Case Study
Laurel Creek Watershed
Ontario, Canada

Nancy Goucher

Fourth-year undergraduate student

School of Planning

University of Waterloo, Waterloo Ontario

200 University Avenue West

Waterloo, Ontario

Canada N2L 3G1

Phone: (519) 888-4567 Ext. 6044

Fax: (519) 725-2827

E-mail: npgouche@fes.uwaterloo.ca

http://www.resourceknowledge.org

CONTENTS

List of Figures

List of Tables

List of Abbreviations

BMP	Best Management Practice
ESPA	Environmentally Sensitive Protection Area
GRCA	Grand River Conservation Authority
GROUP	Get Rid of Urban Pesticides
GRW	Grand River watershed
LCCC	Laurel Creek Citizens Committee
LCW	Laurel Creek watershed
LCWS	*Laurel Creek Watershed Study*
LCWMP	Laurel Creek Watershed Monitoring Program
NGO	Nongovernmental organization

1.0 INTRODUCTION

Laurel Creek is a tributary of the Grand River, one of the largest rivers in southern Ontario. The Laurel Creek watershed (LCW) is a fertile, diverse area rich with aquifers supporting the storage of groundwater, interesting terrestrial resources, and diverse species habitat. Most of the LCW is located within the city of Waterloo; watershed planning, however, is conducted by the Grand River Conservation Authority (GRCA) at the Grand River watershed scale.

The creek has influenced the development of the city of Waterloo through the shape of the roads, the location of the downtown, and the type of industry. As the city developed, the quality of the creek and its watershed was degraded through the clearing of land and draining of wetlands. In the first half of the twentieth century, Laurel Creek underwent a number of structural-related changes for the purpose of flood and erosion control to protect life and property. As a result of the landmark 1993 *Laurel Creek Watershed Study* (Grand River Conservation Authority [GRCA], 1993), a watershed planning approach has been adopted. Local land use policies and planning are the most direct form of control over development. This report describes some examples of this control, including the special zoning for the sensitive West Side moraine lands.

The role of nongovernmental organizations in the management of the watershed is also discussed. Specific attention is paid to a committee involved in the rehabilitation of Laurel Creek. Finally, the last section discusses institutional arrangements, new long-range plans, and current financial arrangements in the LCW. These plans have been derived from a number of studies and are focused around improving the control of flooding, streambank erosion, surface erosion, and sedimentation; water quality; groundwater quality; and natural resources.

2.0 PHYSICAL DESCRIPTION OF THE LAUREL CREEK WATERSHED IN ITS PREMODIFIED STATE

2.1 Basic Information

The Laurel Creek watershed is located in southwestern Ontario, Canada. The creek drains an area of 74.4 km^2 (28.7 mile^2) into the Grand River, which continues to Lake Erie. See Figure 1. LCW is located at the northwestern end of the regional municipality of Waterloo. In 1990, there were 78,905 people living in the watershed, with more than 98 percent living within the urban area of the city of Waterloo (GRCA, 1993).

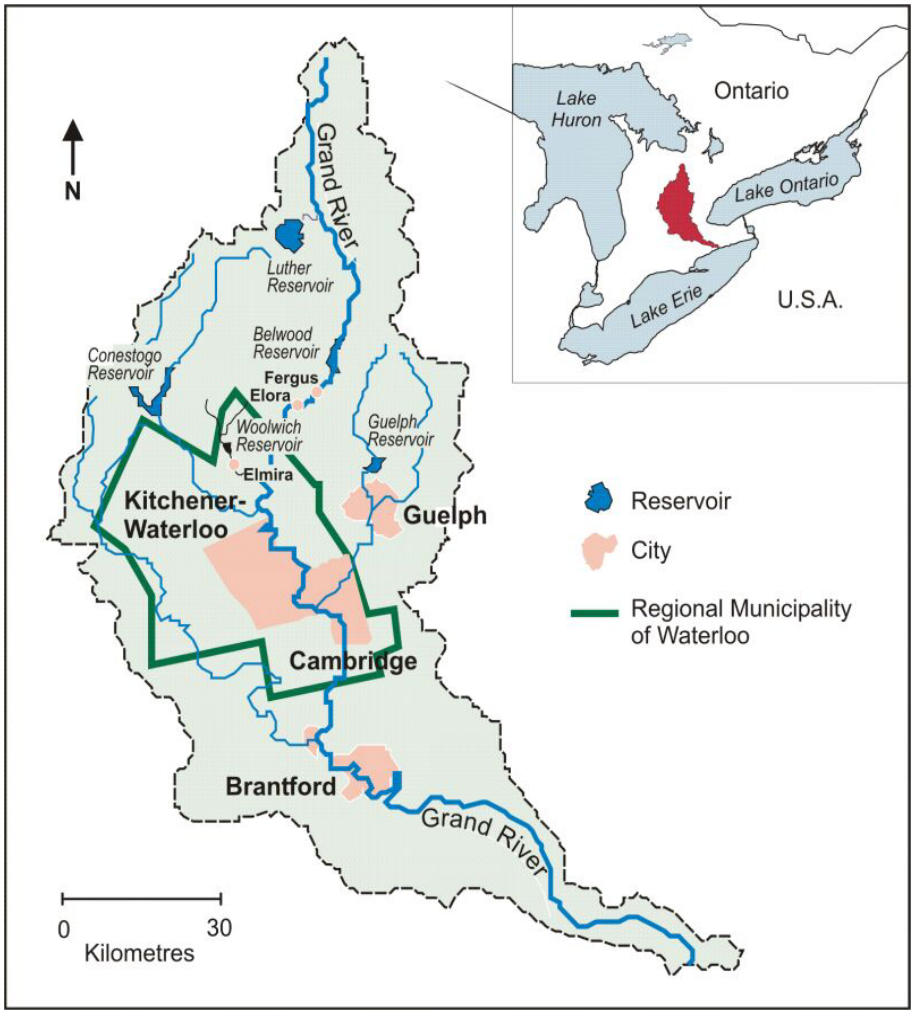

Figure 1: Map of the Grand River Watershed

Source: Ivey, 2002.

The largest municipality in the watershed is the city of Waterloo. See Figure 2. Eighty percent of the city is drained by Laurel Creek (Grand River Watershed Data, 2003). In 2003, the city of Waterloo had a permanent population, excluding students, of 87,874 (City of Waterloo, 2003c). Between 2001 and 2002, the city's population increased by 3.4 percent (Region of Waterloo, 2003).

Laurel Creek's headwaters begin in rural landscapes of the township of Woolwich and Wellesley and drain into the Grand River in the city of Kitchener at Bridgeport Road. Laurel Creek's main tributaries include Clair Creek, Forwell Creek, Beaver Creek, and Monastery Creek, all of which have major sections running through the city of Waterloo (GRCA, 1993).

The watershed is characterized by well-drained soils and moraines that enable groundwater recharge and the sustainability of relatively large aquifer systems. In its original state, the groundwater would contribute to the base flow of Laurel Creek and its tributaries to provide for productive coldwater fisheries. The moraine system also supports a wide range of plant, animal, and bird species.

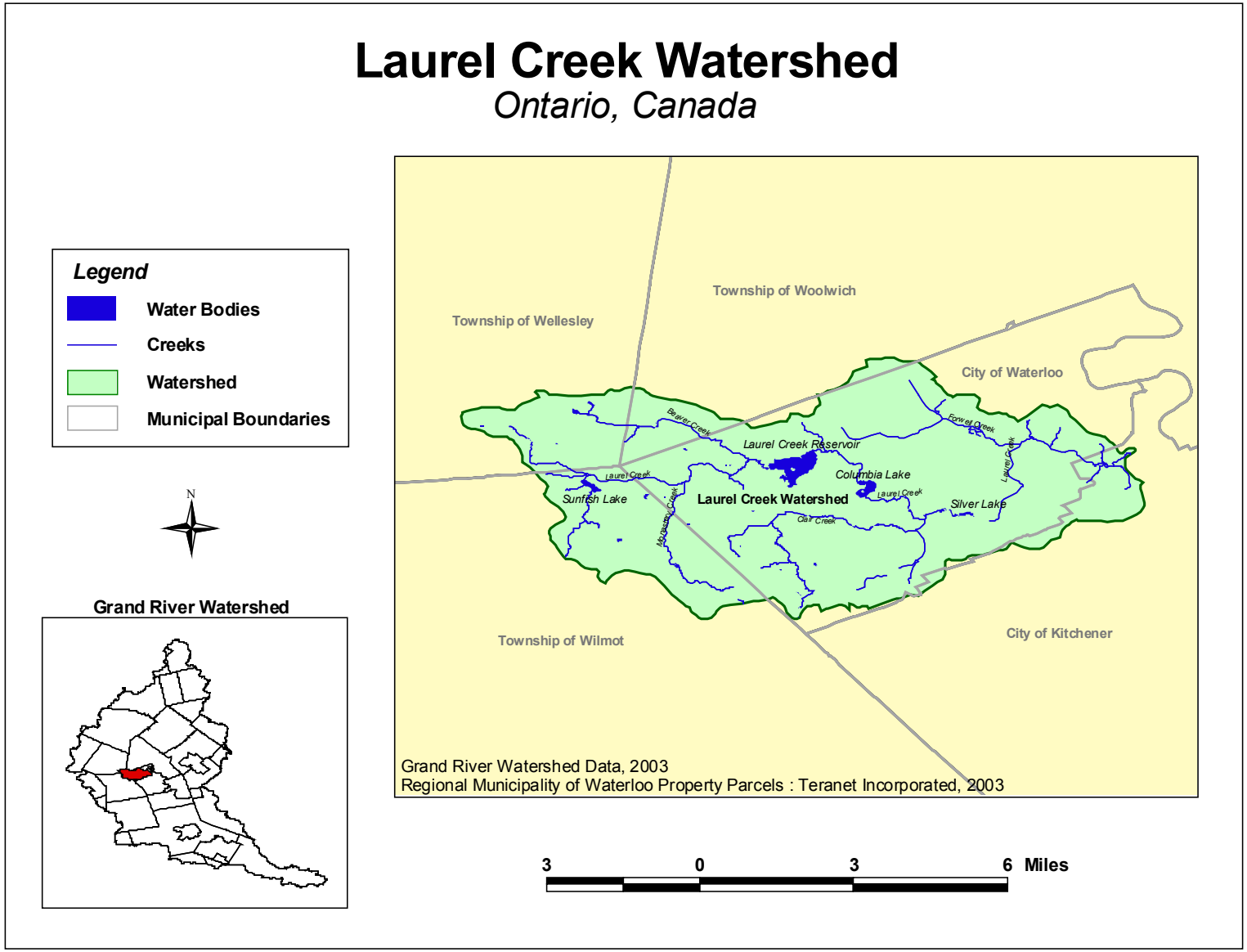

Figure 2: Map of the Laurel Creek Watershed
Source: Assembled from Grand River Watershed Data, 2003.

2.2 Geology

The long-term geologic history, including past glacial activity, has affected the current LCW landscape. Waterloo's underlying bedrock was created during the Silurian Period 430 to 395 million years ago when sediments were deposited in the ancient Silurian and Devonian seas that once covered much of southern Ontario (Nelson et al., 2003). These compressed sediments created a Salina Formation consisting of interbedded gray to green shale, mudstone, dolomite, salt, and gypsum. In the past two million to 11,000 years ago, a number of glacial advances and retreats of the Erie-Ontario and Huron–Georgian Bay ice lobes resulted in between 45 and 100 meters of glacial deposits left on top of the bedrock. See Figure 3. The quaternary geology of the watershed is mostly kame and till. Kames are glacial stream deposits of mostly sand and gravel. In the LCW, kames formed a "hummocky" topography in the west end with numerous small hills and depressions. Till plains are relatively flat with mixed sand, clay, and gravel resulting from glacial advances carrying forward a mix of debris. The LCW also has small areas of outwash, or material deposited by glacial meltwater streams, and "alluvium," or unconsolidated materials recently deposited by rivers and streams (GRCA, 1993).

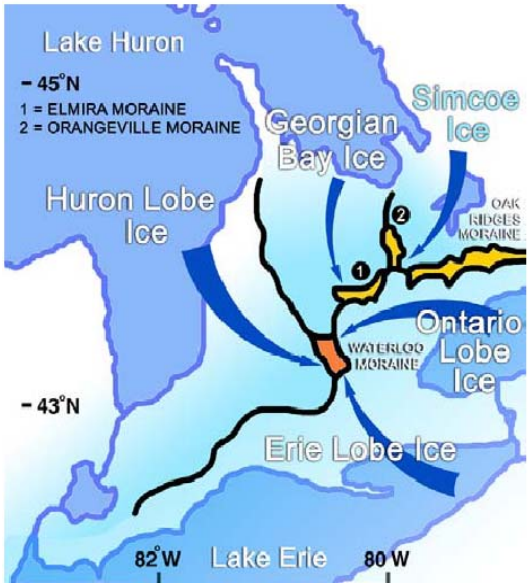

Figure 3: Creation of Waterloo Moraine

Source: City of Waterloo, 2003a.

The kame deposits have created the most significant landscape in the watershed, which is generally called the Waterloo Moraine or Sandhills. This moraine provides opportunity for large aquifers and groundwater recharge and is not only important as a groundwater recharge zone to the LCW, but also to the entire Grand River watershed (GRW). The Waterloo Moraine provides drinking water for at least 300,000 people in the Waterloo region (City of Waterloo, 2003a). Furthermore, numerous spring-fed wetlands and small ponds dot the area.

2.3 Vegetation

The most common surface soils in the LCW are sandy loams, and the topography varies from long, gently rolling (0–3%) to short and steep slopes (> 12%) (GRCA, 1993). In pre-European times, dense forest and extensive marsh wetland dominated the watershed. In fact, 91.3 percent of Waterloo county consisted of nonwetland woodland around 1800 (Larson, 1999). The LCW lies within the Mixed Deciduous and Coniferous Forest Zone. Original vegetation included a mix of upland and lowland species and coniferous and deciduous forests. Common native trees include aspen, beech, Manitoba maple, oak, and white pine (Nelson et al., 2003).

Originally, the area was also rich with wildlife. Mammals there would have included black bears, bobcats, cougars, gray foxes, lynx, raccoons, white-tailed deer, wolves, and woodland caribou. Birds would have included bald eagles, Canada geese, great blue herons, hooded warblers, least bitterns, Louisiana waterthrushes, northern cardinal, short-eared owls, and redheaded woodpeckers. When the streams were cool and high in oxygen, fish such as bluegill, brown trout, perch, redside dace, salmon, and walleye were common (Nelson et al., 2003).

3.0 RELATIONSHIP OF LAUREL CREEK TO FOUNDING AND GROWTH OF SOUTHERN ONTARIO

The history of the watershed is important in understanding changes that have resulted in today's conditions. The following describes how social and cultural changes related to the biological and physical changes.

In 1784, 675,000 acres of land, including the LCW, were given to the Iroquois alliance that made up the League of Six Nations. The Six Nations began to sell the land, and between 1796 and 1798, 93,000 acres had been sold through a Crown Grant to Richard Beasley. The first settlers, Mennonites from Pennsylvania who were running away from the threat of war, came about 1804. They bought land from Beasley and began to clear the area for agricultural uses, and the loss of habitat in addition to hunting and trapping significantly reduced wildlife in the area. In 1808, Albert Erb, sometimes referred to as the founder of Waterloo, built a dam along Laurel Creek for his sawmill and created Silver Lake, later to become a center point of community in Waterloo (GRCA, 1993; Will, 2003).

By the 1820s, there was strong German migration to North America and especially to the Laurel Creek area. More mills were built (a maximum of forty-eight along Laurel Creek in the 1880s), three breweries were established, and the Grand Trunk Railway going through Waterloo, Kitchener, and Cambridge was built in 1856. These developments had a great effect on the physical environment, and some of the mills had to either move to different locations or shut down due to stream flow changes. In 1835, Waterloo township claimed to have the highest level of cleared land in the province of Ontario, and by 1855, half of the watershed was in agricultural production. In 1910, 80 percent of the land in the Laurel Creek watershed was cleared, and loss of habitat has changed the dynamics of wildlife populations (GRCA, 1993).

The city of Waterloo's identity as a service town began with the establishment of insurance companies in 1863 and two universities. The first college, built in 1864, was St. Jerome's, which later became associated with the University of Waterloo, officially established in 1960 (GRCA, 1993). Wilfrid Laurier University began as the Evangelical Lutheran Seminary of Canada in 1911 (Wilfrid Laurier University, 2003). Both universities have contributed to Waterloo's reputation as an important center for higher education and together have a student population of 32,988, which is 27 percent of the municipal population (City of Waterloo, 2003c).

Overall, Laurel Creek affected the development of Waterloo in three main ways. First, the creek influenced the road pattern. Pathways were developed originally to service the mills along the creek; therefore, initial roads were not based on a straight grid. Roads were later paved and formed the foundation of the road system in Waterloo, which was not preplanned, unlike the systems of other adjacent towns. Second, Silver Lake became a focus in the community. Third, the creek influenced industry in the area. The developments of mills and the breweries were based on the flow of the creek. Today, although there is not much left of the historic mills, two of the breweries are still functioning and the buildings from Seagram's Distillery are restored as residential lofts as an important part of the city's heritage (GRCA, 1993).

Although Laurel Creek was relatively important to the development of Waterloo, it had little impact on the development of the Grand River watershed and the rest of southern Ontario. It is a relatively small stream in comparison to most waterways in the area. Furthermore, watershed planning was organized in the 1930s for the Grand River watershed because flooding of that river was causing significant damage to property in the towns through which it flowed (Boyd, Smith, and Veale, 1999). Laurel Creek received attention because it is a tributary of the Grand River and it runs through the core of Waterloo.

4.0 PHYSICAL MODIFICATIONS OF THE LAUREL CREEK WATERSHED TO ADDRESS FLOODING, WATER QUALITY, AND OTHER CONCERNS

4.1 Laurel Creek in Early Years

More than 200 years ago, Laurel Creek was deep enough with sufficient current to power numerous mills. It was cool, it was surrounded by forest, and it carried clean water for pioneering settlers to drink. As the city of Waterloo grew and fairly rapid development proceeded, more and more land was cleared and wetlands were drained. As a result, in the early 1900s, Laurel Creek was described as vengeful in the spring during snowmelts and heavy rainfall and sewerlike in the dry summer months (GRCA, 1993). These conditions led to activities to enhance human safety and to protect real estate.

4.2 Present-Day Laurel Creek

Laurel Creek begins in a rural landscape and flows through a few woodlands (i.e., Schaffer Woods) and wetlands (i.e., Optimistic Bog). Agricultural land uses contribute to the degradation of the stream as fields' edges abut the course allowing for livestock grazing around and in the water. In addition to the resulting soil erosion, runoff of pesticides, fertilizers, and other chemicals is a concern. The creek then flows into Laurel Creek Reservoir, which was specifically built in 1966 to contain heavy stream flows. Here, the water slows, the silt and contaminants are dropped, and the temperature of the water increases because of lack of shade and the shallowness of the lake. Challenges here include water weeds and hundreds of ducks and geese and their waste products. Laurel Creek then cools a little as it leaves the reservoir and some groundwater infiltrates the stream, but it warms again when it travels through Columbia Lake and the ponds on the University of Waterloo campus. Laurel Creek then continues to Silver Lake in UpTown Waterloo. Here too warming water, ducks and geese, and nutrient and silt accumulation prove problematic. A 500-meter (1640-foot) culvert then takes the creek underground, where it emerges beside the Waterloo City Centre. The final stretch includes some shade and attractive components, where

the water cools slightly. Because some buildings are quite close to the waterway, however, erosion is a problem. In addition, people have used the creek as a dumping ground for yard waste and hazardous household products (GRCA, 1993).

4.3 Modification of Laurel Creek

Between 1948 and 1982, a number of structural flood/erosion controls, including diking, channel improvements, and bank stabilization, were used throughout the entire Grand River watershed. From an engineering perspective, building dikes and channelizing creeks increased a river's capacity to handle peak flows. Channel improvements, meant to remove obstructions and straighten, deepen, widen, and line the channel with materials such as concrete, were thought to increase hydraulic efficiency and to provide erosion control. Laurel Creek is one of the waterways within the Grand River watershed to undergo such changes to its structure (GRCA, 1983).

In 1966, Laurel Creek Reservoir was built by the GRCA as a floodwater storage structure. Built to control flood flows with the intent of reducing flood risk downstream, today it is the centerpiece of the Laurel Creek Conservation Area managed by the GRCA. Lands for the conservation area were bought mainly for flood control purposes, but the area has come to be valued as open space in the midst of rapid urban development. Columbia Lake and Laurel Lake were also built around this time, more so for aesthetic reasons than for flood control (GRCA, 1993). Although structural approaches are somewhat effective, a lot of credit for reducing flood damage and increasing water quality has been attributed to watershed planning and floodplain management (discussed in the next section) (City of Waterloo, 2003a).

5.0 PRESENT LAND USE AND MANAGEMENT

5.1 Land Use

In 1993, approximately 50 percent of the LCW was urban and 50 percent was agricultural land. The amount of urban land has since increased as a consequence of growth rates in the area. The city of Waterloo is one of the fastest-growing municipalities in Ontario partially because of its location in Ontario's Technology Triangle (City of Waterloo, 2002b). Table 1 gives a breakdown of the 1993 land use in the LCW. The land north of Laurel Creek Reservoir still has a large percentage of green space characterized by first-order streams, wetland and marsh complexes, and forested areas. The southern portion of the watershed is mostly urbanized and includes established developments as well as vacant land scheduled for new development (City of Waterloo, 2002a).

Table 1: Land Use in the Laurel Creek Watershed, 1993

Land Use	Percent of Land Use
URBAN **Lower Watershed (37.8 km^2)**	**51.0**
Residential	12.1
Open space	11.2
Vacant	8.2
Commercial	8.2
Institutional	7.2
Water	0.6
Not assigned	1.1
Rural	2.2
TOTAL	100.0
GREENFIELD **Upper Watershed (36.6 km^2)**	**49.0**
Residential	1.8

Institutional	0
Water	1.7
Rural	96.2
Vacant	0.3
TOTAL	100.0

Source: GRCA, 1993, pp. 3–5.

5.2 Management

5.2.1 Approach to Management in the Laurel Creek Watershed

The city of Waterloo takes a comprehensive approach to watershed planning as recommended in the LCWS. To address creek flooding and streambank erosion, land use management strategies in addition to structural approaches are used. In fact, the city and the GRCA recognize that adequate management of land use is a more effective method of flood and erosion control than structural solutions (GRCA, 1993). The LCWS laid the basis for the city of Waterloo developing watershed management–based land use policies. As indicated in Table 2, the city of Waterloo is not the only jurisdiction to have responsibilities relevant to watershed management.

5.2.3 Laurel Creek Watershed Study, 1993

The LCWS represents a change in thinking toward using an ecological watershed approach to managing creek flows and water quality. The LCWS addressed six concerns: flooding, water quality, streambank erosion, surface erosion and sedimentation, groundwater, and natural resources. These issues reflect public concerns, challenges facing a rapidly growing city, and the impacts of development on the ecological integrity of the natural system. Public comment, scientific data, and past studies were important inputs into the LCWS. A systems approach was used to develop indicators to measure the overall health of the ecosystem and the effect of ecological stresses (GRCA, 1993). The goals, objectives, and conclusions of the LCWS are summarized in Table 3, and the main accomplishments since the LCWS are summarized in Table 4.

Table 2: Selected Entities with Responsibilities Relevant to Watershed Management

Government Level	Most Active Players in LCW	Jurisdiction/ Responsibilities	Roles	Sample of Legislation/Control
Federal agencies • Environment Canada • Fisheries and Oceans Canada • Transport Canada Foreign Affairs and International Trade		• Water-related issues: navigation, fish habitat, federal and aboriginal lands, and international waters	• Water-related regulation and guidelines • Monitoring and research • Coordination, public information, and education • Providing funding for provincial and local initiatives	• Canada Water Act • Oceans Act • Canada Shipping Act • International Boundary Waters Treaty Act
Provincial ministries • Environment • Natural Resources • Agriculture and Food Municipal Affairs and Housing		• Nonrenewable resources • Hydroelectric power • Municipal institutions • Local works and undertakings • Property and civil rights	• Regulation, standard setting • Monitor, data management • Training and education • Coordination • Funding water quality and quantity tasks	• Ontario Water Resources Act • Lakes and Rivers Improvement Act • Nutrient Management Act
Conservation Authorities	• Grand River Conservation Authority	• Flood management • Forestry management • Watershed planning • Environmental education and outreach • Recreation	• Drinking water in parks • Manage surface water • Monitoring Specific to GRCA: • Implement local rural water quality programs	• Fill, Construction, and Alteration to Waterways regulation • Advise on development

		• Ecosystem restoration • Water quality and quantity management	• Aid drought management • Engage in modeling, planning, and research	applications
Local government (most direct authority to undertake watershed planning)	• City of Waterloo • Region of Waterloo	• Nutrient management and sewer use bylaws • Official plan policies • Incentive-based rural and business water quality programs • Encourage best management practices	• Local drought management initiatives • Encouraging water conservation • Financial incentives • Public information programs Specific to Grand River watershed: • Monitor drinking water • Planning and research • Share information in water managers working group	• Official Plan Policies • Zoning bylaws • Sewer use bylaws • Nutrient management bylaws

Source: Ivey, 2002.

Table 3: Issues, Goals, and Conclusions in Laurel Creek Watershed Study

Issue	Questions to Be Addressed	Goals	Conclusions
Flooding	▪ Will further development result in further flooding?	▪ Minimize risk to life, property, and natural resources ▪ Preserve natural floodplains and hydraulic functions	▪ Identified ten areas in watershed as "high risk" ▪ Reservoirs play a role in controlling floods ▪ Natural storage areas (i.e., bogs) help reduce floods ▪ Natural floodplains control floods and should be maintained ▪ Major cause of flooding in UpTown results from urban runoff ▪ New development in Waterloo will increase flows unless volumes, timing, and flows are controlled
Streambank erosion	▪ Will further development lead to further erosion?	▪ Preserve and protect aquatic resources and water supply	▪ Rehabilitate streambanks and channels
Surface erosion and sedimentation	▪ Are existing agricultural and urban practices causing erosion of open areas, leading to sediment deposits?	▪ Preserve and protect land, water, forest, and wildlife	▪ Some areas have high sediment loads and suspended solids from erosion
Water quality	▪ Can urban growth continue without more degradation? ▪ What is the impact of reservoirs on water quality?	▪ Restore, protect, and enhance water quality and associated aquatic resources and water supplies	▪ Bacteria in reservoir and Columbia Lake prevents recreational use ▪ Reservoirs warm water, add nutrients, and degrade aesthetics ▪ Hard for fish to survive because of low dissolved oxygen, high water temperatures, and high stream vegetation ▪ Phosphorus causes algae blooms and degraded aesthetics
Groundwater	▪ How will groundwater use affect wells in the area and	▪ Protect and restore both quality and quantity of	▪ Maintain inside and outside of the Laurel Creek watershed: infiltration with greatest potential in upper watershed

	groundwater-fed streams?	groundwater	▪ Deeper aquifers to provide water supply ▪ Shallow aquifers sustain river flows
Natural resources	▪ Can urban growth continue and not degrade natural areas further? How can we protect these resources?	▪ Restore, protect, develop, and enhance ecological, historical, cultural, recreational, and visual amenities of both rural and urban origin, particularly around streams	▪ Terrestrial resources are extensive and relatively well connected but are experiencing intense pressure ▪ Remaining areas have important natural resource functions ▪ Remaining areas should be divided into three constraint areas with different management strategies

Source: GRCA, 1993.

Table 4: Accomplishments Since the Laurel Creek Watershed Study	
Accomplishment	**Highlights**
Official plan policies	• LCWS principles are formally recognized • Constraint levels designated to areas in the city, based on LCWS recommendations
Laurel Creek Watershed Monitoring Program (LCWMP)	• The program monitors water quality and quantity, aquatic habitat, and terrestrial features • Monitoring now expanded to areas outside watershed
Parkland naturalization and rehabilitation	• Areas are allowed to naturalize, and volunteers assist in planting efforts • Designation of 15- to 30-meter (49- to 98-foot) buffer areas along all streams
Road salt	• Implementation of GIS in snowplows and salt distribution vehicles to facilitate reduced salt use • Covered salt shed storage • Salt mixed with sand
Stormwater management and creek practices	• Subwatershed study encompassing stormwater facilities and water quality targets required prior to development • Dry stormwater facilities are being retrofitted into wet facilities for water quality control • Creek rehabilitation to improve water quality and increase fish habitat • Ongoing monitoring of stormwater management ponds and creeks

Source: Adapted from City of Waterloo, 2002a.

5.2.4 Constraint Levels

One of the most influential components of the LCWS on land use has been the identification of constraints areas, which appear as part of the official plan policies implemented in 1994. Constraint areas define the level of development permitted. The LCWS recommends that all the lands in the Laurel Creek watershed be designated one of three constraint levels. Table 5 describes each level.

Table 5: Land Use Constraint Areas

Constraint Level	Description	Examples
Constraint Level I	Lands that protect and enhance natural environmental functions and processes	▪ Environmentally sensitive policy areas ▪ Floodplain ▪ Green space core areas ▪ Riparian buffers on perennial streams ▪ Wetlands
Constraint Level II	Lands that could provide valuable ecological functions but are degraded and would require management and rehabilitation to improve functioning (these lands need further research)	▪ Existing and potential groundwater recharge areas ▪ Secondary linkages ▪ Rehabilitation areas ▪ Urban green areas ▪ Riparian buffers on intermittent streams
Constraint Level III	Lands not serving specialized ecological functions; development can proceed with appropriate measures for environmental protection	▪ All lands outside constraint levels I and II

Sources: GRCA, 1993, and City of Waterloo, 2002a.

5.2.5 Managing New Development: Waterloo's Moraine

The LCWS emphasized the importance of the west side of the city of Waterloo to both groundwater and vegetation. The city, however, had already made commitments to develop the land mostly for residential purposes. The solution was to create education programs and impose strict guidelines on development to promote water infiltration. Educational outreach initiatives include interpretive signage along neighborhood trails and brochures distributed to all area residents explaining the sensitivity of the lands. Furthermore, the city of Waterloo's Web site includes descriptions of the history, geology, and rare species found in the area and explains the importance of the moraine for groundwater.

When planning for the development on the moraine, the city of Waterloo attempted to create policies sensitive to the landscape. In addition to the requirements for 15- to 30-meter (49- to 98-foot) vegetative buffers surrounding woodlots, waterways, and wetlands, the city also required extensive pieces of the landscape to be preserved. See Figure 4 for a map of green space on the west side of Waterloo (City of Waterloo, 2003a). Furthermore, the residential zoning in the area was developed specifically for this part of the city. Called “Flexible Residential,” it requires that at least 50 percent of each lot must allow water to infiltrate. Hence, there are regulations with respect to expanding driveways and building sheds or extensions and decks. Overall, the city of Waterloo took a unique approach to development to preserve the integrity of the Waterloo Moraine (City of Waterloo, 2002a).

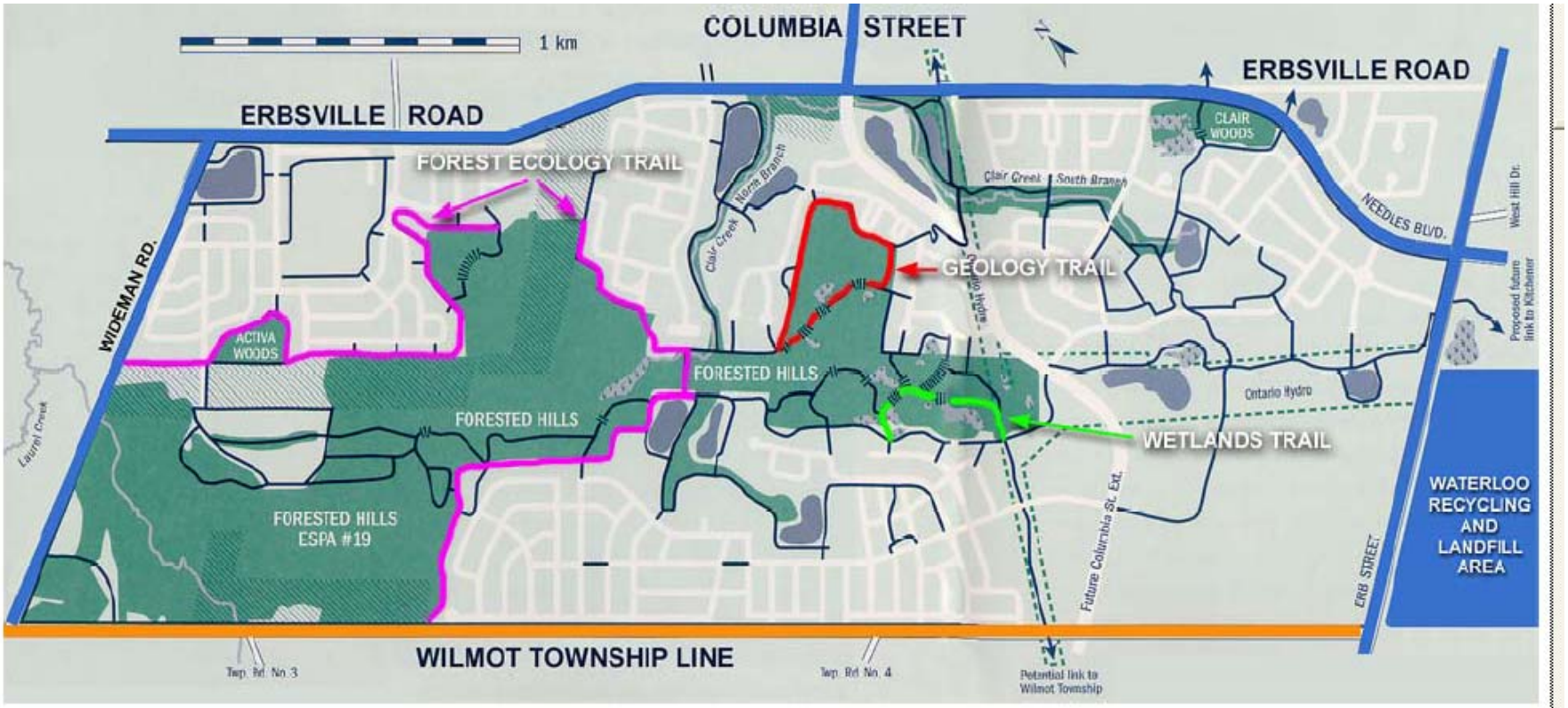

Figure 4: West Side Map of the City of Waterloo

Source: City of Waterloo, 2003d.

6.0 ROLE OF NONGOVERNMENTAL ORGANIZATIONS IN MODIFICATION AND MANAGEMENT OF THE LAUREL CREEK WATERSHED

A number of nongovernmental organizations (NGOs) are involved in the management of Laurel Creek. Some of these groups are action-oriented and others are lobbying the government take action to better protect the integrity of the watershed.

The Laurel Creek Citizens Committee (LCCC) was initiated by concerned citizens in 1990 to protect, rehabilitate, and enhance Laurel Creek. Today, the city of Waterloo, the Grand Creek Conservation Authority, and local environmental consulting firms support the LCCC with advice, funding, and administrative support, but the work is conducted by approximately eighty members. Every year, the LCCC works on a number of projects. The following represents a sample of activities undertaken to date (City of Waterloo, 2003b):

- Planting native species along Laurel Creek and its tributaries
- Pollandering (debris and obstruction removal) along Laurel Creek and its tributaries
- Stream rehabilitation and activities at Silver Lake
- Stream rehabilitation, erosion control, and building of structures such as log deflectors along Laurel Creek and its tributaries
- Stream assessment

Furthermore, the city of Waterloo invites the LCCC as well as other NGOs such as the Waterloo Citizen's Environmental Committee to participate in steering committees for studies done in the subwatershed studies for the LCW and the rest of the city.

Figure 5: Laurel Creek Citizens Committee Members Taking Part in Aquatic Planting at Silver Lake
Source: City of Waterloo, 2003b.

Other NGOs are involved in lobbying city council to protect, enhance, and rehabilitate the watershed. For example, Get Rid of Urban Pesticides (GROUP), a volunteer organization, initiated a campaign in 2001 to help homeowners wean themselves off of pesticides. The campaign was a response to the increasing concerns people had about the use of pesticides on urban lawns. GROUP conducts workshops on natural lawn care and distributes educational material to assist in its mandate of creating a healthier and safer pesticide-free community (Koswan, 2003).

Other NGOs in the area are concerned with stewardship of the watershed. For example, the Kitchener-Waterloo Field Naturalists oppose the sale of conservation lands for development (Kitchener-Waterloo Field Naturalists, 2003).

7.0 INSTITUTIONAL ARRANGEMENTS AND NEW LONG-RANGE PLANS

7.1 Institutional Arrangements

As illustrated in Table 2, the federal, provincial, and municipal governments are responsible for different aspects of water management. Although the province of Ontario has primary responsibility for water management, it has delegated locating, storing, and distributing water for municipal use as well as maintaining water distribution systems to local-level governments (Ivey, 2002).

To undertake natural resources management on a watershed basis, the province of Ontario created conservation authorities in the 1940s. These community-based environmental agencies represent groups of municipalities within a watershed. A distinctive feature of conservation authorities is the extent to which they broker partnerships to deliver programs and services relevant to managing and protecting watersheds (Mitchell and Shrubsole, 2001).

7.2 Changes to Legislation in Ontario as a Result of Walkerton

In Ontario, source water protection and watershed management have recently gained more attention, partially because of the May 2002 Walkerton tragedy. The water supplies of Walkerton, a small town in southern Ontario, were contaminated with E. coli, resulting in seven deaths and more than 2,300 illnesses. A judicial inquiry held on the matter ended with a series of recommendations. The outcome was a number of recent, and ongoing, changes to the management of drinking water in Ontario. Included are new legislation, regulations, and standards to protect water quality and funding for local-level infrastructure and groundwater-related studies (Newswire, 2003).

7.3 Waterloo's Environmental Strategic Plan

The Environmental Strategic Plan guides the city of Waterloo's long-term planning. The guiding tenets of the plan were derived from citizen input. The Environmental Strategic Plan, which takes a systems-based, comprehensive approach to solving problem, is based on several key principles guiding management (City of Waterloo, 2002a):

- High-level vision and goals with implementation responsibilities shared between various stakeholders
- Emphasis on strategies to promote continuous improvement in environmental compliance and accountability
- Watershed-scale environmental management that facilitates a cumulative approach that addresses all environmental media

The goals of the Environmental Strategic Plan can be found in Table 6.

Table 6: Recommendations from Environmental Strategic Plan, 2002

Area	Action	Outcome
Planning and growth	Enhance existing policy	▪ Make policies technically defendable ▪ Support with scientific rationale ▪ Greater protection of significant features
	New official plan policies	▪ Consider emerging issues such as climate change ▪ Encourage infill and development of brownfields ▪ Policies to conserve and create sustainable natural systems and quality of life
	Establish Environment-Development Forum	▪ Increase stakeholder communication ▪ Informed and efficient decision making ▪ Better understanding of needs for different forms of development ▪ Recognize divergent views of business and the environment
	Enhance technical considerations in planning	▪ Establish realistic watershed targets for development controls
Water resources	Improve degraded aquatic ecosystems	▪ Enhance quality of aquatic ecosystems ▪ Improve water quality ▪ Increase habitat and native species diversity ▪ Improve reservoir management ▪ Remove on-line ponds ▪ Efficient response to spills
	Watershed stewardship and community	▪ Increase awareness of watershed issues ▪ Widespread application of best management

	involvement	practices ▪ Greater capacity to improve and protect water resources ▪ Informed stewardship of privately owned riparian areas
	Water resources monitoring	▪ Increased availability of data and information on aquatic resources for decision making ▪ Prioritize list of challenges for water quality improvement ▪ Accessible information for environmental education and stewardship development ▪ Better knowledge of sensitive areas ▪ Feedback and adaptive management of stormwater practices
	Water conservation	▪ Enhanced protection of groundwater ▪ Preservation of baseflow water levels in the Grand River watershed ▪ Reduced per capita usage
Green space health	Create healthy green spaces	▪ Improved natural aesthetics and tree-lined streets ▪ Ecologically healthy buffers along all waterways, wetlands, and forests ▪ Increase total green space area
	Protect existing green space	▪ Protect green space and create natural linkages between these spaces
	Monitor terrestrial resources	▪ Expanded dataset of baseline data for terrestrial bio-indicators ▪ Greater understanding of point and nonpoint pollution sources ▪ Accurate knowledge of resources and healthy of natural areas

Source: Adapted from City of Waterloo, 2002a.

7.4 Current Financial Arrangements

As mentioned previously, watershed planning for the LCW is organized at the Grand River watershed scale by the GRCA. Conservation Authorities were created by the 1946 Conservation Authorities Act, which was based on three fundamental concepts (Conservation Ontario, 2003):

1. *Local initiative.* Local political and citizen support is required prior to consent to create a conservation authority. Watershed-based control allows local issues to be handled at the local level.

2. *Cost sharing.* Costs of projects are shared by the province and municipalities. Projects will only go ahead if local citizens were willing to pay for them.

3. *Watershed jurisdiction.* Conservation Authorities are given power to set regulations within the watershed jurisdiction to allow them to adequately manage issues like flood control.

In the 1990s, the Ontario provincial government drastically reduced its financial support of conservation authorities. The combined funding from the Ministry of Environment and Ministry of Natural Resources was reduced by 80 percent from 1993/1994 to 1997/1998. To compensate for loss of funding, municipal levies increased, federal funding increased slightly, user fees either increased or were created for previously free services, and more effort was put into fund-raising and acquiring private corporation support. To reduce expenditures, conservation authorities restructured, reduced staffing, and reduced or eliminated programming such as environmental education (Sustainable Toronto, 2003). Ontario's conservation authorities spend $158 million on watershed management (Conservation Ontario, 2003), with the GRCA's expenditures at $21.76 million for 2003 (GRCA, 2003). Figure 6 shows GRCA's sources of revenues for 2003.

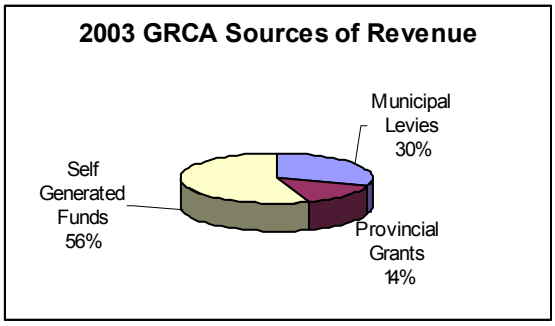

Figure 6: GRCA's 2003 Revenue by Source
Source: GRCA, 2003.

8.0 CONCLUSION

The Laurel Creek watershed, a subwatershed of the Grand River in southern Ontario, has been modified by residents past and present. Present land use and management and the contribution of nongovernment organizations as well as institutional arrangements and long-range planning were briefly described in this paper.

What is noteworthy is the influence of one document—the 1993 *Laurel Creek Watershed Study*—in defining environmental stewardship in the watershed. Not only did the LCWS provide a baseline of the health of the watershed, it has delineated subsequent environmental monitoring and has influenced the nature of development in the watershed. The recommendations from this study, a model of a collaborative exercise between the Grand River Conservation Authority and the city of Waterloo, were incorporated into the city's Official Plan. Reference to this document is widespread both because of its landmark contribution and because there has not been a wide-sweeping update of the basic survey of information it provided.

The case study site is typical of many parts of urban North America: a community within a rapidly urbanizing region that is encroaching on its most sensitive environmental attributes. The city of Waterloo is committed to development, as are the surrounding communities and the region of Waterloo. The challenge faced here is whether the area can undertake that development while achieving rudimentary safeguards for the physical environment essential to life.

ACKNOWLEDGMENTS

Thanks go to Ron Ormson of the city of Waterloo for his assistance in providing materials and his knowledge on this subject matter. His contribution to this project is greatly appreciated. Thanks are due also to Rutherford Platt at the University of Massachusetts at Amherst for enabling a Canadian contribution to the Ecological Cities Project by providing guidance and financial support through a National Science Foundation subgrant.

WORKS CITED

Boyd, D., Smith, A. and Veale, B. 1999. Flood management on the Grand River, Ontario, Canada: A watershed conservation perspective. Environments 27(1): 23–47.

City of Waterloo. 2002a. Environmental Strategic Plan. Waterloo, Ontario: City of Waterloo.

City of Waterloo. 2002b. Height and Density Policy Study Discussion Paper. Waterloo, Ontario: City of Waterloo.
City of Waterloo. 2003a. Environment lands.
http://www.city.waterloo.on.ca/PWS/Environment/Lands/protect2.html Accessed November 26, 2003.

City of Waterloo. 2003b. Laurel Creek Citizens Committee.
http://www.city.waterloo.on.ca/CS/Clerks/Committees/LCCC/ Accessed November 28, 2003.

City of Waterloo. 2003c. Ongoing research on student housing.
http://www.city.waterloo.on.ca/CS/Clerks/Committees/SAS/Research.html Accessed November 28, 2003.

City of Waterloo. 2003d. Street index map.
http://www.city.waterloo.on.ca/Maps/downloads/StreetIndex.pdf
Accessed November 28, 2003.

Conservation Ontario. 2003. Corporate profile. http://www.conservation-ontario.on.ca/profile/profile.htm Accessed December 16, 2003.

Grand River Conservation Authority (GRCA). 1983. Interim Resource Management Plan for the Grand River Watershed. Cambridge, Ontario: GRCA.

Grand River Conservation Authority (GRCA). 1993. Laurel Creek Watershed Study. Waterloo, Ontario: City of Waterloo.

Grand River Conservation Authority (GRCA). 2003. About the Grand River Conservation Authority.
http://www.grandriver.ca/index/document.cfm?Sec=12&Sub1=52&Sub2=0 Accessed December 16, 2003.

Grand River Watershed Data [computer file]. 2003. Cambridge, Ontario: Grand River Conservation Authority.

Ivey, Janet. 2002. Grand River Watershed characterization report, Guelph Water

Management Group, University of Guelph. http://www.uoguelph.ca/gwmg/wcp_home/Pages/G_home.htm Accessed November 28, 2003.

Kitchener-Waterloo Field Naturalists. 2003. Kitchener-Waterloo Field Naturalists. http://www.sentex.net/~tntcomm/kwfn/ Accessed December 23, 2003.

Koswan, Susan. 2003. Getting rid of urban pesticides. http://home.golden.net/~lgoerzen/Group%20Web%20Page.html Accessed November 28, 2003.

Larson, B. 1999. The Woodland Heritage of Southern Ontario: A Study of Ecological Change, Disruption, and Significance. Don Mills, Ontario: Federation of Ontario Naturalists.

Mitchell, B., and Shrubsole, D. 2001. Ontario's conservation authorities. Water News, December 16–21.

Nelson, J. G., J. Porter, C. Farassoglou, S. Gardiner, C. Guthrie, C. Beck, and C. Lemieux. 2003. The Grand River Watershed: A Heritage Landscape Guide. Heritage Landscape Guide Series No. 2. Waterloo, Ontario: Heritage Resources Centre, University of Waterloo.

Newswire. 2003. Eves moves to protect Ontario's drinking water. http://ogov.newswire.ca/ontario/GPOE/2002/10/29/c5952.html?lmatch=&lang=_e.html Accessed November 26, 2003.

O'Connor, D. R. 2002. Report of the Walkerton Inquiry: The events of May 2000 and related issues, Part One. Toronto: Ontario Ministry of the Attorney General Region of Waterloo. 2003. Region of Waterloo. http://www.region.waterloo.on.ca Accessed November 24, 2003.

Statistics Canada. 2003. 2001 Community Profiles. http://www12.statcan.ca/english/profil01/PlaceSearchForm1.cfm Accessed December 16, 2003Sustainable Toronto. 2003. The impact of provincial policies changes on conservation authorities. www.sustainabletoronto.ca Accessed December 16, 2003.

Wilfrid Laurier University. 2003. Laurier history. http://www.wlu.ca/wlu-hp/about/history.shtml Accessed December 16, 2003.

Will, Gary. 2003. A history of Waterloo. http://www.garywill.com/waterloo/history.htm Accessed December 16, 2003.

Appendix A: Useful Links

Below are a number of links that may be useful to understanding selected aspects of the context of the Laurel Creek Watershed.

Ontario sites

Ontario Ministry of Natural Resources, Surface Water Level Reporting

Ontario Ministry of Natural Resources, Land Information Ontario

Ontario Ministry of the Environment, Water

Ontario Ministry of Municipal Affairs and Housing, Oak Ridges Moraine Site

Ontario Ministry of Municipal Affairs and Housing, Municipal Performance Measurement Program

Conservation Ontario

The Walkerton Inquiry—Reports

Watershed Science Centre

Ontario Municipal Home Pages

Canadian sites

Municipal Water Use Database

Environment Canada, Freshwater Website

Environment Canada, State of the Environment Infobase

Environment Canada, National Climate Archive

Statistics Canada 2001 Census Community Profiles

C-CIARN Water Resources and Climate Change

North Battleford Water Inquiry

Source to Tap, Canadian Council of Ministers of the Environment

Environmental Law in Canada—North American Commission for Environmental Cooperation

Nova Scotia's Water Allocation System

Water Efficiency Experiences Database—Canadian Water and Wastewater Association

Great Lakes Information Network

Legislation sites, North America

Full Text Statutes and Legislation Links, United States (Prairienet Community Network)

Ontario Legislation

Federal and Provincial Legislation, Canada

International water sites

The World's Water

The Water Page

The School of Oriental and African Studies, Water Issues Study Group

UNESCO Water Portal

FAO Water Resources, Development and Management Service

International Water Management Institute

UNEP Freshwater Site

The World Water Council

International Water Law Project

Universities Water Information Network

United States Environmental Protection Agency, Water Site

Know Your Watershed, United States

Pacific Institute Water and Climate Bibliography—Pacific Institute for Studies in Development, Environment, and Security

Capacity Building Resources - United Nations Development Programme

Centre of International Relations—UBC: links for media, NGOs, research institutes, North American government

International Water Law Research Institute—University of Dundee

Water Policy and Law Group—University of South Australia