CLEAN UP RURAL BEACHES PLAN
FOR
THE GANARASKA RIVER, COBOURG BROOK
AND BALTIMORE CREEK WATERSHEDS

PREPARED FOR

ONTARIO MINISTRY OF ENVIRONMENT AND ENERGY
AND THE
GANARASKA REGION CONSERVATION AUTHORITY

STUDY CO-ORDINATED BY TRISH GILLMAN
REPORT PREPARED BY DON ROBERTSON

SEPTEMBER 1994

ACKNOWLEDGEMENTS

We would like to express our appreciation to the Ontario Ministry of the Environment and Energy for the support we received for this program, and to the staff of the Ganaraska Region Conservation Authority for the technical assistance and advice that were always available.

Thanks also to the members of the Technical Steering Committee, who provide direction, insight and practical assistance.

Technical Steering Committee Members:

Jim Eddie	Chair, Ontario Ministry of Environment and Energy
Bruce Hancock	Ontario Ministry of Environment and Energy
Jack Kyle	Ontario Ministry of Agriculture and Food
Steve Thompson	Ontario Ministry of Health
Henry Rood	HKPR District Health Unit - Port Hope
Mike Longpre	Senior Environmental Officer, MOEE, Peterborough
Barry Jones	Bay of Quinte Remedial Action Plan
Randy Vilneff	Lower Trent Region Conservation Authority
Jim Tedford	Ganaraska RegionConservation Authority
Mike Whitehead	Town of Cobourg
Kevin Brady	Ontario Federation of Agriculture

Rice Lake Beaches Program Staff 1993-94:

Trish Gillman	Rural Beaches Program Coordinator - G.R.C.A.
Dan Gallagher	Water Quality Technician - G.R.C.A. 1993
Don Robertson	Water Quality Technician - O.R.C.A, GRCA

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Under the Clean Up Rural Beaches (CURB) Program The Ontario Ministry of Environment and Energy provides financial assistance to local Conservation Authorities to conduct a Rural Beaches Study to determine if a particular watershed is suitable for participation in the CURB Program. Participating Conservation Authorities then deliver funding assistance to individuals completing stewardship initiatives falling within the program criteria.

The four beaches in the study watersheds have been closed, due to high bacterial counts, a total of 358 days during swimming seasons of 1989 to 1993. The towns and villages in the region are dependent financially, to a large extent, on tourist spending. Tourism is often enhanced by water related recreational opportunities. Closure of beaches signals a water quality impairment not just to beach users, but to the whole community, and thereby endangers tourism from the entire recreational sector.

Both of the study watersheds discharge directly to Lake Ontario. Concern for Lake Ontario water quality is well known and has been identified by the International Joint Commission. Remediation in the two study watersheds ought to have a positive impact on Lake Ontario.

In the absence of specific data, the study relied on computer modeling using published data, to predict bacterial loading to the study watersheds. The model calculated contamination from four sources identified as most significant; runoff from feedlots and manure storages, cattle access to streams, faulty septic systems, and milkhouse wastewater. The predicted loading verified to some extent by comparison to measured data at selected stations.

Unrestricted cattle access to the rivers and tributary streams was found to be both the largest single source of contamination to Lake Ontario from the study area, and the most cost effective to remediate. Faulty septic systems also present a cost effective remedial contingency (Table Summary-1).

The situation at the Garden Hill beach is somewhat different in that the largest source of contamination is the flock of resident Canada Geese. There is no cattle access to any of the streams leading to the Garden Hill Pond.

The CURB Program has been mandated to address these problems and can be effective in the study watersheds. Enlightenment of the stakeholders, and completion of priority projects are seen as significant aspects of a successful CURB program for the study watersheds.

TABLE SUMMARY-1 : Cost Of Remediation And Efficacy Of Cost Expenditure

GANARASKA RIVER WATERSHED						COBOURG BROOK/BALTIMORE CREEK WATERSHED				
Source	No.	Total Cost	CURB Share	% Total Bacti. Load	Cost Per % Reduction	No.	Total Cost	CURB Share	% Total Bacti. Load	Cost Per % Reduction
Faulty Septic Systems	146	$ 584,000	$ 292,000	27	$ 21,630	183	$ 732,000	$ 366,000	39	$ 18,770
Cattle Access	126	$1,260,000	$ 945,000	70	$ 18,000	110	$1,100,000	$ 825,000	58	$ 18,965
Barnyard Runoff	132	$5,280,000	$1,584,000	2	$2,640,000	120	$4,800,000	$1,440,000	2	$2,400,000
Milkhouse Waste	22	$ 110,000	$ 55,000	1	$ 110,000	17	$ 85,000	$ 42,500	1	$ 85,000

1. INTRODUCTION

1.1. DESCRIPTION OF PROGRAM

The Ministry of Environment and Energy (MOEE) developed the Clean Up Rural Beaches (CURB) Program in response to province wide concern relating to water quality in general and beach closures in particular. The program, initiated in September of 1991, targeted $57 million over a ten year period for incentive grants to certain types of stewardship initiatives. This funding is made available to participating Conservation Authorities after completion of a beaches study and CURB plan documenting the need for the program in a particular area. Funding is then delivered by the Conservation Authority to individuals completing approved projects falling within the program criteria. This document comprises the CURB plan for areas within the Ganaraska Region Conservation Authority jurisdiction that have the potential to impact on local beaches. Three of the four beaches involved in this study are situated on Lake Ontario, and for that reason this study will be referred to herein as the Lake Ontario Study.

1.2 Rationale

Local beaches within the Ganaraska Region watersheds have been subject to frequent closures because of elevated bacterial counts in recent years (Table 1-1).

Table 1-1: Summary Of Beach Closures

	Number Of Days Closed				
Beach Name	1989	1990	1991	1992	1993
Garden Hill	35	21	21	7	15
Victoria Beach	14	56	0	3	9
Port Hope East	35	21	0	3	6
Port Hope West	49	35	0	15	13

In 1992 the provincial guideline for beach closures was changed from 100 Fecal Coliforms/100 milliliters to 100 *Escherichia Coli.* per 100 milliliters. Since E. Coli generally represent a percentage of Fecal Coliforms, the criteria change itself may be responsible for the decrease in beach closures since 1992 with no real attendant improvement in water quality.

The towns and villages in the region are dependent financially, to a large extent, on tourist spending. Tourism is often enhanced by water related recreational opportunities. Closure of beaches signals a water quality impairment to the whole community, not just to beach users, and thereby puts at risk tourism from the entire recreational sector. Beach closures, therefore, are important, not just to the swimming public, but to the community as a whole from a financial perspective.

1.3 Scope of Study

The Lake Ontario Study is a two year initiative involving an intensive water quality sampling program in the first year that was scaled back somewhat in year two. A computer model was developed to calculate quantitative bacterial contributions from specific contamination sources. The data for the model was, to a small extent, collected from land owner interviews and to a larger extent from published statistical data.

Although the model, and for that matter the CURB program, are directed to rural concerns, three of the four beaches in the study area lie in front of the Towns of Port Hope and Cobourg. These towns are substantial and likely to have an impact on the beaches. The contamination from the towns themselves was, therefore, calculated and compared to the rural component (Section 4).

The beaches lying on Lake Ontario are subject to complicated lake dynamics which are beyond the scope of this study. The assumption has therefore been made that, given the proximity of the beaches to the mouths of the respective rivers, contamination from the rivers has the potential to impact the beaches. Notwithstanding the complexity, this assumption was born out to some extent by dye testing (Section 4.1).

2.0 WATERSHED DESCRIPTION

2.1 GANARASKA RIVER WATERSHED

The Ganaraska watershed contains three of the four beaches in the study area, Garden Hill Pond, Port Hope East Beach and Port Hope West Beach. The river is the result of several fast flowing cold water tributaries which come together to form the Ganaraska River, and the North Ganaraska River. A third tributary which is considered part of the North Ganaraska River elsewhere, is here considered separately and is referred to as the East Branch of the Ganaraska River (Figure 1-1).

The three branches of the river all have their origins on the south slope of the Oak Ridges Moraine. The main branch of the river flows in a southeasterly direction from the Oak Ridges Moraine structure, through till and sand plains for its first 20 kilometers where it is joined by the north branch at the Hamlet of Canton. The river then passes into the lacustrine deposits of former Lake Iroquois south of the Hamlet of Canton. Near the end of its 30 kilometer length, the river has eroded to the limestone bedrock as it passes through the Town of Port Hope, before discharging into Lake Ontario (GRCA, 1983).

The North Ganaraska River traverses about 15 kilometers through the Oak Ridges Moraine before joining the main branch at the Hamlet of Canton. The east branch similarly originates in the Oak Ridges Moraine and proceeds southerly into the lacustrine deposits of former Lake Iroquois before joining the main branch north of Port Hope.

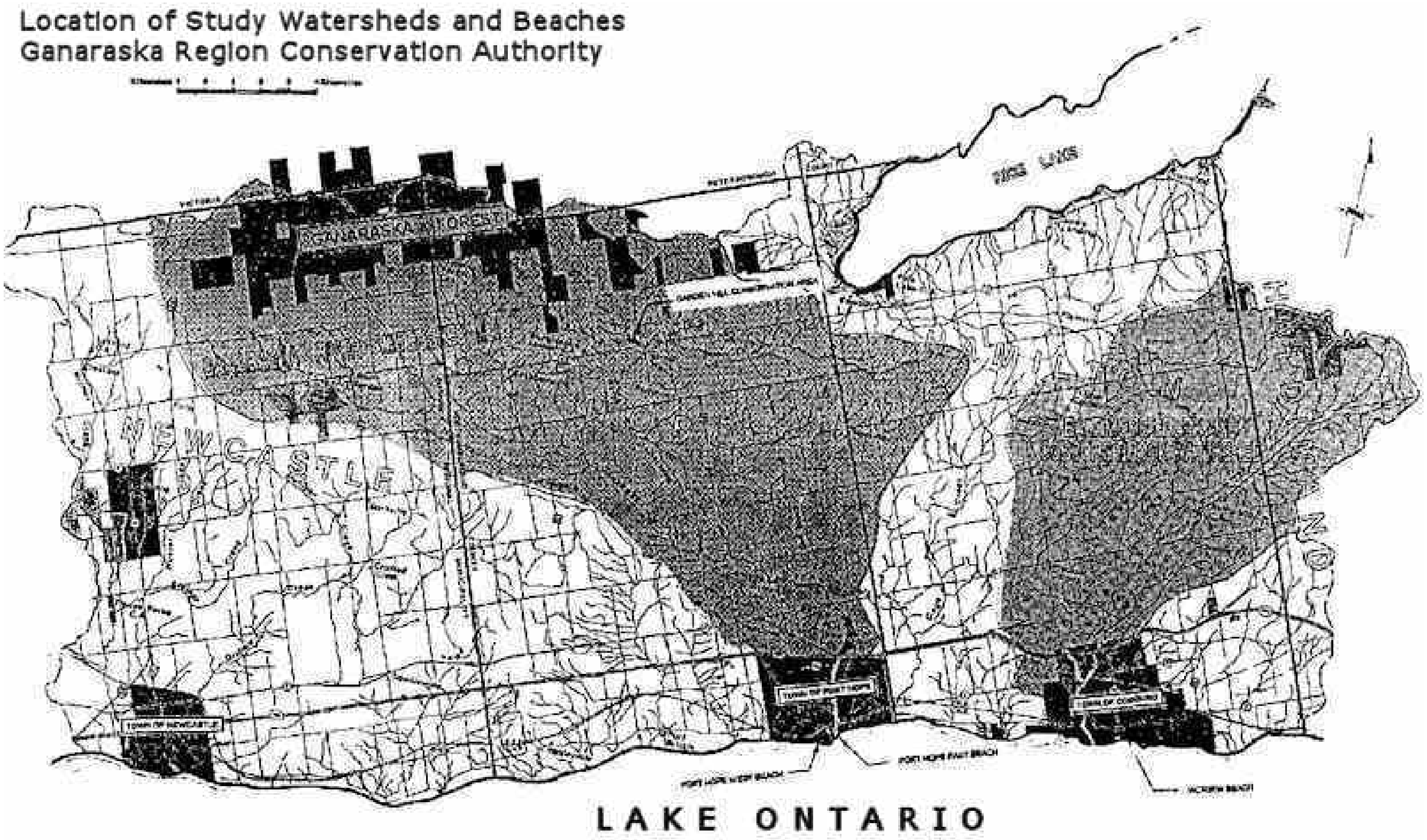

FIGURE 1-1: Location Of Study Watersheds And Beaches

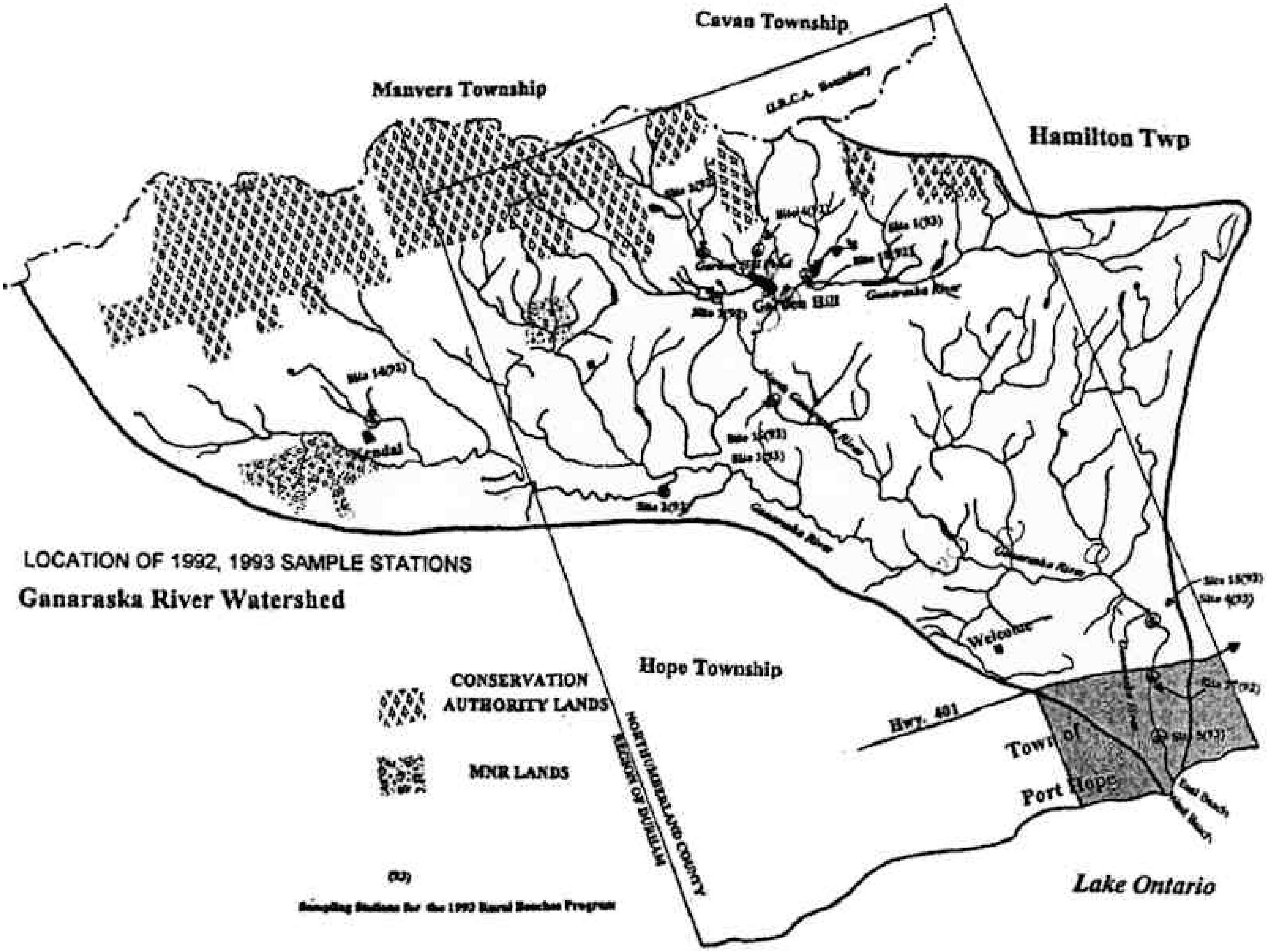
Cavan Township
Manvers Township
Hamilton Twp
G.R.C.A. Boundary
Garden Hill
Ganaraska River
Kendal
LOCATION OF 1992, 1993 SAMPLE STATIONS
Ganaraska River Watershed
Welcome
Hope Township
CONSERVATION
AUTHORITY LANDS
MNR LANDS
NORTHUMBERLAND COUNTY
REGION OF DURHAM
Hwy. 401
Town of
Port Hope
Lake Ontario
(93)
Sampling Stations for the 1993 Rural Beaches Program

Figure 1-2

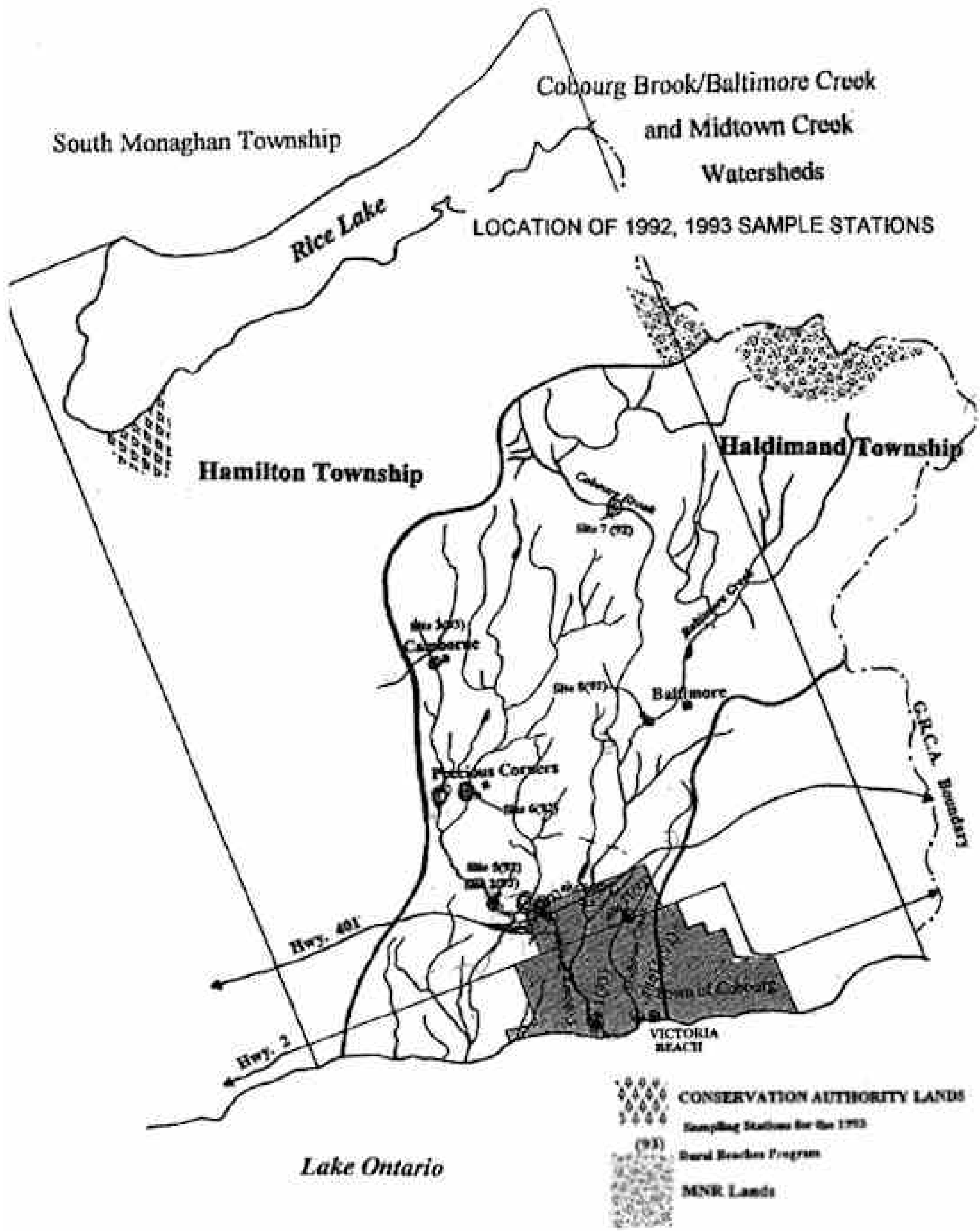
Cobourg Brook/Baltimore Creek
and Midtown Creek
Watersheds
LOCATION OF 1992, 1993 SAMPLE STATIONS
South Monaghan Township
Rice Lake
Hamilton Township
Haldimand Township
Camborne
Baltimore
Precious Corners
G.R.C.A. Boundary
Hwy. 401
Hwy. 2
VICTORIA
BEACH
Lake Ontario
CONSERVATION AUTHORITY LANDS
MNR Lands

Figure 1-3

All branches flow in well defined banks and can be characterized as fast flowing continuous streams joining together to produce an average flow of 3.3 cubic meters per second (GRCA, 1976). Demographically, the watershed is composed of a mixture of agricultural and rural residential inhabitants along with a number of hamlets and villages.

2.1.1 Garden Hill Pond

The Garden Hill Pond is located near the top of the Ganaraska River watershed and is supplied by several tributaries of the North Ganaraska River at their confluence in the Hamlet of Garden Hill. The tributaries are short, steep, fast flowing, cold water streams characteristic of the Oak Ridges Moraine through which they flow.

The pond is dam controlled and covers approximately 14 hectares, while the conservation area itself is about 21 hectares in size. The beach extends approximately 90 meters northerly from the southwest corner of the pond. The conservation area supports a large flock (250, per. comm., G. Elgear) of resident Canada Geese.

2.1.2 Port Hope East and West Beaches

The Port Hope Beaches are located on Lake Ontario on either side of the mouth of the Ganaraska River. The East Beach is located 100 meters east of the confluence of the lake and river while the West Beach is some 500 meters west. Both beaches are within the Town of Port Hope and therefore have the potential for heavy use.

2.2 COBOURG BROOK / BALTIMORE CREEK WATERSHED

2.2.1 Baltimore Creek

Baltimore Creek originates on the south slope of the Oak Ridges Moraine and flows in a southwesterly direction. It can be characterized as a fast flowing, continuous stream of moderate extent. Approximately 70% of its 11.7 kilometer length is forested, with well-defined banks while the remaining 30% is somewhat marshy in nature (GRCA, 1983). Baltimore Creek joins Cobourg Brook west of the Village of Baltimore and continues on as Cobourg Brook.

2.2.2 Cobourg Brook

Cobourg Brook has two main branches. The east branch originates in the till deposits of Hamilton Township and flows in a southerly direction. it is joined about midway through its length by Baltimore Creek and continues on through the lacustrine deposits of former Lake Iroquois to the Town of Cobourg where it is joined by the west branch.

The west branch has similar origin and extent, flowing steeply from the Oak Ridges Moraine onto the lacustrine deposits south of the Village of Camborne and proceeding on to the Town of Cobourg where it is joined by the east branch and finally continues on to its confluence with Lake Ontario where lies the subject beach. Demographically, the watershed is composed of a mixture of agricultural and rural residential inhabitants along with a number of hamlets and villages.

2.2.3 VICTORIA BEACH

Victoria Beach lies on Lake Ontario within the Town of Cobourg, and is located some 1500 meters east of the confluence of Cobourg Brook and Lake Ontario. The beach itself is approximately 1000 meters in length. The surrounding park area offers a variety of recreational opportunities to a large number of, both local residents, and tourists.

3.0 MODEL DEVELOPMENT

3.1 ALGORITHMS

Algorithms are an approximate mathematical representation of natural phenomena, in this case bacterial loadings from certain sources. The CURB algorithms were originally developed under MOEE contract by Ecologistics Limited in 1988. The original model, the Pollution from Livestock Operation Predictor (PLOP), has since been modified and expanded over the course of previous studies, resulting in a comprehensive set of algorithms capable of predicting contaminant loading from a variety of sources. The contaminant sources for which algorithms are available include:

- CATTLE ACCESS
- SEPTIC SYSTEMS
- BARNYARD AND MANURE STORAGE RUNOFF
- MILKHOUSE WASTES
- WINTER MANURE SPREADING
- SPRING, SUMMER, FALL MANURE SPREADING
- URBAN STORMWATER
- WILDLIFE
- GULLS AND PIGEONS

Assessment of previous studies in similar watersheds suggests that many of these sources have minor impact. Those having the largest impact were chosen for inclusion in the Lake Ontario model and in each case a method to collect the necessary parameter data was developed.

3.2 ALGORITHM SELECTION

3.2.1 Cattle Access Algorithm

This algorithm predicts the bacterial loading caused by cattle defecating directly in the watercourse when allowed unrestricted access. Unrestricted cattle access also leads to stream bank erosion and associated water quality deterioration. Livestock access to streams has been found to be a common farming practice in the watershed in the past and in similar watersheds has been a significant source of contamination. Cattle access was therefore considered to be an important component of the model.

3.2.2 Septic System Failures

This algorithm predicts the bacterial contamination caused by private sewage system failures. The communities in the watershed are predominantly rural and septic systems constitute the primary waste treatment system. The Sewell Commission (1992) identified rural septic systems as a major contributor to water quality deterioration and previous studies in similar watersheds have identified septic system failures as a major source of contamination. The proliferation of private residences gives rise to concern for septic systems as an important source of contamination. Septic systems were therefore included as a component of the Lake Ontario model.

3.2.3 Barnyard and Manure Storage Runoff

This algorithm predicts the bacterial contamination caused by storm water contact with barnyard or manure storage systems. In most cases manure is stored in an open area in proximity to the farm buildings, exacerbating the situation further by adding large quantities of water from the roof areas. In cases where there is no facility for handling or diverting storm water, contaminated runoff may reach a watercourse. The dilution of nutrients and bacteria from the stored manure is detrimental both to the downstream users and to the farm operator himself through the loss of nutrients. Barnyard and manure storage runoff have been shown to be a significant source of contamination in previous studies of similar watersheds (TARBS,1993) and was included as a component of the Lake Ontario model.

3.2.4 Milkhouse Washwater Disposal

This algorithm predicts the bacterial contamination caused by untreated milkhouse washwater discharges. Milk wastes provide an ideal medium for bacterial growth. Under certain conditions, delivered contaminants may be up to 500 times greater than at their source (SCRCA, 1991). Milkhouse wastes also contribute large quantities of nutrients in untreated washwater. Dairy operations are a significant segment of the farm community in the study watersheds and this source was, therefore, included as part of the Lake Ontario model.

3.2.5 Winter Manure Spreading

This algorithm predicts the bacterial contamination caused by winter manure spreading. Application of manure in the winter has been a common practice in the past. Insufficient storage capacity and accessibility of frozen crop fields have been compelling incentives for winter spreading. However the loss of nutrients and bacterial contamination during spring runoff are now better understood and farm operator interviews, albeit limited, indicate that winter spreading is seldom practiced. This has been reflected in similar watersheds where this source has been modeled, in that the contributions from winter spreading have been minimal (TARBS,1993). Given the limited impact, and the detailed information required (proximity to watercourse, application rates, etc.) this source of contamination was not included in the Lake Ontario model.

3.2.6 Spring, Summer, Fall Manure Spreading

This algorithm predicts the bacterial contamination caused by manure spreading in seasons other than winter. When properly applied, manure provides valuable nutrients to the soil and is not a hazard to nearby watercourses. In cases where it is improperly applied, runoff may occur leading to bacterial and nutrient contamination. In similar watersheds contamination from this source was found to be minimal (TARBS, 1993). Limited farm operator interviews in the subject watershed also indicate this to be the case. Given the limited impact, and the detailed information required (proximity to watercourse, application rates, etc) this source of contamination was not included in the Lake Ontario model.

3.2.7 Urban Storm Water Runoff

The two rivers in the study area each pass through urban areas before their termination at Lake Ontario where three of the four study beaches lie. The Towns of Port Hope and Cobourg have a major bacterial impact on the Ganaraska River and Cobourg Brook respectively. This bacterial contribution has been estimated using a bacterial loading algorithm developed by Maraslek *et al* in 1985. This algorithm is based on the size of the urban area and a published concentration per unit area (Marsalek, 1985). The estimate was calculated independent of the other loading algorithms (Appendix E) and compared to the total loading from rural sources.

3.2.8 Wildlife

Both study watersheds support robust wildlife populations throughout their rural regions. Although other studies indicate some minor bacterial contribution from this source, (TARBS, 1993) wildlife populations are generally encouraged throughout the watersheds. It has been determined, however, that excessively large populations of Canada Geese may have an impact on some beaches. It is suspected that this may be the case at the Garden Hill Conservation Area, and for that reason, an algorithm to predict bacterial contamination from Canada Geese has been included as part of the model for Garden Hill Pond beach.

3.2.9 Gulls and Pigeons

This algorithm predicts the bacterial contamination caused by Gulls and Pigeons. Gull and Pigeon excrement is high in both bacteria and nutrients. The degree of contamination is a function of the population at individual beaches and was found to vary from beach to beach in a study in which it was included (TARBS,1993). Gulls and Pigeons may locally have an impact on any or all of the study beaches, however it was not possible, within the scope of the study, to obtain an accurate bird census and therefore this source was not included as part of the Lake Ontario model.

3.3 DESCRIPTION OF ALGORITHMS AND PARAMETERS

The CURB algorithms have been coded into a large spread sheet which estimates the contamination from each source, on a block by block basis, simply by inputting the potential number of instances of each source in the block. The actual mathematical algorithms and the source of the parameter data are detailed below.

3.3.1 Contamination from Faulty Septic Systems

CONCENTRATION X DISCHARGE X # PEOPLE / DWELLING X # DWELLINGS X # DAYS X SEPTIC SYSTEM FAILURE RATE X DELIVERY RATE

Concentration	1×10^7 Fecal Coliforms per liter of effluent (MVCA, 1989)
Discharge	300 Liters per person per day (personal communication, Tom Cathcart, 1993)
People per dwelling	2.67 Average from Townships of Hope and Hamilton
Number of dwellings	From survey data.
Number of days	98 (corresponding to sampling season and approximately to swimming season)
Septic system failure rate	19% (GRCA Steering Committee, 1993) (Appendix D)
Delivery	50% (GRCA Steering Committee, 1993)

3.3.2 Contamination from Milkhouse Wastes

CONCENTRATION X (LITERS/COW) X (# MILKING COWS/DAIRY FARM) X [#FARMS < 150M FROM WATERCOURSE X %DAIRY FARMS X % FARMS THAT DISCHARGE WASTE TO SURFACE X DELIVERY RATE + # FARMS X %DAIRY FARMS X %DISCHARGE TO TILE OR WATERCOURSE X DELIVERY RATE] X # DAYS

Concentration	2000 Fecal Coliforms per Liter (SCRCA, 1991)
Liters per cow	13 (personal communication, Peter Mar, 1993)
Number of milking cows per dairy farm	66% of dairy herd (personal communication, Jack Kyle, 1993)
Number of farms closer than 150 meters to a watercourse	From survey data
% Dairy farms	10% Average for Hope and Hamilton Township (OMAFRA Brighton Regional Office)
% Farms discharging washwater to surface	16% (H. Cuthbertson, 1994))
Delivery rate for surface discharge	1% (TARBS, 1993)
% Farms discharging washwater to watercourse or tile	35% (H. Cuthbertson, 1994)
Delivery rate for tile or watercourse discharge	50,000% (TARES, 1993)
Number of days	98 (corresponding to sampling season and approximately to swimming season)

3.3.3 Contamination from Unrestricted Livestock Access to a Watercourse

> CONCENTRATION x (# ACCESS EVENTS/DAY) x
>
> (PROBABILITY OF DEFECATION/ACCESS EVENT) X
>
> ((# FARMS ACCESS IS POSSIBLE X % BEEF FARMS X (#HEAD/BEEF FARM) X AVERAGE BEEF EAU)
>
> + (# FARMS ACCESS IS POSSIBLE X % DAIRY OPERATIONS X (#HEAD/DAIRY FARM)
>
> - # MILKERS X AVERAGE DAIRY EAU)) X # DAYS

Concentration	8.9 x 10^8 Fecal Coliforms per defecation (MVCA,1989)
Access Events per day	2.5 (Demal, 1982)
Probability of defecation per access event	18% (Demal, 1982)
Number of farms where access is possible	From survey data
% Farms that are beef operations	38% Average for Hope and Hamilton Township (OMAFRA Brighton Regional Office)
Number of cattle per beef operation	67 (OMAF, 1991)
Average Equivalent Animal Units for beef operations	0.72 For Northumberland County (Calculated from OMAF 1991 Agricultural Statistics for Ontario)
% Farms that are dairy operations	10% OMAFRA Brighton Regional Office
Number of cattle per daily operation	57 (OMAF, 1991)

Number of milking cows per dairy farm	66% of dairy herd (personal communication Jack Kyle, 1993)
Average Equivalent Animal Units for dairy operations	1.31 For Northumberland County (Calculated from OMAF 1991 Agricultural Statistics for Ontario)
Number of days	98 in case of continuous streams, 30 in case of intermittent streams

3.3.4 Contamination from Barnyard/Manure Stack Runoff

CONCENTRATION X STORAGE AREA X PRECIPITATION X RUNOFF X

DELIVERY X #FARMS < 150M FROM WATERCOURSE X

(#DAYS DELIVERY STREAM FLOWS/#DAYS BEING MODELED)

Concentration	7.5 x 10^9 E. Coli per Hamm (MVCA,1989)
Storage area	0.05 Ha. - Average from survey data (manure stack + feedlot area)
Precipitation	232 mm (Environment Canada Peterborough weather office, 1993)
Runoff	60% (Coote and Hore, 1978)
Delivery	80% (SCRCA, 1991)
Number of farms closer than 150m to a watercourse	Survey data

3.3.6 Contamination from Resident Canada Geese

(CONCENTRATION/ GRAM FECES) X (#GRAMS/ANIMAL/DAY) X #ANIMALS x DELIVERY X #DAYS

Concentration	7.8 X 10^6 Fecal Coliforms/Gram (MTRCA, 1991)
# Grams/Animal/Day	100 (MTRCA, 1991)
# Animals	250 At Garden Hill Conservation Area only (pers. Comm. G. Elgear, 1993)
Delivery	5% (MTRCA, 1991)
# Days	98 (corresponding to sampling season and approximately to swimming season)

3.3.7 Urban Storm Water Runoff

CONCENTRATION X AREA

Concentration	1.10 x 10^7 Fecal Coliforms per cubic meter (Marsalek, 1985)
Area	From clerk's office at Towns of Port Hope and Cobourg

3.3.7. Delivery

DELIVERED LOAD = [LOAD AT SOURCE / (DIE OFF RATE)] X TRAVEL TIME

Load at Source	From model calculations
Die off rate	0.015 Logs per hour (=1.035) (Peter Mar, personal communication)
Travel time	From survey data

3.4 DATA COLLECTION

The model used for the Lake Ontario study was developed to calculate bacterial loading over large areas using a combination of readily available, generalized and specific data. The specific data required deals mostly with numbers of homes and farms and their proximity to watercourses. This type of data was collected from topographic maps and entered into the model.

The general data required deals with such parameters as types of farms, number of animals, and population densities. This type of information was compiled from various sources and is documented in the algorithm descriptions (Section 3.3)

Stream velocities were determined through dye application and travel time measurement, and distances were scaled from topographic maps. The stream intermittency parameter in the model was not necessary in the Lake Ontario watersheds, as all of the streams are continuous.

4.0 PREDICTIONS

The Lake Ontario Model was developed in order to quantify the contamination from certain sources. Presuming that the frequency of beach closures alone is sufficient indication of the need for remedial action, then the magnitude of the loadings and the proportion of contamination contributed by each source becomes important for the purpose of prioritizing remedial projects.

The contamination sources to be modeled have been chosen through the selective process previously outlined. The model in no way represents all possible sources of contamination, nor do model algorithms exist for all possible sources. Further, transport dynamics are complicated and not well understood. The transport model used here was empirically derived from previous studies on various streams and adapted to the general case. The model parameters have been rationalized (Section 3.2) and represent existing conditions as accurately as possible within the study mandate. Nevertheless, broad generalizations were necessary and the general case may not apply to every situation.

The bacterial loadings were calculated for each beach individually and the proportional loading from the various sources was compared. The rural component was addressed separately from the urban component for the purposes of prioritization of the various sources. The total rural component was then compared to the total urban component for each watershed.

4.0.1 GARDEN HILL POND

The Garden Hill Pond watershed is predominantly rural in nature and is home to a large flock of Canada Geese (Section 2.2.2). Consequently this beach is the only case where a wildlife algorithm was included in the model. The total loadings for Garden Hill Pond are listed in Table 4-1 and the proportional loading for each source is illustrated in Figure 4-1.

TABLE 4-1: Bacterial Loading By Source To Garden Hill Pond

SOURCE	AMOUNT
Septic Systems	1.91×10^{12}
Canada Geese	9.66×10^{11}
Milkhouse Waste	1.32×10^{10}
Barnyard Runoff	8.49×10^{10}
Cattle Access	0
Total	2.96×10^{12}

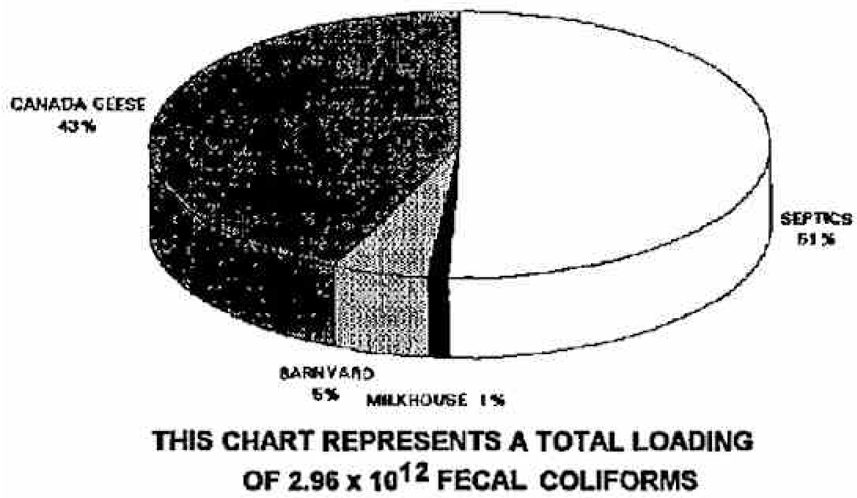

Figure 4-1: Distribution of Bacterial Loading by Source from Selected Rural Sources within the Garden Hill Pond

Given the moderate capacity of approximately 299,000 cubic meters (GRCA, 1977) and modest flow (approx 0.70 cubic meters per second, GRCA 1992), the calculated loading is significant. Septic systems and Canada Geese present the highest potential for contamination, while there is no contamination from cattle access at the present time since the limited number of farms within the watershed have restricted their cattle from the small streams running through their farms. This has not always been the case. The Garden Hill Conservation Area Master Plan (1977) cites instances of cattle access directly to the pond. These farms are presently have no livestock, however there is a potential for renewed access under other proprietorship.

Flow from the Garden Hill Pond continues on as part of the north branch of the Ganaraska River, and the calculated total bacterial loading has been applied to the calculations for the Port Hope Beaches lying downstream.

4.0.2 PORT HOPE EAST AND WEST BEACHES

The predictions for the Port Hope Beaches have been separated into rural and urban components. The rural component includes the total bacterial loading calculated by the model for the Ganaraska River watershed. The bacterial loading was calculated independently for the main branch, north branch and east branch of the river. The calculations for the north branch include the calculated loading for the Garden Hill Pond, adjusted for die off as a function of travel time. The urban component is the non-point bacterial contribution from within the Town of Port Hope.

Although the beaches do not lie directly on the mouth of the river, their proximity to the confluence and the magnitude of the loading indicates a potential impact (Section 1.3, 4.5).

The calculated rural component is tabulated by source in Table 4-2 for the individual branches and the total proportional loading by source is graphically illustrated in Figure 4-2.

TABLE 4-2: Bacterial Loading By Source To Lake Ontario From Rural Sources In The Ganaraska River Watershed

SOURCE	Main Branch	North Branch	East Branch	TOTAL
Septic Systems	9.68×10^{12}	1.98×10^{13}	6.62×10^{12}	3.61×10^{13}
Milkhouse Waste	4.19×10^{11}	7.05×10^{11}	2.48×10^{12}	3.60×10^{12}
Barnyard Runoff	9.09×10^{11}	1.35×10^{12}	5.58×10^{11}	2.82×10^{12}
Cattle Access	2.83×10^{13}	4.50×10^{13}	1.72×10^{13}	9.05×10^{13}
Garden Hill Total		1.35×10^{12}		
Total	3.93×10^{13}	6.82×10^{13}	2.46×10^{13}	1.32×10^{14}

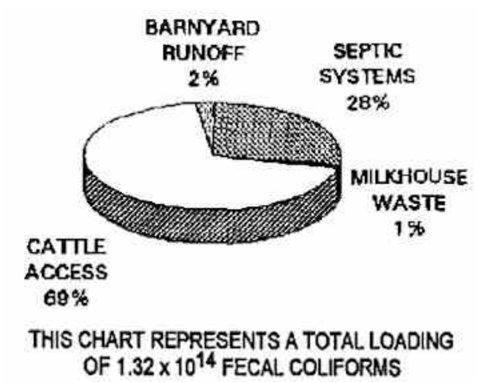

FIGURE 4-2: Distribution Of Bacterial Loading By Source From Selected Rural Sources Within The Ganaraska River Watershed

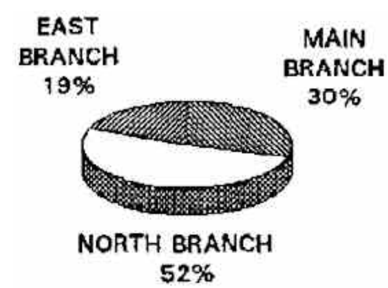

FIGURE 4-3: Proportional Bacterial Loading From Branches Of The Ganaraska River

The proportional loading by source within each of the three branches *is* similar, cattle access being the major sources in each branch. The proportional loading from each branch is illustrated in Figure 4-3.

The urban non-point algorithm results in a total loading of 1.0×10^{13} fecal Coliforms over the 98 day season (Appendix E). Although this is a substantial source of bacterial contamination, it represents only 13% of the combined rural and urban sectors.

4.0.3 VICTORIA BEACH (BALTIMORE CREEK AND COBOURG BROOK WATERSHEDS)

The predicted bacterial loading from the four sources being considered was calculated independently for Baltimore Creek and Cobourg Brook and is tabulated in Table 4-3. The proportional loadings are graphically illustrated for the two watersheds in Figures 4-4 and 4-5.

TABLE 4-3: Bacterial Loading By Source To Lake Ontario From Rural Sources In The Cobourg Brook / Baltimore Creek Watershed

SOURCE	Cobourg Brook	Baltimore Creek	TOTAL
Septic Systems	2.00×10^{13}	2.59×10^{13}	4.59×10^{13}
Milkhouse Waste	5.11×10^{11}	4.60×10^{11}	9.71×10^{11}
Barnyard Runoff	1.07×10^{12}	1.05×10^{12}	2.12×10^{12}
Cattle Access	4.04×10^{13}	2.84×10^{13}	6.88×10^{13}
Total	6.20×10^{13}	5.58×10^{13}	1.18×10^{14}

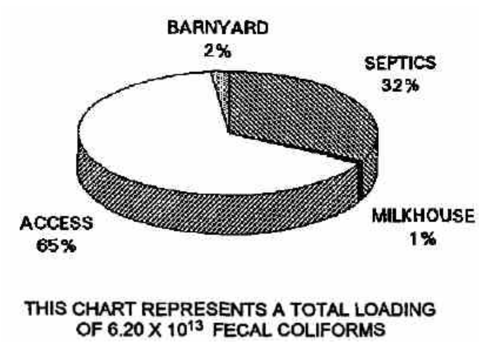

FIGURE 4-4: Distribution Of Bacterial Loading By Source From Selected Rural Sources Within The Cobourg Brook Watershed

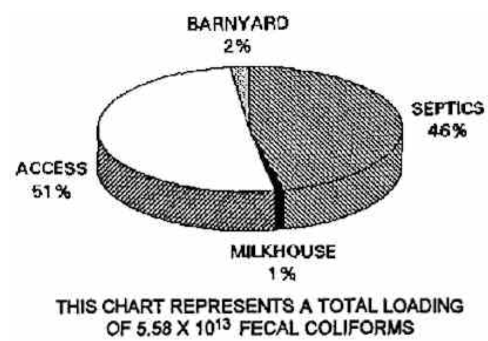

FIGURE 4-5: Distribution Of Bacterial Loading By Source From Selected Rural Sources Within The Baltimore Creek Watershed

Proportional bacterial loading to the two watersheds is similar, cattle access to the tributaries and streams and faulty septic systems being the main source of contamination.

The two streams join near their terminus in the town of Cobourg and continue on to the confluence with Lake Ontario. The proportional loading for the combined stream is illustrated in figure 4-6.

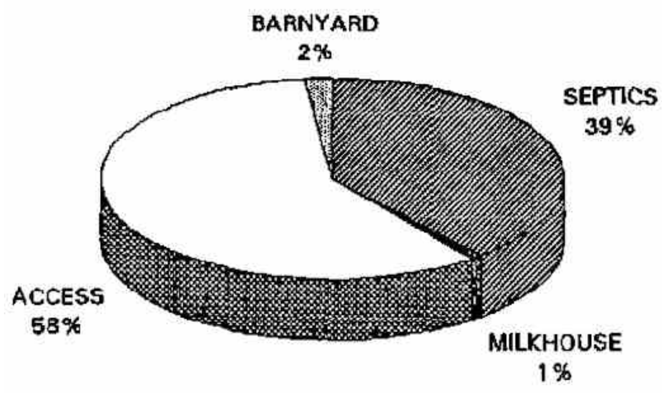

FIGURE 4-6: Distribution Of Bacterial Loading By Source From Selected Rural Sources Within The Combined Cobourg Brook/Baltimore Creek Watershed

Inasmuch as the terminal section of the river flows through the Town of Cobourg, the non point bacterial loading from the town was calculated and compared to the total rural component calculated earlier. The resulting non point bacterial loading amounts to 4.96×10^{13} fecal Coliforms. Although the urban non point loading is substantial, and likely to impact Victoria Beach, it represents only 30% of the combined rural and urban loading.

4.1 DELIVERY

Again, the complexity of Lake Ontario dynamics are far beyond the scope of the current study. The magnitude of the loadings in both study watersheds suggests that there will be an impact on the study beaches.

Despite the complexity, dye testing was undertaken at Cobourg Brook in an attempt to determine the impact on Victoria Beach. It was found that dye added to Cobourg Brook near its confluence with Lake Ontario was carried along the shoreline towards Victoria Beach. Although the dye dissipated before arriving at the beach, it was a positive indication of a connection between the stream and the beach. A similar configuration at Port Hope suggests a similar connection.

4.2 COMPARISON OF CALCULATED AND MEASURED BACTERIAL LOADING

In order to determine the veracity of the calculated loading, flow measurements and water samples were collected at selected stations. This data was then used to compute the total loading at the station over the 98 day sampling season. This total loading was then compared to the loading predicted by the model at the same station. Flow data was available at only two stations, one at Sylvan Glen Conservation Area, and the other at the Television Road/Baltimore Creek crossing (Figure 2-1).

Although the number of stations where the comparison could be made is limited the comparisons at these two stations indicate excellent conformity between the predicted and measured loading (Figure 4-7) indicating that the model ought to emulate actual bacterial loading elsewhere in the watersheds.

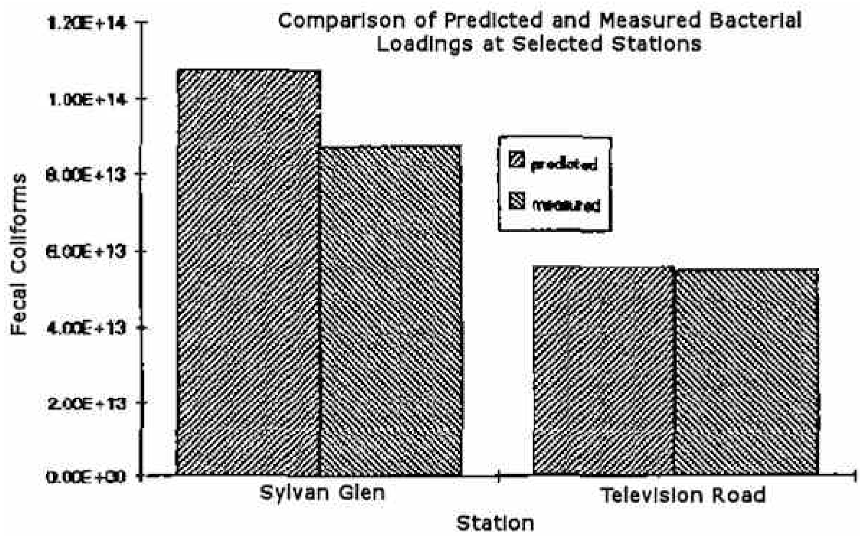

FIGURE 4-7: Comparison Of Predicted And Measured Bacterial Loading At Selected Stations

5.0 COSTS OF REMEDIATION

Remedial costs were calculated based on the expected number of occurrences for each source problem in the model and an average cost to correct each. The purpose of this exercise is to rank the cost effectiveness of the various options, not to suggest that expenditure of exactly the amounts listed will result in the exact attendant reductions in contaminants. The costs for each classification of source problems were compiled from various sources and are shown in Table 5-1. Total costs are illustrated in Table 5-2 based on the cost estimates in Table 5-1. The effectiveness of the expenditures are also detailed in Tables 5-2.

TABLE 5-1 : Estimated Cost Per Project

REMEDIAL PROJECT	COST/PROJECT
Private Septic Systems -	$ 4,000.00*
Livestock Access Restriction Fencing and Alternate Water Supply	$10,000.00*
Manure Storage Pad With Walls/liquid Containment	$ 40,000.00*
Milkhouse Washwater Treatment Trench	$ 5,000.00

* Cost estimates based on similar completed projects from Indian River CURB program.

In both watersheds, the most cost effective remedial undertaking is in the area of restricting cattle access from streams. In both instances cattle access also represents the largest single contribution of bacterial contamination of the four sources considered.

Remediation of faulty septic systems also presents a cost effective opportunity in both watersheds. The other sources considered contribute considerably less of the total contamination and present a far more costly remedial contingency. This is not to say that an individual problem manure storage for instance, won't present a cost effective remedial procedure in a particular case, but generally, cattle access restriction and faulty septic systems present the most cost effective measure.

TABLE 5-2 : Cost Of Remediation And Efficacy Of Cost Expenditure

	GANARASKA RIVER WATERSHED					COBOURG BROOK/BALTIMORE CREEK WATERSHED				
SOURCE	No.	TOTAL COST	CURB SHARE	% TOTAL BACTI. LOAD	COST PER % REDUCTION	No.	TOTAL COST	CURB SHARE	TOTAL BACTI. LOAD	COST PER % REDUCTION
Faulty Septic Systems	146	$ 584,000	$292,000	27	$ 21,830	183	$ 732,000	$ 366,000	39	$ 18,770
Cattle Access	126	$1,260,000	$945,000	70	$ 18,000	110	$1,100,000	$ 825,000	58	$ 18,965
Barnyard Runoff	132	$5,280,000	$1,584,000	2	$2,640,000	120	$4,800,000	$1,440,000	2	$2,400,000
Milkhouse Waste	22	$ 110,000	$55,000	1	$ 110,000	17	$ 85,000	$ 42,500	1	$ 85,000

6. RECOMMENDATIONS

1. That the Ganaraska River, Cobourg Brook and Baltimore Creek watersheds be included in the O.M.E.E. Clean Up Rural Beaches Program, in order to address the sources of contamination identified in the study as contributing to beach closures.

2. That the Ganaraska River, Cobourg Brook and Baltimore Creek CURB Program implement an information and education program, for the purpose of informing the residents of the importance of good water quality and factors leading to its deterioration.

3. That the Ganaraska River, Cobourg Brook and Baltimore Creek CURB Program aggressively promote cattle access restriction projects and septic system improvements, particularly in the vicinity of the watercourses and their tributaries, and the program seek the assistance of appropriate agencies in doing so.

4. That the Ganaraska River, Cobourg Brook and Baltimore Creek CURB Program aggressively promote participation in the Program among the agricultural community and further encourage enhanced environmental land practices in the agricultural community through such initiatives as preparation of an Environmental Farm Plan.

5. That the Ganaraska River, Cobourg Brook and Baltimore Creek CURB Program investigate current technology for controlling Canada Geese and the feasibility of implementing such technology at the Garden Hill Conservation area

6. That the Ganaraska River, Cobourg Brook and Baltimore Creek CURB Program continue to monitor water quality throughout the watershed for the purpose of evaluating success of the remedial projects.

LIST OF APPENDICES

Appendices A & B - insufficient quality to convert from source document

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 1 COBOURG BROOK @ Camborne

DATE	TEMP (C)	F.C.	E.C. per 100 milliliters	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
06/02/1993	10.0	120	100	10	160	485	8.3	13.3	3.9	0.5	0.012	0.001	0.2	0.006	1.27	0.005	1.5	N
06/08/1993	10.5	50	10	10	60	489	8.3	13.9	1.6	2.14	0.018	0.001	0.22	*0.008*	1.21	0.006	1.7	N
15/06/1993	14.0	150	150	10	320	502	8.3	13.6	2.0	0.51	0.014	0.0045	0.22	0.01	1.13	0.007	1.7	Y
22/06/1993	14.0	1500	1300	10	630	546	8.3	13.7	7.1	2.3546	0.034	0.11	0.38	0.016	1.29	0.007	2.9	Y
29/06/1993	13.0	120	120	10	440	512	8.2	13.4	3.1	0.81	0.012	0.001	0.22	0.008	1.16	0.009	1.6	Y
07/06/1993	15.5	120	120	10	270	490	8.2	12.6	7.1	6.1166	0.01	0.0025	0.16	0.022	1.05	0.006	1.6	N
13/07/1993	16.0	60	60	10	370	487	8.3	11,8	3.5	2.1662	0.008	0.003	0.2	0.014	1.02	0.005	1.2	Y
20/07/1993	14.0	120	120	10	250	493	8.2	12.3	1.8	0.6752	0.01	0.0025	0.14	0.004	1.02	0.004	1.3	Y
27/07/1993	14.0	360	240	10	350	479	8.2	11.2	3.8	4.5454	0.008	0.001	0.14	0.01	0.97	0.005	1.2	Y
08/03/1993	14.0	100	40	10	310	474	8.2	11.0	5.8	2.5056	0.006	0.001	0.14	0.01	0.905	0.004	1.3	Y
10/08/1993	16.0	60	40	10	300	478	8.2	10.8	1.3	0.27	0.01	0.001	0.14	0.002	0.89	0.003	1.1	N
17/08/1993	16.0	20	20	10	240	471	8.3	10.4	7.6	5.4754	0.014	0.003	0.12	0.002	0.84	0.002	1.4	Y
24/08/1993	14.0	40	40	10	200	369	7.6	10.1	2.3	0.61	0.004	0.001	0.14	0.008	0.835	0.004	1.3	N
31/08/1993	15.0	40	40	10	160	485	8.3	9.4	1.7	0.44	0.012	0.001	0.14	0.014	0.455	0.005	1.2	Y
Count	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	7.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	12.5	204.3	171.4	10.0	290.0	485.0	8.3	11.4	2.8	0.4700	0.012	0.001	0.170	0.010	0.8625	0.0050	1.4	
Minimum	10.0	20.0	10.0	10.0	60.0	485.0	8.3	9.4	1.7	0.4400	0.012	0.001	0.140	0.006	0.4550	0.0050	1.2	
Maximum	15.0	1500.0	1300.0	10.0	630.0	485.0	8.3	13.3	3.9	0.5000	0.012	0.001	0.200	0.014	1.2700	0.0050	1.5	
Geomean	12.2	99.8	76.8	10.0	256.4	485.0	8.3	11.2	2.6	0.4690	0.012	0.001	0.167	0.009	0.7602	0.0060	1.3	

* Indication of precipitation in the last 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 2 COBOURG BROOK @ Telephone Road

DATE	TEMP (C)	F.C.	E.C. per 100 milliliters	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
06/02/1993	11.0	230	170	10	100	475	8.26	12.1	7.9	2.14	0.006	0.001	0.28	0.014	0.905	0.01	2.6	N
06/08/1993	13.0	890	510	10	170	485	8.34	12.6	3.2	0.46	0.014	0.001	0.32	0.024	0.915	0.011	2.9	N
15/06/1993	16.0	3800	3000	10	420	487	8.28	12.4	8.1	2.88	0.022	0.003	0.34	0.02	0.83	0.023	2.6	Y
22/06/1993	16.0	3100	2300	10	1400	521	8.25	11.1	16.2	7.4786	0.062	0.011	0.64	0.04	1.14	0.024	6.1	Y
29/06/1993	15.0	1200	1200	10	800	613	8.20	12.5	4.8	2.76846	0.018	0.002	0.32	0.012	0.94	0.018	2.8	V
07/06/1993	21.5	2300	1700	10	380	476	8.27	12.7	4.1	1.68846	0.016	0.0015	0.32	0.03	0.785	0.019	2.7	N
13/07/1993	18.6	1100	1100	10	400	466	8.30	12.6	5.3	2.49824	0.014	0.0015	0.34	0.014	0.73	0.01	2.4	Y
20/07/1993	17.0	1800	980	60	700	477	8.23	13.8	4.4	2.73824	0.018	0.0015	0.30	0.014	0.805	0.008	2.7	Y
27/07/1993	19.6	1300	1300	10	640	462	8.28	12.1	6.3	2.2286	0.02	0.001	0.32	0.024	0.755	0.01	2.3	Y
08/03/1993	18.6	1700	1700	10	540	458	8.27	12.9	4.8	1.11824	0.014	0.002	0.30	0.038	0.645	0.009	2.5	Y
10/08/1993	18.6	1200	940	10	700	457	8.23	12.8	3	1.29824	0.02	0.001	0.28	0.018	0.62	0.006	2.3	N
17/08/1993	20.0	1300	1300	10	680	463	8.38	12.4	7.9	4.8086	0.028	0.0066	0.32	0.036	0.064	0.015	2.8	'V
24/08/1993	18.0	1600	940	10	800	367	7.73	12.2	6	2.80846	0.016	0.002	0.26	0.018	0.645	0.009	2.3	N
31/08/1993	20.5	1400	1400	10	960	456	8.23	12.0	8.1	2.94846	0.024	0.001	0.30	0.014	0.40	0.005	2.3	Y
Count	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	17.4	1637	1324	14	619	467.9	8.2	12.4	6.4	1.827	0.021	0.003	0.331	0.023	0.727	0.013	2.7	
Minimum	11.0	230	170	10	100	367.0	7.7	11.1	3.0	0.460	0.008	0.001	0.260	0.012	0.064	0.006	2.3	
Maximum	21.6	3800	3000	60	1400	521.0	8.4	13.8	16.2	2.880	0.082	0.011	0.640	0.040	1.140	0.024	6.1	
Geomean	17.1	1391	1118	11	518	466.3	8.2	12.4	5.7	1.416	0.018	0.002	0.323	0.021	0.634	0.011	2.7	

* Indication of precipitation in the lest 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 3 COBOURG BROOK @ Cobourg Gauge Station

DATE	TEMP (C)	F.C.	E.C. per 100 milliliters	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
06/02/1993	12.0	110	110	10	90	476	8.44	23.9	4.0	1.28	0.028	0.01	0.38	0.018	0.875	0.009	3.2	N
06108/1993	13.0	740	500	10	90	490	8.30	25.9	4.9	1.69	0.046	0.012	0.4	0.03	0.69	0.013	3.5	N
15/06/1993	17.0	940	430	10	500	512	8.29	29.4	8.8	4.2	0.036	0.009	0.84	0.184	0.735	0.016	3.0	Y
22/06/1993	15.0	4200	2400	30	2100	510	8.26	22.0	26.8	7.9388	0.072	0.01	0.78	0.066	0.73	0.013	6.0	Y
29/06/1993	16.0	260	260	10	660	540	8.19	32.3	4.5	2.5	0.044	0.011	0.46	0.014	0.94	0.018	2.8	Y
07/06/1993	21.5	520	160	10	140	546	8.28	38.0	3.7	2.36	0.086	0.044	1.9	1.6	0.615	0.046	3.4	N
13/07/1993	18.0	240	240	10	200	518	8.32	36.0	4.0	2.77	0.062	0.0305	0.6	0.16	0.558	0.02	3.0	Y
20/07/1993	17.0	420	320	10	1300	486	8.25	28.4	4.6	2.38346	0.074	0.0355	0.44	0.01	0.605	0.007	2.0	Y
27/07/1993	19.0	900	420	10	400	491	8.26	32.3	4.4	2.1	0.086	0.049	0.46	0.048	0.57	0.009	3.1	Y
08/03/1993	18.5	400	280	10	400	489	8.29	26.2	3.0	1.79824	0.036	0.016	3.1	2.71	0.56	0.033	2.9	Y
10/08/1993	18.5	1200	940	10	700	490	8.23	28.8	3.1	1.72S46	0.030	0.0035	1.7	1.26	0.025	1.06	2.8	N
17108/1993	20.0	400	220	10	280	486	8.43	28.6	4.8	2.14	0.082	0.0465	0.42	0.022	0.53	0.01	3.6	Y
24/08/1993	19.0	1200	500	10	540	358	7.63	27.4	8.7	2.09846	0.034	0.0075	0.4	0.034	0.545	0.009	2.7	N
31/08/1993	21.0	33000	7000	10	17000	493	8.06	28.5	12.5	1.74S6	0.135	0.001	0.75	0.002	0.81	0.003	3.4	Y
Count	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	17.5	3181	984	11	1743	493	8	29	6.829	2.380	0.081	0.020	0.888	0.439	0.656	0.090	3	
Minimum	12.0	110	110	10	90	368	8	22	3.000	1.280	0.028	0.001	0.380	0.002	0.630	0.003	2	
Maximum	21.5	33000	7000	30	17000	646	8	38	28.800	4.200	0.135	0.049	3.100	2.710	0.940	1.060	6	
Geomean	17.3	778	453	11	499	491	8	29	5.499	2.254	0.064	0.013	0.688	0.068	0.647	0.017	3	

* Indication of precipitation In the last 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

1993 WATER QUALITY RESULTS FOR STATION NO. 1 GANARASKA RIVER @ County Road 10 Garden Hill

DATE	TEMP (C)	F.C.	E.C. per 100 milliliters	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
06/02/1993	13.0	30	30	10	90	369	8.18	4.9	9.0	2.808	0.032	0.005	0.42	0.112	0.705	0.026	2.1	N
06/08/1993	16.0	80	60	10	290	382	8.28	6.1	9.4	1.12	0.038	0.003	0.50	0.10	0.74	0.031	2.3	N
15/06/1993	19.0	550	460	10	650	363	8.07	5.1	18	7.838	0.052	0.007	0.46	0.064	0.735	0.09	2.1	Y
22/06/1993	19.0	2200	2000	20	880	432	8.07	9.2	13.3	6.288	0.058	0.010	0.72	0.13	1.24	0.059	4.3	Y
29/06/1993	18.0	200	140	20	860	404	8.09	7.5	8.5	2.66	0.36	0.004	0.44	0.04	0.8	0.082	3.0	Y
07/06/1993	21.0	140	140	20	480	364	8.07	4.9	7.0	2.56	0.03	0.007	0.38	0.07	0.665	0.044	2.2	N
13/07/1993	20.0	80	60	10	1000	344	8.15	4.6	6.8	3.378	0.032	0.004	0.64	0.074	0.44	0.031	2.2	V
20/07/1993	17.0	140	100	10	1000	348	8.08	4.4	6.8	2.88	0.034	0.004	0.40	0.07	0.515	0.026	2.0	V
27/07/1993	19.0	180	180	20	1700	348	8.10	4.1	6.8	3.168	0.032	0.003	0.34	0.052	0.78	0.026	1.9	Y
08/03/1993	19.0	2900	100	40	1700	343	8.29	4.0	6.7	2.95	0.026	0.001	0.38	0.066	0.405	0.018	2.1	Y
10/08/1993	18.0	80	60	20	1000	351	8.13	4.2	6.6	2.258	0.026	0.001	0.34	0.042	0.505	0.02	2.0	N
17/08/1993	18.0	120	20	20	1600	361	8.26	4.1	7.5	3.038	0.03	0.006	0.34	0.058	0.485	0.027	2.0	Y
24/08/1993	16.0	100	100	10	1100	372	7.39	4.3	6.3	2.548	0.026	0.002	0.34	0.052	0.42	0.022	1.9	N
31/08/1993	17.0	200	100	20	1300	369	8.14	4.2	6.4	1.828	0.034	0.007	0.36	0.056	0.79	0.025	1.8	Y
Count	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	17.9	500.0	253.6	17.1	975.0	367.9	8.1	5.1	8.5	2.43	0.06	0.00	0.43	0.07	0.66	0.04	2.28	
Minimum	13.0	30.0	20.0	10.0	90.0	343.0	7.4	4.0	6.3	1.12	0.03	0.00	0.34	0.04	0.41	0.02	1.80	
Maximum	21.0	2900	2000	40	1700	432	8.0	9	18	2.95	0.36	0.01	0.72	0.13	1.24	0.09	4.30	
Geomean	17.7	191.8	110.8	15.6	795.7	367.1	8.1	4.9	8.1	2.30	0.04	0.00	0.42	0.07	0.63	0.03	2.22	

* Indication of precipitation in the last 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 2 GANARASKA RIVER @ Ossoa Gauge Station, Ossoa

DATE	TEMP (C)	F.C.	E.C.	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
		per 100 milliliters																
06/02/1993	10.0	470	470	10	60	385	8.37	7.0	3.2	1.0086	0.006	0.001	0.20	0.002	0.495	0.004	2.2	N
06/08/1993	13.0	40	30	10	220	381	8.43	7.2	5.0	3.9086	0.016	0.001	0.24	0.014	0.48	0.10	2.3	N
15/06/1993	16.0	400	320	10	190	390	8.27	6.3	10.7	3.2184	0.022	0.001	0.26	0.012	0.60	0.009	1.9	V
22/06/1993	17.5	710	710	10	540	401	8.20	8.7	40.0	11.808	0.072	0.007	0.62	0.024	0.375	0.013	4.9	Y
29/06/1993	14.5	220	220	20	1400	412	8.23	7.4	5.6	2.0686	0.018	0.002	0.28	0.018	0.51	0.009	2.7	Y
07/06/1993	19.0	170	160	10	130	394	8.27	6.1	2.5	1.41	0.012	0.001	0.16	0.018	0.495	0.007	1.9	N
13/07/1993	16.0	200	200	10	300	386	8.35	5.8	3.7	1.5984	0.008	0.001	0.28	0.010	0.505	0.005	1.9	Y
20/07/1993	15.0	490	330	10	430	388	8.26	5.9	3.8	1.6584	0.01	0.001	0.20	0.012	0.52	0.004	2.2	Y
27/07/1993	16.0	730	620	10	270	384	8.27	5.4	10.9	2.8286	0.022	0.001	0.24	0.016	0.535	0.004	1.6	V
08/03/1993	16.0	480	480	10	350	384	8.39	6.0	4.1	1.4486	0.01	0.001	0.22	0.024	0.49	0.004	1.9	Y
10/08/1993	16.0	230	170	10	260	384	8.25	6.0	3.3	1.1886	0.01	0.001	0.18	0.010	0.52	0.005	1.7	N
17/08/1993	18.0	250	210	10	370	392	8.39	5.6	6.3	2.9384	0.018	0.004	0.18	0.008	0.545	0.006	1.7	Y
24/08/1993	16.0	160	110	10	310	369	7.55	5.4	4.2	2.0186	0.012	0.001	0.18	0.012	0.545	0.005	1.7	N
31/08/1993	17.0	110	110	10	270	391	8.31	5.0	4.7	1.3686	0.014	0.001	0.18	0.008	0.525	0.006	1.5	Y
03/09/1993		5700	2400	10	12000	Wet Weather Sampling												
Count	13.0	14.0	14.0	14.0	14.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	
Average	13.0	706	434	11	1217	389	8.24	6.21	8.06	1.41	0.02	0.00	0.25	0.01	0.51	0.01	2.15	
Minimum	13.0	40	30	10	130	369	7.55	5.00	2.50	1.41	0.01	0.00	0.16	0.01	0.38	0.00	1.50	
Maximum	13.0	5700	2400	20	12000	412	8.43	8.70	40.00	1.41	0.07	0.01	0.62	0.02	0.60	0.10	4.90	
Geomean	13.0	312	255	11	417	389	8.24	6.14	5.76	1.41	0.02	0.00	0.23	0.01	0.51	0.01	2.04	

* Indication of precipitation the last 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 1 BALTIMORE CREEK @ Balls Mill Conservation Area

DATE	TEMP (C)	F.C.	E.C.	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
		per 100 milliliters																
08/02/1993	10.5	110	110	10	80	423	8.37	10.70	2.90	0.87	0.0120	0.0015	0.260	0.0060	0.8760	0.0070	2.10	N
08/08/1993	12.0	100	100	10	70	430	8.37	11.20	3.10	2.81	0.0180	0.0025	0.240	0.0200	0.8650	0.0080	2.40	N
15/08/1993	15.0	140	140	10	140	433	8.30	9.50	13.00	2.41	0.0340	0.0065	0.280	0.0060	0.9300	0.0130	1.80	Y
22/06/1993	14.0	1700	1700	10	1100	457	8.28	13.00	8.00	3.9088	0.0420	0.0125	0.520	0.0260	0.5800	0.0140	5.30	V
29/06/1993	14.5	340	100	10	80	447	8.26	10.40	3.10	1.07846	0.0200	0.0065	0.240	0.0200	0.8700	0.0090	2.20	Y
07/06/1993	18.0	100	40	10	220	434	8.33	9.70	3.90	1.18824	0.0220	0.0065	0.220	0.0260	0.8250	0.0100	2.10	N
13/07/1993	16.0	100	80	10	80	431	8.38	9.30	2.80	1.05824	0.0160	0.0065	0.240	0.0160	0.8400	0.0070	1.80	Y
20/07/1993	14.5	440	220	10	320	438	8.29	9.80	2.90	1.1786	0.0180	0.0050	0.240	0.0160	0.8600	0.0070	2.00	Y
27/07/1993	16.0	280	80	10	140	434	8.29	9.00	3.70	1.0788	0.0220	0.0055	0.220	0.0200	0.8900	0.0080	1.90	Y
08/03/1993	18.0	260	160	10	160	430	8.31	9.30	3.70	0.98824	0.0140	0.0055	0.240	0.0300	0.7700	0.0080	2.00	Y
10/08/1993	15.0	140	80	10	200	428	8.28	9.30	3.00	0.38	0.0140	0.0025	0.200	0.0100	0.8000	0.0060	1.60	
17/08/1993	16.0	460	280	10	260	448	8.41	10.40	3.50	1.50824	0.0240	0.0110	0.220	0.0120	0.7800	0.0090	2.50	Y
24/08/1993	15.0	80	20	10	240	387	7.82	9.30	2.70	0.86846	0.0340	0.0075	0.400	0.0340	0.8850	0.0070	1.70	
31/08/1993	16.5	160	160	10	300	436	8.31	9.30	2.80	0.83846	0.0180	0.0080	0.200	0.0140	0.6250	0.0130	1.70	Y
Count	14,0	14	14	14	14	14.0	14.0	14.0	14.0	4.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	13.5	315	232	10	242	429.5	8.3	10.0	2.9	0.6700	0.0150	0.0038	0.2300	0.0100	0.7500	0.0100	1.90	
Minimum	10,5	80	20	10	70	423.0	8.3	9.3	2.8	0.6700	0.0120	0.0016	0.2000	0.0060	0.8250	0.0070	1.70	
Maximum	18.5	1700	1700	10	1100	438.0	8.4	10.7	2.9	0.8700	0.0180	0,0060	0.2800	0.0140	0.8750	0.0130	2.10	
Geomean	13.2	205	120	10	178	429.6	8.3	10.0	2.8	0.8700	0.0147	0.0030	0.2280	0.0092	0.7395	0.0095	1.89	

* This is an indication of if there was precipitation ins the last 48 hours.

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

1993 WATER QUALITY RESULTS FOR STATION NO. 3 NORTH GANARASKA RIVER @ Perrytown

DATE	TEMP (C)	F.C.	E.C.	Ps. A.	F.S.	COND. µhmo/cm	pH	Chl. mg/L	RSP mg/L	TURB	T Phos mg/L	PO4 mg/L	TKN mg/L	NH4 mg/L	NO3 mg/L	NO2 mg/L	DOC mg/L	Rainfall Y/N
		per 100 milliliters																
06/02/1993	12.0	240	240	10	320	348	8.19	3.9	11.0	3.37824	0.04	0.0035	0.36	0.036	0.675	0.024	2.1	N
06/08/1993	15.0	280	280	10	220	355	8.29	4.7	13.4	1.4186	0.04	0.003	0.38	0.028	0.68	0.028	2.5	N
15106/1993	19.0	500	470	10	340	330	8.08	4.0	23.6	10.2086	0.058	0.0075	0.42	0.006	0.615	0.033	2.0	Y
02/08/1993	18.0	7500	4500	10	4400	384	8.09	6.2	28.1	10.9086	0.076	0.012	0.70	0.034	0.97	0.05	4.1	Y
29/08/1993	17.0	170	140	10	420	382	8.05	5.6	14.8	3.59824	0.054	0.004	0.50	0.010	0.73	0.48	3.6	Y
07/06/1993	21.0	160	60	20	300	329	8.09	3.9	9.4	3.1386	0.034	0.0055	0.32	0.026	0.615	0.028	2.1	N
13/07/1993	19.0	340	120	10	4100	325	8.12	3.7	9.7	4.0886	0.04	0.006	0.48	0.020	0.575	0.028	1.9	Y
20/07/1993	17.0	280	280	10	5300	343	8.09	3.0	9.9	3.55846	0.036	0.006	0.34	0.026	0.71	0.03	2.0	Y
27/07/1993	19.0	280	140	20	4300	337	8.08	3.6	11.4	4.41846	0.036	0.0055	0.34	0.024	0.65	0.025	1.8	Y
08/03/1993	18.5	200	200	10	3900	324	8.25	3.5	10.6	3.1486	0.032	0.006	0.32	0.044	0.585	0.017	2.2	Y
10/08/1993	17.5	240	120	20	1600	328	8.08	3.5	8.8	2.5586	0.03	0.0035	0.32	0.016	0.555	0.01	1.8	N
17/08/1993	19.0	220	220	20	1300	331	8.27	3.4	9.5	4.4686	0.032	0.007	0.28	0.016	0.56	0.018	1.7	Y
24/08/1993	17.0	280	140	10	1600	366	7.59	3.6	8.8	3.31846	0.026	0.0035	0.26	0.018	0.525	0.009	1.7	N
31/08/1993	20.0	200	120	20	2400	324	8.15	3.3	8.0	2.3086	0.03	0.0035	0.28	0.0.02	0.486	0.008	1.7	Y
Count	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
Average	17.8	778	502	14	2179	343	8.10	4.03	12.84	4.09	0.04	0.01	0.38	0.02	0.04	0.06	2.23	
Minimum	12.0	160	60	10	220	324	7.59	3.30	8.00	4.09	0.03	0.00	0.28	0.01	0.49	0.01	1.70	
Maximum	21.0	7500	4500	20	5300	384	8.29	8.20	28.10	4.09	0.08	0.01	0.70	0.04	0.97	0.48	4.10	
Geomean	17.8	318	217	13	1298	343	8.10	3.95	11.73	4.09	0.04	0.01	0.37	0.02	0.83	0.03	2.14	

* Indication of precipitation in the last 48 hours

APPENDIX C - 1993 WATER QUALITY SAMPLE PROGRAM RESULTS

PROVINCIAL RURAL BEACHES PROGRAM - GANARASKA REGION CONSERVATION AUTHORITY

WATER QUALITY RESULTS FOR STATION NO. 4 GANARASKA RIVER @ Sylvan Glen Conservation Area

DATE	TEMP	F.C.	E.C.	Ps. A.	F.S.	COND.	pH	Chl.	RSP	TURB	T Phos	PO4	TKN	NH4	NO3	NO2	DOC	Rainfall
	(C)	per 100 milliliters				µhmo/cm		mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Y/N
06/02/1993	12.0	30	30	10	20	384	8.35	6.4	6.9	1.6486	0.014	0.002	0.32	0.016	0.58	0.010	2.7	N
06/08/1993	14.5	80	60	10	30	388	8.43	6.8	9.4	3.1846	0.020	0.001	0.32	0.016	0.56	0.012	2.9	N
15/06/1993	18.0	280	280	10	170	389	8.23	5.9	10.9	3.1824	0.040	0.001	0.40	0.03	0.545	0.017	2.6	Y
22/06/1993	18.0	1500	1200	10	650	405	8.17	7.9	55.4	16.006	0.034	0.007	0.20	0.032	0.635	0.028	5.8	Y
29/06/1993	17.0	180	80	10	280	421	8.22	7.4	10.2	4.496	0.034	0.002	0.40	0.014	0.625	0.017	3.7	Y
07/06/1993	22.0	200	200	10	70	382	8.30	5.8	6.5	2.566	0.016	0.001	0.28	0.03	0.47	0.008	2.5	N
13/07/1993	19.5	120	80	10	350	367	8.31	6.4	5.4	3.1924	0.014	0.001	0.32	0.028	0.42	0.007	2.2	Y
20/07/1993	17.5	140	140	10	500	375	8.24	5.5	8.8	3.5746	0.020	0.001	0.30	0.018	0.565	0.008	2.3	Y
27/07/1993	19.0	80	80	10	290	371	8.27	5.1	5.6	2.896	0.014	0.001	0.26	0.024	0.535	0.007	2.0	Y
08/03/1993	19.0	140	100	10	230	372	8.38	5.4	7.0	2.516	0.016	0.001	0.32	0.034	0.495	0.007	2.3	Y
10/08/1993	18.5	100	100	10	250	375	8.23	5.4	6.5	1.646	0.016	0.001	0.28	0.012	0.47	0.006	2.5	N
17/08/1993	20.0	340	340	10	360	378	8.41	5.2	8.0	4.4846	0.018	0.001	0.26	0.016	0.505	0.008	2.1	Y
24/08/1993	18.0	120	60	10	360	368	7.67	5.0	5.4	2.026	0.008	0.001	0.22	0.014	0.50	0.006	2.0	N
31/08/1993	19.0	100	40	20	320	367	8.30	4.7	5.2	2.426	0.01	0.001	0.24	0.014	0.455	0.005	1.9	Y
03/09/1993		6800	3400	60	12000		Wet Weather Sampling											
Count	13.0	14.0	14.0	14.0	14.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	
Average	18.5	727	440	14	1133	381	8	6	####		0.0200	#####	#####	0.0217	0.5215	0.0104	2.68	
Minimum	14.5	80	40	10	30	367	8	5	5.20	0.0000	0.0080	#####	#####	0.0120	0.4200	0.0050	1.90	
Maximum	22.0	6800	3400	50	12000	421	8	8	####	0.0000	0.0400	#####	#####	0.0340	0.6360	0.0280	5.80	
Geomean	18.4	220	161	12	315	381	8	6	8.39		0.0180	#####	#####	0.0203	0.5180	0.0090	2.54	

* Indication of precipitation in the last 48 hours

WATER QUALITY RESULTS FOR STATION NO. 5 GANARASKA RIVER @ Ontario Street Port Hope

DATE	TEMP	F.C.	E.C.	Ps. A.	F.S.	COND.	pH	Chl.	RSP	TURB	T Phos	PO4	TKN	NH4	NO3	NO2	DOC	Rainfall
	(C)	per 100 milliliters				µhmo/cm		mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Y/N
06/02/1993	12.0	120	60	10	50	398	8.38	10.10	6.20	1.87824	0.016	0.002	0.3800	0.0100	0.55	0.007	3.000	N
06/08/1993	15.0	90	50	10	70	4.01	8.44	10.60	7.60	2.1086	0.022	0.001	0.3400	0.0200	0.525	0.010	3.100	N
16/06/1993	19.0	270	180	10	80	4.02	8.29	9.80	11.90	3.45824	0.040	0.001	0.4000	0.0300	0.545	0.017	2.600	Y
22/06/1993	19.0	1300	1300	10	630	415	8.24	10.90	30.70	12.5086	0.084	0.008	0.7000	0.0440	0.63	0.022	6.000	Y
29/06/1993	17.0	220	140	10	230	434	8.31	10.80	12.60	3.61824	0.036	0.001	0.4400	0.0180	0.615	0.018	3.800	Y
07/06/1993	23.0	220	140	10	100	392	8.31	8.80	11.10	3.55824	0.022	0.001	0.3000	0.0380	0.435	0.009	2.700	N
13/07/1993	21.0	280	200	10	130	372	8.30	8.20	6.30	2.8486	0.020	0.003	0.3400	0.0480	0.33	0.007	2.600	Y
20/07/1993	18.0	480	160	10	270	380	8.29	7.70	9.80	4.84524	0.018	0.001	0.3000	0.0160	0.555	0.008	2.400	Y
27/07/1993	20.6	220	160	10	170	373	8.32	7.40	15.10	6.4086	0.022	0.001	0.3200	0.0260	0.49	0.008	2.100	Y
08/03/1993	20.0	200	140	10	160	371	8.34	7.60	11.50	2.7686	0.018	0.001	0.3000	0.0220	0.45	0.007	2.500	Y
10/08/1993	19.0	340	260	10	280	381	8.31	7.40	9.60	3.0586	0.018	0.001	0.2600	0.0140	0.39	0.005	2.400	N
17/08/1993	20.6	460	260	10	290	387	8.42	8.30	10.00	5.9386	0.022	0.001	0.3000	0.0200	0.47	0.008	2.600	Y
24/08/1993	18.5	300	300	10	220	360	7.77	7.20	6.30	2.9986	0.008	0.001	0.2400	0.0160	0.455	0.060	2.200	N
31/08/1993	19.0	160	140	10	230	368	8.36	6.80	6.10	1.98848	0.010	0.03	0.2400	0.0200	0.485	0.008	2.100	Y
03/09/1993		13000	3300	120	15000	Wet Weather Sampling												
Count	13.0	14.0	14.0	14.0	14.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	
Average	19.2	1263	481	18	1278	325	8.285	8.569	11.43		0.024	0.004	0.346	0.026	0.490	0.014	2.838	
Minimum	15.0	90	50	10	70	4.0	7.770	6.800	6.10	0.000	0.008	0.001	0.240	0.014	0.330	0.005	2.100	
Maximum	23.0	13000	3300	120	15000	434	8.440	10.900	30.70	0.000	0.064	0.030	0.700	0.048	0.630	0.050	6.000	
Geomoan	19.1	369	235	12	254	190	8.283	8.458	10.34		0.021	0.002	0.330	0.024	0.483	0.011	2.714	

* Indication of precipitation in the last 48 hours

APPENDIX D - SEPTIC SYSTEM FAILURE RATE

RATIONALIZATION OF SEPTIC SYSTEM FAILURE RATE

The septic system failure algorithm uses a 19% failure rate and a 50% delivery rate. That is to say that in 19% of all septic systems, one half of the contaminants produced may wind up as a component of surface waters. In a number of previous Beaches Studies a 30% failure rate has been used, some of which have independently verified that rate. Following is a compilation of studies and documented septic system failure rates. The 19% rate used here was calculated by applying the 30% failure rate to certain systems as below.

From an article in the Research Journal of the Water Pollution Control Federation entitled The Next Generation of Septage Treatment page 84, Authors John M. Teal and Susan B. Peterson:

> " But even with minimal maintenance, solids accumulate in the tank and must be removed. If pumping is done regularly, **every two years or so**, solids will be removed before they clog the disposal field." (emphasis added)

And similarly, from Ministry of Environment and Energy Fact Sheet number 07-1990

> "Have septic tanks inspected every 3 or 4 years - by licensed personnel for accumulated load and overall performance"

Compare with survey data from Indian River CURB plan:

Septic system pumped:	every two years	15%
	every 5 years	25%
	when necessary	36%
	never	20%

Limited survey data from the Rice Lake study and the current study indicates similar results.

From a report entitled "Enrichment Status of Lakes in Southeastern Ontario 1991 by The Ministry of Environment and Energy, speaking from the context of properly functioning systems:

> "Although conventional Septic tank-tile field systems are extremely effective at eliminating bacteria from sewage they are not always as effective in their ability to remove phosphorus and nitrogen. Nitrogen and phosphorus in sewage effluent released from septic-tile fields can travel via groundwater to reach an adjacent lake or watercourse. Some of the tile field nutrients are absorbed by soil and removed through uptake by vegetation. The degree of removal is highly variable and depends on the type of soil, the depth of the water table, the nature of the bedrock, the amount of vegetation and the distance to the lake. In some situations, especially for

shoreline development, phosphorus and nitrogen from sewage systems reaches the lake."

From the Sewell Commission Draft Report on Planning in Ontario:

"In Ontario, there are one million conventional septic systems. There is increasing evidence of contamination of both ground and surface water as a result of their use......... problems are now becoming apparent when too many systems are located close together on relatively small lots, and used extensively for dishwashers, clothes washers, hot tubs, and other purposes that increase the volume of water and chemicals entering and leaving the system.

In 1990, the Ministry of the Environment inspected 9067 systems, of which 34 percent were found to be malfunctioning. Ministry studies in Haliburton and Muskoka found one third of the systems were designed to current standards and worked properly, one third were designed below standard and one third were classifiable as a public health nuisance."

In a 1992 study by the Toronto Branch of the Ministry of Health, Michael Brodsky (personal communication) reported:

Of 30,435 private well samples submitted to Peterborough Public Health Laboratory, 23% showed evidence of contamination from private sewage systems and 42% showed signs of fecal contamination in general.

In the Tri - Authority CURB plan Randy Brunatti reported:

“Through the TARBS Program Landowner Contact surveys it was determined that approximately 28% of existing systems in the study area are substandard and likely to be polluting surface water. "

In a study entitled "Review of Private Sewage Disposal in the Province of Ontario" prepared by Paragon Engineering Limited for the Ontario New Home warranty Program it was reported that 17% of new septic systems fail within the first 7 years. Also included in that report is a summary of septic system investigations from the Ministry of the Environment, Approvals Branch. The essence of that summary is outlined in Table F-1 below.

That report goes on to show that of the septic system beds that fail, 67% are greater than 15 years of age and lists lack of maintenance as a contributing factor in 17% of the failures. The level of maintenance shown above suggests that lack of maintenance may also be a contributing factor in the area currently under study.

TABLE F-1: SEPTIC SYSTEM INVESTIGATIONS*

YEAR	Number Of Systems Investigated	Number Of Malfunctioning Systems	Malfunctioning Systems as a Percentage
1984	5154	1417	27
1985	6648	1836	28
1986	7256	3034	42
1987	8426	2794	33
1988	9736	2725	28
1989	8462	2469	29
1990	9067	3111	34
1991	10350	3141	31
TOTAL	64749	20527	31.7

* Compiled from Provincial Reports For On Site Sewage Disposal Program listed in a report by Paragon Engineering Limited entitled Review of Private Sewage Disposal systems *in* the Province of Ontario.

Other recent Beaches Studies which have used the 30% failure rate include:

Fanshawe, Pittock and Wildwood Reservoirs - Upper Thames River Conservation Authority

Huron Beaches (used 60% failure) Ausable Bayfield Conservation Authority

Highland Creek and Coldstream Watersheds St. Clair Region Conservation Authority

Given the amount of recent development in light of the Paragon report that only 17% fail in the first 7 years, a failure rate was devised by applying the 30% rate used elsewhere to those systems greater than 15 years old. This was done by subtracting the total number of use permits granted in each of the townships over the past 15 years from the total number of households in each township and applying the 30% failure rate to the remainder. This exercise resulted as follows;

Class 4 and 6 Use Permits 1979 -1989, Hope Township	455
Total households Hope Township	1421
Therefore 68% of systems older than 15 years. 30% of 68%	20.4%
Class 4 and 6 Use Permits 1979 - 1989 concessions 1 to 6 Hamilton Township	1068
Total households Concessions 1 to 6 Hamilton Township	2647
Therefore 72% of systems older than 15 years. 30% of 72%	18%
Average septic system failure rate, Hope and Hamilton Townships	**19%**

APPENDIX E - URBAN STORMWATER CALCULATIONS

Marsalek (1985) determined an urban loading rate of 3.1×10^{10} Fecal Coliforms per hectare per year. This was applied to the two urban regions in the study area, taking into account that the model is for only 98 days. The value for the area of the urban regions was obtained from the respective municipalities.

PORT HOPE

1205 Hectares X 3.1×10^{10} X 98 / 365 = 1.00×10^{13} fecal coliforms

COBOURG

1603 Hectares X 3.1×10^{10} X 98 / 365 = 1.33×10^{13} fecal coliforms

APPENDIX F - MEASURED BACTERIAL LOADING

MEASURED BACTERIAL LOADING AT SYLVAN GLEN AND TELEVISION ROAD

SYLVAN GLEN

Total flow over 98 day modeling season 2.75×10^{7} Cu.M. (GRCA Mean 1992 and 1993)

Two year mean of 1992 and 1993 fecal coliform concentration 318.3 / 100 ml

Total bacterial load 318.3 FC/100ml x 2.75×10^{11} (100ml units) = 8.75×10^{13} Fecal Coliforms

BALTIMORE CREEK AT TELEVISION ROAD

Total flow over 98 day modeling season 5.23×10^{6} Cu. M. (GRCA Mean 1992 and 1993)

Two year mean of 1992 and 1993 fecal coliform concentration 1046 / 100 ml

Total bacterial load 1046 FC/100ml x 5.23×10^{10} (100ml units) = 5.47×10^{13} Fecal Coliforms