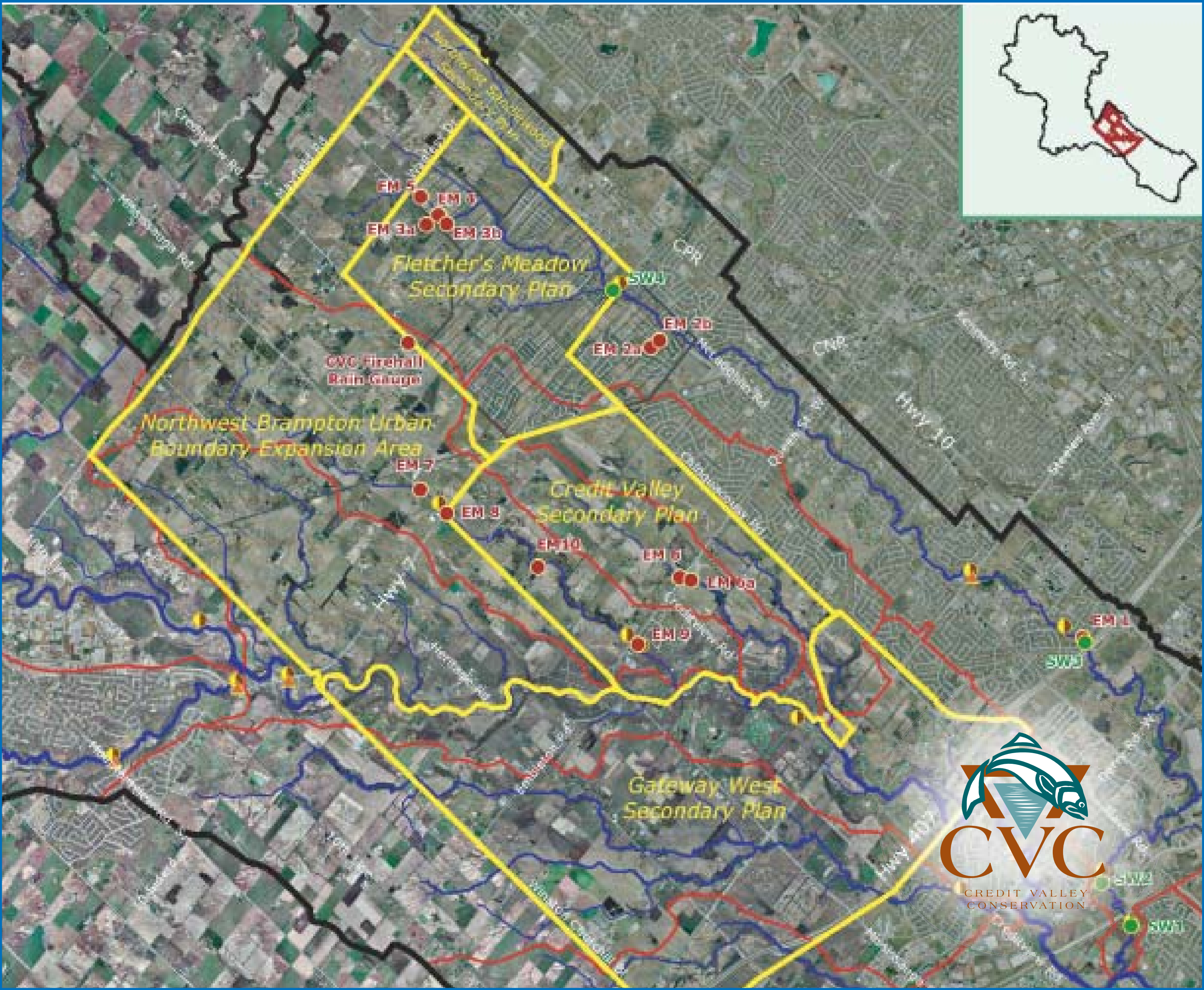
Effectiveness Monitoring Program

Volume I



Background

Credit Valley Conservatin (CVC) recognizes the impact that urbanization has on the North West Brampton subwatersheds. As a result, the City of Brampton is currently conducting a number of background studies to support a proposed Urban Boundary Expansion for North West Brampton. These studies will address technical requirements for the Regional and City Official Plan Amendments.

In 2001, as part of the Phase II Fletcher's Creek Subwatershed Monitoring Strategy Year 3 Final Report performed by Gartner Lee Limited, monitoring was done before and during construction phase. Within the study period two dry years and one wet year were experienced. Due to ongoing land use changes, this study was unable to establish a solid baseline data set at all sites along Fletcher's Creek.

In 2003, the CVC initiated an Effectiveness Monitoring Strategy (EMS) to establish a baseline data set within the North West Brampton subwatersheds to assist the City of Brampton with their planning initiatives and watershed management strategy. The EMP will be used as baseline supporting information when the City of Brampton (in conjunction with the CVC) performs the North West Brampton Subwatershed studies as part of the planning process.

EMS Objectives

- Evaluate the current environmental conditions (flow, precipitation, water chemistry, water temperature, stream morphology, benthic invertebrates, and fish) at a discrete catchment level.
- Determine the effectiveness of stormwater Best Management Practices (BMPs) and current land use planning controls (pre-, during and post-construction, and the use of green space) at mitigating the impact of urbanization.
- Monitoring and evaluating the long-term changes in the ecosystem's response to urbanization.

Program Goals

1. Establish a baseline of current environmental conditions.

2. Assess land use, drainage patterns, construction practices, and BMPs for each catchment.

3. Use knowledge of baseline parameters (gained through the EMP process) to provide guidance for future planning initiatives within North West Brampton.

Method of Approach

To meet the goals and objectives of the EMP, the following parameters are currently being monitored:

- Flow,
- Precipitation,
- Water chemistry,
- Water temperature,
- Stream morphology,
- Benthic invertebrates, and fish.

Sampling locations were chosen to represent drainage areas that are generally small in size (<150 ha) and represent specific land use changes or practices (e.g. upstream and downstream of Stormwater Management (SWM) ponds, residential area developed without BMPs, natural channel design reaches, and agricultural areas that are proposed to undergo development to residential and industrial uses).

CVC crew installing staff gauge for high flow events.

Effects of Urbanization

In a conventional urban setting, forests are cut, farmland excavated and wetlands altered or drained to build houses, roads, parking lots and other forms of impervious cover. These alterations to the natural environment alter the hydrologic cycle by increasing peak volume of streams (during storm events), lowering baseflows of streams (during dry weather periods), and increasing pollutant loads to receiving surface waters (Luymes, 2000; Schueler, 2004). The extent to which urbanization impacts the hydrologic cycle may be predicted by measuring the percent of impervious cover (Scheuler, 2004). Figure 1 (see page 3) demonstrates the impact that various levels of urbanization have on hydrology.

Research on 1st to 4th order streams has shown a direct relationship between impervious cover and stream hydrology (Scheuler, 2004). Schueler (2004) observed that watersheds having between 10-25% impervious cover experienced 1.1-1.5 higher peak flows when comparing a 100 year storm event to a predeveloped watershed. As well, the frequency of bankfull flood events was 1.5-3 times per year in comparison to predeveloped which occurs approximately 0.5 times per year. Schueler (2004) also found that watersheds having between 60-100% impervious cover acted more as urban drains than natural streams. In comparison to a 100 year storm event for a predeveloped watershed, the ratio of peak discharge was 2-3 times higher (Peak developed:Peak undeveloped). The frequency of bankfull flood events was 7-10 times per year for watersheds between 60-100% impervious cover.

CVC and consultant staff check potential monitoring location.

The alteration of watershed hydrology due to urbanization not only impacts quantity it also has an impact on quality, as the watershed's natural ability to filter pollutants through infiltration has been reduced by increased impervious cover.

With urbanization there are often…

Increases In:

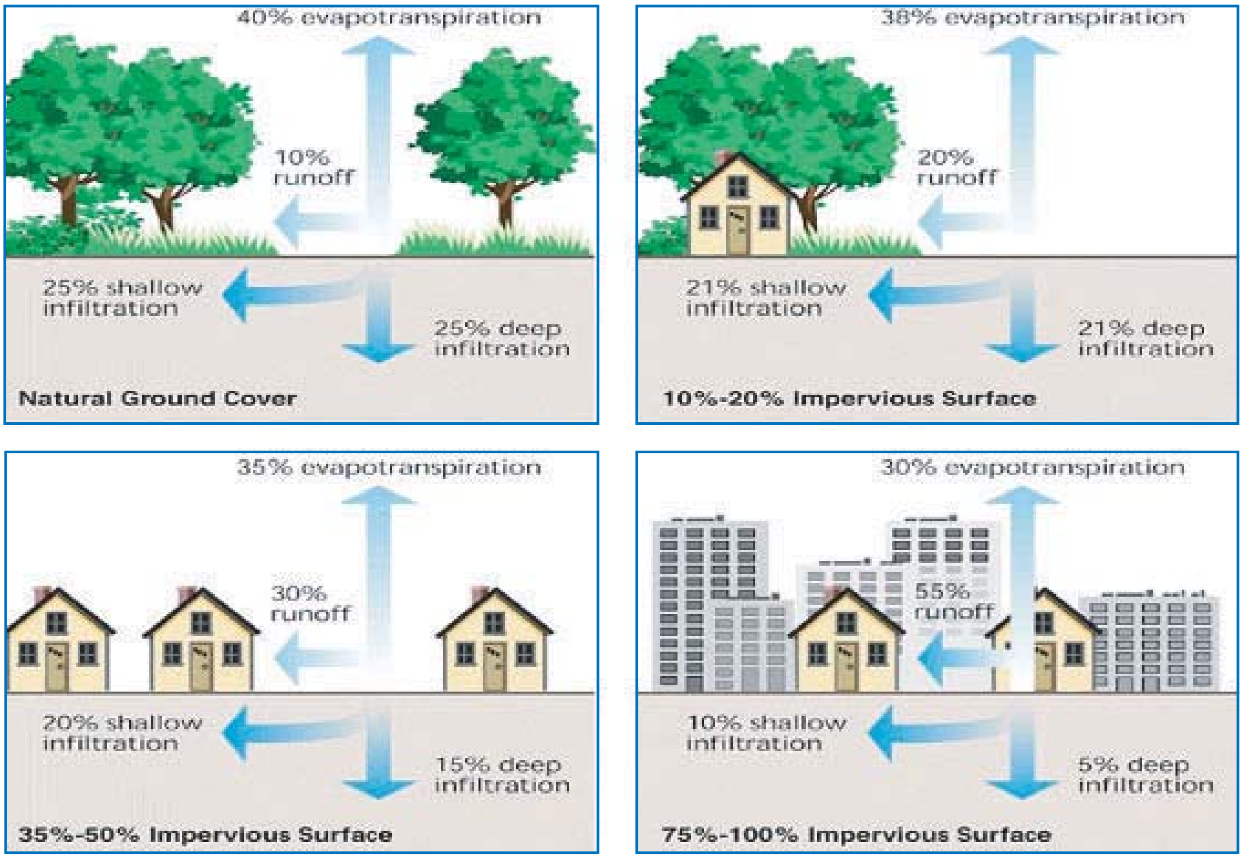
- Suspended Solids and pollutant loads (metals, bacteria)
- Nutrients (nitrogen and phosphorus)
- Stream temperatures (due to increase in runoff, decrease in infiltration)
- Introductions of exotic species
- Channel enlargement (due to increased peak flows)
- Flood potential (size and frequency due to increase in runoff, decrease in infiltration)
- Erosion (due to increase peak flows)

Decreases In:

- Stream stability
- Fish health
- Benthic diversity/health/ species richness
- Water quality (due to increases in suspended solids, nutrients, metals, bacteria)
- Habitat quality
- Vegetative cover
- Groundwater recharge and summer baseflows

To mitigate some of the impacts urbanziation has on the watershed, the MOE requires new development sites to design and install appropriate stormwater Best Management Practices (BMPs). In addition to installing BMPs, subwatershed studies can identify opportunities for improving ecological conditions by removing of fish barriers (such as dams), using innovative stormwater management techniques (such as rain gardens and green-roofs), planting of riparian corridors, natural channel design, native species re-introduction and wetland creation.

Figure 1: The Impact of Conventional Urbanization on the Hydrologic Cycle



Source: PGDER, 1993

EMS Management Tool: Adaptive Environmental Management Cycle

As the future is unknown, there are uncertainties with regards to estimating response conditions and response times of streams to change. The Adaptive Environmental Management (AEM) approach addresses this by setting out objectives (plan), formulating the project (design), creating the works on site (implement), observing change (monitor), determining the effectiveness of the works (evaluate), re-shaping program/project to address deficiencies and incorporating new knowledge (adjust) (adapted from Ohlson 1996). AEM is an on-going process, where adjustments lead back into modifying existing and future plans, and so on. This is the basis for all monitoring programs done by the CVC; and includes long-term learning, experimentation, taking a systems approach and most importantly using research and monitoring to direct management decisions.

In order to provide a better understanding of changes to water quality and quantity, Effectiveness Monitoring is required to learn from our past practices and apply that knowledge to improve future land use change and mitigation decisions. To allow for the complete (and on-going) realization of the adaptive approach, this will be a long-term study.

Peer Review for Minimum Five Years of Study

As part of the AEM process various experts in the watershed management field have been asked to peer review the CVC's EMP. The following section provides a summary of comments with respect to the CVC's EMP.

Jennifer Dougherty (Asst WQ Engineer, Credit Valley Conservation, Mississauga)
-for water chemistry analysis to be statistically robust, an absolute minimum would be 25 to 35 data points per site for small drainage areas with large variations in flow (wet to dry) on a yearly basis

Phase II Fletcher's Creek Subwatershed Monitoring Strategy Year 3 Final Report (Gartner Lee Limited 2001)
-monitoring was done before and during construction phase only, two dry years and one wet year, along with ongoing land use changes prevented the establishment of a solid baseline data set at all sites

Isobel Heathcote (Dean of Graduate Studies and Professor, University of Guelph)
-from water chemistry perspective, the 8 samples (5 wet, 3 dry) per year at each station is insufficient for even annual averages, and even more so for wet vs. dry or quarterly comparisons; need way more data, may need daily/weekly testing for certain parameters (phosphorus, bacteria, etc.), or automatic samplers on a higher frequency
-sampling strategies, especially sampling frequency in a given location, should be tailored to the research questions and the statistical methods intended for data analysis

Neil Hutchinson and Dennis Gregor (Senior Aquatic Scientists, Gartner Lee Limited, Bracebridge and Guelph)
-collect data sets that represent baseline conditions and adequately reflect the normal variability as a result of seasonal and annual variability in snowfall, rainfall, runoff, vegetative cover, temperature and other factors that impact (water) quality of the study areas; in order to compare long-term historical datasets prior to urbanization with data as land use changes; suggest annual sampling of 12 wet weather events and 6-8 for baseflow conditions; CVC schedule to collect 5 years of data to establish baseline conditions, is an absolute minimum for the program, and a scientifically valid assessment

Jack Imhof (National Biologist, Trout Unlimited Canada, Guelph)
-need to monitor for at least 3 generations of your fish species to detect possible changes from normal variability in the population (6-10 years for fish), minimum of 3 to 4 years for macroinvertebrates; since channel morphology changes often lag behind changes in hydrology and sedimentology, a longer period than 5 years would be necessary for channel changes and their potential impacts on fish, bugs and water quality

Chris Jones (Benthic Biomonitoring Scientist, OMOE, Dorset)
-need to document long-term changes, need conservative timeframe- we may understand how streams have responded in other studies but this is a unique case, feel that the 5 year timeframe is too short

Nick Jones (Research Scientist, Ministry of Natural Resources, Peterborough)
-some effects of urbanization may take decades depending on type and degree of disturbance, plan seems short; need to understand complex interactions in streams

Bruce Kilgour (Sr. Environmental Scientist, Stantec, Ottawa)
-having baseline data before development is key, there will be some lag time between developmental changes and biophysical responses; benthos and water quality respond as soon as things get to the stream, which could be immediately or take years; looking at results too early on in the study design, you risk stating there are no effects, when they in fact may occur some years later on

Peer Review for Minimum Five Years of Study

Joan Klaassen (Sr. Climatologist/Meteorologist, Environment Canada, Downsview)
-5 years of precipitation data would be insufficient to determine baseline conditions, a minimum of 10 years is required, and the World Meteorological Organization standard is a 30 year period (now 1971-2000 period) over which climate "normals" are calculated

Bob Morris (Senior Biologist, Credit Valley Conservation, Mississauga)
-five year minimum (standard of Watershed Monitoring Program) based on lifespan and lifecycle of fish, fish are the integrator of monitoring; habitat loss ongoing issue as development progresses (lose swales, high stream density in headwaters)
-land use affects the water cycle, that in turn affects fish; intermittent streams typical of this area are much more variable such that fish sampling may require more than 5 years; and fish may not be the most suitable quantitative indicator on intermittent reaches

John Parish (Parish Geomorphic, Georgetown)
-sampling frequency for sites, especially on smaller streams that are often more affected by land use change, is five times over five years (annual, often with supplemental re-sampling after large flood event(s)), the length of the monitoring should be assessed and modified based on results and annual interpretation following third year; the 5 year timeframe relates (statistically) to ensuring the capture of a large flow event (5-year return or greater) within the monitoring period (important as these events have the capability to alter channel conditions)

John Perdikaris (Watershed Resources Engineer, CVC, Mississauga)
-to determine minimum streamflow, predicted value of streamflow should not be greater than 2x the years of recorded data, eg. to get 7Q20 (7 day low flow with 20 year return) value, minimum 10 years of data is required; records of 50 to 100 years is preferred

Tom Schueler (Former Director, Centre for Watershed Protection, Maryland USA)
-need at least 3 to 5 years data at each site, but will take decades for channel enlargement process to occur, five year minimum is a sensible study design

Hague Vaughan (Director, EMAN, Environment Canada, Burlington)
-valid assessments of baseline conditions require a minimum of 5 years, and larger issues such as climate change, invasives, land conversion are always at play in that characterization; another approach would be to work with stakeholders in an adaptive framework using preliminary evidence, managing hotspots and change, allowing for continuous improvement/adaptive responses; with the distinctly unsustainable identified and addressed directly, this is the process of sustainability

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