

# **Rouge River Watershed**

**Scenario Modelling and Analysis Report**

**Executive Summary**



# EXECUTIVE SUMMARY

## INTRODUCTION

The Toronto and Region Conservation Authority (TRCA) and the Rouge Park Alliance, in cooperation with the multi-stakeholder Rouge Watershed Task Force, have applied an innovative study approach to the development of a watershed plan for the Rouge River watershed. The Rouge River watershed lies in the south-central portion of the Greater Toronto Area, draining an area of 336 km<sup>2</sup> from its headwaters in the Oak Ridges Moraine to its mouth at Lake Ontario. The watershed supports a mix of agricultural, urban and rapidly urbanizing land uses and their associated management challenges. Many stakeholders believe that decisions over the next five to ten years will be critical in determining the long term health of the Rouge River watershed. Therefore, in order to provide effective guidance for the protection and enhancement of the watershed, the study adopted a forward thinking, science-based and integrated approach.

The watershed planning study was carried out in three phases. The first phase involved characterization of watershed systems and evaluation of current conditions according to a set of watershed goals and objectives. This work was documented in the *Rouge River State of the Watershed Report* (TRCA, 2007). In the second phase, current and anticipated future stresses on the watershed and possible management approaches identified in Phase 1 were further analysed through modelling studies, which are the focus of this report. Additional analysis of these issues and approaches occurred during expert workshops, called “management summits”, and with reference to literature from other jurisdictions. Information and strategic recommendations arising from the first two phases of study contributed to the development of the watershed management plan, which constituted Phase 3.

The purpose of this modelling study component of the watershed plan was to assist the technical team and Task Force in:

- improving knowledge of watershed systems, their interdependencies and relative sensitivity to change;
- understanding how watershed conditions would respond to future land use and climate changes; and
- understanding the *relative* effectiveness of various management actions in achieving watershed goals and objectives.

## SETTING AND KEY ISSUES

A description of the climate, physiography, geologic setting and land use of the Rouge watershed provided a basis for study design and interpretation of results. The characterization phase of the study identified current and potential future stresses affecting watershed conditions and put forward possible management approaches for further analysis. The five primary issues and opportunities facing this watershed include:

1. Urban growth pressure;
2. Lack of natural cover;

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3. The need for improved stormwater management;
4. The need to adopt more sustainable urban design forms and lifestyles; and
5. Climate change.

### INTEGRATED STUDY DESIGN

The study design was guided by the following questions, which arose from a review of the five primary watershed issues and opportunities identified in Phase 1:

- **Urban growth:** How will different extents of urban growth affect watershed conditions? Can different forms of urban community design reduce the impacts? How would the protection of lands in the Greenbelt, Rouge Park, and as conceived in Markham's draft Small Streams study affect watershed conditions?
- **Natural cover:** What are the opportunities for expanding natural cover and how would expanded natural cover affect watershed conditions?
- **Stormwater management/retrofits:** How effective would retrofits of end-of-pipe stormwater management ponds be in addressing water management problems? What would be the cumulative effect of lot level, conveyance and end-of-pipe stormwater management practices in new greenfield developments and retrofits in existing urban communities?
- **Sustainable practices:** What would be the cumulative effect of a range of sustainable practices on watershed conditions, if implemented throughout the watershed?
- **Climate change:** How will climate change affect watershed conditions? Can the adoption of sustainable practices mitigate these effects?

A series of eight land use and management scenarios were formulated to depict the possible futures contemplated in the study questions. The scenarios were as follows:

1. Baseline conditions (2002)
2. Official plan (OP) build-out
3. End-of-pipe stormwater retrofit
4. Expanded natural cover
5. End-of-pipe stormwater retrofit and expanded natural cover
6. Full build-out
7. Sustainable community (includes programs in new and existing developments)
8. Climate change (two 2080 climate change predictions applied to scenarios 6 and 7)

The scenarios thereby provided a common basis from which to model/predict and evaluate the watershed's response for a range of ecosystem indicators. Predictive tools included a combination of computerized mathematical models, empirical relationships and professional judgement as follows:

- Surface water balance - WABAS (Water Balance Analysis System) – a distributed continuous water budget model;
- Surface water hydrology and water quality - HSP-F (Hydrological Simulation Program – Fortran) – a continuous hydrologic model with water quality simulation capabilities;

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- Groundwater - MODFLOW (Modular Flow System – Fortran) – a three-dimensional finite difference numerical groundwater flow model;
- Aquatic system - LSAT (Landscape and Stream Assessment Tool) – an aquatic community predictive model based on established relationships between land cover and habitat/species;
- Terrestrial system – TRCA’s Landscape Analysis Model and Terrestrial Natural Heritage System Design Tool - GIS based terrestrial natural heritage models based on principles of landscape ecology;
- Cultural Heritage – TRCA’s probability model for archaeological potential and professional judgement;
- Nature-based Recreation - Professional judgement and literature.

Predicted effects of each scenario were evaluated in terms of acceptability with respect to established watershed goals and objectives and working targets. An overall watershed response model illustrated the pathways and linkages among the individual systems and was used to guide the integrated analysis. The individual models were linked in that often output from one model was required as input to another. Care was taken throughout the study to ensure the compatibility and comparability of study results.

### **SUMMARY OF SCENARIO MODELLING RESULTS**

The key findings of this work have contributed to an improved understanding of the interdependencies of watershed systems, their sensitivity to change and the relative effectiveness of various management actions.

Changes in climate and land cover affect a sequential series of changes in the watershed’s surface water, groundwater and aquatic systems through hydrologic pathways, and impose related direct and indirect impacts to terrestrial natural heritage and cultural and nature-based recreational resources. This pattern of watershed responses also emerged from the analysis of scenarios addressing: conventional urban development, end of pipe stormwater management retrofit ponds, expanded natural cover, sustainable community design and climate change.

#### Conventional urban development

The build out scenarios assumed urbanization according to the existing official plans and potential full build out to the Greenbelt boundary, using conventional approaches to development and stormwater management. Much of the future development and associated effects will occur in the watersheds of the Main Rouge and its tributaries. Additional conventional development will alter the water budget of the watershed as evapotranspiration and infiltration will be reduced and more precipitation will run off newly created impervious surfaces. Consequences of this change include: increases in total stream flows, increases in in-stream erosion potential, potential reduction of local recharge important in sustaining

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baseflow in local streams, reduction in regional aquifer water levels, decreases in groundwater discharge and associated stream baseflow, and deterioration in water quality. Stormwater management ponds designed according to conventional criteria will reduce the impact of increased runoff by providing storage and slower release of the greater volume of flows, but may not be sufficient to completely mitigate erosion impacts. The aquatic community is expected to shift to warm-water tolerant communities within and downstream of the urban boundary, with the likely loss of the rainbow darter, a key target species. Cool and cold water communities, which are currently found in the mid to upper reaches of the watershed will likely become fragmented and isolated, with only the most tolerant fish species remaining. Local populations of redbreasted sunfish, a target cool water species, will likely be directly and severely affected. The quality of terrestrial habitat is predicted to decline from fair to poor with continued urban growth, due to direct loss of habitat or through impacts from surrounding urban land uses.

The population growth associated with this scenario presents opportunities for enriched cultural diversity of the watershed, and will create demand for nature-based recreational experiences.

### End of pipe stormwater retrofit ponds

This analysis considered the effects of improving existing stormwater management ponds or constructing new ones in all existing developed areas where there are opportunities as identified in studies by the Towns of Markham and Richmond Hill. These measures would result in local downstream benefits, but due to the limited numbers of opportunities for new or improved ponds in existing developed areas these measures alone would not be enough to provide significant hydrologic improvements in terms of surface run-off, erosion potential and water quality at a subwatershed scale.

### Expanded natural cover

Expanding natural cover from 24% to 31% of the watershed area, as shown in the targeted natural heritage system map (see Box 1, section 4.5.8), has the potential to provide significant benefits for biodiversity and hydrologic benefits with regards to stormwater management. The primary hydrologic benefit would be the reduction of runoff and stream flow volumes and a corresponding reduction in erosion potential in downstream watercourses in proportion to the amount of additional vegetative cover provided within each sub-watershed. In turn, increased natural cover would benefit fish habitats and associated communities, at least under official plan build-out. These benefits would be most pronounced in the headwaters of the watershed, where there is assumed to be more opportunity for expanded natural cover. However the effects of urbanization would likely overwhelm the benefits of the limited plantings in areas with intense development pressure.

Implementation of the targeted natural heritage system would increase terrestrial habitats to a large measure and improve the quality and connectivity of habitats and corridors. Improvements in the overall habitat quality throughout the watershed will increase the potential for these habitats to support a more diverse range of species, including species of concern. Expanded natural cover may provide a larger greenspace land base to protect sensitive natural areas from incompatible uses and support increased demands for nature-based recreational experiences.

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## Sustainable community design

This scenario comprised four main sets of assumptions:

- An increase in natural cover (as in the expanded natural cover scenario) and additional natural cover associated with Rouge Park and Markham Small Streams policies;
- Sustainable community designs in greenfield developments that reduce overall percent imperviousness and emphasize lot level and other stormwater management practices aimed at maintaining pre-development water balance to the extent possible;
- Naturalized landscaping and stormwater retrofit practices at the lot level, along conveyance systems and at end of pipe in existing urban areas; and
- Shift toward more sustainable, conserving behaviours.

The combination of sustainable community initiatives assumed in this scenario would reduce the negative effects of conventional urban development described above, but are generally not expected to fully offset them. The reductions in negative impacts would likely be more pronounced in areas of new development than in existing urban areas, where opportunities to retrofit with sustainable technologies are limited.

## Climate change

The effect of future climate change on watershed systems is largely uncertain, due to limitations in the prediction of climate change. Notwithstanding the uncertainty, there is the potential for significant changes that should be considered in management and planning decisions. It is believed that the most precautionary approach would be to follow a course of action that attempts to maintain or restore a more natural hydrology and increase aquatic and terrestrial biodiversity to the extent possible, to maximize the watershed's resilience to change. The practices embodied in the sustainable community scenario appear to be the most effective in supporting this approach.

## **RECOMMENDATIONS FOR WATERSHED MANAGEMENT**

The study concluded that the practices associated with the sustainable community design scenario provided the most effective means of achieving multiple objectives for watershed health. These practices can be summarized in the form of three overall management strategies:

1. Expand and enhance of terrestrial natural cover in the watershed;
2. Build more sustainable new communities and retrofit older ones to improve their sustainability; and
3. Create a regional open space system for nature-based recreation.

Additional specific management recommendations pertaining to each of the theme areas of this study are provided in individual sections of Chapter 4 of this report.

The overall study outcomes are considered to be extremely valuable, in terms of improved scientific defensibility for the watershed plan's recommendations and the knowledge capacity built within the technical team.

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## **USE OF THE STUDY RESULTS**

This scenario modelling and analysis study largely constituted the second phase of the watershed planning study, and as such contributed findings and recommendations that were considered by the Rouge Watershed Task Force in the development of the Rouge River Watershed Plan, during the third study phase. As a supporting document to the Rouge Watershed Plan, this report will serve as a technical reference during the plan's implementation. In addition, the scenario modeling results can be used as a guide to comment on the likely relative effects of future scenarios that may contain different assumptions from the ones used in this study. Finally, this study contributes to the continued evolution of the field of integrated watershed planning, and in this regard will help to inform similar studies in other jurisdictions.