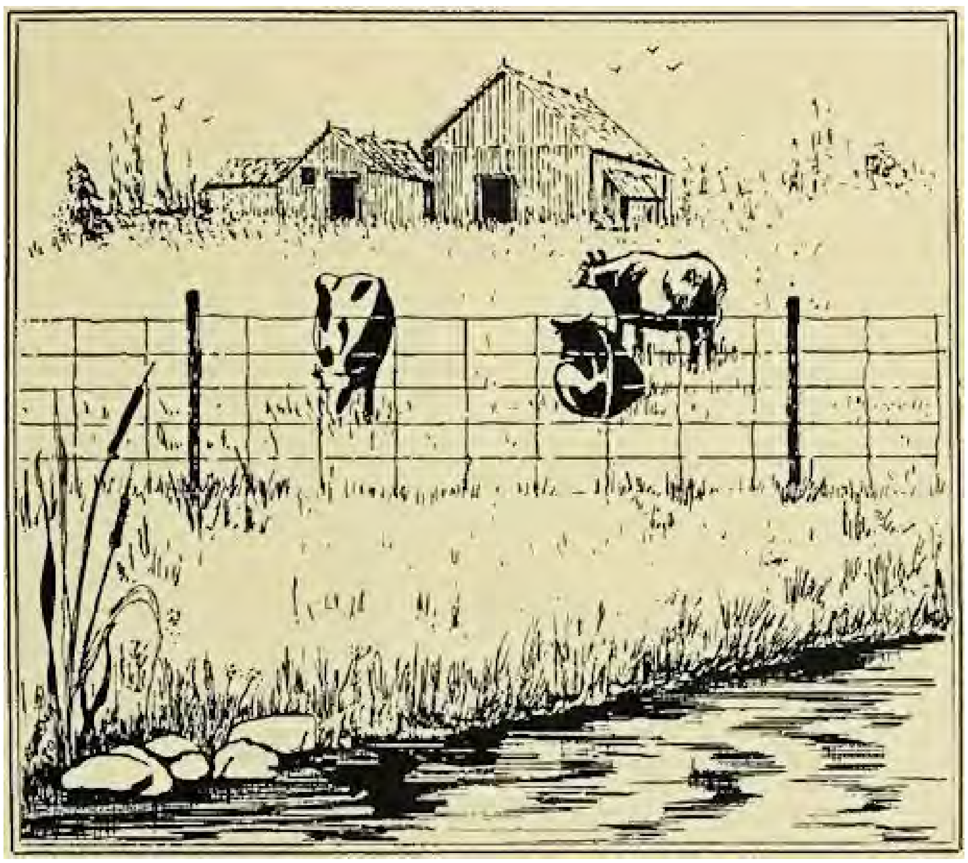
CLEAN UP RURAL BEACHES (CURB) PLAN

FOR THE UPPER NITH, UPPER SPEED AND UPPER CONESTOGO WATERSHEDS



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DISCLAIMER

FOREWORD

This report is one of a series produced under the Provincial Rural Beaches Program. The objective of the Program is to identify the relative impact of pollution sources, and develop a course of action leading to the restoration and long term maintenance of acceptable water quality at provincial rural beaches.

Significant enrichment and bacterial contamination in southern Ontario rivers and lakes originates from rural sources. The discharge of waste material to streams can result in elevated bacterial concentrations, nuisance algae blooms, fish kills, and present a potential health hazard to humans and livestock using the water. Watershed studies have found that a multitude of pollution sources and pathways may affect beaches in Ontario. These include:

1) Urban sanitary and stormwater runoff,
2) Direct livestock manure access to watercourses,
3) Inadequate manure management practices,
4) Direct discharge of milkhouse wastes,
5) Contaminated field tile systems, and
6) Faulty septic systems

The impact upon beaches of any of these sources, either singly or in combination, can range from a few days of elevated concentrations to complete seasonal closures.

Numerous beach closings in 1983 and 1984, drew public and government attention to the severity of this water quality problem. In 1985, the Ontario Ministry of the Environment's (MOE) Water Resources Branch formulated the Provincial Rural Beaches Strategy Program. Directed by the Provincial Rural Beaches Planning and Advisory Committee, it includes representatives from MOE, Ministry of Agriculture and Food (OMAF), and Ministry of Natural Resources (MNR).

With financial and technical assistance from the MOE, local Conservation Authorities carry out studies under the direction of a local technical steering committee. Chaired by an MOE regional staff, the committees typically include representation from OMAF, MNR, the Medical Officer of Health, Conservation Authority, the local Federation of Agriculture, and a local farmer. The chairs of the local committees assure communication between all the projects by participating on the Provincial Committee.
The primary objective of each local study is to identify the relative impact of pollution

sources, their pathways to beaches, and to develop a Clean Up Rural Beaches (CURB) plan specific to the watershed upstream of each beach. The CURB plan develops remedial strategy options and respective cost estimates for each beach through:

1) Field inspections,
2) Farmer consultations,
3) Water quality monitoring, and
4) Basic mathematical modelling techniques.

Recommended actions will include both measures for specific beaches and broader scale Provincial measures based on cumulative results of component studies.

The following related research projects were also MOE funded and undertaken by various Conservation Authorities to improve our understanding of bacterial and nutrient dynamics:

1) *In-situ* bacterial survival studies determine longevity: in watercourses, offshore of beaches, in sediments, and in milkhouse washwater tiles.
2) Biotracer studies determine the speed and nature of travel for bacteria introduced into a watercourse.
3) A liquid manure spreading study examines bacterial movement through the soil column and exiting field tile drains.
4) A target sub-basin study evaluates the effectiveness of a watershed with comprehensive remedial measures.

Numerous demonstration farms have been established with the cooperation of local farmers to display innovative management practices. Research continues on their effectiveness at improving water quality.

Comments and/or questions on this report are welcome. Please send written comments to:

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THE GRAND RIVER RURAL BEACHES STUDY
CLEAN UP RURAL BEACHES
(CURB)
PLAN

August, 1989

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Prepared for: Ontario Ministry of the Environment

Executive Summary

The purpose of the Clean Up Rural Beaches (CURB) Report is to provide alternative strategies to address water quality degradation resulting from livestock farms in the Upper Nith, Upper Speed and Upper Conestogo River Watersheds. There are basically 3 approaches to the problem; deal with the sources, deal with the symptoms, or do nothing.

The do nothing approach has a variety of costs associated with it due to the likelihood of continued water quality degradation. Continued beach closures will result in lower attendance and gate receipts at the conservation areas. Water treatment costs for industrial and domestic use will increase water quality decreases. Contaminated water consumption by livestock results in increased veterinary costs and decreased production. The do nothing approach also affects the recreational potential of the river by reducing the fisheries potential.

Treatment of the symptoms refer to strategies focused on maintaining swimming opportunities. The benefits of these measures are limited to the beach and do not translate into other water quality benefits downstream.

The strategies that address the sources of contamination provide a variety of benefits by improving the water quality of the watershed, although they are costly.

The costs of implementing 100% control measures on all high priority farms range from $2.2 million to $7.6 million in the Upper Conestogo, from $3.5 million to $12.8 million in the Upper Nith and from $0.5 million to $1.7 million in the Upper Speed. The cost of control depends on the type of manure storage system that is considered. Manure storages account for at least 80% of the cost of control. Control of milkhouse wastes and livestock access to watercourses is much less expensive.

Unfortunately control of only one source of pollution in a watershed will not necessarily cleanse a watercourse if the other sources are left unchecked. Agricultural water pollution is a complex issue influenced by the impact of individual farms and the farming practices of individual farmers.

There is an urgent need for an agricultural water quality program that recognizes the complexities of agricultural pollution and the importance of the farmer as the basic unit of change in the countryside. Since water quality impacts on a number of different agencies a co-operative effort is required from OMAF, OME, MNR and MOH. The program must offer educational, technical and financial assistance to the farming community. In order to get the largest return on capital spent, the financial assistance should be targeted to source areas on farmers that are contributing the most to water pollution.

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Acknowledgments

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The author would like to thank the members of the GRCA Rural Beaches Steering Committee for their support, guidance and editorial reviews. The membership consisted of:

1.	Stan Irwin	MOE
2.	Keith Willson	MOE
3.	Mike Young	MOE
4.	Archie McLarty	MOE
5.	Ron MacDonald	OMAF
6.	Jim Myslik	OMAF
7.	Lisa Summers	OMAF
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9.	Pete Mason	GRCA
10.	Tony Smith	GRCA
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1. INTRODUCTION

The Clean Up Rural Beaches plan (CURB) is the culmination of three years of study by GRCA Rural Beaches Program. From 1986-1989 the GRCA Rural Beaches Program investigated the causes of rural water quality degradation in the watersheds of the Upper Nith, Speed and Conestogo Rivers. The Program specifically focused on improving the recreational water quality at beaches associated with these watersheds by dealing with pollution from livestock manure and wastes. The main sources of pollution in these areas is runoff from inadequate manure storages and barnyards, improper disposal of milkhouse wastes, livestock access to watercourses and improper field application of manures.

Within each of the watersheds, the farms which exhibit potential to pollute have been assigned a high or low pollution potential rating. The purpose of the CURB plan is to outline the alternative remedial measures and their costs and provide a framework to facilitate the control of pollution from these sources. In order to do this the CURB outlines seven strategies developed to provide a range of options for dealing with water quality degradation at the beaches. The strategies range from the 'do nothing' approach to implementation of remedial measures to control 100% of the pollution on all farms in the watershed with a potential to pollute.

2. OBJECTIVES

The objectives of the CURB plan are defined by the general outline of expectations for the Rural Beaches Programs. The objectives of the GRCA CURB plan are as follows:

1. To define a range of remedial measures that could be environmentally and socially acceptable to achieve the necessary levels of control over the identified sources of pollution in order to protect and improve recreational water quality at the specified beaches.

2. To provide a schedule of costs which will enable the province to make optimum allocation of capital funds for assisting the agricultural community in upgrading control of pollution from livestock manure and wastes.

3. Identify the agencies responsible for implementing and administering the remedial measures.

4. To identify a process to implement remedial measures.

5. To develop a surveillance and monitoring program to determine water quality trends.

3. The Implementation Strategies

The implementation strategies represent six alternative plans to address the problem of degraded water quality at the beaches. The various strategies provide a range of remedial options and the costs of implementing them in each of the watersheds. The six strategies are as follows:

1. Implement remedial measures to control 100% of the pollution from livestock manure and wastes on the high priority farms that have the greatest potential to impact on the beach.

2. Implement remedial measures to control 100% of the pollution from livestock manure and wastes on both the high and low priority farms that have the greatest potential to impact on the beach.

3. Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all high priority farms in the watershed.

4. Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all high and low priority farms in the watershed.

5. Do nothing.

6. Manipulate the beaches and reservoir in order to enhance swimming opportunities.

The first four strategies outline the costs of implementing remedial measures on targeted farms in the watershed. Targeting farms based on their pollution potential rating ensures that the maximum amount of pollution control is achieved for the dollars spent. The rational behind targeting high potential farms is to control pollution from the farms which are most likely to impact watercourses during most conditions, even periods of low flow. High priority farms are generally larger and therefore control is more cost-effective. The low priority farms, on the other hand, generally have fewer animal units and only impact watercourses during periods of high rainfall and runoff. Therefore the strategies that target both high and low potential farms are aimed at controlling pollution during extreme conditions.

Adequate manure storage, proper disposal of milkhouse wastes and restricted livestock access to watercourses are structural remedial measures capable of providing 100% control of pollution from livestock operations.

The costs of four different manure storages are provided in the strategies in order to account for farmer choice, site conditions and planning considerations. The systems are earthen lagoons, solid with runoff pond, concrete liquid tank and a concrete liquid tank with a reinforced lid.

The farm surveys and questionnaires completed during the course of the study provided information for the calculation of animal units, livestock access sites and improper milkhouse waste disposals. The average number of animal units on a small medium and large farms are 13, 62 and 166 respectively. The farm questionnaires revealed that 85% of all dairy farms surveyed required proper disposal of milkhouse wastes. In each strategy 85% of the targeted dairy farms are assumed to require milkhouse waste storage. Since more than 85% of the dairy farms targeted required manure storages the cost of milkhouse waste storage is provided as an additional cost to a new manure storage.

The length of fencing required for restricting livestock access to watercourses was determined from 1:8,000 scale aerial photographs. Length of fence, number or need for a culvert and need for an alternate water source are based on the interpreters discretion. If the watercourse is close to fence line or had very little pasture on the other side only 1 side of the stream requires fencing. If the pasture is next to the barn it is assumed that water is available at the barn and that no alternative watering device is necessary.

Based on the findings of the Conestogo Lake Cottagers Survey (Wellington et al, 1987), the farm inventories and the drain walking surveys, malfunctioning septic systems do not appear to be a significant source of contamination in the study basins. Septic systems are listed as a remedial measure since contamination of field tiles and watercourses has been observed. These cases have been addressed in the plan.

The costs provided in the strategy should be used as a guideline. The implementation of remedial measures on a farm to farm basis will be affected by the individual farmer's decision making process. The costs strictly refer to remedial measures and not to the costs of program delivery.

Aside from on farm remedial measures the strategies also deal with alternative measures to enhance swimming opportunities at the beach such as chlorination.

3.1 The Upper Conestogo River Watershed

In the Upper Conestogo River watershed, 169 livestock farms have been identified as having a high potential to pollute watercourses. An additional 160 livestock farms were identified as having a low potential to pollute watercourses.

Overall water quality in the watershed has been less than acceptable during the three years that the Rural Beaches Study has been monitoring. None of the 11 stream stations have had fecal coliform densities consistently below the OME objective for recreation. During 1988 the geometric mean density of fecal coliforms for the watershed was 291/100 mL.

Since 1980 the beach at Lake Conestogo has been posted 3 times (Table 1). Approximately 32 bather days have been lost due to fecal contamination. Loss of bathers due to algae blooms may also be occurring but has not been recorded. In 1981 and 1988 the beach was posted in mid-season. During these years the area recorded the lowest attendance in the past decade. In 1981 the beach was reopened but attendance never recovered. In 1983 the beach was posted at the end of the summer, August 26, and therefore did not affect attendance. Lost revenue at the Conservation Areas is one of the costs of beach postings. Attendance was approximately 6,500 below average in 1988. At $2.25 per person, approximately $15,000 was lost in gate receipts. The camping attendance was 3,000 below average which translates into a loss of $9,000 ($6.00 per tent, two people per tent).

Decreasing water quality also impacts on the cottagers. Algae blooms and degraded water quality affects the aesthetics of the lake. Many cottagers have made sizeable investments in order to have the enjoyment of a lakeside retreat.

Table 1: GRCA Beach Closures: Guelph Lake and Conestogo Lake

Year	Conestogo	Guelph Lake	Guelph Pit
75	-	-	-
76	-	-	-
77	-	-	-
78	-	-	-
79	-	-	-
80	-	-	-
81	-	-	-
82	-	-	-
83	Aug. 26	July 26	Aug. 22
84	-	-	-
85	-	-	-
86	-	-	-
87	-	-	-
88	Aug. 19	Aug. 12	-

Algae blooms and beach postings reduce the enjoyment of their investment. Reduced recreational opportunities at the Lake may also negatively affect area businesses that cater to the campers and cottagers.

In terms of biological integrity and fisheries potential the Upper Conestogo River has been severely impacted by agricultural land use. Although, Spring Creek has the potential to be rehabilitated as a trout fishery.

Improving overall water quality of the Upper Conestogo River and its tributaries has many benefits that can accrue to the watershed residents and society in general. Reducing inputs from livestock production will improve the aesthetics of the River which is a benefit to all. It will also improve the downstream quality of the water which is a benefit for the downstream users, especially for the domestic use of Kitchener-Waterloo. Reducing pollution especially sedimentation could significantly reduce treatment costs of water for domestic use. Improved water quality also translates into improved herd health, increased production and reduced veterinary costs on livestock farms.

Reducing manure inputs and restricting cattle access to watercourses decreases the risk of transmitting waterborne diseases such as anthrax, leptospirosis, salmonellosis and brucellosis, between herds. The proliferation of antibiotics to treat diseases has resulted in the spread of antibiotic resistant bacteria to downstream herds. This makes illnesses expensive and difficult to treat. Since most of these diseases can be transmitted to humans via livestock the risk to human health is also reduced if water quality is improved. Poor water quality can also reduce livestock production by reducing water intake. In dairy herds bacterially contaminated water may be a source of mastitis.

Estimating the costs of poor water quality beyond the beach is very difficult. Intangibles such as reduced risk and improved aesthetics are difficult to put a price tag on. The costs of improvement though can be estimated and the following strategies outline a range of options and their costs.

Strategy #1

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on high priority farms that have the greatest impact on the beaches.

Of the 169 high priority farms in the watershed 46 were determined to be able to exert the most influence on the beach. Figure 1 illustrates the location of the 46 high priority farms. Based on results from the water quality monitoring, it appears that during the swimming season the reservoir is influenced primarily by low flow inputs that originate in the vicinity of the reservoir.

The 46 farms consist of approximately 3445 animal units. Forty-five of the farms require control of runoff from manure storage areas and 26 dairy farms require proper storage of milkhouse wastes. There are 14 pastures that require a total of 76,800 m of fencing to restrict livestock access to streams. Seven of the sites require culvert crossings in order to remain viable pastures and 7 require alternate watering devices.

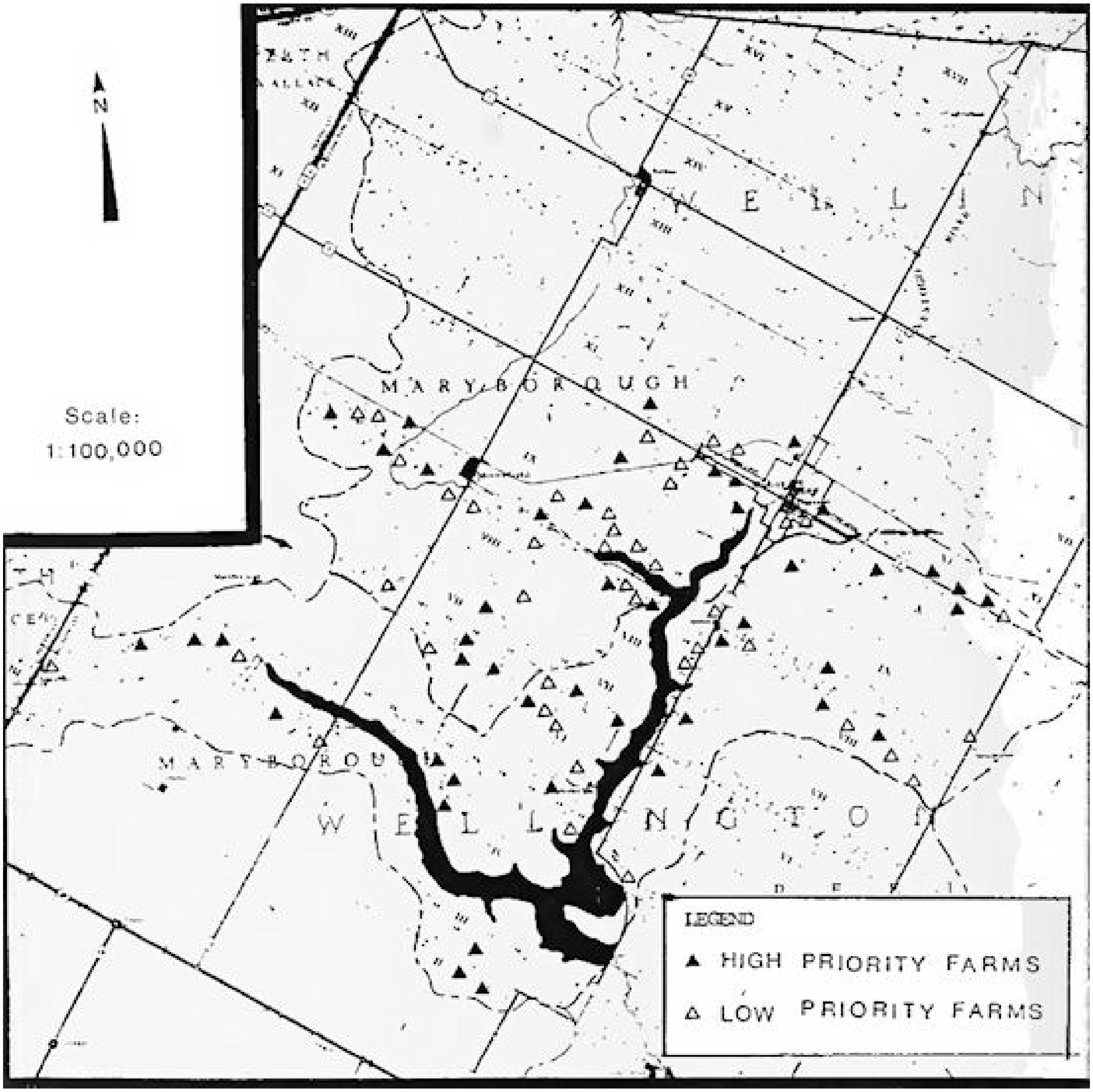

Figure 1: Upper Conestogo River Watershed Curb Plan Targeting - Strategy # 1 and # 2

Remedial Measure Costs of Strategy #1

46 high priority farms
3445 animal units
45 manure storages
26 milkhouse waste storages
14 access sites
- 7875 m of fence
- 7 culvert crossings
- 7 alternate watering devices

manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon
45 x $11,000 = $ 495,000
26 x $ 1,000 = $26,000 (additional expense for milkhouse wastes)
total = $ 521,000

Option #2: Solid storage with Runoff Pond
45 x $18,000 = $ 810,000
26 x $ 1,000 = $26,000
total = $ 836,000

Option #3: Concrete liquid manure storage
45 x $23,000 = $1,035,000
26 x $ 2,000 = $52,000
total = $1,087,000

Option #4: Concrete Liquid Manure Storage with a Reinforced Lid
45 x $46,000 = $2,070,000
26 x $ 2,000 = $52,000
total = $2,122,000

Watercourse Fencing

Fencing
7875 m x $5.75 = $45,281.25

Stream Crossings (culverts)
7 x $2,000 = $14,000.00

Alternate Watering Devices
7 x $1,500 = $10,500.00

Total cost of Restricting Access = $69,781.00
$ 5,000/site

Cost of Remedial Measures for Implementing Strategy #1 in the Upper Conestogo River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 590,800	$ 12,800	$ 172.00
Option #2	$ 931,800	$ 20,300	$ 270.00
Option #3	$1,156,800	$ 25,100	$ 336.00
Option #4	$2,191,800	$ 47,600	$ 636.00

Strategy #2

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on both the high and low priority farms that have the greatest impact on the beach.

In addition to the 46 high potential farms addressed by strategy #1 there are 42 low priority farms in the same vicinity that have the potential to impact on water quality during periods of high runoff. Figure 1 illustrates the location of these livestock operations. The treatment of the problems on low priority farms is the same as for high priority farms. Of the 42 low priority farms that have the greatest potential to impact on the beach, 37 require adequate manure storages to control runoff and 13 dairy farms require adequate storage facilities for milkhouse wastes. There are 5 low priority access sites that require 2825 m of fencing, 2 culverts and 3 alternative watering devices. The 42 farms represent approximately 3099 animal units in addition to those on high priority farms. The following breakdown of costs are for both high and low priority farms impacting the Lake Conestogo Beach.

<u>Remedial Measure Costs of Strategy #2</u>

88 low and high potential farms
6544 animal units
82 manure storages
39 milkhouse waste storages
19 access sites
- 10700 m of fence
- 9 culvert crossings
- 10 alternate watering devices

<u>Manure and Milkhouse Waste Storage</u>

Option #1: Earthen Lagoon

	82 x $11,000	= $ 902,000
	39 x $ 1,000	= $39,000 (additional expense of milkhouse wastes)
	total	= $ 941,000

Option #2:	Solid storage with runoff pond	
	82 x $18,000	= $1,476,000
	39 x $ 1,000	= $39,000
	total	= $1,515,000

Option #3:	Concrete liquid manure storage	
	82 x $23,000	= $1,886,000
	39 x $ 2,000	= $78,000
	total	= $1,964,000

Option #4:	Concrete Liquid Manure Storage with Reinforced Lid	
	82 x $46,000	= $3,772,000
	39 x $ 2,000	= $78,000
	total	= $3,850,000

Watercourse Fencing

Fencing
10,700 m x 5.75 = $61,525
Stream Crossings (Culverts)
9 x 2,000 = $ 4,000
Alternate Watering Devices
10 x $1,500 = $15,000

Total cost of Restricting Access = $94,525
$ 5,000/site

Cost of Remedial Measures for Implementing Strategy #2 in the Upper Conestoga Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$1,035,500	$ 11,800	$ 158.00
Option #2	$1,609,500	$ 18,300	$ 246.00
Option #3	$2,058,500	$ 23,400	$ 315.00
Option #4	$3,944,500	$ 44,800	$ 603.00

Strategy #3

Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all high priority farms in the Upper Conestogo River Watershed.

The purpose of this strategy is to improve the overall water quality in the watershed by controlling inputs from the major sources of livestock manure and waste pollution. There are 169 high priority farms in the watershed, representing approximately 10,839 animal units. Within the watershed 155 farms were identified as requiring manure storages to control runoff. Sixty-three of the farms require proper storage of milkhouse wastes. There are 63 sites that require approximately 41,440 m of fencing to restrict livestock access to watercourses. These sites also require 40 culvert crossings and 45 alternate watering devices in order to remain viable pastures.

Remedial Measure Costs of Strategy #3

169	high priority farms
10,839	animal units
155	manure storages
63	milkhouse waste storages
74	access sites
	41440 m of fence
	40 culvert crossings
	45 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1:	Earthen Storage		
	155 x $11,000	= $1,705,000	
	63 x $ 1,000	= $ 63,000	(additional expense of milkhouse wastes)
	total	= $1,768,000	
Option #2:	Solid Storage with Runoff Pond		
	155 x $18,000	= $2,790,000	
	63 x $ 1,000	= $ 63,000	
	total	= $2,853,000	
Option 43:	Concrete Liquid Manure Storage		
	155 x $23,000	= $3,565,000	
	63 x $ 2,000	= $ 126,000	
	total	= $3,691,000	

Option #4: Concrete Liquid Manure Storage with a Reinforced Lid

	155 x $46,000	= $7,130,000
	63 x $ 2,000	= $ 126,000
	total	= $7,256,000

Watercourse Fencing
Fencing
41440 x $5.75 = $238,280
Stream Crossing
40 x $2,000 = $ 80,000
Alternate Water Device
45 x $1,500 = $675,000

Total Cost of Restricting Access = $385,780
$5,200/site

Cost of Remedial Measures for Implementing Strategy #3 in the Upper Conestogo River Watersheds

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$2,153,800	$ 12,700	$ 199.00
Option #2	$3,238,800	$ 19,200	$ 299.00
Option #3	$4,076,800	$ 24,100	$ 376.00
Option #4	$7,641,800	$ 45,200	$ 705.00

Strategy #4

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all high and low priority farms in the Upper Conestogo River Watershed.

Strategy #4 addresses all identified sources of pollution from livestock manure and wastes in order to improve the overall water quality of the watershed. There are 329 high and low priority farms in the watershed. They represent approximately 18,397 animal units.

<u>Remedial Measure Costs of Strategy #4</u>

329	low and high priority farms
18,397	animal units 290 manure storages
104	milkhouse waste storages
96	access sites

53,740 m of fence
52 culvert crossings
58 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1:	Earthen Lagoon		
	290 x $11,000	= $3,190,000	
	104 x $ 1,000	= $ 104,000	(additional expense for milkhouse waste storage)
	total	= $3,294,000	
Option #2:	Solid storage with Runoff Pond		
	290 x $18,000	= $5,220,000	
	104 x $ 1,000	= $ 104,000	
	total	= $5,324,000	
Option #3:	Concrete Liquid Manure Storage		
	290 x $23,000	= $6,670,000	
	104 x $ 2,000	= $ 208,000	
	total	= $6,878,000	
Option #4:	Concrete Liquid Manure Storage with Reinforced Lid		
	290 x $43,000	= $12,470,000	
	104 x $ 2,000	= $ 208,000	
	total	= $12,678,000	

Watercourse Fencing
Fencing
    53,740 m x $5.75 = $309,005
Stream Crossings (Culverts)
    52 x $2,000 = $104,000
Alternate Watering Devices
    58 x $1,500 = $ 87,000

Total Cost of Restricting Access = $500,005
$ 5,200/site

Cost of Remedial Measures from Strategy 4 in the Upper Conestogo River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 3,794,000	$ 11,600	$ 206.00
Option #2	$ 5,824,000	$ 17,700	$ 317.00
Option #3	$ 7,378,000	$ 22,400	$ 401.00
Option #4	$13,178,000	$ 40,000	$ 716.00

Strategy #5

Do Nothing

The do nothing strategy is a status quo approach to water quality degradation in Lake Conestogo. This strategy does not propose the implementation of any remedial measures beyond those that farmers may voluntarily choose to install themselves, although there are no costs associated with implementation there are a number of costs related to this strategy.

With the do nothing strategy the risk of beach postings will likely escalate resulting in lower attendance and gate receipts at the Lake Conestogo Conservation Area. More frequent beach postings and algae blooms will also affect the cottagers and may result in lower usage. Reduced visitation to the area could seriously affect a number of businesses in the area such as firewood dealers and vegetable growers that cater to the cottagers.

In general the 'do nothing' approach will in all likelihood aggravate the water quality problems that presently exist in the Upper Conestogo River watershed. The costs of health risks, poor aesthetics and degraded biological integrity will impact watershed residents and downstream users.

Strategy #6

Manipulate the beaches in order to enhance swimming opportunities.

Strategy #6 is the 'band-aid' approach to improving the swimming opportunities at Lake Conestogo. This approach does not treat the causes but deals with the symptoms at the beach. The following options may be utilized to decrease or eliminate the potential of beach postings.

1. Beach Maintenance

Shallow shoreline areas are often heavily contaminated by fecal conforms due to contamination by waterfowl and swimmers and lack of circulation (OME, 1984). Fecal coliforms also appear to thrive in the fine sediments found at the shoreline (Hubbard *et al*, 1987).

A daily program of beach maintenance may help to reduce fecal coliforms at the shoreline. Raking and removing all litter, algae and bird droppings from the beach will reduce contamination from these sources. Harrowing the beach sand helps to dry the sand and sediment desiccating bacteria and exposing it to sunlight which is a natural bactericide. Applications of fresh clean sand will also reduce the potential for contamination from the beach sediment.

Beach maintenance has very little cost associated with it since it can be incorporated into the daily maintenance regime of the park staff. Over the course of the summer the cost of sand would be negligible as 17 tonnes (1 truckload) costs about $150.

2. Beach Location and Formation

Due to a number of factors such as currents and location of inputs there may be shoreline areas which are less prone to fecal contamination. Further investigation and sampling would determine if a better beach location exists in the Conservation Area.

The slope of the beach and composition of beach material may also be factors affecting the occurrence of postings. The beach is composed of sand over silt and has a very shallow grade into the water. As the reservoir is drawn down in the summer the silty bottom material is exposed and forms the beach.

Since shallow areas appear to have higher concentrations of fecal coliforms than deeper waters, shallow areas should be kept to a minimum. Regrading the beach to a steeper grade and maintaining water levels may also help. In order to make the substrate less habitable to bacteria the silt should be replaced with gravel and overlaid with sand.

Renovation of the beach at the Lake Conestogo Conservation Area would cost approximately $15,000. This would require removing the present silt substrate and regarding the slope to a 1 to 3 slope. The beach and bathing area covers approximately 2200 square feet. This would require approximately 1000 yards of sand and gravel.

3. Beach Chlorination

Installation of a chlorination system and swimming curtain would ensure that the beach remains open all season. The system has been used by Metropolitan Toronto and Region Conservation Authority and the Hamilton Region Conservation Authority at a few of their heavy use beaches that had frequent postings.

The system provides a semi-natural swimming environment by curtaining off the swimming area and chlorinating the water in the enclosed space. The beach and substrate remain untouched. The curtain must be installed in the spring and removed in the fall. The main drawback is that water inside the curtain has a muddy appearance since sediment disturbed by swimming remains trapped in the area.

Based on figures provided by MTRCA (pers comm.) the chlorination system, curtain and initial installed cost approximately $75,000. Yearly operation and maintenance of the system is about $15,000.

3.2 The Upper Nith River Watershed

There are 286 high priority farms and 200 low priority farms identified in the Upper Nith River watershed as having the potential to pollute watercourses. The overall water quality of the Upper With River is poor. During 1988 the geometric mean density of fecal coliforms at the 4 stations was 665/100 mL.

Although there is no beach in New Hamburg, the pond once provided a great deal of water based recreation opportunities. Due to poor water quality, weed growth and algae blooms the riverfront is presently underutilized. The Town of New Hamburg is currently seeking to revitalize the river front.

The revitalization proposal includes reconstruction of the dam, installation of a fish ladder, dredging the pond, landscaping the riverbanks and installing a 60 foot waterwheel. The main purpose of this revitalization project is to attract tourism to stimulate the economy of New Hamburg.

Improving the water quality in the New Hamburg Pond would be extremely beneficial to the waterfront development proposal.

Improving the water quality of the Upper With River and its tributaries would be beneficial to a number of user groups. As with the Upper Conestogo River improved water quality would benefit livestock producers by reducing the transmission of waterborne diseases. The downstream users and society in general would benefit from cleaner water and a better environment.

Improvements in the Upper Nith would also enhance warm water/cool water fisheries potential. A walleye and small mouth bass fishery already exists above New Hamburg but improvements to water quality and the riparian environment could dramatically enhance this resource. The installation of a fishway in the dam at New Hamburg by MNR will enable walleye to migrate to the northern tributaries of the Nith such as Smith Creek where suitable spawning and rearing habitat exist. The potential exists for the development of important doorstep angling opportunities in the Upper Nith River.

The following strategies will outline the alternatives and their costs associated with improving water quality in the Upper Nith River watershed.

Strategy #1

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on high priority farms that have the greatest impact on the pond in New Hamburg.

Of the 286 high pollution potential farms in the Upper Nith River Watershed 37 of them may exert the greatest impact on the pond. Based on the water quality data the farms closest to the impoundment may provide a majority of the pollution inputs. The locations of the farms are shown on Figure 2.

Implementing remedial measures on the farms will control the pollution from approximately 2,808 animal units. The remedial measures required include 33 manure storages, 12 milkhouse waste storage facilities and restricted livestock access at 5 sites.

Remedial Measure Costs of Strategy #1

37 high potential farms
2808 animal units
33 manure storages
12 milkhouse waste storages
5 access sites
- 2800 m of fence
- 3 culvert crossings
- 2 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon

33 x $11,000	= $ 363,000	
12 x $ 1,000	= $ 12,000	(additional expense for milkhouse waste storage)
total	= $ 375,000	

Option #2: Solid storage with Runoff Pond

33 x $18,000	= $ 594,000
12 x $ 1,000	= $ 12,000
total	= $ 606,000

Option #3: Concrete liquid manure storage

33 x $23,000	= $ 759,000
12 x $ 2,000	= $ 24,000
total	= $ 783,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid

33 x $46,000	= $1,518,000
12 x $ 2,000	= $ 24,000
total	= $1,542,000

Watercourse Fencing

Fencing

2800 m x $5.75 = $16,100

Stream Crossings (Culverts)

3 x $2,000 = $ 6,000

Alternate Water Devices

2 x $1,500 = $ 3,000

Total Cost of Restricting Access = $25,100

$ 5,000/site

Cost of Remedial Measures for Implementing Strategy #1 in the Upper Nith Riv Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$400,000	$ 10,800	$ 142.00
Option #2	$631,000	$ 17,000	$ 225.00
Option #3	$808,000	$ 21,800	$ 288.00
Option #4	$1,567,000	$ 42,400	$ 558.00

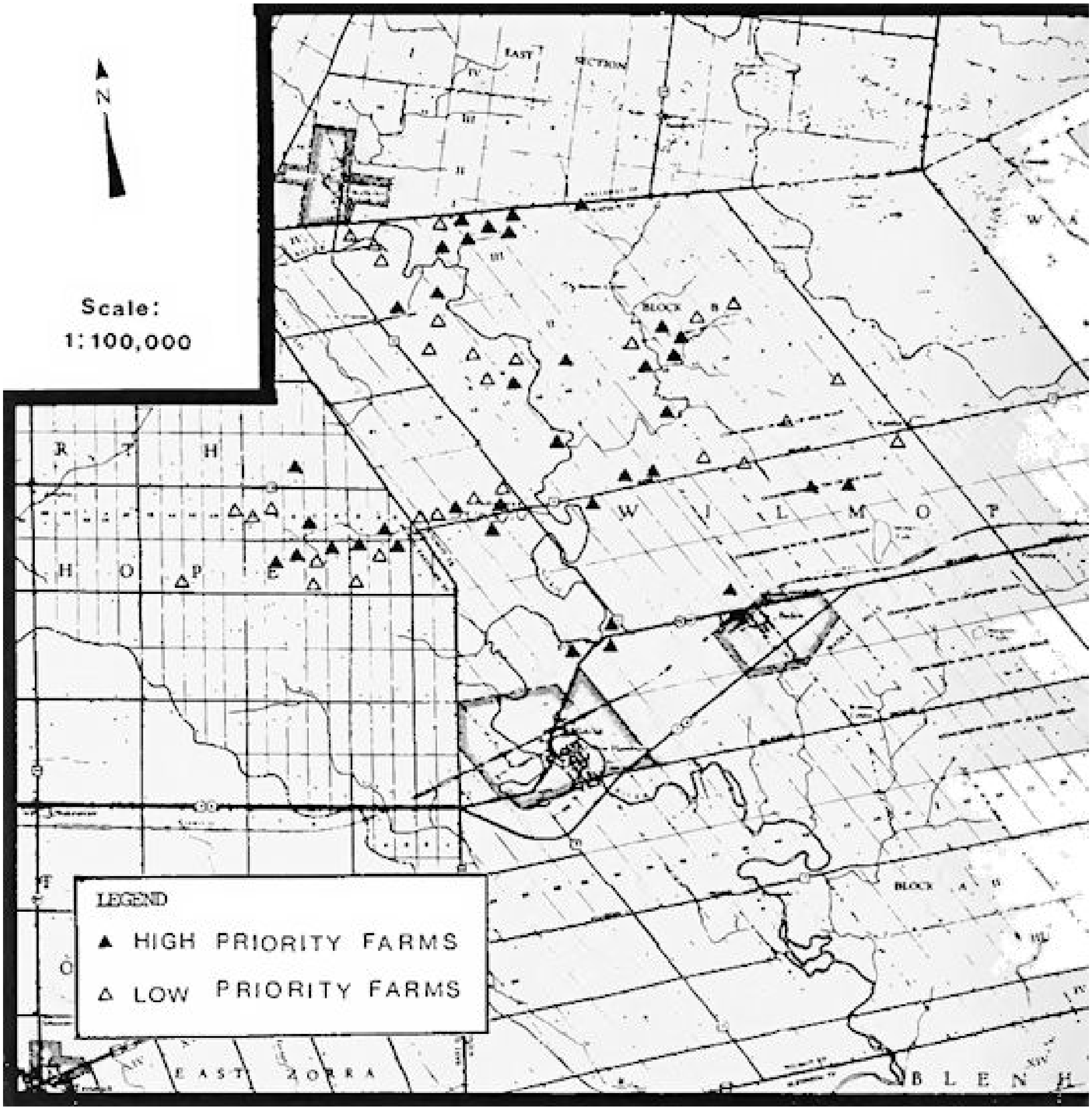

Figure 2: Upper Nith River Watershed Curb Plan Targeting - Strategy # 1 and # 2

Strategy #2

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on both the high and low priority farms that have the greatest impact on the pond in New Hamburg.

In the same vicinity as the high priority farms addressed in strategy #1 are an additional 29 low potential livestock farms. These farms represent 1577 animal units in addition to the 2808 animal units on the high potential farms. In total there are 60 farms which require proper manure storage facilities to control manure runoff, 20 of the farms also need proper storage for milkhouse wastes. There are a total of 7 access sites which require approximately 4100 m of fencing to restrict livestock from watercourses.

<u>Remedial Measure Costs of Strategy #2</u>

66 Low and high potential farms
4385 animal units
60 manure storages
20 milkhouse wastes storages 7 access sites
4100 m of fence
3 culvert crossings
4 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon

60 x $11,000	= $ 660,000	
20 x $ 1,000	= $ 20,000	(additional expense of storing milkhouse wastes)
total	= $ 680,000	

Option #2: Solid storage with Runoff Pond

60 x $18,000	= $1,080,000
20 x $ 1,000	= $ 20,000
total	= $1,100,000

Option #3: Concrete liquid manure storage

	60 x $23,000	= $1,380,000
	20 x $ 2,000	= $ 40,000
	total	= $1,420,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid

	60 x $46,000	= $2,760,000
	20 x $ 2,000	= $ 40,000
	total	= $2,800,000

Watercourse Fencing

Fencing

4100 m x 5.75 = $23,575

Stream Crossings

2 x 2,000 = $ 4,000

Alternate watering devices

2 x $1,500 = $ 3,000

Total Cost of Restricting Access= $35,575
$4,800/site

Cost of Remedial Measures for Implementing Strategy #2 in the Upper With River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 713,600	$ 10,800	$ 163.00
Option #2	$1,133,600	$ 17,200	$ 259.00
Option #3	$1,453,600	$ 22,000	$ 331.00
Option #4	$2,833,600	$ 42,900	$ 646.00

Strategy #3

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all the high priority farms in the Upper Nith River Watershed.

Control of pollution originating from all the high potential farms in the watershed will improve the overall quality of water in the watershed. There are 286 high priority farms in the watershed. Of these farms 261 require control of manure runoff, 134 of these require control of milkhouse wastes. In the watershed 31 contaminated tile outlets were identified on high priority farms. Of these 10 were identified as being contaminated by septic tank wastes. The remaining 21 tiles appear to be contaminated with milkhouse wash water. Thirteen of these tiles are located on farms that require control of manure runoff and therefore storage of milkhouse wastes is incorporated into the manure storage facility. The remaining 8 farms require separate facilities for milkhouse waste treatment. Within the watershed there are 84 access sites that require approximately 50,400 m of fencing to restrict livestock to the watercourse.

Remedial Measure Costs of Strategy #3

286	high priority farms
20,503	animal units
261	manure storages
133	milkhouse waste storages 31 contaminated tiles
	10 septic systems
	8 milkhouse waste treatment systems
84	access sites
	50,400 m of fence
	45 culvert crossings
	50 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1: Earthen Storage

261 x $11,000	= $2,871,000		
134 x $ 1,000	= $ 134,000	(additional expense for storage of
total	= $3,005,000	milkhouse wastes)

Option #2: Solid Storage with Runoff Pond
261 x $18,000 = $4,698,000
134 x $ 1,000 = $ 134,000
total = $4,832,000

Option #3: Concrete Liquid Manure Storage
261 x $23,000 = $6,003,000
134 x $ 2,000 = $ 268,000
total = $6,271,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid
261 x $46,000 = $12,006,000
134 x $ 2,000 = $ 268,000
total = $12,274,000

Watercourse Fencing
Fencing
50,400 x $5.75 = $289,800
Stream Crossing
45 x $2,000= $ 90,000
Alternate Water Device
50 x $1,500= $ 75,000
total= $454,800
$ 5,400/site

Septic Systems
10 x $3,000= $ 30,000
Milkhouse Waste Treatment Facility
8 x $3,500= $ 28,000

Cost of Remedial Measures for Implementing Strategy #3 in the Upper Nith River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$3,518,000	$ 12,300	$ 172.00
Option #2	$5,345,000	$ 18,700	$ 261.00
Option #3	$6,784,000	$ 23,700	$ 331.00
Option #4	$12,787,000	$ 44,700	$ 624.00

Strategy #4

> Implement remedial measures to control 100% of the pollution from livestock and manure wastes on all the high and low priority farms in the Upper Nith River Watershed.

In order to improve the overall water quality of the watershed during periods of high runoff the pollution from low potential farms as well as high potential farms, should be controlled. Strategy #4 address the control of all identified sources of pollution from livestock manure and wastes in the watershed. There are 200 low priority farms in the watershed in addition to the 286 high potential farms addressed in Strategy #3. These farms represent approximately 30,555 animal units. In the watershed there are 447 farms that have been identified as requiring manure storages to control runoff. Of these farms 220 require additional storage to contain milkhouse washwater. As noted in strategy #3, 10 farms require new septic systems and 8 dairy farms require milkhouse washwater settling tanks with treatment trenches. Between the high and low potential farms there are 98 areas where livestock have access to watercourses. Approximately 58,520 m of fencing is required to restrict livestock access to the Watercourses. In addition to the fencing, 52 culvert crossings and 59 alternate watering devices are need in order to maintain the viability of the pastures.

<u>Remedial Measure Costs of Strategy #4</u>

486	High and Low Priority Farms		
30,555	animal units		
447	manure storages		
220	milkhouse wastes storages		
31	contaminated tiles		
		10 septic tanks	
		8 milkhouse waste treatment systems	
98	access sites		
		58,520 m of fence	
			52 culvert crossing
			59 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon

447 x $11,000 = $4,917,000

220 x $ 1,000 = $ 220,000
total = $5,137,000

Option #2: Solid Storage with Runoff Pond
447 x $18,000 = $8,046,000
220 x $ 1,000 = $ 220,000
total = $8,266,000

Option #3: Concrete Liquid Manure Storage
447 x $23,000 = $10,281,000
220 x $ 2,000 = $ 440,000
total= $10,721,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid
447 x $46,000 = $20,562,000
220 x $ 2,000 = $ 440,000
total = $21,002,000

Watercourse Fencing
Fencing
58,520 m x 5.75 = $ 336,490
Stream Crossings (culverts)
52 x 2,000= $ 104,000
Alternate water devices
59 x $1,500 = $ 88,500
Total Cost of Restricting Access = $528,990
$5,400/site

Septic Systems.
10 x $3,000 = $ 30,000
Milkhouse Waste Treatment System
8 x $3,500 = $28,000

Cost of Remedial Measures for Implementing Strategy #4 in the Upper Nith River Watershed

	Total Cost	cost/Farm	cost/Animal Unit
Option #1	$ 5,724,000	$ 11,800	$ 187.00
Option #2	$ 8,853,000	$ 18,200	$ 290.00
Option #3	$11,308,000	$ 23,300	$ 370.00
Option #4	$21,589,000	$ 44,400	$ 707.00

Strategy #5

Do nothing.

The do nothing strategy proposes that no action be taken to address the problems of manure and livestock waste pollution in the Upper Nith River watershed. The costs of this strategy are difficult to assess since there is presently no swimming in the pond at New Hamburg. The adoption of this strategy would virtually eliminate the potential for the pond to be restored to swimming quality. It is therefore not a risk of closure but a loss of future opportunities that must be measured.

The do nothing strategy also has the potential to adversely affect the future of the waterfront development in New Hamburg. Excessive weed growth and algae blooms would be detrimental to the success of the waterfront park.

As with the other watersheds the costs of the do nothing strategy are not restricted to the recreational area but watershed residents and downstream users. Aside from the general problems such as health risks and lost livestock production, which are discussed earlier degraded water quality could seriously interfere with MNR's attempts to restore walleye habitat in the Upper Nith River.

Strategy #6

Manipulate the beaches and reservoir in order to enhance swimming opportunities.

Strategy #6 addresses only one symptom of degraded water quality in the Upper Nith River; the lack of swimming in the New Hamburg pond. Unlike the other 2 watersheds there is no beach to restore or manipulate. In addition to this the fecal coliform densities are consistently above the ONE objective of 100/100 mL.

The only method of immediately restoring swimming to the New Hamburg pond appears to be the establishment of a semi-artificial beach area through the installation of a curtain and chlorination system.

This method, as described earlier in the report provides a quasi-natural swimming area by curtaining off an area that is chlorinated throughout the swimming season. The capital costs of the system are approximately $75,000, while yearly operation and maintenance is about $15,000.

3.3 The Upper Speed River Watershed

There are 37 farms with a high potential to pollute and 87 low potential livestock farms identified in the watershed. In general the farms are smaller and have fewer animal units than those in the other watersheds.

Guelph Lake Conservation Area has two swimming beaches; the lake beach and the pit beach. The lake beach has been posted twice since the reservoir opened; July 26, 1983 and August 12, 1988. Both of these postings have closed the beach for the season. The pit beach was posted for the season on August 22, 1983, but remained open during 1988.

Beach postings have appeared to reduce Conservation Area attendance and gate receipts. In 1988 the total attendance dropped 14,000 below average. At $2.25 per person, the Conservation Authority lost approximately $31,000 in admission fees. Camping attendance was approximately 6,000 below normal which accounts for a lost of approximately $18,000 in camping fees.

Water based recreation is a major drawing card for the Guelph Lake Conservation Area. Ensuring that swimming opportunities are consistently available is important to the long-term viability of the park.

The Upper Speed River and its tributaries have the potential to be restored for native brook trout. Remnant populations exist in some tributaries and improvement of water quality and the riparian corridor is crucial to the fisheries survival.

Improving water quality in the Upper Speed River watershed will provide many benefits to the watershed residents and downstream users. Inputs of manure and livestock wastes affect a watercourses ability to support desirable fish species and increases its sediment and nutrient enrichment. These changes reduce the aesthetics, and recreational opportunities of the river as well as the quality for downstream users.

As mentioned earlier waterborne diseases and viruses are very real risks to watercourse users whether they be animal or human.

Water quality improvements benefit all of society. The following strategies outline a number of alternatives and the associated costs of improving water quality in the Upper Speed River watershed.

Strategy #1

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on high priority farms that have the greatest impact on the Guelph Lake beaches.

Water quality data indicates that the main branch of the speed River above the reservoir has remarkably good water quality with a 1988 geometric mean density of 118 fecal coliforms per 100 mL. As well a dye study conducted in the reservoir from July 26 to July 28, 1988 indicated that the speed River may not continuously impact the recreational beaches since the injected rhodamine WT dye exhibited very limited movement during that time. Suitable wind conditions of northeast to easterly may provide some periodic influence. See Appendix A for the preliminary report.

Fecal coliform inputs from farms nearest the reservoir may be exerting the greatest impact on the reservoir. Figure 3 illustrates the 9 high priority farms that are targeted for strategy #1.

Remedial Measure Costs of Strategy #1

9 high priority farms
411 animal units
8 manure storages
2 milkhouse waste storages
3 access sites
- 1795 m of fence
- 2 crossings
- 1 alternate watering device

Manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon
8 x $11,000 = $ 88,000
2 x $ 1,000 = $ 2,000 (additional expense for milkhouse waste
total = $ 90,000storage)

Option #2: Solid storage with Runoff Pond
8 x $23,000 = $ 184,000
2 x $ 2,000 = $ 4,000
total = $ 188,000

Option #3: Concrete Liquid Manure Storage
8 x $23,000 = $ 184,000
2 x $ 2,000 = $ 4,000
total = $ 188,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid
8 x $46,000 = $ 368,000
2 x $ 2,000 = $ 4,000
total = $ 372,000

Watercourse Fencing
Fencing
1795 m x $5.75 = $10,321.00
Stream Crossings (Culverts)
3 x $2,000 = $ 6,000.00
Alternate Watering Device
1 x $1,500 = $ 1,500.00
Total cost of Restricting Access= $ 17,821
$ 5,900/site

Cost of Remedial Measures for Implementing Strategy #1 in the Upper Speed River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 105,800	$ 11,800	$ 257.00
Option #2	$ 163,800	$ 18,200	$399.00
Option #3	$ 205,800	$ 22,800	$ 501.00
Option #4	$ 389,800	$ 43,300	$ 948.00

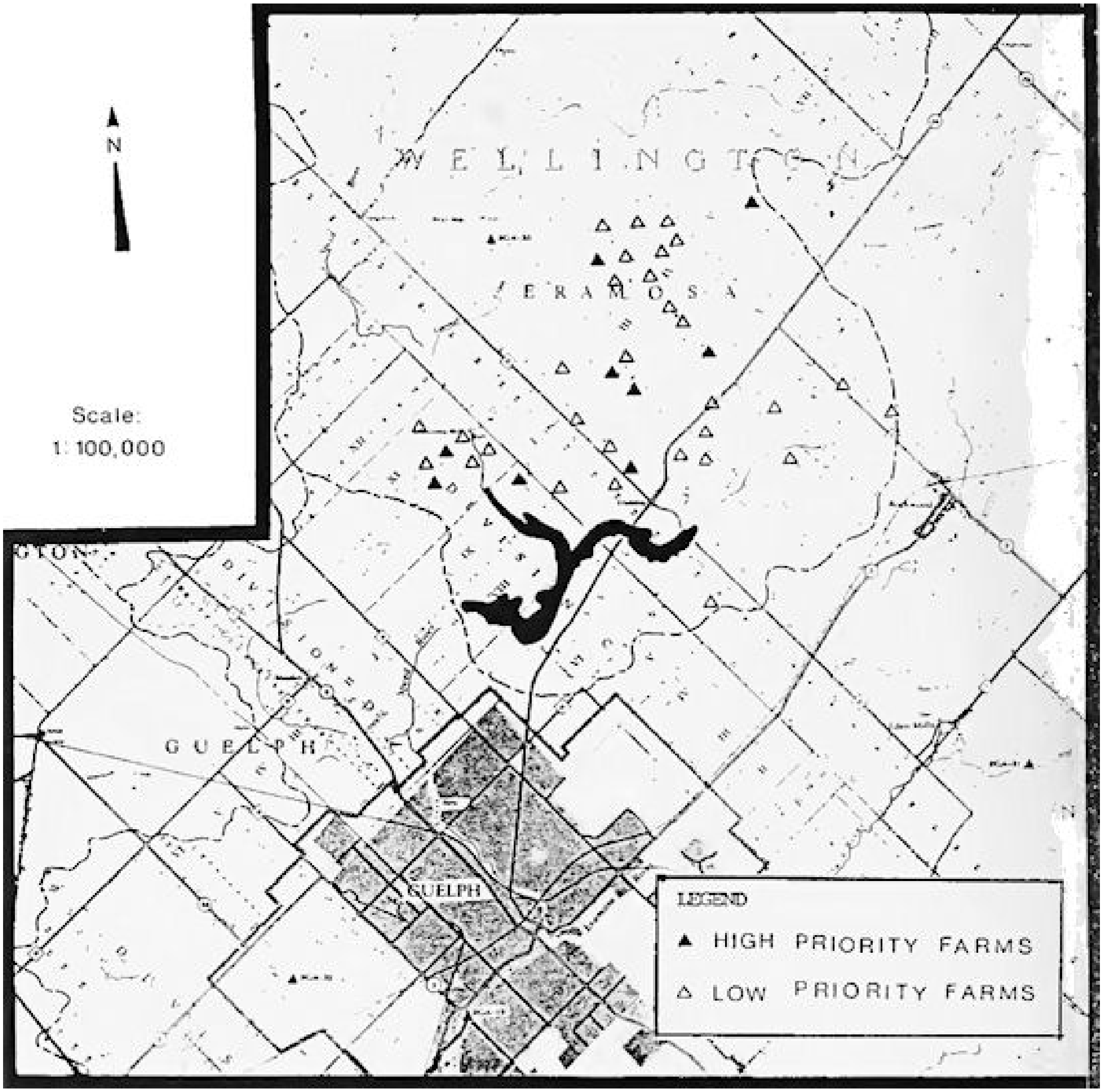

Figure 3: Upper Speed River Watershed Curb Plan Targeting- Strategy # 1 and Strategy # 2

Strategy #2

Implement remedial measures to control 100% of the pollution from livestock manure and wastes on both the high and low priority farms that have the greatest impact on the Guelph Lake beaches.

Implementing remedial measures on the low priority farms as well as the high potential farms will reduce all the livestock inputs that influence the beaches under all conditions.

In addition to the 9 high priority farms addressed in Strategy #1 there are also 30 low potential farms in the vicinity. These 39 farms represent approximately 1674 animal units. Thirty-four of the farms require manure storages. Five of these farms require additional storage space for milkhouse washwater. There are 7 sites that require 3975 m of fencing in order to restrict livestock access to watercourse.

<u>Remedial Measure Costs of Strategy #2</u>

39 High and Low Priority Farms
1674 animal units
34 manure storages
5 milkhouse wastes storages
7 access sites
3975 m of fence
5 culvert crossings
3 alternate watering devices

Manure and milkhouse Waste Storage

Option 41: Earthen Lagoon

34 x $11,000	= $ 374,000	
5 x $ 1,000	= $ 5,000	(additional expense for milkhouse waste storage)
total	= $ 379,000	

Option 42: Solid Storage with Runoff Pond

34 x $18,000	= $ 612,000
5 x $ 1,000	= $ 5,000
total	= $ 617,000

Option #3: Concrete Liquid Manure Storage

34 x $23,000	=	$ 782,000
5 x $ 2,000	=	$ 10,000
total	=	$ 792,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid

34 x $34,000	=	$1,564,000
5 x $ 2,000	=	$ 10,000
total	=	$1,574,000

Watercourse Fencing

Fencing

3975 m x 5.75 = $22,856.25

Stream Crossings (Culverts)

5 x 2,000 = $10,000.00

Alternate watering devices

3 x $1,500 = $ 4,500.00

Total cost of Restricting Access = $37,356.25
$5,300/site

Cost of Remedial Measures for Implementing Strategy #2 in the Upper Speed River Watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 416,400	$ 10,700	$ 249.00
Option #2	$ 654,400	$ 16,800	$ 391.00
Option #3	$ 829,400	$ 21,300	$ 495.00
Option #4	$1,611,400	$ 41,300	$ 963.00

Strategy #3

> Implement remedial measures to control 100% of the pollution from livestock manure and wastes on all the high priority farms in the Upper Speed River Watershed.

The objective of strategy #3 is to improve the overall water quality of the watershed by controlling pollution from the farms with the highest potential to pollute. There are 37 livestock farms in the Upper Speed River watershed that have been identified as having high potential to pollute watercourses. Of these farms 35 require adequate manure storages to control manure runoff. Eight of these farms require additional storage space in order to properly dispose of milkhouse wash water. There are 14 sites that require approximately 7238 m of fencing in order to restrict livestock from the streams.

<u>Remedial Measure Costs of Strategy #3</u>

37 high priority farms 2,532 animal units
35 manure storages
8 milkhouse waste storages 14 access sites
7238 m of fence
8 culvert crossings
4 alternate watering devices

Manure and Milkhouse Waste storage

Option #1:	Earthen Storage	
	35 x $11,000	= $385,000
	8 x $ 1,000	= $ 8,000 (additional expense for milkhouse waste storage)
	total	= $393,000
Option #2:	Solid Storage with Runoff Pond	
	35 x $18,000	= $630,000
	8 x $ 1,000	= $ 8,000
	total	= $638,000
Option #3:	Concrete Liquid Manure Storage	
	35 x $23,000	= $805,000
	8 x $ 2,000	= $ 16,000
	total	= $821,000

Option #4: Concrete Liquid Manure Storage with Reinforced Lid

35 x $46,000	= $1,610,000
8 x $ 2,000	= $ 16,000
total	= $1,626,000

Watercourse Fencing

Fencing

7238 x $5.75 = $41,618.50

Stream Crossing (Culvert)

8 x $2,000 = $16,000

Alternate Watering Device

4 x $1,500 = $6,000

Total Cost of Restricting Access = $63,618.50

$4,500/site

Cost of Remedial Measures for Implementing Strategy #3 in the upper Speed River Watersheds

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$ 456,600	$ 12,300	$ 180.00
Option #2	$ 701,600	$ 19,000	$ 277.00
Option #3	$ 884,600	$ 24,000	$ 349.00
Option #4	$1,689,000	$ 45,700	$ 667.00

Strategy #4

> Implement remedial measures to control 100% of the pollution from livestock and manure wastes on all the high and low priority farms in the Upper Speed River watershed.

In addition to addressing the pollution potential of the 37 high priority farms in the watershed, strategy #4 deals with potential inputs from the 87 low priority farms in the watershed. The low priority farms are generally smaller and pose the greatest threat to water quality during high runoff generating events. The objective of strategy #4 is to improve the water quality at the beaches by improving the overall water quality in the watershed. This strategy controls the pollution from 5,687 animal units.

<u>Remedial Measure Costs of Strategy #4</u>

124 Low and High Potential Farms
5867 animal units 113 manure storages
16 milkhouse waste storages
23 access sites
11,963 m of fence
13 culvert crossings
9 alternate watering devices

Manure and Milkhouse Waste Storage

Option #1: Earthen Lagoon

113 x $11,000	= $1,243,000	
16 x $ 1,000	= $ 16,000	(additional expense for milkhouse waste storage)
total	= $1,259,000	

Option #2: Solid Storage with Runoff Pond

113 x $18,000	= $2,034,000
16 x $ 1,000	= $ 16,000
total	= $2,050,000

Option #3: Concrete Liquid Manure Storage

113 x $23,000	= $2,599,000
16 x $ 2,000	= $ 32,000
total	= $2,631,000

Watercourse Fencing
Fencing
11,963 m x 5.75 = $68,787.25
Stream Crossings (Culverts)
13 x 2,000 = $26,000
Alternate watering devices
9 x $1,500 = $13,500

Total Cost of Restricting Access= $108,287.25
$4,700/site

Cost of Remedial Measures for Implementing Strategy #4 in the Upper Speed River watershed

	Total Cost	Cost/Farm	Cost/Animal Unit
Option #1	$1,327,800	$ 10,700	$ 233.00
Option #2	$2,118,800	$ 17,100	$ 373.00
Option #3	$2,699,800	$ 21,800	$ 475.00
Option #4	$5,298,800	$ 42,700	$ 932.00

Strategy #5

Do nothing.

The 'do nothing' strategy does not provide for the implementation of any remedial measures in the Upper Speed River Watershed. As such there are no implementation costs associated with this strategy. There are however costs associated with the risks of continued water quality degradation.

The risk of beach closures may escalate if steps are not taken to control pollution originating on livestock operations. For Guelph Lake Conservation Area the cost of frequent beach postings may well exceed $40,000 per year. The Upper Speed River also represents an important fishery opportunity. If remedial measures to reduce the impact of agriculture are not implemented it will be impossible to restore brook trout to the watershed.

Aside from recreational impacts, on fishing and swimming the lack of action to reduce agricultural inputs will affect watershed residents and downstream users. The occurrence of water transmitted disease to livestock will likely increase as will the cost of water treatment for downstream users will increase.

Strategy #6

Manipulate the beaches in order to enhance swimming opportunities.

Strategy #6 is the 'band-aid' approach to avoiding beach postings. The methods proposed by this strategy attempt to alleviate some of the symptoms as opposed to treating the causes.

1. <u>Beach maintenance</u>

Although regular beach maintenance is not a solution to beach postings due to livestock contaminated water it may help to avoid the potential contamination from shore sources or resuspension of contaminated sediment. Litter, bird droppings and algae should be removed daily. Removal of debris will reduce contamination of the shallows as well as discourage birds from congregating and defecating on the shoreline. Regular beach raking and harrowing will dry out the beach sand and in the process expose bacteria to sunlight. This reduces the potential for bacteria along the shoreline to be resuspended in the water column. Resurfacing the beach with clean sand, periodically during the summer may also help keep the beach clean. As with Lake Conestogo the cost of this would be minimal and could be incorporated into the staff's daily maintenance.

2. <u>Beach Location and Configuration</u>

The pit beach has only been posted once late in the season while the main beach has been posted twice. The location and configuration of the two beaches differ significantly. These differences may be the source of variation between postings. The pit beach has a steeper grade from shore resulting in less shallows than the main beach which has a gentle grade. The pit beach also has a gravel substrate as opposed to silt and sand in which bacteria thrive. The location of the beaches may also influence the presence of bacteria.

The main beach could be regarded and resurfaced in order to more closely resemble the pit beach. As with the beach at Lake Conestogo, the regrading, sand and gravel may exceed $20,000.

2. <u>Chlorination</u>

Installation of a curtain and chlorination system would ensure that the main beach remain swimmable during the swimming season. The main draw-back to this semi-natural swimming area is that the water has a tendency to become muddy looking due to the suspension of sediment and the lack of circulation. The cost of this system is approximately $75,000, while yearly maintenance and operation is about $15,000.

4. STRATEGY SUMMARY

The six strategies should be regarded as options for dealing with the problem of beach postings due to fecal contamination from livestock farms. The strategies are not definitive guidelines for remediation, but should be regarded as an indication of the alternatives and associated costs of clean up. There are basically 3 approaches that can be utilized; do nothing, deal with the sources or deal with the symptoms. Within each of these approaches are numerous costs and benefits.

If the sole objective of the project is to consistently maintain - swimming at the beaches the installation of a chlorination system and swimming curtain appears to be the option with the lowest capital cost and a 100% success rate. This solution however provides no other benefit and does not address the problems associated with water quality degradation and the impacts on the watershed and downstream users. The chlorination system does not provide pristine natural swimming conditions and therefore the attendance may not actually increase even though swimming is available.

Strategies #1 to #4 deal with the sources of bacterial contamination. Strategies #1 and #2, only address the farms in the vicinity of the beach. These strategies may provide adequate control to ensure that swimming is maintained but will not provide benefits to the rest of the users of the Rivers. Strategies #3 and #4 address the sources of fecal contamination in the entire watershed. These two strategies provide benefits to all users of the watershed. Reducing inputs from livestock improves the overall water quality of the watercourse. This improves the aesthetics of the watershed as well as the quality of water to downstream users. Livestock producers benefit by increases in herd health and reduction in disease and treatment costs. Fisherman and aquatic life benefit by improved habitat for better quality fish species.

The costs of implementing 100% control remedial measures on all high priority farms range from $2.2 million to $7.6 million in the Upper Conestogo River, from $3.5 million to $12.8 million in the Upper With River and from $0.5 to $1.7 million in the Upper Speed River. Within each watershed increments of control can be achieved for less. Restricted livestock access for instance would likely provide major improvements to localized areas by improving fisheries habitat and reducing the risks to herd health. This remedial measure could be implemented on all high and low priority farms in the Upper Nith and Conestogo River watersheds for approximately $500,000 each and $100,000 in the Upper Speed River Watershed.

Controlling 100% of manure runoff from all high and low potential farms accounts for the main expense of strategies #1 to #4. Manure storages represent at least 80% of the cost of implementing strategies #1 to #4.

The treatment of milkhouse wastes accounts for a very small proportion of the total cost of implementing remedial measures on priority farms. If milkhouse waste treatment was separate from manure storages the costs in strategies #1 to #4 would range from $91,000 to $364,000 in the Upper Conestogo River Watershed, $42,000 to $770,000 in the Upper Nith River and from $7,000 to $56,000 in the Upper Speed River Watershed. These figures may be somewhat low since the strategies deal only with high and low priority dairy farms when in fact all dairy farms have the potential to impact surface water via subsurface drainage.

It is evident from this discussion that 100% control of the identified sources of pollution from livestock farms in the three watersheds is extremely costly. The estimate ranges from $11 million to $40 million depending on the type of storage implemented. If only particular sources of pollution are addressed the cost is significantly less.

Control of pollution is not a simple problem and there are many aspects that must be addressed. Installation of one type of remedial measure such as restricted cattle access will not necessarily cleanse a stream if all other inputs continue unchecked. Water quality is a complex issue that must be addressed by a comprehensive program. The following section outlines some considerations for a program to reduce agricultural impacts on water quality.

5. AN AGRICULTURAL WATER QUALITY PROGRAM

Since the PLUARG studies in the seventies agriculture has been recognized as a major contributor of pollution in rural watersheds. Soil erosion and livestock manure contribute sediments, nutrients, organic matter, fecal bacteria and pesticides to watercourses. A number of government programs have addressed the mitigation of these pollutants. Programs such as the Soil and Water Environmental Enhancement Program (SWEEP), the Ontario Soil Conservation and Environmental Protection Assistance Program (OSCEPAP), Land Stewardship Program (LSP) and the Rural Beaches Strategy (RBS) have offered technical and/or financial assistance to farmers who adopt specific remedial measures.

Generally all of the programs except the RBS have had a decided focus on controlling soil erosion, although the B section of OSCEPAP did provide financial assistance for protecting water resources by controlling the potential for pollution from manure, milkhouse wastes and pesticide storage. Programs that focus on reducing soil erosion tend to be of limited value in translating these reductions into improved water quality. The projects and practices are designed to keep soil in the fields but are not specifically located in the areas where delivery to streams is highest. As a result the remedial measures tend to be widely scattered over a politically defined area as opposed to being targeted to hydrological units.

The Joint Agricultural Soil and Water Program (JASWCP) and the RBS program are based on hydrological units and are strictly advisory programs promoting the financial assistance of the existing grant programs. The JASWCP generally focuses on reducing soil erosion while the RBS focuses on reducing the impact of manure and livestock wastes in specific watersheds. Although the two programs co-operate they still do not provide a comprehensive approach to reducing the impact of agriculture on water quality.

5.1 Program Approach

To effectively accomplish water quality improvements the program must be by definition a 'water quality program'. Its primary objective must be to reduce all significant agricultural inputs to watercourses in a hydrologically defined area. The program must employ land management techniques to control pollutants at their source. If inputs are reduced; it is hoped that the watercourse will be able to cleanse itself. The program must stress local participation since it affects local residents directly. Since improving water quality impacts on a number of different groups the program will require a co-operative effort from a number of agencies. The program must offer educational, technical and financial assistance. In order to get the largest return on capital spent the financial assistance should be targeted to areas which are contributing the most to water pollution.

5.2 Program Administration

As has been mentioned the problem of agricultural water quality degradation is a complex issue that crosses political boundaries and impinges on many government agencies. Essentially the stake holders such as OMAF, OME, MOH, the C.A.'s and the agricultural community are already co-operating in programs such as RBS and JASWCP. The format of a multi-agency steering committee directing a team of specialists is ideally suited to an agricultural water quality program. The C.A. should be the lead agency as it is empowered by the Conservation Authorities Act to enter into agreements with various groups and administer programs. It is also based on a watershed unit. Conservation Authorities such as the GRCA are already recognized by the agricultural community as being involved in conservation farming and therefore an established rapport with farmers and farm organizations exists.

The Conservation Authorities are also involved with urban lands through the floodplain regulations process. C.A's are already dealing with problems of a non agricultural nature such as construction site runoff and stormwater management. Some of the other urban pollution problems may also be addressed through the Conservation Authorities public education programs. *As* well Conservation Authorities are already involved in water quality monitoring.

Funding for an agricultural water quality program should be provided by OME, OMAF, MNR and MOH. Municipalities that depend on good water quality for either domestic use or recreation should also be approached for funding.

5.3 Staffing

The JASWCP at the GRCA presently has 4 soil conservation advisors, 1 water quality advisor and 1 engineer. A shift in focus would require that there be at least one more water quality staff person as well experts from the other ministries should be identified and be made available for technical advice. Within the Conservation Authority there are many opportunities to cooperate with staff from other areas such as forestry and fisheries.

5.4 Program Delivery Mechanisms

There is a traditional view of farmers held by society that they are keepers of the countryside and that nature and agriculture are in timeless harmony. Unfortunately this image has created two fallacies. The first is that "the farmer knows best" and the second is that if farmers could earn a decent living they would be better stewards of the land. What is overlooked by these statements is that farmers are in the business of farming and central to their motivations is the desire and the need to succeed commercially.

The current state of water quality in the three watersheds generally proves that all farmers do not know best when it comes to water quality. Greater returns on farm produce does not necessarily translate into better stewardship. Prosperous farmers improve their farm efficiency and reinvest their money into revenue producing aspects of their farms. Unfortunately the costs of improving water quality accrue to the farmer while the benefits accrue to society in general.

An agricultural water quality program must recognize the mix of private rights and public obligations when developing program delivery mechanisms. "Conservation walks a narrow line between a farmer's freedom and the overall interests of society" (Boger, 1981). In delivering a program it is important that the motivational factors affecting remedial measure adoption be incorporated.

Remedial measures that can be utilized to reduce the pollution potential of manure and livestock wastes range from capital intensive structures to management practices. Brief descriptions of possible remedial measures are provided in Appendix B. The descriptions highlight the costs and benefits of each measure in terms of the farm operation.

Farmers are the basic unit of change in the countryside and although economic benefit is a major factor for decision making it is not simply a matter of cost vs. benefit. Farmers must evaluate remedial measures in terms of their attributes and how they fit into their farming operation. Lamble (1984) identified five attributes that affect the rate of remedial measure adoption. These attributes are relative advantage, compatibility, complexity, trialability and observability. Recognition of a remedial measures attributes can be utilized to develop incentives that capitalize on these aspects and increase the rate of adoption.

A remedial measure must be perceived as having a relative advantage over a previous practice. Relative advantage can be in terms of social prestige, economic profitability or physical convenience. A remedial measure's perceived relative advantage can be increased by emphasizing its merit or by offering economic incentives.

If a new practice is compatible with previous practices as well as socio-cultural values and beliefs the likelihood of acceptance is increased. It is important to stress how a remedial measure fits in with existing practices and to encourage farmers to adopt practices that fit their operation. This helps to develop a positive attitude to change and pave the way for subsequent innovations.

The more complex a remedial measure the less chance it has of being adopted. Innovations that are perceived as being complex or difficult to understand are generally difficult to promote. The perception of complexity will depend on the farmer's existing practices, if he is innovative and has adopted new systems in the past a remedial measure such as ensuring the proper rate of manure application will not appear too complex. On the other hand another farmer may find soil and manure testing and adjusting application rates as involving too many steps and therefore too complex.

Workshops and free technical assistance can help to simplify a practice and ensure that it is utilized.

The ability to be able to try a practice on a limited scale increases the acceptability of a remedial measure. Remedial measures that must be adopted "all-or-nothing" are generally adopted at a slower rate than those practices that can be tried experimentally. Farmers are reticent to commit time effort and money to a remedial practice which they must adopt on an "all-or-nothing" basis. Demonstration sites enable the farmer to psychologically try an innovation without committing any of his or her own resources. Trialability has been successfully used to promote the adoption of soil conservation tillage in Ontario.

Observability of results increase the rate of adoption. Remedial measures that have results which are easy to observe and communicate to others will be diffused and adopted more readily than remedial measures that are not easily observed. Again the use of demonstration sites are important in heightening the observability of remedial measures.

Agricultural benefits are therefore only one aspect of increasing farmer acceptability. Cost of an innovation must be weighted against its attributes. A low cost innovation is not necessarily the most likely to be adopted simply based upon cost. The cost of the remedial measure is more apt to influence the type of program delivery mechanism required rather than simply determining whether a remedial measure will be adopted or not.

Legislation, education and financial incentives must be combined to encourage farmers to adopt measures to reduce water quality degradation. Through a combination of these incentives farmers can be encouraged to control the pollution potential of their farms.

Erosion

Programs such as SWEEP, LSP and OSCEPAP have successfully combined education and technical assistance with financial remuneration to encourage the adoption of conservation tillage and erosion control practices. These methods should continue, although more emphasis should be placed on targeting farms which are delivering the most sediment to watercourses. More emphasis should also be placed on the promotion of cover crops, yearly rotation, tree planting, buffer strips and the retirement of fragile lands.

The issue of cross-compliance to encourage land stewardship should also be investigated. The scale of cross-compliance need not be as restrictive as that implemented in the United States. It could be used to restrict farmers access to certain types of subsidies unless they are taking steps to reduce erosion. Cross-compliance could also be used to increase the level of funding for certain financial programs in order to reward farmers who practice land stewardship without necessarily penalizing those who don't.

Funding levels as set by LSP and OSCEPAP appear to have been adequate although more incentives may be required for things such as tree planting and fragile land retirement.

Manure Storage and Barnyard Runoff

Control of manure runoff accounts for at least 85% of the cost of reducing the impact of livestock farms on water quality. The cost of constructing a storage for manure and runoff ranges from $11,000 to $46,000 per farm depending on the type of storage. One-hundred percent control of manure runoff on each farm is not economically feasible. Site-by-site evaluation of the targeted farms will determine where storages will be most effective. Due to the relatively small economic benefit that accrue's to the farmer, substantial financial assistance is required. The present grant of 40% up to $7,500 is not an adequate incentive due to the high cost of the structures. The level of funding should be at least 60% up to $15,000 for the high priority farms. If all 451 high priority farms that require manure storages used the maximum grant amount, $6,765,000 would be required in the 3 study watersheds.

An alternative to grants would be a low interest loan. A loan of up to $10,000 could be available in conjunction with a lower grant of $10,000. The interest rates should be well below prime and payable over a period of up to 10 years.

Farmers receiving grant money should be subject to signing a cost-share agreement. This agreement would protect the public's investment in water quality improvements by ensuring that the structures are properly maintained and managed for at least 10 years. If the agreement is breached the grant must be paid back in full.

In addition to financial incentives, technical assistance must be offered and education provided. The merits of improved manure storage systems must be promoted. Demonstration farms help farmers observe the practice in action, and find out first hand how the system operates. Through the experience of the host farmer other farmers are able to 'try out' the practice. Demonstration farms also stress improvements in handling and the relative advantages a system offers. Demonstration farms also provide incentive through peer pressure as improving water quality becomes the right thing to do.

Municipalities must also be encouraged to reflect their concern for water quality in their by-laws and planning documents by adopting manure storage policies that protect water quality while at the same time providing flexibility to farmers. All new livestock facilities should be located at least 150 m from a watercourse and have adequate manure storage facilities for the maximum animal unit capacity. Additions to existing livestock buildings should be allowed only if manure handling facilities are adequate. The municipality should also ensure that the land base is capable of disposing the manure without risk to the environment.

The preferred method of dealing with manure runoff problems is by voluntary compliance however if this is not effective some form of regulation may be warranted. Pollution permit programs, such as those developed in some States, require livestock operators to develop and implement a plan to control pollution associated with livestock manures. Farms are evaluated if an operation expands, changes hands or when a new livestock facility is constructed. Livestock operations may also be inspected when a pollution event occurs. If the evaluation indicates that a farm is a pollution hazard, interim controls would be set and a timetable outlining control implementation would be developed. A permit program may be one way of policing the agricultural pollution problem.

Regulatory programs should be viewed as a last resort measure. If regulatory options are to be considered, major cost-share incentives should be offered prior to regulation to ensure that farmers are given a fair chance to implement remedial measures without suffering undue financial hardships.

Due to the cost of structures to control runoff, cost-effective manure management alternatives must be developed. Remedial measures that provide less than 100% control should be tested to determine their effectiveness. Measures such as surface water diversions, eavestroughing and partial barnyard roofing may reduce the volume of runoff enough to keep it from impacting on nearby watercourses. Buffer strips and vegetative treatment of runoff may also be effective in certain situations. May small-scale livestock farms can not justify a manure storage structure and therefore these low-tech, low-cost measures may be more compatible with their farming operation and management system.

In addition to technical and financial assistance, education is an important aspect of a delivery program. Education efforts should continue to stress the impact of water quality contamination on herd health and livestock production as well as on human health. Farmers should be kept informed of steps being taken by other farms to improve their manure handling and storage facilities. Information should be provided as to how manure management fits with low-input agriculture. The public also needs to be educated concerning basic agricultural practices. This will increase their ability to recognize good agricultural management practices. With the importance of low input agriculture and organic food the general public should be shown how important manure is to food production and increase their tolerance to odour problems.

Milkhouse Wastes

Improper disposal of milkhouse wastes was found to occur on 85% of the dairy farms surveyed. Many farmers did not realize that disposal of milkhouse washwater through a tile drain was detrimental to water quality. Awareness was on the rise due to recent magazine and newspaper articles. Direct education of this group is possible through the Milk Marketing Board and dairy producer meetings and publications. Greater emphasis of the herd health risks may help to encourage the adoption of proper storage and disposal facilities.

Research is required to develop cost-effective methods of treating or disposing of milkhouse washwater. The modified sediment tank and treatment trench must be proven to operate efficiently under normal farm conditions before farmers will trust its design. Work should be done to determine if vegetative filter areas will operate effectively in the Ontario situation.

Funding for milkhouse waste facilities should continue. Farmers should be eligible to receive 60% funding up to $3,000 for approved systems. Farmers who incorporate milkhouse wastes into a new liquid manure storage should receive compensation beyond the manure storage grant for the added expense. An additional $1,500 may help offset the costs of incorporating the extra liquid. Farmer's receiving grants should be subject to signing cost-share agreements similar to those suggested for manure storages. In addition to cost-share agreements proper milkhouse disposal systems should be tied into a cross-compliance program with other financial assistance programs.

As with manure storages, regulation of milkhouse wastes should be considered as a last resort. If regulations are deemed necessary it should be incorporated into an overall permit program to control pollution hazards on farms. In addition all new dairy facilities or additions to dairy facilities should be required as part of the municipal planning process to install proper disposal facilities for milkhouse wastes.

Livestock Access to Watercourses

Unrestricted livestock access to watercourses appears to be one of the most cost-effective methods of reducing the impact of livestock on watercourses. Restricting livestock from a watercourse can be achieved for as little as a few cents a foot and can have immediate affects on stream quality. Limiting livestock access to watercourses has the greatest potential for co-operation between resource agencies and user groups since the benefits to fisheries can be very significant.

Targeting streams which have high fisheries potential can achieve significant fisheries improvements in conjunction with the other water quality benefits. Targeting of priority areas for fencing should be done in consultation with fisheries staff. Funding and assistance could also involve user groups such as Hunters and Anglers as is provided in the Community Fisheries Improvement Program.

Although generally inexpensive, restricting livestock access appears to be an unpopular remedial measure. To most farmers fencing does not appear to provide a relative advantage. It is considered as being inconvenient and costly. Pasturing on bottom lands is a traditional practice that has been acceptable for years. Fencing is not compatible with their socio-cultural beliefs. Improvements in production and herd health are often not observable since many farmers do not associate poor performance and illness to poor water quality.

Demonstrations and education to stress the importance of fencing are required. These efforts must stress the benefits to the farmers in terms of herd health improvements and reductions in drain cleanouts. Education must also play upon a farmers moral and ethical obligation to ensure that he does not impact upon downstream users.

Total exclusion of livestock from the watercourse is preferred although not always feasible. Each pasture situation needs to be evaluated to determine what measures are compatible with the farming operation. More work should be done to develop alternate water sources that are reliable and cost-effective.

Financial incentives should be set at 75% up to $10,000. The eligibility for funding criteria should be flexible to enable a farmer to develop a system to suit his needs. This flexibility would include electric fencing, culvert crossings and provision of water from a barn or existing well. Farmers receiving funding should be required to sign a cost-share agreement to ensure that fencing is maintained for at least 10 years. Fencing watercourses could be a cross-compliance condition for other financial assistance programs.

Consideration should be given to the provision of funds for retiring lands from pasture where fencing is not viable. This land would remain ungrazed and could be rehabilitated to a natural riparian zone. This could be accomplished through conservation easements where the landowner would receive a single lump payment or tax deductions in exchange for setting permanent limitations on the use of the land. The limitations are transferable and attached to the deed.

Land Application

Proper manure application has the potential to result in the most benefits to farmers since proper rate, timing and method can maximize the utilization of manure for crop production. Improperly applied manure can cause severe impacts on water quality.

The increased use of liquid manure has not been matched by an increased knowledge of application methods and rates. Research is required to determine the fate of land applied liquid manure. Information is required on application rates for specific soil types and conditions.

Applicators, whether they are farmers or custom applicators, require information concerning rates and problem mitigation. Licensing of custom applicators should be considered to make them solely responsible for their actions.

Manure testing and soil testing should be promoted through the use of workshops, clinics and free services. These types of forums would allow farmers to try these measures with very little risk or investment. The assistance provided would simplify the procedures and enable farmers to observe the results on their own farms. In conjunction with these services manure spreader calibration and nutrient budgeting can also be provided or demonstrated. The development of easy-to-use nutrient budgets and worksheets will help to simplify nutrient management. Workshops and technical assistance aimed at maximizing the benefits of manure to crop production will help reduce the complexity of nutrient management. They also demonstrate that the practices are compatible with the farmer's operation and that they offer a relative advantage over his previous practices. The results are observable in both money saved on fertilizer and better crops. A farmer's investment is very minor and therefore nutrient management can be tried before he permanently adopts any of the practices. An opportunity exists to promote proper application practices in light of low-input/organic farming. As crop inputs become more expensive and questions over chemical safety continue, proper manure application will become more appealing as a way to cut costs and reduce chemical use.

Septic Systems

Improperly functioning septic systems pose a severe risk to water quality and human health. Education and legislation are the two methods best suited to deal with this problem.

Many homeowners are unaware of the care and maintenance required by septic systems. Many do not realize that 'grey water' is as much of a pollutant as is black water'. By utilizing utility bill mailings all homeowners could be reminded of their duty to safely dispose of household domestic wastes. Other educational forums should also be utilized. Home buyers should also be made aware of the responsibilities associated with a domestic septic system. A properly functioning system could therefore be a condition of sale.

Septic systems are subject to inspection upon installation. At this time all hazards to water quality should be considered. Regulations to ensure that septic systems are maintained should be enacted. A septic system operation certificate is an option that should be explored. This program would require that all septic system owners have their systems pumped once a year and renew their certificate at that time, similar to a vehicle license. A small renewal fee would be assessed to pay for the administration of this program. Hiring of inspectors may also be required to inspect suspect septic systems.

5.5 Monitoring

Water quality monitoring should occur to determine if the remedial measures being implemented are transferring into water quality improvements. The water quality monitoring should test for nitrogen, phosphorous, bacteria, and suspended solids. A number of individual sites should be sampled periodically to determine the water quality improvements achievable from isolated remedial measures. This may not be required if data is already available from Beaches Projects. Sub basins where a number of measures have been implemented should be monitored as well as larger watersheds.

In addition to water quality monitoring, representative watercourses should be monitored to determine if their general health has been improved.

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APPENDIX A

GUELPH LAKE DYE STUDY

Ontario

Ministry of the Environment | Ministere de l'Environnement | West Central Region | Region du Centre-Ouest

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August12,1988

MEMORANDUM

TO: Pete Mason
Grand River Conservation Authority
Cambridge

FROM: Richard Vickers
Water Resources Assessment Officer
West Central Region

RE: <u>Guelph Lake Dye Study</u>

This memo will serve as a brief summary of the dye dispersion work carried out by the Technical Support Section during the period July 26 to July 28, 1988. I will be providing a more detailed summary in September or October following my return from vacation.

Rhodamine WT dye was injected at the abandoned bridge crossing (Figure 1, Point 1) into the north bay of the reservoir (near the ampitheatre) and timed at various transits downstream. By 8:30 p.m., the leading edge of the dye had reached a point about 100 metres downstream of the private sailing club, a distance of about 1 km, (Figure 1, Point 2). However, at this time, the dye was widely dispersed in the north bay and did not exhibit classical "slug" time of travel characteristics. Some of the initial dye injection traveled upstream from the bridge for about 75 metres, and remained visibly stationary and stagnant for the majority of the day. A moderate northwest breeze was evident for most of the day, and I suspect that it was the major factor responsible for downstream dye movement, not the natural in flow influence of the Speed River.

An automatic sampler was placed in the lake at location A overnight on July 26th in an attempt to try and trace further dye movement. Although some sampler mechanical problems occurred during the night, samples that were collected (between 9:00 p.m. and 1:00 a.m.) showed no traces of dye fluorescence.

On the morning of July 27, several diagonal transects were completed on the lake during which the depth integrated sampling did not show any fluorescent traces. Some residual fluorescence was located near the shore of sailing club (Point 2, Figure 1), however, concentrations were not significant enough to be conclusive. The wind was calm overnight, and during the diagonal transect exercise.

During the early afternoon of July 27, dye was injected at Point 2. The wind dispersion suspicions outlined above seemed to be confirmed as a light south breeze was observed to influence the dye so that the mass was located at Point 3 on Figure 1, approximately 3 hours after injection. This location was upstream from where the dye was traced the Previous day. Depth composite sampling in the old river channel downstream of the injection point confirmed that dye was not stream current influenced at sub-surface depths.

The preliminary results of this survey seem to indicate that the Speed river may not continuously impact the recreational beaches, although some suitable wind conditions (northeast to easterly) may provide some periodic influence. If you have any additional questions, please call me after September 12, 1988.

R. Vickers

cc: S. Irwin, Ministry of the Environment
A. McCarty, Ministry of the Environment

RV/hm

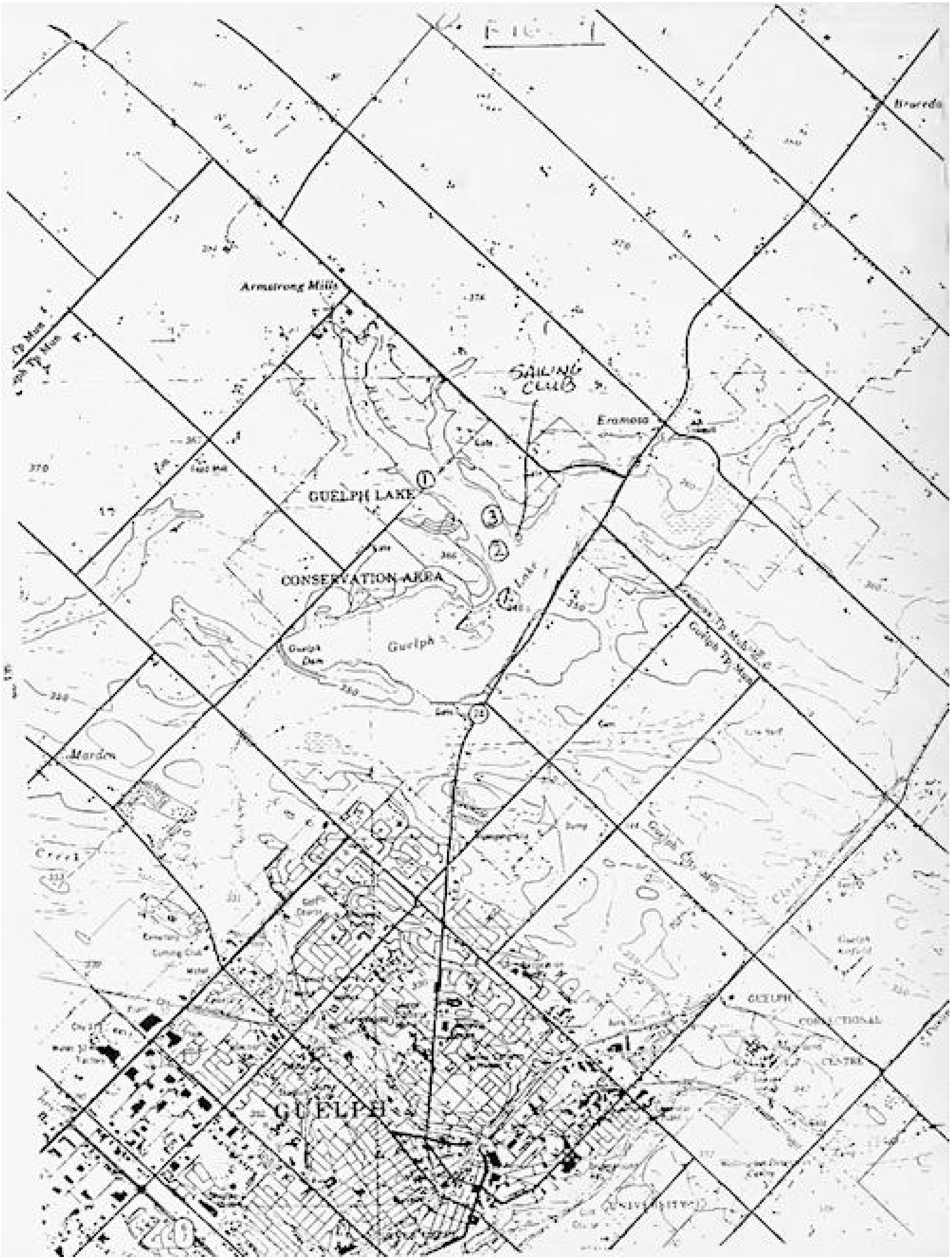
FIG. 1
Armstrong Mills
SAILING CLUB
Eramosa
GUELPH LAKE
CONSERVATION AREA
Guelph Dam
Marden
GUELPH
GUELPH
CORRECTIONAL
CENTRE

APPENDIX B

REMEDIAL MEASURE DESCRIPTIONS

1) Proper Rate of Manure Application

Ontario currently uses about 1,000,000 tonnes of fertilizers annually (OMAF, 1988). Ontario produces approximately 125 million dollars worth of manure in terms of its fertilizer value (Beauchamp, 1983). The efficient application of manure could greatly reduce the potential for water quality contamination as well as the usage of commercial fertilizers. Manure can supply an appreciable portion of the nutrients required for crop production as well as supplying the soil with organic matter. Crops which require nitrogen, and soils deficient in phosphorus and potassium make the most effective use of manure. Corn, grass, hay or pastures respond well to the nitrogen in manure. Cereals may lodge if excessive rates of nitrogen are supplied. Legumes, on the other hand, do not require the nitrogen in manure.

Manure varies in its nutritive value depending on animal species, age, bedding, storage conditions and feed programs etc. Chemical analysis will indicate the amount

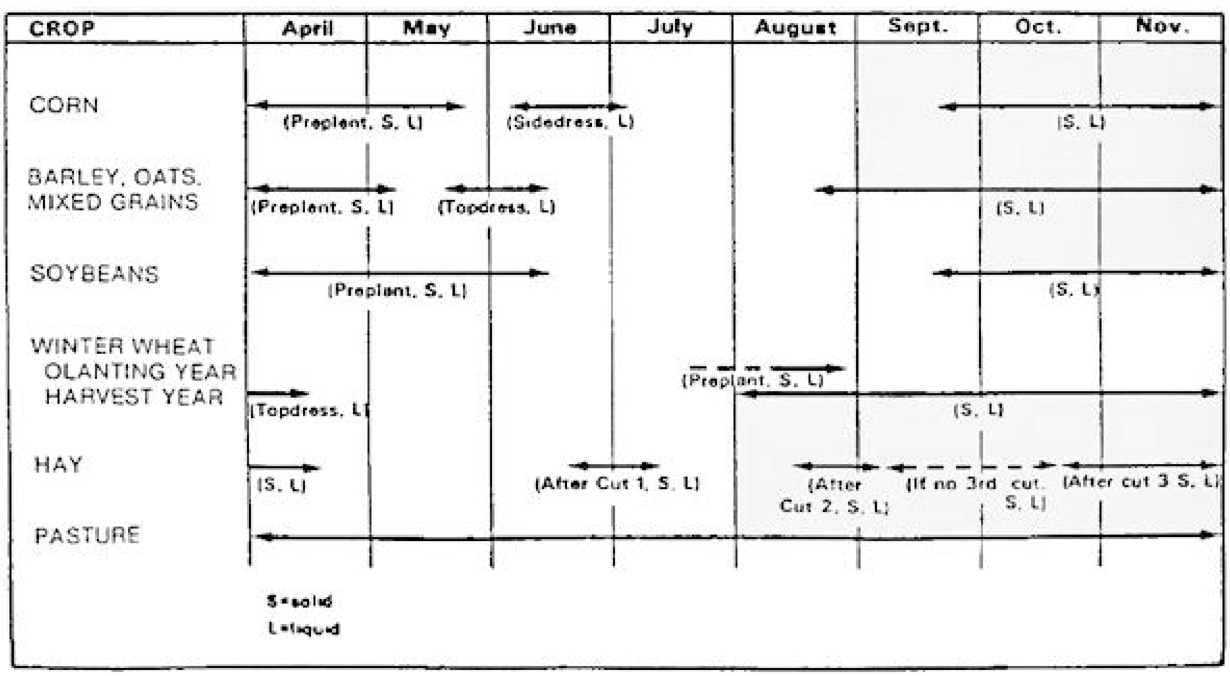

Figure 1: Possible Manure Application Time Periods

of nutrients in the manure being used. Soil testing should be done to match the nutrient value to the crop requirements.

Table 1 provides a general indication of the quantities of manure required the year a particular crop is grown. Some nutrients are carried over into subsequent year and helping to build and restore the long-term fertility of the soil. Aside from the major crop nutrient, manure also contains a number of important micronutrients such as boron and magnesium.

The organic matter in manure increases crop yield 2-4% above those received from comparable commercial fertilizer rates. Soil structure, tilth and permeability are all improved by manure application.

Table 1: Reductions in fertilizer applications where manure is applied in the same crop year(OMAF, 1988)

Class of Livestock	Nitrogen (kg / ha)			Phosphate	Potash
	F. & W.[2,]	Spr.[2]	Spr.C[2]	P_2O_5(kg / ha)	K_2O(kg/ha)
	Liquid Manure at 10 m^3 / ha (900 gal. / acre)				
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
	Solid Manure at 10 tonnes / hectare (4.5 tons / acre)[3]				
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

1 These adjustments are based on slightly below average quality manure.

2 F&W denotes fall and winter applied manure; Spr. denotes spring applied and not covered immediately, including surface application after seeding; Spr. C. denotes spring applied manure injected or otherwise covered within one day of application

3 The density of manure in the spreader will vary from 400 kg/m^3 (25 lb/ft^3) for heavily bedded or very dry manure to 100 kg $/m^3$ (62 lb/ft^3) for semi-solid or liquid manures.

On Farm Costs and Benefits

The cost of this practice in monetary terms is minimal. Farmers may perceive it as an inconvenience, since it requires manure testing and soil testing as well as manure spreader calibration. More planning is also required then the usual practice of spreading as much manure as possible, in the closest field, whenever time and weather permits.

The agricultural benefits are appreciable. Commercial fertilizer costs can be significantly reduced and yields can be improved by 2-4%. Soil structure and the long term fertility of the soil is also improved. Proper rate of manure application also reduces problems such as lodging (lying down) in cereals due to excessive nitrogen rates. The added benefit of this practice, is that the likelihood of mismanaging manure is reduced due to its recognition as an important resource on the farm.

2) Optimum Timing of Manure Application

Optimum timing of manure application can be used to control runoff and the potential for leaching to groundwater. The timing of manure applications to meet crop needs is essential to maximizing crop development and reducing the potential for pollution from runoff. Time of application greatly affects the effectiveness of nutrients in the manure on crop production. Figure 1 illustrates the possible timing of manure application for several common crops. Manure should not be spread in winter or early spring on fields which are subject to runoff. Only 25% of the manure nitrogen is available to a crop if a manure is spread in the winter. Spring application provides the greatest benefit to crops.

On Farm Costs and Benefits

Proper timing of manure application can effectively improve the fertilizer value of manure as well as reducing the pollution potential of spread manure. There are very few monetary costs associated with this practice. If an application is split, it may require an extra trip across the field. This cost may be offset by the reduction in commercial fertilizer and the 2-4% yield improvement.

The costs may be intangibles such as the inconvenience of spreading during a busier period and the unpredictability of weather. Spreading in the spring can also delay planting since manure should not be applied unless the soil is ready for seedbed preparation. The potential fertilizer value of manure must be weighed against the fertility requirements of the soil as well as a possible delay in planting (Beauchamp, 1983).

3) <u>Optimum Method of Manure Application</u>

Soil incorporation of manures greatly reduces the potential for runoff as well as increasing the nutrient availability of manure. Injection, cultivation and banding (placement in the seedbed) are all feasible alternatives. Immediate covering provides approximately 25% more nitrogen to the crop than if it is not covered (Beauchamp, 1983).

<u>On-Farm Costs and Benefits</u>

Immediately incorporating manure reduces nutrient losses due to runoff and volatilization thus increasing the nutrient value and reducing the potential for runoff. Incorporation places the nutrients in the root zone where they are most needed. Incorporation also reduces odour from manure application.

The cost to the farmer may involve additional time and field passes to incorporate the manure. Hiring a custom operator to inject liquid manure costs approximately $0.02 per gallon. Custom application saves the farmer time and reduces costs for equipment and maintenance.

4) A Minimum Separation Distance between Watercourse and New Livestock Facilities

All new livestock facilities should be located at least 150 m away from a watercourse and have adequate manure storage facilities. PLUARG (1978) identifies 122 m as the attenuation distance of phosphorus. Subsequent manure management studies (Ryan, 1982 and Balint, 1983) utilized 150 m as the critical separation distance.

Education and zoning bylaws would ensure that a minimum separation distance between new livestock facilities and watercourses be observed. This would greatly reduce the probability of any contaminated runoff reaching watercourse.

On-Farm Costs and Benefits

There is no cost to the farmer associated with this remedial measure unless there is an existing livestock facility near the watercourse. In this case, exceptions may be necessary since it is inconvenient to locate new facilities elsewhere. This measure requires a great deal of support from the agricultural community in order to be implemented. This remedial measure will not affect operations already impacting watercourses but will effectively reduce contamination from any future livestock operations.

5) Vegetative Buffer Strips

Vegetative buffer strips located along an open channel can effectively maintain the integrity of a streambank as well as reducing the inputs of pollutants from runoff, vegetative buffer strips discourage the formation of gullies and rills which are runoff pathways. Buffer strips filter sediments, utilize nutrients and reduce overland flow. They also strengthen stream banks helping to mitigate bank failures.

The size of vegetative buffer strips is dependent on the topography of the banks and the depth and velocity of incoming flows. Literature is replete with a number of recommendations on buffer width. Ministry of Natural Resources "Guideline on the Use of Vegetative Buffer Zones to Protect Fish Habitat in an Urban Environment" (1987) suggests that 15 m can provide an effective buffer between land uses and aquatic habitats. The effectiveness of a buffer improves with increases in width. A minimum of at least 5 m should be maintained to provide some degree protection to watercourses.

On Farm Costs and Benefits

The cost associated with the vegetated buffers relates to the amount of land taken out of production and the cost to plant and maintain the buffer. The cost to each individual farmer therefore is dependent on his or her present practices. If a farmer crops to the ditch bank the cost of establishing a buffer will be far greater than if some natural vegetation already exists along the stream edge. Maintenance and cost of establishment also depends on if the buffer is being seeded to a forage or is being re-vegetated with trees and shrubs. If the buffer is to be a forage crop the cost is the difference between the price of a grain crop and a hay crop.

Vegetative buffers can provide many intangible benefits to farmers. Buffer strips are often installed as a safety precaution to keep machinery away from unstable stream banks. If a buffer is wide enough it may be a laneway or permanent turning row. Buffers also enhance fish and wildlife habitat.

6) Surface Water Diversion

Surface water diversions are useful in areas where upstream runoff accesses feedlots, barnyards or manure storage areas. Surface water diversions are used to reduce the amount of runoff water contaminated by manure.

Surface water should be intercepted by a diversion berm or channel and diverted away from manure covered areas. Eavestroughing should be used to divert roof runoff away from these areas, Removal of excess water before it is contaminated greatly reduces the amount of runoff that must be stored for later land application.

On Farm Costs and Benefits

Diverting surface and roof water away from manure covered areas can effectively reduce the amount of contaminated runoff that is generated. Berms and ditches should generally be designed for a 1 in 10 year storm. The cost varies according to the complexity of the diversion system. Eavestroughing costs approximately $3.00/foot. Diversion of surface water does not negate the need for a storage but can be used to reduce the amount of liquid that must be stored. These measures can also be used as interim controls to reduce the impact of a livestock operation on a watercourse. These measures require regular maintenance and may be inconvenient. Surface water diversions and eavestroughing may be installed exclusive of each other depending on the nature of the problem.

7) Feedlot Runoff Control

As well as diverting upstream water away from manure covered areas, runoff generated from these areas should be contained and stored for field application.

Earthen berms or concrete walls can be used to contain liquids in the feedlot. Runoff should then be directed into a suitable liquid manure storage sized to contain 6 months of runoff.

<u>On Farm Costs and Benefits</u>

By containing and storing feedlot runoff the pollutant potential is greatly reduced. Benefits to the farmer include increased nutrient retention, improved feedlot conditions and a cleaner farmstead. This remedial measure assumes that a liquid manure storage is in place. If a storage is not in place construction of a runoff storage ranges from $2,000 for an earthen lagoon to more than $10,000 for a concrete tank. Pumping and land application costs range upward of $500 per year.

8) <u>Adequate Disposal of Milkhouse Wastes</u>

Untreated milkhouse wastes have been identified as a major source of bacterial and phosphorus contamination in rural streams. In the GRCA study basins a large number of field tiles were observed discharging untreated milkhouse wastes into watercourses. Adequate disposal of milkhouse wastes can be accomplished in one of two ways a treatment trench system or storage and land application.

<u>On Farm Costs and Benefits</u>

Aside from moral and ethical 'peace of mind' there are very few benefits for a farmer providing adequate milkhouse waste disposal. If the milkhouse waste is discharging to a low spot, adequate disposal will improve on-farm sanitation. Storage of milkhouse wastes provides approximately $100 of nitrogen and phosphorus for crop application.

Treatment trench systems have had problems and are not presently not well received, although new design considerations may improve their operation.

A treatment trench system costs approximately $3,500. The tank requires pumping 1 to 2 times per year depending on the volume of the tank. The cost per cleaning is approximately $150 (Miller *et al*, 1987).

Storage and land application of milkhouse wastes is the most economical method if it can be included into a liquid manure storage tank. When constructing a liquid storage the cost of expanding the storage to accommodate 200 days of milkhouse wastes is proportional to the increase in volume. At approximately $0.02 per litre for construction of a large concrete manure tank, the additional, volume would cost less than $2,000. The additional capital cost would be approximately $1,000 if it was an earthen lagoon. The cost for land spreading range from $300 to $600 annually.

Generally the cost of installing a separate storage for milkhouse wastes is prohibitive unless an earthen storage is constructed. The cost of a concrete tank for 200 days of milkhouse waste would be approximately $6,000.

An earthen storage would cost approximately $1,500. The cost of application from either storage ranges from $300 to $600 annually depending on whether a tanker wagon system or irrigation system is utilized.

9) <u>Limited Livestock Stream Access</u>

Fencing watercourses to restrict livestock access prevents cattle from disturbing streambeds, trampling streambanks and defecating in the watercourse. Fencing can be permanent or installed during the grazing season, depending on the topography.

Fencing should be set back at least 5 m from the top of bank to provide a buffer.

Water for the livestock can be provided by an alternate device such as a nose pump or water trough. If these alternatives are not feasible water can also be made available by installing a controlled access site such as a ramp or low level crossing.

On Farm Costs and Benefits

Restricting livestock access to watercourses provides a number of benefits to farmers. By reducing streambank destruction and sedimentation, drain cleanout may be less frequent. Fencing reduces the incidence of livestock injuries and deaths due to bank failures and uneven footing. The risk of contracting waterborne disease is eliminated if an alternative water source is provided. The incidence of mastitis in dairy cattle can also be reduced if they are not permitted to wade in contaminated streams. If a stream crossing is installed it can provide a stable crossing for farm machinery.

Farmers have generally been reluctant to fence watercourses. They feel that productive land is lost by fencing and that livestock do not have a large impact on watercourses. Maintaining fences is inconvenient especially in areas which are prone to flooding.

The monetary cost of fencing is dependent on the length of access, the type of fencing and the type of watering system. Permanent fencing costs range from $1.50 to $2.50 per foot, (approximately $5.75/m) while temporary fencing averages less than $1.00 per foot, depending on the number of strands and power source.

Although low level crossings and controlled livestock access sites still allow cattle to access the watercourse and defecate in it these options are often the most feasible alternative. Controlled access sites and low level crossings have graded banks that are stabilized by gravel or concrete. These sites reduce trampling and sedimentation as well as restricting the area of watercourse which can be defecated in. Culverts are the recommended method of stream crossings since they totally exclude livestock from the stream. They may not be suitable at all sites due to high flows and ice jams. Culverts crossings generally cost about $2,000. Low level crossings costs from $3,000 to $5,000 depending on the materials used. Alternate watering devices such as nose pumps or solar powered pumps can cost up to $2,000, depending on the system chosen and number of cattle being watered.

10) Adequate Livestock Manure Storage

All manure and contaminated runoff from barnyards and feedlots should be contained in a storage for land application. Storage capacity should be at least 6 months to insure against overflows and emergency disposals. Adequate storage also provides more flexibility in choosing proper timing of application. Manure can be stored as a solid, semi-solid or liquid. Solid manure storages, unless roofed to exclude precipitation, require an auxiliary liquid storage to contain all runoff. Semi-solid storages contain all liquids and solids. These storages are less popular than they once were since the manure is sloppy and difficult to handle. Two basic types of liquid manure storages exist, reinforced concrete tanks and excavated earthen lagoons.

On Farm Costs and Benefits

Adequate manure storages have a high level of effectiveness of reducing the pollution potential of a farm if the manure is handled as a resource. Proper sized manure storages can reduce the workload on the farm by reducing the number of times manure must be handled. Containment of all manure and runoff improves sanitation on the farm and can reduce fly problems and disease transmission. Manure storages maximize nutrient containment and increase the fertilizer benefits from the resource. In general, manure storages are "service assets" because they service a need and do not generate revenue.

The costs of constructing an adequate manure storage are very high. The following construction costs are based on the total costs submitted for OSCEPAP reimbursement in Waterloo and Wellington multiplied by 5% inflation. The average costs of an open topped concrete liquid manure storage was $23,000 and adding a reinforced concrete lid increases the cost to approximately $46,000. Earthen lagoons averaged $11,000 and solid manure storages with runoff ponds average $18,000. Maintenance costs vary from $500 to $1,000 per year depending on the system and the equipment required. Manure is a valuable resource but it can also be a liability if too much money is spent trying to save it. (Rose, 1986)

11) <u>Household Septic Systems</u>

Properly designed septic tanks and tile beds utilize the natural filter and treatment processes of the soil to safely dispose of domestic sewage and household waste water. Improperly functioning septic systems can pose significant health risks and severely impact surface water quality.

Although all new tanks must be inspected by a health department official, tanks installed prior to 1968 were not required to be built to any specific standards. Many home owners are not aware of problems with their systems, others are unaware of the health risks associated with their remedial fixes such as hooking up to a field tile in order to keep their tank operating. Malfunctioning household septic systems should be replaced or repaired to ensure that all household sewage and grey wastes are treated.

Household Costs and Benefits

A new septic system costs approximately $3,000. The main benefit to the homeowner is the knowledge that their system is not causing a health risk or contributing to water quality degradation. Depending on the problems associated with the systems there may be other benefits such as eliminating odours, wet spots and back ups.

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