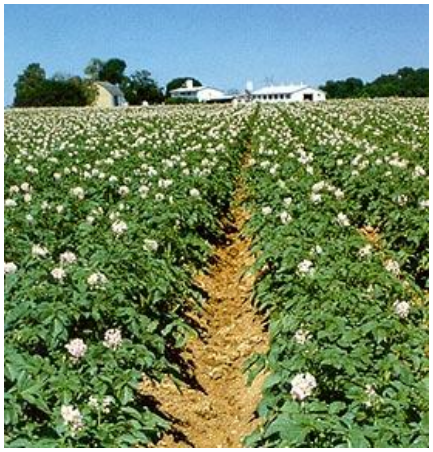
Developing a Research Instrument for Uncovering Benefits and Barriers to Phosphorus Reduction Management Practices in the Agricultural Landscape of the Innisfil Creek Subwatershed



March 2010

CBSM Research and Strategy Report

Prepared by Lura Consulting for:

Ontario Ministry of Agriculture, Food and Rural Affairs

Nottawasaga Valley Conservation Authority

Prepared by:

515 Consumers Road
Suite 201
Toronto, ON M2J 4Z2
P: 416.410.3888
F: 416.536.3453
www.lura.ca

Acknowledgments

Lura Consulting would like to acknowledge Deborah Brooker, Ministry of Agriculture, Food and Rural Affairs, Ryan Post, Nottawasaga Valley Conservation Authority, and the members of the Experts Group for their assistance and input in this research. In addition, the staff at Nottawasaga Valley Conservation Authority and Silvia Pedrazzi of Nottawasaga Futures provided important support to the project.

1. EXECUTIVE SUMMARY

Community-Based Social Marketing (CBSM) has been employed internationally as a method of fostering sustainable behaviour. CBSM employs specific tools, developed through the science of behavioural psychology, to assist people to adopt behaviours that have a beneficial impact on the environment. While traditional communications strategies focus on communicating the benefits of adopting a behaviour through mass-media advertising, CBSM strategies focus on fostering the behaviour change through personal contact with people, and seek to remove the barriers which might reduce the likelihood of adoption of the preferred behaviour.

CBSM projects have typically focused on changing or moderating simple behaviours such as switching off lights and recycling. Farming practices are much more complex and changing farmer practices is challenging as this often involves adopting a range of new or modified practices and potentially investment in new technology, rather than fostering discrete behaviours. The application of CBSM strategies to such complex behaviours is unique and has the potential for breakthroughs where resistance has been difficult to overcome in past efforts to encourage more sustainable practices.

This research project focuses on reduction of nutrient loading in watercourses from agricultural operations. The Innisfill Creek subwatershed was chosen as a study site because it is dominated by agricultural land uses (78%) and there are serious water quality issues due to elevated nitrogen and phosphorus (P) concentrations in surface waters. Based on 2006 CANWET modelling, the primary source of P in the subwatershed is fertilizer applied to cropland.[i] Implementation of agricultural Best Management Practices (BMPs) is projected to reduce phosphorous loading by 24% relative to current conditions. Examining the likelihood of adoption of favourable P-reduction BMPs using CBSM strategies was therefore the research objective of this Canada-Ontario Agreement (COA) project.

With the focus on P reduction, the CBSM project methodology employed a background literature review, a meeting of 'P Experts', and 3 focus group meetings of equine, cash crop, and potato farmers to identify the benefits and barriers of P-reduction BMPs commonly used by the local farming community in the Innisfil Creek subwatershed. From this qualitative data, a list of phosphorous Best Management Practices (P-BMPs) was developed and ranked according to impact and probability of adoption to determine which behaviours warranted further exploration in a future research instrument – a quantitative survey – during the next phase of the project. The top ranked BMPs identified included:

For Cash Crop Farmers

- Maintain wind breaks for erosion control
- Establish appropriate riparian buffer zones
- Use of cover crops after harvest

For Potato Farmers

- Apply fertilizers to land at appropriate rate, time and place
- Install site appropriate buffer strips at appropriate field drainage locations
- Install (or maintain) farm level wind breaks

Equine Farm Owners/Managers

- Complete an Environmental Farm Plan (Equine tailored)
- Install site appropriate buffer strips at appropriate field drainage locations
- Maintain septic systems through regular pumping of septic tanks

The key barriers to adoption of the above P-BMPs uncovered by the study's research were: lack of knowledge (e.g. equine farm owners lack information on how to participate in the Environmental Farm Plan (EFP) Program); lack of motivation (e.g. low motivation to increase frequency and number of field sites for soil testing); inconvenience (e.g. few programs in place to support installation of windbreaks); and, a lack of social pressure (e.g. economic sustainability of crop production trumping environmental sustainability of aquatic habitat and water quality).

The study's findings recommend the initiation of a CBSM pilot program for equine farms drawing on the recommendations found in this report. The pilot program should be developed in conjunction with the equine community so that the willingness to implement behaviour changes can be measured and evaluated during the pilot phase.

For the Cash Crop and Potato farmers, further research is required to determine the willingness to change behaviours based on the individual CBSM tools and the target behaviours that will be selected for a CBSM strategy. Recommendations on next steps for further research are included in this report.

This project was funded by the Canada-Ontario Agreement Respecting the Great Lakes Ecosystem.

TABLE OF CONTENTS

APPENDICES

2. INTRODUCTION AND BACKGROUND

The Situation

The Innisfil Creek subwatershed, located in south-central Ontario, comprises 491 km^2 of area with watercourses, which eventually drain into Georgian Bay. Land use activities in the area are dominated by intensive agriculture uses, with extensive acreage in the potato, sod, carrots, onion, and cash crop sectors.

Water quality, based on total phosphorus and total suspended solids levels, received an "F" grade in the Innisfil Creek Subwatershed Report Card (Nottawasaga Valley Conservation Authority, 2007), identifying both non-point (diffuse source) and point source (direct source) contributors.

Recognizing the water quality issues in a subwatershed dominated by intensive agricultural activity, the Ontario Ministry of Agriculture and Rural Affairs (OMAFRA) and the Nottawasaga Valley Conservation Authority (NVCA) developed a two-phase, Community-Based Social Marketing project to identify and test pilot opportunities that may achieve desired behavioural change in the management of nutrients in agriculture operations. The agencies retained Lura Consulting for the first phase of the project, with the purpose of identifying potential behavioural changes in the management of nutrients in the agricultural community, the barriers to adoption of the new behaviours, and the benefits of potential phosphorus reduction that would accrue by altering current management practices.

Purpose of the Project

In 2007, the governments of Canada and Ontario signed a new Canada-Ontario Agreement (COA) – Respecting the Great Lakes Basin Ecosystem to continue actions to restore and protect the Great Lakes environment. Under the 2007-2010 COA, Annex 3 - Goal 1 is 'to encourage and enhance Great Lakes sustainability to achieve social, economic and aquatic ecosystem well-being.' Specifically, Annex 3 - Goal 1, Result 1.1 (a) (2007-2010 COA 3.1.1 a) commits to:

Develop a coordinated multi-year action plan to increase Basin residents' awareness and appreciation of the Great Lakes, including better understanding of the relationship between social and economic well-being and healthy aquatic ecosystems.

The Ontario Ministry of the Environment, in consultation with COA party-agencies (i.e., Ontario Ministry of Natural Resources, Ontario Ministry of Agriculture Food and Rural Affairs, and Environment Canada), is developing a CBSM initiative for phosphorus reduction in the Ontario Great Lakes basin. This project, led by the Ontario Ministry of Agriculture, Food and Rural Affairs in partnership with the Nottawasaga Valley Conservation Authority, seeks to add to the understanding of the phosphorus issue with respect to agricultural practices in the Innisfil Creek subwatershed, and assist in addressing the COA commitment to increase Great Lakes Basin residents' awareness, protection and appreciation of the Great Lakes.

Recognizing there are existing and ongoing programs (e.g. Environmental Farm Plans) that are addressing stewardship in the agricultural community, the purpose of this two-phase project is to:

1. Identify barriers to, and benefits of, better nutrient management in the agricultural industry, leading to phosphorus reduction in the water courses of the Innisfil Creek subwatershed; and

2. Change land practice behaviours within the agricultural community to BMPs that will reduce phosphorus loading in the subwatershed, with the goal of establishing a social norm.

While urban and other rural residential and industrial sources may also be a causal agent of phosphorus input to the water courses of the subwatershed, this study did not explore the behaviours of those target audiences.

The purpose of this report is to:

1. Document the CBSM research methods, including the literature review, consultation with partners/experts, and focus groups, used to develop a list of potential target behaviours;
2. Describe the target audiences selected and list of potential desired behaviours derived from research;
3. Describe barriers to, and benefits of, adoption of the behaviours;
4. Document the method of selection of a shortlist of behaviours; and
5. Outline recommendations of next steps for the development of a CBSM pilot and implementation strategy.

Readers of this report will recognize that the phosphorus loading issue varies from watershed to watershed, based on a number of factors such as the percentage of natural land cover, land uses, extent of paved urban area and roadways, population, topography, best management practice implementation and other hydro-geological watershed characteristics. Further targeted research will be required to determine specific local attitudes and behaviours and the associated barriers and benefits to changing those behaviours for the residents of different watersheds.

Community-Based Social Marketing

The research study was carried out using the principles of Community-Based Social Marketing (CBSM). CBSM seeks to determine preferred behaviours and who should be performing them (referred to as target audiences) in order to implement behaviour change strategies that have a positive, sustainable impact. In order to maximize adoption of the desired behaviours, research is conducted to determine the barriers to adoption, and strategies are developed to remove those barriers. As well, the benefits of adoption are determined so that the potential positive impact of the behaviour can be assessed, as well as communicated to the target audience to provide motivation. The behaviours with the most potential for meaningful impact have fewer barriers (which increases the likelihood that they will be adopted by more people in the target audience) and greater benefits.

A fundamental principle of CBSM is that behaviour change is most effectively achieved through initiatives delivered at the community level. Unlike traditional mass-media advertising campaigns, CBSM employs direct, personal contact with the target audience.[ii]

3. RESEARCH METHODOLOGY OVERVIEW

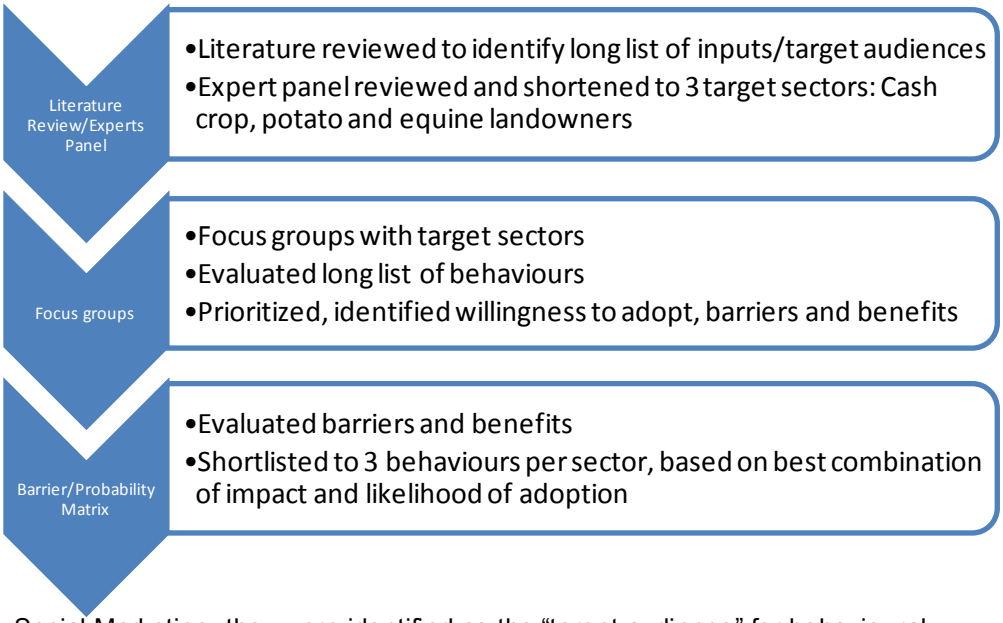
This report focuses on steps 1 and 2 of the CBSM strategy development and implementation process:

1. Identifying benefits and barriers to adoption of desired behaviours; and
2. Assessing potential impact of behaviours and developing strategies to remove the barriers to their adoption.

This project followed a 3 step research approach (see Figure 1Research approach) to developing a list of target audiences and preferred behaviours for sustainable nutrient management in the subwatershed.

The first step identified the target audiences for a CBSM campaign. A long list of potential phosphorous inputs was developed through a review of literature on the subject and examination of activity in the study area. That list was evaluated in a workshop by a group of 16 experts in phosphorous sources and impacts. The experts distilled the list to 3 significant sources: cash crop farmers, potato farmers, and equine landowner/managers. These three groups were identified as being the most important sources of phosphorous in the watershed and the groups which should be targeted for promotion of BMPs. In the language of Community-Based

FIGURE 1RESEARCH APPROACH



Social Marketing, they were identified as the “target audience” for behavioural change.

The second step was to determine the Best Management Practices (termed “target behaviours” in CBSM parlance) that the target audiences should be encouraged to undertake. A long list of BMPs was developed and evaluated in three focus groups: one for each of the three target audiences. In the focus groups participants were asked to provide input on each of the behaviours listed. Their input

included prioritization of the BMPs, whether they were already being performed, and their impact on phosphorous reduction. In addition, the barriers to adoption were identified for each BMP. The list of BMPs explored during the focus groups can be found in Appendix C.

In the third and final step, the input from the focus groups was evaluated to develop a list of three BMPs for each of the three target audiences, based on a combination of likelihood of adoption and the most impact on phosphorous reduction. The evaluation was conducted with the use of a standard CBSM tool, a barriers and benefits impact/probability matrix. The methodology involves assigning numeric values to the impact and probability of adoption of a series of potential behaviours, and then adding these numbers together. This approach readily identifies those behaviours which have the best combination of impact and probability of adoption.

The behaviours with the highest probability and impacts were used to develop the study findings and recommendations.

Limitations of the Research

Although the information gathered through the research was comprehensive, a limiting factor was the attendance at the equine focus group, which was limited to only two participants. In order to gather more input, interviews were conducted with 6 equine landowners after the focus group, bringing the input for the equine group up to the level of the other two sectors.

4. RESULTS

This section of the report explains how the Target Audiences and BMPs were selected and evaluated. Each of the following headings refers to a step in an iterative process used to generate and evaluate a long list of Target Audiences and BMPs and narrow down to the most important to pursue in the Innisfil Creek subwatershed.

Literature Review

An extensive review of available literature was conducted to seek information on:

- Best Management Practices for nutrient management;
- Community-Based Social Marketing programs related to agriculture, water and water quality;
- The effects of phosphorous on water bodies; and
- The health of the Great Lakes, particularly Lake Huron.

A complete list of references of the documents that guided this portion of the research can be found in Appendix A.

A long list of potential target audiences was identified that would be applicable to the Innisfil Creek subwatershed. The list included the following sources of phosphorous:

- Agricultural land uses (including Specialty farms – sod farms, potato farms)

- Municipal land uses (including stormwater, sewage treatment plants)
- Erosion – wind and water
- Rural Residential land uses (including golf courses)
- Rural Natural Land Uses

This list was brought forward for analysis to the next stage of the research, the Experts Group Workshop.

Experts Group

The group of experts on phosphorus, agricultural, and BMPs topics was assembled for a workshop in September 2009. The Experts Group comprised staff from University of Guelph, Ontario Soil and Crop Improvement Association, OMAFRA, NVCA, and Nottawasaga Futures and Lura Consulting.

The purpose of the workshop was to confirm and prioritize the full list of target audiences that had been identified during the literature review as the leading causes of excess phosphorus loading in the Innisfil Creek subwatershed.

The Experts Group reviewed the list of potential phosphorous sources in the subwatershed. After discussion and analysis, the group determined the three most significant contributors and recommended that these would be the most suitable to be targeted for promotion of BMPs to reduce phosphorous loading in the subwatershed. The recommended target audiences were:

1. Cash crop farmers;
2. Potato farmers; and,
3. Equine landowners

The notes from the workshop, including details on the discussions that led to the determination of the target audiences, can be found in Appendix C.

The Experts Group also provided guidance on a prioritized list of BMPs for the target audiences, which was helpful in distilling the long list BMPs down to three for each target audience.

Focus Groups

Based on the recommendations from the Experts Group, three target audience focus group meetings were held in Alliston in early December 2009, one with each of the groups identified above. The purpose of the focus groups was to explore the long list of over 40 selected BMPs and identify the barriers to adoption of the BMPs. The full list of BMPs evaluated can be found in Appendix C.

In each of the focus groups, participants were asked to provide input on all of the BMPs in the list. The tool in Appendix C was used to gather some of that input. As well, in a discussion facilitated by Lura Consulting, the participants discussed each of the behaviours. The facilitator sought to determine participants' perceptions and level of understanding of phosphorous loading from their operations and the barriers

to adopting BMPs in their operations. This information was recorded to inform the decisions on shortlisting the BMPs for each of the three target audiences.

A summary of the findings from the focus groups can be found in Appendix B.

Shortlisting BMPs for Each Target Audience

Following the completion of the focus groups, an analysis of the information on BMPs was conducted for each of the three target audiences.

For each BMP, barriers to implementation and the impact of phosphorous reduction were evaluated and a score for each factor was assigned. The analysis of impacts and probability is a subjective analysis, and the scores assigned were derived from the literature review, Experts Group advice, target audience focus group findings and professional experience.

The scoring for the impact of the BMPs ranges from zero to four with zero (0) meaning that there is no impact to four (4) where there is the highest impact of the behaviour on phosphorus reduction, water quality benefits or on sustainability of that particular behaviour. For the barriers, the range of scores is from zero to four, with zero (0) being no probability of the behaviour being adopted due to barriers to four (4) which would be the highest probability of adoption.

The values in the matrix were derived with input from some members of the Expert Group and were entered into an impact/probability matrix, which is included here as Table 1. The behaviours are organized by target audience.

Table 1: Innisfil Creek Subwatershed - Evaluation of Impact and Probability
Per Behaviour (Input from expert group and target audience focus groups)

ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed ? *(range: 0-4)*	*Which behaviour will have additional water quality benefits?* *(range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem?* *(range: 0-4)*	*Which behaviour has the fewest barriers to overcome* *(range: 0-4*	*Avg*	
	Cash Crop Sector										
CF1	Proper Storage of Fertilizer	0	0		0	0	0	0	0	0	0
CF2	Maintain septic system: pump every 3-5 years	1	1	2	1.33	2	2	3	2	2.25	3.58
CF3	Prepare a EFP	2	2	2	2.0	3	3	2	3	2.75	4.75

ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed? (range: 0-4)	*Which behaviour will have additional water quality benefits? (range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem? (range: 0-4)*	*Which behaviour has the fewest barriers to overcome (range: 0-4*	*Avg*	
CF4	Install windbreak (s)	2	2	2	2.0	3	2	2	1	2.0	4.0
CF5	Maintain Windbreak (s)	2	3	4	3.0	3	3	3	3	3	6.0
CF6	Establish appropriate riparian buffer zones	3	3	3	3.0	4	2	3	2	2.75	5.75
CF7	Use of cover crop after harvest	3	4	4	3.33	3	3	4	3	3.25	6.58
CF8	Apply P fertilizer at appropriate rate using GPS technology	3	2	3	2.67	2	2	3	2	2.25	4.92

ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed? *(range: 0-4)*	*Which behaviour will have additional water quality benefits?* *(range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem?* *(range: 0-4)*	*Which behaviour has the fewest barriers to overcome* *(range: 0-4*	*Avg*	
	Potato Farming Audience										
PF1	Apply P fertilizer at appropriate rate using soil testing	3	3	3	3	2	1	3	1	1.75	4.75
PF2	Apply P fertilizer at appropriate rate using GPS technology	3	3	2	2.67	2	2	3	2	2.25	4.92
PF3	Apply fertilizers to land at appropriate rate, time and place	3	3	3	3.0	3	3	3	3	3.0	6.0

ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed? *(range: 0-4)*	*Which behaviour will have additional water quality benefits?* *(range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem?* *(range: 0-4)*	*Which behaviour has the fewest barriers to overcome* *(range: 0-4*	*Avg*	
PF4	Apply nutrients (manure) in the spring, summer and fall (depending on crop) and at the right rate	2	2	1	1.67	2	1	3	2	2.0	3.67
PF5	Install site-appropriate buffer strips at appropriate drainage locations	4	4	3	3.67	3	2	4	2	2.75	6.42
PF6	Install farm level wind breaks	3	3	3	3.0	3	2	4	3	3.0	6.0

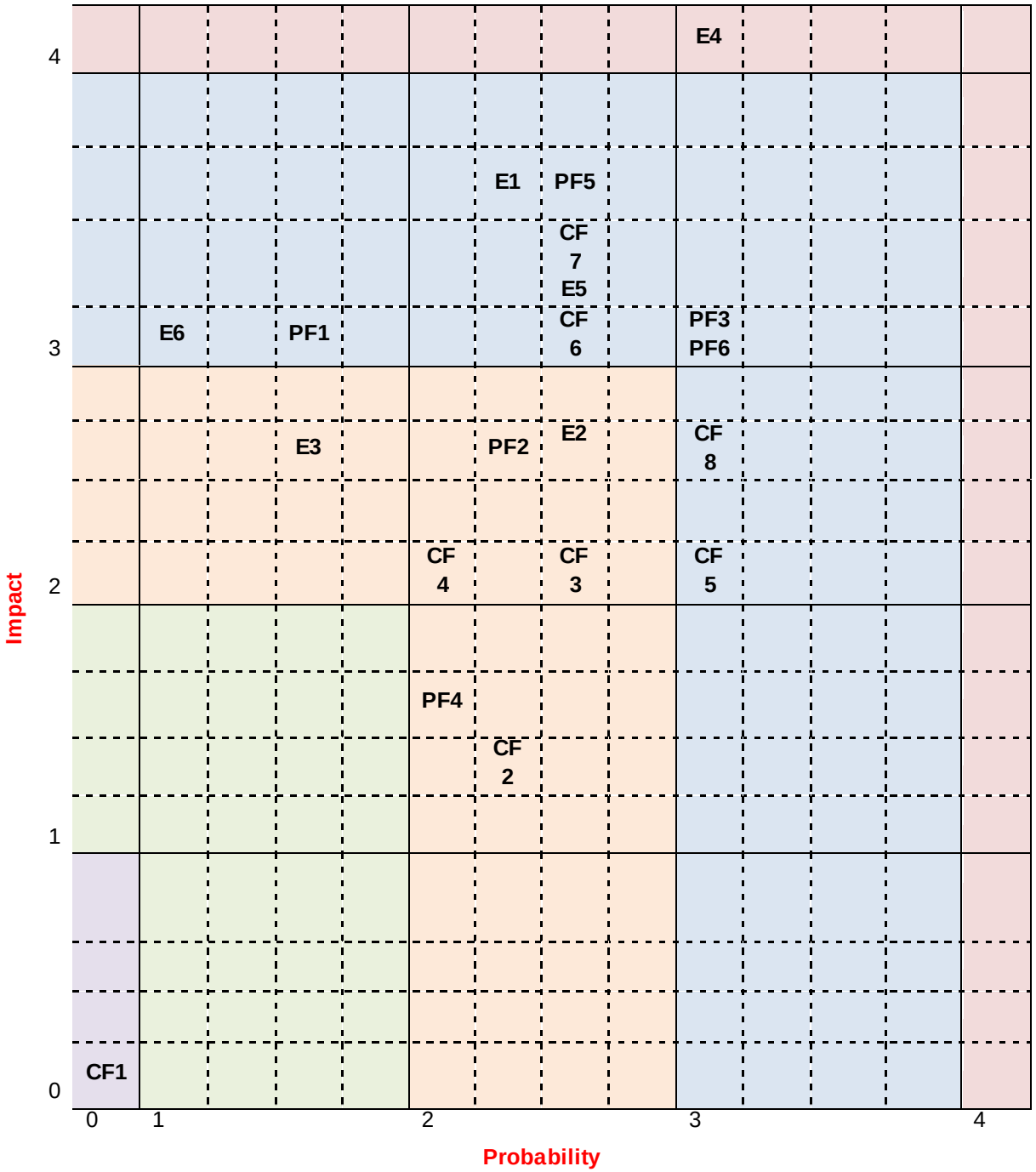
ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed? *(range: 0-4)*	*Which behaviour will have additional water quality benefits?* *(range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem?* *(range: 0-4)*	*Which behaviour has the fewest barriers to overcome* *(range: 0-4*	*Avg*	
	Equine Farm Audience										
E1	Complete Equine Adapted EFP	4	3	3	3.33	2	3	3	2	2.5	5.83
E2	Apply rotational grazing practices in pasture lands	2	3	3	2.67	3	2	3	3	2.75	5.42
E3	Apply nutrients (manure) in the spring, summer and fall and at the right rate	2	3	3	2.67	2	0	2	2	1.5	4.17

ID	BEHAVIOUR	IMPACT				PROBABILITY					Sum of Avgs.
		Which behaviour will result in the highest reduction of P to watershed? (range: 0-4)	*Which behaviour will have additional water quality benefits? (range: 0-4)*	*Which behaviour is the most sustainable? (range: 0-4)*	*Avg.*	*Which behaviour will be the most affordable to promote to my audience? (range: 0-4)*	*Which behaviour will be the most affordable for my audience to adopt? (range: 0-4)*	*For which behaviour will it be easiest to show a link to the problem? (range: 0-4)*	*Which behaviour has the fewest barriers to overcome (range: 0-4*	*Avg*	
E4	Install site-appropriate buffer strips at appropriate drainage locations	4	4	4	4	3	3	3	3	3.0	7.0
E5	Maintain septic systems through regular pumping	3	4	3	3.33	3	2	3	3	2.75	6.08
E6	Employ manure storage BMP	4	3	2	3.0	1	1	2	1	1.25	4.25

Note: For each audience above, the three behaviours that scored highest are highlighted in grey.

The respective values assigned to the impacts and the probabilities of adoption were plotted in a graph to illustrate the findings and graphically illustrate the combined value for each behaviour. In the graph below, the BMPs which warrant the most attention are up and to the right.

Table 2: Probability & Impacts Graph



Note: See ID codes on previous table to identify behaviours

The result of the analysis is a shortlist of three BMPs for each of the target audiences.

- Cash Crop Sector
    - Maintaining wind breaks (CF5)
    - Establish appropriate riparian buffer zones (CF6)
    - Using cover crop after harvest (CF7)
- Potato Producers Sector
    - Apply fertilizers to land at appropriate rate, time and place (PF3)
    - Install site appropriate buffer strips at appropriate field drainage locations (PF5)
    - Install (or maintain) farm level windbreaks (PF6)
- Equine Farm Owners/Managers Sector
    - Complete an Environmental Farm Plan (E1)
    - Install site appropriate buffer strips at appropriate field drainage locations (E4)
    - Maintenance septic systems through regular pumping of septic tanks (E5)

5. BARRIERS AND BENEFITS

Through the process of identifying the BMPs for each target audience, barriers and benefits for each of the preferred practices were also established. This section is organized by target audience and describes each BMP, the associated barriers to adoption, and the benefits of adoption. Each of the barriers and benefits listed below were identified in the focus groups and represent the statements made.

Cash Crop Sector

Maintaining Wind Breaks (CF5)

Many farm properties throughout the subwatershed have vegetative wind breaks that were established in the past as part of programs to target wind erosion of farm soil. The social norm was to install wind breaks with young trees and then let them mature. Maintenance instructions for the wind breaks were either never given to the farmers or have been forgotten as the wind break grew. Over time, many of the wind breaks have grown into a solid vegetative wall with little or no wind porosity. If the wind break is a solid mass of material, the wind will simply flow over the wind break and continue on with the eroded soil from the farm. On the other hand, if the wind break is maintained through silvicultural practices by removing approximately one third of the trees as they grow, this will slow the wind allowing the soil to be deposited on the adjacent field and not deposited in the watercourses with the resulting phosphorus loading. The best farm wind breaks will act much like a snow

fence with thirty percent porosity to slow the wind and deposit the snow/soil on the lee side of the windbreak. As farm equipment has improved and increased in size, there has been a general farm practice to remove fencerows and associated wind breaks to allow for a larger and more equipment-friendly field layout. Maintaining a wind break involves removing dead and diseased trees and approximately every third tree to maintain thirty percent porosity.

Barriers identified by farmers to establishing wind breaks include:

- Mixed messages from government in the past about the use of wind breaks. Programs have been offered to incent farmers to both install and remove wind breaks creating confusion about the best practice;
- Perception of reduction in crop yields caused by wind breaks;
- Lack of understanding of the wind dynamics associated with wind breaks and soil movement by the wind;
- Wind breaks installed in the past using inappropriate plant material, that have little beneficial effect;
- Belief that the wind break will bring additional wildlife to the farm field, resulting in crop losses;
- Belief that there is no benefit for the small associated cost of this activity.

Benefits to this behaviour include:

- Soil maintained on farm;
- Firewood from wind break thinning;
- Reduction in home heating costs.

Establish appropriate riparian buffer zones (CF6)

The establishment of riparian buffers zones adjacent to farm fields has been scientifically demonstrated to significantly reduce soil erosion and the subsequent nutrient deposit into the surface water of creeks and streams. A generic buffer of 10 to 30 meters along a riparian zone has become the norm but is not always the best approach to providing a vegetative filter for field runoff. An enhanced buffer zone at the intersecting portion of the riparian zone and the low or drainage portion of the field would provide additional nutrient filtration. The remainder of the field could have a reduced buffer strip since drainage off the field does not flow through those areas. The overall impact is reduced farm land loss to the riparian buffer, with increased effectiveness of nutrient filtration and soil erosion from the targeted buffer.

Barriers identified by farmers to establishing appropriate riparian buffer zones include:

- Loss of farm land to riparian buffer establishment and thus reduction in farm income;

- Harder to work with farm equipment on non-square or rectangular fields that would result from targeted buffer zones on the low or drainage portion of the field/riparian zone;
- Cost of establishment of the buffer strip on a riparian zone;
- Cost to maintain and keep noxious weeds from buffer strip;
- Not seen as a benefit to farm or landowner;
- Society benefits, so society should pay for establishment and loss of crop land (alternative land use services concept).

Benefits to this behaviour include:

- Incentive programs to establish buffers do work, especially if farm in-kind resources are properly valued;
- Social norm, especially if other landowners on the same stream have installed a buffer.
- Reduction in nutrient loss from fields to streams
- Improvement in overall stream water quality

Using cover crop after harvest (CF7)

After the fall harvest of cash crops, fields are sometimes left as bare soil until the following spring when they are planted to a new crop again. The use of cover crops can provide multiple benefits to the farm, through reduction of soil erosion, increase in soil nutrients and organic matter to name a few.

Barriers identified by farmers to this behaviour include:

- Lack of knowledge about this BMP;
- Cost of establishing the buffer crop and lack of knowledge of financial benefits of this BMP;
- Not knowing the best cover crop to use, following the harvest of different crops;
- Changing or non-conducive spring or fall weather patterns do not allow for consistent planting the same type of cover crops on a yearly basis.

Benefits to this behaviour include:

- Increased yields and reduction of crop input cost;
- Increased organic material in the soil;
- Reduced erosion.

Potato Producers Sector

Apply fertilizers to land at appropriate rate, time and place (PF3)

Potato farmers apply fertilizers based on historical practices and previous yield, or with the use of soil tests. Soil testing is infrequently used in this subwatershed by potato producers, since the application of fertilizers is used throughout the season to increase crop yield.

Install site appropriate buffer strips at appropriate field drainage locations (PF5)

The establishment of riparian buffers zones adjacent to potato fields has been demonstrated to reduce soil erosion and the subsequent nutrient deposit into the surface water of creeks and streams. The generic equal sized buffer usually of 10 to 30 meters along a riparian zone has become the norm but is not always the best approach to providing a vegetative filter for field runoff to the riparian zone. An enhanced buffer zone at the intersecting portion of the riparian zone and the low or drainage portion of the field would provide additional nutrient filtration. The remainder of the field could have a reduced buffer strip since drainage off the field does not flow through those areas. The overall impact is less farm land loss to the riparian buffer, with increased effectiveness of nutrient filtration and soil erosion from the targeted buffer.

Barriers identified by farmers to installing site appropriate buffer strips include:

- Loss of farm land to riparian buffer establishment and thus reduction in farm income;
- Harder to work with farm equipment on non-square or rectangular fields that would result from targeted buffer zones on the low or drainage portion of the field/riparian zone;
- Cost of establishment of the buffer zone;
- Cost to maintain and keep noxious weeds from buffer zone;
- Not seen as a benefit to farm or landowner;
- Society benefits, so society should pay for establishment and loss of crop land (alternative land use services concept);
- Too dependent on lay of the land for establishment of field rows and turning strip for equipment.

Benefits to this behaviour include:

- Properly placed and designed buffer will reduce the amount of land removed from agricultural production;
- Incentive programs to establish buffer strips do work, especially if farm in-kind resources are properly valued;

- Social norm, especially if other landowners on the same stream have installed a buffer.

Install (or maintain) farm level wind breaks (PF6)

See discussion under CF5 on wind breaks. The only difference is that the potato farmers identified the need to keep wind breaks at the farm level and not at the field level, due to planting and harvesting equipment needs.

Barriers identified by farmers to appropriate farm level wind breaks include:

- Mixed messages from government in the past about the use of windbreaks. Programs have been offered to incent farmers to both install and remove wind breaks creating confusion about the best practice;
- Perception of reduction in potato crop yields caused by windbreaks at the field level;
- Lack of understanding of the wind dynamics associated with wind breaks and soil movement by the wind;
- Wind breaks installed in the past using inappropriate plant material that have little beneficial effect;
- Belief that the windbreak will bring additional wildlife to the farm field, resulting in crop losses;
- Belief that there is no benefit for the associated cost of this activity.

Benefits to this behaviour include:

- Soil maintained on farm;
- Firewood from windbreak thinning.

Equine Farm Owners/Managers Sector

Complete an Environmental Farm Plan (Equine tailored, E1)

Many equine farm owners do not associate with traditional farm programs and activities, and as a result have not been inclined to participate in the Environmental Farm Plan program. If an equine tailored EFP could be developed this would be welcomed by the equine farm community.

Barriers identified by farmers to completing an Environmental Farm Plan include:

- Lack of knowledge in farm environmental BMPs;
- Lack of understanding on BMPs for phosphorus reduction;
- Lack of knowledge that the EFP exists and the results from this activity.

Benefits to this behaviour include:

- Social opportunity for equine farm owners to gather and share farm and business experiences in the EFP workshop format.

Install site appropriate buffer strips at appropriate field drainage locations (E4)

See above discussion for PF5. For Equine farm owners, buffer strips on riparian zones represent an additional cost that they are willing to share if incentives are provided to establish a buffer strip and horse exclusion fencing to protect the watercourse.

Barriers to this behaviour include:

- Cost of establishment of the buffer zone;
- Cost to maintain and keep noxious weeds from buffer zone.

Benefits to this behaviour include:

- Properly placed buffer will provide aesthetic appeal for the property;
- Incentive program to establish buffer, especially if equine in-kind resources are properly valued;
- Social norm, especially if other equine farms on the same stream have installed a buffer.

Maintain septic systems through regular pumping of septic tanks (E5)

Proper maintenance of septic systems ensures an operating system that does not leak. During the research phase of the project, it was determined that there is a lack of awareness of septic systems amongst the equine group. Some people in this sector have moved from urban settings into rural areas and are new to septic system maintenance and installation.

Barriers to this behaviour include:

- Lack of knowledge of septic operations;
- Lack of knowledge of effects of improperly maintained septic system and water quality effects.

Benefits to this behaviour include:

- Longer operating term for properly maintained septic systems will mean less cost in the long run

6. ADDITIONAL RESEARCH FINDINGS

Beyond the findings regarding barriers and benefits, the research process identified other important aspects of the target audiences and preferred BMPs.

The following describes relevant findings of the research with respect to BMPs and program delivery. This list can inform the design of further research, particularly with crop and potato farmers.

Behaviour findings:

1. **The traditional crop and potato agricultural audiences have a good understanding of phosphorus issues and a relatively good understanding of the impacts.** With high value crops such as potatoes, Innisfil Creek farmers are well informed of nutrient management BMPs to maximize yields, while at the same time they understand there may be negative environmental impacts to the local watercourses relative to phosphorus inputs, however these farmers are willing to consider phosphorus reduction BMP options to reduce the negative impacts. (in support of behaviours PF3).

2. **Wind and water soil erosion are suspected to be major contributors of phosphorus in the Innisfil Creek subwatershed based on evidence of 'dirty snow' and muddy streams during storm events.** Relatively few programs are in place to support installation of wind breaks to combat wind erosion. There are no existing programs that deal with maintenance of wind breaks. Water erosion is being dealt with in an ad-hoc manner through a variety of programs that confuses the local agricultural audience (in support of behaviours PF5,6 and CS5,6,7).

3. **Phosphorus inputs to agricultural lands in the Innisfil Subwatershed are a lesser problem than wind and water erosion.** Farmers do not tend to over-apply nutrients, but rather apply the right amount at the right time to maximize yields and save money (in support of behaviour PF3).

4. **A significant barrier to action is that equine farm owners lack information on what they can do to assist with reducing phosphorus inputs to the subwatershed.** The Environmental Farm Plan does not generally target this farm audience and equine farm owners do not circulate amongst traditional farm organizations that could provide the necessary information on incentive programs and BMP adoption (e.g. behaviour E1).

5. **Equine farm owners generally do not have the required knowledge to have their septic systems properly maintained**. With many of the equine farm owners being ex-urbanites and new to rural living, they do not have the history or family connections to understand the need to properly maintain their septic systems. Failure of these septic systems will cause excess phosphorus to enter the watershed (e.g. behaviour PF5, 6).

Targeted program delivery findings:

6. **An effective organizational structure that will organize and coordinate the CBSM program is essential**. This can be as small as a chairperson and a volunteer committee or a partnership of many different organizations, including the conservation authority, local, provincial and federal governments, research and education institutions, landowners and conservation groups.

7. **Program flexibility is important to allow people to participate in a manner that is convenient and within their reach**. The focus should be on reasonable and practical behaviours, which can be tailored for different areas of the subwatershed and the priorities of local partners. It is best to start with the behaviours that are easiest to adopt and work toward the more difficult behaviours as the target audience gains understanding on the topic.

8. **Timing of a program can influence the program's success, as certain behaviours apply to certain seasons**. The distribution of materials and attempts to gather commitment from the target audience should be scheduled based on the behaviour being promoted. For instance, all farmers should be targeted in the winter season for education on nutrient management BMPs because this is the time of year when there are fewer responsibilities on the farm to attend to.

9. **Program materials should be informative and written in plain language.** Most CBSM programs use posters, distribute information brochures, fact sheets, and guides. Vivid and clear language allows people to best understand the behaviour and the benefits of undertaking the activity.

10. **Great partnerships are essential in the overall success of a campaign.** The Chicago Wilderness Alliance is a good model for the collaborative approach to conservation endeavours, growing from 34 founding organizations to more than 170 participating members. Ideally, the more groups and organizations are participating in a program, the more it gains recognition, and the less effort or resources are needed by each to achieve their individual missions.

7. FURTHER RESEARCH DIRECTIONS TO DEVELOP AN INNISFIL CREEK SUBWATERSHED CBSM STRATEGY

It is recommended that further research on crop and potato farm operations be conducted to further substantiate the findings from this research, particularly with respect to barriers to participation. The generic survey tool in Appendix D could be adopted and implemented using an on-line survey device such as Survey Monkey to confirm the willingness to change behaviours for these target audience. It could also be administered in person, either door-to-door or at an agriculture event. It would be best if a farm organization, such as OSCIA or OFA, conducted the survey as farmers would likely be more comfortable in talking with their peers. Government or government agencies should not conduct the survey, as farmers may be less forthcoming in answering questions.

Following this additional research, it will be possible to improve the barriers and benefits matrix above to determine which behaviours should be targeted for a CBSM pilot program. Through developing a pilot CBSM program to test and evaluate the validity of the strategies for changing target behaviour, there is greater certainty that the audience will actually change behaviour. This will result in the greatest reduction of phosphorus to the Innisfil Creek subwatershed.

After the additional research is conducted, a pilot project should be conducted. Pilot projects provide an opportunity to test CBSM strategies in the field to determine their effectiveness. Sometimes the pilot program will include different approaches to the same end (such as providing one group with an incentive to adopt a BMP and asking a commitment from another, without an incentive) to evaluate the cost-effectiveness of the different approaches. Pilot programs usually identify improvements that can be made to the approach, and sometimes can determine that a component of the strategy is ineffective and should be abandoned. It is important to determine these improvements with a small and relatively inexpensive pilot scale before embarking on a more expensive and rollout. For that reason, it is recommended that all CBSM strategies be piloted on a small scale before the program is rolled out to a larger audience.

After the pilot project is conducted and the CBSM strategy is finalized, the strategy can be rolled out to the full NSVCA watershed. .

It is possible to initiate a CBSM pilot program for equine farms using the recommendations noted above. The pilot program should be developed in conjunction with the equine community so that the willingness to implement behaviour changes can be measured and evaluated during the pilot phase.

8. CONCLUSION

The research conducted through this project has indicated that the three agricultural farming audiences of equine, cash crop, and potato farmers are very willing to do the right thing with respect to best management practices for the reduction of phosphorus to the subwatershed. However, the research suggests that there is a combination of a lack of knowledge among farm operators about the cumulative effects of excess phosphorus in the subwatershed, along with a lack of understanding about which BMP is best for their specific farm operation to reduce the most phoshorus on their property. Operators feel that it is important that they conduct their farm operations in the most environmentally and economically sound manner with the highest regard for land stewardship practices while also maintaining profitability. Sustainability of farm practices to reduce phosphorus in the subwatershed would be best fostered through a CBSM strategy that will ultimately develop a societal norm for these activities. Further, the identified barriers to participation are relavtively few. These findings hold true across all three target farm categories. Futher research involving cash crop and potato farmers is necessary to substantiate the target bahaviours that should be piloted in an CBSM strategy.

An effective phosphorus CBSM strategy can be built on the strong foundation of a very high participation in the Environemental Farm Plan and other stewardship programs by the agricultural community in the Innisfil area.

Endnotes

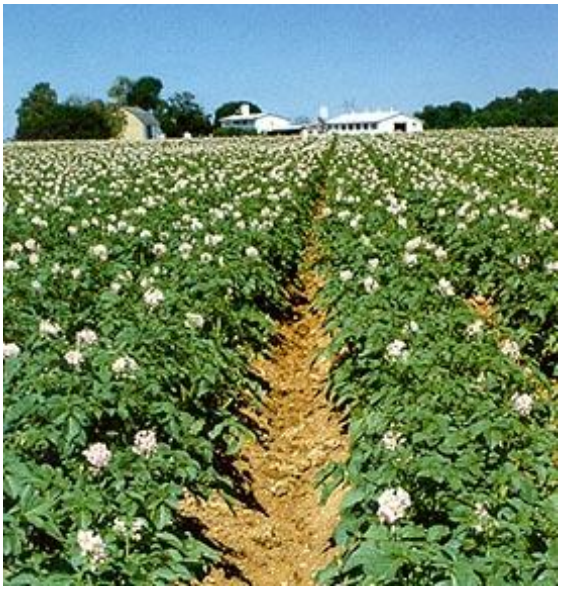
[i] Greenland International Consulting Ltd. (2006). Assimilative Capacity Studies CANWET™ Modeling Project Lake Simcoe and Nottawasaga River Basins. Collingwood: Greenland International Consulting Ltd. Retrieved from: http://www.lsrca.on.ca/pdf/reports/acs/greenland_canwet_modelling.pdf

[ii] McKenzie-Mohr, Doug. (n.d). *Quick Reference: Community-Based Social Marketing* (fact sheet).

Appendix A Literature Review - Bibliography

Innisfil Creek Subwatershed Phosphorus Management

Community-Based Social Marketing Project



January 2010

Bibliography

Prepared by Lura Consulting

LURA
LISTEN · UNDERSTAND · RELATE · ADVANCE

TABLE OF CONTENTS

BIBLIOGRAPHY OF PHOSPORUS RESOURCES

Following is a list of references that guided the development of the Innisfil Creek Subwatershed, Community-Based Social Marketing project. The bibliography lists general references, as well as those relating to Best Management Practices.

Best Management Practices

Agriculture and Agri-Food Canada, December 1997, **Water Quality Matters: Protecting Your Water** (PDF) (4 pp)

Agriculture and Agri-Food Canada, April 2000, **Water Quality Matters: Agricultural Best Management Practices** (PDF) (4 pp)

Agriculture and Agri-Food Canada, April 2000, **Water Quality Matters: Nutrient Management Planning** (PDF) (4 pp)

Agriculture and Agri-Food Canada, April 2000, **Water Quality Matters: Riparian Area Management** (PDF) (4 pp)

Agriculture and Agri-Food Canada, April 2000, **Water Quality Matters: Soil Texture and Water Quality** (PDF) (4 pp)

Barling, Rown D. and Ian D. Moore, "Role of buffer strips in management of waterway pollution: A review," **Environmental Management**, 18(4):543-558 (PDF) (16 pp)

Bjorneberg, David & April Leytern, **Phosphorus Loss with Surface Irrigation**, NRCS Phosphorus BMPs Fact Sheet

Broward County (FL), no date, **Landscape Best Management Practices** (PDF) (2 pp brochure)

Bruce Wilson, no date, **Streambank & Shoreline Protection**, NRCS Phosphorus BMPs Fact Sheet (PDF) (2 pp)

California Stormwater Quality Association, 2003, **Stormwater Best Management Practices Handbook: Municipal** (PDF) (300 pp)

Chambers, P.; Guy, M.; Roberts, E.S.; Charlton, M.N.; Kent, R.; Gagnon, C.; Grove, G. & Foster, N., 2001, **Nutrients and Their Impact on the Canadian Environment** (PDF) (10 pp)

Colorado State University Cooperative Extension, 1994, **Best Management Practices for Phosphorus Fertilization** (PDF) (8 pp)

Environment Canada, 2001, **Nutrients in the Canadian Environment: Reporting on the State of Canada's Environment** (PDF) (90 pp)

Fertilizer Research Organization, no date, **Best Management Practices for Phosphorus (P) Fertiliser Use** (PDF) (2 pp from website:

http://www.fertresearch.org.nz/code-of-practice/best-management-practices-and-ideas/fertiliser-use/best-management-practices-for-ph)

Filson, G. et al., 2009, "Beneficial management practice adoption in five southern Ontario watersheds," **Journal of Sustainable Agriculture**, 33:2,229-252 (PDF) (25 pp)

Gilley, John E. and Bahman Eghball, **Erosion Control Systems**, NRCS Phosphorus BMPs Fact Sheet (PDF) (2 pp)

Heartland Regional Water Coordination Initiative, no date, **Agricultural Phosphorus Management and Water Quality Protection in the Midwest**.

Illinois Council on BMPs, no date, **Phosphorus BMPs**. (PDF) (2 pp brochure)

Iowa Department of Natural Resources, 2004, **Assessments of Practices to Reduce Nitrogen and Phosphorus Nonpoint Source Pollution of Iowa's Surface Waters** (PDF) (380 pp)

Kansas State University 2002, **BMPs for Phosphorus** (PDF) (2 pp. fact sheet)

Lamba, Pamela, Glen Filson and Bamidele Adekunle, 2009, "Factors affecting the adoption of best management practices in southern Ontario," **Environmentalist**, 29:64-77.

Malison, J. & C. Hartleb (eds), 2005, **BMPs for Aquaculture in Wisconsin and the Great Lakes Region** (PDF) (136 pp)

Metropolitan Council/Barr Engineering Co., no date, **Housekeeping: Landscape Design & Maintenance** (PDF) (4 pp fact sheet)

Mullen, Robert et al., 2009, **Best Management Practices for Mitigating Phosphorus Loss from Agricultural Soils**, Ohio State University Extension. (PDF) (4 pp. fact sheet)

No Author, no date, **We Need Your Help to Save the Lakes: Stop Feeding the Algae!** (fact sheet for Lake Arrowhead watershed) (PDF) (5 pp)

No Author, no date, **BMPS for the Homeowner** (PDF) (2 pp brochure)

Ontario Ministry of Agriculture, Food & Rural Affairs, **Best Management Practices Fact Sheets** (http://www.omafra.gov.on.ca/english/environment/bmp_books.htm)

Ontario Ministry of the Environment, March 2003, **Stormwater Management Planning and Design Manual** (PDF) (21 pp)

Papillion Creek Watershed Project, no date, **Best Management Practices** (PDF of website: http://www.papillioncreek.org/best_management.html)

Rao, N. et al., 2009, "Modeling watershed-scale effectiveness of agricultural best management practices to reduce phosphorus loading," **Journal of Environmental Management**, 90:1385–1395

Richards, C.E. et al, 2008, "Assessment of a turfgrass sod best management practice on water quality in a suburban watershed," **Journal of Environmental Management**, 86:229–245.

Rosen, Carl J., 2007, "Proceedings from the Symposium: Best Management Practices for Nutrients and Irrigation Research, Regulation, and Future Directions," **American Journal for Potato Research**, 84:1 (PDF) (1 pp)

Trenholm, Laurie, no date, **Homeowner Best Management Practices for the Home Lawn, University of Florida Extension**, Fact Sheet ENH979 (PDF) (5 pp)

University of Idaho Extension, no date, **BMPs for Phosphorus Management** (PDF) (5 pp from website: http://www.uiweb.uidaho.edu/wq/wqbr/wqbr15.html)

University of Tennessee Agricultural Extension Service, no date, **BMPs for Phosphorus in the Environment** (PDF) (14 pp)

USDA, 1999, **CORE4 Conservation Practices Training Guide: The Common Sense Approach to Natural Resource Conservation** (Conservation Tillage, Nutrient Management, Pest Management, Buffers) (PDF) (395 pp)

USEPA, 1986 (revised 1989), **An Evaluation of the Cost Effectiveness of Agricultural Best Management Practices and Publicly Owned Treatment Works in Controlling Phosphorus Pollution in the Great Lakes Basin** (PDF) (173 pp)

USDA, September 2003, **Agricultural Phosphorus & Eutrophication**, Second Edition, ARS-149

CBSM or Other Communications Projects

Alliance for the Chesapeake Bay Journal, 2007, **Campaign promotes cutting fertilizers to aid Chesapeake Bay; MD Senate passes emissions bill; and more...** (http://www.bayjournal.com/article.cfm?article=3061)

Ballinger, Nicole, 2007, **Casin' the Basin (Volume XV, Spring 2007, Number 1), Don't "P" on Your Lawn!** (article) (PDF) (12 pp)

Bay Journal (no author), 2007, **Campaign promotes cutting fertilizers to aid Chesapeake Bay** [http://www.bayjournal.com/article.cfm?article=3061] (PDF from Bay Journal website)

Bell, Doug; McDonald, Kahli & Lehman, John; 2008, **Assessment of Phosphorus Concentrations in the Huron River in Response to an Ordinance Banning the Use of Phosphorus-Containing Lawn Fertilizers**, October 2008 (PDF) (5 pp)

Beran, S. & McGrath, A., no date, **Restoring the Redwood River** (http://www.cbsm.com/cases/restoring+the+redwood+river_168)

Bergman, Michael, 2008, **Posting on Fostering Sustainable Behaviour listserv re: "Save The Crabs...Then Eat Them' campaign** (PDF of posting)

Brant Lake Improvement Association, March 6 2008, **Minutes of the Interlakes Water Quality Committee** [http://www.brantlake.org/dakotaww.html] (PDF) (2 pp)

CBSM website, no date, **Restoring the Redwood River (summary of the Redwood River Clean Water Project)** [http://www.cbsm.com/cases/restoring+the+redwood+river_168] (PDF) (3 pp)

Chesapeake Bay Program, 2005, **Chesapeake Bay Social Marking Initiative: 2004-2005 Final Report** (PDF) (6 pp)

Chesapeake Club, no date, **Chesapeake Bay Crab Campaign Poster: "Is the grass really greener if all of the blue crabs are gone?"** (Media release)

Chesapeake Club, no date, **Chesapeake Bay Crab Campaign Poster: "No appetizers were injured in the making of this lawn"** (Media release)

City of Ann Arbor, Michigan, no date, **Be "The Hero With The Zero" Phosphorus:**

Naturally-Abundant Nutrient Degrades Water Quality, news release (PDF) (2 pp)

City of Ann Arbor, Michigan, no date, **Phosphorus Ordinance and Lawn Fertilizers – Everything You Need to Know!,** news release (PDF) (2 pp)

City of Oakdale, no date, **Lawn Fertilizer sign** (PDF of sign) (1 pp)

City of Orillia, no date, **Take Action to Reduce Phosphorus Use** (fact sheet) (PDF) (2 pp)

Clean Water Minnesota, no date, **Green Crayon Poster: What crayon will a child need to color a lake in twenty years?** (news release) (PDF)

Clean Water Minnesota, no date, **Obituary for Lake Patricia** (poster) (PDF)

County of Wayne, Michigan, 2003, **Rouge River Nutrient Reduction Campaign Wayne County Department of Environment Progress Summary** (PDF) (4 pp)

Duxbury, L. and Arrowsmith, N., 2008, Australian Government, Land & Water Australia: "The Watershed Torbay experience: Community, change, collaboration and celebration", **River and Riparian Land Management Technical Guideline,** 8, 1-24. (PDF)

Duxbury, L., 2003, **Torbay Catchment Landholder Survey 2002-2003** (PDF) (14 pp)

Duxbury, M., 2007, **Implementing a Relational Worldview: Watershed Torbay, Western Australia – Connecting Community and Place** (PDF) (404 pp)

Empowerment Institute, no date, **2. Natural Lawn – Reducing Your Use of Weed Killers and Fertilizers on Your Lawn** (PDF) (2 pp)

Empowerment Institute, no date, **10. A No Rainer – Installing a Rain Barrel or Downspout Extension** (PDF) (2 pp)

Genskow, Ken, 2008, "Using Social Indicators to Reduce Nonpoint Source Pollution," **Environmental Communication and Social Marketing**, Summer 2008, page 5 (PDF) (1 pp)

Grand River Conservation Authority, no date, **Rural Water Quality Program (overview from website)** [http://www.grandriver.ca/index/document.cfm?sec=25&sub1=0&sub2=0] (PDF of website)

Grand River Conservation Authority, no date, **Water: Ours to Protect** (Eligibility brochure for funding opportunities) (PDF) (2 pp)

Howard, J. and McGregor, D., 2000, "Reducing nutrient enrichment of waterways through public education: a tale of two cities", **Environmental Conservation**, 27: 351-358.

Johnson, Gretchen, 2007, **Community Based Social Marketing that Improve Rural Water Quality – posting on CBSM website** (PDF) (4 pp)

The Kalamazoo River/Lake Allegan TMDL Implementation Committee, 2002, **Kalamazoo River/Lake Allegan Watershed Total Maximum Daily Load (TMDL) for Phosphorus** (PDF) (2 pp)

Ladies of the Lake, no date, **Social Marketing: It's Gotta Be Fun!** (presentation slides) (PDF) (14 pp)

Michigan State University, no date, **Kalamazoo River Watershed Phosphorus Reduction – Five years of progress** (PDF) (4 pp)

Michigan State University Extension, 2001, **Coordinating Phosphorus Reduction in the Kalamazoo River/Lake Allegan Watershed (Grant Outline)** (PDF)

Michigan State University Extension, 2007, **Enhancing Phosphorus Reduction Strategies in the Kalamazoo River Basin Project – Volunteer Water Quality Monitoring Results 2006 Growing Season** (PDF) (2 pp)

Labadie, P., no date, **Huron River Watershed Council – Phosphorus Information & Education Efforts Presentation** (PDF) (16 pp)

Lake Champlain Basin Program, 2009, **Education & Outreach Materials and Programs** (http://www.lcbp.org/programs)

Lake Champlain Basin Program, no date, **Fertilizer poster: "When you're fertilizing the lawn, remember you're not just fertilizing the lawn"** (news release) (PDF)

Lake Champlain Basin Program, no date, **Fact Sheet Series: Nonpoint Source Pollution (Number 2)** (PDF) (6 pp)

Lake Champlain Basin Program, no date, **Oil leak poster: "When your car's leaking oil on the street, remember it's not just leaking oil on the street"** (news release) (PDF)

Lake Champlain Basin Program, no date, **Pet waste poster: "When your pet goes on the lawn, remember it doesn't just go on the lawn"** (news release) (PDF)

Lake Champlain Basin Program, 2005, **List of Phosphorus-Free Automatic Dishwashing Detergents** (PDF)

Lawn to Lake, 2009, **What's the fuss about phosphorus?** (http://www.lawntolake.org/phos.htm)

Lawn to Lake, 2008, **Don't P on your lawn!** (http://www.lawntolake.org)

Lubnow, F.S. & Macalle-Holly, D., 2008, North American Lake Management Society

Ministry of the Environment, May 26, 2008, **Cleaning Lakes by Reducing Phosphorus** (PDF of posting on OntarioGardening.com)

Ochlockonee River Soil and Water Conservation District, no date, **TAPP Program Overview** (fact sheet) (PDF) (2 pp)

Partnership for Phosphate Reduction, 2009, **New Idea for Phosphorus Reduction from Sweden** (http://www.dcphosphatefree.org/012109_swedes.html)

Phosphorus Action Group, no date, **Algae Buster Campaign** [http://www.sercul.org.au/pag.html] (PDF of website)

Province of Manitoba, 2007, **Province Launches Education Campaign to Promote Individual Action to Protect Manitoba Waterways,** news release, June 28 (PDF) (1 pp)

Red Cedar TMDL Coordination Team, 2009, **2009 Semi Annual Report for Partnership for Conservation Implementation** (PDF) (2 pp)

Red Cedar River TMDL (Total Maximum Daily Load) Coordination Team, 2007, **Red Cedar River TMDL Report** (PDF) (3 pp)

River Country RC&D, 2009, **Farmer Designed Pilot Project a Success** (news release) (PDF) (2 pp)

Ryan, Clare, 2009, "Managing Nonpoint Source Pollution in Western Washington: Landowner Learning Methods and Motivations," **Environmental Management,** 43:1122–1130. (PDF)

Town of Southeast New York, no date, **Public Education and Outreach on Storm Water Impacts** (http://www.townofsoutheast-ny.com/Public_Documents/SoutheastNY_Planning/Storm/outreach)

U.S. Environmental Protection Agency (EPA), 2001, **EPA Nonpoint Source Pollution Focus Groups Final Report** (PDF) (48 pp)

U.S. Environmental Protection Agency (EPA), 2003, **Getting In Step: A Guide for Conducting Watershed Outreach Campaigns** (PDF) (136 pp)

USEPA, 2003, **Getting in Step: A Guide for Conducting Watershed Outreach Campaigns** (PDF) (136 pp)

USGS, 2007, **Enhancing Lakefront Buffer Adoption through Social Marketing (pilot project) – Abstract** (PDF) (1 pp)

USGS, 2007, **Report as of FY2007 for 2005ME81B: "Enhancing Lakefront Buffer Adoption through Social Marketing (pilot project)"** (PDF) (8 pp)

Valatka, R, 2009, **Press Release – Partnership for Phosphate Reduction: New Idea for Phosphorus Reduction From Sweden** (PDF) (2 pp)

Wayne County Department of Environment, 2003, **Rouge River Nutrient Reduction Campaign: Progress summary** (PDF) (4 pp)

Wilbur, Jack, 2006, **Getting Your Feet Wet with Social Marketing: A Social Marketing Guide for Watershed Programs** (PDF) (143 pp)

Winquist, Aileen, no date, **Chapter 10 – The Neighborhood Water Stewardship Program:**

An Innovative Approach to Behavior Change in Northern Virginia (PDF) (7 pp)

Yokel, Lee S., 2008, **Gulf of Mexico Alliance Environmental Education Network,**

Eutrophication/Algal Growth

Andersen, Jesper H., Louise Schluter and Gunni Aertebjerg, 2006, "Coastal eutrophication: recent development in definitions and implications for monitoring strategies," **Journal of Plankton Research**, 28(7):621-628

Chambers P.A., C Vis, R.B. Brua, M Guy, J.M. Culp & G.A. Benoy, 2008, "Eutrophication of agricultural streams: defining nutrient concentrations to protect ecological condition," **Water Science and Technology**, 58: 2203–2210

Charlton, M., M. Giddings, C. Holmes, W. Carmichael, J. Ridal, S. Watson and B. Brownlee, 2001, **Threats to Water Quality: Algal Toxins and Taste and Odour**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 01-176

Daniel, T.C., A.N. Sharpley, J.L. Lemunyon, 1998, "Agricultural phosphorus and eutrophication: a symposium overview," **Journal of Environmental Quality**, 27:251-257

Higgins, S. N. and Hecky, R. E., 2007, **Modeling and Managing Cladophora Growth in the Laurentian Great Lakes**, A technical report submitted to the Ontario Ministry of the Environment

Higgins, Scott N., Sairah Y. Malkin, E. Todd Howell, Stephanie J. Guildford, Linda Campbell, Veronique Hiriart-Baer, Robert E. Hecky, 2008, "An ecological review of *cladophora glomerata* (chlorophyta) in the Laurentian Great Lakes," **Journal of Phycology**, 44(4):839-854

Hiriart-Baer, V.P., L.M. Campbell, S.N. Higgins, M.N. Charlton, L.F. Moore, S.J. Guildford and R.E. Hecky, 2007, **Cladophora Resurgent and Revisited: A Brief Literature Review**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 07-252

Hyland, Charles, Quirine Ketterings, Dale Dewing, Kristen Stocktin, Karl Czymmek, Greg Albrecht, Larry Geohring, 2005, **Phosphorus Basics – The Phosphorus Cycle**, Nutrient Management Spear Program, Cornell University Cooperative Extension, Agronomy Fact Sheet Series, Fact Sheet 12 (PDF) (2 pp)

Keddy, Paul, 2000, "Eutrophication: too much of a good thing", **Wetland Ecology: Principles and Conservation**, Cambridge Studies in Ecology, pg. 267

Phosphorus, Nutrients, Soil Fertility

Phosphorus - General

Agriculture Canada, no date, *Chapter 18: Phosphorus*, in **Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series—Report #2** (PDF) (5 pp)

Author Unknown, no date, **Indicator: Phosphorus Discharges from Detroit Wastewater Treatment Plant**, pages 294 – 296 (PDF) (3 pp from unknown document)

Bay County, Michigan, no date, **Phosphorus Ban website** (PDF) (1 pp)

Bruulsema, T.W., G. Paliyath, A. Schofield, & M. Oke, 2004, "Phosphorus and phytochemicals," **Better Crops**, 88(2): 6-11 (PDF)

CBC website, 2008, **Canada moves to cut phosphates to fight algae problem** (http://www.cbc.ca/canada/montreal/story/2008/02/15/qc-phosphates0215.html)

Environment Canada, 2009, **Phosphorus Guidance: National Pollutant Release Inventory** (PDF) (1 pp from website)

Lean, D.R.S. and Charlton, M.N. and Burnison, B.K. and Murphy, T.P. and Millard, S.E., 1975, "Phosphorus: changes in ecosystem metabolism from reduced loading," **Verh. Internat. Verein. Limnol**, 19: 249-257.

Michigan Department of Environmental Quality, 2007, **Phosphorus Policy Advisory Committee: Final Report**, March 15 (PDF) (23 pp)

Minnesota House of Representatives, 2004, **The Continuing Concern over Phosphorus** (information brief) (PDF) (10 pp)

Mullins, G. et al., no date, **SERA-17 Phosphorus Management and Policy Workgroup: Position Papers on Key Scientific Issues** (PDF) (1 pp)

Nürnberg, Gertrud, 2007, "Internal Phosphorus Loading in Ontario Cottage Country," **Canadian Society of Environmental Biologists**, 64(4): Winter

Osmond, D. L. et al., no date, **Phosphorus Management within Multi-State Watersheds** (PDF) (12 pp)

Van Bochove, E.; Thériault, G.; Dechmi, F. and Leclerc, M.-L., 2007, "Section 18: Phosphorus" in **Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #2** (PDF) (5 pp)

Wiederholt, R & B. Johnson, 2005, **Phosphorus Behavior in the Environment**, North Dakota State University Extension Service Fact Sheet NM-1298, November (PDF) (4 pp)

USDA - Natural Resources Conservation Service, 1994, **The Phosphorus Index: A Phosphorus Assessment Tool** (PDF) (11 pp)

USEPA, **Introduction to the Limnology Program and Overview of Results** (PDF) (Great Lakes Limnology Program website, 5 pp)

USEPA, 2007, **Phosphorus** (PDF) (5 pp from Technology Transfer Network Air Toxics website)

Nonpoint Phosphorus

Carpenter, S. R. et al., 1998, "Nonpoint pollution of surface waters with phosphorus and nitrogen," **Ecological Applications**, 8(3): 559–568 (PDF) (10 pp)

Issues in Ecology, 1998, **Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen** (PDF) (14 pp)

No Author, Excerpt from NPS Strategy, **Nonpoint Source** (PDF) (6 pp)

Panda, R. K. & S. Behara, 2003, "Non-point source pollution of water resources: problems and perspectives," **Food, Agriculture & Environment**, 1(3&4): 308-311 (PDF) (4 pp)

Nutrients - Agricultural Sources

Anderson, B. H., and F. R. Magdoff, 2000, "Dairy farm characteristics and managed flows of phosphorus," **American Journal of Alternative Agriculture**, 15(1):19-25

Baum, K., Pierzynski, G., Kleinman, P., Kovar, J., Maguire, R., Moore, P., and Zhang, T.Q., 2006, "Evaluating the influence of storage time, sample handling method and filter paper on water-extractable phosphorus in animal manures," **Communications in Soil Science and Plant Analysis**, 37: 451-463

Bittman, S., Forge, T.A., Kowalenko, C.G., Hunt, D.E., Bounaix, F., and Zhang, T.Q., 2007, **Long Term Effects of Dairy Manure on Grass: Production and Soil Nutrient Shifts**, 2007 Annual Meeting of CPS-SCP (with Plant Canada 2007), Saskatoon, SK, Canada, June 10-14, pp. SG3-4

Diebel, Matthew W., Jeffrey T. Maxted, Dale M. Robertson, Seungbong Han, M. Jake Vander Zanden, 2009, "Landscape planning for agricultural nonpoint source pollution reduction iii: assessing phosphorus and sediment reduction," **Environmental Management**, 43:69-83 (PDF) (15 pp)

Parry, Roberta, 1998, "Agricultural phosphorus water quality: a U.S. Environmental Protection agency perspective," **Journal of Environmental Quality** 27:258-261

Sims, J.T., R.R. Simard, B.C. Joern, 1998, "Phosphorus loss in agricultural drainage: historical perspective and current research," **Journal of Environmental Quality**, 27:277-293

Nutrients and Water Quality

Chambers, P.A., M. Guy, E. Roberts, M.N. Charlton, R. Kent, C. Gagnon, G. Grove, N. Foster, C. DeKimpe and M. Giddings, 2001, "Nutrients - nitrogen and phosphorus," In **Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada**, Chapter 6, 72 p., National Water Research Institute, NWRI Scientific Assessment Report Series No. 1, Burlington, ON, p. 23-26

Chambers, P.A., M. Guy, E.S. Roberts, M.N. Charlton, R. Kent, C. Gagnon, G. Grove and N. Foster, 2001, "Les elements nutritifs et leurs effets sur l'environnement au Canada," In Agriculture et Agro-Alimentaire Canada, Environnement Canada, Peches et Oceans Canada, Sante Canada et Ressources naturelles Canada (eds.), **Les Elements Nutritifs et Leurs Effets Sur L'environnement au Canada**, Bureau national de recommandations et des normes, Environnement Canada, p. 271

Chambers, P.A., M. Guy, E.S. Roberts, M.N. Charlton, R. Kent, C. Gagnon, G. Grove and N. Foster, 2001, "Nutrients and their Impact on the Canadian Environment," In Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada and Natural Resources Canada (eds.), **Nutrients and their Impact on the Canadian Environment**, National Guidelines and Standards Office, Environment Canada, p. 241

Chambers P.A., M. Guy, S.S. Dixit, G.A. Benoy, R.B. Brua, J.M. Culp, D. McGoldrick, B.L. Upsdell & C. Vis, 2009, **Nitrogen and Phosphorus Standards to Protect the Ecological Condition of Canadian Streams, Rivers and Coastal Waters,** National Agri-Environmental Standards Initiative (NAESI) Synthesis Report No. 11, Environment Canada, Gatineau, GC (79 pp)

Chambers P.A., M. Guy, E.S. Roberts, M.N. Charlton, R. Kent, C. Gagnon, G. Grove & N. Foster, 2001, **Nutrients and their Impact on the Canadian Environment**, Agriculture and Agri-Food Canada, Environment Canada, Fisheries and Oceans Canada, Health Canada, and Natural Resources Canada, En21-205/2001E

Chambers P.A., M. Guy, E. Roberts, M.N. Charlton, R. Kent, C. Gagnon, G. Grove, N. Foster, C. DeKimpe & M. Giddings, 2001, "Nutrients – Nitrogen and Phosphorus," In **Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada**. NWRI Scientific Assessment Report No. 1. pg. 23-26 [Environment Canada]

City of London (ON), no date, **Understanding Phosphorus, the Need for Reduction and the Effect of Too Much Phosphorus on the Environment** (PDF) (3 pp)

Conservation Ontario, no date, **Watershed Economic Incentives through Phosphorus Trading and Water Quality** (PDF) (4 pp)

Correll, David L., 1998, "The role of phosphorus in the eutrophication of receiving waters: a review," **Journal of Environmental Quality**, 27:261-266

Fraterrigo, Jennifer & John A. Downing, 2008, "The influence of land use on lake nutrients varies with watershed transport capacity," **Ecosystems**, 11: 1021–1034

Howard, Allan et al., 2006, **Impact of Soil Phosphorus Loading on Water Quality in Alberta: A Review** (PDF) (50 pp)

Keller, S., Zhang, T.Q., Webb, S., Brugam, R., Johnson, K., and Lin, Z.Q., 2008, "Effects of suburban land use on phosphorous compositions in Upper Peruque Creek, eastern Missouri," **Water Environment Research**, 80(4), pp. 316-323(8). DOI: 10.2175/106143007X221283

Lee, Fred & Anne Jones-Lee, 2002, **Assessing the Water Quality Impacts of Phosphorus in Runoff from Agricultural Lands** (PDF) (20 pp)

Li, Yong et al., 2006, "Research advances in nutrient runoff on sloping land in watersheds," **Aquatic Ecosystem Health & Management**, 9(1):27–32

Puckett, L., 1995, "Identifying the major sources of nutrient water pollution," **Environmental Science & Technology**, Vol. 29(9): 408-414

USGS, 1999, **A Review of Phosphorus Control Measures in the United States and Their Effects on Water Quality**, Water Resources Investigations Report 99-4007 (PDF) (46 pp)

Soil Fertility

Bruulsema, TW, 2002, "Nutrients and product quality," Chapter 9 in **Plant Nutrient Use in North American Agriculture**, PPI/PPIC/FAR Technical Bulletin 2002-1, Published by Potash & Phosphate Institute, 655 Engineering Drive, Suite 110, Norcross, GA, USA 30092-2837. ISBN # 0-9629598-4-7

Bruulsema, T.W., 2004, "Understanding the science behind fertilizer recommendations," **Better Crops**, 88(3): 16-19 (PDF)

Bruulsema, T.W., 2006, "Soil fertility in the northeast region," **Better Crops**, 90(1): 8-10 (PDF)

Liu, A., Hamel, C., Spedding, T., Zhang, T.Q., Mongeau, R., Lamarre, G.R., and Tremblay, G., 2008, "Soil microbial carbon and phosphorus as influenced by phosphorus fertilization and tillage in a maize-soybean rotation in south-western Quebec," **Canadian Journal of Soil Science**, 88(1): 21-30

University of Arkansas Division of Agriculture, no date, **Soil Phosphorus Levels: Concerns and Recommendations** (PDF) (6 pp fact sheet)

Phosphorus Modeling/Measuring

Cassell, E.A., J.M. Dorioz, R.L. Kort, J.P. Hoffman, D.W. Meals, D. Kirschtel and D.C. Braun, 1998, "Modeling phosphorus dynamics in ecosystems: mass balance and dynamic simulation approaches," **Journal of Environmental Quality**, 27:293-298

Maguire, R.O., Q.M. Ketterings, J.L. Lemunyon, A.B. Leytem, G. Mullins, D.L. Osmond and J.L. Wel, no date, **Phosphorus Indices to Predict Risk for Phosphorus Losses** (PDF) (5 pp)

Mallarino, A.P. et al., no date, **Soil Sampling Methods for Phosphorus – Spatial Concerns A SERA-17 Position Paper** (PDF) (16 pp)

Pierzynski, Gary, Hailin Zhang, Ann Wolf, Peter Kleinman, Antonio Mallarino, and Dan Sullivan, no date, **Phosphorus Determination in Waters and Extracts of Soils and By-Products: Inductively Coupled Plasma Spectrometry versus Colorimetric Procedures** (PDF) (17 pp)

Radcliffe, D. and N. Nelson, no date, **Predicting Phosphorus Losses** (PDF) (10 pp)

Vadas, P.A. et al., no date, **The Importance of Sampling Depth when Testing Soils for their Potential to Supply Phosphorus to Surface Runoff** (PDF) (14 pp)

Nutrient Use/Management in Agriculture

Calberry, Jodi (Program Assistant/OMAFRA), 2004, **Dietary Phosphorus in Dairy Cattle - How to Manage Nutrients and Protect the Environment**, Fact Sheet, January (http://www.omafra.gov.on.ca/english/livestock/dairy/facts/04-001.htm)

Ertl, D.S., K. A. Young and V. Raboy, 1998, "Plant genetic approaches to phosphorus management in agricultural production," **Journal of Environmental Quality**, 27:299-304

Herath, A., Zhang, T.Q., Forge, T.A., Hamel, C., and Goss, M.J., 2006, **Chemical Behavior of Phosphorus in a Sandy Loam Soil Long-Term Applied with Dairy Slurry**, 2006 ASA-CSSA-SSSA International Annual Meetings: Symposium Integrating Weather Variability into Nitrogen Recommendations, Indianapolis, IN, USA, November 12-16

Herath, A., Zhang, T.Q., Hamel, C., Tan, C.S., Welacky, T.W., and Goss, M.J., 2007, **Immediate and Residual Effects of Swine Manure and its Compost on Soil Phosphorus Fractions in a Clay Loam Soil Under Corn-Soybean Rotation**, 2007 Annual Meeting of CPS-SCP (with Plant Canada 2007), Saskatoon, SK, Canada, June 10-14, pp. SF3-4

Hilborn, Don (Engineer/OMAFRA) & Robert Stone (Engineer/OMAFRA), 2005, **Determining the Phosphorus Index for a Field**, Fact Sheet 05-067 (http://www.omafra.gov.on.ca/english/engineer/facts/05-067.htm)

Hogan D. & M. Blackwell, 2006, "Review of nutrient management in agricultural watersheds – a wetlands solution," in E.J. Dunne, K. R. Reddy, & O.T. Carton [Eds.], **Grass and Forage Science**, 61: 97-100

Kleinman, P., Sullivan, D., Wolf, A., Brandt, R., Dou, Z., Elliott, H., Kovar, J., Leytem, A., Maguire, R., Moore, P., Saporito, L., Sharpley, A., Shober, A., Sims, T., Toth, J., Toor, G., Zhang, H., and Zhang, T.Q., 2007, "Selection of a water-extractable phosphorus test for manures and biosolids as an indicator of runoff loss potential," **Journal of Environmental Quality**, 36(5):1357-1367

Lentz, R .D., R. E. Sojka and C.W. Robbins, 1998, "Reducing phosphorus losses from surface-irrigated fields: emerging polyacrylamide technology," **Journal of Environmental Quality**, 27:305-312

Lowrence, et al., 1984, "Riparian Forests as Nutrient Filters in Agricultural Watersheds," **BioScience**, 34(6): 374-377

Ma, R.K., Zhang, T.Q., and Tan, C.S., 2005, **Influences of Low-Phosphorus Swine Manure on Soil Properties Under Various Water Conditions**, 2005 Northeastern Branch of the American Society of Agronomy Annual Meeting, Storrs, CT, USA, July 10-15

Ma, B.-L., Subedi, K.D., and Zhang, T.Q., 2007, "Assessing methods for detecting crop nitrogen requirements for sweet corn production," **CSA News**, 52(1): 9-33

Ma, B.-L., Subedi, K.D., and Zhang, T.Q., 2007, "Pre-sidedress nitrate test and other crop-based indicators for fresh market and processing sweet corn," **Agronomy Journal**, 99: 174-183

Makarewicz, Joseph C., Peter E. D'Aiuto and Isidro Bosch, 2007, "Elevated nutrient levels from agriculturally dominated watersheds stimulate metaphyton growth," **Journal of Great Lakes Research**, 33:437-448

No Author, no date, "Environmental impacts of potato nutrient management," **Red Orbit News** (http://www.redorbit.com/modules/news/tools.php?tool=print&id=229641)(PDF) (10 pp)

Potter, Barry (Livestock Specialist/OMAFRA), 2005, **Reduced Phosphorus Feeding Makes Sense, May** (http://www.omafra.gov.on.ca/english/livestock/dairy/facts/reduced_phosphorus.htm)

Poulter-Miller, S.B., Zhang, T.Q., Smith, M., Brugam, R.B., Johnson, K.A., and Lin, Z.Q., 2007, **Co-application of Biosolids and Drinking Water Treatment Residues in Agricultural Soil: Effects on Leachate Phosphorus**, Illinois State Academy of Sciences 100th Annual Meeting, Springfield, IL, USA, April 20-21, 2007

Reddy, K. R., G. A. O Connor and P. M. Gale, 1998, "Phosphorus sorption capacities of wetland soils and stream sediments impacted by dairy effluent," **Journal of Environmental Quality**, 27:438-447

Reid, Keith (Soil Fertility Specialist/OMAFRA), 2007, **Fertilizer Recommendation Tables - 2008 Revision** (http://www.omafra.gov.on.ca/english/crops/facts/fert-rec-tables-toc.htm)

Reynolds, W.D., Drury, C.F., Tan, C.S., Zhang, T.Q., Welacky, T.W., and Yang, X.M., 2005, **Compost Addition Improves the Quality and Productivity of a Degraded Clay Loam Soil**, Canadian Compost Conference, AB, Canada

Reynolds, W.D., Drury, C.F., Tan, C.S., Zhang, T.Q., Welacky, T.W., and Yang, X.M., 2005, **Effects of Compost Addition on Soil Quality and Corn Yield for a Degraded Clay Loam Soil**, 2005 Canadian Soil Science Society Annual Meeting, Halifax, NS, Canada, May 12-15

Reynolds, W.D., Fox, C., Drury, C.F., Tan, C.S., Zhang, T.Q., and Yang, X.M., 2006, **Spatial Interactions Among Soil Properties in a Structured Soil**, Canadian Geophysical Union and Canadian Soil Sci. Soc. Annual Scientific Meeting., Banff, AB, Canada, May 14-17

Reynolds, W.D., Drury, C.F., Yang, X.M., Fox, C., Tan, C.S., and Zhang, T.Q., 2007, **Effects of Consistent and Changing Land Management on the Physical Quality of a Clay Loam Soil**, AQSSS - SCSS Congrès / CSSS Annual Meeting, Sainte-Catherine-de-la-Jacques-Cartier, Québec City, QC, Canada, June 3-7

Reynolds, W.D., Drury, C.F., Yang, X.M., Fox, C., Tan, C.S., and Zhang, T.Q., 2007, "Land management effects on the near-surface physical quality of a clay loam soil," **Soil & Tillage Research**, 96(1-2): 316-330

Royer, T. et al., 2006, "Timing of riverine export of nitrate and phosphorus from agricultural watersheds in Illinois: implications for reducing nutrient loading to the Mississippi River," **Environmental Science & Technology**, 40: 4126-4131

Sanderson, JB, JA MacLeod, R Coffin, B Douglas, & TW Bruulsema, 2003, "Phosphorus research on potato in PEI," **Acta horticulturae**, Nov(619): 409-417

Shi, J. and Zhang, T.Q., 2005, "Vegetable: horticulture and processing," in Hui, Y.H. et al (eds.) - **Handbook of Food Science, Technology and Engineering**, Vol. 4. Food Technology and Food Processing. Series: Food Science and Technology, CRC Press, pp. 170-179.

Shrestha, B., Lipe, S., Johnson, K., Zhang, T.Q., Retzlaff, W., and Lin, Z.Q., 2006, "Soil hydraulic manipulation and organic amendment for the enhancement of selenium volatilization in a soil-pickleweed system," **Plant and Soil**, 288: 189-196

Snyder, C.S. and T.W. Bruulsema, 2002, "Nutrients and Environmental Quality," Chapter 8 in **Plant Nutrient Use in North American Agriculture**, PPI/PPIC/FAR Technical Bulletin 2002-1, Published by Potash & Phosphate Institute, 655 Engineering Drive, Suite 110, Norcross, GA, USA 30092-2837. ISBN # 0-9629598-4-7

Sullivan, D., Kleinman, P., Wolf, A., Brandt, R., Dou, Z., Elliott, H., Kovar, J., Leytem, A., Maguire, R., Moore, P., Sharpley, A., Shober, A., Sims, J.T., Toor, G., Zhang, H., and Zhang, T.Q., 2005, **Standardizing the Water-Soluble Phosphorus Test for Manures and Biosolids**, 2005 ASA-CSSA-SSSA International Annual Meetings, Salt Lake City, UT, USA, November 6-10

Tan, C.S., Zhang, T.Q., Reynolds, W.D., Warner, J.T., and Drury, C.F., 2005, **Farm-scale processing tomato production using surface and subsurface dip irrigation and fertigation**, 2005 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 25-27

Wright, Tom (Dairy Nutritionist/OMAFRA), 2003, **Managing Dietary Phosphorus in Lactating Cows**, March (http://www.omafra.gov.on.ca/english/livestock/dairy/facts/info_phosphorus.htm)

Yang, X.M., Drury, C.F., Zhang, T.Q., Ajakaiye, A., Forsberg, C.W., and Philip, J.P., 2006, "Inorganic N dynamics from soils amended with low-P manure from genetically modified pigs (EnviropigTM)," **Nutrient Cycling in Agroecosystems**, 75: 297-304

Yang, X.M., Drury, C.F., Zhang, T.Q., Ajakaiye, A., Forsberg, C.W., Fan, M.Z., and Philip, J.P., 2008, "Short-term carbon dioxide emissions and enitrification losses from soils amended with low-P manure from genetically modified pigs," **Nutrient Cycling in Agroecosystems**, 80(2): 153-160

Zhang, T.Q., Hu, Q.C., Drury, C.F., Reynolds, W.D., Tan, C.S., Yang, X.M., and Fleming, R.J., 2005, **Comparisons of Phosphorus Fractions in Three Composts**

and Their Effects on Soil Phosphorus Availability, 2005 ASA-CSSA-SSSA International Annual Meetings, Salt Lake City, UT, USA, November 6-10

Zhang, T.Q., Lin, Z.Q., Fan, M.Z., and Forsberg, C.W., 2005, **Phosphorous Characterization of Manures from Genetically Modified Pigs, Enviropigs**, 2005 ASA-CSSA-SSSA International Annual Meetings, Salt Lake City, UT, USA, November 6-10

Zhang, T.Q., Tan, C.S., Drury, C.F., and Reynolds, W.D., 2005, **Long-term impacts of crop rotation and fertilization on phosphorus losses in tile drainage of a clay loam soil**, SEARA-17 Reducing Phosphorus Losses from Agriculture Annual Meeting, Banff, AB, Canada, July 26-29

Zhang, T.Q., Tan, C.S., Drury, C.F., Hu, Q.C., Gaynor, J.D., Reynolds, W.D., Welacky, T.W., and Yang, X.M., 2005, "Phosphorus in pig manure compost: bioavailability and impacts on water quality," **2005 Livestock Environmental Initiative**, 2005, pp. P67-68

Zhang, T.Q., Tan, C.S., Warner, J.T., and Hamill, A.S., 2005, **Agronomic and environmental consequences of applying fertilizer N and P to green peppers under drip fertigation**, 2005 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 25-27

Zhang, T.Q., Tan, C.S., Warner, J.T., Drury, C.F., and Reynolds, W.D., 2005, **Yield response of processing tomato to fertilizer N and P under fertigation and post-harvest soil NO3-N levels**, Canadian Soil Science Society Annual Meeting, Halifax, NS, Canada, May 12-15

Zhang, T.Q., Tan, C.S., Warner, J.T., Drury, C.F., Reynolds, W.D., and Hamill, A.S., 2005, **Agronomic and environmental consequences of applying fertilizer N and P to processing tomatoes under drip fertigation**, 2005 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 25-27

Zhang, T.Q., Tan, C.S., Warner, J.T., Drury, C.F., Reynolds, W.D., Liptay, A., and Hamill, A.S., 2005, **Agronomic and environmental consequences of applying fertilizer nitrogen and phosphorus to processing tomatoes and green peppers under drip fertigation**, The 4th year annual progress report and the final report to OPVG, OTRI, OABA, CFI, Zoological Society of Japan, 45 pages. (Report)

Zhang, T.Q., Zandstra, J., Tan, C.S., Warner, J.T., Drury, C.F., and Reynolds, W.D., 2005, **Optimizing soil nitrogen management for processing sweet corn to maximize marketable yield and minimize damages to water quality**, 2005 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 25-27

Zheng, Z.M., MacLeod, J.A., and Zhang, T.Q., 2005, **Potential for preferential pathways of phosphorus subsurface runoff, Ecological implications of nutrient enrichment on freshwater and coastal ecosystem**, sponsored by Fisheries and Oceans Canada and Environment Canada., Summerside, PEI, Canada, March 30-31

Zhang, T.Q. and Tan, C.S., 2006, **Optimizing application of phosphorus and potassium to processing tomatoes under drip irrigation to maximize quality and yield while minimizing adverse impacts on water quality**, 1st year annual progress report Ontario Processing Vegetable Growers, Zoological Society of Japan, 20 pages. (Report)

Zhang, T.Q., Tan, C.S., and Bruulsema, T., 2006, "Fertigation boost optimum nitrogen for tomatoes and peppers," **Better Crops with Plant Food**, 90(4): 8-10.

Zhang, T.Q., Tan, C.S., and Warner, J.T., 2006, **Fresh market sweet corn production under clear and solar mulch films**, Joint Colloquium of the CSA-CSAS-CAHS, Westin Nova Scotian, Halifax, NS, Canada, August 1-5

Zhang, T.Q., Tan, C.S., Drury, C.F., and Reynolds, W.D., 2006, **Long-term (e43 years) fate of soil phosphorus as related to cropping systems and fertilization**, 18th World Congress of Soil Science, Philadelphia, PA, USA, July 9-15

Zhang, T.Q., Tan, C.S., Warner, J.T., and Hamill, A.S., 2006, **Agronomic and environmental consequences of applying fertilizer N and P to green peppers under drip Fertigation**, 2006 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 24-26

Zhang, T.Q., Tan, C.S., Warner, J.T., Drury, C.F., and Reynolds, W.D., 2006, **Agronomic and environmental consequences of applying fertilizer N and P to processing tomatoes under drip fertigation**, The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 24-26

Zhang, T.Q., no date, **Determination of Some Key Factors for Ontario Soil P Index and Effectiveness of Manure Application Practices for Mitigating Risk to Water Resource**, Greenhouse & Processing Crops Research Center, Agriculture & Agri-Food Canada, Harrow, ON (http://www.ridgetownc.uoguelph.ca/research/documents/ohalloran_NM8002_Zhang.pdf) (PDF) (27 pp)

Zhang, T.Q. and Forge, T.A., 2007, **Behaviour and fate of phosphorus in soil: Changing concepts and research perspectives of soil phosphorus chemistry and fertility**, 2007 Annual Meeting of CPS-SCP (with Plant Canada 2007), Saskatoon, SK, Canada, June 10-14, pp. SF3-2

Zhang, T.Q. and Forge, T.A., 2007, **Changing concepts and research perspectives of soil phosphorus chemistry and fertility**, 2007 Annual Meeting of CPS-SCP (with Plant Canada 2007), Saskatoon, SK, Canada, June 10-14

Zhang, T.Q. and Tan, C.S., 2007, **Optimizing application of phosphorus and potassium to processing tomatoes under drip irrigation to maximize quality and yield while minimizing adverse impacts on water quality**, 2007 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 23-24

Zhang, T.Q., Drury, C.F., and Reynolds, W.D., 2007, "Effects of long-term (47 years) consistent fertilization and crop rotation on feed and diet productivity and

quality.", in Zhu, Y.G., Lepp, N., and Naidu, R. (eds.) - **Biogeochemistry of Trace Elements: Environmental Protection, Remendiation and Human Health,** Tsinghua University Press, Beijing, pp. 297-299.

Zhang, T.Q., Drury, C.F., Tan, C.S., and Reynolds, W.D., 2007, **Effects of long-term (47 years) consistent fertilization and crop rotation on feed and diet productivity and quality**, 9th International Conference of Biogeochemistry of Trace Elements, Beijing, China, July 15-19

Zhang, T.Q., Tan, C.S., and Bruulsema, T., 2007, **Fertigation Boosts Optimum Nitrogen Needs by Tomatoes and Peppers**, published by AAFC Greenhouse and Processing Crops Research Centre, Harrow, ON, pp. 3, AAFC/AAC 10365 (Factsheet)

Zhang, T.Q., Tan, C.S., and Warner, J.T., 2007, "Fresh market sweet corn production with clear and wavelength selective soil mulch films," **Canadian Journal of Plant Science**, 87(3): 559-564.

Great Lakes Basin - General

Allan, D. & E. Rutherford, no date, **Nutrient Loading and its Relevance to the Great Lakes Basin: A "White Paper" Literature Review**, prepared for a University of Michigan Initiative, in Great Lakes Research (PDF) (49 pp)

Annex 3 Technical Sub-group of the RWG D, 2007, **Examination of the Status of the Goals of Annex 3 of the Great Lakes Water Quality Agreement** (members: J. V. DePinto (U.S. co-chair), D. Lam (Canadian co-chair), M. Auer, N. Burns, S. Chapra, M. Charlton, D. Dolan, R. Kreis, T. Howell, D. Scavia with assistance from D. Rockwell (U.S. co-chair of RWG D), E. van Bochove (Canadian co-chair of RWG D) Tom Looby (RWG D secretary)

Bertram, Paul, no date, **Nutrients in the Great Lakes: Is this an issue again?** U.S. EPA, Great Lakes National Program Office (PPT file) (20 slides)

Bootsma, Harvey, 2006, **Naturally Occurring Chemicals: Nutrients** (PDF of presentation) (36 pp)

Canada Ontario Agreement Memorandum of Cooperation, 2004, **Notes from the Joint Municipal-Provincial Committee Meeting #4 – Summary Theme: Nearshore Water Quality**, February 11, 2009 (PDF) (7 pp)

Canada-Ontario Agreement Memorandum of Cooperation, 2008, **Municipal Great Lakes Working Group Meeting #2, Summary of Discussion, Wednesday, November 26, 2008, 1:30-3:30pm**, Teleconference Call (PDF) (9 pp of notes)

Canada Ontario Agreement Memorandum of Cooperation, 2009, **Canada Ontario Agreement Memorandum of Cooperation Joint Municipal-Provincial Committee Meeting #4 – Summary Theme: Nearshore Water Quality**, February 11, 2009

Charlton, M.N., 2008, **Nearshore Waters Presentation Notes**, SOLEC 2008 (PDF)

Charlton, M.N., 1998, **Zebra Mussels and Other Exotic Species in the Great Lakes: A Primer for Non-Specialists**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 98-240

Da Ouyang, Yung-Tsung Kang, Jon Bartholic, 1996, **Agricultural Phosphorus Assessment in the Great Lakes Basin: A Case Study**, Submitted to The Great Lakes Commission, April (PDF)

DeWeerd, Amy, 2008, **Contaminants, Biotic Communities, and Invasive Species**, Presentation notes, SOLEC 2008 (PDF) (41 pp)

Dolan, Dave, Peter Richards and Kevin McGunagle, 2008, **Total Phosphorus Loading to the Great Lakes**, Presentation, Lake Erie Millennium Network, March (PDF) (25 pp)

Edsall, Thomas A.& Murray Charlton, 1997, **Nearshore Waters of the Great Lakes - Background Paper, State of the Lakes Ecosystem Conference 1996** (PDF) (179 pp)

Edsall, T. and M.N. Charlton, 1997, **Nearshore Waters of the Great Lakes**, State of the Lakes Ecosystem Conference 1996 Background Paper, EPA 905-R-97-015a (PDF) (179 pp)

Environment Canada, no date, **Lakewide Management Plans** (PDF) (2 pp from website)

Environment Canada, no date, **Great Lake Success Stories – Don Williams** (PDF from website) (2 pp)

Environment Canada, 1996, **Nearshore Waters of the Great Lakes, Section 7.1.6 - Nutrient Enrichment & Algae: Nearshore Waters of the Great Lakes** (PDF) (13 pp from website: http://www.on.ec.gc.ca/solec/nearshore-water/paper/part7.html)

Environment Canada, 1996, **Nearshore Waters of the Great Lakes, Section 9.0 – Emerging Challenges** (PDF) (15 pp from website: http://www.on.ec.gc.ca/solec/nearshore-water/paper/part10.html)

Excerpts from **2006 Assimilative Capacity Study for Lake Simcoe and Nottawasaga River basins** (Word file)

Gale, P., 1999, **Addressing Concerns for Water Quality Impacts from Large-Scale Great Lakes Aquaculture** (PDF) (8 pp)

Gartner Lee Ltd., 2006, **Development of Ecoregion Based Phosphorus Guidelines for Canada: Ontario as a Case Study**, Report Prepared for Water Quality Task Group, Canadian Council of Ministers of the Environment (PDF) (65 pp)

Government of Canada, no date, **Great Lakes Sustainability Fund Agricultural Non-Point Source Pollution Control Program - What Have We Learned?**, Great Lakes Sustainability Fund website (PDF) (6 pp from website)

Government of Canada, no date, **Our Great Lakes** (PDF) (15 pp)

Great Lakes and St. Lawrence Cities Initiative, 2009, **At the Shoreline: A Mayors' Collaborative Action Plan to Protect the Great Lakes**

Great Lakes Commission, 2008, **LaMPs 2008: Lakewide Management Plan Updates for the Great Lakes** (PDF) (8 pp)

Great Lakes Phosphorus Forum website (http://www.greatlakespforum.com/)

Great Lakes Water Institute, no date, **Phosphorus Loading Declined until 1990s** (PDF) (1 pp from website)

Great Lakes Water Institute, no date, **Water Institute Scientists Help Report on the State of the Lakes** (PDF) (2 pp from website)

Haffner, Doug Dr., 2008, **St.Clair/Detriot River presentation notes**, SOLEC 2008 (PDF)

Hecky, R. E. et al, 2004, "The nearshore phosphorus shunt: a consequence of ecosystem engineering by dreissenids in the Laurentian Great Lakes," **Canadian Journal of Fisheries and Aquatic Science**, 61(7): 1285–1293

Higgins, S.N., Malkin, S.Y., Howell, E.T., Guildford S.J., Campbell, L., Hiriart-Baer, V., Hecky, R.E., 2008, "An ecological review of *cladophora glomerata* (chlorophyta) in the Laurentian Great Lakes," **Journal of Phycology**, 44 : 839-854

International Joint Commission, no date, **Successes and Challenges for the GLWQA** (PDF) (3 pp from website)

International Joint Commission, 2003, **Priorities 2001-2003: Priorities & Progress under the Great Lakes Water Quality Agreement**, September (PDF) (166 pp)

International Joint Commission, 2003, **Phosphorous - Further Matters - 11th Biennial Report - Great Lakes Water Quality**, Section 3 (Phosphorus), Annex 3 (PDF)

International Joint Commission, 2004, **12th Biennial Report on Great Lakes Water Quality**, September 2004.

MacDonald, Graham K. and Elena M. Bennett, 2009, "Phosphorus accumulation in Saint Lawrence River watershed soils: a century-long perspective," **Ecosystems**, 12:621-635.

MacKool, Alesa, no date, "Slimed," **ejmagazine**, p.47-48 (PDF) (2 pp)

Neilson, M. et al, 2003, "Ecological monitoring for assessing the state of the nearshore and open waters of the Great Lakes," **Environmental Monitoring and Assessment**, 88: 103–117

No author, no date, "Ecosystem, Lake Ontario," **Great Canadian Lakes**, website accessed on July 17, 2009: http://www.greatcanadianlakes.com/ontario/lake_ontario/species-home.html.

No author, 2006, "Michigan County Bans Phosphorus Fertilizers," **Grand Haven (Michigan) Tribune**, December 14 (posted on Great Lakes Directory website) (PDF)

Nurnberg, Gertrud K., 1991, "Phosphorus from internal sources in the Laurentian Great Lakes, and the concept of threshold external load," **Journal of Great Lakes Research**, 17(1)132-140

O'Neill, Carolyn, October 7, 2008, **Low Impact Development and the Great Lakes** - Presentation to the Credit Valley Conservation Low Impact Development Workshop, Great Lakes Office, Ontario Ministry of the Environment (PDF of presentation)

Orr, Steve, March 17, 2009, "Officials push to ban phosphorus in detergents: Mineral blamed for algae blooms in lakes and rivers," **Ithaca Journal** (posted on Great Lakes Directory: http://www.greatlakesdirectory.org/New%20York/031709.htm)

Rapport, D. J. et al (eds), 1999, "Chapter 70: Environmental & Socioeconomic Indicators of Great Lakes Basin Ecosystem Health," in **Managing for Healthy Ecosystems**, Lewis Publishers

Rast, Walter & Dennis Gregor, 1979, **Report On Differences in Great Lakes Phosphorus Load Estimates**, Submitted to the Pollution from Land Use Activities Reference Group of the International Joint Commission

Rockwell, David, **Great Lakes Offshore Biological Desert and the Nearshore Slime Around the Tub**, Monitoring Indicators and Reporting Branch US EPA, Great Lakes National Program Office (PPT file)

Safe Drinks Water Foundation, no date, **The Great Lakes** (PDF) (7 pp)

Science Advisory Board, no date, **1997-1999 Priorities Report - Toledo Nonpoint Workshop: Nonpoint Sources Of Pollution To The Great Lakes Basin** (PDF) (http://www.ijc.org/rel/boards/sab/pr9799/nonpoint.html)

Shear, H. et al, 2003, "The development and implementation of indicators of ecosystem health in the Great Lakes Basin," **Environmental Management and Assessment**, 88: 119-152 (PDF) (30 pp)

USEPA, **The Great Lakes Today: Concerns** (segment of The Great Lakes: An Environmental Atlas & Resource Book) (PDF) (15 pp from website)

USEPA, **Joint Management of the Great Lakes** (segment of The Great Lakes: An Environmental Atlas & Resource Book) (PDF) (9 pp from website)

Lake Huron

Ausable-Bayfield Conservation Authority, 2007, **Watershed Report Card** (multiple PDFs, one per subwatershed)

Bierman, V. et al, 2005, "Modeling the Role of Zebra Mussels in the Proliferation of Blue-green Algae in Saginaw Bay, Lake Huron," **Journal of Great Lakes Research**, 31:32-55 (PDF) (24 pp)

Bluewater Biosciences Inc., 2007, **Water Quality Monitoring Report 2007: Township of Georgian Bay,** November (PDF) (118 pp)

Bonte-Gelok, Shelly & Douglas M. Joy, 1999, **Final Report Huron County Surface Water Quality Data Study,** Report to the Huron Farm Environmental Coalition

Caldwell, Wayne, 2008, **Developing Strategies to Engage Agriculture and Recreation Along the Lake Huron Shoreline: A community Based Approach to Solving Water Quality Issues, Research Proposal by Wayne J. Caldwell, Ph.D., MCIP, RPP** (PDF from website: http://www.waynecaldwell.ca/Projects/shoreline.html) (2 pp)

Environment Canada, 2007, **Letter to Bluewater Shoreline Residents' Association regarding Adopt a Watershed program (and other issues),** signed by Brian Gray, Assistant Deputy Minister. (PDF) (4 pp)

Environmental Protection Agency, 2006, **State of the Lakes 2005: What Are The Current Pressures Impacting Lake Huron?** (PDF) (2 pp)

Gale, Peggy, 1999, **Addressing Concerns for Water Quality Impacts from Large-Scale Great Lakes Aquaculture, Appendix 9: Water Quality Impacts from Aquaculture Cage Operations in the LaCloche/North Channel of Lake Huron,** International Joint Commission (PDF) (8 pp) (http://www.ijc.org/php/publications/html/aquaculture/app09.html)

Howell, T., 2004, **Occurrence of nuisance benthic algae on the southeastern shores of Lake Huron, 2003,** Technical Memorandum, Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment, 37pp, June

Howell, T., S. Abernathy, A.S. Crowe, T. Edge, H. House, J. Milne, M. Charlton, P. Scharfe, S. Sweeny, S. Watson, S. Weir, A.M. Weselan and M. Veliz, 2005, **Sources and Mechanisms of Delivery of E. coli (bacteria) Pollution to the Lake Huron Shoreline of Huron County, Ontario,** Interim Report: Science Committee to Investigate sources of Bacterial Pollution of the Lake Huron Shoreline of Huron County

Huron County et al., 2006, **A Stewardship Guide for the Lake Huron Coastline** (PDF) (162 pp)

Lake Huron Binational Partnership, 2004, **Management Goals** (PDF) (2 pp)

Lake Huron Binational Partnership, 2006, **Phosphorus in Saginaw Bay, Have We Met the Target?** February (PDF) (4 pp)

Lake Huron Binational Partnership, 2008, **Lake Huron Binational Partnership 2008-2010 Action Plan**

Lake Huron Centre for Coastal Conservation, 2004, **A Preliminary Report on Historical Nearshore Water Quality Information for Southeastern Lake Huron Sauble Beach to Sarnia**

Lake Huron Centre for Coastal Conservation, 2007, **Beach Stewardship Guide for Huron-Kinloss** (PDF) (82 pp)

Lake Huron-Georgian Bay Watershed, 2007, **Pilot Projects** (section of website: http://www.lakehuroncommunityaction.ca/index.php?option=com_content&task=view&id=67&Itemid=91) (PDF) (4 pp)

Lake Huron Southeast Shore Newsletter, Summer 2008 (PDF) (4 pp)

Lakeland Alliance, no date, **A Shoreline Owner's Guide to Lakeland Living** (PDF) (32 pp)

Le Sage, R. and M.N. Charlton, 1996, **Sediment Ammonia Gradient in Penetang Harbour: Pilot Study**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 96-65

Mason, Greg, 2008, "Bringing science to Lake Huron communities," **Beacon Star, Lifestyles**, Friday, November 21 [http://www.parrysound.com/voice/1227290023/] (PDF) (6 pp)

Michigan Lake Huron Initiative, no date, **Appendix A: Lake Huron Critical Pollutants Uses and Problem Areas** (PDF) (23 pp)

Milne, J.E. and M.N. Charlton, 2004, **Escherichia Coli in Water and Sand at Beaches in Lake Huron, Lake Ontario, and Hamilton Harbour,** National Water Research Institute, Environment Canada. August 10

Milne, J.E. and M.N. Charlton, 2004, **A Study of E. coli in Beach Sand at Lake Huron, Hamilton Harbour and Lake Ontario**, Presented at the IAGLR, Waterloo, Ontario, May 24-28

Milne, J.E. and M.N. Charlton, 2006, **Observations of Fallowing at a Freshwater Caged-Aquaculture Farm on Manitoulin Island, Ontario**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution

Milne, J. and M. Charlton, 2008, **Penetanguishene Harbour, Severn Sound, Ontario 1996 to 2007: Pore Water Ammonia and Percentage Loss on Ignition Observations After Waste Water Treatment Plant Upgrades,** Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 08-293

Milne, J. and M. Charlton, 2008, **Water Quality Observations Near a Working Cage-Aquaculture Farm in the North Channel, Manitoulin Island, Ontario,** Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 07-320

Peach, Geoff, 2006, "Pine River Watershed Improvement – a recipe to WIN," **Great Lakes Aquatic Habitat News,** Volume 14, Number 5, Winter 2006 (PDF from website) [http://glhabitat.org/news/glnews560.html]

Pine River Watershed Improvement 2006 (brochure) (PDF) (2 pp)

Pine River Watershed Initiative Network, **Minutes, November 27, 2007,** Huron-Kinloss Council Chambers, Ripley, Ontario, 9:30 a.m.

Pine River Watershed Initiative Network, **Minutes, August 1, 2007,** Huron-Kinloss Council Chambers, Ripley, Ontario, 9:30 a.m.

Reid, Garit, 2009, "Update on (Pine River) Watershed presented to council," **Lucknow Sentinel** (website) (PDF)

Ross, B.M. & Associates, 2006, **Township of Huron-Kinloss Pine River Water Quality Monitoring Program 2005 Annual Report** (PDF) (36 pp)

Saugeen Valley Conservation Authority, 2007, **Minutes from the Annual Meeting** (includes mention of Adopt-A-Watershed program), Friday, January 19 (PDF) (9 pp)

Syed, A. & R. Jodoin, 2006, **Estimation of Nonpoint-Source Loads of Total Nitrogen, Total Phosphorus, and Total Suspended Solids in the Black, Belle, and Pine River Basins, Michigan, by Use of the PLOAD Model,** USGS and USDI Scientific Investigation Report 2006-5071. (PDF) (49 pp)

University of Guelph et al., 2007, **Rural Land Owner Stewardship Guide**

Water Management

Warner, J., Tan, C.S., and Zhang, T.Q., 2006, **Drip irrigation water management strategies to enhance processing tomato fruit solids, quality and yield,** 2006 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 24-26

Warner, J.T., Tan, C.S., and Zhang, T.Q., 2005, **Drip irrigation water management strategies to enhance processing tomato fruit solids, quality and yield,** The 3rd project annual report to OTRI and AAFC MII program, AAFC Greenhouse and Processing Crops Research Centre, Harrow, ON, 8 pages (Report)

Warner, J.T., Tan, C.S., and Zhang, T.Q., 2005, **Drip irrigation water management strategies to enhance processing tomato fruit solids, quality and yield,** 2005 The Ontario Processing Vegetable Industry Conference, London, ON, Canada, January 25-27

Warner, J.T., Tan, C.S., and Zhang, T.Q., 2007, **Drip Irrigation Improves Processing Tomato Yield and Quality**, published by AAFC Greenhouse and Processing Crops Research Centre, Harrow, ON, pp. 3, AAFC/AAC 10348 (Factsheet)

Warner, J.T.Tan, C.S., and Zhang, T.Q., 2007, "Water management strategies to enhance fruit solids and yield of drip irrigated processing tomato," **Canadian Journal of Plant Science**, 87(2): 345-353

Wong, I, Fong, P, Booty, W.G., Neilsen, C, Benoy, G., and Swayne, D.A., 2008, **The Land and Water Integration Decision Support System**, AMCIS 2008 Proceedings, paper 176

Water Quality

Booty, W., Bowen, G., León, L., Lam, D.C., 2001, **Decision Support Technology Transfer for Non-point Source Water Quality Modelling**, 36th Canadian Symposium on Water Pollution Research, CCIW, Burlington, On., Canada, February

Booty, W., Lam, D.C., Bowen, G., Resler, O., and Leon, L.F., 2005, "Modelling changes in stream water quality due to climate change in a southern Ontario watershed," **Journal of Canadian Water Resources**, 30(3): 2-15

Booty, W.G. and Benoy, G., 2008, "Multi criteria review of non-point source water quality models for nutrients, sediment and pathogens," **Water Quality Research Journal of Canada**, 44(4)

Canadian Council of Ministers of the Environment (CCME), 2002, **Linking Water Science to Policy: Effects of Agricultural Activities on Water Quality: A CCME Sponsored Workshop** (PDF) (43 pp)

Canadian Council of Ministers of the Environment (CCME), 2004, Canadian Water Quality Guidelines for the Protection of Aquatic Life, **Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems**

Chambers P.A., J. Dupont, K.A. Schaefer & A.T. Bielak, 2002, **Effects of Agricultural Activities on Water Quality**, Canadian Council of Ministers of the Environment, Winnipeg, Manitoba. CCME Linking Water Science to Policy Workshop Series, Report No. 1. (31 pp) [Environment Canada]

Charlton, M.N., 1990, **Laguna Lake (Philippines): Water Quality Trend Analysis Study**, Environment Canada, National Water Research Institute, Burlington, Ontario, NWRI Contribution No. 90-22

Environment Canada, 2001, **Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada** (PDF) (84 pp)

Environment Canada, 2001, **Threats to Sources of Drinking Water and Aquatic Ecosystem Health in Canada** (PDF) (84 pp)

Fitzpatrick, M.L., D.T. Long, B.C. Pijanowski, 2007, Exploring the effects of urban and agricultural land use on surface water chemistry, across a regional watershed, using multivariate statistics," **Applied Geochemistry**, 22:1825-1840

HPJ website, no date, **Partnership to Help Protect Water Quality Praised by Recent EPA Report** (PDF) (1 pp from website)

Ritter, L. et al., no date, **Sources, Pathways and Relative Risks of Contaminants in Water**, Institute for Resources and Environment, University of British Columbia (PDF) (178 pp)

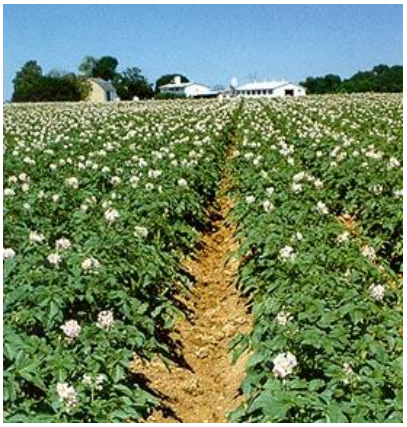
Smith, R.E.H., B. Furgal, V. Greenberg, V. Hiriart and M.N. Charlton, 1999, "Ultraviolet radiation in a large lake with low dissolved organic matter concentrations," **Canadian Journal of Fisheries and Aquatic Sciences**, 56: 1351-1361

Tan, C.S., Zhang, T.Q., Drury, C.F., Reynolds, W.D., Oloya, T.O., and Gaynor, J.D., 2006, **Wetland-Reservoir system improves water Quality and crop production**, IWA World Water Congress and Exhibition, Beijing, China, September 9-14

Tan, C.S., Zhang, T.Q., Drury, C.F., Reynolds, W.D., Oloya, T.O., and Gayner, J.D., 2007, "Water quality and crop production improvement using a wetland-reservoir and drainage/subsurface irrigation system," **Canadian Water Resources Journal-Revue Canadienne des Ressources en Eau**, 32(2): 129-136

Appendix B Focus Group Summary Notes

FOCUS GROUP SUMMARY INNISFIL CREEK SUBWATERSHED



January, 2010

Appendix B

TABLE OF CONTENTS

1. FOCUS GROUP SUMMARY REPORT

This report describes the results of the three focus groups that were conducted to determine the behaviours for reducing phosphorus inputs to the Innisfil Creek Subwatershed.

The findings from the focus groups have been used to develop a Phosphorus Reduction - Community-based Social Marketing strategy for the Innisfil Creek subwatershed. This report describes the important findings and recommendations that arise from the focus group research that was conducted.

The methodology questions and findings are presented below.

Equine Focus Group

Questions

The following questions were posed to guide the equine farm owner/manager focus group conversation in seeking to determine benefits and barriers that were top of mind for the equine farm owners and their relative willingness to change behaviours related to specific actions for reducing phosphorus inputs to the watershed. Due to the small turn out for the equine focus group this list of questions were posed during phone interviews to Innisfil watershed equine farm owners to confirm the findings from the focus group.

1. What does 'poor' water quality mean to you?
2. Do you see a connection to nutrients such as phosphorus and nitrogen and algae growth or poor water quality?
3. What connection is there between what you do on the land and how that could affect water quality in nearby streams or the Great Lakes?
4. What BMP's are used by equine farms in the Innisfil Area?
5. How many equine farms have prepared an Environmental Farm Plan or intend to do so in the area? Why or why not?
6. What do you do on your horse farm to reduce phosphorus build up and run off?
7. Do you have a water course or stream running through your property?
8. How to you store and deal with manure on your farm?
9. Do you rely on local farmers to assist with manure removal?
    - How much? 100% 50% 25% none
10. What do you do to remove and/or deal with accumulated manure?
11. What do you see as the major sources of P from the farmsteads and fields in the area as well as other places in the watershed?
12. Do you think P from fertilizer application and/or storage of fertilizer are a bigger concern than P from overland flow from intense storms, spring snowmelt flow, infiltration, tile drainage?
13. Do you follow a grazing management planning (BMP #2403) as an equine BMP?
14. What prevents equine farms in the Innisfil area from adopting best management practices related to Phosphorus?

15. What would motivate you to adopt recommended BMPs?
16. Do you have targeted buffer strips adjacent to water courses? Equine exclusion fencing from water courses? (practice code 1003)
17. Are soil tests done for pasture management? (soil tests eligible only if part of NMP; practice code 2401) Pasture and exercise paddocks: soil erosion control planning (practice code 2404) or farmyard facilities runoff control management if needed (category 5)
18. What do you do to minimize bare soil on your farm? (category 15)
    - Nutrient Management planning (practice code 2401)
    - Grazing management Planning (practice code 2403)
19. Do you think there is any loss of nutrients from your fields in wind or water erosion?
20. What practices have you done in the past to stop this nutrient loss?
21. How did you learn about fertilizer applications? From their family? From CCA? From university?
22. How do you get information on phosphorus and nutrient management? (Family, friends, Ontario Farmer publications, technical advisors, other?)
23. If we were to ask you to install various soil erosion barriers, what would it take to get you to do this?
24. What do equine farmers see as the benefits to:
    a. Preparing a Nutrient Management Plan or Strategy
    b. Preparing an Environmental Farm Plan
    c. Installing buffer strips on water courses
    d. Installing equine exclusion fencing from water courses
25. What do equine farms see as the downside to:
    a. Preparing a Nutrient Management Plan or Strategy
    b. Preparing an Environmental Farm Plan
    c. Installing buffer strips on water courses
    d. Installing equine exclusion fencing from water courses
26. What has prevented or would prevent equine farms from:
    a. Preparing a Nutrient Management plan
    b. Preparing an Environmental Farm Plan
    c. Installing buffer strips on your property
    d. Installing equine exclusion fencing on your property
27. What encouraged or would encourage equine farms to:
    a. Prepare a Nutrient Management plan
    b. Prepare an Environmental Farm Plan
    c. Install buffer strips adjacent to water courses on your property
    d. Install equine exclusion fencing adjacent to water courses on your property
28. How willing would equine farms be to:
    a. Prepare a Nutrient Management plan
    b. Prepare an Environmental Farm Plan
    c. Install buffer strips adjacent to water courses on your property
    d. Install equine exclusion fencing adjacent to water courses on your property
29. Would equine farms be more or less likely to use one or more of these BMPs? Why or why not?
30. Where do you obtain information on land stewardship practices and nutrient management for your farm?
31. Who do you trust to give you the best information on land stewardship and nutrient management practices for your farm?

Summary of Findings - Equine focus group/interviews:

- Most do not fully understand phosphorus outputs from equine farm or home operations and the equally do not fully understand the phosphorus inputs to the watershed from their farm
- Most have not completed an environmental farm plan
- Many are ex-urbanites and new farmers and do not have all the knowledge of the requirements or best management practices (BMPs) for nutrient management both for farm and home operations
- Most are eager to learn and a suite of education programs on BMPs and nutrient management programs would be welcome by the equine farm group
- A land and nutrient stewardship kit for new equine farm owners would be welcome and useful
- Networking and equine farm/stable tours are good method to impart nutrient management information
- Demonstrating cost saving through proper rotational grazing and nutrient management would be an incentive to implement these BMPs
- Better information distribution on equine farm incentives for BMP activities was felt to be required
- Riparian buffer strips are welcome and most would be willing to install with incentive funding
- Cost to implement BMPs is of concern, since most do not have a farm income from the equine operations on the farm
- Many are not familiar with septic systems operations and maintenance and have little knowledge of home phosphate inputs to the watershed
- The highest level of trust for sources of information on these topics is from the municipality and equine associations followed by OMAFRA.
- Other sources of trusted information was from Veterinarians and Feed mills

Crop Farms Focus Group

Crop and Potato Focus Group Questions

The following questions were posed to guide the crop farmer's focus group conversation in seeking to determine benefits and barriers that were top of mind for the crop farmers and their relative willingness to

change behaviours related to specific actions for reducing phosphorus inputs to the watershed.

1. What does 'poor' water quality mean to you?
2. How would you define poor water quality?
3. Do you see a connection to nutrients such as phosphorus and nitrogen and algae growth in the Great Lakes?
4. What connection is there between what you do on the land and how that could affect water quality in nearby streams or in the Great Lakes?
5. Using the BMP table: (Appendix C) Work through each BMP and record your response.
    i. What BMPs do your (and the group) think are poor, good or best for P-reduction?
    ii. What BMP's are used by farmers in the Innisfil Area?
6. Would farmers be more or less likely to use one or more of these BMPs? Why or why not?
7. How many farms have prepared an Environmental Farm Plan or intend to do so in the Innisfil Creek area?
8. What do you do on your farm to reduce phosphorus build up and run off?
9. Do you have a water course or stream running through your property?
10. What do you see as the major sources of P from the farmsteads and fields in the area as well as other places in the watershed?

11. Do you think P from fertilizer application and/or storage of fertilizer are a bigger concern than P from overland flow from intense storms, spring snowmelt flow, infiltration, tile drainage?
12. What prevents farms in the Innisfil area from adopting best management practices related to Phosphorus?
13. What would motivate you to adopt recommended BMPs?
14. Do you have buffer strips adjacent to water courses?
15. Are soil tests done for nutrient management?
16. What do you do to minimize bare soil time on your farm?
17. Do you think there is any loss of nutrients from your fields caused by wind or water erosion?
18. What practices have you done in the past to stop this loss?
19. How did you learn about fertilizer applications? From their family? From CCA? From university?
20. How do you get information on phosphorus and nutrient management? (Family, friends, Ontario Farmer publication, technical advisors, other.)
21. If we were to ask farmers to reduce their fertilizer application amount, what would it take to get you to do this?
22. If we were to ask you to install various soil erosion barriers, what would it take to get you to do this?
23. What do farmers in the Innisfil area see as the benefits to:
    a. Preparing a Nutrient Management plan
    b. Preparing an Environmental Farm Plan
    c. Buffer strips on water courses
    d. Install or maintain wind breaks
24. What do farmers see as the downside to:
    a. Preparing a Nutrient Management plan
    b. Preparing an Environmental Farm Plan
    c. Buffer strips on water courses
    d. Install or maintain wind breaks

25. What has prevented or would prevent farmers from:
    a. Preparing a Nutrient Management plan
    b. Preparing an Environmental Farm Plan
    c. Installing buffer strips on your property
    d. Install or maintain wind breaks
26. What encouraged or would encourage farmers to:
    a. Prepare a Nutrient Management plan
    b. Prepare an Environmental Farm Plan
    c. Install buffer strips on your property
    d. Install or maintain Wind breaks
27. Where do you obtain information on land stewardship practices?
28. Who do you trust to give you the best information on land stewardship practices?

Summary of Findings – Crop Farmers focus group:

- Crop farmers understand nutrient management and specifically phosphorus causes and inputs to the watershed from farm or home operations

- Fertilizers for farm use are stored at the farm suppliers operation and not at farm locations due to the regulations and strict storage and handling requirements that the farmers do not want to manage due to cost and potential environmental issues. Most crop farmers contract out fertilizer applications and do so at the right method, right rate, right place and right time based on soil testing and historical knowledge of applications rates and specific crop requirements

- Soil testing is completed on a regular basis and utilized to provide nutrient application prescriptions

- Wind erosion of soil from crop-free fields is generally handled with cover crops, but not every year, depending on the seasonal weather and crop harvesting schedules and end date of the harvest

- Wind breaks for soil erosion are not favoured at the field level but are acceptable at the farm level, due to the size of equipment used for planting and harvesting

- Wind breaks of material other than trees would be more acceptable due to the yield loss adjacent to traditional treed wind breaks

- Established treed wind breaks are generally not maintained with a 30% porosity to be more effective

- Variable rate application of fertilizer is being used by more farmers using GPS technology

- The GPS technology is used by crop farmers for planting, nutrient management and harvesting operations with great success including banding fertilizer spreading every 2.2 meters

- Riparian buffers are welcome and utilized, however if a channelized stream is present, erosion remains an issue during spring run-off

- There is a general willingness for designing increased riparian buffers to target specifically field drainage if the shape of the field can be maintained, rather than increase buffers to a standard size such as 90 meters for the entire field/riparian interface

-

- Many are very familiar with septic systems operations and maintenance and have little or no need for further knowledge on home phosphate inputs to the watershed

- The highest level of trust for sources of information on the topic of nutrient management is from the farm organizations, farm fertilizer supply operations and

Potato Farm Focus Group

Focus Group Questions

The questions that were posed to guide the potato farmer's focus group conversation were similar to the questions posed to the crop farmers as listed above. More emphasis was placed on water and wind erosion from potato farms due to amount of bare soil left after harvesting was completed until the next crop is planted. The questions were framed to determine benefits and barriers that were top of mind for the potato farmers and their relative willingness to change behaviours related to specific actions for reducing phosphorus inputs to the watershed.

Summary of Findings – Potato farmers focus group:

- Most potato farmers have a superior understanding of nutrient management and specifically phosphorus causes and potential inputs to the watershed from farm or home operations

- Fertilizers for farm use are stored at the farm suppliers operation and not at farm locations due to the regulations and strict storage and handling requirements that the farms do not want to manage due to cost and potential environmental issues. Most potato farmers contract out fertilizer applications and do so at the right method, right rate, right place and right time based on soil testing and historical knowledge of applications rates and specific crop requirements

- Potato farmers in the Innisfil subwatershed regularly rotate their potato fields to other crops such as sod to manage high phosphorus levels, if the terrain and soil type are conductive to this rotation

- Soil testing is completed on an regular to infrequent basis since potato farmers find that the application rates for phosphorus do not change year over year, based on the soil test results. They tend to use historical crop yields to forecast the nutrient application rates.
- Confirmed confidentiality of soil testing results would be seen as an incentive to complete more soil testing for proper nutrient management planning
- Wind erosion from bare soil is generally handled with cover crops (winter wheat/rye), but not every year, depending on the seasonal weather and crop harvesting schedule end dates in the fall
- Wind breaks for soil erosion are not favoured at the field level but are acceptable at the farm level, due to the size of equipment used for planting and harvesting
- Established treed wind breaks are generally not maintained with a 30% porosity to be more effective
- Variable rate application of fertilizer is being used by more potato farmers using GPS technology
- The GPS technology is used by potato farmers for planting straight rows that in turn results in less crop loss to damage during harvesting. If the GPS unit is already exists on the farm, then it is also used for nutrient management and with great success and at a substantial cost savings
- Many are very familiar with septic systems operations and maintenance and have little or no need for further knowledge on home phosphate inputs to the watershed
- The highest level of trust for sources of information on the topic of nutrient management is from the farm organizations, farm fertilizer supply operations and from professional nutrient management specialists

Appendix C Phosphorus BMPs List

Innisfil Focus Groups
December 2009

Best Management Practices for Phosphorus Reduction

Best Management Practice	Comments	BMP in General Use In Innisfil Creek Area y/n (Circle one)	Is this BMP Best (B), Good (G) or Poor (P) for Phosphorus Reduction? (Circle One)
Manure Management (Engineering)			
Septic Management		**Y N**	**B G P**
Manure storage		**Y N**	**B G P**
Livestock Yards		**Y N**	**B G P**
Washwater Management		**Y N**	**B G P**
Fertilizer Storage		**Y N**	**B G P**
Reduce P content in manure		**Y N**	**B G P**
Spills management and Contingency Plans		**Y N**	**B G P**
Non-Point Source			
Nutrient Management Planning – 10 steps		**Y N**	**B G P**
Determine and interpret P-Index for fields		**Y N**	**B G P**
Soil Test		**Y N**	**B G P**
Nutrient Use Efficiency		**Y N**	**B G P**
Variable Rate Technology		**Y N**	**B G P**
Crop Nutrient Management			
Right Method Right Rate Right Place Right Time		**Y N**	**B G P**
Manure Management (Agronomic)			
Manure test Rate of application – follow NMP, calibrate + maintain application equipment		**Y N**	**B G P**
Right time – avoid rain, no winter application, when crop can use, split applications		**Y N**	**B G P**
Right Place – P-Index-based separation distances, surface inlets, avoid steep slopes		**Y N**	**B G P**
Right Method – Inject, Incorporate		**Y N**	**B G P**
Pre-till on tile drained land		**Y N**	**B G P**
Monitor tile outlets and surface inlets		**Y N**	**B G P**

Best Management Practice	Comments	BMP in General Use In Innisfil Creek Area y/n (Circle one)	Is this BMP Best (B), Good (G) or Poor (P) for Phosphorus Reduction? (Circle One)
Soil Management			
Organic matter additions		**Y N**	**B G P**
Timely tillage		**Y N**	**B G P**
Sub-surface Drainage		**Y N**	**B G P**
Cover Crops		**Y N**	**B G P**
Crop Rotation		**Y N**	**B G P**
Soil Conservation Practices			
Reduced Tillage		**Y N**	**B G P**
Residue Management		**Y N**	**B G P**
No-Till		**Y N**	**B G P**
Erosion Control Practices			
Field Buffers		**Y N**	**B G P**
Strip Cropping		**Y N**	**B G P**
Contour farming		**Y N**	**B G P**
Grazing Management plan		**Y N**	**B G P**
Erosion Control Structures			
Grassed Waterways		**Y N**	**B G P**
Water and Sediment Control Basins		**Y N**	**B G P**
Diversion terraces		**Y N**	**B G P**
Spillways and grade control structures		**Y N**	**B G P**
Surface Inlets with Flow restrictors		**Y N**	**B G P**
Riparian and Watercourses			
Buffer Strips		**Y N**	**B G P**
Tile Outlet Protection		**Y N**	**B G P**
Streambank protection		**Y N**	**B G P**
Livestock exclusion		**Y N**	**B G P**
Constructed Wetlands		**Y N**	**B G P**

Appendix D Further Research Questionnaire

Barriers and Benefits of Nutrient Management in (_____) Area
Generic Questionnaire

Survey Background

This generic survey has been developed to assist in conducting Community-Based Social Marketing research for nutrient management in the agricultural sector.

This version of the survey is intended to serve as a starting point. Organizations wishing to use it should feel free to change it as they see fit in order to gather the information that they require for planning purposes.

This survey is designed to:

1. Determine and assess the historical and current nutrient best management practices (BMPs) taken by local farmers and other rural landowners (e.g. equine, sod, etc.)
2. Assess the knowledge and understanding of BMPs for nutrient and erosion control and the attitude towards the practices;
3. Develop a baseline against which progress can be measured in later research;
4. Determine barriers to the adoption of nutrient BMPs, and opportunities to remove those barriers; and,
5. Gain a better understanding of CBSM motivational tools and techniques that would ensure local farmers and landowners change their behaviours and implement nutrient BMPs.

Survey

A. Introduction

Hello, my name is _____ and I am calling on behalf of _____. We are conducting a survey on issues of interest to people who live in rural Ontario and are farming or raising livestock on rural lands.

Please be assured that we are not selling any products or services, nor are we acting on behalf of any private company. This research will be conducted to develop programs for farmers and rural landowners to assist with improving water quality in the Great Lakes area.

Is the property where you live a farm, agricultural operation or rural property that livestock or horses are kept?

Yes – continue
No – thank you for your time.

This survey will involve me asking you a variety of questions about your farm, your land and how you manage it. There are no right or wrong answers to these questions. We are simply interested in your opinions. Your answers will be kept confidential. I am going to begin with a question about the ownership of your property

Questions

FARM/LAND STATUS

1. Do you currently:
   CODE ONE ONLY

   a. Own all your farm/land
   b. Rent all your farm/land
   c. Own and rent farm/land
   d. Neither own or rent, but work on this farm/land

2. Would you classify the farm/land as a:
   CODE ONE ONLY

   a. Commercial Farm
   b. Hobby Farm
   c. Rural property
   d. Other property (specify _____)

3. What is the size of the property you own? (own only, rent is next question)
   CODE ONE ONLY

   a. 1 – 25 acres
   b. 25 – 50 acres
   c. 51 - 100 acres
   d. 101 - 250 acres
   e. More than 250 acres
   f. Not Applicable

4. What is the size of the property you presently rent?
   CODE ONE ONLY

   a. 1 – 25 acres
   b. 25 – 50 acres
   c. 51 - 100 acres
   d. 101 - 250 acres
   e. More than 250 acres
   f. Not Applicable

5. What crops or livestock do you farm?
   DO NOT READ – CODE ALL THAT APPLY

   a. Potato
   b. Row crops – no till
   c. Row crops – conventional till
   d. Cash crops – carrots, onions, oriental vegetables
   e. Sod
   f. Corn
   g. Soya
   h. Equine
   i. Hog
   j. Cattle
   k. Dairy
   a. Other Animals (please name) _____
   b. Other Crops: (please name) _____
   l. Other...

KNOWLEDGE OF WATER AND WATER QUALITY

6. Would you say that the quality of streams, lakes and rivers in your area are:
   CODE ONE ONLY

   a. Excellent
   b. Very Good
   c. Good
   d. Satisfactory
   e. Poor
   f. Very Poor
   g. Don’t know

7. If you have a stream close to or on your property, would you say that the water quality of that stream is:
   CODE ONE ONLY

   a. Excellent
   b. Very Good
   c. Good
   d. Satisfactory
   e. Poor
   f. Very Poor
   g. Don't know
   h. n/a – no stream close to or on property

8. How would you describe good water quality in streams in your area?
   DO NOT READ – CODE ALL THAT APPLY

   a. Clear water
   b. Healthy fish population
   c. Benthic population
   d. No algae
   e. No weeds
   f. Lots of weeds/plant growth
   g. No debris
   h. Approved for swimming the Health Unit
   i. Other _____
   j. Other _____

9. How would you describe poor water quality in streams in your area?
   DO NOT READ – CODE ALL THAT APPLY

   a. Smell of water
   b. Dead Fish
   c. Muddy
   d. Nutrient loading
   e. Algae
   f. High E-coli count
   g. Garbage or debris
   h. Weed growth
   i. Farm animal access to stream
   j. Closed to swimming
   k. Other _____
   l. Other _____

MANAGEMENT PRACTICES

10. Has an environmental farm plan or stewardship plan been developed for your farm/land?
    CODE ONE ONLY

a. Yes, and I have implementing all of it
b. Yes, and I have implementing part of it
c. Yes, however I have not implemented it yet
d. No
e. Don't know/Not Applicable
f. Refused to answer

11. (If yes to 10) How effective has your environmental farm plan been for improving the environmental health of surface water quality on or near your farm?
CODE ONE ONLY

a. Very effective
b. Somewhat effective
c. Not very effective
d. Not at all effective
e. Don't know
f. Refused to answer

12. Do you have a nutrient management plan for your farm/land?
CODE ONE ONLY

a. Yes, and I have implemented all of it
b. Yes and I have implemented part of it
c. Yes, however I have not implemented it yet
d. No
e. Don't know/Not Applicable
f. Refused to answer

13. Do you have a nutrient management strategy for your farm/land?
CODE ONE ONLY

a. Yes, and I have implementing all of it
b. Yes and I have implemented part of it
c. Yes, however I have not implementing it yet
d. No
e. Don't know/Not Applicable
f. Refused to answer

14. (If yes to 12 or 13) How effective has your nutrient management plan or strategy been for improving the environmental health of surface water quality on or near your farm?
CODE ONE ONLY

a. Very effective
b. Somewhat effective
c. Not very effective
d. Not at all effective
e. Don't know
f. Refused to answer

15. How impactful would you say farming/land use practices are on the water quality of the _____ creek watershed?
CODE ONE ONLY

    a. Very impactful
    b. Somewhat impactful
    c. Not very impactful
    d. Not at all impactful
    e. Don't know
    f. Refused to answer

16. What types of farming/land practices have the most impact on the water quality of the _____ creek watershed?)
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Improper fertilizer spreading
    b. Improper manure spreading practices
    c. Conventional till, soil left bare for part of year
    d. Livestock/animal access to creek, riparian zone
    e. No nutrient management plan
    f. No Environmental Farm Plan
    g. No riparian buffer strip
    h. Removal of riparian vegetation (plants, shrubs, trees)
    i. Other _____
    j. Other _____
    k. Other._____

17. What types of farming/land management best management practices have the most impact on improving the water quality of the _____ creek watershed?)
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Nutrient management planning
    b. Proper manure management practices
    c. Soil conservation (No-till, or conservation till practices)
    d. Restricted livestock/animal access to creek, riparian zone
    e. Erosion control (Strip cropping, contour farming, field buffers)
    f. Environmental Farm Planning
    g. Streambank buffer strip
    h. Tile outlet protection
    i. Constructed wetlands
    j. Planting shrubs, trees)
    k. Other _____
    l. Other _____
    m. Other._____

18. How often is soil erosion (by wind or water) occurring on your farm?
CODE ONE ONLY

    a. Often (more than once a year)
    b. Not very often (once a year)
    c. Seldom
    d. Very rarely
    e. Rarely
    f. Never
    g. Don't know
    h. No response

19. What time of year does soil erosion happen on your farm/land?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Spring
    b. Summer
    c. Fall
    d. Winter
    e. Only after heavy rain
    f. Only on windy days
    g. Don't know
    h. No response

20. How often does soil erosion caused by water happen on your farm/land?
CODE ONE ONLY

    a. Often (more than once a year)
    b. Not very often (once a year)
    c. Seldom
    d. Very rarely
    e. Rarely
    f. Never
    g. Don't know
    h. No response

21. How often does soil erosion caused by wind happen on your farm/land?
CODE ONE ONLY

    a. Often (more than once a year)
    b. Not very often (once a year)
    c. Seldom
    d. Very rarely
    e. Rarely
    f. Never
    g. Don't know
    h. No response

NUTRIENTS (FERTILIZER)

22. Do you use fertilizers in your farm operations?
CODE ONE ONLY

    a. Yes
    b. No (skip to next section)
    c. Don't know/Not Applicable
    d. Refused to answer

23. If yes, what kind of fertilizer(s) do you use?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Fertilizer 1 _____
    b. Fertilizer 2 _____
    c. Fertilizer 3 _____
    d. Fertilizer 4 _____
    e. Don't know/Not Applicable
    f. Refused to answer

24. How do you calculate the amount of fertilizer that you use?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Traditional practices / based on past use
    b. Based on crop planted
    c. Based on past yields from that piece of land
    d. Follow nutrient management plan
    e. Based on training received
    f. Based on soil testing
    g. Based on crop yields
    h. Based on professional advice/plan
    i. Don't know/Not Applicable
    j. Refused to answer
    k. Other _____
    l. Other _____

25. Have you heard about or are you using technologies that could help improve fertilizer use?
CODE ONE ONLY

    a. Yes
    b. No (skip to question 27)
    c. Don't know/Not Applicable
    d. Refused to answer

26. What technologies have you heard about?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. GPS
    b. Technology 2_____
    c. Technology 3_____

d. Technology 4_____
e. Don't know/Not Applicable
f. Refused to answer

27. On a scale of 1 to 10 where 1 is Not Interested at All and 10 is Very Interested; how interested are you in learning more about new technologies such as GPS to help improve fertilizer application and use?
CODE ONE ONLY

Not Interested at All→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Very Interested	DK	RTA

28. On a scale of 1 to 10 where 1 is Not Likely at All and 10 is Very Likely; how likely is that you would use new technologies to help improve fertilizer application to your farmland?
CODE ONE ONLY

Not Likely at All→	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Very Likely	DK	RTA

NUTRIENTS (MANURE)

29. Do you use manure on your farm?
CODE ONE ONLY

a. Yes
b. No (skip to next section)
c. Yes, I have used it but not anymore
d. Don't know/Not Applicable
e. Refused to answer

30. Is manure produced on your farm?
CODE ONE ONLY

a. Yes
b. No
c. Don't know/Not Applicable
d. Refused to answer

31. When do you apply manure to your fields and crops?
DO NOT READ – PROBE – CODE ALL THAT APPLY

a. Spring
b. Summer
c. Fall
d. Winter
e. In more than one season
f. According to my nutrient management plan

g. Don't know/Not Applicable
h. Refused to answer
i. Other _____

32. How do you calculate the amount of manure that you need to apply?
DO NOT READ – PROBE – CODE ALL THAT APPLY

a. Traditional practices / based on past use
b. Based on crop planted
c. Based on past yields from that piece of land
d. Follow nutrient management plan
e. Based on training received
f. Based on soil testing
g. Based on crop yields
h. Based on professional advice/plan
i. Don't know/Not Applicable
j. Refused to answer
k. Other _____
l. Other _____

EROSION CONTROL - RIPARIAN BUFFER STRIPS

33. Are you familiar with riparian buffer strips?
CODE ONE ONLY

a. Yes
b. No
c. Somewhat familiar
d. Don't know/Not Applicable
e. Refused to answer

34. Do you have any riparian buffer strips in your property?
CODE ONE ONLY

a. Yes
b. No
c. Don't know/Not Applicable
d. Refused to answer

35. On a scale of 1 to 10 where 1 is Not Very Important and 10 is Very Important; how important would you consider the usefulness of buffer strips?
CODE ONE ONLY

Not Very Important →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10** ←Very Important	DK	RTA

36. On a scale of 1 to 10 where 1 is Not Interested at All and 10 is Very Interested; how interested are you in learning more about buffer strips?

CODE ONE ONLY

Not Interested at All →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Interested	DK	RTA

37. On a scale of 1 to 10 where 1 is Not Likely at All and 10 is Very Likely; how likely is it that you would install a buffer strip in your property?
CODE ONE ONLY

Not Likely at All →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Likely	DK	RTA

38. On a scale of 1 to 10 where 1 is Not Interested at All and 10 is Very Interested; how interested are you in becoming more aware about best management practices for nutrient management techniques for farmers/landowners?
CODE ONE ONLY

Not Interested at All →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Interested	DK	RTA

EROSION CONTROL - WIND BREAKS

39. Are you familiar with farm wind breaks?
CODE ONE ONLY

    a. Yes
    b. No
    c. Somewhat familiar
    d. Don't know/Not Applicable
    e. Refused to answer

40. Do you have any vegetative (shrub or trees) wind breaks on your property?
CODE ONE ONLY

    a. Yes
    b. No
    c. Don't know/Not Applicable
    d. Refused to answer

41. (If yes to 39) Are there wind breaks on your property?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Surrounding each field
    b. Only on the farm property lines

c. Only surrounding the home/barns
d. Both around the barns and fields.
e. Don't know/Not Applicable
f. Refused to answer
g. Other _____

42. (If yes to 39) How often do you maintained your windbreaks by thinning, pruning or planting new stock in gaps in the windbreak?
CODE ONE ONLY

a. Yearly
b. Every 2-5 years
c. Every 5 – 10
d. Every 10 year plus
e. Never
f. Refused to answer
g. Other _____

43. On a scale of 1 to 10 where 1 is Not Very Important and 10 is Very Important; how important would you consider the usefulness of wind breaks for controlling soil erosion?
CODE ONE ONLY

Not Very Important →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Important	DK	RTA

44. On a scale of 1 to 10 where 1 is Not Interested at All and 10 is Very Interested; how interested you are in learning more about installing and maintaining wind breaks?
CODE ONE ONLY

Not Interested at All →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Interested	DK	RTA

45. On a scale of 1 to 10 where 1 is Not Likely at All and 10 is Very Likely; how likely is it that you build new wind breaks in your property?
CODE ONE ONLY

Not Likey at All →	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	←Very Likely	DK	RTA

INFORMATION SOURCES

46. Marketing channels and strategies
    What information have you received in the past about best management practices concerning water quality in your area?
    DO NOT READ – PROBE – CODE ALL THAT APPLY

    1. SPECIFY _____
    2. None
    3. No answer / don't know

47. Where did you get this information?
DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Conservation Authority
    b. Other environmental organization (NGO)
    c. Ontario Ministry of the Environment
    d. Ontario Ministry of Agriculture, Food and Rural Affairs
    e. Local municipal / township office
    f. Other government offices
    g. Library
    h. Family
    i. Friends
    j. Neighbours
    k. Television programs
    l. Other _____
    m. Other _____

47. Thinking back to where you have received information on nutrient management, what sources do you remember?
    DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Newspaper articles
    b. Government publications
    c. Brochures
    d. Television/Radio
    e. School/University
    f. Environmental groups
    g. Scientific papers/Journals
    h. Internet
    i. Farmers' Association
    j. Other farmers
    k. Other _____

48. What is the best way to provide information to you on nutrient management and water quality?
    DO NOT READ – PROBE – CODE ALL THAT APPLY

    a. Newspaper articles
    b. Government publications
    c. Brochures

d. Television/Radio
e. School/University
f. Environmental groups
g. Scientific papers/Journals
h. Internet
i. Farmers' Association website or listserve
j. Other farmers
k. Other _____

DEMOGRAPHICS

And, now I'd like to ask you a few final questions for statistical purposes only. Your answers to these questions will be kept confidential.

49. I am going to read some age groups, please indicate which one you fall into.
CODE ONE ONLY

a. 18-25
b. 26-35
c. 36-45
d. 46-55
e. 56-65
f. 65- 75
g. 75 or older
h. Refused to answer

50. Into which of the following categories would you put the total annual income in 20XX of all the members of your household, including yourself, before taxes and deductions?
CODE ONE ONLY READ IF NECESSARY

a. 1 - $10,000 or less
b. 2 - $10,001 to $25,000
c. 3 - $25,001 to $50,000
d. 4 - $50,001 to $75,000
e. 5 - $75,001 to $100,000
f. 6. - More than $100,000
g. 12 - No answer
h. 13. - don't know

51. What is the highest level of education that you have reached?
CODE ONE ONLY

a. Some Grade School
b. Grade School Graduate
c. High School Graduate
d. Some College or University
e. College or University Graduate
f. Some Graduate Studies
g. Post-Graduate Degree
h. Refused to answer

52. Have you taken any specialized agricultural education?
DO NOT READ – PROBE – CODE ALL THAT APPLY

a. Agriculture certificate
b. Agriculture Diploma
c. College/University Degree in Agriculture
d. Post-Graduate Degree in Agriculture
e. Continuing Education Courses in Agriculture
f. Advanced Agriculture training
g. None
h. Not applicable
i. Refused to answer

53. Do not ask

Gender M / F

~~~ O ~~~
~~~