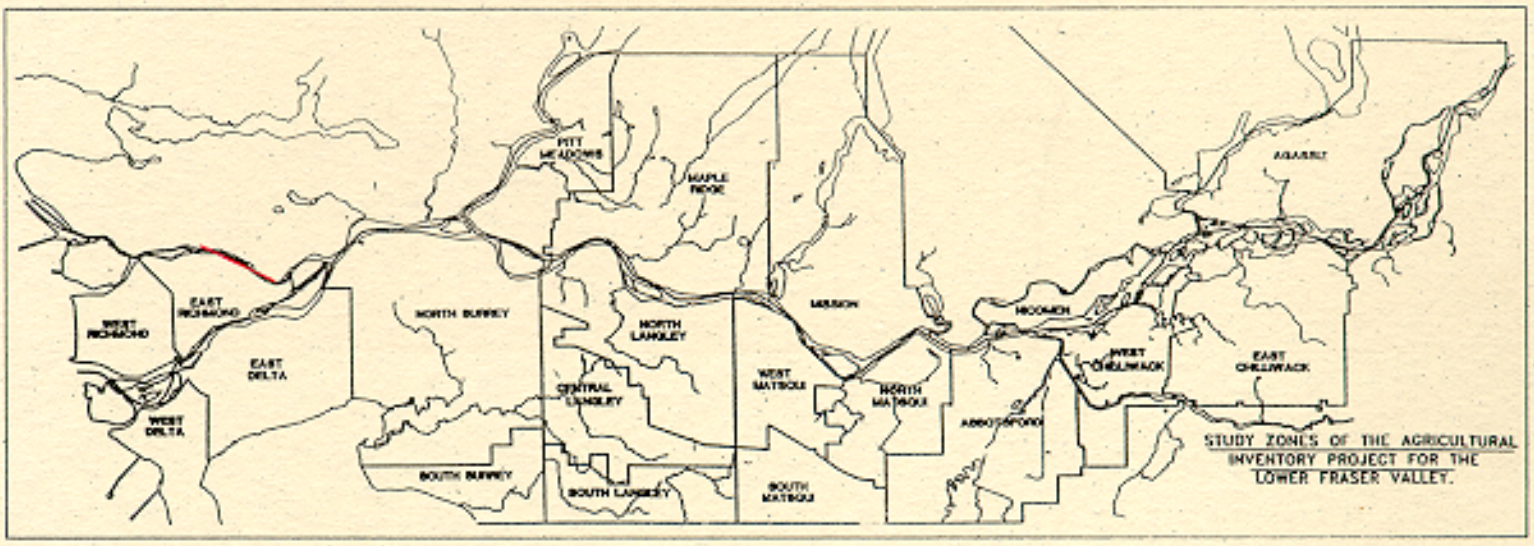
DESCRIPTION OF SELECTED WASTE MANAGEMENT PROBLEMS, OPTIONS AND STRATEGIES



Component Project
of
Management of Livestock and Poultry Manures in the Lower Fraser Valley

REPORT 8

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FRASER RIVER ACTION PLAN — PLAN D'ACTION DU FRASER

Ministry of Environment, Lands and Parks

Ministry of Agriculture, Fisheries and Food

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Prepared for

BC Ministry of
Environment, Lands and Parks

Environment Canada
Fraser River Action Plan

BC Ministry of
Agriculture, Fisheries and Food

Fisheries and Oceans
Fraser River Action Plan

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Disclaimer

This report contains the results of a project conducted under contract. The ideas and opinions expressed herein do not necessarily state or reflect those of the participating parties.

TABLE OF CONTENTS

1.0 INTRODUCTION **1**

2.0 AGRICULTURE IN THE LOWER FRASER VALLEY **5**

3.0 OPTIONS DEVELOPMENT PROCESS **6**

4.0 OPTIONS: DISCUSSION AND EVALUATION **8**

4.1 ON-FARM OPTIONS 8
4.1.1 Manure Applications 8
4.1.2 Manure Storage Structures 13
4.1.3 Conservation Farming and Riparian Area Management 15
4.1.4 Air Emissions 16
4.1.5 Approaches to Improved On-farm Management 17

4.2 OPTIONS TO DEAL WITH EXCESS NUTRIENTS 18
4.2.1 Restrictions on Livestock Densities 19
4.2.2 Restrict Agricultural Activities 21
4.2.3 Removal of Excess Nutrients 21
4.2.4 Reduce Nutrients in Wastes 22
4.2.5 Waste Treatment 23

5.0 STRATEGY DEVELOPMENT **24**

5.1 LAND USE MANAGEMENT 24

5.2 AWARENESS AND ALTERNATIVES 25

5.3 INCENTIVES AND FINANCIAL ASSISTANCE 26

5.4 POLICY, LEGISLATION AND REGULATION 28

5.5 ENVIRONMENTAL QUALITY OBJECTIVES AND EVALUATION 29

6.0 CURRENT GOVERNMENT ACTIVITIES **31**

6.1 PROVINCIAL GOVERNMENT 31
6.1.1 BC Ministry of Environment, Lands and Parks 31
6.1.2 BC Ministry of Agriculture, Fisheries and Food 31
6.1.3 BC Ministry of Health 34
6.1.4 Agricultural Land Commission 34

6.2 FEDERAL GOVERNMENT 34
6.2.1 Department of Environment 34
6.2.2 Department of Fisheries and Oceans 35
6.2.3 Department of Agriculture and Agri-Food 36

6.3 LOCAL GOVERNMENTS 37

7.0 MANAGEMENT FRAMEWORK 38

7.1 NEEDS TO ACHIEVE SUSTAINABILITY 38
7.1.1 Groundwater Quality Protection 38
7.1.2 Surface Water Quality Protection 40
7.1.3 Air Quality Protection 42
7.1.4 Soil Quality Protection 42

7.2 RECOMMENDED KEY ACTIVITIES 42
7.2.1 The BAWMP Process 43
7.2.2 Management of Excess Nutrients 45
7.2.3 Land Use Management 45
7.2.4 Promotion of Awareness and Alternatives 48

7.3 LEADERSHIP AND RESOURCES 48

REFERENCES

ACKNOWLEDGMENTS

LIST OF FIGURES

Figure 1.1 Agricultural Waste Management Zones 2
Figure 4.1 Option Categories Discussed and Evaluated 9
Figure 4.2 Nitrogen Balances - Large Farms - Lower Fraser Valley 20

LIST OF TABLES

Table 7.1 Key Actions Needed to Achieve Protection of Groundwater, Surface Water, Air and Soil Quality 39
Table 7.2 Recommended Activities to Support the BAWMP Process 44
Table 7.3 Recommended Activities to Support Management of Excess Nutrients 46
Table 7.4 Recommended Activities to Support Land Use Management 47
Table 7.5 Recommended Activities to Support Awareness and Alternatives 49

APPENDICES

Appendix A Management of Agricultural Wastes in the Lower Fraser Valley - List of Reports
Appendix B Meeting Attendance
Appendix C Producer Conservation Groups in the Lower Fraser Valley
Appendix D Agencies and Organizations with an Interest in Agricultural Nutrient Management in the Lower Fraser Valley

1.0 INTRODUCTION

The goal of the "Management of Agricultural Wastes in the Lower Fraser Valley" program is to evaluate the production, treatment and disposal of agricultural wastes, primarily manure, within the context of groundwater contamination and impacts to surface water. The findings of this evaluation will provide a background against which policies and strategies for improving nutrient (manure and inorganic fertilizers) management can be developed through a multi-stakeholder consultative process.

For the purposes of this program the Lower Fraser Valley was divided into twenty Agricultural Waste Management Zones; these zones are shown in Figure 1.1.

The program has been broken into several component projects (Appendix A) which address three general questions:

- what is the current state of agricultural nutrient management,
- what are the practical options for improving nutrient management, and
- how might the various practical options be implemented.

The evaluation of the current state of agricultural nutrient management relied heavily on consultation workshops and interviews with technical specialists, including several members of the Steering Committee, and on previous and on-going studies. This approach was very productive and aided in setting up an appropriate technical framework.

Reports for those projects which have been completed include:

- Agricultural Inventory of the Lower Fraser Valley - Data Summary Report (Brisbin, 1994)

- Application of Inorganic Fertilizers in the Lower Fraser Valley (Brisbin, 1995a)

- Agricultural Nutrient Pathways (Brisbin and Runka, 1995)

- Agricultural Nutrient Management in the Lower Fraser Valley (Brisbin, 1995b)

- Livestock Waste Management Practices and Legislation Outside British Columbia (Runka, 1995)

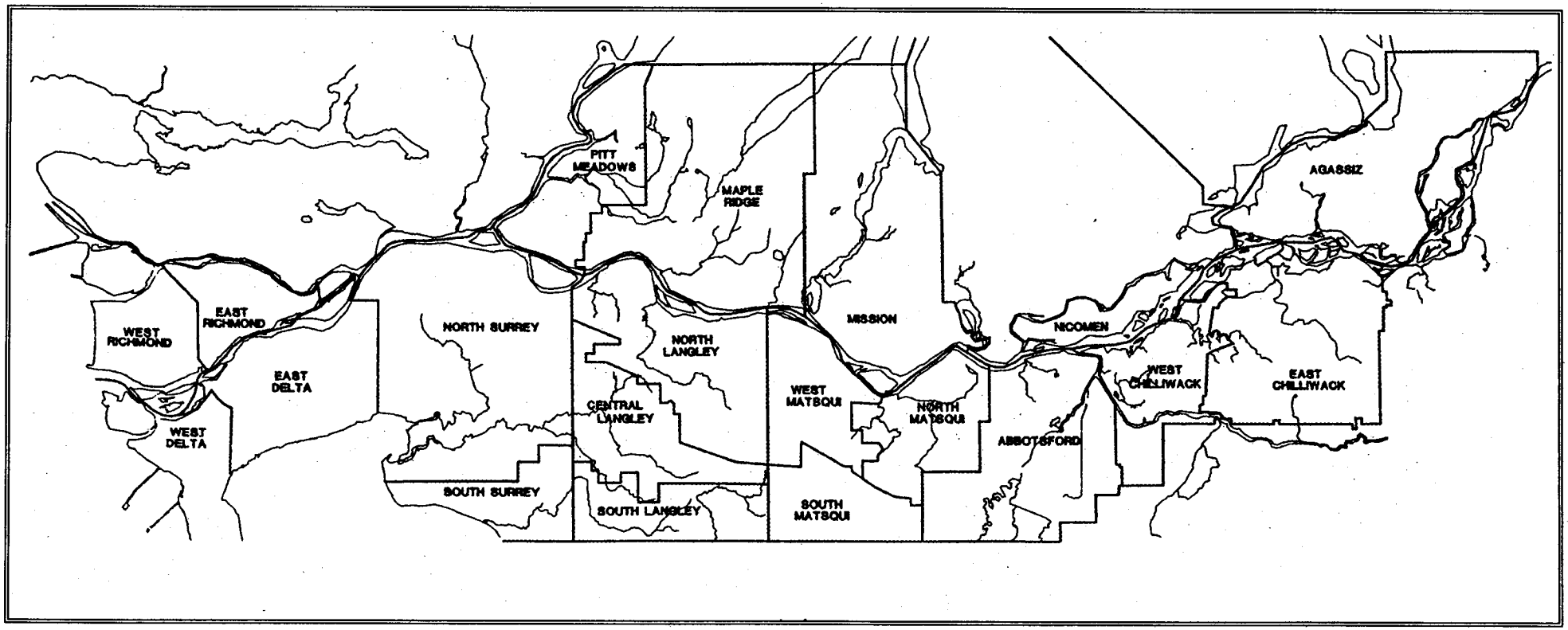
- A Literature Review of the Economics of Manure Management Options (Wohl, 1996)

- Management of Agricultural Wastes in the Lower Fraser Valley - Interim Summary Report (Brisbin, 1996a)

- Producer Workshop Proceedings: Management of Livestock and Poultry Manures in the Lower Fraser Valley (Brisbin, 1996b)

This report summarizes discussions of possible options for improving agricultural nutrient management and outlines a framework to implement the more favourable

Figure 1.1 : Agricultural Waste Management Zones



options. This discussion is based on an evaluation of practices and legislation in other jurisdictions (Runka, 1995) and on the results of a workshop attended by several producers and producer group representatives (Brisbin, 1996b), but is primarily the result of a series of workshops attended by members of the Steering Committee.

In looking at the options for improving agricultural waste management in the Lower Fraser Valley, it must be kept in mind that we are dealing with a diverse and complex system.

Many of the agricultural waste sources potentially contribute to non-point source (NPS) pollution, pollution which originates from many diffuse sources. While the loading from these sources may not necessarily be large individually, the overall loading could result in significant environmental effects. A localized source can also have an immediate impact. Runoff into streams that has been contaminated with manure may have ammonia concentrations that are toxic to fish. It has been shown that contamination from agricultural sources is an issue in many areas of the Lower Fraser Valley (IRC, 1994a; IRC, 1994b; Liebscher et al, 1992; Wassenaar, 1994; Zebarth et al, 1995) NPS pollution may be hard to control effectively and it may be difficult to utilize the "polluter pay" principle per se, since it is often difficult to identify all of the contributing sources.

Resource users and managers are concerned about documented water and air quality problems. It is expected that there will be continuing pressure for agriculture to improve its environmental performance. In the Lower Fraser Valley there are health concerns related to groundwater quality and fisheries concerns related to surface water quality. There are several instances where nitrate levels in groundwater exceed acceptable limits for drinking water and aquatic habitat degradation is seriously impacting commercially important fisheries. Tributaries of the Lower Fraser provide about 65% of the spawning habitat for Fraser River coho salmon and about 85% of the spawning habitat for Fraser River chum salmon. The intensive farming practices of the Lower Fraser Valley can create more serious NPS pollution problems than may be encountered elsewhere in the province.

In attempting to reduce NPS pollution from agriculture there will be trade offs between regulation and voluntary action. The more agricultural producers understand about the nature of pollution problems and make progress in addressing the problems, the less need there is for strict regulation. On the other hand, there is the need for some amount of regulation and enforcement to ensure that producers will not use obviously inadequate management practices.

Producers, government and the non-farming public must all work towards acquiring a better understanding of the factors which cause NPS pollution. There are numerous, inter-related factors, including hydrology, weather conditions, crop cover, and the amount, timing and methods of applying nutrients to land which interact and ultimately determine the impacts of agricultural wastes on the environment. Farm lands within the Lower Fraser Valley are often in the lower portions of watersheds where they are easily affected by upstream, often non-farming, activities. Innovative solutions are required to manage human activities in watersheds in a sustainable manner. There is a need to find the appropriate balance between our environmental, economic and social expectations in order to initially define and then to achieve sustainability.

A variety of factors, including economics, international trade and government policy have led to the intensive farming practices in the Fraser Valley. There is increasing pressure from the public and other resource users to deal with environmental concerns. There are management issues pertaining to the desire for inexpensive food and the desire for a better environment. The public want inexpensive food and environmental responsibility demonstrated by producers while producers strive to generate an adequate income in an increasingly competitive market.

While there have been significant efforts to improve agriculture's environmental performance in recent years, there is still considerable scope for further improvement. There is no simple solution and there is no perfect model which has been developed in other jurisdictions and which can be used as a prototype for the Lower Fraser Valley situation (Runka, 1995). There is a need for a "made in" the Lower Fraser Valley agricultural waste management policy.

The following chapters in this report present a brief overview of agriculture in the Lower Fraser Valley (Chapter 2), outline the option discussion process (Chapter 3), provide a discussion and evaluation of options (Chapter 4) and strategy development (Chapter 5), summarize current government activities related to agricultural waste management (Chapter 6) and present a recommended framework for further action (Chapter 7).

It is clearly understood that more work will be needed to fine tune and implement any proposed strategy. This and the other projects which have been part of the Management of Agricultural Wastes in the Lower Fraser Valley program, set a sound foundation on which to determine how best to address the agricultural waste management problems in the Lower Fraser Valley.

2.0 AGRICULTURE IN THE LOWER FRASER VALLEY

The intensive agricultural production in the Lower Fraser Valley contributes significantly to the regional and provincial economy. The Lower Fraser Valley contains about 4% of the provinces agricultural land but 30% of the farms and generates 56% of the total provincial gross farm receipts. Gross farm receipts generated in the Lower Fraser Valley were estimated to be $859 million in 1995 (BCMAFF, 1996).

The individual commodity group production in the Lower Fraser Valley, as a percentage of the provincial total, are estimated to be:

- dairy 67%
- poultry 82%
- beef 18%
- pork 73%
- vegetable 83%
- nursery 68%
- greenhouse vegetables 65%
- floriculture 80%
- mushrooms 95%

In 1991 the primary agricultural industries in the Lower Fraser Valley represented over $3.5 billion in capital investment and paid over $126 million in cash wages.

While agriculture's contribution to the economy is significant, the costs, both social and private, of inadequate nutrient management may also be significant. These costs are difficult to quantify and no rigorous effort to do so has been done as part of this program. There are clear indications that the “costs” to society of current practices are high (Wohl, 1996).

3.0 OPTIONS DEVELOPMENT PROCESS

The purpose of this process was to identify and evaluate potential options and then to select those which would likely have the best chance of helping solve the agricultural waste management problems in the Lower Fraser Valley. The review of agricultural waste management practices and legislation in jurisdictions other than BC showed that there is no single comprehensive strategic model which can meet all needs. A "made in" the Lower Fraser Valley strategy is required.

The discussion of options to include in a Lower Fraser Valley agricultural waste management policy began with the formulation of a general outline that considered three basic elements.

1. In order to make progress towards acceptable solutions there is a need for educational, financial, technical and regulatory tools which will:

    - stabilize nutrient loadings (prevent problems from getting worse);
    - reduce nutrient loadings in areas where this is necessary; and
    - achieve sustainability (achieve an acceptable long term nutrient balance).

2. Options can include one or several of the following components:

    - research;
    - development of guidelines;
    - extension;
    - development and demonstration of appropriate technology;
    - incentives and financial assistance;
    - policy, legislation, regulation and enforcement; and
    - evaluation.

3. There must be options to address both of the general types of agricultural waste management problems which have been identified:

    - those where the available land base is adequate to effectively utilize the nutrients in the wastes generated on that land base such that on-farm improvements can prevent pollution and achieve a healthy nutrient balance; and

    - those where the land base is not sufficient to effectively utilize the waste generated and where livestock numbers must be decreased or nutrients (manure) moved in order to achieve an acceptable nutrient balance.

Although the objective of long term sustainability can only be achieved over a period of several years there is a need to intensify efforts, refine objectives and choose appropriate tools as progress is made.

Information from the review of experiences in jurisdictions other than BC, the local experience of the Steering Committee and others with an interest in agricultural waste management provided an initial list of potential options for discussion.

A number of meetings and a workshop (Appendix B) were held where the options were proposed, discussed and evaluated, and from which a policy strategy and implementation framework was developed.

These sessions involved members of the Steering Committee, BCMAFF staff and representatives of conservation farming groups. A workshop (Brisbin, 1996b) was held to solicit both input and focus from several “representative” producers.

More detailed discussions of the environmental impacts associated with agricultural nutrient management are found in Agricultural Nutrient Pathways (Brisbin and Runka, 1995) and Agricultural Nutrient Management in the Lower Fraser Valley (Brisbin, 1995b). The discussion and evaluation of options is summarized in the following Chapter.

4.0 OPTIONS: DISCUSSION AND EVALUATION

The first section of this Chapter discusses options which are applicable to all farms. The second section discusses options which address excess nutrient situations where the land base is not sufficient to effectively utilize the nutrients generated on that land base. Figure 4.1 presents an outline of the options discussed.

4.1 ON-FARM OPTIONS

This group of options primarily addresses on-farm management improvements and includes: manure application, manure storage structures, conservation farming techniques, riparian area management, air emissions and approaches to improving on-farm management. Some of these options are addressed, at least partially, by the existing Code of Agricultural Practice for Waste Management (B.C. Reg. 131/92).

4.1.1 Manure Applications

The **timing of manure application** is a critical management factor. Manure must be applied at the correct time of year to prevent unnecessary losses to surface water, groundwater and the atmosphere, and to optimize the utilization of manure nutrients by growing plants. More effective utilization of manure nutrients reduces the need for inorganic fertilizers. Proper timing is a function of several variables, including weather, soil conditions and stage of crop growth.

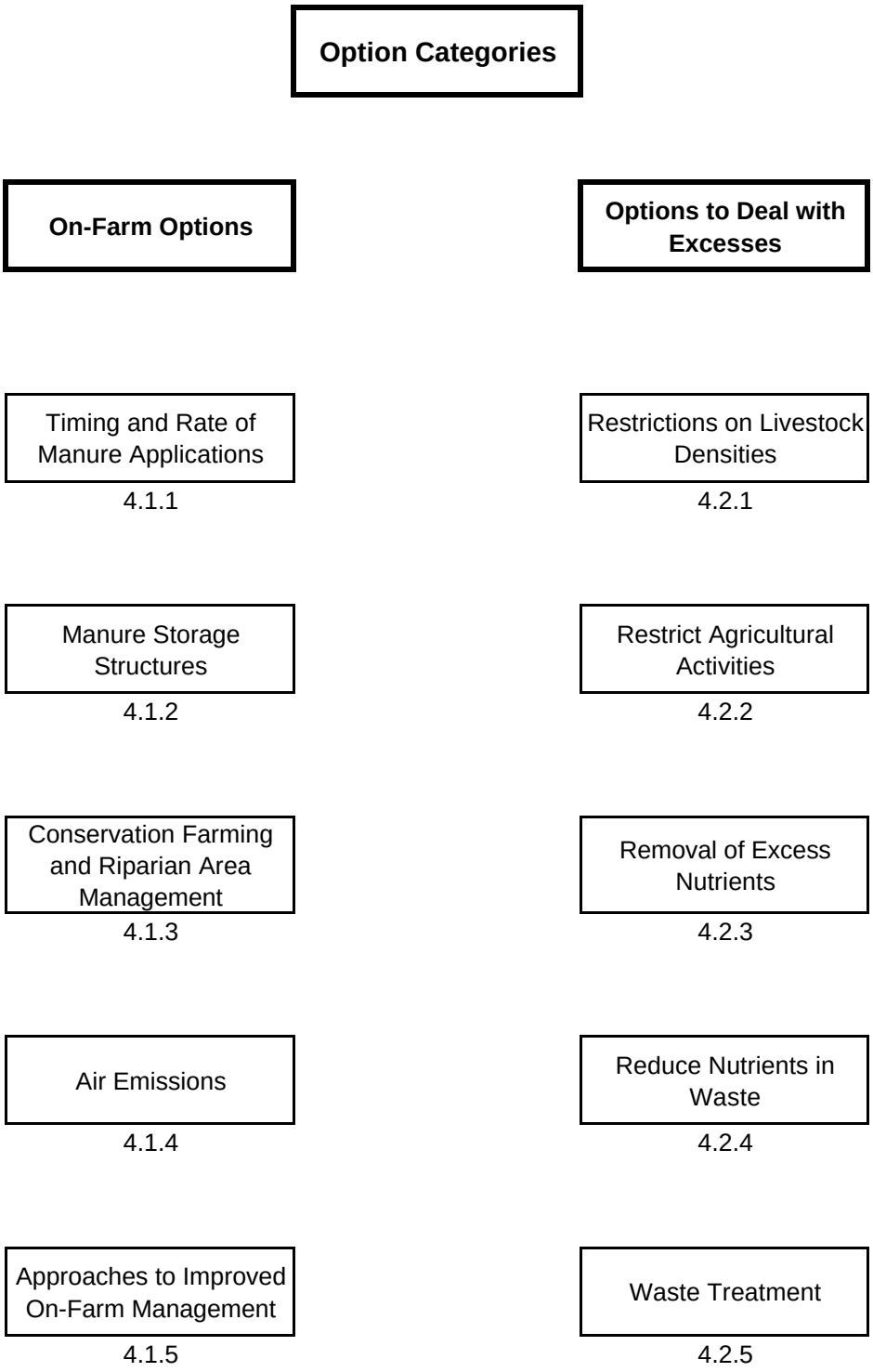
The Code of Agricultural Practice contains the general requirement that agricultural waste can only be applied to land as a fertilizer or soil conditioner and specifies certain conditions under which agricultural wastes must not be applied. Unlike some jurisdictions, such as Holland (where spreading of manure is prohibited between September 15 and February 1), Denmark, Sweden and Switzerland, BC does not have a regulation which specifically prohibits applications at certain times of the year.

Some stakeholders feel that the Code is not specific enough and that manure application should be prohibited during certain periods of the year when there is a high risk of causing pollution. There are some situations where the apparent risk of causing pollution far outweighs any agronomic benefits from manure application. There are other times such as in early spring where crops will benefit from manure application, yet the risk of pollution is still appreciable.

BC Environment in consultation with other stakeholders including BCMAFF, the Agricultural Environmental Protection Council and Producer Conservation Group representatives has recently developed Manure Management Guidelines for the Lower Fraser Valley (BC Environment, 1996). The guidelines focus on high risk fall and winter manure applications and the covering of manure piles. They identify date restrictions for fall and winter spreading of manure, according to crop type and soil condition, and specify setbacks from watercourses during manure application. These restrictions on fall and winter manure application attempt to balance the risk of pollution from manure spreading with the fertilizer attributes of manure.

Figure 4.1

Option Categories Discussed and Evaluated



The **method of manure application** also influences the risk of pollution. Injecting the manure into the soil or incorporating the manure into the soil soon after application will reduce the risk of manure contaminated runoff and will reduce the loss of nitrogen to the air due to ammonia volatilization. In some jurisdictions acceptable methods and equipment for manure application are specified. Several European countries require that manure be injected directly into the soil or that it be incorporated within a short period of time after spreading. In some areas of Sweden manure is to be incorporated within 4 hours of application. Denmark requires that manure applied to bare soil must be incorporated within 12 hours and in the Netherlands manure is to be incorporated within 24 hours.

The timing and rate of nutrient **applications must be matched with crop needs** if agriculture is to achieve environmental sustainability. In some jurisdictions maximum nutrient application rates are specified; the European Community is working towards limiting nitrogen applications to 170 kg per hectare per year by the year 2000. Limits to the use of inorganic fertilizers have been imposed in some jurisdictions and in others (the Netherlands) detailed records of manure production and application are required. Specifying maximum nutrient applications has the disadvantage of not recognizing the large variation in crop nutrient removal rates. For crops commonly grown in the Fraser Valley the amount of nitrogen removed in the harvested portion of the crop can vary from 25 kg-N/ha to over 400 kg-N/ha.

The Code does not address this issue in detail, stating only that agricultural wastes be applied as a fertilizer or soil conditioner. Some stakeholders interpret this to mean that if conditions are not acceptable for the application of manure as a fertilizer, then manure cannot be applied only as a soil conditioner. The recent BC Environment guidelines are more specific and limit maximum nutrient applications, as a function of total annual crop requirements, during certain times of the year.

The development and implementation of **nutrient management plans** can be used to help achieve a good match between nutrient applications and crop needs and to optimize the utilization of the nutrients contained in manure. These plans should address several issues such as the variable nutrient content of manure, the variable response of soils and crops to manure applications, the variable nutrient needs of crops and the efficiencies of application equipment.

There are no regulations stating that producers must develop nutrient management plans, however, BC Environment has ordered some producers to develop and implement Best Agricultural Waste Management Plans (BAWMPs) in which nutrient management plans have been an integral part. Several jurisdictions (Netherlands, Denmark, Pennsylvania) require that intensive livestock operations develop and implement nutrient management plans.

Existing Environmental Guidelines (BCMAFF, 1992-96) recommend manure application rates based on the crop removal of nitrogen only and do not provide recommendations with respect to other nutrients, such as phosphorus and potassium. To prevent degradation of water and soil quality and to optimize the utilization of nutrients in manure, nutrients other than nitrogen and the status of these nutrients in the soil should also be considered.

With the variability in manure quality, soils and crop needs, nutrient management planning should include regular sampling and analysis of manure, soil and crop tissue.

Current research, supported by industry and government programs, is examining a methodology for spring and pre-side dress soil nitrogen sampling for silage corn (Zebarth et al, 1996), improving the understanding of the nitrogen needs of raspberries (Zebarth and Kowalenko, 1995; Zebarth et al, 1994 and Hughes-Games and Zebarth, 1994) and evaluating alternate application equipment (Bittman et al, 1995). A summary of other pertinent research is found in Kowalenko, 1995. There is, however, a need for continuing research and the development of management guidelines which address the appropriate sampling methodology and interpretation of results so that manure applications are effectively matched to crop needs. Extension of this information to the farming community through education and workshops is also required.

Monitoring soil nitrate, phosphorus and potassium levels at the end of the growing season has been suggested as the best way to determine whether excessive amounts of nutrients have been applied (Kowalenko, 1991).

Monitoring soil phosphorus is problematic in that soils will tend to immobilize a certain portion of the applied phosphorus, up until such time as that immobilization capacity is fully utilized. This creates the situation where, when the soil can still immobilize phosphorus, phosphorus must be applied in excess of crop needs. When the soil capacity to immobilize phosphorus decreases, less is required to satisfy plant needs and there is a greater risk that excess applications will reach surface water courses or groundwater (Yuan and Lavkulich, 1995). There are strong indications that, in general, local soil phosphorus levels have been increasing (Kowalenko, 1992, Bomke and Lavkulich, 1975). There has been little local research directed at determining what soil phosphorus levels should be to prevent excessive amounts from reaching surface water.

Another requirement for optimizing the use of manure nutrients is to have equipment which will apply manure at an acceptably uniform rate. Equipment commonly in use for manure application in the Lower Fraser Valley does not achieve the same uniformity of application as does the equipment used to apply inorganic fertilizers. There is the need for continued demonstration and evaluation of available equipment and there is a need for research to develop or test new equipment and application techniques.

Another issue which must be considered in nutrient management plans is the atmospheric deposition of nitrogen, a process which may be of significant magnitude and which is only beginning to be investigated in the Lower Fraser Valley. The magnitude and timing of atmospheric deposition must be better understood if it is to be included in on-farm nutrient budgeting.

Nutrient management plans should also include an on-farm nutrient accounting system to record nutrient applications (volume of manure applied, manure composition), crop responses (yields and tissue analysis), and soil sample analyses. Producers should review these records, with professional assistance in some instances, on an annual basis to provide a summary and evaluation of previous nutrient budgets and to develop a plan for the following growing season.

To achieve the proper timing of manure application and to maximize manure nutrient utilization adequate **manure storage capacity** is required.

Regulations in Europe often specify a minimum storage capacity of 4 to 6 months; in Denmark the minimum required capacity is 9 months and in Sweden up to 10 months storage may be needed to meet spreading restrictions. B.C.'s Code contains no specific minimum storage requirements, although it does state that capacities must be sufficient to allow waste to be applied as a fertilizer or soil conditioner, or to allow for the waste to be removed from the farm.

In order to accomplish effective nutrient management the storage facility must have an adequate capacity. If wastes are to be applied when conditions are acceptable the wastes must be stored when conditions for application are not favourable. Average storage capacities of 4 months for dairy operations and 4.4 months for hog operations have been reported for Sumas Prairie (IRC, 1994b). Environmental guidelines for BC producers (BCMAFF, 1992-96) recommend 6 to 7 months storage in the Lower Fraser Valley.

Several of the on-farm options discussed above have the advantage of generating direct on-farm benefits by increasing the effective utilization of manure nutrients and thereby decreasing the costs of purchasing inorganic fertilizers.

Sections 6 and 12 through 14 of the **Code of Agricultural Practice** address the timing and amount of waste application and storage capacity. These sections are reprinted below.

Storage facility

6. A storage facility must
(a) be of sufficient capacity to store all the agricultural waste produced or used on the farm for the period of time needed to allow for
(i) the application of agricultural waste as a fertilizer or soil conditioner, or
(ii) the removal of agricultural waste,

Allowable application

12. Agricultural waste must be applied to land only as a fertilizer or a soil conditioner.

Prohibited application

13. Agricultural waste must not be applied to the land if, due to meteorological, topographical or soil conditions or the rate of application, runoff or the escape of agricultural wastes causes pollution of a watercourse or groundwater.

Conditions unfavourable to application

14. Agricultural wastes must not be applied
(a) on frozen land
(b) in diverting winds
(c) on areas having standing water

(d) on saturated soils, or
(e) at rates of application that exceed the amount required for crop growth,
if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary.

4.1.2 Manure Storage Structures

Requirements such as permits and engineered designs for the **design and location of storage facilities**, with specific objectives of preventing or minimizing any losses from storage, are regulated in some jurisdictions outside BC. The BC Code (the pertinent sections of the Code are reprinted at the end of this section) specifies required setbacks from watercourses and states that storage facilities must be maintained in a manner to prevent pollution, but contains no requirement for either building permits, government approvals or engineered designs. In the Lower Fraser Valley local by-laws require that most storage structures be built under permit and to specific structural standards. Requirements to meet environmental standards vary considerably; in some local jurisdictions (municipalities) certain permit applications are referred to BC Environment for comment while in other cases earthen lagoons can be constructed without permit and to no specific standards.

Although the general provisions of the Waste Management Act and the Fisheries Act do apply, there is not necessarily a mechanism in place to ensure that BCMELP or DFO review plans to identify, and thereby hopefully avoid, potential problems.

The construction of inappropriate or inadequate facilities is a concern in the Lower Fraser Valley, particularly with respect to earthen lagoons (Schmidt, 1995). There have been several such facilities constructed over the past few years. Permits and engineered designs have not been required and the integrity of these structures is in doubt. There may be significant losses to infiltration or runoff from some facilities, however there has been no inventory of these facilities nor an evaluation of their integrity.

Sections 4 through 9 of the **Code** address the location and integrity of storage structures and are reprinted below.

General

4. Agricultural waste may be stored on a farm only if the waste is produced or used on that farm.

Storage methods

5. When agricultural waste is stored, it must be stored
(a) in a storage facility,
(b) as field storage, or
(c) in the case of waste from fur bearing animals, under their outdoor pens.

Storage facility

6. A storage facility must

(a) be of sufficient capacity to store all the agricultural waste produced or used on the farm for the period of time needed to allow for
    (i) the application of agricultural waste as a fertilizer or soil conditioner, or
    (ii) the removal of the agricultural waste,
(b) prevent the escape of any agricultural waste that causes pollution, and
(c) be maintained in a manner to prevent pollution.

Location of storage facility

7.(1) A storage facility must be located at least 15m from any watercourse and 30m from any source of water for domestic purposes.

(2) Subsection (1) does not apply to a storage facility existing prior to April 1, 1992 provided that a report
(a)demonstrating to the satisfaction of the manager that no pollution of any watercourse or domestic water supply is occurring from the storage facility, and
(b) produced by
    (i) a person with professional qualifications in the field of environmental assessment and licenced to practice in British Columbia, or
    (ii) staff of the Ministry of Agriculture, Fisheries and Food under a Best Agricultural Waste Management Plan
    is made available to the manager within 12 months of his or her request.

Field storage

8.(1) Solid agricultural waste may be stored on a field for 2 weeks or less if the agricultural waste is
(a) used within 2 weeks, and
(b) stored in a manner that prevents the escape of agricultural waste that causes pollution.

(2) Solid agricultural waste may be stored on a field for more than 2 weeks if the agricultural waste is
(a) stored for no longer than 9 months,
(b) located at least 30m from any watercourse or any source of water used for domestic purposes, and
(c) stored in a manner that prevents the escape of agricultural waste that causes pollution.

(3) Berms or other works must be constructed around a field storage area if this is necessary to prevent the escape of agricultural waste that causes pollution.

Rainy season field storage

9. In areas of the Province, including the Fraser Valley and Vancouver Island, that receive a total average precipitation greater than 600 mm (24 in) during the months of October to April inclusive, field stored solid agricultural wastes, except vegetation waste, must be covered from October 1 to April 1 inclusive to prevent the escape of agricultural waste that causes pollution.

4.1.3 Conservation Farming and Riparian Area Management

Conservation farming practices, such as conservation tillage, mulching, cover cropping, inter-planting and relay cropping can be used to reduce surface runoff and the resultant nutrient loading and to increase the utilization of nutrients by crops.

Interest in and use of conservation farming techniques, particularly the use of cover crops and more recently relay cropping, is increasing. However, there is still a need for continuing research, demonstration and promotion to evaluate alternative crops and to increase the number of producers utilizing the techniques.

Riparian area management, restricting agricultural activities and maintaining permanent vegetation in riparian zones, those areas immediately adjacent to watercourses (including ditches and wetlands), can be very effective in reducing the amount of contaminants in runoff and hence the amount of contaminants in surface water.

Several concerns have been expressed by some stakeholders over providing riparian area vegetation or permanently vegetated buffer strips, particularly with respect to farm ditches. The concerns include a reduction in the land available for cropping, increased weed problems, shading of crops, beaver activity, and a decreased capacity of the watercourse to act as a drainage channel.

On the other hand present agricultural land use practices (along with other land use practices such as urban and forestry) near many watercourses have severely impaired the ability of these systems to support aquatic ecosystems. Small watercourses provide important habitat to all species of Pacific salmon, but particularly to coho and chum in the Lower Fraser Valley. In particular, the historic straightening, or channelization, of natural streams has resulted in very large habitat losses, contributing to the reduction in numbers and potential extinction of several genetically distinct runs of coho and chum salmon and reducing the commercial, recreational and aboriginal fisheries.

Improved riparian area management can, by providing a natural filter and improving surface water quality, significantly improve the aquatic habitat. There are also potential benefits for producers. Improved riparian area management can reduce stream bank erosion and riparian area vegetation can provide windbreaks and reduce soil erosion. Plantings within the riparian area could include commercial crops with managed harvesting. A good ditch design combined with riparian area management can reduce the costs associated with ditch maintenance.

However, by improving riparian area management there could be significant costs associated with the loss of agriculturally productive land along many Lower Fraser Valley watercourses, particularly along farm ditches. Within farming areas the appropriate width for a permanently vegetated riparian area will depend on the site specific conditions, the adjacent farming activities and the sensitivity of the receiving waters. In some situations well managed riparian zones of 30 metres or more on each side of a water course may be required to provide a high level of protection for surface

water. In other situations relatively narrow vegetated buffer strips may provide sufficient protection.

With input from BCMELP and BCMAFF, DFO has developed draft guidelines for farm ditches (DFO, 1996). DFO and several stakeholders are currently cooperating on the development of stream stewardship guidelines for agriculture. Current drafts of these documents discuss the benefits of improved riparian area management and provide general recommendations for ditch construction and maintenance. There is general agreement that the width and nature of buffer strips should be a function of stream sensitivity although specific management guidelines have not as yet been developed. Guidelines should consider the competing demands for the land adjacent to watercourses and attempt to provide a reasonable and sustainable balance.

The Fisheries Act, in Section 35 (1), states that "No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat" and in Section 36 (3) that "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance that results from the deposit of the deleterious substance may enter any such water."

The Code of Agricultural Practice does not specifically discuss riparian area management. There are, however, several Sections of the Code which state that certain farming practices (including storage of wastes, Sections 6(b), 8(1)(b), 8(2)(c), 8(3) and 10(1)(a); land application, Sections 13 and 14; and composting, Sections 15(c) and 16(1)(c)) must not cause pollution, implying that these practices must not cause contaminated runoff to harm the environment, and specifying setbacks from watercourses (15 m) and wells (30 m) for storage facilities (Sections 7(1) and 10(1)(a)) and composting facilities (Sections 15(b) and 16(1)(b)).

The Environmental Guidelines for various commodity groups (BCMAFF, 1992-96) recommend setbacks from watercourses for the application of manure and pesticides, however they contain no mention of setbacks for spreading inorganic fertilizers.

4.1.4 Air Emissions

In some jurisdictions, such as in the Netherlands, there are regulations aimed at **minimizing ammonia emissions** (both the Netherlands and Sweden hope to reduce ammonia emissions by 50% by the year 2000). Regulations require that all manure storages be covered, that ventilation systems be designed to minimize ammonia emissions, and that manure be incorporated into the soil within a specified time after application (as quickly as 4 hours in some jurisdictions). In some cases the equipment to be used is also specified.

It should be kept in mind that if the amount of nitrogen lost to the atmosphere as ammonia is reduced while other manure management factors remain the same there will be more nitrogen available for land application. While this could provide additional plant nutrients it may also mean that additional nitrogen is lost to groundwater or surface water.

The impact of agricultural ammonia emissions on Lower Fraser Valley air quality is not well understood, however the magnitude of these emissions is of concern and may be a significant factor in the formation of small particulates. Small particulates are a concern with respect to health and visibility. The benefits of reducing ammonia emissions have not been quantified. There is a need for a better understanding of ammonia related air quality issues and ultimately for air quality objectives relative to agriculture.

Other agricultural air emissions were not included in the Management of Agricultural Wastes in the Lower Fraser Valley program. The Code of Agricultural Practice addresses emissions from forced air ventilation systems (Section 17), wood fired boilers (Section 18) and incineration of mortalities (Section 23 (d)).

4.1.5 Approaches to Improved On-Farm Management

An **integrated approach** to on-farm management of agricultural wastes is often encouraged or required. Best Agricultural Waste Management Plans (BAWMPs), Nutrient Management Plans (NMPs) or Manure Management System Approvals are the key components of agricultural waste management strategies being used in several other jurisdictions. In the Lower Fraser Valley, BAWMPs are encouraged by government agencies (BCMAFF and BC Environment) and in some problem cases have been ordered by BC Environment under the Waste Management Act.

The problem of agricultural waste management is often complex and with interrelated issues. An integrated approach to farm planning, which considers all available options, is likely the best approach to formulating an optimal solution for an individual farm. Issues which should be addressed in a BAWMP include nutrient management, manure storage, the need to move manure off the farm, conservation farming techniques and riparian area management. BAWMPs are discussed further in Section 7.2.1 of this report.

Financial incentives for such plans are common, particularly in the USA, and advisory services are often provided by government staff at no cost to producers. In some cases such plans are mandatory for operations of a certain size or type. Annual preparation of plans is required in some jurisdictions (Denmark). Ensuring compliance with such plans is difficult without significant monitoring efforts.

BAWMPs must be developed by qualified people and some jurisdictions in the USA have certification programs. There is also a need for producers to understand the need for developing and implementing BAWMPs.

Waste management permits are required of certain producers in some jurisdictions outside BC. In Sweden, permits are required for any operation with more than 100 animal units and in the USA, federal regulations require a state permit program for any dairy operation with over 700 head. Such permits may include monitoring and reporting which can be costly for both the producer and the responsible agency. Permit requirements are usually applied to larger operations or to operations which have not complied with more general requirements. There is no jurisdiction which has required all agricultural producers to obtain the equivalent of waste management permits.

Under the BC Agricultural Waste Control Regulation producers who do not comply with the Code of Agricultural Practice, or who have an operation of an unusual nature, are expected to apply for a Waste Management Permit. While there are farms which are not in compliance with the Code, there are not any BC farms which are currently under permit for only agricultural wastes.

In some jurisdictions (France) there is simply a requirement that **ecological damage be "made good",** that the environment be returned to it's original state and that the costs of such restoration be paid by the land owner. A more proactive approach, which attempts to prevent problems rather than fix them after they have occurred is the preferred approach. Aquatic systems can take years to recover from damage and habitat damage can result in the permanent loss of some genetically distinct fish populations.

The Fisheries Act has provisions to order that habitat damage be repaired and allows for substantial fines against those who contravene the Act by damaging fish habitat or impairing water quality.

4.2 OPTIONS TO DEAL WITH EXCESS NUTRIENTS

Previous work using a model to estimate agricultural nutrient flows (Brisbin, 1995b) indicated that there are areas in the Lower Fraser Valley where nutrient applications are excessive.

The model used a mass balance approach to model a complex set of processes and to estimate balances for the three major nutrients; nitrogen, phosphorus and potassium. These balances were calculated as the difference between net nutrient applications (manure, inorganic fertilizer and atmospheric deposition less losses of nutrients during the manure management process) and the potential nutrient removal by crops. In previous reports a positive balance had been referred to as a surplus and a negative balance as a deficit. A negative balance can be generated since the model estimates the potential rather than actual crop nutrient removal and this potential value may be greater than the net nutrient application.

The "losses" of nutrients from soils is a natural part of the various nutrient cycles and cannot be eliminated from agricultural systems. Attempting to achieve a zero balance is not realistic. To assess whether a particular balance is excessive or not the ultimate destination of those nutrients (surface water, groundwater, accumulation in the soil) and the sensitivity of that destination must be considered. Acceptable balances are those which do not lead to pollution yet allow for commercial crop yields. Excessive balances are those which cause pollution while contributing little or nothing to higher crop yields.

An important factor which was not considered in the model is the storage of nutrients in soil. Soils may represent a very significant destination where large amounts of nutrients can accumulate with no negative impacts, or soils may represent a source which will add to the balance. Although this soil storage factor was omitted from the

modeling exercise, comparison of the model results with several water quality studies indicates that the estimated balances are useful indices for evaluating nutrient applications.

Discussions of the significance of the estimated balances (Brisbin, 1995b) arrived at some degree of consensus that acceptable balances for nitrogen applications might fall in the range of 50 to 100 kg/ha. It was considered that balances in this range would likely provide protection to the aquatic environment and still allow agriculture to maintain current levels of crop productivity. This range for acceptable balances is only a preliminary estimate. For sensitive areas and for areas where soils have high levels of accumulated nutrients, acceptable nitrogen balances may by substantially below the 50 to 100 kg/ha range.

Figure 4.2 shows the nitrogen balances which were estimated for management practices as of 1991 for each of the twenty Agricultural Waste Management Zones within the Lower Fraser Valley. These estimated balances are averages for an entire zone and provide no indication of the range of actual balances which may occur on a farm by farm basis within a particular zone.

There are several options which have been used to address the problem of high livestock densities; situations where the amount of nutrients in the waste exceeds the capacity of the available land base to adequately accommodate the nutrients as fertilizer, resulting in excessive applications. Excessive applications can lead to high nitrate levels in drinking water, high levels of nitrogen and phosphorus in surface waters and high levels of potassium in the soil.

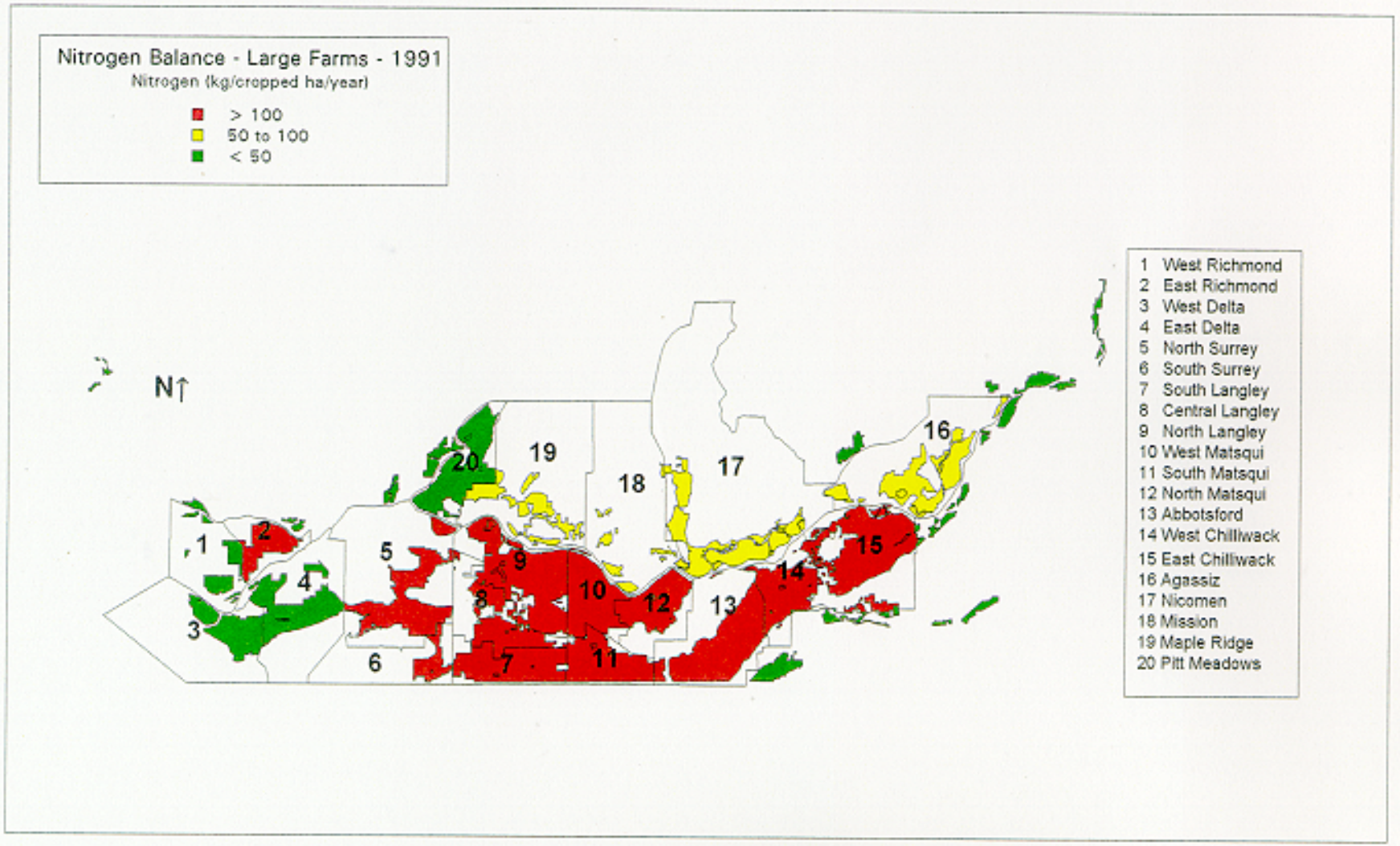
4.2.1 Restrictions on Livestock Densities

Simple **restrictions on livestock densities,** the number of livestock or poultry per unit cropped area, have been used in several jurisdictions (Sweden has animal density regulations for all farms of 10 or more hectares, and in the Netherlands the expansion of livestock operations is prohibited). In some situations the restriction has been applied to an allowable amount of manure production rather than the number of livestock. Livestock density restrictions have often been applied to new or expanding operations but efforts to apply such restrictions to established operations has been more troublesome. Such restrictions have been applied to both commercial and hobby farms.

The application of simple restrictions of this nature does not consider the variability in crop nutrient utilization and possible reductions in the amount of nutrients generated nor does it allow for the movement of manure nutrients to other locations. Producers are likely to be opposed to any regulation which simply restricts animal densities.

This concept may, however, be appropriate for certain Lower Fraser Valley situations and a detailed analysis of the application and success of this concept in other jurisdictions is warranted.

Figure 4.2 Nitrogen Balance - Large Farms - Lower Fraser Valley



4.2.2 Restrict Agricultural Activities

Another approach is to identify **environmentally sensitive areas**, areas where, because of their proximity to important water resources, agricultural activities have a much greater chance of creating significant environmental problems, and place restrictions on agricultural activities in these areas. France has Water Protection Zones, the United Kingdom has Nitrate Sensitive Areas and Denmark has classified 4% of its arable land base as environmentally sensitive.

This approach can be used to recognize the variable environmental sensitivity of different areas by applying more stringent objectives, guidelines or regulations where a higher level of management of agricultural wastes is required to protect water resources. Some may argue that all riparian areas should be designated as environmentally sensitive.

In some jurisdictions (the United Kingdom, the Netherlands) the designation of an environmentally sensitive area has been accompanied by compensation to producers to cover their lost opportunities for agricultural production. It would be difficult to deny compensation when limiting a producers opportunities, particularly if the area has been designated for agriculture (such as the Agricultural Land Reserve).

The United Kingdom has designated Nitrate Sensitive Areas where commercial nitrogen fertilizer use is limited and total nitrogen applications are limited to 174 kg/ha/year. Fertilizer applications are banned from July to November and tillage practices are controlled. Producers are compensated for lost productivity.

The outright purchase of land in sensitive areas (New York), and in cases restoring the land to a more natural state, has also been tried.

The designation of environmentally sensitive areas or the purchase of land in particularly sensitive areas may be an effective means of protecting more valuable water resources and thereby providing significant benefits to the environment, but this should be approached with some degree of caution and selectivity since the costs of compensation or purchase could be very high.

4.2.3 Removal of Excess Nutrients

When livestock or poultry densities exceed the capacity of the land base to accommodate the nutrients contained in the manure an obvious solution is to **remove the excess nutrients** to an area where there is no excess of nutrients and manage the nutrients properly in that area.

This approach is not without problems. In addition to the technical problems and costs of dealing with a bulky and variable product, there are several administrative problems such as how to ensure that there is a reliable, long term destination for these nutrients. Some jurisdictions require legally binding contracts (in Denmark such contracts must be for 5 or more years) that manure will be accepted before high animal densities will be allowed on a particular farm.

Another issue is responsibility for the proper management of nutrients after they are moved; the farm generating the nutrients or the farm receiving the nutrients. A common theme is that the producer of the nutrients must practice due diligence in ensuring that the nutrients are managed in a responsible manner once they leave the originating farm. Another alternative is to require that anyone receiving manure from another farm must have a nutrient management plan in place to ensure that their farm is capable of effectively utilizing the nutrients. There have been problems with those taking manure receiving payment for the manure and then simply disposing of the manure at rates which cause pollution.

Manure banks have been tried in jurisdictions such as the Netherlands. With this option an organization is established to try to match nutrient production to nutrient needs; to match the land base to the livestock. Funding for such approaches has been provided by assessing a levy on those farms where an excess of nutrients are generated and by financial assistance by government. For the manure bank approach to work on a large scale there is the need for efficient transport, supervision and, in some cases, processing of manure.

The Sustainable Poultry Farming Group is coordinating efforts to move poultry manure from areas of excess nutrients, in particular over the Abbotsford aquifer, to other areas in the Lower Fraser Valley and elsewhere. The amount of manure moved has been increasing steadily since their efforts began about one year ago, but the amount which is currently being moved from areas with large excesses is well below the amount needed to achieve a reasonable nitrogen balance.

"Land swapping" has been suggested as means of redistributing nutrients between farms. This concept involves crop rotations between farms to achieve a better match between waste applications and crop needs.

The removal of manure from farms where an excess exists may be the only alternative to relocating the livestock or poultry if a reasonable nutrient balance is to be achieved.

4.2.4 Reduce Nutrients in Wastes

There are significant opportunities to reduce the amount of nutrients excreted by livestock by **changing feed rations and feeding strategies**. Improving the efficiency of use of the nutrients fed to livestock and poultry will reduce the amount of nutrients in the manure and hence the amount of land required to accommodate the nutrients. Changing feed rations and feeding strategies can also reduce the amount of ammonia lost to the atmosphere.

On many LFV farms a high percentage of the feed is imported onto the farm. Better utilization of home grown feed would improve the nutrient balance of an individual farm. The home grown feed will contain nutrients which have been recycled through the waste and therefore a lesser amount of nutrient will be brought onto the farm.

There are several feeding strategies which are being researched and demonstrated in the Lower Fraser Valley including; better formulation of feed rations to reduce the amount of nutrients excreted, more extensive use of pasture systems for dairy which

would effectively increase the utilization of home grown feed, and ground ear corn production for dairy rations with the corn stalks providing a low energy and low potassium content feed for dry cows (Bittman, 1996).

Further local research and demonstration is needed. Producers have indicated concerns over the costs associated with changing feeding strategies.

4.2.5 Waste Treatment

To improve the marketability of agricultural waste, particularly for the non-farm markets, some **on-farm waste processing** may be needed. There is a need for further research and demonstration of small scale manure processing technology and a need to develop markets and promote the use of organic nutrients rather than inorganic nutrients.

Off-farm central processing, where manure is removed from areas of excess and then processed, has been suggested as a possible solution for areas of the Lower Fraser Valley where livestock densities are high. This option has been tried elsewhere, most notably in Holland, with less than favourable results. Expensive treatment facilities have been built which have proven to be uneconomic.

A solution of this type must be put to a rigorous economic and technical analysis if it is to be given consideration. With existing technology this option should not be given priority consideration, although efforts should be made to keep current on developments elsewhere.

5.0 STRATEGY DEVELOPMENT

Subsequent sections discuss options from the perspective of land use management; education (awareness and alternatives); incentives and financial assistance; policy, legislation and regulation; and objectives and evaluation.

5.1 LAND USE MANAGEMENT

Land use planning is a very important factor in agricultural waste management. If agricultural wastes are to be applied to land as a fertilizer or soil conditioner the land base must be available; the preservation of agricultural land for this use is therefore a limiting factor in any agricultural waste management strategy.

The Agricultural Land Reserve (ALR) has done a good job of preserving agricultural land in the Lower Fraser Valley but there are concerns over changing land use within the ALR. There are continuing losses of actively farmed land when use is changed to allowable non-farm uses such as golf courses. As well there appears to be a significant change from commercial farming to hobby farming in some areas. The land is sold for non-commercial agricultural use and the livestock are sold to another operation where livestock numbers are now increased on the same land base. This effectively reduces the land base available for the application of manure from commercial farms even though no land has been removed from the ALR. As well, the land which is no longer being used for commercial agriculture is often developed with more buildings and impervious surfaces and may well have higher effective livestock densities than the former commercial farm operation. There is a need to maintain commercial agricultural units within the ALR if the current land base available for manure application is to be maintained.

In many parts of the Lower Fraser Valley the agricultural land base associated with small farms (hobby farms) is significant. In many cases this land base is underutilized and could represent a destination for excess nutrients, however the land owners would have to be interested in utilizing organic nutrients and in utilizing the crops produced.

Integrated land use planning should be done on a watershed basis with efforts made to appreciate the integrated nature of each watershed and the impacts which changes on non-agricultural land use may have on agricultural land use. In the United States the Environmental Protection Agency is promoting a watershed protection approach (EPA, 1991). The three main principles of this approach are: to target watersheds where pollution poses the greatest risk to human health, the environment and desirable uses of the water; encourage the involvement of all parties which have a stake in the situation; and consider the full range of methods and available tools to develop and implement an integrated, coordinated and multi-organizational strategy.

Some degree of watershed-based planning could be achieved by encouraging local governments to include agricultural lands within study areas for Liquid Waste Management Plans. Guidelines for the development of Liquid Waste Management Plans discuss the relationship between official community land use planning and liquid waste management planning. Including agricultural runoff and infiltration in the planning process could result in more comprehensive and integrated planning and

ensure that local governments are aware of agricultural waste management issues within their jurisdictions.

In some jurisdictions new, expanding or renovating operations are required to prove some degree of environmental sustainability before building permits are granted. This type of approach would encourage environmental planning for operations which are undergoing change but there would have to be cooperation between different levels of government and the involved agencies would require agriculturally and environmentally knowledgeable staff to evaluate the proposed measures.

Property taxation policies need to be reviewed to ensure that they do not create disincentives to improved environmental practice. Higher taxation rates applied to idle land can promote farming in environmentally sensitive areas and act as a disincentive for riparian area management.

5.2 AWARENESS AND ALTERNATIVES

There is a common belief that education and a better attitude is the best approach to solving NPS pollution problems; that to achieve long term solutions there is the need to change the way those involved think and act, to have individuals become better stewards of the environment.

If producers are made more aware of the issues involved and of the impacts which their operations can have on the environment and their farmland there is a better chance that they will incorporate sustainable farming concepts into their operations, and that they will have a positive influence on neighbours and others in their industry.

In many other jurisdictions there is a trend toward more producer involvement in developing and implementing sustainability strategies. However, to be involved and take an active and productive role, they need a better understanding of the problems which exist and of the potential solutions.

BC has three programs (the Agricultural Environmental Protection Council , or AEPC, administered by the BC Federation of Agriculture; Enviro-Alert administered by the BC Cattlemen's' Association and a complaint resolution program administered by the BC Horticulture Coalition) through which peer advisors consult with producers who have an environmental problem. This approach is strongly supported by producers and many would prefer that the peer advisors talk to them first about a complaint rather than a representative of a regulatory agency. Both producers and others, such as the regulatory agencies, believe that the peer advisors need training to understand the issues they must deal with and the environmental standards which farms should meet. The issues involved may be complex and solutions are not always readily evident.

There are some stakeholders who consider that this approach has not been as successful as was anticipated, believing that peer advisors have at times attempted to justify the current situation rather than help find solutions. On the other hand there have been instances where advice from peers has resulted in sincere efforts to improve.

Peer advisors presently operate on a voluntary basis. If they are to have more training it is likely that some form of remuneration will be required. If this type of program is to be continued, “softer” approaches of this type should be evaluated to demonstrate successes and identify limitations.

Several conservation farming groups have been active in the Lower Fraser Valley over the past several years. These groups, listed in Appendix C, have a professional advisor and activities are directed by a board of producers from the respective commodity group or area. It is generally believed that these groups have been effective in promoting an increased level of awareness among producers, in evaluating and demonstrating solutions to problems and in having producers provide a degree of leadership in addressing environmental issues. These groups have received a portion of their funding from government sources (the Green Plan), however this assistance is scheduled to expire in March 1997. Some producers consider that these types of groups are the best approach to solving agricultural environmental problems while others believe that their problems have been solved and there is no need for continued activities by these groups.

The development of integrated waste management plans, such as BAWMPs, can play an important educational role. As problems are identified and alternative solutions developed and assessed producers' understanding will increase.

There have been several comments that the non-farm public also needs a better understanding and appreciation of agriculture, of the problems that sustainable agriculture must cope with and of the role that agriculture plays in our economy.

5.3 INCENTIVES AND FINANCIAL ASSISTANCE

Even though the "polluter pay" concept is a principle applied to pollution issues in BC there are stakeholders who believe that some form of cost sharing can be more cost effective in solving NPS problems than relying solely on regulation and enforcement. Cost sharing, particularly for technical advice and capital works, is common in many other jurisdictions in both the United States and Europe. Cost sharing for municipal waste treatment has been common in BC and the rest of Canada. As well, the costs associated with a concentrated effort to have producers comply with environmental regulations and guidelines could be considered "transitional expenditures" and there are precedents, such as assistance related to the elimination of feed freight assistance, of providing assistance for transitional expenditures.

At present there is little financial assistance available to producers for implementing environmentally related works. In BC only the Sustainable Practices Program (SPP) is available. This program provides grants of approximately 50% of the first $10,000 of any approved projects. The program currently has an annual budget of about $400,000 with funding in place only to March 1997.

There are significant social costs associated with poor environmental practices and these costs will continue, or increase, as long as the poor practices continue. The more significant costs are likely to be health related costs associated with drinking

water quality (including the costs to consumers of purchasing bottled water) and poor air quality and the losses to commercial and recreational fisheries. It may well be that it is less expensive to subsidize the solutions over the short term rather than to continue to pay the social and environmental costs of poor practices.

Although producers would benefit directly from achieving environmental sustainability it is expected that the on-farm costs would exceed the short term on-farm benefits. A common concern of producers is that they must cope with competition from areas where the costs of environmental compliance are not as high or where financial incentives and assistance are provided. There are also some who will argue that producers should not be blamed for all of the environmental problems associated with the existing production systems; producers have adapted to their markets and to government policy, and in some cases very effectively.

The economic issues are significant. Wohl, 1996 surveyed the literature covering both the private and societal costs of manure-management options. Although the qualitative nature of the social costs made those costs difficult to estimate, the social costs of current practices in the Lower Fraser Valley were considered to likely be substantial. On the other hand, agriculture contributes a great deal to the local economy; gross farm gate receipts in the Lower Fraser Valley totaled $859 million in 1995 , 56% of the provincial total (BCMAFF, 1996).

Financial assistance can take several forms; cost sharing programs, "green" charges on consumption to fund environmental programs, levies on imports from areas where the costs of environmental compliance are not as great and changes to tax structures to promote more sustainable production. The concept of cross-compliance, where producers must meet certain environmental standards before they are eligible to take part in other programs, was suggested as a means of encouraging the adoption of sustainable farming methods. However at present there are no significant programs in B.C. for compliance to be tied to.

A detailed analysis of various financial assistance options has not been done. The costs of any prospective program should be addressed and related to the benefits which might be achieved, and the constraints to and complexity of implementing a program should also be considered. Some options would require the cooperation of more than one level of government and the conditions imposed by international trade agreements have to be considered.

If financial assistance programs are to be developed they should recognize that the problems are often complex and have several interrelated components. On-farm financial assistance should therefore be directed at implementing an integrated plan rather than directed at one specific component of waste management.

5.4 POLICY, LEGISLATION AND REGULATION

Within the complex and interrelated nature of environmental issues the development and implementation of policy, legislation and regulation is often a shared responsibility between different levels of government, with an increasing involvement from producers.

This results in a significant need for coordination between the different levels of government and the agencies involved.

Policy should concentrate on education and cooperative involvement by the different groups involved, but there will be the need for some amount of regulation and enforcement. Enforcement of regulations will be required to deal with those who continue to practice poor management. A cost effective balance between cooperative action and enforcement is required.

An emphasis on education and cooperation rather than regulation is supported in part by the anticipated costs. Enforcement of environmental regulations aimed at NPS problems can be a costly and time consuming exercise. To date there have been only minimal resources dedicated to enforcing the Code of Agricultural Practice in B.C. It is expected that a greater enforcement effort will be required to ensure that some producers comply with the Code. To date the role of federal agencies in regulation has been limited. This role is being reviewed and there may be a greater emphasis on enforcing sections of the Fisheries Act in the future.

Producers have indicated that they are not in favour of increased regulation. Many believe that the Code of Agricultural Practice provides all the regulation that is required. They appear to favour solving the problems within their own industry although some support the principle that regulations must be enforced when there is no legitimate effort made to comply. Producers who have made the effort and investment rightly believe that others should do so as well.

As discussed earlier there is concern over the effectiveness of the efforts in B.C. to have the different commodity groups manage their own environmental problems. There is the need to realistically evaluate the success of this approach and make improvements to the peer inspection process as required. If concerns over the peer advisor approach are validated and improvements not implemented, regulatory agencies are expected to step to the front and bypass the peer inspection process.

Producers have indicated that environmental and agricultural land use decisions and regulations should be made at the provincial rather than local level. They believe that there needs to be consistency between municipalities or regions and that local governments do not have a large enough appreciation for agriculture. If there were local environmental bylaws such bylaws would have to be enforceable and the local enforcement officers would have to have the tools and knowledge to enforce them.

Ticketing for non-compliance with agricultural regulations does not currently exist. Such an approach would work only if applied to very specific regulations where little discretionary interpretation is involved. If the regulations were unclear the process would be inundated with appeals. Also, if the amount of the fine was relatively small some might consider it just another cost of doing business.

The lack of groundwater legislation in B.C. was identified by the Steering Committee as a significant short coming in environmental legislation.

5.5 ENVIRONMENTAL QUALITY OBJECTIVES AND EVALUATION

Periodic review of regulations and programs is required to assess their effectiveness and should be included in any strategy. A review can occur both at the environmental level (are environmental objectives being checked and are they being achieved) and at the process level (are programs delivering what they were designed to deliver).

Monitoring of the receiving environment can be used as a report card to assess progress and determine if more effort is required. Criteria for several water quality parameters have been developed (BC Environment, 1994), however there are some notable exceptions, such as for phosphorus levels in streams, and there has been no comprehensive review of the adequacy of these criteria with respect to agriculture and individual streams in the Lower Fraser Valley. The Code discusses air quality objectives with respect to emissions from forced air ventilation systems, wood fired boilers and incinerators, however there are no objectives or regulations which address ammonia emissions from agriculture.

In using environmental monitoring to evaluate progress it must be kept in mind that there is often a lag time between the implementation of improved management techniques and improved environmental quality.

The approach to be used to select the appropriate criteria which would reflect the environmental needs of the Lower Fraser Valley and address the variability in sensitivity of receiving environments, while also recognizing the needs of the agricultural industry, must be the right one.

One approach is to set water quality objectives based on the most sensitive potential use of a resource and then implement a strategy to achieve the objectives. If all possible uses were considered as potential uses in every location the result would be stringent objectives being applied over the entire Lower Fraser Valley. This approach does not recognize that conditions vary throughout the Lower Fraser Valley, and although achieving such objectives would no doubt result in significant social and environmental benefits, the costs to agriculture would be very high.

Generally members of the Steering Committee felt that objectives should recognize the variability which occurs in the Fraser Valley and consider compromises between different potential uses. This type of approach would be more difficult in that an evaluation of both the benefits and the costs of meeting objectives is required and there would have to be decisions made as to the relative importance of different uses. It was recognized that a detailed evaluation of benefits and costs, particularly of the many subjective benefits, is essentially impossible. However, there should be some effort to develop an appreciation for the magnitude of both the benefits and the costs and attempt to develop guidelines and objectives specific to different watercourses or watersheds.

Input to the process of developing objectives should be broad based, with specific input from the local level where the issues regarding the environment, the economy and social well being are felt most strongly, and where the impacts of changes will be most noticeable. The Sustainable Communities and Local Round Table discussions have

advocated this type of approach (The British Columbia Round Table on the Environment and the Economy, 1991).

Other evaluation measures are required at the process level and could include an evaluation of on-farm environmental planning (the number of producers which have prepared and implemented integrated plans such as BAWMPs), an evaluation of the effectiveness of the Agricultural Waste Control Regulation and Code of Agricultural Practice for Waste Management, an evaluation of regional nutrient surpluses using updated inventory information and GIS-based tracking of manure movements and land use changes.

Water and air quality monitoring results and program evaluations should be reported to the public.

6.0 CURRENT GOVERNMENT ACTIVITIES

The following sections highlight current activities of several agencies and groups in areas related to agricultural waste management in the Lower Fraser Valley; in several cases the funding for activities is no longer secure. There are several instances of government funding providing leverage in that partial funding is provided by government with additional matching funding from private sources.

Two programs which have made very important contributions to addressing agricultural waste management issues, and for which committed funding ends soon, are the Green Plan for Agriculture (joint BC Ministry of Agriculture, Fisheries and Food and Agriculture Agri-Food Canada initiative) and the Fraser River Action Plan (FRAP is a joint federal Departments of Environment and Fisheries and Oceans initiative). The contributions of these two programs are discussed in more detail in the following sections.

6.1 PROVINCIAL GOVERNMENT

6.1.1 BC Ministry of Environment, Lands and Parks (BCMELP)

The BCMELP is responsible for enforcing the Code of Agricultural Practice and has been supported in part, through the Fraser River Action Plan.

The BCMELP regulates all emissions to air (the GVRD has jurisdiction over air emissions within its boundaries), water and land; sets emission and ambient standards and objectives (provincial standards can be more, but not less, stringent than national standards); sets provincial policies and standards for waste reduction, recycling, treatment and disposal; and researches and monitors the state of the environment provincially.

The BCMELP also administers allocation of surface water through water licences (groundwater is not yet regulated), regulates in-stream works, conducts hydrologic research, monitors air quality in problem areas and regulates specific air quality emissions.

The provincial government manages designated fresh water sports fisheries along with the land and water that make up fresh water fish habitat. Provincial laws and management programs must, however, comply with federal fisheries laws and the Fisheries Act for the protection of fish habitat. The BCMELP researches, assesses and manages freshwater fish populations and habitat and regulates sports fishing.

The BCMELP also regulates and restricts the use of pesticides, including herbicides.

6.1.2 BC Ministry of Agriculture, Fisheries and Food (BCMAFF)

The BCMAFF supports the development of agricultural and food industries through technology transfer, education and marketing programs, provides financial assistance

and insurance programs, and operates provincial marketing, regulatory and advisory boards.

In the 1995-96 fiscal year the BCMAFF devoted approximately nine person years to address agricultural environmental issues in the Lower Fraser Valley. About three quarters of this time was devoted to livestock and cropping issues while about one quarter was devoted to pesticide related issues. The majority of time was provided by personnel in the Resource Management Branch and South Coastal Regional personnel from the Agriculture, Dairy and Horticulture Programs.

The BCMAFF administers the Canada-British Columbia Green Plan for Agriculture. This is a 12.6 million dollar, six year federal-provincial program providing funds to the agri-food sector in BC to address environmental concerns. The program is scheduled to end in March 1997.

The Green Plan program includes three sub-programs.

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1. Adaptation and adjustments of agri-food practices

The focus of this sub-program is minimizing the negative impact of agri-food practices on soil, water and air quality by encouraging the adoption of environmentally sustainable practices. This portion of the program recognizes the important and essential role that producers play in evaluating and promoting the adoption of conservation practices.

Within this sub-program the Sustainable Practices Program, a cost sharing program, attempts to accelerate the adoption of environmentally sustainable practices by funding up to 50% of the eligible costs of a project, with maximum assistance of $5000 per project. Annually funding assistance through this program is about $400,000 and it is currently the only direct funding program available to BC producers.

To encourage the development, evaluation, transfer and adoption of environmentally sustainable practices through partnerships with producers a number of producer conservation groups have been formed. The Green Plan provides up to 80% of the eligible costs, to an annual maximum of $40,000 for these groups. Within the Lower Fraser Valley there are seven such groups or programs:

- the Dairy Producers' Conservation Group
- the Sustainable Poultry Farming Group
- the Horse Council of BC Environmental Protection Practices program
- the Hog Producers' Sustainable Farming Group
- the Sumas Prairie Soil Conservation Group
- the Matsqui / Langley Soil Conservation Group and
- the Delta Conservation and Farm Stewardship Project.

2. Education and awareness

The focus of this sub-program has been to increase the understanding, by both the public and producers, of the environmental and economic issues facing the agri-food sector and of the actions required to make the sector environmentally sustainable. This has been done largely through producing and disseminating educational materials.

Included in this sub-program has been funding assistance for new and improved curricula and teaching materials for schools, agricultural colleges and universities.

3. Research

This sub-program funds practical, applied research projects dealing with clearly identified gaps in the understanding of environmentally sustainable production practices. Fifteen projects related to Lower Fraser Valley environmental issues were funded.

The BCMAFF is involved in the production of several publications which include Environmental Guidelines for various commodity groups (BCMAFF, 1992-96), some of which were partially supported through FRAP:

- Poultry (a second edition to be produced this year)
- Beef
- Dairy
- Horse
- Mushroom
- Nursery and Turf
- Berry
- Greenhouse
- Field Vegetables
- Pork (currently in production)

A BC Agricultural Waste Management / Environmental Protection Manual is being produced to provide guidance for planning, designing and managing systems where agricultural wastes are involved. This manual is intended for advisors to the agricultural industry.

There are several other publications which have relevance to the sustainability of agricultural production, including a composting manual (currently being edited), the BC Drainage Manual (a revised edition is being written) and the BC Agricultural Fencing Handbook.

There are also commodity specific Production Guides, factsheets and newsletters which frequently contain articles and information on the prevention of pollution from agriculture and sustainable production.

The BCMAFF also leads, delivers and supports applied research and technology transfer projects, in cooperation with industry, to enhance competitiveness and environmental sustainability and provides extension services in the areas of water and waste management, crop and livestock production, pesticide management and agri-business.

Recently there has been a major effort dedicated to the Farm Practices Protection (Right to Farm) Act and Reference Guide. Both the Act and the guide require that producers comply with the Waste Management Act. Significant staff resources are committed to implementing and administering this legislation.

BCMAFF staff participate in and provide input to numerous and diverse committees and meetings hosted by local, provincial and federal agencies which are dealing with agricultural environmental issues.

Staff also assist programs which respond to nuisance and pollution concerns through the use of peer advisors (the BC Federation of Agriculture's Agricultural Environmental Protection Council, the BC Cattlemen's Enviro-Alert program and the Horticulture Coalition's complaint resolution program).

6.1.3 BC Ministry of Health

The BC Ministry of Health tests and regulates drinking water quality, has authority over on-site sewage disposal and conducts surveys of groundwater quality.

6.1.4 BC Agricultural Land Commission (ALC)

The BC Agricultural Land Commission has jurisdiction over land use within the Agricultural Land Reserve and over exclusions from and inclusions to the ALR.

6.2 FEDERAL GOVERNMENT

6.2.1 Department of Environment (DOE)

The DOE develops federal water management policy under federal-provincial agreements, compiles data on water quantity and quality, sets national water quality guidelines, researches impacts of pollution and climatic change, and researches and monitors the state of the environment nationally. The DOE also maintains a land status/capability inventory and data system and conducts research and policy analysis on sustainable land and resource uses.

The DOE sets national environmental protection standards and administers the pollution prevention provisions of the Fisheries Act.

The Fraser River Action Plan is a six year federal government Green Plan initiative (FRAP, 1994; FRAP 1995). The main objectives of this program are to repair environmental damage to the Fraser Basin and develop a management program to promote sustainable development, keep the Basin's ecosystems healthy and productive, and to work in partnership with the industries, communities, aboriginal groups and other stakeholders.

To address agricultural issues this program has provided funding for a broad range of activities:

- economic and planning studies
- environmental quality assessments and development of research objectives
- pollution abatement
- enforcement

- habitat acquisition and enhancement
- atmospheric data acquisition and forecasting

DOE funding for the Fraser River Action Plan is scheduled to end in March 1998.

The National Tri-Council Secretariat provided funding for a three year Eco-Research Project (ending in 1996). Conducted by the University of British Columbia, the project addressed many issues including water quality and agricultural sustainability, in two Lower Fraser Valley watersheds.

6.2.2 Department of Fisheries and Oceans (DFO)

The federal government has jurisdiction over all coastal and inland fisheries, however in BC authority for management of specific sports fisheries and freshwater fish stocks has been delegated to the province. The federal government retains jurisdiction over all fish habitat.

The DFO is responsible for managing and regulating fisheries, conserving fish stocks and habitat, and operating salmon enhancement projects. The DFO also conducts research on a broad range of subjects pertinent to protecting the fisheries resource.

Under the Fisheries Act the DFO plays a major role in land and water use decision making. DFO approval is required for works which could impact fish or fish habitat, including activities such as ditch cleaning. Resource management decisions are made in support of the national "No Net Loss" policy, implemented to protect fish habitat and populations.

Most DFO activities directed towards addressing fish/agriculture conflicts have come via the Fraser River Action Plan, for which DFO is jointly responsible with DOE. Efforts have included the following:

- Funding for water quality sampling in the Sumas River, Salmon River and Matsqui Slough watersheds, in order to identify upstream / downstream and seasonal trends in the agricultural portions of the watershed, and seasonal trends in water quality. This effort was complimentary to work undertaken by DOE, MELP and the Westwater Research Centre to document information about land use and agricultural waste management practices.
- Participation in and some funding for the "Agricultural Waste Management in the Lower Fraser Valley" project.
- Participation in the MELP Non-Point Source Pollution Steering Committee.
- Leading in the development of a Stewardship Guide for Agriculture, which will apply across BC but is partly in response to what has been learned in the Lower Fraser Valley. The intention is to also develop and implement a stewardship training program for producers and Peer Advisors.
- Funding and participation in a joint DOE/DFO/Agriculture Canada study designed to assess the effectiveness of different manure application protocols in reducing contaminants in runoff.
- Regular operations such as handling referrals associated with works in or about streams.

DFO involvement in the Fraser River Action Plan is scheduled to end in March 1997.

6.2.3 Department of Agriculture and Agri-Food

The Department of Agriculture and Agri-Food provided $6.0 million in funding for the Green Plan for Agriculture.

The Department of Agriculture and Agri-Food establishes national agriculture policy, carries out and funds research programs in agricultural practice and products, provides assistance programs to farmers and operates national marketing boards.

The mandate of the Pacific Agricultural Research Centre (PARC) in Agassiz is largely one of research, however personnel are encouraged to take an active role in the promotion of research results through extension and development of guidelines.

There are currently seven research scientists associated with PARC who are involved in issues relating to agricultural waste management in the Lower Fraser Valley. These scientists have other research responsibilities, therefore the amount of time devoted to this specific issue varies. Some projects have been partially supported through FRAP.

Current relevant research issues include:

- feed rations
  - excessive potassium levels in dairy feed
  - effect of feed quality on nitrogen excretion in dairy animals and poultry
- storage and housing
  - effect of feed rations on ammonia volatilization during manure storage
  - use of absorbents in poultry litter to reduce ammonia emissions
  - nitrous oxide emissions from liquid dairy manure
  - effect of additives to methane emissions from manure storages
- land application
  - use of sleigh foot applicator for liquid manure applications
  - nitrous oxide emissions during land application of manure
  - banded manure applications in raspberry fields
  - fall liquid manure application impacts on nutrient and sediment loading from silage corn land
  - quantifying nitrogen loading to groundwater from animal manure
  - impacts of long term manure applications to grass land
  - effectiveness of fall applied manure
- crop production
  - development of soil and plant analysis methods for predicting nitrogen requirements for various crops
  - nitrogen dynamics in forage grass systems for improving nutrient utilization
  - manure vs inorganic fertilizer use in raspberry production
  - crop production strategies for high potassium soils
- composting of farm wastes
  - improvements in general composting technology
  - assessment of compost in crop production

    - compost as a component of potting media for the nursery industry
    - compost as a slow release fertilizer
- biological processes
    - computer simulation modeling applied to the nitrogen cycle
    - development of analytical methodologies for proper interpretation of soil and plant measurements
    - quantification of soil nitrogen transformation processes

Research funding is now heavily dependent on outside sources. "A-level" funding basically supports the salaries of scientists and some technical support as well as infrastructure such as administration and facilities. Almost all of the research activities depend on outside funding to pay for other related costs. There is currently a Matching Investment Initiative fund whereby funding by industry is matched.

Support by industry and other programs such as the Green Plan are required to maintain the research initiatives discussed above.

6.3 LOCAL GOVERNMENTS

Municipalities have the authority to regulate development on floodplains, including setbacks from watercourses, building regulations and the use of private and community owned lands within their boundaries through official community plans, zoning bylaws and subdivision requirements.

Local governments provide community water supply services, must comply with provincial water licencing requirements and health standards, are involved with dyking and drainage works, storm water management and, through development standards, watercourse protection.

Local governments also develop community solid and liquid waste management and minimization plans, operate waste disposal facilities, and can regulate the disposal of waste.

With respect to fish and fish habitat, local governments must comply with federal laws. Municipalities can enact bylaws to prevent the fouling or obstruction of waterways. Municipalities and regional districts may, in designated areas, require that waterways be preserved, enhanced or protected through development permits.

Municipalities can designate land for agriculture, regulate intensive agriculture control areas for which land use, operations and irrigation regulations can be developed, and can pass bylaws regulating the keeping of animals. Where bylaws impact the ALR they must be consistent with the direction set by the ALC.

7.0 MANAGEMENT FRAMEWORK

The knowledge gained through the Management of Agricultural Wastes in the Lower Fraser Valley program strongly indicates the need to develop an outline to help guide the course of action for improved agricultural nutrient management in the Lower Fraser Valley.

7.1 NEEDS TO ACHIEVE SUSTAINABILITY

The broad goal is to attain environmental sustainability in Lower Fraser Valley agriculture, in particular with respect to nutrient management. Sustainable agri-food systems have been defined as "those that are economically viable, and meet society's need for safe and nutritious food, while conserving or enhancing natural resources and the quality of the environment for future generations" (The Advisory Committee to the Accord on Environmental Sustainability in the Agri-Food Sector, 1993).

The key actions identified in this project are summarized in Table 7.1. The following discussion on environmental protection concentrates on the three major nutrients contained in animal manures (nitrogen, phosphorus and potassium). It is anticipated that the proper management of these key constituents will result in the acceptable management of other manure constituents (e.g. pathogens).

7.1.1 Groundwater Quality Protection

The principal need for groundwater quality protection is to prevent further increases in nitrate levels in groundwater sources. In areas where nitrate levels exceed the drinking water standard of 10 mg-N/l, the nitrogen loadings must be reduced so that acceptable groundwater nitrate concentrations are met. Other issues such as pesticide use and management with respect to agriculture and environmental quality were not addressed in this program.

The most significant area of immediate groundwater concern is the Abbotsford Aquifer. Groundwater quality in this area has received considerable attention. This area has been identified as the portion of the Lower Fraser Valley which experiences the largest excess application of nutrients (Brisbin, 1995b), and agriculture is considered the major contributor to high nitrate levels. A technical action plan (Technical Subcommittee to the Federal/Provincial Groundwater Coordinating Committee, 1995), aimed at reducing contaminant loadings to groundwater from agriculture and other sources, has been prepared by a team of representatives from several provincial and federal government agencies.

The strategy of the technical action plan includes;

- designation of the area over the aquifer as a sensitive water supply area,
- development of a "package" of suitable land use practices for the designated area and development of environmental safeguards,
- a legislated management system (authorized under the suggested groundwater legislation and developed with input from all stakeholders) to openly and fairly enforce the suitable land use practices and environmental safeguards, and

Table 7.1 **KEY ACTIONS NEEDED to ACHIEVE PROTECTION OF GROUNDWATER, SURFACE WATER, AIR AND SOIL QUALITY**

ACTIONS	GROUNDWATER QUALITY PROTECTED	SURFACE WATER QUALITY PROTECTED	AIR QUALITY PROTECTED	SOIL QUALITY PROTECTED
GENERAL	- No increase in nitrate levels - Nitrate loadings reduced before concentration reaches 10 mg-N/l - Technical Action Plan for the Abbotsford Aquifer adopted and implemented - Groundwater protection legislation adopted and implemented	- Compliance with Code of Agricultural Practice and Fisheries Act - Appropriate water quality objectives developed and implemented to protect sensitive uses - Riparian zones and buffer strips established to protect and enhance aquatic environments	- Issues fully defined - Monitoring conducted to better understand issues and improve model	- Soil quality maintained for all uses - Potassium levels reduced in high potassium soils
BAWMP PROCESS (Table 7.2)	- Nutrients applied at agronomic rates and at appropriate times - No leachate or runoff from housing or storage structures - Nutrient surpluses identified and solutions suggested - Recommend soil and manure analyses program - Increased on-farm feed production promoted	- Nutrients applied at agronomic rates and at appropriate times - No leachate or runoff from housing or storage structures - Surface water runoff during manure applications minimized - Nutrient surpluses identified and management solutions suggested - Riparian area management promoted and guidelines developed	- Nitrogen volatilization losses minimized	- Nutrient management plans developed (emphasis on potassium) - Routine soil, manure and crop sample analyses and interpretation - Benefits of soil organic matter promoted - Conservation farming techniques promoted to prevent soil erosion
MANAGE EXCESS (Table 7.3)	- Excess manure moved to areas where use is sustainable - Land exchanges (crop rotations between farms) promoted - Livestock and/or poultry production relocated to areas where it is sustainable	- Excess manure moved to areas where use is sustainable - Land exhcanges (crop rotations between farms) promoted - Livestock and/or poultry production relocated to areas where it is sustainable		- Excess manure moved to areas where use is sustainable - Land exhcanges (crop rotations between farms) promoted - Livestock and/or poultry production relocated to areas where it is sustainable
MANAGE LAND USE (Table 7.4)	- Use of underutilized agricultural land optimized - Agricultural land preserved - Commercial agricultural units preserved - Watershed based approach used for land use planning - Land use monitored and reported regularly	- Use of underutilized agricultural land optimized - Agricultural land preserved - Commercial agricultural units preserved - Watershed based approach used for land use planning - Land use monitored and reported regularly - Aquatic and terrestrial habitat planning improved		- Soil quality monitored and reported regularly
AWARENESS AND ALTERNATIVES (Table 7.5)	- Promote 'area" conservation groups (area = watershed, recharge area) using a community rather than only a commodity based model - Promote stewardship	- Promote 'area" conservation groups (area = watershed, recharge area) using a community rather than only a commodity based model - Promote stewardship	- Airshed concept promoted	Promote conservation farming groups Promote stewardship

- a communication plan to educate, and obtain the cooperation of all stakeholders to the water resource.

The technical action plan also includes the following specific recommendations for action with respect to agricultural nutrient management:

- improved manure and fertilizer nitrogen management over that portion of the aquifer in agricultural production,
- identification of alternate uses of poultry manure, and enhanced movement of manure off of the aquifer,
- initiation and continuation of research and monitoring activities, and
- implementation of a wellhead protection plan.

The recommendations of the technical action plan are ambitious, particularly the recommendation for a legislated land use management system. However, considering that the Abbotsford Aquifer recharge area (the South Matsqui AWMZ) does have the highest positive nutrient balance in the Lower Fraser Valley and that the aquifer is an important international water resource such ambitious action may be required.

This area is unique in the Lower Fraser Valley in that it is an area of large excess nutrient applications over a large unconfined aquifer. There are other, smaller areas where excess nutrient applications are contributing to groundwater contamination and for which similar actions may be need. However, for these areas a less ambitious plan focusing on integrated on-farm waste management planning, as discussed in Section 7.2, may be adequate to solve most of the problems.

The absence of groundwater protection legislation has been identified as a key obstacle to controlling activities which lead to groundwater contamination. The implementation of groundwater legislation allowing for the regulation of activities which can degrade groundwater resources is recommended.

7.1.2 Surface Water Quality Protection

The primary nutrient management concern for the protection of surface water quality relates to controlling "direct" surface runoff. This runoff can result in excessive loadings of several contaminants (including ammonia, phosphorus, bacteria, solids, oxygen demanding material, and organic matter). There are also issues with "subsurface drainage" water where concerns will be primarily over phosphorus and nitrate loading.

Minimizing the amount of contaminated field or yard runoff can significantly reduce loadings of several contaminants. When water containing these contaminants is allowed to flow through the soil profile the physical filtering and biological activity (crop uptake and transformation) which takes place reduces the concentration of many of the contaminants.

Nitrogen in the ammonia form can be toxic to fish at low concentrations (as low as 1.5 mg N/l). This form of nitrogen can easily be introduced through manure contaminated surface runoff. However, when dissolved ammonia flows through the soil and is subject to microbial action it will likely be oxidized to nitrate, a much less toxic form of

nitrogen, before leaving the rooting zone. As nitrate, average concentrations of less than 40 mg-N/l may present no toxicity problems to aquatic life. Concentrations of less than 10 mg-N/l are acceptable for drinking water.

Nitrate concentrations below 40 mg-N/l may contribute to eutrophication in surface waters although phosphorus is often considered the limiting nutrient in this process. Eutrophication in Lower Fraser Valley watercourses is not well understood and there are no guidelines addressing acceptable nitrate or phosphorus concentrations with respect to this process.

The primary pathway for phosphorus entering surface water is often believed to be via "direct" surface runoff since most soils have a high capacity to immobilize phosphorus. However once this immobilization capacity is fully utilized phosphorus can be leached through the soil into subsurface drainage water and eventually enter surface water. Little information is available on actual phosphorus loadings from agricultural land in the Lower Fraser Valley, and there are currently no criteria for acceptable phosphorus concentrations in streams.

There are several documented cases of eutrophication of Lower Fraser Valley watercourses. More monitoring would likely further demonstrate the problems associated with NPS pollution and the need to manage it. Integrated watershed based monitoring programs would help to develop a better understanding of some of the interactions that exist between land management practices and environmental quality in different areas of the Lower Fraser Valley. Water quality parameters of typical concern to agricultural waste management include ammonia, nitrate, phosphorus, bacteria, solids, oxygen demand, pH, organic matter, dissolved oxygen and chlorophyll-a (a measure of algae production).

The significance of "direct" surface runoff in introducing contaminants to surface water highlights the need to consider management practices in riparian areas, those areas immediately adjacent to watercourses. Activities within the riparian zones can have a large impact on the adjacent and downstream watercourses. Proper management, and in several situations, restoration within these areas can greatly improve water quality and the productivity of the aquatic habitat, and potentially provide direct benefits to producers through improved water quality for irrigation and livestock watering and reduced streambank erosion.

However, there are competing demands for lands next to watercourses; in many cases setting aside the area required to maximize the benefits to the aquatic habitat would result in a significant reduction in the area available for agricultural production. On the other hand, research shows that surface runoff quality can be greatly improved by providing relatively small vegetated buffer strips next to watercourses.

Addressing the needs of land and stream stewardship together is an appropriate strategy to develop management guidelines for riparian areas. Guidelines should consider the level of improvement provided to both the land base and the water resource under various management practices, and should be based on some appreciation of the benefits and costs associated with the different management practices.

The variability in LFV watersheds, including the agricultural and urban landscapes, and the degree of physical alteration of some watercourses highlights the need to plan on a watershed basis.

7.1.3 Air Quality Protection

Ammonia emissions may be the most important air quality concern related to agricultural waste management in the Lower Fraser Valley. Research suggests that ammonia is a key component in the formation of small particulate matter. Small particulate matter is a major health and visibility concern (BCMELP, 1994b), particularly in the eastern portion of the Lower Fraser Valley. Agriculture is believed to be the most significant source of ammonia to the Lower Fraser Valley airshed (Levelton, 1995; Brisbin, 1995b).

Although air quality issues are being actively researched by Environment Canada, BC Environment and the Greater Vancouver Regional District, the dynamics of small particulate formation is not yet well understood. The chemical and physical processes which occur in the airshed are complex and it is not known if reducing ammonia emissions would result in a reduced amount of small particulates (ammonia may not be the limiting factor in small particulate formation) or if reducing the amount of ammonia would create a different but still serious problem.

However, given the available information the general view is that agricultural waste management practices should not increase ammonia emissions beyond current levels. There should be continued research and demonstration of management practices (several have been developed elsewhere) which reduce the amount of ammonia lost to the atmosphere. It may be that reducing losses of nitrogen as ammonia and having more nitrogen available for land application is attractive in optimizing the use of manure as a nutrient in crop production.

7.1.4 Soil Quality Protection

Within the context of agricultural nutrient management the most important soil quality concern involves potassium. Excessive applications of potassium is not uncommon (Schmidt, 1994; Brisbin, 1995b), a situation which can lead to high levels of potassium in forage crops and costly herd health problems for dairy producers.

Efforts are required to identify high potassium soils and to develop and promote the implementation of management practices which will reduce the amount of potassium in these soils and thereby reduce the associated dairy herd health problems.

7.2 RECOMMENDED KEY ACTIVITIES

A balanced management approach incorporating education, coordinated planning and enforcement is recommended for the Lower Fraser Valley. This approach is supported by other work on NPS pollution. A coordinated planning model, rather than the status quo or a regulatory control model, has been suggested as the best approach to meeting the requirements of a NPS management strategy in B.C. (KPMG, 1996).

For each of the key actions (Figure 7.1) recommended activities have been identified and summarized under the following groupings: research and guidelines; extension; technology development and demonstration; policy, legislation, regulation and enforcement; and evaluation.

7.2.1 The BAWMP Process

A key recommended action is the development and implementation of Best Agricultural Waste Management Plans (BAWMPs) for all Lower Fraser Valley farms.

These integrated on-farm waste management plans would identify environmental problems on individual farms, evaluate and recommend alternative solutions and encourage the implementation of chosen alternatives. Key actions in support of BAWMPs are summarized in Table 7.2.

A comprehensive Best Agricultural Waste Management Plan would address the following issues for individual farms:

- nutrient management,
  - application rates (based on the soils and crops of the available land base and using soil, manure and plant tissue sampling programs, to ensure acceptable nutrient balances)
  - application timing (to minimize surface runoff and maximize the utilization of manure nutrients)
  - application methods
- manure storage,
  - capacity
  - location
  - integrity
- off-farm movement of manure if required,
  - with or without some level of on-farm treatment
- reduction in manure generated on the farm,
  - changes to feed rations and feeding strategies
  - greater utilization of home grown feed
- riparian area management, and
- conservation farming techniques.

There are currently not enough farms in the LFV which have developed and implemented BAWMPs to provide the desired level of environmental protection. If all farms were to develop and implement a comprehensive BAWMP agricultural nutrient management problems would largely be resolved. BAWMPs would provide site specific problem assessments and solutions. BAWMPs can also provide an education component as problems are identified and solutions developed.

The BAWMP process requires encouragement through educational promotion and, to some degree, through enhanced enforcement of current regulations. There are several technical issues which require further research and guideline development, and potential management techniques which require evaluation and demonstration.

Table 7.2 **RECOMMENDED ACTIVITIES to SUPPORT BAWMP PROCESS**

Conduct Research and **Develop Guidlelines**	**Extension**	**Technology Development Demonstration**	**Policy Legislation Regulation**	**Enforcement**	**Evaluation**
- nutrient application rates and timing for all crops (R,G) - earth storage construction (G) - soil and drainage water phosphorus levels (R) - manure application methods (R,G) - atmoshperic nitrogen deposition rates (R) - runoff quantity and quality predictions for risk assessment (R) - buffer strip and riparian area mgmt guidelines (G) - on-farm manure treatment systems (R,G) - feed rations and feeding strategies (R,G) - water quality objectives (R,G) - cover cropping, inter-cropping (R,G) - soil & manure sampling and analysis techniques (R,G) R = research G = guidelines	- promote implementation strategy for BAWMPs - develop BAWMP training and accreditation - regular seminars involving stakeholders	- promote "demonstration" farms	- develop implementation strategy for BAWMPs (new or expanding operations) (all farms within areas with an identified need) (all farms over a specified size or animal density)	- enforcement of Code of Agricultural Practice - timing of manure applications - storage capacity, location, integrity - compliance with Nutrient Management Plan - random evaluation of development and implementation of BAWMPs - granting of building permits dependent on proof of environmental sustainability	- evaluate BAWMP implementation using GIS - water quality evaluation programs - evaluate success of Agricultural Waste Control Regulation - evaluate priority watersheds

7.2.2 Management of Excess Nutrients

When the land base of an individual farm is not sufficient to effectively utilize the nutrients in the manure generated on that farm the excess nutrients must be managed in other ways (Table 7.3).

In some cases this excess nutrient problem can be solved by reducing the nutrient content of manure, through changing feed rations and feeding strategies, or by changing cropping patterns so that more nutrients are removed by the crops.

However, there are farms which would have excess nutrients even after the adoption of different feeding strategies and cropping patterns. In these situations, and those where a relocation option is more economical, the solutions will involve either moving the excess nutrients to locations where they can be accommodated by the land base or moving some of the livestock or poultry operations to locations where an adequate land base is available.

Although there are some situations where an acceptable balance can be achieved by moving manure to nearby farms there are situations, the South Matsqui AWMZ being the most noteworthy, where excess nutrients are common over a large area and more ambitious efforts to move manure to a suitable area are required. Suitable destinations or markets for this manure are needed. Transportation issues must be addressed; there is a need for finding or developing suitable equipment for handling the manure, for loading at the originating farm, for transport, and for storage and application at the receiving location. Transportation costs will be an issue which may be at least partially off-set by the nutrient value in the manure.

It is expected that to develop large enough markets to accommodate all of the excess manure there will be a need for groups or individuals to "broker" the manure. There may also be a need for some on-farm treatment to make the material more acceptable to the targeted market or to facilitate handling and transport.

Continued research on appropriate on farm treatment technologies and development of potential markets is required. More promotion of the use of organic nutrient sources as an alternative to inorganic nutrients is needed.

7.2.3 Land Use Management

There are several key land use management actions which are required to support improvements to agricultural nutrient management while maintaining agricultural productivity (Table 7.4).

The need to preserve the agricultural land base has not lessened. However, ensuring that a balance exists between nutrient supply and crop needs is a necessity. Preserving commercially cropped agricultural units to handle livestock and poultry manure production is required as part of any plan to achieve acceptable zonal nutrient balances. Reducing animal numbers in certain areas to achieve an acceptable balance should also be considered.

Table 7.3 **RECOMMENDED ACTIVIITES to SUPPORT MANAGEMENT OF EXCESS NUTRIENTS**

Conduct Research and **Develop Guidlelines**	**Extension**	**Technology Development Demonstration**	**Policy Legislation Regulation**	**Enforcement**	**Evaluation**
- reduce nutrients (feed) imported onto farm (R,G)	- promote BAWMP process	- assess new developments in central treatment	- develop and implement groundwater legislation	- enforcement of Code of Agricultural Practice	- evaluate zonal surplus applications using 1996 Census
- identify and develop alternative manure products to market (R)	- promote awareness and alternatives	- develop and implement zone and/or regional nutrient accounting system	-designate protected water supply areas and habitats through ESAs	- timing of manure applications	- develop regional data base to track generation and destination of manure
- identify and develop markets (R)	- encourage use of organic rather than inorganic nutrient sources	- assess developments in small scale treatment processes	- adopt Technical Action Plan for Canadian portion of Abbotsford Aquifer	- manure storage capacity, location, integrity	- continued monitoring of water quality
- identify inorganic/organic crop nutrient needs (R,G)	- encourage producers to develop and implement BAWMPs		- assess need to limit further expansion of livestock and poultry production	- compliance with Nutrient Management Plan	- evaluate success of Agricultural Waste Control Regulation
	- educate end user of manure nutrient value		- assess need to limit livestock or poultry densities	- random evaluation of development and implementation of BAWMPs	- environmental monitoring in areas receiving manure from elsewhere
	- provide education in languages other than English				
	- encourage non-livestock producers and hobby farmers to use manure			- proof of environmental sustainability required for buidling permits	

Table 7.4 **RECOMMENDED ACTIVITIES to SUPPORT LAND USE MANAGEMENT**

Conduct Research and **Develop Guidlelines**	**Extension**	**Technology Development Demonstration**	**Policy Legislation Regulation**	**Enforcement**	**Evaluation**
- determine optimal potential for underutilized agricultural land base (R) - develop and demonstrate watershed land use planning model (R)	- promote concept of ecological footprint and self-sufficiency	- develop and implement nutrient accounting system	-designate protected water supply areas and habitats through ESAs - maintain preservation of agricultural land - maintain commercial agricultural units - adopt Technical Action Plan for Canadian portion of Abbotsford Aquifer - ensure land use planning and managment of uplands protect agricultural land - provide protection to producers from imports from areas of lesser environmental standards - investigate expanding ALC mandate to include environmental issues - evaluate environmental subsidies to producers in competing areas	- assess use of bylaws - proof of environmental sustainability required for buidling permits	- evaluate regional surplus applications using 1996 Census - develop regional data base to track generation and destination of manure - water quality monitoring

Other important land use management actions involve designation of sensitive areas where restrictions to agricultural activities are warranted. Compensation mechanisms are needed to off-set the lost opportunity to producers who reduce or eliminate activities in designated areas. Taxation policies should not penalize producers who, rather than farm sensitive areas, leave them in a more natural condition.

Most importantly there is a need for more watershed based land use planning. All activities within the watershed, and their effects on each other, need to be considered when making land use decisions.

7.2.4 Promotion of Awareness and Alternatives

Increasing producer and public awareness of issues and alternatives to current practices is a key component in fostering the attitudes needed to achieve increased environmental sustainability (Table 7.5).

Many of the needed actions will occur on farms and it will be producers who will implement and manage the changes. In order for producers to properly fulfill their roles as stewards and managers of agricultural lands they must understand the issues and be part of the solution making process. They must be also be aware of the alternatives which are available and of others' interests.

Continuing extension and technology demonstration programs are important. Government agencies can provide some of this, however the efforts of groups which include producers, such as the sustainable farming groups, are considered a highly effective means for developing increased awareness and cooperation.

7.3 LEADERSHIP AND RESOURCES

The Code of Agricultural Practice (BC Reg 131/92), enacted in 1992, set the legislative benchmark for change and from which to evaluate progress. Although the overall impact of recent activities aimed at improving agriculture's environmental performance has not been evaluated, some progress towards meeting the "Code" and achieving environmental sustainability has been made. There have been several successful initiatives which have focused on agricultural issues.

Government agencies (BC Ministry of Agriculture, Fisheries and Food; BC Ministry of Environment, Lands and Parks; Environment Canada; the Department of Fisheries and Oceans and Agriculture and Agri-Food Canada) have devoted manpower and financial resources to addressing the complex and inter-related issues.

The Canada-B.C. Green Plan for Agriculture has provided assistance to:

- the Sustainable Practices Program which included cost sharing for on-farm waste management improvements,
- the formation and operation of Producer Conservation Organizations whose work was directed by producers and included extension, problem definition, applied research and technology development and demonstration,
- numerous joint industry and agency applied research projects,

Table 7.5 **RECOMMENDED ACTIVITIES to SUPPORT AWARENESS and ALTERNATIVES**

Conduct Research and **Develop Guidlelines**	**Extension**	**Technology Development Demonstration**	**Policy Legislation Regulation**	**Enforcement**	**Evaluation**
- evaluate protein quality in feed (R)	- support existing commodity and area conservation groups	- promote land sharing (crop rotations between farms)	- assess new developments in agricultural policy, nationally and interntionally	- promote increased awareness by producers of regulations	- evaluate success of various programs and initiatives and report to public
- develop increased self-sufficiency in livestock feed (better utilization of homegrown feed) (R)	- develop "area" conservation groups based on community model				(success = level of implementation and effectiveness)
- develop and evaluate different production systems (ie. more dairy on pasture) (R,G)	- support agency extension efforts (BCMAFF, BCMELP, Environment Canada, Agriculture Canada, DFO)				
- evaluate ground ear corn production with utilization of stalks as low energy, low potassium feed for dry cows (R)	- promote increased awareness of agriculture by non farm public				
	- support proper training of peer advisors in AEPC - promote increased awareness by producers of habitats and aquatic life - assess, review and report on current activities of groups and programs with an interest in agricultural nutrient management				

- planning, monitoring and evaluation programs,
- a program to assist in the removal of poultry manure from the Central Fraser Valley, and
- public and producer awareness initiatives.

The Fraser River Action Plan has provided assistance for;
- environmental quality monitoring programs,
- the development of Stream Stewardship publications,
- economic and planning studies,
- enforcement,
- pollution abatement,
- habitat enhancement, and
- atmospheric data acquisition.

The Eco-Research Program provided assistance to:
- foster advanced research and training in environmental studies including NPS pollution and watershed management in the Lower Fraser.

If the current level of effort were to be maintained, then continued progress on several fronts would be expected. This progress may be offset by increased intensification in the livestock and poultry industries, with no net benefit to the environment. If a lower level of effort is provided then it is expected that the environmental performance of agriculture will stall and possibly deteriorate. The positive momentum achieved over the past few years will be lost.

Unfortunately, the Green Plan for Agriculture is scheduled to end in March 1997, the Fraser River Action Plan to end in March 1998 and government agencies are under continuing pressure to reduce their budgets. In order to continue to make measurable progress towards addressing agricultural waste management issues, new approaches and funding sources will need to be considered.

Sources might include "green" charges on agricultural products, levies on imports from areas where the costs of environmental compliance are not as great and changes in taxation measures to promote practices that incorporate and meet stewardship requirements.

It was beyond the scope of this program to estimate the cost of all on-farm works needed to achieve environmental sustainability in Lower Fraser Valley agriculture. However, this program identified significant reductions in on-farm operating costs (Brisbin, 1995b) that could be realized through reductions in inorganic fertilizer use, savings which could be used to off-set at least a portion of the costs.

The objective of long term environmental sustainability in agriculture can only be achieved over a period of years. There is a need to track that process, especially within key AWMZs.

A management framework is required, one which will continue to build upon the progress which has been made to date. Determining what that detailed framework might be was beyond the terms and scope of this program. There are several agencies and organizations (Appendix D) which have a mandate or interest in agricultural

nutrient management and should have input into the development and implementation of a management framework. All parties need to understand what each others management issues and obstacles are, and then work together to develop long term cooperative arrangements to have win-win solutions.

With such a large and diverse group of interested parties and the need for action on several fronts, coordination is essential. Information must be shared between the different agencies and organizations. Coordination is needed to ensure that the different groups are aware of the activities of the other groups and of new developments occurring elsewhere, for suggesting priorities for and initiating research, for the development of appropriate guidelines and for effective enforcement.

Although there is some amount of coordination of activities at present (the Steering Committee of this program is an example) a more formal and detailed level of cooperation and coordination is recommended. Leadership in the process should be provided by the provincial government.

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Environmental Guidelines for Mushroom Producers in British Columbia (1994)
Environmental Guidelines for the Nursery and Turf Industry in British Columbia (1994)
Environmental Guidelines for Horse Producers in British Columbia (1995)
Environmental Guidelines for Berry Producers in British Columbia (1995)
Environmental Guidelines for Tree Fruit and Grape Producers in British Columbia (1995)
Environmental Guidelines for Field Vegetable Producers in British Columbia (1996)
Environmental Guidelines for Pork Producers in British Columbia (in production)

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George Derksen. Pollution Abatement Coordinator. Fraser Pollution Abatement Office. Environment Canada. North Vancouver B.C.

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Grant Kowalenko. Research Scientist. Pacific Agriculture Research Centre. Agriculture and Agri-Food Canada. Agassiz, B.C.

Bev Locken. BC Ministry of Environment, Lands and Parks. Surrey, B.C.

Jennifer Nener. Water Quality Coordinator. Fraser River Action Plan. Fisheries and Oceans. Vancouver, B.C.

Rick Van Kleeck. Waste Management Engineer. Resource Management Branch. BC Ministry of Agriculture, Fisheries and Food. Abbotsford, B.C.

APPENDIX A

Management of Agricultural Wastes in the Lower Fraser Valley

List of Reports

Report Number	Title
1	Agricultural Inventory of the Lower Fraser Valley - Data Summary Report (Brisbin, 1994) DOE FRAP 1994-28
2	Application of Inorganic Fertilizers in the Lower Fraser Valley (Brisbin, 1995) DOE FRAP 1995-31
3	Agricultural Nutrient Pathways (Brisbin and Runka, 1995) DOE FRAP 1995-28
4	Agricultural Nutrient Management in the Lower Fraser Valley (Brisbin, 1995) DOE FRAP 1995-27
5	Livestock Waste Management Practices and Legislation Outside British Columbia (Runka, 1995) DOE FRAP 1995-26
6	A Literature Review of the Economics of Manure Management Options (Wohl, 1996) DOE FRAP 1996-15
7	Producer Workshop Proceedings - Management of Livestock and Poultry Manures in the Lower Fraser Valley (Brisbin, 1996) DOE FRAP 1996-28

Appendix B

Meeting Attendance - Discussion and Evaluation of Options

December 18, 1995

Peter	Andzans	City of Abbotsford
Kevin	Chipperfield	Sustainable Poultry Farming Group
Kelly	Der	Greater Vancouver Regional District
George	Derksen	Environment Canada
Liz	Freyman	BC Environment
Ted	Haughton	BC Environment
Bill	Koberstein	Upper Fraser Valley Health Unit
Bev	Locken	BC Environment
Jennifer	Nener	Fisheries and Oceans
Gary	Runka	GG Runka Land Sense Ltd.
Dave	Sands	BC Ministry of Agriculture, Fisheries and Food
Orlando	Schmidt	Dairy Producers' Conservation Group
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Pat	Brisbin	Charcoal Creek Projects Inc.

February 6, 1996

Basil	Bactawar	BC Ministry of Agriculture, Fisheries and Food
Ron	Barker	BC Ministry of Agriculture, Fisheries and Food
Ron	Charles	BC Ministry of Agriculture, Fisheries and Food
Bob	Cheatley	BC Ministry of Agriculture, Fisheries and Food
Kevin	Chipperfield	Sustainable Poultry Farming Group
Kelly	Der	Greater Vancouver Regional District
George	Derksen	Environment Canada
Liz	Freyman	BC Environment
Ted	Haughton	BC Environment
Earl	Jenstad	BC Ministry of Agriculture, Fisheries and Food
John	Luymes	BC Ministry of Agriculture, Fisheries and Food
Dave	Melnychuk	BC Ministry of Agriculture, Fisheries and Food
Narender	Nagpal	BC Environment
Jennifer	Nener	Fisheries and Oceans
Gary	Runka	GG Runka Land Sense Ltd.
Orlando	Schmidt	Dairy Producers' Conservation Group
Graham	Strachan	BC Ministry of Agriculture, Fisheries and Food
Pat	Brisbin	Charcoal Creek Projects Inc.

February 28, 1996

Producer Workshop

March 28, 1996

Marg	Crowley	BC Federation of Agriculture
George	Derksen	Environment Canada
Ted	Haughton	BC Environment
Bev	Locken	BC Environment
Narender	Nagpal	BC Environment
Jennifer	Nener	Fisheries and Oceans
Gary	Runka	GG Runka Land Sense Ltd.
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Jennifer	Wohl	University of British Columbia
Pat	Brisbin	Charcoal Creek Projects Inc.

April 24-25, 1996

Shabtai	Bittman	Agriculture and Agri-Food Canada
George	Derksen	Environment Canada
Ted	Haughton	BC Environment
Jennifer	Nener	Fisheries and Oceans
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Pat	Brisbin	Charcoal Creek Projects Inc.

May 16, 1996

George	Derksen	Environment Canada
Ted	Haughton	BC Environment
Jennifer	Nener	Fisheries and Oceans
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Pat	Brisbin	Charcoal Creek Projects Inc.

June 20, 1996

Shabtai	Bittman	Agriculture and Agri-Food Canada
Marg	Crowley	BC Federation of Agriculture
George	Derksen	Environment Canada
Liz	Freyman	BC Environment
Ted	Haughton	BC Environment
Bev	Locken	BC Environment
Narender	Nagpal	BC Environment
Jennifer	Nener	Fisheries and Oceans
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Jennifer	Wohl	University of British Columbia
Pat	Brisbin	Charcoal Creek Projects Inc.

July 18, 1996

Ron	Bertrand	BC Ministry of Agriculture, Fisheries and Food
George	Derksen	Environment Canada
Ted	Haughton	BC Environment
Bev	Locken	BC Environment
Dave	Morrison	BC Environment
Jennifer	Nener	Fisheries and Oceans
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Harry	Vogt	BC Environment
Pat	Brisbin	Charcoal Creek Projects Inc.

August 20, 1996

Shabtai	Bittman	Agriculture and Agri-Food Canada
Marg	Crowley	BC Federation of Agriculture
George	Derksen	Environment Canada
Ted	Haughton	BC Environment
Grant	Kowalenko	Agriculture and Agri-Food Canada
Rick	Van Kleeck	BC Ministry of Agriculture, Fisheries and Food
Jennifer	Wohl	University of British Columbia
Pat	Brisbin	Charcoal Creek Projects Inc.

APPENDIX C

Producer Conservation Groups in the Lower Fraser Valley

Dairy Producers' Conservation Group

Sustainable Poultry Farming Group

Hog Producers' Sustainable Farming Group

Horse Council of BC Environmental Protection Practices Program

Sumas Prairie Soil Conservation Group

Matsqui / Langley Soil Conservation Group

Delta Conservation and Farm Stewardship Project

APPENDIX D

Agencies and Organizations with an Interest in Agricultural Nutrient Management in the Lower Fraser Valley

Provincial Government

- BC Ministry of Environment, Lands and Parks
- BC Ministry of Agriculture, Fisheries and Food
- BC Ministry of Health
- BC Agricultural Land Commission

Federal Government

- Department of Environment
- Department of Fisheries and Oceans
- Department of Agriculture and Agri-Food

Local Governments

- Greater Vancouver Regional District
- Fraser Valley Regional District
- Municipal Governments

Producer Groups

- BC Federation of Agriculture
- BC Horticulture Coalition
- BC Cattlemens Association

Universities and Colleges

- University of British Columbia
- University College of the Fraser Valley

Conservation Groups

- Dairy Producers' Conservation Group
- Sustainable Poultry Farming Group
- Hog Producers' Sustainable Farming Group
- Horse Council of BC Environmental Protection Practices Program
- Sumas Prairie Soil Conservation Group
- Matsqui / Langley Soil Conservation Group
- Delta Conservation and Farm Stewardship Project

Industry Groups

Environmental Groups

Public

(this is not intended to be complete list of all groups which may have an interest in agricultural waste management)