildlife habitats
- Provide technical support to the Ontario agricultural and rural community to implement sustainable farm practices

Result 6

Improved scientific understanding of the fate and effects of harmful pollutants and the cause of ecological impairments for each lake.

- Undertake and encourage research in watershed ecosystem

Result 7

Coordinated and integrated monitoring for scientific interpretive reporting, decision-making and reporting on progress.

- Monitoring the health of coastal wetlands
- Monitor water and sediment quality near shore areas, connecting channels and tributaries
- Monitor natural heritage systems

A Joint Strategic Plan for Management of Great Lakes Fisheries

A Joint Strategic Plan for Management of Great Lakes Fisheries was first proposed in 1980 and was adopted in 1981 by each of the state, provincial, federal, and tribal natural resource agencies in the Great Lakes Basin. This plan was revised in 1997.

This plan recognized that various interest groups had become active and influential in determining the uses and environmental management of the Great Lakes. Both the International Joint Commission (IJC) and the Great Lakes Fisheries Commission had accepted the ecosystem approach to Great Lakes management and that any impact on part of the system may, to some degree, affect the entire lake, connecting channels, and even the entire basin. As a result, lakewide-basinwide perspectives were recognized as essential to effective management.

The revised 1997 plan, was strengthened by lessons learned from implementing the original plan. One challenge was to better coordinate and integrate fisheries and environmental ecosystem management initiatives, particularly the implementation of the Great Lakes Water Quality Agreement (WQA) between the US and Canada. The WQA calls for the development of Remedial Action Plans (RAP) and Lakewide Area Management Plans (LAMP). The 1997 plan attempted to address this challenge by strengthening the fisheries management/environmental management coordination by adding strategic procedures into the plan.

The Great Lakes Fishery Commission (GLFC)

A key role of the Great Lakes Fishery Commission is to support the various parties in their efforts to implement the Joint Strategic Plan for Management of Great Lakes Fishery. The Commission represents fishery interests to appropriate bodies and works with Fishery Management Agencies to develop means of predicting the effects of the fishery and environmental decisions.

They also maintain a Habitat Advisory Board to work with Lake Committees (and environmental agencies) to formulate environmental objectives compatible with Lake Committee fishery objectives.

State of the Lakes Ecosystem Conference (SOLEC)

The 1996, State of the Lakes Ecosystem Conference examined the effects of urban growth. SOLEC concluded the major stress to the Great Lakes Ecosystem is growth and development, namely urban sprawl. Extensive urban growth in the Great Lakes Basin creates more impervious surfaces, thus increasing runoff and impairing water quality in urban watersheds unless action is taken.

SOLEC 1996 identified that community-based planning process used to develop and implement watershed plans in Annex 13 of the Great Lakes Water Quality Agreement will assist by determining which tools are the most effective, feasible, and acceptable in achieving reduction targets.

One of the identified weaknesses in the provisions of Annex 13, is the lack of linkages between local development decision making. This Watershed Plan is an example of how agencies, local municipalities, stakeholders, and residents can cooperate to achieve Annex 13 goals.

Wetland Preservation

The wetland loss in the Great Lakes Basin has been well documented and understood to be a key factor in alterations of ecological structure and function of the Great Lakes Basin Ecosystem. SOLEC 1998 identified the importance of identifying and protecting basin wetlands. Through this Watershed Plan and TRCA's Regional Natural Heritage Strategy, opportunities for habitat restoration have been identified including wetland protection.

CHAPTER

9

9.0 FINAL MESSAGES FROM THE DUFFINS CREEK AND CARRUTHERS CREEK TASK FORCES

Key management issues in the Duffins Creek and Carruthers Creek watersheds are associated with urban growth, the potential development of a regional airport, the ongoing stewardship needs associated with existing agricultural and urban land use activities, and the protection of existing natural lands.

People are interested in the health of Duffins Creek and Carruthers Creek. Golf courses, aggregate and agricultural communities, members of Environmental Advisory Committees, organized community groups, and individual citizens have expressed their interest and excitement in both adopting and implementing this Plan. The commitment and support of the five local and two regional governments in the study area have not wavered over more than two years of planning.

If there is anywhere in the GTA where the principles of Smart Growth and sustainable development can be applied effectively, it is in the Duffins Creek watershed. It is not only in a relatively

healthy state, but citizens and communities have an extensive scientific knowledge base in place to support their innovative design and decision making. As well, the public land holdings in the watershed afford unique opportunities to apply these state-of-the-art designs and to monitor effectiveness.

A critical finding is the importance of the groundwater flow system arising south of the Oak Ridges Moraine. Recharge across the south slope of this feature, and the critical role played by the Lake Iroquois Shoreline feature in the form of groundwater discharge, clearly demonstrate that the management focus for groundwater should move off the Moraine. Groundwater studies completed in support of this Watershed Plan address the sensitivities of both the provincial and federal land holdings to changes in impervious cover, reduction in local recharge and the benefits of enhanced natural cover as a mechanism for achieving a desired ecological watershed function. Future development of the provincial and federal land holdings will require special care and attention to achieve the protection of this groundwater flow system and its associated base flows in the Whitevale, Ganatsekiagon, Urfe, and Brougham creeks. For example, studies completed in the mid 1990s by the MNR showed more young of the year rainbow trout in the Ganatsekiagon Creek than in the entire West Duffins Creek. Duffins Creek, as a whole, has a robust fish community and is known as an angling destination in the Greater Toronto Area. Not only is there a legislated mandate to protect and enhance this fishery, there is also a strong public interest in continuing these recreational fishing opportunities.

Technical studies repeatedly demonstrated the possibility of achieving multiple watershed management goals addressed by the protection and enhancement of terrestrial natural heritage cover. The Natural Heritage Strategy provides for an increase in the amount of forest, wetland, and meadow habitats in the headwaters of both the Duffins and Carruthers Creek watersheds. In Duffins Creek, the strategy for increasing natural cover builds upon opportunities in the Oak Ridges Moraine Conservation Plan, including regeneration of public lands and the commitment of local residents already willing to participate in conservation easements on their properties. Further technical studies suggest there is merit in managing for an increase in natural cover on Federal Airport Lands and Seaton Lands as senior governments make plans to develop their holdings. The supporting technical studies have generated a valuable set of data, modeling tools, information, and criteria that will greatly assist in the future management of these watersheds. All the data collected on the Duffins Creek and Carruthers Creek watersheds for the purpose of this study, will be made available to anyone undertaking future studies in support of land use planning, urban design, stormwater management, and other initiatives that would advance the implementation of this Plan.

Conclusions from this Watershed Plan have extended the knowledge base of the Carruthers Creek watershed. The development of the Carruthers Creek watershed beyond the current urban boundaries requires caution, given the watershed sensitivity to ground flow systems and a less robust terrestrial natural heritage system. Very few opportunities exist through the normal development process to increase the natural cover in this watershed to levels recommended by the Plan. Without major changes in development planning, it is very likely that the health of

Carruthers Creek will continue to decline. Some of these potential losses may be mitigated by some retrofitting approaches including reforesting, streambank management, and other changes in cultural practices.

This study emphasized the need for more effective sediment and erosion control practices in both watersheds, including urban areas and especially during construction. The development industry and municipal officials have a unique opportunity not only to address this concern but also to demonstrate effectiveness through both self monitoring and enforcement programs.

Trails are important for human health, for the appreciation of human heritage and for outdoor recreation. The Watershed Plan advocates an expanded trail system, starting with existing trails, and trails under development to create a continuous route from the headwaters to Lake Ontario, and east and west to neighbouring watersheds and municipalities.

The National Round Table on the Environment and the Economy has come up with a simple set of five tools to determine whether Canada is running down its natural capital — clean air and water, non-renewable resources, and greenspaces — at the expense of future generations.

Five indicators are proposed for tracking Canada's natural capital:

- Forest Cover
- Fresh Water Quality
- Air Quality
- Greenhouse Gas Emissions
- Extent of Wetlands

The recommendation is that these indicators will eventually be combined with existing economic indicators, such as the gross domestic product and the consumer price index.

Taken from an article: Counting the Full Cost of Growth, Toronto Star. May 19, 2003

GLOSSARY OF TERMS

Aquifer:	An underground zone of soil or rock saturated with water.
Aquitard:	An underground zone of soil or rock not saturated with water.
Annual loads:	Total mass of substance transported by the stream (e.g., sediment).
Baseflow:	The component of stream flow that comes from groundwater sources.
Benthic:	Living at or near the bottom of a water body.
Enhanced Natural Heritage System:	The concept of increasing natural cover in those areas of a watershed that would achieve multiple watershed management benefits.
Erosion:	A process whereby surface soil and rock is loosened, dissolved, or worn away and moved from one place to another.
Floodlines:	Lines on a watershed map depicting regional flow conditions based on a specific historic event (e.g., Hurricane Hazel).
Floodplain:	The area, usually low lands adjoining a watercourse, which has been or may be subject to flooding hazards.
Fluvial:	Of or belonging to rivers.
Geomorphology:	The study of stream and river corridors.
Groundwater:	Water that enters the soil, moves downward, and then collects in aquifers.
Groundwater Discharge:	The movement of water from underground zones to the surface waters.
Headwaters:	The origins of streams and rivers.
Hydrogeology:	The study of water below the ground surface.
Hydrology:	The study of surface water flow systems.
Impervious:	Surfaces that do not allow water to easily penetrate or be absorbed.

Invertebrates:	Animals lacking a spinal column such as insects, crustaceans, clams, snails, and worms.
Instream barriers:	A structure in a river or stream that hinders or prevents the movement of fish and other aquatic organisms.
Peak flows:	High stream flows resulting from snow melt or rainfall.
Recharge:	Water absorbed by the ground that fills groundwater aquifers.
Runoff:	Water that flows over land (from agricultural, urban, and natural areas) and enters a watercourse.
Source Protection Plan:	A Management Plan for the protection of surface water and drinking water supplies.
Stormwater:	Rain and snowmelt that runs off urban land and roadways into lakes and rivers.
Stormwater Management:	Techniques to control the quantity and quality of stormwater before it reaches the river or lake.
Subwatershed:	A catchment or segment of a watershed.
Topography:	The physical features of a watershed as defined by changes in elevation (e.g., hills, valleys).
Water Budget:	The proportion of water that falls in the form of snowfall and rainfall that either evaporates, enters the ground, or flows to the stream.
Watershed:	The land area drained by a river or stream and its tributaries.
Watershed Divide:	The high land elevations that separate watersheds and determine the direction of flow.

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