CALEDON CREEK AND CREDIT RIVER SUBWATERSHEDS – A CASE STUDY

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ABSTRACT

The Caledon Creek and Credit River Subwatershed study is a three-phased assessment that details the environmental and water related issues. These subwatersheds have been undergoing increasing development pressures including extraction activities and related land uses of existing pits as well as expansion of licensed areas. Specifically, an analysis of the groundwater and surface water hydrology, riparian and aquatic and terrestrial habitat, water quality and stream morphology were undertaken. The goal of these analyses was to achieve a thorough understanding of how the ecosystem functions and how land use changes will impact upon it.

Background

Project History

In January 1992, Credit Valley Conservation (CVC) in concert with all member municipalities and the Ministries of Natural Resources (MNR) and Environment (MOE), completed a watershed management plan titled *Credit River Water Management Strategy* (CRWMS), Phases I and II. These studies evaluated the present and future state of the Credit River Watershed with respect to overall health. The results for the future scenario indicated that the ever-increasing pressures for development and resource use, the impacts to the watershed if not properly managed would be irreparable. The study recommended that the entire watershed be subdivided into 20 subwatersheds and that plans be prepared in order to properly manage the health of the watershed.

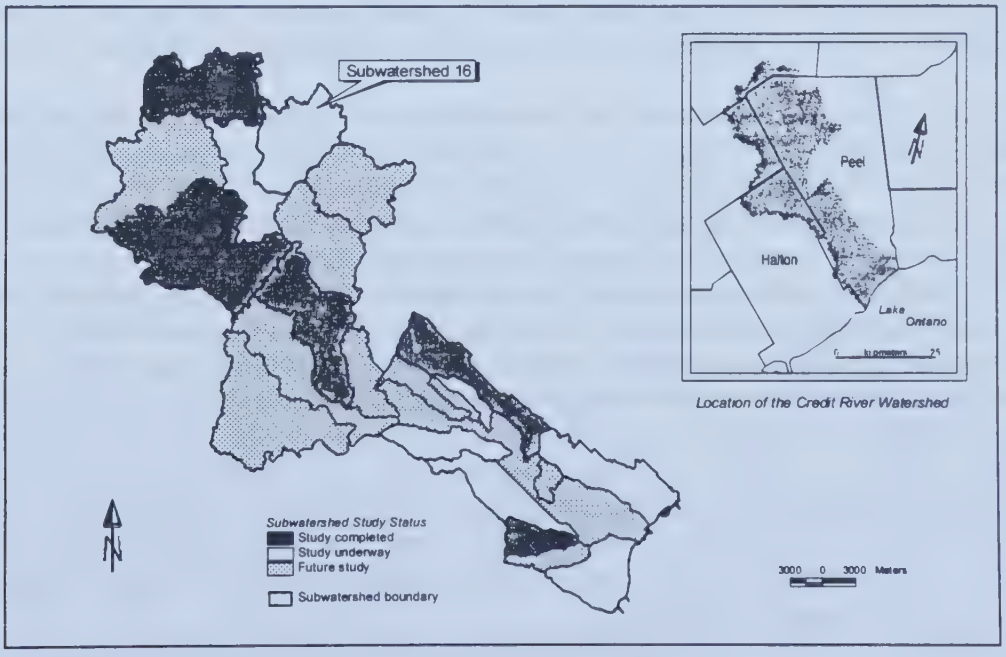


Figure 1 shows the location of the Credit River Watershed with respect to Lake Ontario and also shows the location of the subwatersheds under study within the Credit River Watershed.

The Caledon Creek and the Credit River Subwatersheds (Subwatersheds 16 and 18) have been undergoing increasing development pressures including extraction activities and related land uses of existing pits as well as expansion of licensed areas. This has caused a number of agencies including Region of Peel, Town of Caledon, Credit Valley Conservation (CVC) and the Niagara Escarpment Commission to express a significant concern over the lack of a comprehensive area-wide analysis of the cumulative impacts on the environment and the community, caused by land use changes. As a result, these agencies gave their support for initiating the subwatersheds study. CVC was requested to manage the study and the Region of Peel allocated the financial resources necessary to carry out the study.

Study Purpose

The study covers the environmental and water related issues within Caledon Creek (Subwatershed 16) and the Credit River (Subwatershed 18). Specifically, an analysis of the groundwater and surface water hydrology, riparian and aquatic and terrestrial habitat, water quality and stream morphology were undertaken. The goal of these analyses was to achieve a thorough understanding of how the ecosystem functions and how land use changes will impact upon it. The study is intended to be used as one component of a land use management strategy that may be developed by municipal partners in an effort to balance economic, social and environmental needs within the community.

Related Initiatives

Coordination with other ongoing initiatives has been essential in order to take advantage of collecting additional information and realizing cost savings to the study. Such initiatives include ongoing subwatershed studies (Subwatersheds 19 and 15); the Caledon Community Resources Study and the Town of Caledon Well head Protection Area Program.

Study Process

The study is managed on a daily basis by CVC. The overall direction is provided by a Technical Committee made of representatives from Region of Peel, Town of Caledon, Niagara Escarpment Commission, MOE, MNR, CVC and a representative from the local aggregate operators. Each representative in turn reports to senior management whom in turn report to Municipal Council, Commissions or Board of Directors.

The study has been divided into three phases and is to be carried out over a two-year timeframe. The following describes each phase:

- Phase I – This is the Characterization Phase and can be defined as the assessment that is carried out to establish the form, function and linkages of the various components of the natural environment. In order to characterize the subwatershed, an inventory of existing information was carried out in order to establish data gaps and refine the proposed field program to collect the important missing data. The field program was initiated early in the study process in order to take advantage of seasonal conditions. This phase was concluded with a report that summarizes the important water linkages between environmental components.
- Phase II – This is the Impact Assessment Phase and can be defined the assessment whereby the response of the subwatershed is determined by applying various stressors over time using predictive models. The objective of this phase is to determine subwatershed sensitivity to these stressors in order to determine the limits to change and the ability to apply various mitigative measures to avoid cumulative impacts.
- Phase III – This is the phase in which the Vision and Goals developed for the subwatershed are utilized to assist in selecting those mitigative measures that offset the impacts from future land use changes. An Implementation Plan is developed and responsibilities are assigned to ensure that the

recommendations of the study are followed. Implementation is usually overseen by an appointed committee the issues usually center around ensuring that recommendations are followed up on and land use planning policies, stewardship and education, retrofit and rehabilitation, monitoring and research and development.

The conclusion of the study does not signal an end to process but a beginning to managing our actions in an adaptive manner. As additional monitoring is carried out over time, initial assumptions and the predictive tools used can be checked and necessary modifications to management decisions can be made.

Subwatershed Characterization

Methodology

The approach taken for this phase was to divide the natural environment into components, study each in detail and then re-aggregate the system so that the findings could be integrated in a manner that allows the important water linkages to be defined.

Component Studies

Hydrogeology

The movement of groundwater in the area is primarily controlled by the geologic setting. Highly permeable sand and gravel materials located along and adjacent to the Credit River and the main branch of the Caledon Creek provide excellent areas for water to infiltrate into the ground and recharge the groundwater. Most recharge in this area become part of a larger more regional groundwater flow system. The till units in the northeastern part, and just south of subwatershed 16, provide important, but lesser opportunity for water to enter the ground, and provide water to the local aquifer system.

Groundwater flow radiates out from the groundwater high located in the till unit in the northeastern portion of Subwatershed 16. Groundwater originating from this area provides baseflow to Caledon Creek, the Credit River, the Humber River (outside of the Credit River watershed) and the Little Credit River (Subwatershed 13).

The Amabel formation, a permeable dolostone bedrock unit underlying much of the study area is the medium through which most of the groundwater in the subwatersheds travels through to adjacent areas. This is evident in the southern portion of Subwatershed 16 where the groundwater flows through the bedrock and into the sand and gravel along the buried Niagara Escarpment. Providing the source of headwaters for the Little Credit River.

The western portion of the Caledon Meltwater Channel has a large storage volume and is the conduit for much of the groundwater that flows through the regional system toward the Credit River. At its westerly boundary, the unit fans out. Groundwater flows this deltaic path into the Credit and results in significant discharge to the river downstream of the Caledon Creek confluence. Further groundwater contributions to this reach originate in the West Credit (Subwatershed 15). As much as 15% of the water recharging Subwatershed 15 discharges into Subwatershed 18. Other areas of less significance include the upstream reaches of Caledon Creek (local recharge only), and the upstream reach of the Credit River (moderate regional recharge contributions).

Hydrology

Specific characteristics found in Subwatersheds 16 and 18 impose a dominant influence on the flow response in these areas. The dominant characteristics identified here include: significant closed drainage systems, limited

municipal drainage, significant floodplain storage (Subwatershed 18 only), high percentage of forest cove, prevalence of high infiltration soils, and the presence of significant extraction activities.

The near absence of municipal drains combined with hummocky topography associated with the Singhampton Moraine and large wetland areas have resulted in large areas with either no surface drainage outlet or restricted outlets. These areas are referred to as closed drainage systems. Precipitation is retained in these areas, and either recharges the groundwater aquifers or evaporates. Closed drainage systems occur mostly in the Caledon Creek subwatershed, and account for about 30% of the area.

Channel floodplain storage is a dominant feature of Subwatershed 18, where the Credit River follows a broad glacial spillway. The broad floodplains and flat channel gradients associated with these spillways result in considerable floodplain storage, which greatly attenuates flood flows originating in the headwaters of the Credit River.

Subwatersheds 16 and 18 have significant forest cover. The high infiltrability associated with the soils under forest cover restricts the amount of precipitation appearing as runoff for entry into the surface drainage network. In addition, snowmelt in heavily forested areas melts much later than agricultural areas. The delayed snowmelt reduces the potential for flooding and provides additional opportunities for groundwater recharge.

The predominance of highly permeable soils in Subwatershed 18 and the lower portion of Subwatershed 16 results in high recharge rates to groundwater aquifers, and reduced surface water runoff to flow within the subwatershed. Field observations confirm that many reaches of the Caledon Creek have no permanent flow, drying up each spring and summer. Flow is likely to occur in many reaches only during the spring freshet, when frozen ground conditions contribute runoff for all soil types.

Stream Morphology

Characterization was completed at the basin scale and utilized background documentation, air photos, and field analyses. Channels within Subwatershed 16 are typically classified as 'C-type' with some tributaries exhibiting steeper and entrenched conditions, similar to a 'B-type' channel. The headwaters have been largely modified for agricultural use, thereby reducing its stability. The creek conveys very little flow and sediment which results in a narrow channel which is highly influenced by riparian vegetation.

The characteristics of the main channel in Subwatershed 18 have been influenced by the regulated flow regime. The channels are generally classified as 'C-type' and the lower sections as 'B-type' and are fairly stable. There are sections where the overall stability is not as good. Upstream, above the Alton branch, cattle access has resulted in poor bank definition and higher sediment contributions. The reach upstream from the Caledon Creek exhibits some unusual channel forms, which are likely due to some channel alteration (dumping of sediment or channelization) over 50 years, from which complete adjustment of the watercourse has not yet occurred.

Some of these unusual forms and areas of channel instability can also influence the sensitivity of the channel to alterations. These alterations can either be direct (channelized, hard structures) or indirect (flow regime, sediment dynamics). A channel with a high sensitivity will adjust or respond to slight or minor alterations and generally take longer to recover or stabilize. Reaches which are steeper or have coarser substrates are typically less sensitive than flatter channels with sand or silt substrates.

Terrestrial

Subwatershed 18

The areas of highest priority include the Credit River valley system and adjacent lands from Alton to the confluence with the West Credit River. This natural area includes the most diverse areas in the subwatershed containing; both macro corridors; a large percentage of core area and deep core areas and Class 1 communities (based on relative community size).

The Dufferin Lake area is also a significant natural area containing the only Provincially Significant Life Science ANSI in Subwatershed 16 or 18. It also contains habitat for an endangered species and three Class 1 communities (based upon relative community size).

Another important area is Forest Conservation Area #1 and the adjacent area. This area is highly diverse, containing four Class 1 communities (based upon relative community Size); a community with trees greater than 125 years of age, and is a source area for tributaries in both Subwatershed 18 and Subwatershed 15.

Subwatershed 16

The most important areas within Subwatershed 16 are the headwater areas of Caledon Creek, particularly in Concessions 3, 4 and 5 EHS, north of 15th Sideroad. These areas contain the only 200 metre core areas in the entire subwatershed; are part of the Provincially Significant Speersville Wetland Complex, and have many Class 1 Communities (based on relative community size).

Another significant area is the natural area north of the Village of Caledon. This patch is relatively diverse but a majority of the area consists of Class 1 communities (based on relative community size). As well, the area contains some 100 metre core, and is classified as the locally significant Caledon Village Wetland.

Aquatic

Subwatershed 16

In all, 19 fish species reside in Caledon Creek. Caledon Creek is dominated by species considered to be tolerant of a range of environmental conditions. This is reflective of the intermittent nature of this subwatershed but also suggests the importance of permanent flowing reaches or pools and wetlands to provide seasonal refuge.

The most sensitive species, particularly with respect to groundwater gradients into the stream, are brook trout, which are only found in the lower reach of Caledon Creek where permanent baseflow exists. The provincially significant species redside dace was sampled in one tributary of Caledon Creek and are indicative of cool water conditions along with another coolwater species the rainbow darter.

Subwatershed 18

Twenty-four fish species reside in the Credit River. Healthy brook trout populations reside in the downstream half of the Credit River within the study area. The most critical spawning habitat identified is just north of Highway 24. Populations in the upper half are restricted to smaller "refuge" areas. Historical and recent data suggests the area just downstream of 20th Sideroad has seen a disappearance of the local brook trout population. Downstream of the Cataract Falls brown trout coexist with the brook trout population. Both are wild self-sustaining populations that provide a high quality recreational fishery and serve as environmental barometers.

Protection and rehabilitation strategies of the fishery should focus on groundwater contributions, thermal impacts from ponds/impoundments and areas lacking riparian cover, predation from northern pike and stream morphology south of 20th Sideroad.

Water Quality

Sites where water quality is excellent were generally located in headwater areas. The headwater tributaries of Caledon Creek, the majority of the upstream portion of the Credit River and the reach of the Credit just upstream of the Forks of the Credit have excellent water quality.

In contrast, sites with poor water quality include the downstream portions of the tributaries of Caledon Creek east of Heart Lake Road, and the tributaries to the upper part of the Credit.

Factors that can influence water quality include groundwater inputs, presence of on line ponds and wetlands, the presence of riparian vegetation, and the adjacent land use. It should be noted that the results of the Hilsenhoff Biotic Index can be related directly to the aquatic communities.

Summary of Findings

The combination of the Singhampton Till layer, in close association with the Amabel bedrock formation and the Caledon Meltwater channel create what appear to be a regionally significant recharge and storage area for several subwatersheds. The location and slope of the Caledon Meltwater Channel in association with the elevation and slope of the Amabel bedrock formation create an enormous opportunity for groundwater discharge into specific reaches of Subwatershed 18. The location, character and shape of the Caledon Meltwater channel creates a "Horn of Plenty" shape facing towards the Credit River. Consequently it is not a coincidence that the best coldwater habitat, highest productivity of trout and best spawning areas for brook trout are found in this reach of river.

The dampened pattern of high flows in Subwatershed 18 which result from both the geology and the large riparian forests, create very stable channel forms for fish habitat, while the distribution of groundwater flow to streamflow provide good conditions for fish communities. The upper sub-basin of Subwatershed 18 contains good fish habitat and temperatures quite suitable for a coldwater community dominated by brook trout. The middle sub-basin contains less groundwater activity and has potential for a coldwater community, although habitat appears limited because of unusual channel structure. The lower portion of the sub-basin contains high quality fish habitat, active spawning, medium to high biomass of trout and ample amounts of groundwater, a result of the significant contributions of groundwater from Subwatershed 16 and to a lesser degree Subwatershed 15.

Three major geographic forms occur in the two subwatersheds and provide the opportunities for terrestrial species diversity and richness: riverine corridors, till plain and hummocky till plain, and buried Niagara Escarpment. Of these three units, the first two generated the highest priorities for protection, based upon a comparison of: communities or patches; community class; core characteristics; "natural" forest and/or wetlands.

The aquatic system within the two sub-basins are very different from each other, based upon the characteristics of geology, groundwater movement, surface water flow and land cover. Fish community distribution is based upon a number of factors: flow regime (flow stability and base flow volumes), thermal regime (seasonal temperature maximum, minimum and means), structural habitat (channel morphology and groundwater discharge areas), land cover in the riparian zone (contributions of nutrients to the stream, shading, contributions of woody debris, contributions to channel and bank stability and fish community dynamics).

Water quality throughout the two subwatersheds, (based upon an analysis of invertebrate populations) is generally good. The best water quality found in Subwatershed 16 is found in its headwaters, associated with forested and/or wetland features, whereas the poorest water quality is found in the lower tributaries of Caledon Creek and east of Heart Lake Road, associated with more active land uses.

Subwatershed 18 appears to be an extremely healthy, productive and stable subwatershed. Aquatic productivity is generally high, water quality is good, and terrestrial features are in general intact, despite the fact that this subwatershed is within one hour drive of over 3 million people. Overall health is a direct result of the recharge and storage characteristics of Subwatershed 16. The characteristics and quality of Subwatershed 18 rely heavily on the recharge and storage capabilities of Subwatershed 16 and the maintenance of an intact riparian system along its valley. Alterations in the functional characteristics of recharge and storage in Subwatershed 16 should be carefully assessed in order to avoid altering the quality and quantity of groundwater moving from Subwatershed 16 into the other adjacent subwatersheds.

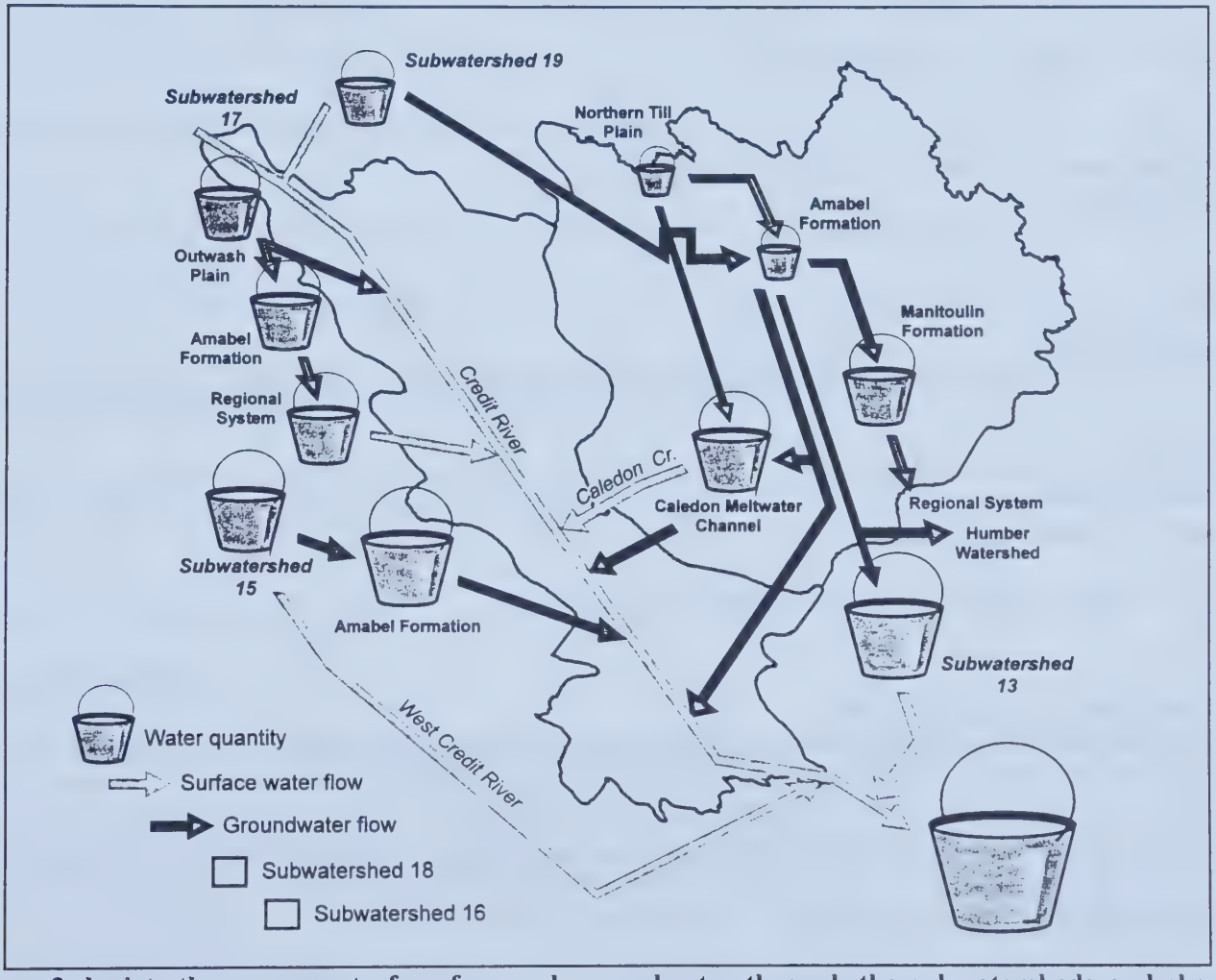


Figure 2 depicts the movement of surface and groundwater through the subwatersheds and shows the important water linkages.

The quality of the fish community and specifically the trout community of Subwatershed 18 relies fundamentally on the recharge characteristics of Subwatershed 16 and the valley shape, discharge characteristics and riparian characteristics of Subwatershed 18.

Goals and Objectives

The vision and goals for Subwatersheds 16 and 18 were developed with the assistance of the Focus Group. The technical committee have also had input and have since endorsed them. The vision and goals will be consulted if future restoration or rehabilitation work is planned.

Vision

Our vision of the Caledon Creek and Credit River Subwatersheds includes the protection of the natural features and functions that exist today (1997) as well as the enhancement of natural features and functions where they most benefit the overall environmental health of the area.

Consistent with this vision, is our desire to keep the character of the countryside of these two subwatersheds in balance with the use of the resources within the subwatersheds.

Goals – Subwatershed 16 – Caledon Creek

PROTECT
- existing important natural features and functions
- groundwater

MAINTAIN
- existing functions of the water flow system
- coldwater fishery
- communication with subwatershed residents and other interested parties on the health of the subwatershed

ENHANCE
- coldwater fishery
- natural features and functions

RE-ESTABLISH the riparian vegetation upstream of the gravel pits

RESTORE
- stream channel in aggregate areas
- damaged or degraded natural features and functions (use gravel pit restoration as an opportunity)

PROVIDE
- recreational and interpretive opportunities (use gravel pit restoration as an opportunity to add to public open space in critical areas)
- support for private land stewardship

ENCOURAGE, where feasible and practical, suitable agricultural practices that acknowledge compatibility of production with riparian habitat

ESTABLISH a monitoring program to detect and report changes to the community and decision-makers about the environmental conditions within the subwatershed

Goals – Subwatershed 18 – Credit River

PROTECT
- existing important natural features and functions
- groundwater

MAINTAIN
- existing functions of the water flow system
- self sustaining coldwater fishery
- communications with subwatershed residents and other interested parties regarding the health of the subwatershed

ENHANCE
- self sustaining coldwater fishery
- natural features and functions

RESTORE damaged or degraded natural features and functions

PROVIDE
- recreational and interpretive opportunities (use gravel pit restoration as an opportunity to add to public open space in critical areas)
- support for private land stewardship

ENCOURAGE, where feasible and practical, suitable agricultural practices that acknowledge compatibility of production with riparian habitat

ESTABLISH a monitoring program to detect and report changes to the community and decision-makers about the environmental conditions within the subwatershed

Subwatershed Impact Assessment

Proposed Methodology

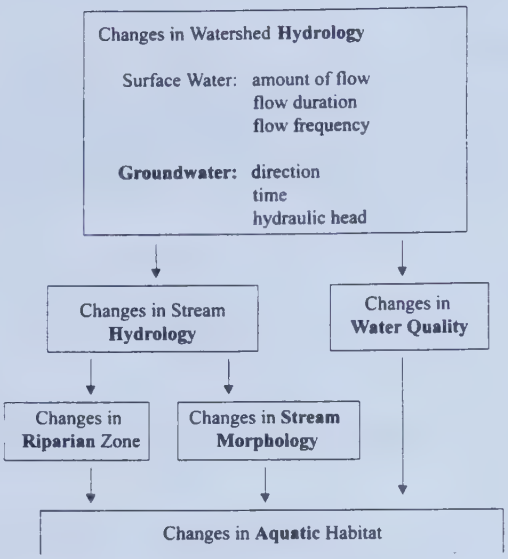
The underlying principles behind the impact assessment deal with the issues of scale (spatial and temporal), development of a stress-response framework and sensitivity testing. The scale of the impact assessment will be carved out at the subwatershed level. Spatial analyses will be limited to a subcatchment and associated stream reach. A stress-response framework was selected by utilizing three landuse conditions. These three conditions represent existing 1998 conditions, a future interim landuse condition (sensitivity test 1) and an ultimate landuse condition (sensitivity test 2). The future landuse changes include increased urbanization and aggregate mining, and decreased land uses.

All three conditions were modeled using hydrologic models to establish impacts to groundwater and surface water flow regimes. The flow chart shows how these impacts are translated to the other environmental components and ultimately to the aquatic system, which are being used as indicators of watershed health.

This analysis is currently underway and will be completed in early fall.

Public Participation

Environmental Impact Model
as Defined by Water Linkages



A Communications Committee was formed at the onset of the subwatershed study process. The purpose of the committee was to seek out and encourage public involvement throughout the study process. In order not to confuse the public with other ongoing initiatives, public meetings were jointly held with these initiatives. Short presentations were made to such groups as the Ratepayers Association, Women's Institute, Optimist Club and a local Environmental Advisory Committee. Historically, the relationship between those involved in the aggregate extraction industry and approval agencies has not been ideal. Therefore a meeting was convened with the major aggregate operators in the subwatershed to determine how they wish to be involved in the process. Analyses were also undertaken using the municipality's Tax Assessment information to determine the types of land use and therefore determine the target audience for contact. This also assisted in developing a mailing list to contact those landowners whose properties were selected for fieldwork to collect additional data. A landowner contact process was initiated and a protocol was developed in order to outline landowner permission, sharing data collected and keeping the landowner informed of the progress of the study. In addition, a 30 member Focus Group was formed exclusively to the study. The groups role is to receive study results and participate in discussions regarding local knowledge, provide reactions to findings, assistance with the generation of a Vision and Goals for the study area, as well as feedback on policies and priorities.

Other smaller initiatives included a contest held at the local public school to design the study logo. A field trip was held for the environmental club of the local high school to participate in streamside benthic identification. Local residents also participated by measuring waterlevels at established locations after heavy rainfalls. These events were also covered by the local newspapers.

Future Work

The study is ongoing and will be completed in approximately two months. The Impact Assessment will be completed and mitigation measures reviewed and selected using the established Goals and Objectives. Following this the Implementation phase will be initiated and will be developing a clear action plan with assigned responsibilities for the coming years.

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