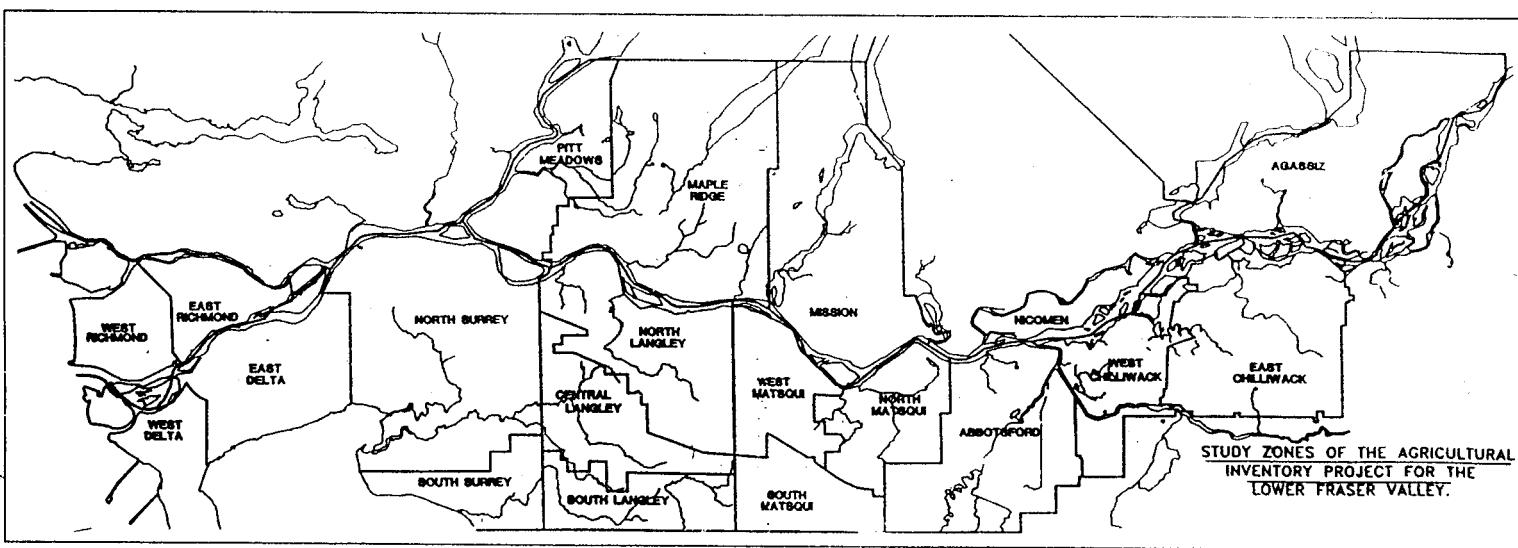


AGRICULTURAL NUTRIENT MANAGEMENT in the LOWER FRASER VALLEY



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

REPORT 4

DOE FRAP 1995 - 27



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DU FRASER



Ministry of Agriculture,
Fisheries and Food

December 1995

**MANAGEMENT OF AGRICULTURAL WASTES
in the
LOWER FRASER VALLEY**

Project 3

**AGRICULTURAL NUTRIENT MANAGEMENT
in the
LOWER FRASER VALLEY**

prepared for:

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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.

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Appendix E Nutrient Model Input Variables
Improved Fertilization, Manure Handling and Feed Rations

1.0 INTRODUCTION

The overall objective 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. The findings of this evaluation will provide a solid background against which policies and strategies for improving nutrient (manure and inorganic fertilizers) management can be developed.

The program has been broken into several component projects 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.

For the purposes of this program the Lower Fraser Valley (LFV) has been divided into twenty Agricultural Waste Management Zones (AWMZs) based on municipal boundaries and in some cases subdivisions based on watershed or predominant agricultural land use considerations. These zones are shown in Figure 1.0.

While this study emphasizes management on large (commercial) farm operations, with a primary focus on livestock operations, plans are to consider nutrient management of small (hobby) farms as well. It is anticipated that nutrient loadings from the hobby farm sector may be significant in some areas. For this study large farms are defined as those with gross annual farm receipts of \$40,000 or above, as defined by the 1991 Census of Agriculture. Small farms are those with gross farm receipts below \$40,000 per year.

There are several recent and on-going projects addressing various components of nutrient management in the LFV. This study attempted to utilize existing information and reports pertaining to agricultural waste management within the Fraser Valley as much as possible.

This study has relied heavily on consultation workshops and interviews with technical specialists, including several members of the Steering Committee. This approach was very productive and aided in setting up an appropriate technical framework. The members of the Steering Committee and others who have been consulted are listed in Appendix A.

This report summarizes the findings of the component projects which looked at 1991 agricultural nutrient management and resultant impacts, including the mass balance model used to estimate the impacts, and potential improvements to agricultural nutrient management and the reduction in nutrient loading which might result from the implementation of such improvements.

The mass balance model is described in Chapter 2 and input variables used in this study are discussed in Chapters 3 and 4.

The results of the mass balance calculations using 1991 management assumptions are presented, for each of the twenty zones, in Chapter 5. 1991 was chosen as the base

year because of data availability; 1991 was a census year and several surveys of manure management practices were conducted in 1990 and 1991.

Two improved management scenarios were considered. The first assumed a reduced rate of inorganic fertilizer use and improved manure management. The second scenario added feeding strategies which would, by improving nutrient utilization efficiency, reduce the amount of nutrients excreted by livestock. These two improvement scenarios are discussed in Chapter 6 and the resultant changes to nutrient flow estimates are presented in Chapters 7 and 8.

The purpose of this report is to present estimates of nutrient flows within LFV agriculture to provide a better understanding of the magnitude of environmental impacts resulting from agricultural nutrient management and the magnitude of the changes which might be achieved by improving nutrient management.

This report provides a base on which to develop sound strategies and recommendations for improved agricultural nutrient management in the LFV. Attempts were made to highlight the many areas where further investigation of nutrient management issues is warranted. No specific recommendations are made at this time; such recommendations warrant the input of others with interests in agricultural nutrient management and development of such recommendations are planned for a later study.

1.1.1 Component Projects

Reports for those projects which have been completed include:

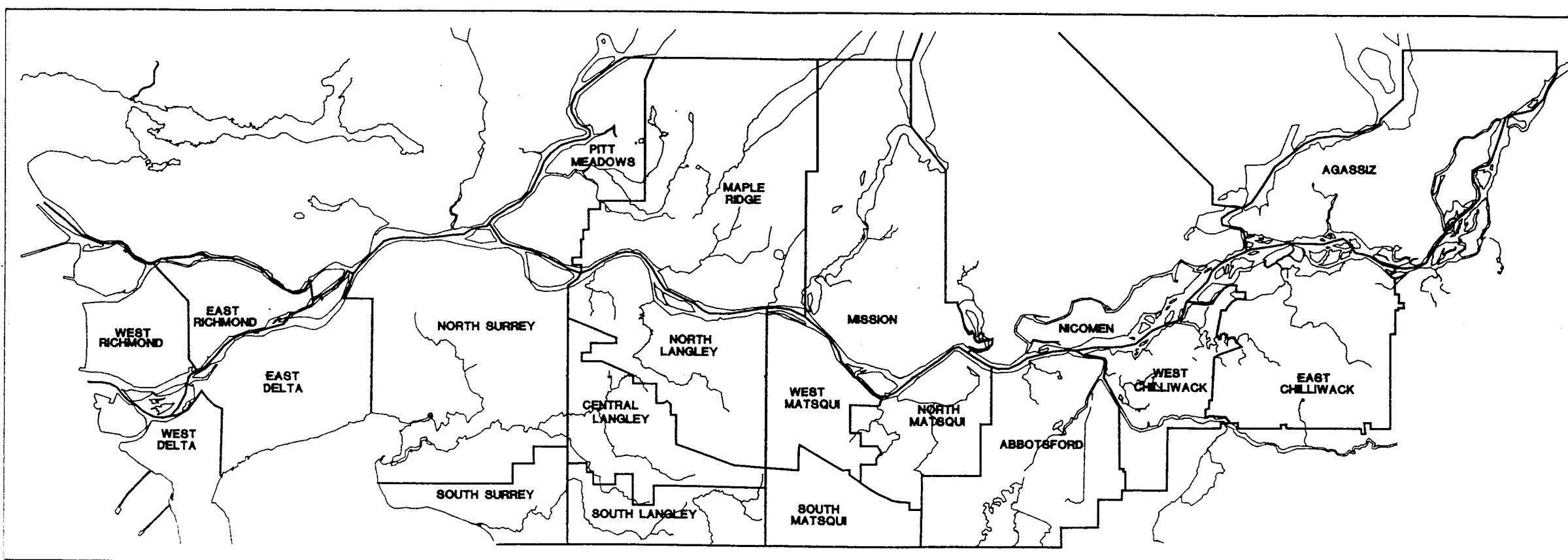
Agricultural Inventory of the Lower Fraser Valley - Data Summary Report
(Brisbin, 1994)

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

Agricultural Nutrient Pathways (Brisbin, 1995b)

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

FIGURE 1 AGRICULTURAL WASTE MANAGEMENT ZONES



2.0 AGRICULTURAL NUTRIENT MODEL

To estimate the size of the various nutrient (nitrogen, phosphorus and potassium) pathways a mass balance model was developed (Excel spreadsheet format). A printout of one model run is contained in Appendix B (Abbotsford / large farms - 1991 Management). Appendix C contains a framework of the model printout with an outline of the calculations which the model performs.

A diagram showing the major nutrient pathways is shown in Figure 2.0.1 and a flowchart outlining the model methodology is presented in Figure 2.0.2. A brief description of the model follows. Tables references which appear in UPPER CASE in this report refer to the TABLES WITHIN THE MODEL (Appendices B to E) rather than to tables in the report text.

The model relies on a number of input variables: livestock inventory (TABLE 2); unit livestock nutrient production (TABLE 2); manure management practices and associated nutrient losses (TABLES 4 AND 7 TO 10); agricultural land base inventory (TABLE 3); unit crop nutrient removal (TABLE 5); inorganic fertilizer use TABLE 5 and soil-atmosphere nitrogen exchange factors (TABLE 6). Input variables are discussed in Chapters 3 and 4.

The model utilizes these variables in a series of calculations to estimate the losses of nutrients to the atmosphere, surface water and groundwater. The calculations pertaining to nitrogen are described below. Calculations for phosphorus and potassium are done in a similar fashion except that it was assumed that there was no atmospheric exchange of these two nutrients.

Unit livestock nutrient production estimates are applied to livestock inventory values to generate total manure nutrient production by livestock type and commodity (TABLE 2).

Nutrient loss factors (the percentage of the nutrient "lost" during a particular component of the manure management process, to be applied to the total amount of the nutrient entering that component of the system) for various manure management system components (TABLES 7 TO 10) are prorated by the distribution of the management system components (TABLE 4) to generate composite loss factors for each commodity group. The composite loss factors are then applied to the total manure nutrient production for each commodity group to generate estimates of nutrient losses which occur at different steps of the manure management process and a net application of manure to land (TABLE 11). The net application to land includes that "applied" by livestock on pasture.

Losses during the manure management process include losses to the atmosphere, losses to surfaces water, losses to groundwater and export. The model estimates losses which occur during housing and collection, from yard areas and pasture, from storage and during land application. The export factor allows for nutrients to be removed from the system (area) being studied.

Unit crop nutrient removal and inorganic fertilizer application values are applied to the land base inventory and a value for inorganic fertilizer application less crop removal is calculated (TABLE 5).

An estimate of the soil-atmosphere nitrogen exchange is made (TABLE 6) utilizing estimates of a background net input to soil plus estimates of a return flow from agricultural activities which is calculated as a percentage of the total losses to the atmosphere during the manure management process (denitrification losses are not used in this calculation).

The values for total manure nutrient production (amount excreted, TABLE 2) and manure management losses (TABLE 11) are combined with the crop - inorganic fertilizer application balance (TABLE 5) and the soil-atmosphere balance (TABLE 6) to generate an estimate of the surplus (or deficit) applied to the soil (TABLE 12).

A surplus value does not necessarily mean that excessive amounts of nutrients are being applied to the soil. The term "surplus" in this case means only that the nutrients produced in manure less manure management losses plus inorganic fertilizer applications plus net input from the atmosphere exceed crop nutrient removal. "Losses" of nutrients from soils are part of the various nutrient cycles and cannot be eliminated from agricultural systems, therefore "no surplus" is not the objective of responsible nutrient management. **Surplus applications, as defined in this study, have not been well defined in terms of environmental risk potential. A proper interpretation of whether or not a surplus value is excessive or not must consider the ultimate destination (surface water or groundwater) of the nutrient, the form the nutrient is in and the sensitivity of the destination to nutrient loading.** However, the estimated surplus values do provide a relative comparison between zones and identify extreme situations.

The model can generate a negative surplus value (a deficit), meaning that the total estimated inputs to the soil system are less than the estimated crop removal. Since this cannot occur in the field, a deficit value indicates that inputs are underestimated (e.g. more inorganic fertilizer is applied) or crop removal is overestimated (e.g. yields are less than implied by the crop removal estimates).

Surplus applications to the land are then partitioned into losses to denitrification, surface water and groundwater (TABLE 14) using various soil release factors (TABLE 13). Denitrification losses are calculated as a percentage of the "net manure application". "Deep losses" (nutrients which move below the rooting zone) are calculated as the surplus application less denitrification losses and are split between losses of surface water and losses to groundwater.

The model has the ability to estimate the exchange of nutrients within the soil (releases from organic matter within the soil and immobilization within the soil) however in this study it was assumed that the net of this exchange would be zero; the amount released from the soil equals the amount immobilized by the soil. When the model is applied to a particular geographic area it is being assumed that the rate of mobilization (mineralization) within that geographic area equals the rate of immobilization. This

does not imply that the two rates are actually equal for all locations within that geographic area, only that the two totals are equal.

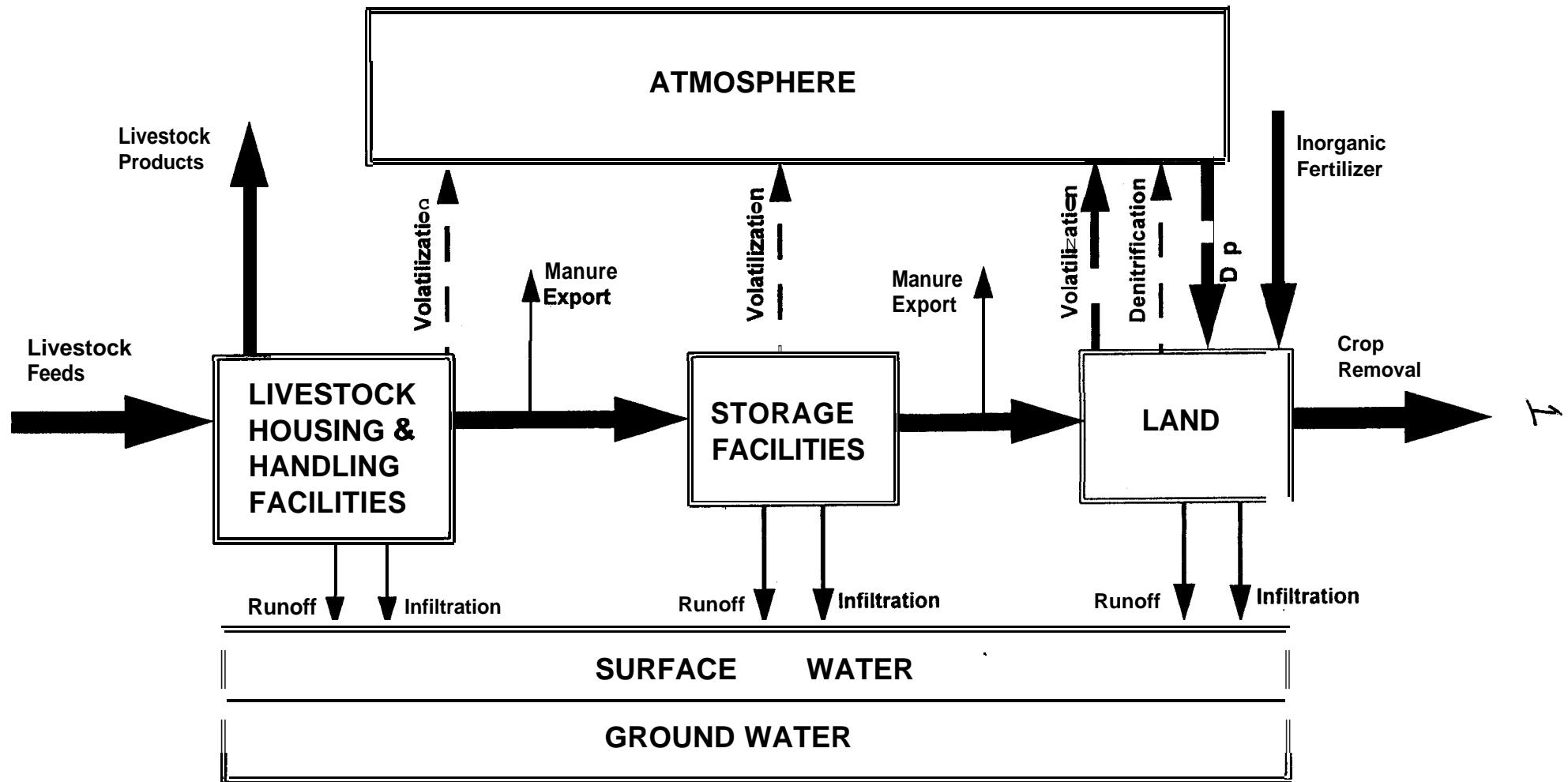
Nutrient exchanges in the soil can be very significant over the short term, however with constant cropping and management there will be a tendency for a soil system to approach an equilibrium where annual rates of immobilization equal rates of mobilization.

A similar set of calculations is made for both phosphorus and potassium. The manure management loss factor assumptions and estimates of management losses, and applied surpluses for phosphorus and potassium are contained in TABLES 15 THROUGH 30 of the model.

TABLE 1 of the model provides a nutrient pathway summary for each of the three nutrients studied. The results are expressed as tonnes per year (total for the entire area to which the model was applied) and as kg per cropped hectare per year.

Figure 2.0.1

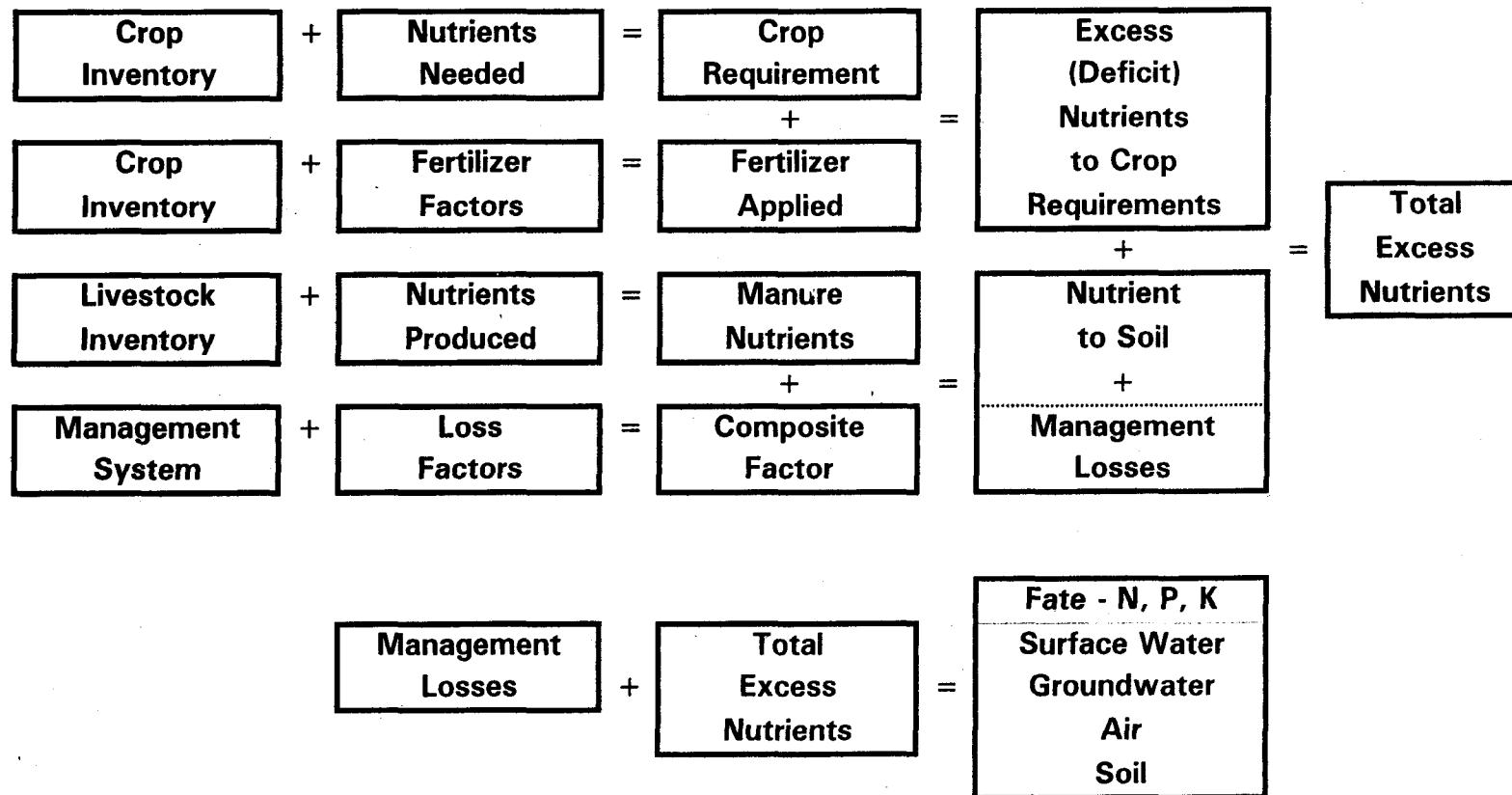
MAJOR NUTRIENT PATHWAYS



(— — — — —) Denotes Nitrogen Pathway Only

Figure 2.0.2

Model Methodology



3.0 NUTRIENT MODEL INPUT VARIABLES

Estimates for the livestock and agricultural land base inventory and estimates of inorganic fertilizer applications are taken from Brisbin, 1994 and Brisbin, 1995a respectively. The reader is referred to these reports for a discussion of information sources and assumptions used in generating these figures. Unit livestock nutrient production values, unit crop nutrient removal estimates, manure management loss factors and denitrification, surface water and groundwater factors are discussed in the following sections and manure management practices for the various commodity groups are discussed in Chapter 4.

3.1 Unit Livestock Nutrient Production

Unit livestock nutrient production estimates were provided by Rick Van Kleeck (BCMAFF) and are presented in Table 3.1.1. These estimates are based on locally derived data and, where local data were not available, on values published in various references. This is the same data used in the current Environmental Guidelines for various commodity groups in BC.

3.2 Unit Crop Nutrient Removal

Estimates for nitrogen removal are values developed by the Resource Management Branch, BCMAFF and used in their various Environmental Guidelines publications. Unit phosphorus and potassium removal rates were made by applying a ratio to the nitrogen removal value.

These nutrient removal values attempt to reflect the amount of nutrient in the harvested portion of the crop. Therefore nutrient removal estimates themselves do not include any allowances for losses or inefficiencies. However, to achieve the yields upon which the nutrient removal rates are based there will be some losses of nutrients from the agricultural system.

The P:N and K:N ratios for grass crops (grass hay, improved pasture, unimproved pasture and sod) and corn silage were based on information provided by Rick Van Kleeck and Don Bates (BCMAFF) and derived from analyses of forage samples submitted to the South Coastal Forage Competition. The K:N ratio was adjusted to represent the maximum level which should be in rations being fed to dairy cattle. This ratio is about 3 times the ratio required in a dairy ration and in excess of what a grass crop actually requires for healthy growth.

The ratios for potatoes, grains, corn and peas were derived from information published by the Western Canada Fertilizer Association (WCFA, 1992). For other crops the ratio of phosphorus removal to nitrogen removal was assumed to be 0.33 and the ratio of potassium removal to nitrogen removal to be 1.00.

Table 3.2.2 summarizes the estimated crop nitrogen removal rates, the P:N and K:N ratios and the resultant estimates of nutrient removal rates for various crops. This table also summarizes the estimated 1991 unit inorganic fertilizer applications which were

used in this study (Brisbin, 1995a), and reduced inorganic fertilizer applications which are discussed in Section 6.1.

3.3 Manure Management Loss Factors

Nitrogen loss factors for various manure management steps were developed using a consensus of opinion approach; a best guess was solicited from members of the Steering Committee and others who study manure management systems in the LFV. Primary input into this process was provided by Dr. John Paul and Rick Van Kleeck. Input into appropriate loss factors was also provided by Bernie ZebARTH, Grant Kowalenko, Kevin Chipperfield, Orlando Schmidt and J. C. Yu.

The nitrogen loss factors chosen to be most representative of LFV conditions are shown in TABLES 7 TO 9 of Appendix B.

In applying these loss factors the appropriate factor for each management step is applied to the amount of nutrient entering that step. The loss factor for each step is independent of the losses which occurred in previous steps and does not influence the loss factors in subsequent steps.

It was assumed that there was no atmospheric exchange of phosphorus or potassium. Factors related to phosphorus losses to surface water (runoff) were assumed to be 50% of the factor used for nitrogen and for potassium losses to surface water (runoff) factors were assumed to be 150% those used for nitrogen. Factors related to both phosphorus and potassium losses to groundwater (infiltration) were assumed to be equal to the equivalent factor used for nitrogen.

3.4 Atmospheric Input Factors

Input of atmospheric nitrogen to the soil is made up of two components; a background input and return flow input. Background inputs of nitrogen were assumed to be 9 kg-N/ha/yr and return flow estimates were made by assuming that 30% of the nitrogen lost to the atmosphere during manure management (denitrification losses were not included) would return to cropped land.

When the model was applied to the various AWMZs in this study it was assumed that 30% of the manure management nitrogen losses to the atmosphere (excluding denitrification) from both large and small farms within that zone would return to the cropped area of both large and small farms of the zone.

No research on "atmospheric input" of nitrogen in the LFV has been done, however the assumed levels of background input and the estimated return flow (when applied to a relatively large geographic area) are not high when compared to such loadings in intensive livestock areas in Europe. Studies in Europe suggest that as much as 60 to 70% of volatilized nitrogen may return to land within a few kilometers of the source. (Welte and Timmerman, 1987)

Since there will no doubt be atmospheric transport of nitrogen from one zone to the next, the model will tend to overestimate the atmospheric input in zones where livestock

and poultry densities are high (volatilization losses per cropped area) and underestimate atmospheric input in zones where livestock and poultry densities are low.

3.5 Denitrification, Surface Water and Groundwater Factors

The factors used to model denitrification rates and the partitioning of deep losses to either surface water or groundwater are shown in Table 3.5.1. Denitrification factors were developed using the consensus of opinion approach with consideration given the dominant surficial geology, soil types and drainage conditions for the agricultural areas of each AWMZ.

The estimates of surface water / groundwater factors are very rough. These factors were chosen after only a brief review of information contained in BC Environment - Environment Canada,1994 and Kreye and Wei,1994.

Table 3.1.1

UNIT LIVESTOCK NUTRIENT PRODUCTION

LIVESTOCK CATEGORY		unit nutrient production (kg/animal/year)		
		N	P	K
Dairy	bulls	112.0	20.1	76.4
	cows	116.0	13.1	97.1
	heifers	42.0	47.2	37.4
	calves	20.0	21.9	14.9
	milking centre *	1.7	1.0	2.4
Poultry (meat)	chickens (1000's)	0.60	0.23	0.28
	turkeys (1000's)	0.86	0.27	0.43
	other (1000's)	0.60	0.23	0.28
Poultry (layers)	pullets (1000's)	0.34	0.10	0.12
	layers (1000's)	0.80	0.23	0.28
Swine	boars	24.3	7.5	9.5
	sows	18.3	5.6	7.1
	other	7.2	2.4	4.6
Beef	bulls	112.0	20.1	76.4
	cows	78.0	13.5	39.8
	heifers	44.0	14.4	33.2
	steers	50.0	16.2	36.5
	calves	20.0	21.9	14.9
Horses		45.5	7.6	28.4
Sheep	rams	11.0	1.6	8.0
	ewes	11.0	1.6	8.0
	lambs	4.4	0.6	3.2
Goats		11.0	1.6	8.0

* per milking cow

Table 3.2.2

**CROP NUTRIENT REMOVAL RATES
AND INORGANIC FERTILIZER APPLICATIONS**

Crop	N removal (kg/ha/yr)	crop nutrient removal ratios			crop removal (kg/ha/yr)			1991 inorganic fertilizer applications (kg/ha/yr)			fertilizer applications - crop removal (kg/ha/yr)			reduced inorganic fertilizer applications (kg/ha/yr)			reduced fertilizer - crop removal (kg/ha/yr)		
		N	P:N	K:N	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Grass hay	300	0.12	0.40	300	36	120	240	24	58	-60	-12	-62	90	11	36	-210	-25	-84	
Improved Pasture	200	0.12	0.40	200	24	80	120	12	29	-80	-12	-51	60	7	24	-140	-17	-56	
Unimproved Pasture	100	0.12	0.40	100	12	40	0	0	0	-100	-12	-40	0	0	0	-100	-12	-40	
Silage corn	185	0.17	1.00	185	31	185	140	42	87	-45	10	-98	56	9	56	-130	-22	-130	
Grain	80	0.17	1.54	80	14	123	180	35	95	100	21	-28	24	4	37	-56	-10	-86	
Vegetables	potatoes	230	0.22	1.38	230	51	317	90	85	162	-140	35	-156	230	51	317	0	0	0
	peas	20	1.28	1.67	20	26	33	20	37	83				6	8	10	-14	-18	-23
	corn	160	0.22	0.26	160	35	42	130	48	91	-30	13	50	48	11	12	-112	-25	-29
	beans	45	0.33	1.00	45	15	45	45	39	75				14	4	14	-32	-10	-32
	cole crops	120	0.33	1.00	120	40	120	200	48	95	80	8	-25	36	12	36	-84	-28	-84
	other	130	0.33	1.00	130	43	130	100	66	141	-30	23	11	39	13	39	-91	-30	-91
Berries	raspberries	70	0.33	1.00	70	23	70	75	42	104	5	18	34	21	7	21	-49	-16	-49
	strawberries	70	0.33	1.00	70	23	70	75	46	100	5	23	30	70	23	70	0	0	0
	blueberries	75	0.33	1.00	75	25	75	70	55	79	-5	30	4	75	25	75	0	0	0
	other	15	0.33	1.00	15	5	15	15	9	12	0	4	-3	15	5	15	0	0	0
Other field crops		100	0.33	1.00	100	33	100	132	45	92	32	12	-8	30	10	30	-70	-23	-70
Tree Fruits		70	0.33	1.00	70	23	70	75	42	104	5	18	34	70	23	70	0	0	0
Nursery Crops		50	0.33	1.00	50	17	50	60	22	25	10	5	-25	50	17	50	0	0	0
Sod		60	0.12	1.00	60	7	60	70	31	66	10	23	6	60	7	60	0	0	0
Summerfallow		0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Catch crops		0	0.00	0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

with the exception of the crops listed below

reduced inorganic fertilizer applications is 30% of the crop nutrient requirement or current inorganic fertilizer application, whichever is less
for the following crops, reduced inorganic fertilizer applications equals the crop nutrient requirement

potatoes, strawberries, blueberries, other berries, tree fruits, nursery crops and sod

Table 3.5.1

DENITRIFICATION FACTORS
SURFACE WATER AND GROUNDWATER FACTORS

Waste Management Zone	denitrification	surface water factor	groundwater factor
West Richmond	0.15	0.70	0.30
East Richmond	0.15	0.70	0.30
West Delta	0.15	0.70	0.30
East Delta	0.15	0.70	0.30
North Surrey	0.10	0.85	0.15
South Surrey	0.05	0.65	0.35
South Langley	0.05	0.55	0.45
Central Langley	0.05	0.70	0.30
North Langley	0.10	0.70	0.30
West Matsqui	0.05	0.75	0.25
South Matsqui	0.05	0.05	0.95
North Matsqui	0.15	0.70	0.30
Abbotsford	0.15	0.80	0.20
West Chilliwack	0.15	0.60	0.40
East Chilliwack	0.15	0.65	0.35
Agassiz	0.15	0.60	0.40
Nicomen	0.15	0.60	0.40
Mission	0.10	0.70	0.30
Maple Ridge	0.10	0.55	0.45
Pitt Meadows	0.15	0.70	0.30

4.0 1991 AGRICULTURAL WASTE MANAGEMENT PRACTICES

The following information on 1991 agricultural waste management practices is based on information contained in producer surveys which were conducted in 1990 and 1991 for the three major livestock commodity groups (DPCG, 1992; HPSFG, 1992; SPFG, 1993) and discussions with Rick Van Kleeck, Orlando Schmidt, Kevin Chipperfield and J. C. Yu.

The distribution of various management practices developed for each of the livestock and poultry commodity groups are shown in TABLE 4 of Appendix B. For this study the distribution of waste management practices, except for the export factor and poultry-layer housing factors, was assumed to be constant throughout the LFV (no variation between AWMZs).

4.1 Dairy

Dairy waste management systems were characterized by three housing systems; free stall (94% of the dairy cows using this system), tie stall (3%) and bedded stalls or sawdust pack (3%) and four storage systems; slurry in a tank (80%, of which 95% provide complete containment of manure, i.e. no losses to either surface or groundwater), slurry in an earth lagoon (8%, of which 67% provide complete containment), semi-solid storage (9%, complete containment in 50%) and solid storage (3%, complete containment in only 30%).

The waste management survey implied that about 65% of milking centre wastes were handled with the manure, 20% discharged through tile fields and 15% discharged directly to water courses.

There was apparently no significant "export" of dairy manure from any of the AWMZs in 1991.

It was estimated that the "average" dairy animal spends between 9 and 10% of their time in outside yard areas and between 0 and 8% of their time on pasture, depending on the time of the year. The average time on yard or pasture areas considers that in some systems cattle are totally confined while in others the cattle spend significant amounts of time on pasture.

Land applications of manure (the fraction of the annual total applied in a particular month) were derived from a "manure application time line" developed by Orlando Schmidt (Schmidt, 1993) and from the distribution of storage capacities on dairy farms as reported in the dairy manure management survey (DPCG, 1992).

This time line presented a schedule of manure applications for a dairy farm with 75% of cropped area in grass and 25% in corn silage and with a 6 month storage capacity. This storage capacity allowed for the appropriate timing and quantities of manure to be applied to optimize the use of nutrients in the manure. The timing and amount applied (percentage of total annual manure production) as shown on the time line was taken as the "best practices" land application scenario.

For storage capacities of less than 6 months, time lines were developed which tried to match the 6 month storage scenario as best as possible. Using information on the distribution of storage capacities from the survey a weighted average time line was developed, generating the land application timing pattern used when modeling 1991 management practices.

4.2 Poultry

Broiler, roaster and turkey (poultry - meat) management systems were characterized by two housing systems; concrete floor (74%) and dirt floor (26%) and three storage systems; contained storage (1%, on concrete and covered), semi-contained storage (1%, on ground but covered) and uncontained storage (98%, uncovered concrete pad without runoff control or uncovered on ground).

Information in the poultry industry waste management survey (SPFG,1993) implied that 34% of the total manure from broiler and roaster operations in the Fraser Valley was "exported" for use in the production of mushroom compost and that all of this export was from 9 AWMZs (North Surrey, South Surrey, South Langley, Central Langley, North Langley, Central Langley, North Langley, West Matsqui, South Matsqui, North Matsqui and Abbotsford). If export occurred only from these 9 AWMZs, it would represent 40% of the broiler and roaster manure produced in those AWMZs. Export factors for these 9 AWMZs was then estimated to be 40% of the nutrients (after housing losses) produced by "other chickens" in each of these nine AWMZs. It was assumed that manure produced by turkeys and other poultry (and by the poultry-layer category) was not exported in any significant quantity.

The poultry waste management survey also provided information on the reported timing of manure applications by Fraser Valley poultry producers. This information was used to derive the land application patterns used to model 1991 practices. The same land application pattern was used for "poultry-meat" and "poultry-layers".

Egg production systems (layers and pullets) were characterized by five housing systems; three pit systems (73%) and two floor systems (27%). Of the pit systems it was estimated that 97% of the manure production is stored in the deep pits (with or without drying fans) in the barn and 3% of manure is removed from the barn and stored in an outside pit. The proportion of in-barn deep pit systems was varied by AWMZ based on information in the poultry waste management survey. For floor systems it was estimated that 97% were concrete floors and 3% were dirt floors.

Characterization of poultry-layer manure storage was similar to that for poultry-meat manure; contained (1%), semi-contained (2%) and uncontained (97%).

4.3 Swine

Three housing systems; slatted floors (45%), partially slatted floors (50%) and bedded floor (5%) and five manure storage systems; covered tank (50%, of which 95% are contained, i.e. no infiltration nor runoff occurs), uncovered tank (25%, 95% contained), earth lagoon (20%, 67% contained), solid storage (3%, 50% contained) and composted manure (3%, 100% contained) were considered representative of the hog industry.

There was no significant export of hog manure from any of the AWMZs in 1991.

The land application pattern for hog manure was developed in the same way as for dairy manure. The application timing as a function of storage capacity was assumed to be the same as that used for dairy manure and the storage capacity distribution on hog operations was taken from hog industry waste management survey (HPSFG, 1992).

4.4 Beef, Horse and Other Livestock Management Systems

Information on the distribution of manure handling systems for beef, horses and other livestock was not readily available and since these livestock groups represent less than 9% of the total manure nutrients produced on large farms in the Fraser Valley the manure management practices for these commodity groups were characterized using the following assumptions.

It was assumed that all of these livestock groups were housed with significant amounts of bedding and that all manure was stored as a solid. Animals were assumed to be on pasture 25% of the time during the months of October to March and 50% of the time from April to September. Twenty percent of the stored manure was applied in each of the months of February to May inclusive and 5% in each of June to September inclusive.

5.0 IMPACTS OF 1991 MANAGEMENT PRACTICES

The output of the mass balance model using the 1991 management assumptions are summarized in Tables 5.0.1 to 5.0.8. Estimates are presented for nitrogen, phosphorus and potassium for both large and small farms and in units of kg/ha and total tonnes for each zone.

A brief discussion of the results for each of the three nutrients considered follows.

5.1 Nitrogen

The large farm surplus of nitrogen (surplus is the "applied surplus" less denitrification losses) for each of the twenty AWMZs is presented in Figure 5.1.1, along with the surplus less the estimated atmospheric input (assuming no atmospheric deposition of nitrogen). A similar presentation for small farms is given in Figure 5.1.2. Since the assumptions used to estimate atmospheric deposition are very rudimentary and not based on local data, and since the atmospheric deposition estimates are often significant, estimates of the surplus excluding any atmospheric deposition were presented to provide an appreciation for the potential magnitude of atmospheric exchange and to provide an estimate of the lower limit for surplus values.

For the large farms, surpluses range from a high of 408 kg/ha in South Matsqui to a low of -28 kg/ha in West Delta, including atmospheric input, with an average over the Lower Fraser Valley of 115 kg/ha.

When considering any estimates of averages for the entire LFV it must be noted that to achieve such averages considerable amounts of manure would have to be moved from areas of high nutrient surpluses to areas of deficits or low surpluses.

Similarly, surpluses estimated for a particular AWMZ represent an average over the entire zone and assume that some amount of manure is transported within the zone. These estimates therefore provide no indication of the range of surpluses which might be experienced within that AWMZ. For example, the Pitt Meadows AWMZ has one of the lower estimated surpluses (-1 kg N/ha). However for that zone 2164 ha, of a total agricultural land base of 4755 ha, is classed as unimproved pasture and the model assumes that all of this unimproved pasture would receive applications of nutrients. If it is assumed that no nutrients are applied to the unimproved pasture the estimated surplus increases to 79 kg N/ha.

When it is assumed that there is no atmospheric input surpluses range from 285 kg/ha in South Matsqui to -42 kg N/ha in West Delta with a Fraser Valley average of 75 kg/ha. The estimates of atmospheric input ranged from 123 kg/ha in South Matsqui to 10 kg/ha in West Richmond.

The surpluses for small farms are generally much smaller. The LFV small farm average surplus, when atmospheric input is included, is 20 kg N/ha, dropping to -20 kg N/ha when atmospheric input of nitrogen is excluded.

There was considerable discussion within the committee over what might be acceptable values for "surpluses". It was accepted that soil based agricultural production systems will "leak" some amount of nutrients to both the atmosphere and water, but it was felt that defining specific targets was beyond the scope of this study. The main points of the discussion over surplus values are summarized below.

Some perspective on the significance of the surpluses to surface and groundwater is provided by considering the amount of dilution which might occur. If 100 kg/ha is diluted in 1 metre of water covering the same area the resulting concentration would be 10 mg/l. Therefore if there was a surplus of 100 kg/ha of nitrogen and if all of this was leached as nitrate to groundwater along with a 1 metre depth of recharge the resulting concentration of nitrate in the groundwater would be 10mg/l, the current maximum allowable concentration for drinking water (BC Environment,1994a).

A brief analysis of water balance factors suggests that the average annual amount of infiltration through the surface soils (defined as average annual precipitation less average annual evapotranspiration) will range from 0.5 to 1.4 m, depending on location, with significant annual variation at any one location.

Results from recent studies which looked at agricultural activities and water quality in the Fraser Valley were also compared to the results of this study to provide an appreciation for the significance of the estimated surplus values.

The South Matsqui AWMZ in this study includes the majority of the Canadian portion of the Abbotsford aquifer recharge area, and agriculture, and in particular manure management, has been implicated as the most significant contributor to the unacceptably high level of nitrates in the groundwater of the Abbotsford aquifer (ZebARTH et al,1994; Wassenaar,1994; Liebscher et al,1992). These results imply that surplus nitrogen values over 400 kg-N/cropped ha/yr, as estimated in this study for the South Matsqui AWMZ, are excessive.

Studies of the Matsqui Slough and Sumas River Watersheds (IRC,1994a; IRC,1994b) have suggested that agriculture is partially responsible for degraded surface water quality in both watersheds and degraded groundwater quality in the Matsqui Slough watershed. The Matsqui Slough watershed study area contains most of the North Matsqui AWMZ which is within the ALR, and the Sumas River watershed study area is almost the same as the ALR portion of the Abbotsford AWMZ.

These studies suggest that the surpluses as estimated for the North Matsqui AWMZ (152 kg-N/cropped ha/yr) and the Abbotsford AWMZ (135 kg-N/cropped ha/yr) may be too high to achieve desirable levels of water quality.

There was some degree of agreement within the Steering Committee that a realistic target for surplus nitrogen might fall in the 50 to 100 kg N/ha range. It was felt that such levels might provide protection to the aquatic environment and still allow agriculture to maintain current levels of crop productivity. However, there are several significant issues which should be considered when deciding if a particular surplus value is excessive, including the needs of and the benefits to the water resources and the costs to agriculture, and the significant variability in both land use and water resources.

Figure 5.1.3 is a graphical presentation of the percentage of the total cropped area for which average surplus values within an AWMZ exceed the indicated surplus value. The estimated surpluses in 3 of the twenty AWMZs, representing 10% of the total cropped area, exceed 200 kg N/ha. The estimated surpluses exceed 100 kg N/ha in another 7 AWMZs (representing a further 47% of the total cropped area). A further 6 AWMZs (21% of the cropped area) have estimated surpluses between 50 and 100 kg N/ha.

5.1.1 Losses to the Atmosphere

Estimated losses of nitrogen to the atmosphere, excluding denitrification losses and therefore primarily losses of nitrogen as ammonia, are summarized in Figures 5.1.4 and 5.1.5. The first of these figures presents the data as total tonnes per year for each AWMZ and the second presents the data as kg/cropped hectare/year. The losses are shown as the total for large farms plus small farms, and when presented as kg/cropped ha/year the losses are averaged over the total cropped area of both large and small farms.

Total losses (large farms plus small farms) to the atmosphere of nitrogen as ammonia for the study area were estimated to be 7579 tonnes-N per year. Estimates for losses of ammonia by AWMZ went from a high of 1156 tonnes-N/yr in South Matsqui to 17 tonnes-N/yr in West Richmond. Expressing these losses as kg N/yr/cropped hectare estimates ranged from 381 kg N/ha in South Matsqui to 5 kg N/ha in West Richmond with an average over the study area of 103 kg-N/cropped hectare.

There are significant air quality issues related to ammonia; ammonia has been identified as a key component in the formation of small particulates (Thomson, per. com.) and small particulates may be the most significant air quality concern in the eastern Fraser Valley (BC Environment, 1994b). However, even though agriculture is likely the largest source of atmospheric ammonia in the LFV, the significance of these ammonia loadings is not well understood. At this time it is not known if reducing ammonia emissions would improve air quality.

5.1.2 Surface Water

The estimates of losses of nitrogen to surface water are shown in Figure 5.1.6. Total N to surface water ranged from a high of 239 kg N/cropped hectare in West Matsqui to a low in 1 kg N/cropped hectare in West Richmond and West Delta. The average for the LFV was estimated to be 82 kg N/cropped hectare.

As can be seen from looking at Figure 5.1.6 the losses to surface water resulting from the "surplus" are generally much higher than the loss of nitrogen from manure handling and application. However it must be kept in mind that the losses to surface water during manure handling and application are expected to be primarily as dissolved ammonia while the losses resulting from surplus applications to land will be primarily as nitrate (which has a much lower toxicity to aquatic life, by a factor of about 10 to 20, than ammonia). In some situations controlling the direct surface runoff of nitrogen may have a greater impact on improving aquatic habitat than controlling the losses of nitrogen through the soil profile.

In interpreting the losses to surface water it must be kept in mind that these losses will be diluted only by water which leaves an area as surface water.

5.1.3 Groundwater

Figure 5.1.7 presents the estimated losses of nitrogen to groundwater. It is expected that these losses will primarily be as nitrate and estimates ranged from 399 kg N/ha in South Matsqui to insignificant in West Richmond and West Delta.

Agriculture has been implicated as a major contributor to groundwater nitrate levels in the Abbotsford aquifer, and if the estimated losses of 399 kg/cropped acre within the South Matsqui AWMZ are correct there cannot be any doubt that excess applications of nitrogen are a problem in this area.

Nitrogen losses to groundwater which occur during manure handling are much less than the losses which occur from the surplus applications. In both cases the nitrogen is expected to be in the form of nitrate.

5.2 Phosphorus

Surplus phosphorus estimates (large farms) for each of the twenty AWMZs are shown in Figure 5.2.1. The average phosphorus surplus for the LFV was estimated to be 85 kg-P/ha or 2.9 times the estimated crop removal.

The highest phosphorus surplus was estimated for South Matsqui at 270 kg-P/ha (which represented 11.3 times the estimated crop removal for phosphorus) while the lowest surplus was estimated for Pitt Meadows at 21 kg P/ha (which represents 1.1 times the estimated crop nutrient removal). It should be noted that for the Pitt Meadows zone there is a relatively high percentage of the cropped area as "unimproved pasture" and the model assumes that unimproved pasture will receive nutrients. No effort was made to estimate the portion of unimproved pasture which might not, due to a various constraints (such as poor drainage), realistically receive any applications of nutrients for any of the AWMZs.

The fate of surplus phosphorus applications was not modeled. Certainly a large portion of the surpluses may be immobilized in the soil, however continued excess applications of phosphorus will eventually saturate the immobilization capacity of the soils and phosphorus will then leach through the soil profile.

Experience in Quebec and the Netherlands (ZebARTH, per. com.) suggest that once the immobilization capacity of a soil profile is saturated the leaching of phosphorus through the profile can be significant. It may be that if nutrient loading is the water quality concern then phosphorus may be the "limiting nutrient". A rule of thumb for vegetative growth in fresh water is that if the ratio of N:P is greater than 10 or 15, phosphorus will be the limiting nutrient rather than nitrogen. This ratio suggests that surface water may be 10 to 15 times as sensitive to phosphorus loading as it would be to an equivalent nitrogen loading.

Information on the current phosphorus status of soils, amounts of phosphorus which may leach, and the sensitivity of receiving waters to phosphorus, specific to the LFV, is not readily available.

Phosphorus pathways and of the impact which phosphorus may have on water quality should be given further consideration. Phosphorus may be the nutrient to base nutrient management strategies on rather than nitrogen.

5.3 Potassium

Surplus potassium estimates for large farms are presented in Figure 5.3.1. The LFV average surplus for potassium was estimated to be 126 kg K/cropped hectare, or 1.2 times the estimated crop removal.

South Matsqui again yielded the highest value; 340 kg K/cropped hectare or 4.6 times the estimated crop removal. A deficit of 32 kg K/cropped hectare was estimated for West Delta.

It is unlikely that surplus potassium will cause any problems with respect to water quality although excess applications are of significant concern in grass crop production for the dairy industry. High soil potassium levels can lead to excessively high levels of potassium in grass crops which can in turn lead to serious and costly health problems in dairy herds. BCMAFF staff feel that elevated soil potassium problems may already exist on 75% of LFV dairy farms. This suggests that potassium should be the limiting factor in manure management in some situations.

Information needed for a detailed discussion of the extent and severity of potassium related problems is not readily available. However if potassium is applied at rates which exceed crop removal plus losses to water, the concentration in the root zone will increase and if excess applications continue long enough a potassium problem will occur.

5.4 Sensitivity Analysis

An analysis of the sensitivity of the model results to variations in input variables was done for two of the AWMZs, Abbotsford and South Matsqui. Individual input variables were individually increased or decreased by 10% and the resultant changes to model output compared to the original estimates.

The changes to the estimated losses to the atmosphere, surface water and groundwater are presented in Tables 5.4.1 and 5.4.2 (Abbotsford), and 5.4.3 and 5.4.4 (South Matsqui). It should be noted that changes in losses of less than 1/2% (i.e. rounded down to 0) are not shown in these tables.

For the Abbotsford zone the model showed the greatest sensitivity to changes in livestock inventory, unit nutrient production, crop removal and inorganic fertilizer use. A 10% change in input variable resulted in changes to estimated nutrient loadings of 4 to 13%. A more moderate sensitivity, a 1 to 3 % change in nutrient loadings result from

10% variations in individual input variables, was shown for the land base, housing losses - atmosphere, storage losses - atmosphere, application losses - atmosphere, background atmospheric input, atmospheric return flow and denitrification assumptions.

The response to changes in land base inputs results are less than what might be expected; this is because while the total land base was increased the unit inorganic fertilizers values were not changed and hence total inorganic fertilizer use for zone also increased.

Changes to other input variables produced little or no change in nutrient loss estimates.

In the South Matsqui zone the higher responses (7 to 10% change in nutrient loadings) resulted only from changes to the livestock inventory and unit nutrient production assumptions.

Moderate responses (1 to 4% change in nutrient loading) resulted from 10% variations in crop removal, inorganic fertilizer use, housing losses - atmosphere, export, storage losses - atmosphere, application losses - atmosphere, application losses - surface water, and atmospheric return flow assumptions.

5.5 Extreme Value Analysis

In order to develop an upper and lower bound for the estimated nutrient loadings which result from 1991 management practices the degree of confidence in the estimated magnitude of input variables were classified as high, moderate or low and assigned ranges of plus or minus 10%, 25% and 50% respectively. Table 5.5.1 shows the confidence level which was assigned to the various input variables.

Input variables were adjusted to the limit of each respective range to develop two extreme value estimates, one representing a minimum impact on water quality of agricultural nutrient management and one representing a maximum impact, for two of the AWMZs (Abbotsford and South Matsqui). The results of this extreme value analysis are shown in Tables 5.5.2 and 5.5.3.

For Abbotsford the minimum estimate of total nitrogen to surface water was 16 tonnes per year while the maximum estimate was 1516 tonnes per year, with a "best estimate" of 726 tonnes. Estimates of annual nitrogen to groundwater were a minimum of 10 tonnes, a maximum of 407 tonnes and a best estimate of 198 tonnes. Estimates for phosphorus and potassium showed less variation. Estimates of the applied surplus for phosphorus ranged from a minimum of 367 tonnes per year to a maximum of 727 with the best estimate at 550 tonnes. The estimates for the applied surplus of potassium were 545 tonnes per year as a minimum, 1463 as a maximum and 1016 as the best estimate.

The estimates generated for South Matsqui showed less variation than those for Abbotsford. The minimum estimate of nitrogen to surface water for South Matsqui was 30 tonnes while the maximum was 130 tonnes with the best estimate of 72. For

nitrogen to groundwater the estimates were 393 tonnes (minimum), 1401 tonnes (maximum) and 851 tonnes (best estimate).

This analysis generated a considerable range of values for the magnitude of nutrient pathways. This large range reflects the complexity and variability in the systems which are being studied as well as the limited amount of local information which is available for some of the variables.

Even though this analysis shows that there is a definite degree of uncertainty in the estimates of absolute values for nutrient loadings which are occurring, it does not negate the results of other studies which have discussed the importance of agricultural nutrient loading nor does it reduce the usefulness of the model in comparing the relative losses between AWMZs.

When looking at the results of the extreme value analysis it must be kept in mind that the likelihood of all variables being out by the maximum amount or all by the minimum amount is very low. Therefore it is expected that actual values will be well within the extreme value limits.

Table 5.0.1

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - 1991 Management Nitrogen (kg / cropped ha)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	731	19	750	41	0	17	1	0	23	116	80	-37	10	-3	3	20	-6	0	1	0	0
East Richmond	1483	202	1685	204	0	102	4	3	95	112	88	-23	37	109	14	116	95	66	70	28	31
West Delta	2684	189	2873	41	0	16	1	0	24	160	98	-62	14	-24	4	20	-28	0	1	0	0
East Delta	3465	399	3864	74	0	31	2	1	41	170	135	-35	18	23	6	37	17	12	14	5	6
North Surrey	4039	550	4589	370	40	140	7	3	180	186	139	-47	41	174	18	158	156	133	140	23	26
South Surrey	593	118	711	490	73	212	8	5	191	221	157	-64	48	176	10	222	166	108	116	58	63
South Langley	1302	280	1582	614	103	257	9	6	239	181	115	-66	48	220	12	269	208	114	123	94	100
Central Langley	1470	236	1706	327	38	136	6	3	145	200	145	-55	35	124	7	143	117	82	88	35	38
North Langley	2336	472	2808	283	28	128	5	3	119	179	129	-50	34	103	12	140	91	64	69	27	30
West Matsqui	1623	398	2021	813	151	349	12	8	294	182	139	-43	66	317	15	364	302	227	239	76	84
South Matsqui	2136	718	2854	969	102	528	13	11	315	107	92	-15	123	424	16	544	408	20	33	388	399
North Matsqui	3416	259	3675	357	20	152	7	3	175	213	170	-44	47	178	26	178	152	106	113	46	49
Abbotsford	6687	345	7032	283	5	124	6	3	145	207	173	-34	46	157	22	146	135	108	114	27	30
West Chilliwack	2455	229	2684	348	0	163	7	4	174	193	157	-36	51	188	26	189	162	97	104	65	69
East Chilliwack	5867	432	6299	322	0	142	7	3	169	205	157	-48	45	166	25	167	141	91	98	49	52
Agassiz	2622	237	2859	213	0	89	5	2	117	229	171	-58	33	92	18	107	74	45	50	30	32
Nicomen	3305	369	3674	215	0	91	5	2	117	242	179	-63	31	85	18	109	67	40	45	27	29
Mission	472	73	545	166	0	67	4	2	93	211	163	-48	23	68	9	76	59	41	45	18	20
Maple Ridge	795	163	958	185	0	79	4	2	101	184	125	-59	27	68	10	89	58	32	36	26	28
Pitt Meadows	4571	185	4756	84	0	33	2	1	49	153	85	-68	18	-1	7	40	-8	0	2	0	1
Fraser Valley	52031	5875	57906	299	20	132	6	3	138	187	140	-47	40	131	16	149	115	72	77	45	48

Table 5.0.2

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - 1991 Management Phosphorus (kg / cropped ha)												Potassium (kg / cropped ha)													
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal
West Richmond	731	19	750	9	0	0	0	9	25	40	14	23	33	0	2	0	31	108	74	-33	-2								
East Richmond	1483	202	1685	71	0	1	1	69	20	25	5	74	111	0	5	2	105	72	49	-22	82								
West Delta	2684	189	2873	11	0	0	0	11	36	55	19	30	30	0	1	0	28	171	111	-60	-31								
East Delta	3465	399	3864	22	0	0	0	22	31	39	8	30	61	0	3	1	58	118	84	-34	24								
North Surrey	4039	550	4589	127	19	2	1	105	32	38	6	111	244	23	10	2	208	127	78	-49	159								
South Surrey	593	118	711	165	33	2	2	128	29	22	-7	120	259	44	10	4	202	104	50	-54	148								
South Langley	1302	280	1582	215	48	3	3	162	24	16	-8	155	334	61	12	4	257	81	37	-44	213								
Central Langley	1470	236	1706	105	18	1	1	84	27	23	-4	80	204	22	8	2	171	101	52	-49	122								
North Langley	2336	472	2808	92	13	1	1	76	25	21	-3	73	168	16	7	2	143	89	49	-40	103								
West Matsqui	1623	398	2021	288	72	3	3	209	27	24	-3	206	424	88	15	5	316	94	51	-42	274								
South Matsqui	2136	718	2854	316	47	4	5	260	24	34	10	270	419	60	16	7	335	74	79	5	340								
North Matsqui	3416	259	3675	110	9	2	1	98	30	29	-1	96	251	12	10	3	227	115	63	-51	175								
Abbotsford	6687	345	7032	88	3	1	1	83	32	31	-1	82	213	3	9	2	198	116	69	-47	152								
West Chilliwack	2455	229	2684	115	0	2	2	111	31	33	2	113	231	0	10	3	218	114	72	-41	176								
East Chilliwack	5867	432	6299	102	0	2	1	99	29	27	-2	97	244	0	11	3	230	115	60	-54	176								
Agassiz	2622	237	2859	70	0	1	1	68	30	23	-7	61	175	0	8	2	165	110	53	-57	108								
Nicomex	3305	369	3674	66	0	1	1	64	31	22	-9	55	172	0	8	2	162	106	51	-55	107								
Mission	472	73	545	50	0	1	1	49	29	24	-4	45	133	0	6	2	125	109	57	-52	74								
Maple Ridge	795	163	958	59	0	1	1	57	24	17	-7	50	117	0	5	2	110	86	36	-49	61								
Pitt Meadows	4571	185	4756	27	0	0	0	27	20	15	-6	21	64	0	3	1	60	73	30	-43	17								
Fraser Valley	52031	5875	57906	97	9	1	1	85	29	29	0	85	194	12	8	2	172	108	63	-45	126								

Table 5.0.3

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - 1991 Management Nitrogen (tonnes)																			
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater		
West Richmond	731	19	750	30	0	12	1	0	17	85	58	-27	8	-2	3	15	-5	0	1	0	0	0	
East Richmond	1483	202	1685	303	0	152	6	4	141	165	131	-34	55	162	21	173	141	99	105	42	46		
West Delta	2684	189	2873	110	0	42	3	1	64	428	262	-166	38	-64	10	52	-74	0	3	0	1		
East Delta	3465	399	3864	257	0	106	6	3	142	589	466	-123	62	81	21	127	60	42	48	18	21		
North Surrey	4039	550	4589	1496	161	565	29	12	727	750	562	-188	164	703	73	638	630	536	565	95	107		
South Surrey	593	118	711	291	44	126	5	3	114	131	93	-38	29	104	6	132	98	64	69	34	37		
South Langley	1302	280	1582	799	134	334	12	8	311	236	150	-86	62	287	16	350	271	149	161	122	130		
Central Langley	1470	236	1706	481	55	200	9	4	213	295	213	-82	51	182	11	211	171	120	129	51	55		
North Langley	2336	472	2808	661	65	300	12	6	278	419	302	-117	80	242	28	328	214	150	162	64	70		
West Matsqui	1623	398	2021	1320	245	566	19	12	478	295	225	-70	107	514	24	590	490	368	387	123	135		
South Matsqui	2136	718	2854	2070	217	1128	28	23	674	229	197	-32	263	905	34	1162	871	44	72	828	851		
North Matsqui	3416	259	3675	1219	67	520	24	11	597	729	580	-149	161	608	90	610	518	363	387	156	167		
Abbotsford	6687	345	7032	1892	36	826	40	17	973	1383	1154	-229	309	1053	146	972	907	726	766	181	198		
West Chilliwack	2455	229	2684	855	0	401	18	10	427	474	386	-88	124	462	64	465	398	239	257	159	169		
East Chilliwack	5867	432	6299	1886	0	832	41	19	994	1203	922	-281	264	977	149	981	828	538	579	290	309		
Agassiz	2622	237	2859	558	0	233	13	5	307	600	447	-153	87	241	46	279	195	117	130	78	83		
Nicomen	3305	369	3674	711	0	299	17	7	388	799	591	-209	102	282	58	357	224	134	151	90	97		
Mission	472	73	545	78	0	32	2	1	44	100	77	-23	11	32	4	36	28	19	21	8	9		
Maple Ridge	795	163	958	147	0	63	3	2	80	147	99	-47	21	54	8	71	46	25	28	21	23		
Pitt Meadows	4571	185	4756	384	0	149	9	3	223	700	388	-312	82	-7	33	182	-40	0	9	0	3		
Fraser Valley	52031	5875	57906	15548	1053	6876	295	151	7173	9754	7298	-2456	2083	6800	843	7729	5973	3732	4029	2360	2511		

Table 5.0.4

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - 1991 Management Phosphorus (tonnes)												Potassium (tonnes)													
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal
West Richmond	731	19	750	6	0	0	0	6	19	29	10	17	24	0	1	0	23	79	54	-24	-2								
East Richmond	1483	202	1685	106	0	2	2	102	29	37	8	110	165	0	8	3	155	107	73	-33	122								
West Delta	2684	189	2873	30	0	1	0	29	97	149	52	81	81	0	4	1	76	458	298	-160	-84								
East Delta	3465	399	3864	78	0	1	1	75	109	136	27	102	212	0	9	3	200	408	291	-118	82								
North Surrey	4039	550	4589	513	77	7	5	424	128	152	24	449	985	94	41	10	841	515	316	-198	642								
South Surrey	593	118	711	98	20	1	1	76	17	13	-4	71	154	26	6	2	120	62	30	-32	88								
South Langley	1302	280	1582	280	62	3	4	211	31	21	-10	201	434	79	16	5	334	105	49	-57	278								
Central Langley	1470	236	1706	154	26	2	2	124	40	34	-6	118	299	32	12	3	252	149	77	-72	180								
North Langley	2336	472	2808	215	31	3	3	178	58	50	-8	171	393	38	16	5	334	207	113	-94	240								
West Matsqui	1623	398	2021	467	117	5	6	339	43	39	-5	334	689	143	24	8	513	152	83	-69	444								
South Matsqui	2136	718	2854	674	100	9	11	555	51	73	21	576	894	129	35	14	716	158	169	10	727								
North Matsqui	3416	259	3675	376	32	5	4	334	104	99	-5	329	858	39	35	9	774	391	216	-175	599								
Abbotsford	6687	345	7032	587	17	9	7	554	212	208	-4	550	1425	21	60	16	1327	775	463	-311	1016								
West Chilliwack	2455	229	2684	281	0	5	4	272	77	81	5	277	567	0	25	8	534	279	178	-101	433								
East Chilliwack	5867	432	6299	599	0	10	8	582	170	159	-11	571	1429	0	62	17	1350	673	354	-319	1031								
Agassiz	2622	237	2859	183	0	3	2	178	78	60	-17	161	458	0	20	5	432	289	139	-150	282								
Nicomen	3305	369	3674	218	0	4	3	212	101	72	-30	182	567	0	25	7	536	350	167	-183	353								
Mission	472	73	545	24	0	0	0	23	13	12	-2	21	63	0	3	1	59	51	27	-24	35								
Maple Ridge	795	163	958	47	0	1	1	45	19	13	-6	39	93	0	4	1	88	68	29	-39	48								
Pitt Meadows	4571	185	4756	125	0	2	1	122	94	67	-27	95	292	0	13	3	276	335	137	-198	78								
Fraser Valley	52031	5875	57906	5061	494	73	64	4430	1489	1501	12	4441	10082	619	418	121	8923	5606	3257	-2349	6575								

Table 5.0.5

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Small Farms (hectares)			Small Farms - 1991 Management Nitrogen (kg / cropped ha)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	2700	691	3391	5	0	2	0	0	3	115	26	-89	10	-75	0	2	-75	0	0	0	0
East Richmond	159	35	194	37	0	14	1	0	22	149	106	-42	37	17	3	17	14	10	11	4	4
West Delta	342	64	406	72	0	25	2	0	45	155	112	-43	14	16	7	32	9	6	8	3	3
East Delta	323	69	392	55	0	19	1	0	34	151	114	-37	18	15	5	24	10	7	8	3	3
North Surrey	1812	499	2311	77	0	27	2	1	47	172	108	-63	41	24	5	32	19	16	18	3	4
South Surrey	495	126	621	99	0	34	3	1	62	174	103	-71	48	39	3	37	36	23	26	13	14
South Langley	1817	388	2205	105	0	38	3	1	64	191	116	-74	51	40	3	41	37	20	23	17	18
Central Langley	1709	429	2138	95	0	33	2	1	59	178	108	-71	35	23	3	36	20	14	16	6	7
North Langley	2132	1199	3331	101	0	37	2	1	60	177	103	-74	34	21	6	43	15	11	13	5	6
West Matsqui	1739	433	2172	108	0	39	3	1	65	181	114	-67	66	63	3	42	60	45	48	15	16
South Matsqui	899	229	1128	77	0	31	2	1	43	131	87	-44	123	122	2	33	120	6	8	114	115
North Matsqui	893	238	1131	90	0	32	2	1	54	191	132	-59	47	43	8	40	35	24	26	10	11
Abbotsford	543	117	660	315	0	129	8	2	176	195	143	-52	46	170	26	155	144	115	123	29	31
West Chilliwack	770	146	916	153	0	59	4	1	89	177	110	-67	51	72	13	72	59	35	39	23	24
East Chilliwack	1687	404	2091	122	0	44	3	1	73	178	121	-56	45	62	11	55	51	33	36	18	19
Agassiz	423	168	591	84	0	30	2	1	51	197	143	-54	33	30	8	38	22	13	15	9	10
Nicomex	1209	495	1704	69	0	26	2	1	40	161	93	-69	31	3	6	32	-3	0	2	0	1
Mission	471	182	653	77	0	28	2	0	47	157	80	-77	23	-7	5	33	-12	0	2	0	0
Maple Ridge	706	327	1033	102	0	36	3	1	62	156	79	-77	27	12	6	42	6	3	6	3	4
Pitt Meadows	741	123	864	43	0	15	1	0	27	185	137	-49	18	-4	4	19	-8	0	1	0	0
Fraser Valley	21557	6364	27921	88	0	33	2	1	53	167	100	-67	40	26	5	38	20	18	20	13	13

Table 5.0.6

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Small Farms (hectares)			Small Farms - 1991 Management Phosphorus (kg / cropped ha)										Potassium (kg / cropped ha)									
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)		
West Richmond	2700	691	3391	1	0	0	0	1	15	5	-10	-8	3	0	0	0	3	50	11	-39	-36		
East Richmond	159	35	194	11	0	0	0	11	26	32	6	17	23	0	1	0	21	83	58	-24	-3		
West Delta	342	64	406	17	0	0	0	17	27	30	3	20	44	0	2	0	42	92	65	-27	14		
East Delta	323	69	392	16	0	0	0	16	25	26	2	17	34	0	2	0	32	89	59	-30	1		
North Surrey	1812	499	2311	22	0	0	0	22	24	20	-4	17	48	0	2	0	45	83	43	-41	4		
South Surrey	495	126	621	27	0	0	0	26	23	14	-9	17	63	0	3	1	59	78	31	-47	13		
South Langley	1817	388	2205	34	0	1	0	33	24	13	-10	23	64	0	3	1	60	80	32	-49	12		
Central Langley	1709	429	2138	28	0	0	0	27	23	13	-9	18	59	0	3	0	56	76	31	-45	11		
North Langley	2132	1199	3331	32	0	1	0	31	23	13	-9	22	62	0	3	1	58	75	30	-45	13		
West Matsqui	1739	433	2172	36	0	1	0	35	23	15	-9	26	63	0	3	0	60	78	33	-45	15		
South Matsqui	899	229	1128	23	0	0	0	23	22	24	2	24	46	0	2	1	43	71	57	-14	29		
North Matsqui	893	238	1131	34	0	1	0	33	27	23	-4	29	58	0	3	1	54	89	49	-40	14		
Abbotsford	543	117	660	110	0	2	1	107	29	27	-2	105	190	0	10	2	178	99	62	-37	141		
West Chilliwack	770	146	916	58	0	1	1	56	24	17	-7	49	98	0	5	1	92	82	40	-42	50		
East Chilliwack	1687	404	2091	48	0	1	0	47	24	18	-6	41	78	0	4	1	73	85	41	-43	30		
Agassiz	423	168	591	31	0	1	0	30	26	21	-6	25	53	0	3	0	50	89	51	-38	12		
Nicomex	1209	495	1704	21	0	0	0	20	21	13	-8	12	45	0	2	0	42	71	30	-40	2		
Mission	471	182	653	26	0	0	0	26	20	10	-10	16	49	0	2	0	46	66	23	-43	3		
Maple Ridge	706	327	1033	30	0	1	0	29	20	12	-9	20	65	0	3	1	61	68	26	-42	19		
Pitt Meadows	741	123	864	13	0	0	0	13	27	26	-1	12	29	0	1	0	27	88	52	-36	-9		
Fraser Valley	21557	6364	27921	29	0	0	0	28	22	16	-7	22	55	0	3	0	52	76	35	-40	11		

Table 5.0.7

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Small Farms (hectares)			Small Farms - 1991 Management Nitrogen (tonnes)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	2700	691	3391	13	0	5	0	0	8	310	70	-240	28	-204	1	6	-205	0	0	0	0
East Richmond	159	35	194	6	0	2	0	0	4	24	17	-7	6	3	1	3	2	2	1	1	
West Delta	342	64	406	25	0	9	1	0	15	53	38	-15	5	5	2	11	3	2	3	1	1
East Delta	323	69	392	18	0	6	0	0	11	49	37	-12	6	5	2	8	3	2	2	1	1
North Surrey	1812	499	2311	139	0	50	4	1	85	311	196	-115	74	44	9	59	36	30	34	5	6
South Surrey	495	126	621	49	0	17	1	0	31	86	51	-35	24	19	2	19	17	11	12	6	6
South Langley	1817	388	2205	191	0	69	5	1	116	347	211	-135	92	73	6	75	67	37	42	30	31
Central Langley	1709	429	2138	162	0	56	4	1	100	305	184	-121	60	39	5	61	34	24	28	10	11
North Langley	2132	1199	3331	214	0	79	5	2	129	377	221	-157	73	45	13	92	32	22	27	10	12
West Matsqui	1739	433	2172	187	0	69	4	1	113	316	199	-117	114	110	6	75	104	78	82	26	27
South Matsqui	899	229	1128	69	0	28	2	1	39	118	78	-40	111	110	2	30	108	5	7	103	104
North Matsqui	893	238	1131	80	0	29	2	1	49	170	118	-52	42	38	7	36	31	21	23	9	10
Abbotsford	543	117	660	171	0	70	4	1	95	106	78	-28	25	92	14	84	78	62	66	16	17
West Chilliwack	770	146	916	118	0	46	3	1	68	136	85	-52	39	56	10	56	46	27	30	18	19
East Chilliwack	1687	404	2091	205	0	75	5	1	124	300	205	-95	76	104	19	94	85	56	61	30	31
Agassiz	423	168	591	35	0	13	1	0	22	83	60	-23	14	13	3	16	10	6	7	4	4
Nicomen	1209	495	1704	83	0	32	2	1	49	195	112	-83	37	4	7	39	-3	0	2	0	1
Mission	471	182	653	36	0	13	1	0	22	74	38	-36	11	-3	2	15	-5	0	1	0	0
Maple Ridge	706	327	1033	72	0	25	2	1	44	110	56	-54	19	8	4	29	4	2	4	2	3
Pitt Meadows	741	123	864	32	0	11	1	0	20	137	101	-36	13	-3	3	14	-6	0	1	0	0
Fraser Valley	21557	6364	27921	1906	0	703	47	13	1143	3602	2154	-1448	860	555	118	822	440	389	436	271	284

Table 5.0.8

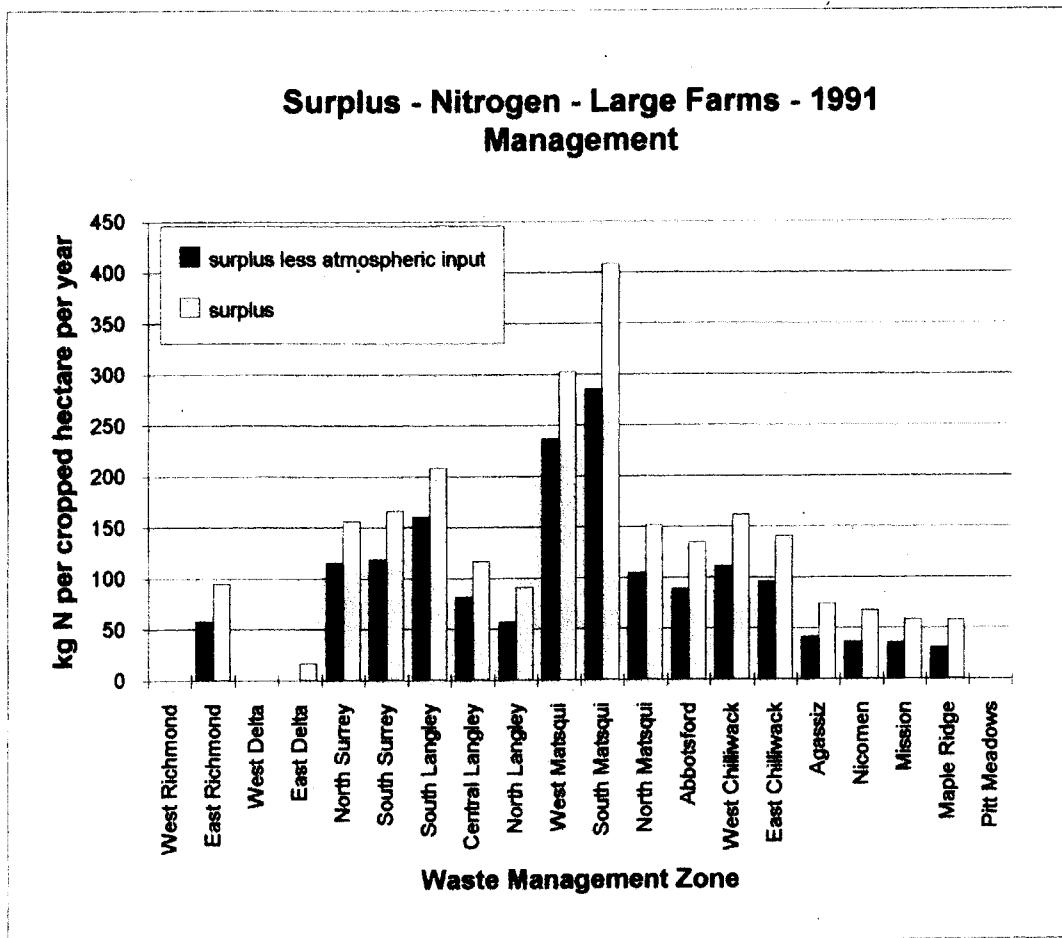
NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Small Farms (hectares)			Small Farms - 1991 Management Phosphorus (tonnes)										Potassium (tonnes)											
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration
West Richmond	2700	691	3391	3	0	0	0	3	40	14	-26	-23	8	0	0	0	8	135	30	-105	-97				
East Richmond	159	35	194	2	0	0	0	2	4	5	1	3	4	0	0	0	3	13	9	-4	0				
West Delta	342	64	406	6	0	0	0	6	9	10	1	7	15	0	1	0	14	32	22	-9	5				
East Delta	323	69	392	5	0	0	0	5	8	8	1	6	11	0	1	0	10	29	19	-10	0				
North Surrey	1812	499	2311	40	0	1	0	39	44	36	-8	31	87	0	4	1	82	151	77	-74	8				
South Surrey	495	126	621	13	0	0	0	13	11	7	-4	9	31	0	2	0	29	39	16	-23	6				
South Langley	1817	388	2205	62	0	1	1	60	43	24	-19	41	116	0	6	1	110	145	57	-88	22				
Central Langley	1709	429	2138	48	0	1	0	46	38	23	-16	31	101	0	5	1	95	130	53	-77	19				
North Langley	2132	1199	3331	68	0	1	1	67	48	28	-20	47	131	0	6	1	124	160	64	-95	28				
West Matsqui	1739	433	2172	62	0	1	0	61	41	26	-15	46	110	0	5	1	104	136	58	-78	26				
South Matsqui	899	229	1128	21	0	0	0	20	20	22	2	22	41	0	2	0	39	64	51	-13	26				
North Matsqui	893	238	1131	30	0	1	0	29	24	20	-4	26	51	0	2	0	48	79	43	-36	13				
Abbotsford	543	117	660	50	0	1	1	58	16	15	-1	57	103	0	5	1	97	54	33	-20	76				
West Chilliwack	770	146	916	45	0	1	0	43	18	13	-5	38	76	0	4	1	71	63	31	-32	38				
East Chilliwack	1687	404	2091	81	0	1	1	79	40	30	-10	68	131	0	6	1	124	143	70	-73	51				
Agassiz	423	168	591	13	0	0	0	13	11	9	-2	10	23	0	1	0	21	38	21	-16	5				
Nicomex	1209	495	1704	25	0	0	0	24	26	16	-9	15	54	0	3	1	51	85	37	-49	2				
Mission	471	182	653	12	0	0	0	12	9	5	-5	8	23	0	1	0	22	31	11	-20	1				
Maple Ridge	706	327	1033	21	0	0	0	20	14	8	-6	14	46	0	2	0	43	48	18	-30	13				
Pitt Meadows	741	123	864	10	0	0	0	9	20	19	-1	9	21	0	1	0	20	65	38	-27	-7				
Fraser Valley	21557	6364	27921	627	0	11	5	611	485	338	-147	464	1185	0	58	11	1116	1631	758	-873	243				

Figure 5.1.1

**SURPLUS
NITROGEN**
Large Farms
1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus less atmospheric input	surplus	atmospheric input
West Richmond	-16	-6	10
East Richmond	58	95	37
West Delta	-42	-28	14
East Delta	-1	17	18
North Surrey	115	156	41
South Surrey	118	166	48
South Langley	160	208	48
Central Langley	82	117	35
North Langley	57	91	34
West Matsqui	236	302	66
South Matsqui	285	408	123
North Matsqui	105	152	47
Abbotsford	89	135	46
West Chilliwack	111	162	51
East Chilliwack	96	141	45
Agassiz	41	74	33
Nicomex	36	67	31
Mission	36	59	23
Maple Ridge	31	58	27
Pitt Meadows	-26	-8	18
Fraser Valley	75	115	40



negative surplus values (deficits) are not shown on the graph

Figure 5.1.2

**SURPLUS
NITROGEN**

Small Farms
SMALL FARMS - 1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus less atmospheric input	surplus	atmospheric input
West Richmond	-85	-75	10
East Richmond	-23	14	37
West Delta	-5	9	14
East Delta	-8	10	18
North Surrey	-22	19	41
South Surrey	-12	36	48
South Langley	-14	37	51
Central Langley	-15	20	35
North Langley	-19	15	34
West Matsqui	-6	60	66
South Matsqui	-3	120	123
North Matsqui	-12	35	47
Abbotsford	98	144	46
West Chilliwack	8	59	51
East Chilliwack	6	51	45
Agassiz	-11	22	33
Nicomex	-34	-3	31
Mission	-35	-12	23
Maple Ridge	-21	6	27
Pitt Meadows	-26	-8	18
Fraser Valley	-20	20	40

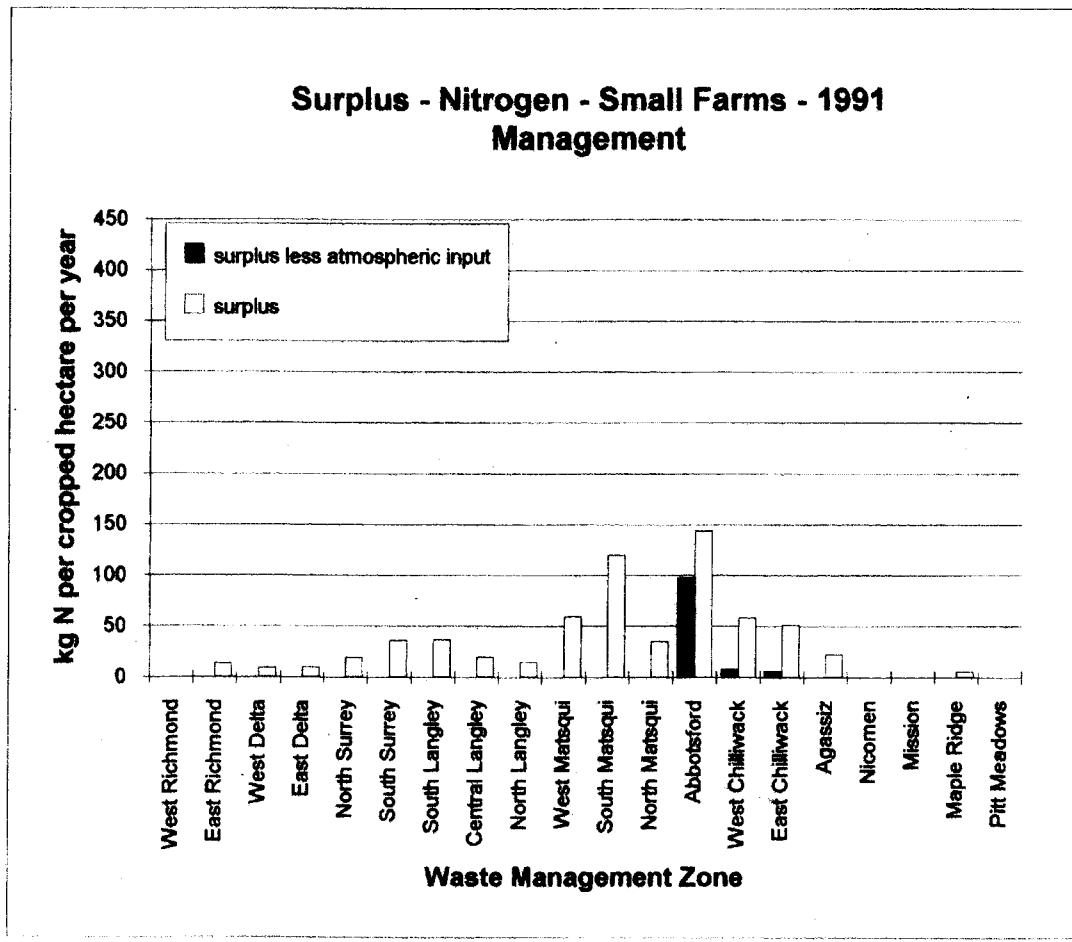


Figure 5.1.3

**LAND BASE vs
SURPLUS NITROGEN** Large Farms
1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus	cumulative cropped area (%)	cumulative cropped area (ha)
South Matsqui	408	4%	2136
West Matsqui	302	7%	3759
South Langley	208	10%	5061
South Surrey	166	11%	5654
West Chilliwack	162	16%	8109
North Surrey	156	23%	12148
North Matsqui	152	30%	15584
East Chilliwack	141	41%	21431
Abbotsford	135	54%	28118
Central Langley	117	57%	29588
East Richmond	95	60%	31071
North Langley	91	64%	33407
Agassiz	74	69%	36029
Nicomex	67	76%	39334
Mission	59	76%	39806
Maple Ridge	58	78%	40601
East Delta	17	85%	44066
West Richmond	-6	86%	44797
Pitt Meadows	-8	95%	49368
West Delta	-28	100%	52052
Fraser Valley	115		52031

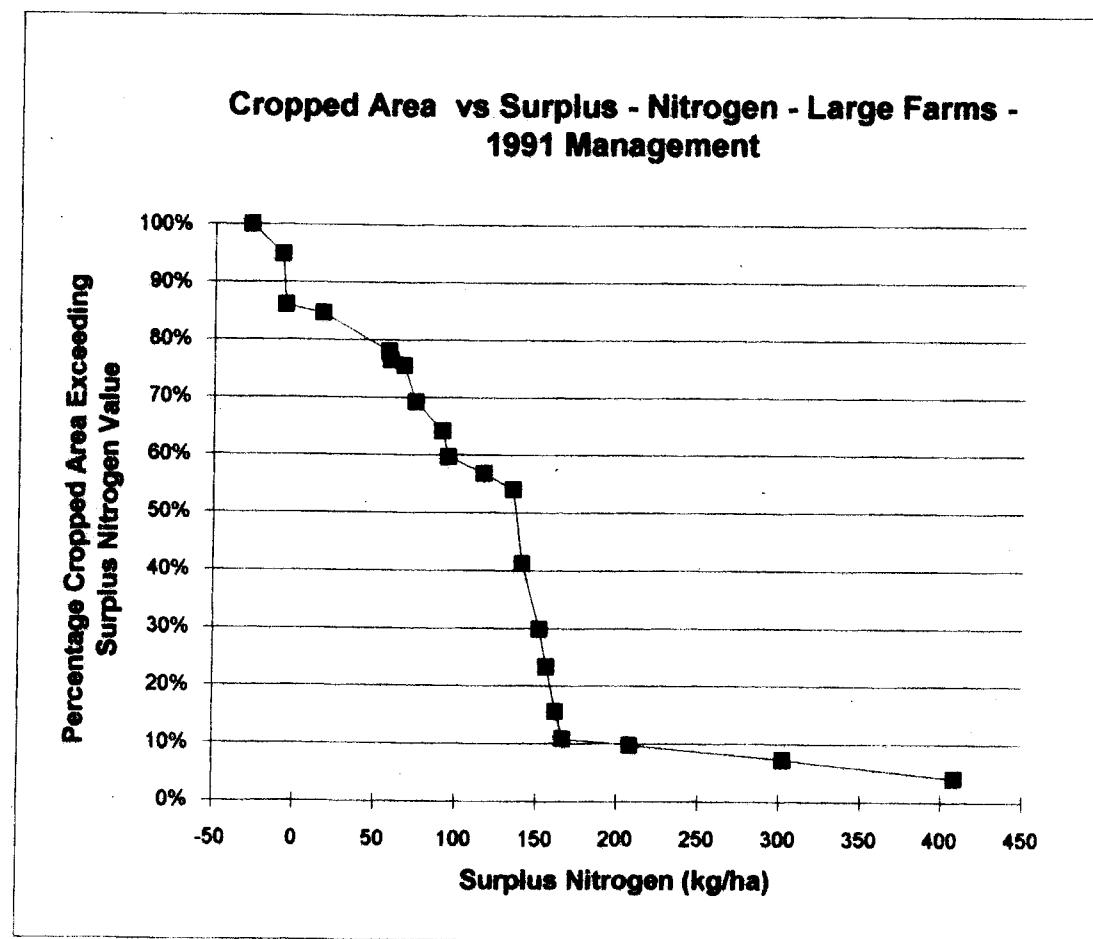


Figure 5.1.4

LOSSES TO THE ATMOSPHERE

(tonnes nitrogen per year)

(excluding denitrification in the soil)

Waste Management Zone	1991 management
West Richmond	17
East Richmond	154
West Delta	51
East Delta	112
North Surrey	615
South Surrey	143
South Langley	403
Central Langley	256
North Langley	379
West Matsqui	635
South Matsqui	1156
North Matsqui	549
Abbotsford	896
West Chilliwack	447
East Chilliwack	907
Agassiz	246
Nicomex	331
Mission	45
Maple Ridge	88
Pitt Meadows	160
Fraser Valley	7579

Large Farms plus Small Farms

1991 MANAGEMENT

Losses to the Atmosphere (tonnes N per year, total for large and small farms, by Waste Management Zone)

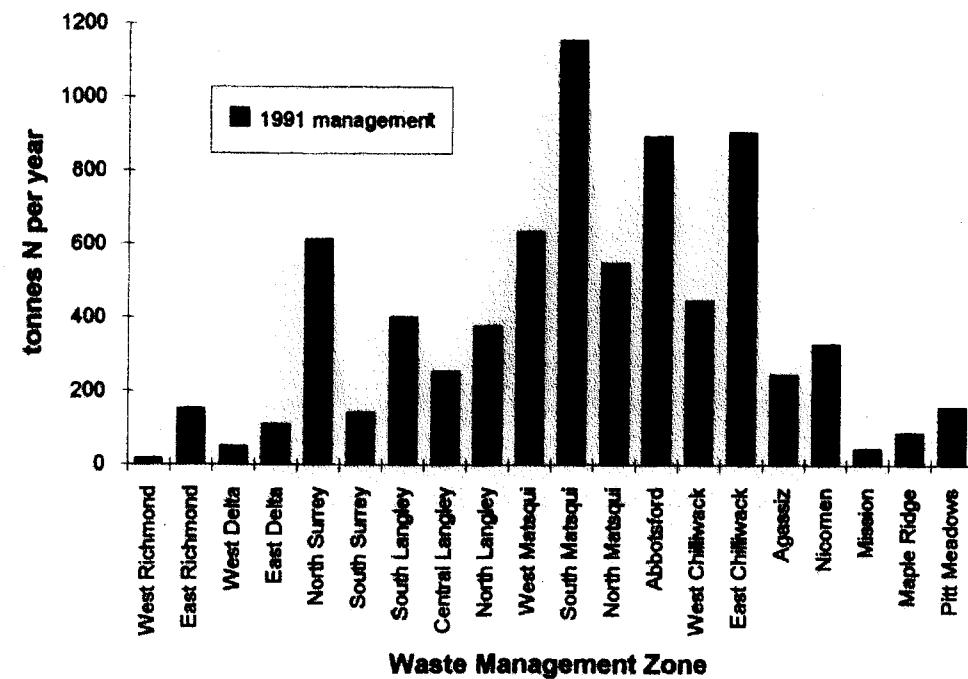


Figure 5.1.5

LOSSES TO THE ATMOSPHERE

(kg nitrogen per cropped hectare per year)
(excluding denitrification in the soil)

Waste Management Zone	1991 management
West Richmond	5
East Richmond	94
West Delta	17
East Delta	30
North Surrey	105
South Surrey	131
South Langley	129
Central Langley	81
North Langley	85
West Matsqui	189
South Matsqui	381
North Matsqui	127
Abbotsford	124
West Chilliwack	139
East Chilliwack	120
Agassiz	81
Nicomen	73
Mission	48
Maple Ridge	59
Pitt Meadows	30
Fraser Valley	103

Large Farms plus Small Farms 1991 MANAGEMENT

Losses to the Atmosphere (kg N per cropped hectare per year, average over large and small farms, by Waste Management Zone)

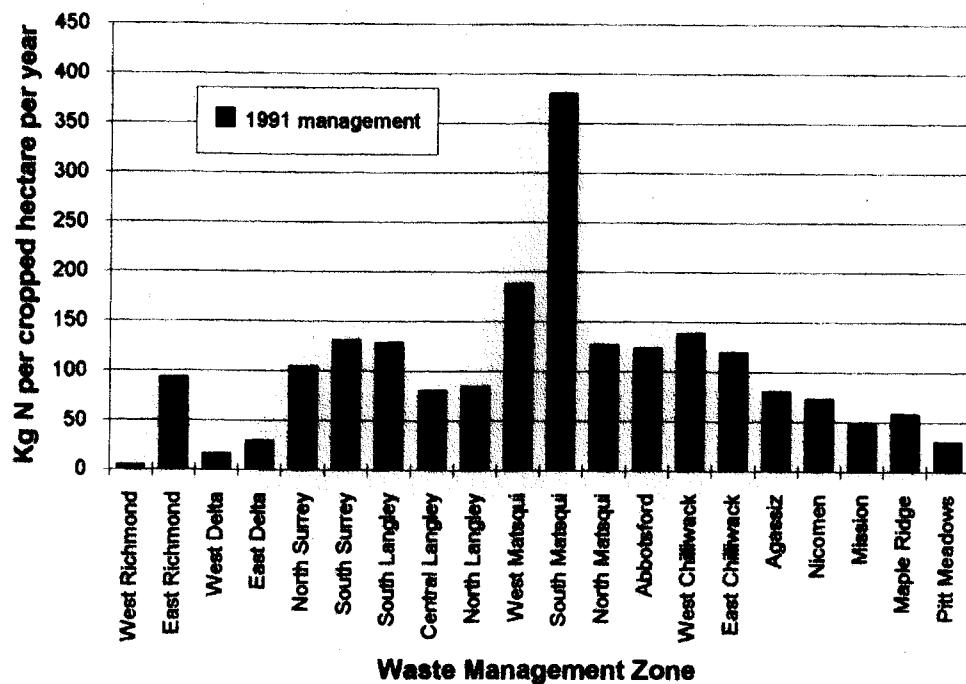


Figure 5.1.6

**LOSSES TO SURFACE WATER
NITROGEN**
Large Farms
1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	runoff during manure handling	losses of surplus to surface water	total losses to surface water
West Richmond	1	0	1
East Richmond	4	66	70
West Delta	1	0	1
East Delta	2	12	14
North Surrey	7	133	140
South Surrey	8	108	116
South Langley	9	114	123
Central Langley	6	82	88
North Langley	5	64	69
West Matsqui	12	227	239
South Matsqui	13	20	33
North Matsqui	7	106	113
Abbotsford	6	108	114
West Chilliwack	7	97	104
East Chilliwack	7	91	98
Agassiz	5	45	50
Nicomex	5	40	45
Mission	4	41	45
Maple Ridge	4	32	36
Pitt Meadows	2	0	2
Fraser Valley	6	76	82

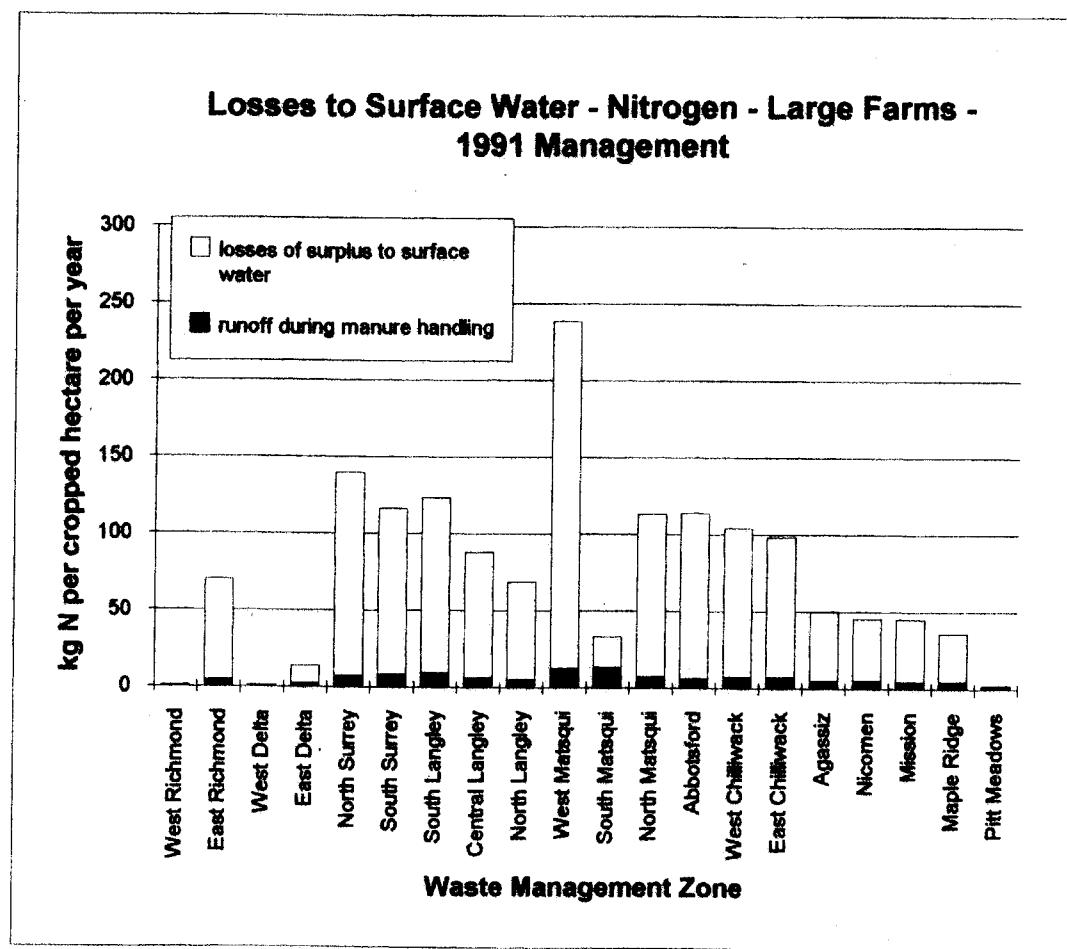


Figure 5.1.7

LOSSES TO GROUNDWATER

NITROGEN

(kg per cropped hectare per year)

ZONE	Infiltration during manure handling	losses of surplus to groundwater	total losses to groundwater
West Richmond	0	0	0
East Richmond	3	28	31
West Delta	0	0	0
East Delta	1	5	6
North Surrey	3	23	26
South Surrey	5	58	63
South Langley	6	94	100
Central Langley	3	35	38
North Langley	3	27	30
West Matsqui	8	76	84
South Matsqui	11	388	399
North Matsqui	3	46	49
Abbotsford	3	27	30
West Chilliwack	4	65	69
East Chilliwack	3	49	52
Agassiz	2	30	32
Nicomex	2	27	29
Mission	2	18	20
Maple Ridge	2	26	28
Pitt Meadows	1	0	1
Fraser Valley	3	41	44

Large Farms 1991 MANAGEMENT

Losses to Groundwater - Nitrogen - Large Farms - 1991 Management

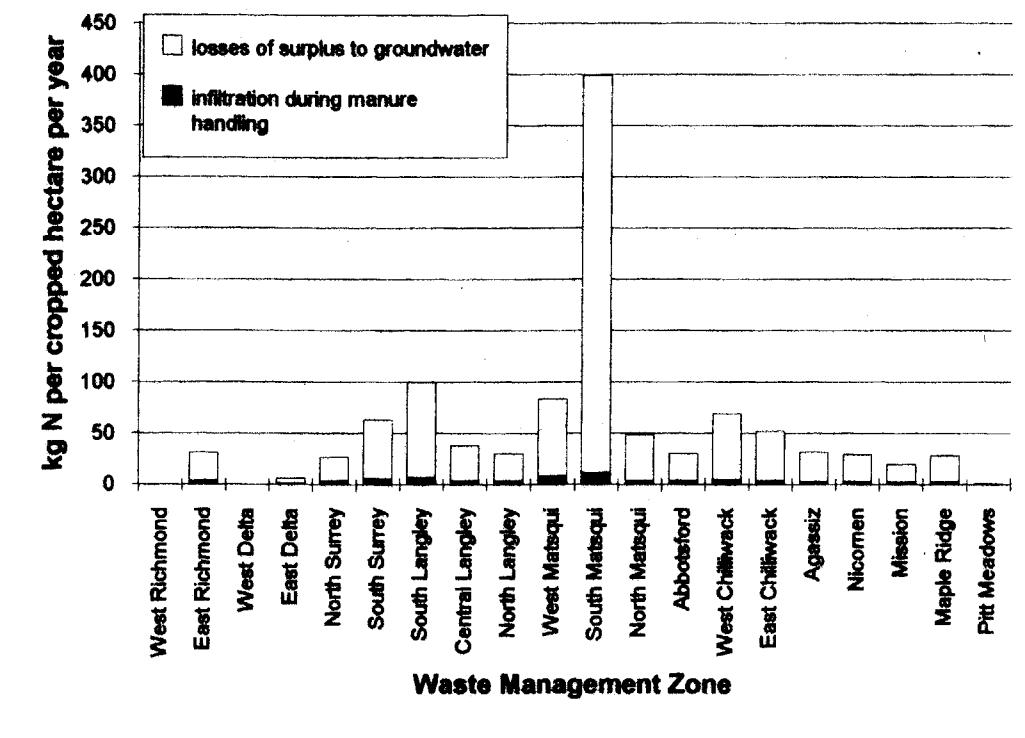


Figure 5.2.1

**SURPLUS
PHOSPHORUS**
Large Farms
1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus - 1991 management
West Richmond	23
East Richmond	74
West Delta	30
East Delta	30
North Surrey	111
South Surrey	120
South Langley	155
Central Langley	80
North Langley	73
West Matsqui	206
South Matsqui	270
North Matsqui	96
Abbotsford	82
West Chilliwack	113
East Chilliwack	97
Agassiz	61
Nicomex	55
Mission	45
Maple Ridge	50
Pitt Meadows	21
Fraser Valley	85

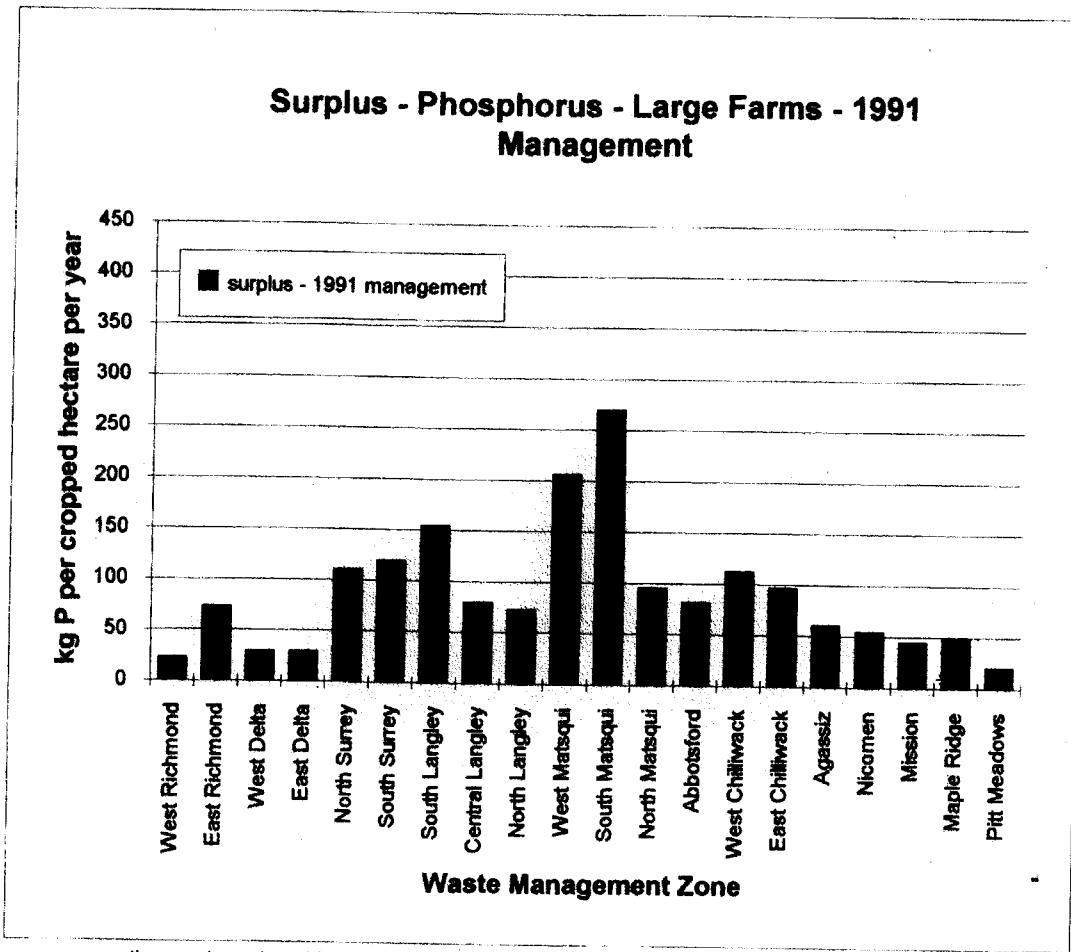


Figure 5.3.1

**SURPLUS
POTASSIUM**
Large Farms
1991 MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus - 1991 management
West Richmond	-2
East Richmond	82
West Delta	-31
East Delta	24
North Surrey	159
South Surrey	148
South Langley	213
Central Langley	122
North Langley	103
West Matsqui	274
South Matsqui	340
North Matsqui	175
Abbotsford	152
West Chilliwack	176
East Chilliwack	176
Agassiz	108
Nicomex	107
Mission	74
Maple Ridge	61
Pitt Meadows	17
Fraser Valley	126

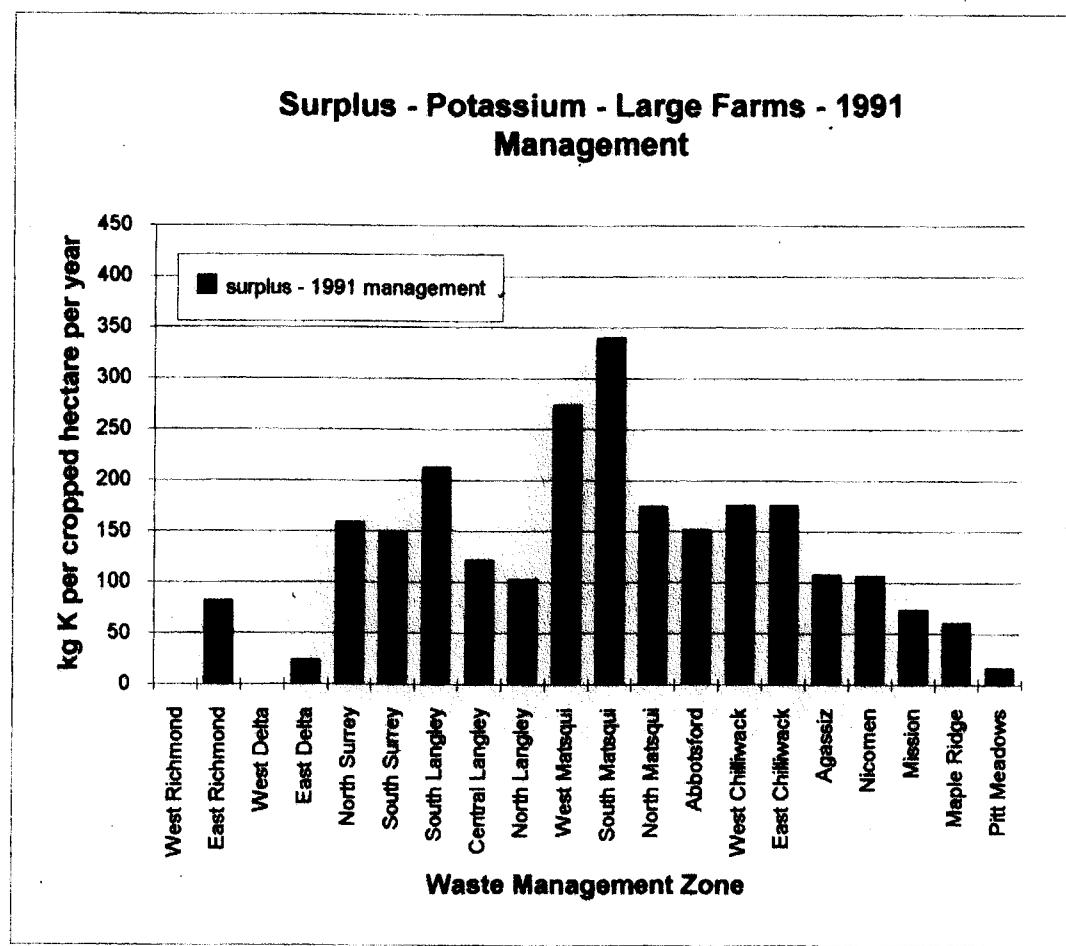


Table 5.4.1

Abbotsford **Sensitivity Analysis** **Large Farms**
Nitrogen

Variable	Losses to the Atmosphere				Losses to Surface Water				Groundwater				
	increase 10%		decrease 10%		increase 10%		decrease 10%		increase 10%		decrease 10%		
	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	tonnes	%	
Livestock Inventory	98	10%	-97	-10%	88	12%	-88	-12%	23	12%	-22	-11%	
Unit Nutrient Production	98	10%	-97	-10%	88	12%	-88	-12%	23	12%	-22	-11%	
Land Base					-12	-2%	12	2%	-3	-2%	3	2%	
Crop Removal					-110	-14%	110	14%	-28	-14%	28	14%	
Inorganic Fertilizer Use					92	12%	-92	-12%	23	12%	-23	-12%	
Housing Losses	Atmosphere	16	2%	-15	-2%	-8	-1%	9	1%	-2	-1%	3	1%
	Groundwater												
Export													
Storage Losses	Atmosphere	11	1%	-12	-1%	-6	-1%	7	1%	-1	-1%	2	1%
	Surface Water												
Yard Losses	Groundwater												
	Atmosphere												
	Surface Water												
Pasture Losses	Groundwater												
	Atmosphere												
	Surface Water												
Application Losses	Atmosphere	27	3%	-26	-3%	-15	-2%	15	2%	-4	-2%	4	2%
	Surface Water												
Background Atmospheric Input					5	1%	-5	-1%	1	1%	-1	-1%	
Atmospheric Return Flow					20	3%	-20	-3%	5	3%	-5	-3%	
Denitrification		15	2%	-15	-2%	-12	-2%	12	2%	-3	-1%	3	1%

Table 5.4.2

Abbotsford

Sensitivity Analysis

Large Farms

Table 5.4.3

South Matsqui

Sensitivity Analysis

Large Farms

Nitrogen

Table 5.4.4

South Matsqui

Sensitivity Analysis

Large Farms

Table 5.5.1

INPUT VARIABLES - EXTREME VALUE ANALYSIS

Input Variable		Minimum Impacts		Maximum Impacts	
		confidence limit	change factor by	confidence limit	change factor by
Livestock Inventory		-10%	0.90	10%	1.10
Unit Nutrient Production		-10%	0.90	10%	1.10
Land Base		10%	1.10	-10%	0.90
Crop Removal		10%	1.10	-10%	0.90
Inorganic Fertilizer Use		-25%	0.75	25%	1.25
Housing Losses	Losses to the Atmosphere	10%	1.10	-10%	0.90
	Losses to Groundwater	-50%	0.50	50%	1.50
Export		10%	1.10	-10%	0.90
Storage Losses	Losses to the Atmosphere	25%	1.25	-25%	0.75
	Losses to Surface Water	-50%	0.50	50%	1.50
	Losses to Groundwater	-25%	0.75	25%	1.25
Yard Losses	Losses to the Atmosphere	50%	1.50	-50%	0.50
	Losses to Surface Water	-50%	0.50	50%	1.50
	Losses to Groundwater	-50%	0.50	50%	1.50
Pasture Losses	Losses to the Atmosphere	50%	1.50	-50%	0.50
	Losses to Surface Water	-50%	0.50	50%	1.50
Application Losses	Losses to the Atmosphere	50%	1.50	-50%	0.50
	Losses to Surface Water	-50%	0.50	50%	1.50
Background Atmospheric Input		-25%	0.75	25%	1.25
Atmospheric Return Flow		-50%	0.50	50%	1.50
Denitrification		50%	1.50	-50%	0.50

Table 5.5.2

Extreme Value Analysis

		Large Farms 1991 MANAGEMENT Nitrogen (tonnes)																	
		manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus less denitrification	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
Abbotsford		1892	36	826	40	17	973	1383	1154	-229	309	1053	146	972	907	726	766	181	198
	minimum change	1533	31	845	16	10	631	1673	952	-721	177	87	142	987	-55	0	16	0	10
	maximum change	2290	40	713	75	28	1434	1120	1299	179	391	2003	108	821	1895	1516	1591	379	407
South Matsqui		2070	217	1128	28	23	674	229	197	-32	263	905	34	1162	871	44	72	828	851
	minimum change	1677	189	1053	10	13	412	277	162	-115	133	431	31	1084	400	20	30	380	393
	maximum change	2505	243	1113	58	38	1053	185	221	36	371	1461	26	1139	1435	72	130	1363	1401

Table 5.5.3

Extreme Value Analysis

	Large Farms 1991 MANAGEMENT Phosphorus (tonnes)										Large Farms Potassium (tonnes)									
	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)		
Abbotsford	587	17	9	7	554	212	208	-4	550	1425	21	60	16	1327	775	463	-311	1016		
minimum change	475	15	4	4	452	257	172	-85	367	1154	19	26	10	1100	937	382	-555	545		
maximum change	710	18	16	11	665	172	234	62	727	1724	23	107	25	1569	627	521	-106	1463		
South Matsqui	674	100	9	11	555	51	73	21	576	894	129	35	14	716	158	169	10	727		
minimum change	546	89	4	6	447	62	60	-2	445	724	115	14	8	587	192	139	-52	535		
maximum change	816	109	16	17	674	42	82	40	714	1082	140	64	22	856	128	190	62	917		

6.0 IMPROVED NUTRIENT MANAGEMENT PRACTICES

Three nutrient management improvement scenarios were considered; reduced applications of inorganic fertilizers, improved manure handling (increased storage capacity and better timing of manure application) and improved feeding strategies (to reduce the unit nutrient production from livestock and poultry).

6.1 Reduced Fertilizer Applications

An obvious and relatively cost effective way to improve nutrient management within LFV agriculture would be to give a proper accounting to the nutrient value of manure and reduce the use of inorganic fertilizers.

In order to estimate the realistic improvements to nutrient loading which might result from using less inorganic fertilizer, unit inorganic fertilizer application rate assumptions in the model were reduced, for most crops, to 30% of crop removal estimates. Unit application rates were not reduced when there was an agronomic justification for using no manure. These improved rates are presented in Table 3.2.2 (crops for which no change was made are noted at the bottom of this table).

It was felt that complete elimination of inorganic fertilizer use was neither attainable nor desirable and a consensus was reached that a rate of 30% of crop removal rates, with the remainder of the nutrients provided by manure, would be the maximum which could be realistically achieved while maintaining or enhancing current levels of crop productivity.

The attraction of this improvement scenario is the fact that some of the costs of implementation will be returned directly to producers in the way of reduced inorganic fertilizer costs. The savings in inorganic fertilizer costs between the original assumptions and the improved rates would be about \$12 million per year using 1991 fertilizer costs.

6.2 Improved Manure Handling

A second improvement scenario considered improved manure management. Factors in the model were changed to reflect management practices which would be in compliance with the Code of Agricultural Practice with respect to manure storage and timing of manure application, but not to reflect compliance with respect to an adequate land base for application of manure.

For this set of improvements it was assumed that there were no losses to either surface or groundwater during housing or storage (loss factors for land application remained the same) and that sufficient storage capacity would be available so that manure application timing would allow for an optimal utilization of manure nutrients. The optimal timing of manure application was taken as that developed by Orlando Schmidt for dairy operations (Schmidt, 1993) as discussed in Section 4.1.

The revised management system factors (model TABLE 4) and loss factors (model TABLES 7 TO 10) used to represent "improved manure handling" are contained in Appendix D.

6.3 Improved Feeding Strategies

Large amounts of nutrients are imported onto many LFV farms as animal feeds and supplements. Feeding strategies can be changed to reduce unit livestock nutrient production rates. It should be noted that this study made no effort to consider the economic feasibility of any of the improved feeding strategies discussed below.

For poultry and hogs current efforts on improving feeding strategies involve achieving a better balance between the required amino acids in the rations and in feeding the appropriate ration for the age and type of animal (Paul, per. com.; Jacob, 1995).

To ensure that feed rations provide sufficient amounts of all essential amino acids formulation of the rations often reflect the need for the most limiting amino acid. This usually results in the other essential amino acids being fed in excess.

The use of synthetic amino acids allows a more balanced formulation of feed rations where sufficient amounts of all the essential amino acids are still available but with a lower total intake of protein and a resultant reduction in the amount of nitrogen and/or phosphorus being excreted.

Within each species of livestock there are significant differences in nutritional needs which are dependent on the type (growing pig vs. breeding sow) physiological state (pregnant vs. lactating sow) and growth phase. "Phase feeding" can also reduce nutrient excretion by better matching rations to the needs of the particular type, state and growth phase of the animals.

Nutrient uptake efficiency can be improved by the use of supplemental feed enzymes which improve the digestibility of the protein in feed rations.

For dairy cattle improved feeding strategies involve achieving a better balance between energy and protein so that nitrogen and phosphorus are used more efficiently (Paul, per. com.). The rumen of cattle digest food to sub-amino acid molecules so there is no advantage in attempting to balance amino acids in the ration.

The reductions in unit livestock nutrient production assumed for the improved feed ration scenario are presented in Table 6.3.1. Reductions of 25% of the amount of nitrogen excreted was assumed to be attainable for dairy, poultry and swine and a 30% reduction in excreted phosphorus attainable for poultry and swine.

No changes were made to unit livestock nutrient production for other livestock categories. As well no changes to the amount of potassium excreted were modeled although there is a large amount of potassium imported onto dairy farms in the form of feed concentrates (Schmidt, 1994) and an improved potassium balance can be achieved by changing feeding rations.

The majority of the reduced nitrogen production will be in the form of urea, which readily changes to ammonia. Therefore there would be a reduction in the amount of ammonia which would volatilize from livestock and poultry housing systems.

It was felt that the breakdown of organic forms of nitrogen to ammonia would occur quickly enough to compensate for the reduced ammonia (urea) generation and that percentage losses to volatilization in storage systems would not be changed. The reductions in housing system volatilization losses are presented in model TABLE 7, Appendix E.

The projected impacts of the nutrient management improvement scenarios are discussed in the following Chapters.

Table 6.3.1

UNIT LIVESTOCK NUTRIENT PRODUCTION - IMPROVED FEEDING STRATEGIES

LIVESTOCK CATEGORY		unit nutrient production			unit nutrient production			change		
		1991 management (kg/animal/year)			improved feed ratios (kg/animal/year)					
		N	P	K	N	P	K	N	P	K
Dairy	bulls	112.0	20.1	76.4	84.0	20.1	76.4	-25%	0%	0%
	cows	116.0	13.1	97.1	87.0	13.1	97.1	-25%	0%	0%
	heifers	42.0	47.2	37.4	31.5	47.2	37.4	-25%	0%	0%
	calves	20.0	21.9	14.9	15.0	21.9	14.9	-25%	0%	0%
	milking centre *	1.7	1.0	2.4	1.7	1.0	2.4	0%	0%	0%
Poultry (meat)	chickens (1000's)	0.60	0.23	0.28	0.45	0.16	0.28	-25%	-30%	0%
	turkeys (1000's)	0.86	0.27	0.43	0.65	0.19	0.43	-25%	-30%	0%
	other (1000's)	0.60	0.23	0.28	0.45	0.16	0.28	-25%	-30%	0%
Poultry (layers)	pullets (1000's)	0.34	0.10	0.12	0.26	0.07	0.12	-25%	-30%	0%
	layers (1000's)	0.80	0.23	0.28	0.60	0.16	0.28	-25%	-30%	0%
Swine	boars	24.3	7.5	9.5	18.2	5.3	9.5	-25%	-30%	0%
	sows	18.3	5.6	7.1	13.7	3.9	7.1	-25%	-30%	0%
	other	7.2	2.4	4.6	5.4	1.7	4.6	-25%	-30%	0%
Beef	bulls	112.0	20.1	76.4	112.0	20.1	76.4	0%	0%	0%
	cows	78.0	13.5	39.8	78.0	13.5	39.8	0%	0%	0%
	heifers	44.0	14.4	33.2	44.0	14.4	33.2	0%	0%	0%
	steers	50.0	16.2	36.5	50.0	16.2	36.5	0%	0%	0%
	calves	20.0	21.9	14.9	20.0	21.9	14.9	0%	0%	0%
Horses		45.5	7.6	28.4	45.5	7.6	28.4	0%	0%	0%
Sheep	rams	11.0	1.6	8.0	11.0	1.6	8.0	0%	0%	0%
	ewes	11.0	1.6	8.0	11.0	1.6	8.0	0%	0%	0%
	lambs	4.4	0.6	3.2	4.4	0.6	3.2	0%	0%	0%
Goats		11.0	1.6	8.0	11.0	1.6	8.0	0%	0%	0%

* per milking cow

7.0 IMPACTS OF REDUCED FERTILIZER APPLICATIONS AND IMPROVED MANURE HANDLING

A second set of model runs were made utilizing the assumptions for reduced inorganic fertilizer application and improved manure handling. The results of these model runs are summarized in Tables 7.0.1 to 7.0.4.

7.1 Nitrogen

The large farm surpluses of nitrogen, with reduced fertilizer applications and improved manure handling, for each of the twenty AWMZs are shown in Figure 7.1.1. This figure also shows the estimated surplus less atmospheric input for each zone.

Estimated surpluses range from 407 (South Matsqui) to -55 (Pitt Meadows) kg/ha with an average over the study area of 46 kg N/ha. If atmospheric input is ignored the range becomes 296 (South Matsqui) to -73 (Pitt Meadows) with a LFV average of 8 kg N/ha.

Compared to the estimates for current management practices, reducing inorganic fertilizer use and improving manure handling reduced the LFV average surplus by 60%, from 115 kg N/ha to 46 kg N/ha. However, for the South Matsqui AWMZ the reduction in surplus nitrogen was negligible. The increase in applied manure nutrients, resulting from lower handling and application losses, essentially canceled the reduction in applied inorganic fertilizer nutrients. A 78% decrease in surplus occurred in the Abbotsford AWMZ (from 135 kg N/ha to 30 kg N/ha).

The impact of these management scenarios is presented in Figure 7.1.2. This graph shows the percentage of the total Fraser Valley cropped area which lies within zones where the average surplus was calculated to be in excess of a particular surplus value.

With these nutrient management improvements in place the estimated surplus exceeded 200 kg N/ha in 2 AWMZs (7% of the cropped area), was 100 kg N/ha or greater in another 3 AWMZs (12% of the cropped area) and greater than 50 kg N/ha in another 4 AWMZs (25% of the cropped area). The reduction in cropped area represented by AWMZs with a surplus of 100 kg N/ha or greater, as compared to the 1991 management situation, amounted to 38% of the total cropped area. The cropped area represented by AWMZs with a surplus of 50 kg N/ha was reduced by 34% of the total cropped area.

7.1.1 Losses to the Atmosphere

Losses of nitrogen to the atmosphere (excluding denitrification losses) estimated with this nutrient management improvement scenario are shown in Figures 7.1.3 (as tonnes N per year) and 7.1.4 (as kg N/cropped hectare). These figures include losses from both large and small farms.

Estimates of losses to the atmosphere (excluding denitrification) for the LFV were reduced by 314 tonnes, or 4%.

7.1.2 Losses to Surface Water

Figure 7.1.5 summarizes the estimated losses to surface water when inorganic fertilizer use is decreased and manure handling improved. LFV average losses of nitrogen to surface water are estimated to be reduced by 43 kg N/ha (52%).

Figure 7.1.6 presents estimates of that portion of nitrogen losses to surface water which occur during manure handling and land application (nitrogen primarily as ammonia). LFV average values for this nutrient pathway were reduced by 50%, from 6 to 3 kg N/ha.

7.1.3 Losses to Groundwater

Estimated losses to groundwater are shown in Figure 7.1.7. Average losses over the entire LFV to groundwater decreased by 45%, or 20 kg N/ha, from 44 to 24 kg N/ha, however the calculated losses to groundwater from the South Matsqui zone decreased by only about 3%, from 399 to 386 kg N/ha/yr.

7.2 Phosphorus

Figures 7.2.1 and 7.2.2 present estimates of surplus phosphorus, as kg P/ha in the former and as a ratio to estimated crop removal in the second. The estimated average applied surplus of phosphorus for the LFV decreased by 16 kg P/ha, or 19%.

However, even with these improvements to nutrient management it appears that on average phosphorus applications would still be well in excess of crop removal. The management improvements modeled here would decrease the ratio of applied surplus to crop removal from 2.9 to only 2.4.

7.3 Potassium

Estimates for surplus potassium are presented in a similar fashion in Figures 7.3.1 and 7.3.2.

Potassium surpluses, averaged over the entire LFV, decreased by 11% (14 kg K/ha), from 126 to 112 kg K/ha. Expressed as a ratio to estimated crop removal, surplus potassium decreased from 1.2 times the crop removal to 1.0 times.

Table 7.0.1

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - Improved Fertilization and Manure Handling Nitrogen (kg / cropped ha)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	731	19	750	41	0	17	1	0	24	116	76	-41	10	-6	4	21	-10	0	1	0	0
East Richmond	1483	202	1685	204	0	90	2	0	112	112	52	-59	32	84	17	107	67	47	49	20	20
West Delta	2684	189	2873	41	0	16	1	0	24	160	108	-52	14	-13	4	20	-17	0	1	0	0
East Delta	3465	399	3864	74	0	31	1	0	42	170	68	-102	18	-42	6	37	-48	0	1	0	0
North Surrey	4039	550	4589	370	40	133	5	0	192	186	73	-113	39	119	19	152	100	85	90	15	15
South Surrey	593	118	711	490	73	186	5	0	226	221	63	-159	43	111	11	197	100	65	70	35	35
South Langley	1302	280	1582	614	103	230	6	0	275	181	49	-132	44	187	14	244	173	95	101	78	78
Central Langley	1470	236	1706	327	38	129	4	0	157	200	63	-137	32	52	8	137	44	31	35	13	13
North Langley	2336	472	2808	283	28	120	3	0	132	179	54	-125	33	40	13	133	27	19	22	8	8
West Matsqui	1623	398	2021	813	151	314	7	0	340	182	57	-125	61	277	17	331	260	195	202	65	65
South Matsqui	2136	718	2854	969	102	473	8	0	386	107	36	-71	111	426	19	492	407	20	28	386	386
North Matsqui	3416	259	3675	357	20	151	4	0	183	213	67	-147	47	83	27	178	56	39	43	17	17
Abbotsford	6687	345	7032	233	5	124	3	0	150	207	63	-144	46	52	23	147	30	24	27	6	6
West Chilliwack	2455	229	2684	348	0	154	4	0	190	193	60	-134	47	103	29	183	75	45	49	30	30
East Chilliwack	5867	432	6299	322	0	141	4	0	177	205	61	-144	44	77	27	168	50	33	37	18	18
Agassiz	2622	237	2859	213	0	91	3	0	120	229	66	-163	34	-9	18	109	-27	0	3	0	0
Nicomex	3305	369	3674	215	0	92	3	0	121	242	70	-172	31	-20	18	110	-38	0	3	0	0
Mission	472	73	545	166	0	69	2	0	94	211	62	-149	24	-31	9	78	-40	0	2	0	0
Maple Ridge	795	163	958	185	0	71	3	0	112	184	52	-132	24	4	11	82	-7	0	3	0	0
Pitt Meadows	4571	185	4756	84	0	33	1	0	50	153	39	-114	18	-47	8	41	-55	0	1	0	0
Fraser Valley	52031	5875	57906	299	20	126	3	0	149	187	63	-125	38	63	17	143	46	31	34	28	28

Table 7.0.2

NUTRIENT PATHWAY SUMMARY

	Large Farms (hectares)			Large Farms - Improved Fertilization and Manure Handling										Potassium (kg / cropped ha)																	
				Phosphorus (kg / cropped ha)					Crop requirement					Applied fertilizer less crop removal		Manure produced			Manure exported		Net manure application			Crop requirement		Applied fertilizer less crop removal					
Waste Management Zone	Cropped area	Non-cropped area	Total agricultural land base	Manure produced	Manure exported	Losses - runoff	Losses - infiltration	Net manure application	Fertilizer applied	Applied Surplus (deficit)	Manure produced	Manure exported	Losses - runoff	Losses - infiltration	Net manure application	Fertilizer applied	Applied Surplus (deficit)	Manure produced	Manure exported	Losses - runoff	Losses - infiltration	Net manure application	Fertilizer applied	Applied Surplus (deficit)	Manure produced	Manure exported	Losses - runoff	Losses - infiltration	Net manure application	Fertilizer applied	Applied Surplus (deficit)
West Richmond	731	19	750	9	0	0	0	9	25	18	-7	1	33	0	1	0	32	108	84	-23	9	0	32	108	84	-23	9				
East Richmond	1483	202	1685	71	0	1	0	71	20	11	-9	62	111	0	3	0	109	72	43	-29	80	0	0	109	72	43	-29	80			
West Delta	2684	189	2873	11	0	0	0	11	36	24	-12	-1	30	0	1	0	29	171	135	-36	-7	0	0	29	171	135	-36	-7			
East Delta	3465	399	3864	22	0	0	0	22	31	13	-18	4	61	0	2	0	60	118	59	-58	1	0	0	60	118	59	-58	1			
North Surrey	4039	550	4589	127	19	1	0	107	32	14	-18	89	244	23	6	0	214	127	61	-66	148	0	0	214	127	61	-66	148			
South Surrey	593	118	711	165	33	1	0	131	29	8	-21	110	259	44	6	0	210	104	30	-74	136	0	0	210	104	30	-74	136			
South Langley	1302	280	1582	215	48	1	0	166	24	7	-17	149	334	61	7	0	266	81	24	-57	209	0	0	266	81	24	-57	209			
Central Langley	1470	236	1706	105	18	1	0	86	27	9	-18	68	204	22	5	0	177	101	37	-64	113	0	0	177	101	37	-64	113			
North Langley	2336	472	2808	92	13	1	0	78	25	8	-17	62	168	16	4	0	148	89	30	-59	89	0	0	148	89	30	-59	89			
West Matsqui	1623	398	2021	288	72	2	0	214	27	10	-17	196	424	88	8	0	328	94	33	-61	267	0	0	328	94	33	-61	267			
South Matsqui	2136	718	2854	316	47	2	0	267	24	9	-15	252	419	60	9	0	349	74	28	-46	303	0	0	349	74	28	-46	303			
North Matsqui	3416	259	3675	110	9	1	0	100	30	10	-20	80	251	12	6	0	234	115	38	-76	158	0	0	234	115	38	-76	158			
Abbotsford	6687	345	7032	88	3	1	0	85	32	10	-22	63	213	3	5	0	205	116	36	-80	125	0	0	205	116	36	-80	125			
West Chilliwack	2455	229	2684	115	0	1	0	114	31	10	-21	92	231	0	6	0	225	114	37	-77	148	0	0	225	114	37	-77	148			
East Chilliwack	5867	432	6299	102	0	1	0	101	29	9	-20	81	244	0	6	0	238	115	36	-79	159	0	0	238	115	36	-79	159			
Agassiz	2622	237	2859	70	0	1	1	69	30	9	-21	48	175	0	4	0	170	110	32	-78	92	0	0	170	110	32	-78	92			
Nicomen	3305	369	3674	66	0	1	0	65	31	9	-22	44	172	0	4	0	167	106	31	-75	92	0	0	167	106	31	-75	92			
Mission	472	73	545	50	0	0	0	50	29	9	-20	30	133	0	3	0	129	109	33	-76	54	0	0	129	109	33	-76	54			
Maple Ridge	795	163	958	59	0	1	0	58	24	8	-16	42	117	0	3	0	114	86	28	-58	56	0	0	114	86	28	-58	56			
Pitt Meadows	4571	185	4756	27	0	0	0	27	20	6	-14	13	64	0	2	0	62	73	24	-49	13	0	0	62	73	24	-49	13			
Fraser Valley	52031	5875	57906	97	9	1	0	87	29	11	-18	69	194	12	5	0	177	108	43	-65	112	0	0	177	108	43	-65	112			

Table 7.0.3

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - Improved Fertilization and Manure Handling Nitrogen (tonnes)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	731	19	750	30	0	12	0	0	17	85	55	-30	8	-5	3	15	-8	0	0	0	0
East Richmond	1483	202	1685	303	0	133	4	0	166	165	77	-88	47	125	25	158	100	70	74	30	30
West Delta	2684	189	2873	110	0	43	2	0	65	428	290	-139	38	-35	10	53	-45	0	2	0	0
East Delta	3465	399	3864	257	0	109	3	0	144	589	237	-352	63	-145	22	131	-167	0	3	0	0
North Surrey	4039	550	4589	1496	161	539	19	0	777	750	294	-456	159	479	78	617	401	341	360	60	60
South Surrey	593	118	711	291	44	110	3	0	134	131	37	-94	26	66	7	117	59	39	42	21	21
South Langley	1302	280	1582	799	134	300	8	0	358	236	64	-172	58	243	18	318	225	124	132	101	101
Central Langley	1470	236	1706	481	55	190	5	0	231	295	93	-202	47	76	12	202	64	45	50	19	19
North Langley	2336	472	2808	661	65	281	7	0	309	419	127	-292	77	94	31	312	63	44	51	19	19
West Matsqui	1623	398	2021	1320	245	510	12	0	552	295	92	-202	99	449	28	538	421	316	328	105	105
South Matsqui	2136	718	2854	2070	217	1010	18	0	825	229	78	-151	236	910	41	1051	869	43	61	825	825
North Matsqui	3416	259	3675	1219	67	514	14	0	624	729	228	-501	160	283	94	608	189	133	147	57	57
Abbotsford	6687	345	7032	1892	36	830	22	0	1005	1383	420	-963	309	350	151	981	199	159	181	40	40
West Chilliwack	2455	229	2684	855	0	378	10	0	467	474	146	-328	115	254	70	448	184	110	120	74	74
East Chilliwack	5867	432	6299	1886	0	827	23	0	1036	1203	360	-843	260	454	155	982	299	194	217	105	105
Agassiz	2622	237	2859	558	0	238	7	0	314	600	173	-427	88	-25	47	285	-72	0	7	0	0
Nicomex	3305	369	3674	711	0	303	9	0	399	799	231	-569	103	-67	60	363	-127	0	9	0	0
Mission	472	73	545	78	0	33	1	0	45	100	29	-70	11	-15	5	38	-20	0	1	0	0
Maple Ridge	795	163	958	147	0	57	2	0	89	147	42	-105	19	3	9	66	-6	0	2	0	0
Pitt Meadows	4571	185	4756	384	0	152	6	0	227	700	178	-523	83	-213	34	186	-247	0	6	0	0
Fraser Valley	52031	5875	57906	15548	1053	6562	172	0	7761	9754	3253	-6502	1999	3258	897	7466	2384	1619	1794	1456	1456

Table 7.0.4

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - Improved Fertilization and Manure Handling																	
				Phosphorus (tonnes)						Potassium (tonnes)											
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)
West Richmond	731	19	750	6	0	0	0	6	19	13	-5	1	24	0	1	0	23	79	62	-17	6
East Richmond	1483	202	1685	106	0	1	0	105	29	17	-13	92	165	0	4	0	161	107	64	-42	119
West Delta	2684	189	2873	30	0	0	0	30	97	65	-32	-2	81	0	2	0	78	458	361	-97	-19
East Delta	3465	399	3864	78	0	1	0	77	109	47	-62	15	212	0	5	0	207	408	206	-202	4
North Surrey	4039	550	4589	513	77	4	0	432	128	56	-72	360	985	94	26	0	865	515	248	-267	598
South Surrey	593	118	711	98	20	1	0	78	17	5	-12	65	154	26	3	0	124	62	18	-44	81
South Langley	1302	280	1582	280	62	2	0	216	31	9	-22	194	434	79	9	0	346	105	31	-74	272
Central Langley	1470	236	1706	154	26	1	0	126	40	14	-27	100	299	32	7	0	260	149	55	-94	166
North Langley	2336	472	2808	215	31	2	0	182	58	19	-39	144	393	38	9	0	346	207	70	-137	208
West Matsqui	1623	398	2021	467	117	3	0	347	43	16	-28	319	689	143	14	0	532	152	53	-99	433
South Matsqui	2136	718	2854	674	100	5	0	569	51	19	-32	537	894	129	19	0	746	158	59	-99	647
North Matsqui	3416	259	3675	376	32	3	0	341	104	36	-68	273	858	39	20	0	798	391	131	-260	538
Abbotsford	6687	345	7032	587	17	5	0	565	212	66	-146	419	1425	21	34	0	1370	775	242	-533	837
West Chilliwack	2455	229	2684	281	0	2	0	279	77	25	-52	227	567	0	14	0	553	279	90	-189	364
East Chilliwack	5867	432	6299	599	0	5	0	594	170	54	-117	478	1429	0	35	0	1395	673	210	-463	932
Agassiz	2622	237	2859	183	0	2	0	182	78	22	-55	127	458	0	11	0	447	289	84	-205	242
Nicomex	3305	369	3674	218	0	2	0	216	101	29	-72	145	567	0	14	0	554	350	102	-248	305
Mission	472	73	545	24	0	0	0	24	13	4	-9	14	63	0	2	0	61	51	16	-36	25
Maple Ridge	795	163	958	47	0	0	0	46	19	6	-13	33	93	0	3	0	91	68	22	-46	44
Pitt Meadows	4571	185	4756	125	0	1	0	124	94	29	-64	60	292	0	8	0	284	335	110	-225	59
Fraser Valley	52031	5875	57906	5061	494	39	0	4528	1489	550	-939	3589	10082	619	239	0	9224	5606	2235	-3371	5853

Table 7.1.1

**SURPLUS
NITROGEN**

(kg per cropped hectare per year)

ZONE	surplus less atmospheric input	surplus	atmospheric input
West Richmond	-20	-10	10
East Richmond	35	67	32
West Delta	-31	-17	14
East Delta	-66	-48	18
North Surrey	61	100	39
South Surrey	57	100	43
South Langley	129	173	44
Central Langley	12	44	32
North Langley	-6	27	33
West Matsqui	199	260	61
South Matsqui	296	407	111
North Matsqui	9	56	47
Abbotsford	-17	30	46
West Chilliwack	28	75	47
East Chilliwack	6	50	44
Agassiz	-61	-27	34
Nicomex	-69	-38	31
Mission	-64	-40	24
Maple Ridge	-31	-7	24
Pitt Meadows	-73	-55	18
Fraser Valley	8	46	38

Large Farms

IMPROVED FERTILIZATION AND MANURE HANDLING

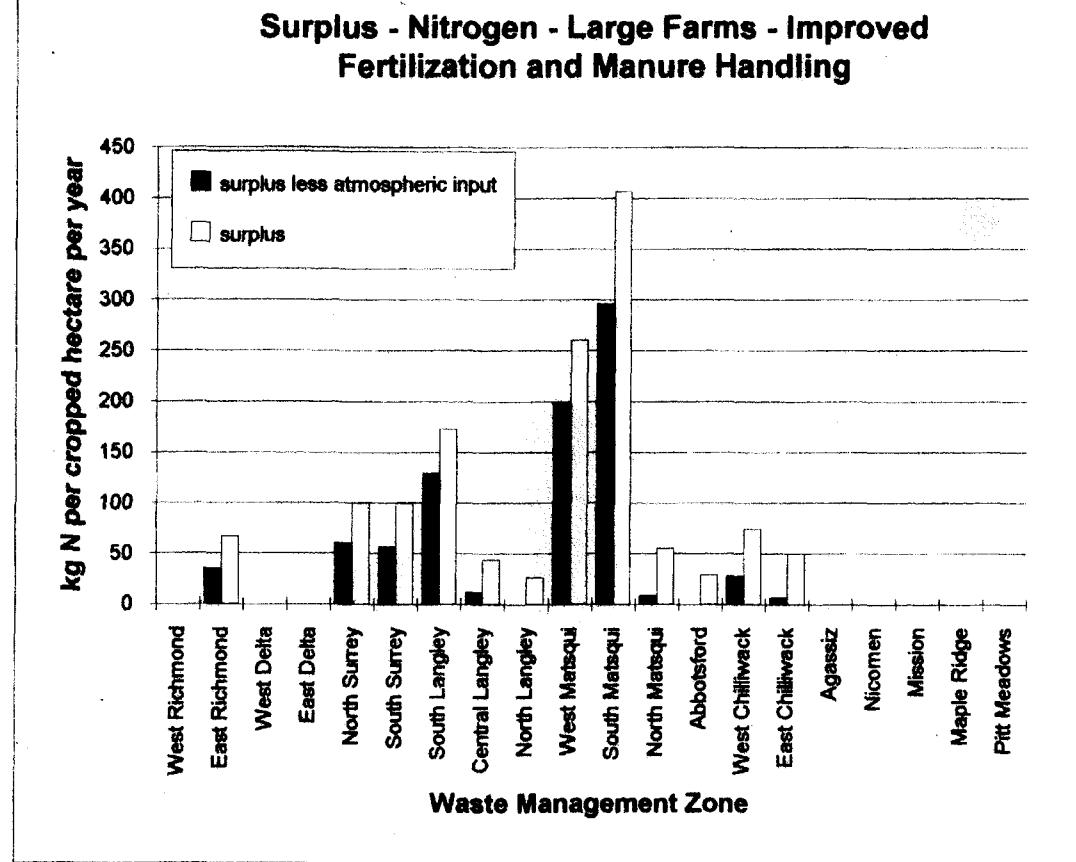


Figure 7.1.2

**LAND BASE
vs SURPLUS NITROGEN**
(kg per cropped hectare per year)

surplus nitrogen	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed rations
-100	100%	100%	100%
-50	100%	91%	77%
0	85%	64%	51%
50	78%	44%	19%
100	57%	19%	10%
150	30%	10%	7%
200	10%	7%	4%
250	7%	7%	4%
300	7%	4%	4%
350	4%	4%	0%
400	4%	4%	0%
450	0%	0%	0%

Large Farms
IMPROVED MANAGEMENT

Cropped Area vs Surplus - Nitrogen - Large Farms - Improved Management

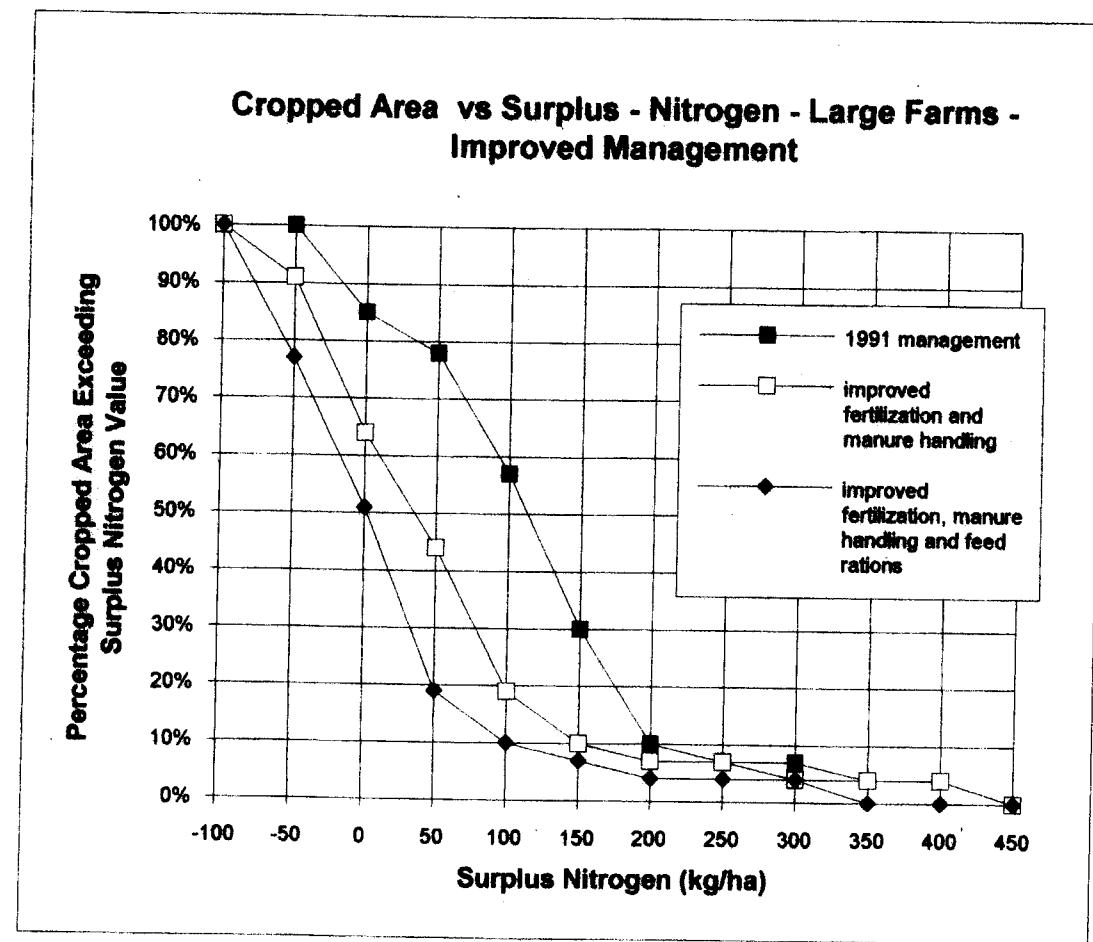


Figure 7.1.3

LOSSES TO THE ATMOSPHERE

(tonnes nitrogen per year)

(excluding denitrification in the soil)

Large Farms plus Small Farms

IMPROVED FERTILIZATION, MANURE HANDLING AND FEED RATIOS

Waste Management Zone	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed ratios
West Richmond	17	17	15
East Richmond	154	135	97
West Delta	51	52	45
East Delta	112	115	87
North Surrey	615	589	484
South Surrey	143	127	95
South Langley	403	369	281
Central Langley	256	246	195
North Langley	379	360	282
West Matsqui	635	579	424
South Matsqui	1156	1038	729
North Matsqui	549	543	398
Abbotsford	896	900	667
West Chilliwack	447	424	316
East Chilliwack	907	902	672
Agassiz	246	251	188
Nicomex	331	335	254
Mission	45	46	38
Maple Ridge	88	82	70
Pitt Meadows	160	163	136
Fraser Valley	7579	7265	5465

Losses to the Atmosphere (tonnes N per year, total for large and small farms, by Waste Management Zone)

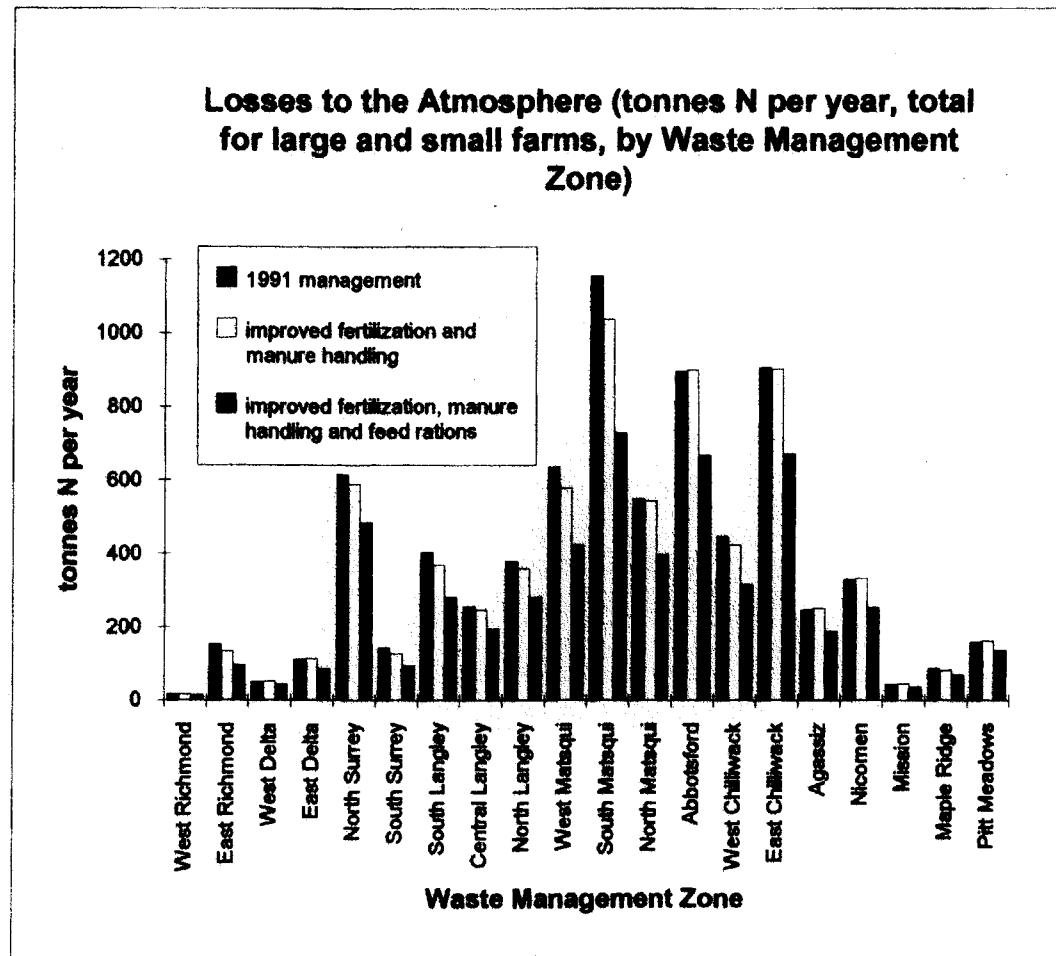


Figure 7.1.4

LOSSES TO THE ATMOSPHERE

(kg nitrogen per cropped hectare per year)
(excluding denitrification in the soil)

Waste Management Zone	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed ratios
West Richmond	5	5	4
East Richmond	94	82	59
West Delta	17	17	15
East Delta	30	30	23
North Surrey	105	101	83
South Surrey	131	117	87
South Langley	129	118	90
Central Langley	81	77	61
North Langley	85	81	63
West Matsqui	189	172	126
South Matsqui	381	342	240
North Matsqui	127	126	92
Abbotsford	124	124	92
West Chilliwack	139	131	98
East Chilliwack	120	119	89
Agassiz	81	82	62
Nicomex	73	74	56
Mission	48	49	40
Maple Ridge	59	55	47
Pitt Meadows	30	31	26
Fraser Valley	103	99	74

Large Farms plus Small Farms

IMPROVED FERTILIZATION, MANURE HANDLING AND FEED RATIOS

Losses to the Atmosphere (kg N per cropped hectare per year, average over large and small farms, by Waste Management Zone)

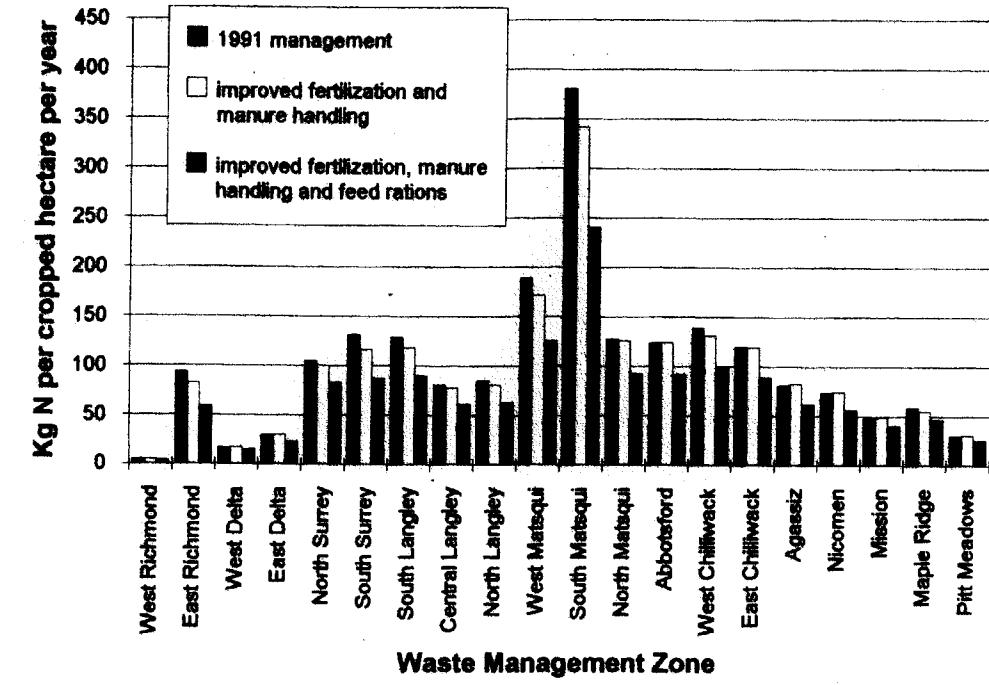


Figure 7.1.5

LOSSES TO SURFACE WATER

NITROGEN

(kg per cropped hectare per year)

ZONE	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed rations
West Richmond	1	1	0
East Richmond	70	49	33
West Delta	1	1	1
East Delta	14	1	1
North Surrey	140	90	66
South Surrey	116	70	37
South Langley	123	101	68
Central Langley	88	35	11
North Langley	69	22	2
West Matsqui	239	202	141
South Matsqui	33	28	23
North Matsqui	113	43	11
Abbotsford	114	27	3
West Chilliwack	104	49	23
East Chilliwack	98	37	10
Agassiz	50	3	2
Nicomen	45	3	2
Mission	45	2	2
Maple Ridge	36	3	2
Pitt Meadows	2	1	1
Fraser Valley	82	39	21

Large Farms

IMPROVED MANAGEMENT

Losses to Surface Water - Nitrogen - Large Farms - Improved Management

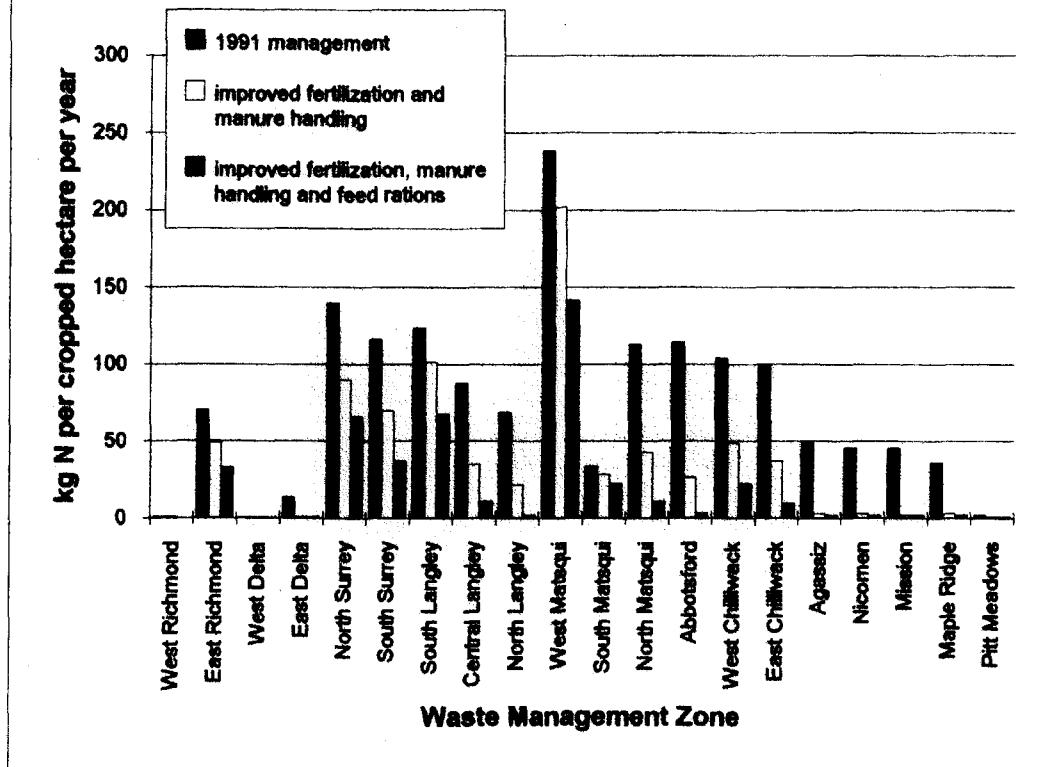


Figure 7.1.6

**RUNOFF DURING MANURE HANDLING
NITROGEN**
(kg per cropped hectare per year)

ZONE	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed ratios
West Richmond	1	1	0
East Richmond	4	2	2
West Delta	1	1	1
East Delta	2	1	1
North Surrey	7	5	4
South Surrey	8	5	4
South Langley	9	6	5
Central Langley	6	4	3
North Langley	5	3	2
West Matsqui	12	7	6
South Matsqui	13	8	7
North Matsqui	7	4	3
Abbotsford	6	3	3
West Chilliwack	7	4	3
East Chilliwack	7	4	3
Agassiz	5	3	2
Nicomex	5	3	2
Mission	4	2	2
Maple Ridge	4	3	2
Pitt Meadows	2	1	1
Fraser Valley	6	3	3

**Large Farms
IMPROVED MANAGEMENT**

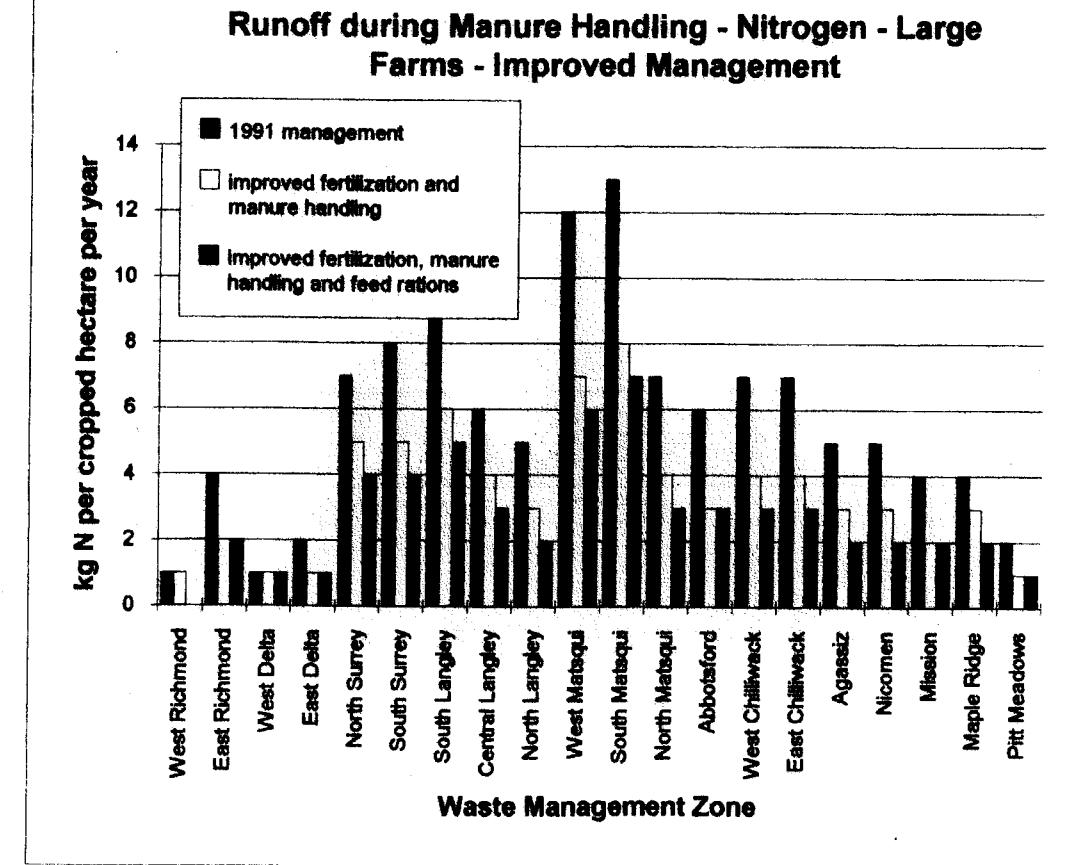


Figure 7.1.7

LOSSES TO GROUNDWATER

NITROGEN

(kg per cropped hectare per year)

ZONE	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed rations
West Richmond	0	0	0
East Richmond	31	20	13
West Delta	0	0	0
East Delta	6	0	0
North Surrey	26	15	11
South Surrey	63	35	18
South Langley	100	78	51
Central Langley	38	13	3
North Langley	30	8	0
West Matsqui	84	65	45
South Matsqui	399	386	295
North Matsqui	49	17	3
Abbotsford	30	6	0
West Chilliwack	69	30	13
East Chilliwack	52	18	4
Agassiz	32	0	0
Nicomex	29	0	0
Mission	20	0	0
Maple Ridge	28	0	0
Pitt Meadows	1	0	0
Fraser Valley	44	24	14

Large Farms IMPROVED MANAGEMENT

Losses to Groundwater - Nitrogen - Large Farms - Improved Management

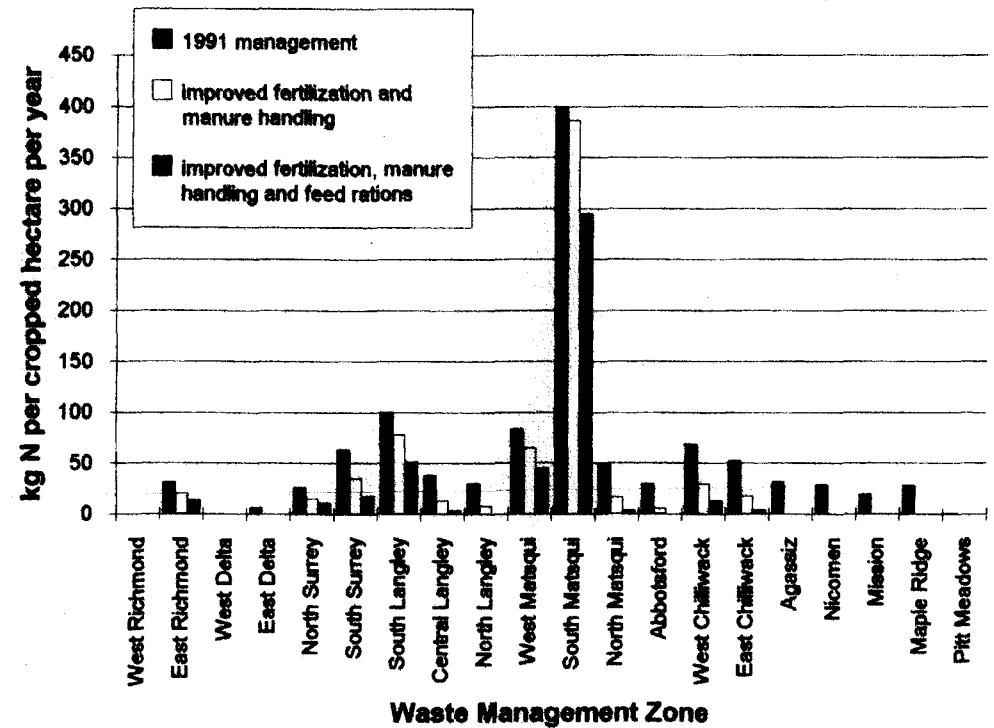


Figure 7.2.1

**SURPLUS
PHOSPHORUS** Large Farms
IMPROVED MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus - 1991 management	surplus - improved fertilization and manure handling	surplus - improved fertilization, manure handling and feed rations
West Richmond	23	1	1
East Richmond	74	62	46
West Delta	30	-1	-1
East Delta	30	4	4
North Surrey	111	89	79
South Surrey	120	110	80
South Langley	155	149	112
Central Langley	80	68	55
North Langley	73	62	49
West Matsqui	206	196	144
South Matsqui	270	252	175
North Matsqui	96	80	68
Abbotsford	82	63	56
West Chilliwack	113	92	75
East Chilliwack	97	81	74
Agassiz	61	48	47
Nicomex	55	44	42
Mission	45	30	30
Maple Ridge	50	42	33
Pitt Meadows	21	13	13
Fraser Valley	85	69	57

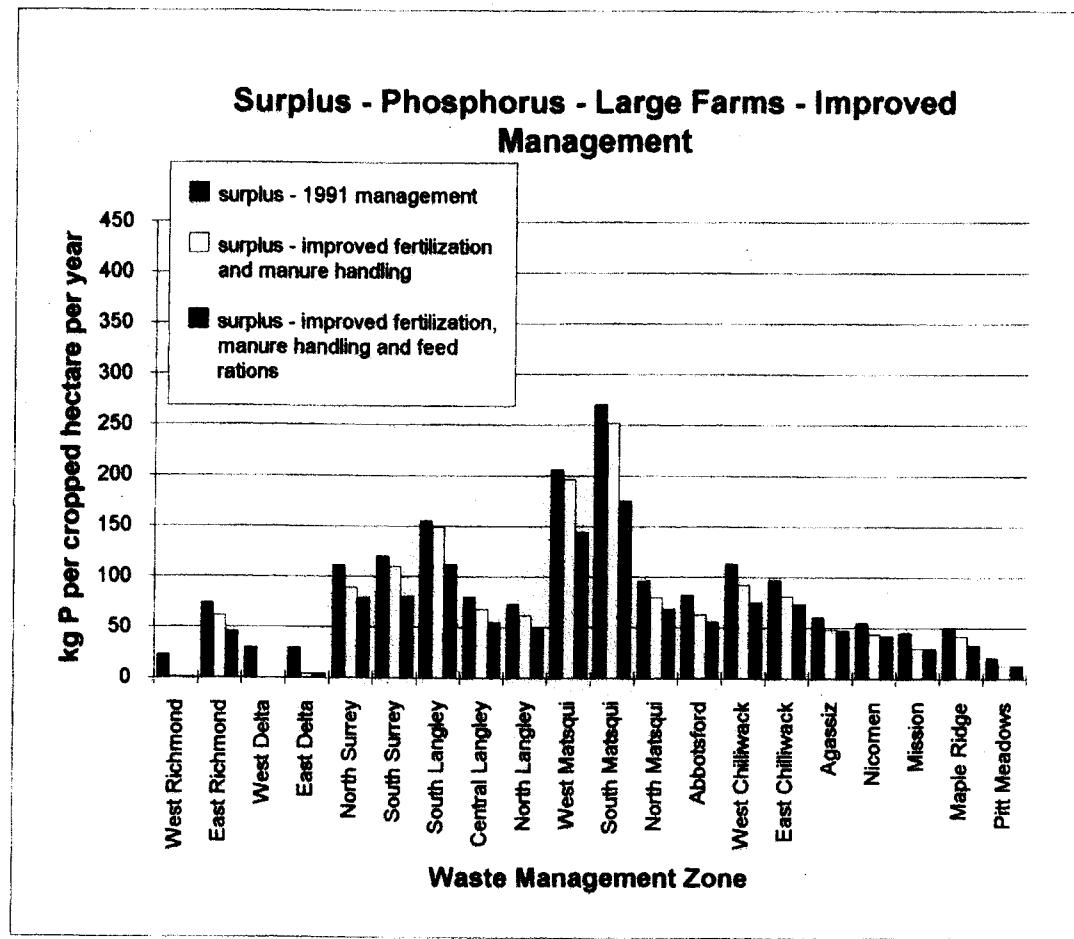


Figure 7.2.2

**RATIO: APPLIED SURPLUS TO CROP REMOVAL
PHOSPHORUS**
(kg per cropped hectare per year)

ZONE	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed ratios
West Richmond	0.9	0.0	0.0
East Richmond	3.7	3.1	2.3
West Delta	0.8	0.0	0.0
East Delta	1.0	0.1	0.1
North Surrey	3.5	2.8	2.5
South Surrey	4.1	3.8	2.8
South Langley	6.5	6.2	4.7
Central Langley	3.0	2.5	2.0
North Langley	2.9	2.5	2.0
West Matsqui	7.6	7.3	5.3
South Matsqui	11.3	10.5	7.3
North Matsqui	3.2	2.7	2.3
Abbotsford	2.6	2.0	1.8
West Chilliwack	3.6	3.0	2.4
East Chilliwack	3.3	2.8	2.6
Agassiz	2.0	1.6	1.6
Nicomex	1.8	1.4	1.4
Mission	1.6	1.0	1.0
Maple Ridge	2.1	1.8	1.4
Pitt Meadows	1.1	0.7	0.7
Fraser Valley	2.9	2.4	2.0

**Large Farms
IMPROVED MANAGEMENT**

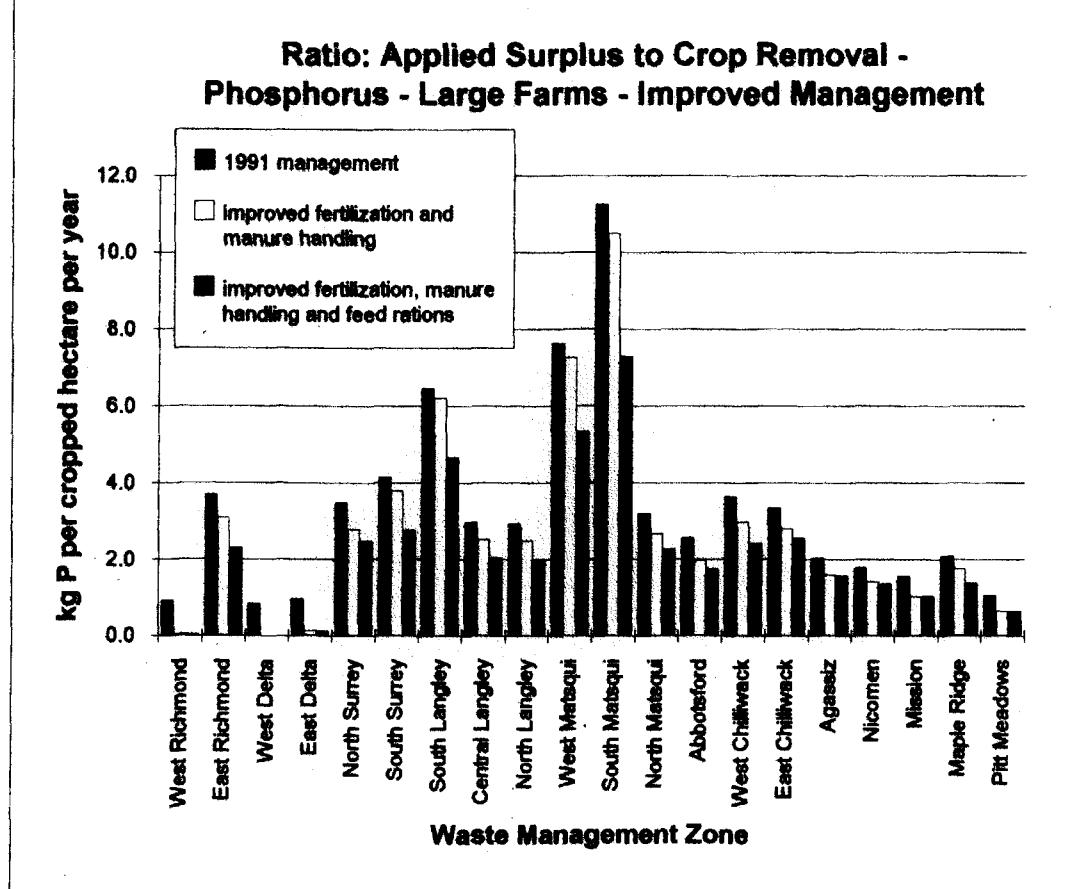


Figure 7.3.1

**SURPLUS
POTASSIUM**
Large Farms
IMPROVED MANAGEMENT
(kg per cropped hectare per year)

ZONE	surplus - 1991 management	surplus - improved fertilization and manure handling	surplus - improved fertilization, manure handling and feed rations
West Richmond	-2	9	9
East Richmond	82	80	80
West Delta	-31	-7	-7
East Delta	24	1	1
North Surrey	159	148	148
South Surrey	148	136	136
South Langley	213	209	209
Central Langley	122	113	113
North Langley	103	89	89
West Matsqui	274	267	267
South Matsqui	340	303	303
North Matsqui	175	158	158
Abbotsford	152	125	125
West Chilliwack	176	148	148
East Chilliwack	176	159	159
Agassiz	108	92	92
Nicomex	107	92	92
Mission	74	54	54
Maple Ridge	61	56	56
Pitt Meadows	17	13	13
Fraser Valley	126	112	112

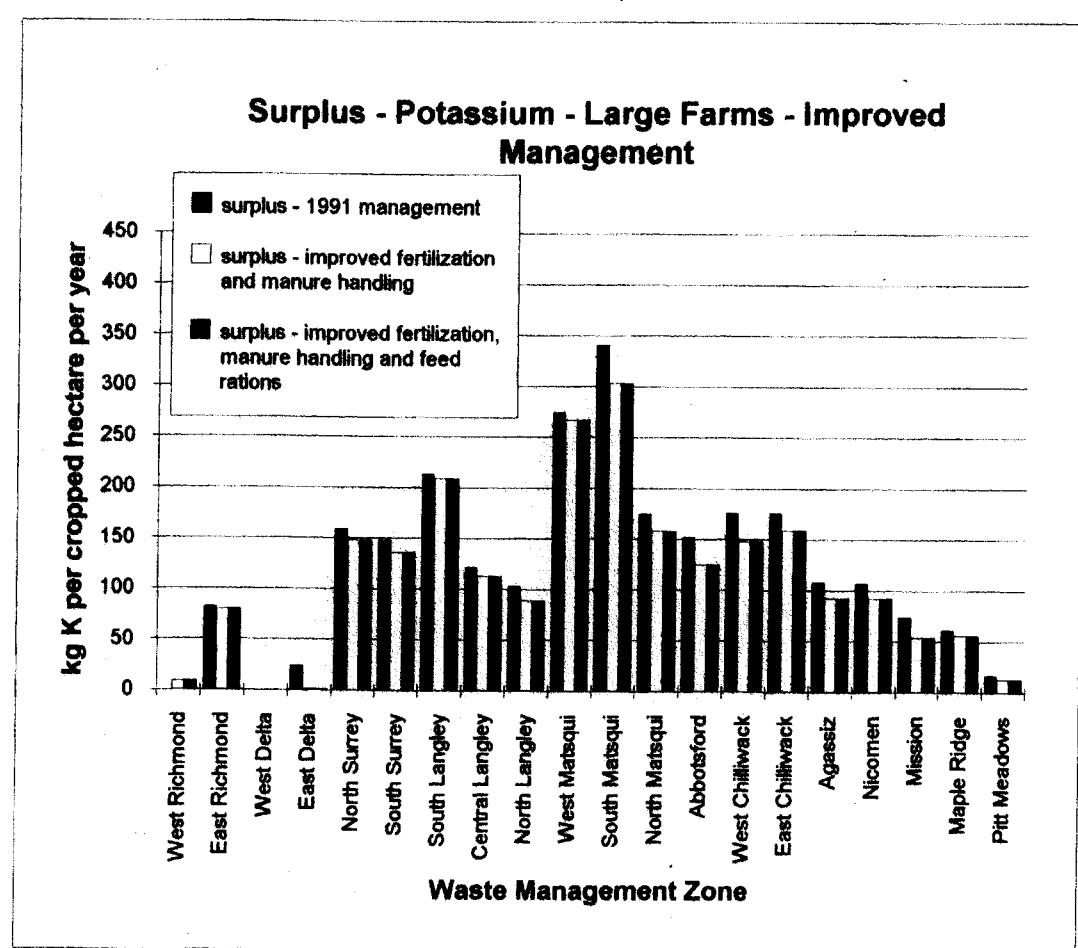


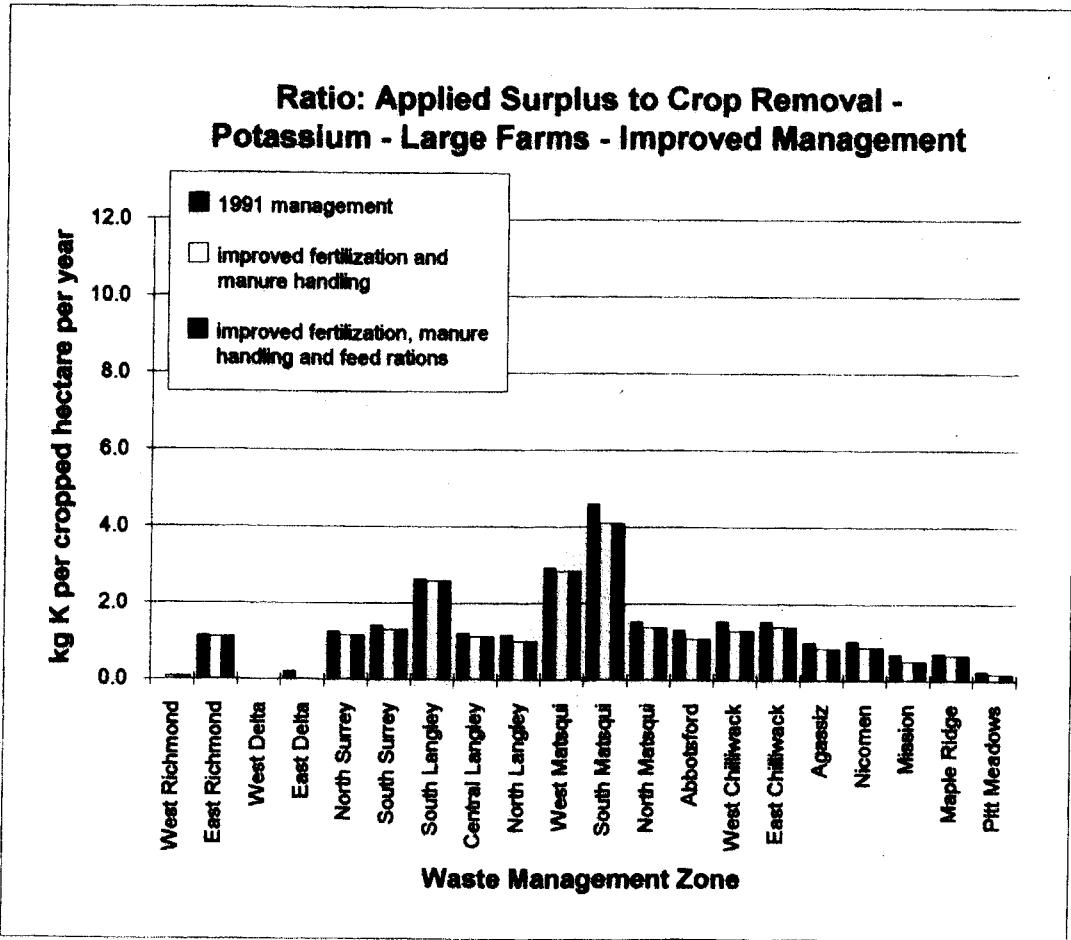
Figure 7.3.2

RATIO: APPLIED SURPLUS TO CROP REMOVAL POTASSIUM

(kg per cropped hectare per year)

ZONE	1991 management	improved fertilization and manure handling	improved fertilization, manure handling and feed ratios
West Richmond	0.0	0.1	0.1
East Richmond	1.1	1.1	1.1
West Delta	-0.2	0.0	0.0
East Delta	0.2	0.0	0.0
North Surrey	1.3	1.2	1.2
South Surrey	1.4	1.3	1.3
South Langley	2.6	2.6	2.6
Central Langley	1.2	1.1	1.1
North Langley	1.2	1.0	1.0
West Matsqui	2.9	2.8	2.8
South Matsqui	4.6	4.1	4.1
North Matsqui	1.5	1.4	1.4
Abbotsford	1.3	1.1	1.1
West Chilliwack	1.5	1.3	1.3
East Chilliwack	1.5	1.4	1.4
Agassiz	1.0	0.8	0.8
Nicomen	1.0	0.9	0.9
Mission	0.7	0.5	0.5
Maple Ridge	0.7	0.7	0.7
Pitt Meadows	0.2	0.2	0.2
Fraser Valley	1.2	1.0	1.0

Large Farms IMPROVED MANAGEMENT



8.0 IMPACTS OF IMPROVED FEEDING STRATEGIES

A third set of nutrient pathway estimates were made using the improved feeding strategy assumptions along with the reduced inorganic fertilizer use and improved manure handling assumptions. Results of this set of estimates are given in Tables 8.0.1 to 8.0.4.

8.1 Nitrogen

The estimates of large farm surpluses of nitrogen, combining the three sets of improved nutrient management assumptions, are presented in Table 8.1.1. Values for both the total estimated surplus and surplus less atmospheric input are shown.

The highest estimated surplus was again in South Matsqui, 310 kg N/ha, and the lowest in the Nicomen zone, -65 kg N/ha. Ignoring atmospheric input the estimated surplus is highest in South Matsqui (229 kg N/ha) and lowest in Nicomen (-91 kg N/ha).

A comparison of surplus nitrogen estimates for the three model runs is given in Figure 8.1.2. With improved feeding strategies in place (as well as reduced inorganic fertilizer use and improved manure handling) the average surplus is reduced by 102 kg N/ha (compared to 1991 management) or 89%, from 115 kg N/ha to 13 kg N/ha. The change in the South Matsqui AWMZ is from 408 kg N/ha to 180 kg N/ha, a 56 % decrease.

With all nutrient management improvements in place there is only one zone where the estimated surplus exceeds 200 kg N/ha (South Matsqui, 4% of the cropped area). There are another 2 AWMZs (6% of the cropped area) with surpluses between 100 and 200 kg N/ha and a further 2 AWMZs (9% of the cropped area) where estimated surpluses are between 50 and 100 kg N/ha. This "exceedance" information is presented in Figure 7.1.2.

Compared to the current management scenario the cropped area within AWMZs with an average surplus of 100 kg N/ha dropped by 47% of the total cropped area (to 10%), and the area within AWMZs with surpluses exceeding 50 kg N/ha was reduced by 59% (to 19%) of the cropped area.

8.1.1 Losses to the Atmosphere

Losses to the atmosphere (excluding denitrification) are shown in Figures 7.1.3 (tonnes N per AWMZ) and 7.1.4 (kg N/cropped hectare).

Losses of ammonia to the atmosphere are estimated to decrease by 2114 tonnes N per year, or 28% compared to estimates for 1991 management.

8.1.2 Losses to Surface Water

Average losses to surface water (shown in Figure 7.1.5) decrease from 82 kg N/ha to 21 kg N/ha (74%) if all the discussed nutrient management improvements are in place.

8.1.3 Losses to Groundwater

Average losses to groundwater decrease to 14 kg N/ha, from 44 kg N/ha with current management, a drop of 68%. Estimates of losses to groundwater are summarized in Table 7.1.7. With the improved management in place only three zones have losses to groundwater estimated to be greater than 20 kg N/ha/yr; South Matsqui, West Matsqui and South Langley.

8.2 Phosphorus

Improved feeding strategies, in conjunction with reduced inorganic fertilizer use and improved manure handling, lower estimates of surplus phosphorus from 85 kg/ha (1991 management) to 57 kg P/ha, a decrease of 33%. This decrease represents a lowering of the ratio of surplus phosphorus to crop removal from 2.9 to 2.0.

Phosphorus surplus estimates for this management scenario are presented in Figures 7.2.1 and 7.2.2.

8.3 Potassium

The assumptions used for improved feeding strategies did not include any reductions in the amount of potassium excreted.

Table 8.0.1

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - Improved Fertilization, Manure Handling, and Feed Rations Nitrogen (kg / cropped ha)																	
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater
West Richmond	731	19	750	33	0	13	0	0	20	116	76	-41	10	-11	3	16	-14	0	0	0	0
East Richmond	1483	202	1685	156	0	64	2	0	90	112	52	-59	27	58	14	78	45	31	33	13	13
West Delta	2684	189	2873	36	0	13	1	0	22	160	108	-52	13	-17	3	16	-20	0	1	0	0
East Delta	3465	399	3864	57	0	23	1	0	33	170	68	-102	16	-53	5	28	-58	0	1	0	0
North Surrey	4039	550	4589	313	31	107	4	0	170	186	73	-113	34	90	17	124	73	62	66	11	11
South Surrey	593	118	711	377	58	132	4	0	184	221	63	-159	35	60	9	141	51	33	37	18	18
South Langley	1302	280	1582	470	81	163	5	0	222	181	49	-132	36	125	11	174	114	63	68	51	51
Central Langley	1470	236	1706	255	30	94	3	0	128	200	63	-137	27	18	6	100	12	8	11	3	3
North Langley	2336	472	2808	219	22	87	2	0	108	179	54	-125	28	11	11	98	0	0	2	0	0
West Matsqui	1623	398	2021	615	119	219	6	0	271	182	57	-125	47	194	14	233	180	135	141	45	45
South Matsqui	2136	718	2854	731	80	328	7	0	316	107	36	-71	81	326	16	344	310	16	23	295	295
North Matsqui	3416	259	3675	270	16	108	3	0	143	213	67	-147	37	33	21	129	12	8	11	3	3
Abbotsford	6687	345	7032	214	4	89	3	0	118	207	63	-144	37	10	18	107	-8	0	3	0	0
West Chilliwack	2455	229	2684	263	0	110	3	0	150	193	60	-134	38	55	23	133	33	20	23	13	13
East Chilliwack	5867	432	6299	243	0	102	3	0	139	205	61	-144	36	31	21	123	10	7	10	4	4
Agassiz	2622	237	2859	164	0	67	2	0	95	229	66	-163	28	-40	14	81	-54	0	2	0	0
Nicomen	3305	369	3674	165	0	67	2	0	95	242	70	-172	26	-51	14	81	-65	0	2	0	0
Mission	472	73	545	132	0	53	2	0	78	211	62	-149	21	-50	8	61	-58	0	2	0	0
Maple Ridge	795	163	958	154	0	56	2	0	96	184	52	-132	23	-13	10	66	-23	0	2	0	0
Pitt Meadows	4571	185	4756	72	0	27	1	0	44	153	39	-114	17	-54	7	34	-61	0	1	0	0
Fraser Valley	52031	5875	57906	231	16	92	3	0	121	187	63	-125	31	27	14	106	13	15	18	18	18

Table 8.0.2

NUTRIENT PATHWAY SUMMARY

	Large Farms (hectares)			Large Farms - Improved Fertilization, Manure Handling, and Feed Rations																	
				Phosphorus (kg / cropped ha)						Potassium (kg / cropped ha)											
Waste Management Zone	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)
West Richmond	731	19	750	9	0	0	0	9	25	18	-7	1	33	0	1	0	32	108	84	-23	9
East Richmond	1483	202	1685	56	0	0	0	55	20	11	-9	46	111	0	3	0	109	72	43	-29	80
West Delta	2684	189	2873	11	0	0	0	11	36	24	-12	-1	30	0	1	0	29	171	135	-36	-7
East Delta	3465	399	3864	22	0	0	0	22	31	13	-18	4	61	0	2	0	60	118	59	-58	1
North Surrey	4039	550	4589	111	13	1	0	97	32	14	-18	79	244	23	6	0	214	127	61	-66	148
South Surrey	593	118	711	124	23	1	0	100	29	8	-21	80	259	44	6	0	210	104	30	-74	136
South Langley	1302	280	1582	163	33	1	0	129	24	7	-17	112	334	61	7	0	266	81	24	-57	209
Central Langley	1470	236	1706	86	13	1	0	73	27	9	-18	55	204	22	5	0	177	101	37	-64	113
North Langley	2336	472	2808	75	9	1	0	65	25	8	-17	49	168	16	4	0	148	89	30	-59	89
West Matsqui	1623	398	2021	213	50	1	0	162	27	10	-17	144	424	88	8	0	328	94	33	-61	267
South Matsqui	2136	718	2854	225	33	2	0	190	24	9	-15	175	419	60	9	0	349	74	28	-46	303
North Matsqui	3416	259	3675	95	7	1	0	88	30	10	-20	68	251	12	6	0	234	115	38	-76	158
Abbotsford	6687	345	7032	80	2	1	0	78	32	10	-22	56	213	3	5	0	205	116	36	-80	125
West Chilliwack	2455	229	2684	97	0	1	0	97	31	10	-21	75	231	0	6	0	225	114	37	-77	148
East Chilliwack	5867	432	6299	94	0	1	0	93	29	9	-20	74	244	0	6	0	238	115	36	-79	159
Agassiz	2622	237	2859	69	0	1	0	68	30	9	-21	47	175	0	4	0	170	110	32	-78	92
Nicomex	3305	369	3674	64	0	1	0	63	31	9	-22	42	172	0	4	0	167	106	31	-75	92
Mission	472	73	545	50	0	0	0	50	29	9	-20	30	133	0	3	0	129	109	33	-76	54
Maple Ridge	795	163	958	50	0	0	0	50	24	8	-16	33	117	0	3	0	114	86	28	-58	56
Pitt Meadows	4571	185	4756	27	0	0	0	27	20	6	-14	13	64	0	2	0	62	73	24	-49	13
Fraser Valley	52031	5875	57906	82	7	1	0	75	29	11	-18	57	194	12	5	0	177	108	43	-65	112

Table 8.0.3

NUTRIENT PATHWAY SUMMARY

Waste Management Zone	Large Farms (hectares)			Large Farms - Improved Fertilization, Manure Handling, and Feed Rations Nitrogen (tonnes)																		
	cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - air	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	net atmospheric input	applied surplus (deficit)	denitrification	total to atmosphere	surplus (deficit)	surplus to surface water	total to surface water	surplus to groundwater	total to groundwater	
West Richmond	731	19	750	24	0	10	0	0	14	85	55	-30	8	-8	2	12	-10	0	0	0	0	
East Richmond	1483	202	1685	232	0	95	3	0	134	165	77	-88	40	86	20	115	66	46	49	20	20	
West Delta	2684	189	2873	95	0	36	1	0	58	428	290	-139	36	-45	9	45	-54	0	1	0	0	
East Delta	3465	399	3864	199	0	81	3	0	115	589	237	-352	55	-182	17	98	-199	0	3	0	0	
North Surrey	4039	550	4589	1262	127	434	17	0	685	750	294	-456	136	365	69	503	297	252	269	44	44	
South Surrey	593	118	711	224	34	78	2	0	109	131	37	-94	21	36	5	83	31	20	22	11	11	
South Langley	1302	280	1582	612	105	212	6	0	288	236	64	-172	47	163	14	226	149	82	88	67	67	
Central Langley	1470	236	1706	375	44	139	4	0	189	295	93	-202	40	27	9	148	18	12	16	5	5	
North Langley	2336	472	2808	512	51	203	6	0	252	419	127	-292	65	26	25	228	1	1	7	0	0	
West Matsqui	1623	398	2021	998	193	355	9	0	440	295	92	-202	76	314	22	377	292	219	228	73	73	
South Matsqui	2136	718	2854	1562	172	701	15	0	675	229	78	-151	173	697	34	735	663	33	48	630	630	
North Matsqui	3416	259	3675	922	53	369	11	0	489	729	228	-501	125	114	73	442	41	28	39	12	12	
Abbotsford	6687	345	7032	1429	28	597	17	0	786	1383	420	-963	245	-69	118	715	-49	0	17	0	0	
West Chilliwack	2455	229	2684	646	0	270	8	0	368	474	146	-328	94	134	55	325	79	47	55	32	32	
East Chilliwack	5867	432	6299	1428	0	597	18	0	813	1203	360	-843	209	179	122	719	57	37	55	20	20	
Agassiz	2622	237	2859	430	0	175	6	0	249	600	173	-427	72	-105	37	212	-142	0	6	0	0	
Nicomen	3305	369	3674	545	0	222	7	0	315	799	231	-569	86	-168	47	269	-215	0	7	0	0	
Mission	472	73	545	62	0	25	1	0	37	100	29	-70	10	-24	4	29	-28	0	1	0	0	
Maple Ridge	795	163	958	123	0	45	2	0	76	147	42	-105	18	-10	8	53	-18	0	2	0	0	
Pitt Meadows	4571	185	4756	329	0	125	5	0	199	700	178	-523	76	-247	30	155	-277	0	5	0	0	
Fraser Valley	52031	5875	57906	12009	830	4762	140	0	6276	9754	3253	-6502	1628	1402	721	5490	700	778	919	914	914	

Table 8.0.4

NUTRIENT PATHWAY SUMMARY

	Large Farms (hectares)			Large Farms - Improved Fertilization, Manure Handling, and Feed Rations																	
				Phosphorus (tonnes)						Potassium (tonnes)											
Waste Management Zone	Cropped area	non-cropped area	total agricultural land base	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)	manure produced	manure exported	losses - runoff	losses - infiltration	net manure application	crop requirement	fertilizer applied	applied fertilizer less crop removal	applied surplus (deficit)
West Richmond	731	19	750	6	0	0	0	6	19	13	-5	1	24	0	1	0	23	79	62	-17	6
East Richmond	1483	202	1685	82	0	1	0	82	29	17	-13	69	165	0	4	0	161	107	64	-42	119
West Delta	2684	189	2873	30	0	0	0	30	97	65	-32	-2	81	0	2	0	78	458	361	-97	-19
East Delta	3465	399	3864	78	0	1	0	77	109	47	-62	15	212	0	5	0	207	408	206	-202	4
North Surrey	4039	550	4589	448	53	4	0	391	128	56	-72	319	985	94	26	0	865	515	248	-267	598
South Surrey	593	118	711	74	14	1	0	59	17	5	-12	47	154	26	3	0	124	62	18	-44	81
South Langley	1302	280	1582	213	43	1	0	168	31	9	-22	146	434	79	9	0	346	105	31	-74	272
Central Langley	1470	236	1706	126	18	1	0	107	40	14	-27	80	299	32	7	0	260	149	55	-94	166
North Langley	2336	472	2808	175	21	1	0	152	58	19	-39	114	393	38	9	0	346	207	70	-137	208
West Matsqui	1623	398	2021	346	81	2	0	262	43	16	-28	234	689	143	14	0	532	152	53	-99	433
South Matsqui	2136	718	2854	480	70	3	0	407	51	19	-32	374	894	129	19	0	746	158	59	-99	647
North Matsqui	3416	259	3675	324	22	2	0	299	104	36	-68	231	858	39	20	0	798	391	131	-260	538
Abbotsford	6687	345	7032	537	12	4	0	521	212	66	-146	375	1425	21	34	0	1370	775	242	-533	837
West Chilliwack	2455	229	2684	239	0	2	0	237	77	25	-52	185	567	0	14	0	553	279	90	-189	364
East Chilliwack	5867	432	6299	552	0	5	0	548	170	54	-117	431	1429	0	35	0	1395	673	210	-463	932
Agassiz	2622	237	2859	181	0	2	0	179	78	22	-55	124	458	0	11	0	447	289	84	-205	242
Nicomen	3305	369	3674	211	0	2	0	209	101	29	-72	137	567	0	14	0	554	350	102	-248	305
Mission	472	73	545	24	0	0	0	24	13	4	-9	14	63	0	2	0	61	51	16	-36	25
Maple Ridge	795	163	958	40	0	0	0	39	19	6	-13	27	93	0	3	0	91	68	22	-46	44
Pitt Meadows	4571	185	4756	125	0	1	0	124	94	29	-64	60	292	0	8	0	284	335	110	-225	59
Frasier Valley	52031	5875	57906	4290	344	33	0	3912	1489	550	-939	2974	10082	619	239	0	9224	5606	2235	-3371	5853

Figure 8.1.1

SURPLUS NITROGEN

Large Farms

IMPROVED FERTILIZATION, MANURE HANDLING AND FEED RATIONS

(kg per cropped hectare per year)

ZONE	surplus less atmospheric input	surplus	atmospheric input
West Richmond	-24	-14	10
East Richmond	18	45	27
West Delta	-33	-20	13
East Delta	-74	-58	16
North Surrey	39	73	34
South Surrey	16	51	35
South Langley	78	114	36
Central Langley	-15	12	27
North Langley	-28	0	28
West Matsqui	133	180	47
South Matsqui	229	310	81
North Matsqui	-25	12	37
Abbotsford	-45	-8	37
West Chilliwack	-6	33	38
East Chilliwack	-26	10	36
Agassiz	-82	-54	28
Nicomen	-91	-65	26
Mission	-79	-58	21
Maple Ridge	-46	-23	23
Pitt Meadows	-78	-61	17
Fraser Valley	-18	13	31

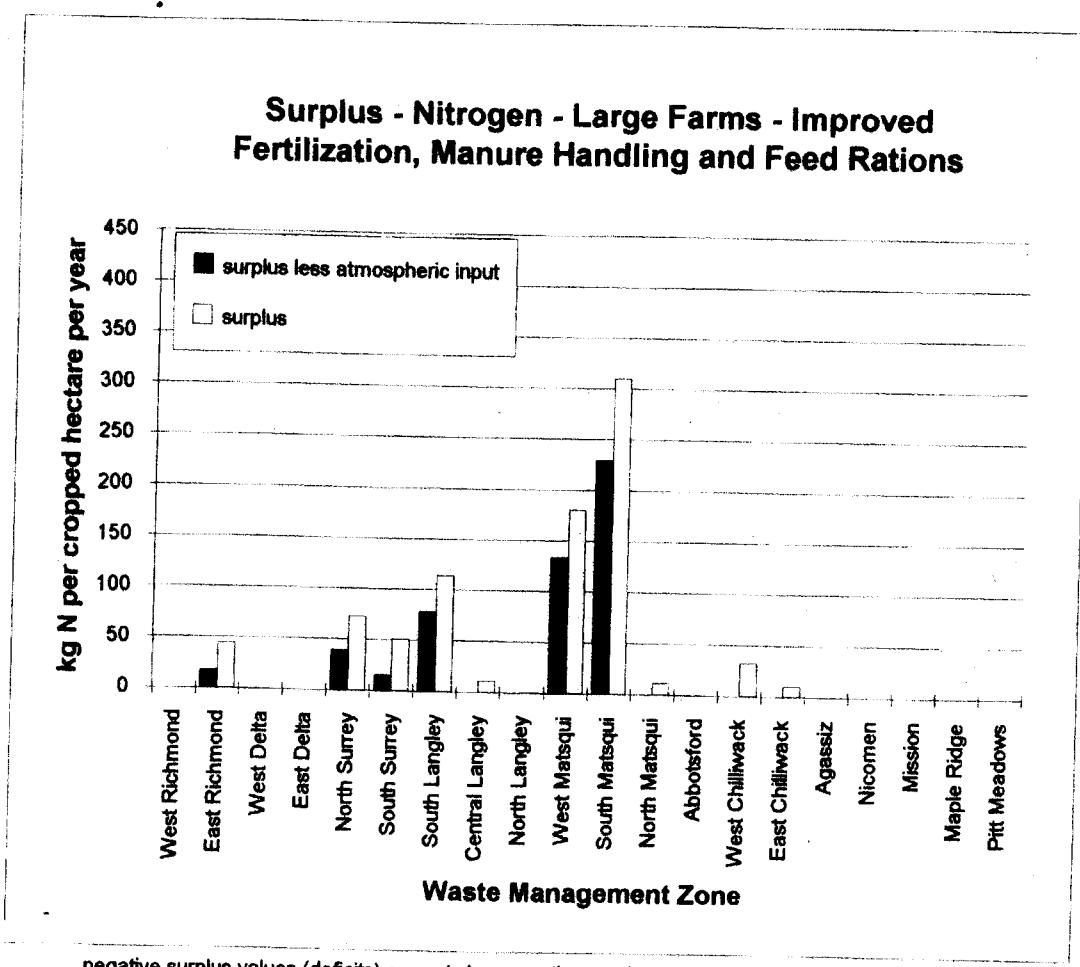


Figure 8.1.2

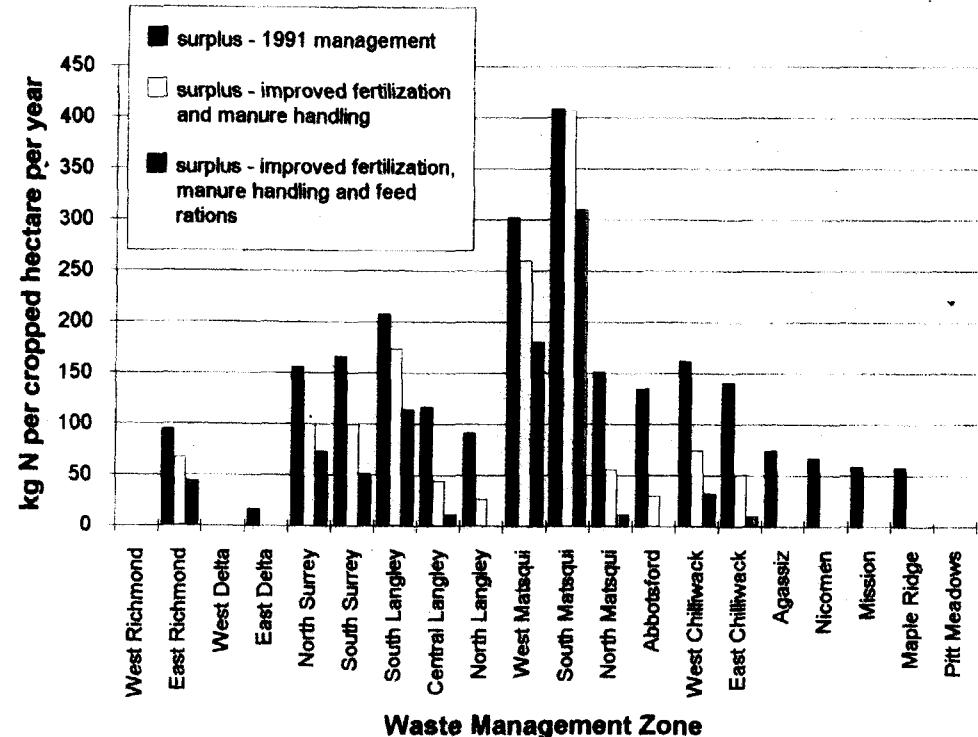
SURPLUS NITROGEN

(kg per cropped hectare per year)

ZONE	surplus - 1991 management	surplus - improved fertilization and manure handling	surplus - improved fertilization, manure handling and feed rations
West Richmond	-6	-10	-14
East Richmond	95	67	45
West Delta	-28	-17	-20
East Delta	17	-48	-58
North Surrey	156	100	73
South Surrey	166	100	51
South Langley	208	173	114
Central Langley	117	44	12
North Langley	91	27	0
West Matsqui	302	260	180
South Matsqui	408	407	310
North Matsqui	152	56	12
Abbotsford	135	30	-8
West Chilliwack	162	75	33
East Chilliwack	141	50	10
Agassiz	74	-27	-54
Nicomex	67	-38	-65
Mission	59	-40	-58
Maple Ridge	58	-7	-23
Pitt Meadows	-8	-55	-61
Fraser Valley	115	46	13

Large Farms SURPLUS vs MANAGEMENT SCENARIO

Surplus - Nitrogen - Large Farms vs Management Scenario



negative surplus values (deficits) are not shown on the graph

9.0 SUMMARY

The mass balance model developed and used in this study attempts to model the very complex and variable system of nutrient flows in agriculture. The model utilizes a number of assumptions, many of which are not based on detailed research, and therefore the absolute numbers generated by the model must be accepted with a degree of caution.

However, it is expected that the relative results of the model runs are valid. In several of the Agricultural Waste Management Zones (AWMZs) where the model showed relatively high nutrient loadings, field studies have indicated that agricultural nutrient management is having adverse impacts on the environment.

The sensitivity analysis suggests that the most significant factors involved in whether or not excessive surplus exist are simply the amount of manure generated (livestock inventory and unit nutrient production) and land use (crop removal and inorganic fertilizer use). However, when interpreting the results it must be kept in mind that the nutrients can be lost in different forms and there is a large variability in the receiving environments and their ability to accommodate nutrient loadings.

For example, while reducing surface runoff during manure management and application may not have a large impact on reducing a surplus application it may have a significant environmental impact in that the amount of dissolved ammonia escaping to surface water can be dramatically reduced.

The results of this study suggest that there is a large percentage of the Lower Fraser Valley (LFV) agricultural land base where animal densities are near or beyond an acceptable limit.

Using the 1991 management assumptions approximately 60% of the land on large farms has a surplus exceeding 100 kg N/ha (Figure 5.1.3). As discussed previously there was some amount of agreement that an acceptable surplus is expected to be in the range of 50 to 100 kg N/ha. Even after allowing for errors in assumptions and data, this indicates that with 1991 management practices there is high N loading occurring over much of the agricultural land base.

Surplus applications of both phosphorus and potassium are also of concern and one or the other of these nutrients might well be of greater environmental concern in some situations. Further study is required to determine which nutrient should most appropriately be the limiting factor in agricultural nutrient management.

However, with reduced applications of commercial fertilizers and improved manure management the land area with surpluses greater than 100 kg N/ha can be substantially reduced, from about 60% to 20% of the agricultural land base.

This indicates that improved on-farm management alone can lower nitrogen surpluses to acceptable levels in many areas. However it also suggests that there are significant

areas where animal densities are just simply too high to achieve a reasonable nutrient balance.

The nutrient management problems can therefore be considered to fall into two general categories; one where the problems can be solved by improved on-farm management (such as reduced use of commercial fertilizers, improved manure handling and improved feeding strategies) and a second where the problems cannot be solved through on-farm management changes alone (the animal densities are simply too high relative to the crop removal rates).

There is a considerable amount of information available on improving on-farm management with respect to reducing nutrient loading to the environment and there are several programs and initiatives, many involving producer groups, aimed at achieving a better level of management. It is expected that the management improvements which have been implemented over the past few years have been significant in reducing agricultural nutrient impacts.

However, continued effort is required to maximize the benefits of improved on-farm management; continued efforts to educate the agricultural community and ensure that they have the information needed are required.

Unfortunately, efforts to address the problems resulting from excessively high animal densities have been less significant. How to improve the situation in areas where the density is already excessive and preventing excessive densities from developing in other areas is not a simple issue to address. Innovative ideas will be required to address this problem so that an adequate level of environmental protection is provided while maintaining the significant agricultural productivity in the Lower Fraser Valley.

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APPENDIX A
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APPENDIX B

NUTRIENT MODEL EXAMPLE

ABBOTSFORD / LARGE FARMS - 1991 MANAGEMENT

Table 1
NUTRIENT PATHWAY SUMMARY

Abbotsford / large farms
1991 Management

1

Agricultural Land Base

Cropped Area	6687 hectares
Non-cropped area	345 hectares
Total Agricultural Land Base	7032 hectares

Estimated Annual Nutrient Balance (tonnes)

	N	P	K
Manure Produced			
Dairy	1369	415	1157
Poultry (meat)	124	47	58
Poultry (layers)	104	30	36
Swine	272	89	159
Beef	18	4	11
Other	6	1	4
Total	1892	587	1425
Exported	36	17	21
Management Losses			
air	826		
runoff	40	9	60
infiltration	17	7	16
Net Manure Application	973	554	1327
Crop Requirement	1383	212	775
Fertilizer Applied	1154	208	463
Net Crop-Fertilizer	-229	-4	-311
Net Atmospheric Input	309		
Applied Surplus (Deficit)	1053	550	1016

Estimated Annual Nutrient Balance (kg / cropped hectare)

	N	P	K
Manure Produced - Total	283	88	213
Manure Exported	5	3	3
Manure Management Losses			
air	124		
runoff	6	1	9
infiltration	3	1	2
Net Manure Application	145	83	198
Crop Requirement	207	32	116
Fertilizer Applied	173	31	69
Net Crop-Fertilizer	-34	-1	-47
Net Atmospheric Input	46		
Applied Surplus (Deficit)	157	82	152

LIVESTOCK INVENTORY (from Project 1 Inventory)			LIVESTOCK NUTRIENT PRODUCTION								
			unit nutrient production (kg/animal/year)			total nutrient production (tonnes/year)			total by commodity and percentage		
	number		N	P	K	N	P	K	N	P	K
Dairy	bulls	53	112.0	20.1	76.4	5.9	1.1	4.0			
	cows	9435	116.0	13.1	97.1	1094.5	123.6	916.1	1369	415	1157
	heifers	4305	42.0	47.2	37.4	180.8	203.2	161.0	72%	71%	81%
	calves	3570	20.0	21.9	14.9	71.4	78.2	53.2			
	milking centre		1.7	1.0	2.4	16.0	9.4	22.6			
Poultry (meat)	chickens (1000's)	185.0	0.60	0.23	0.28	111.0	42.6	51.8	124	47	58
	turkeys (1000's)	6.0	0.86	0.27	0.43	5.2	1.6	2.6	7%	8%	4%
	other (1000's)	12.8	0.60	0.23	0.28	7.7	2.9	3.6			
Poultry (layers)	pullets (1000's)	37.1	0.34	0.10	0.12	12.6	3.7	4.5	104	30	36
	layers (1000's)	114.4	0.80	0.23	0.28	91.5	26.3	32.0	6%	5%	3%
Swine	boars	144	24.3	7.5	9.5	3.5	1.1	1.4	272	89	159
	sows	3131	18.3	5.6	7.1	57.3	17.5	22.2	14%	15%	11%
	other	29349	7.2	2.4	4.6	211.3	70.4	135.0			
Beef	bulls	18	112.0	20.1	76.4	2.0	0.4	1.4			
	cows	104	78.0	13.5	39.8	8.1	1.4	4.1	18	4	11
	heifers	54	44.0	14.4	33.2	2.4	0.8	1.8	1%	1%	1%
	steers	105	50.0	16.2	36.5	5.3	1.7	3.8			
	calves	0	20.0	21.9	14.9	0.0	0.0	0.0			
Horses		112	45.5	7.6	28.4	5.1	0.9	3.2	5	1	3
									0%	0%	0%
Sheep	rams	4	11.0	1.6	8.0	0.0	0.0	0.0	1	0	0
	ewes	28	11.0	1.6	8.0	0.3	0.0	0.2	0%	0%	0%
	lambs	42	4.4	0.6	3.2	0.2	0.0	0.1	0	0	0
Goats		12	11.0	1.6	8.0	0.1	0.0	0.1	0%	0%	0%
			Total			1892	587	1425			

Table 3 LAND BASE INVENTORY (from Project 1 Inventory)		hectares
Grass hay		3008
Improved Pasture		380
Unimproved Pasture		212
Silage corn		1137
Grain		173
Vegetables	potatoes	9
	peas	306
	corn	178
	beans	25
	cole crops	586
	other	178
Berries	raspberries	198
	strawberries	55
	blueberries	28
	other	14
Other field crops		0
Tree Fruits		17
Nursery Crops		55
Sod		67
Summerfallow		61
Catch crops		0
Total cropped area		6687
Total non-cropped land		345
Total agricultural land		7032

Table 4 LIVESTOCK WASTE MANAGEMENT SYSTEMS (fraction livestock under each management system)		Abbotsford / large farms 1991 Management										3										
DAIRY WASTE MANAGEMENT SYSTEMS																						
HOUSING																						
	free stall	0.94																				
	tie stall	0.03																				
	bedded housing	0.03																				
MILKING CENTRE																						
	with manure	0.65																				
	tile fields	0.20																				
	discharge	0.15																				
EXPORTED																						
	before storage	0.00																				
	after storage	0.00																				
YARD AND PASTURE - fraction time in yard or on pasture																						
	yard	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct									
		0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.09									
	pasture	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.08	0.00									
LAND APPLICATION - fraction applied, from storage																						
	applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct									
		0.07	0.02	0.02	0.02	0.27	0.03	0.21	0.10	0.08	0.08	0.08	0.02									
	incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00									
POULTRY (MEAT) WASTE MANAGEMENT SYSTEMS																						
HOUSING																						
	concrete floor	0.74																				
	dirt floor	0.26																				
EXPORTED																						
	before storage	0.36																				
	after storage	0.00																				
LAND APPLICATION - fraction applied, from storage																						
	applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct									
		0.07	0.03	0.03	0.16	0.16	0.16	0.16	0.03	0.03	0.03	0.07	0.07									
	incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
POULTRY (LAYERS) WASTE MANAGEMENT SYSTEMS																						
HOUSING																						
	pit	0.73	fans	0.16																		
		no fans	0.81																			
		outside	0.03																			
	floor	0.27	concrete	0.97																		
		dirt	0.03																			
EXPORTED																						
	before storage	0.00																				
	after storage	0.00																				
LAND APPLICATION - fraction applied, from storage																						
	applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct									
		0.07	0.03	0.03	0.16	0.16	0.16	0.16	0.03	0.03	0.03	0.07	0.07									
	incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
PORK WASTE MANAGEMENT SYSTEMS																						
HOUSING																						
	slatted floor	0.45																				
	partially slatted floor	0.50																				
	bedded floor	0.05																				
EXPORTED																						
	before storage	0.00																				
	after storage	0.00																				
LAND APPLICATION - fraction applied, from storage																						
	applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct									
		0.07	0.02	0.02	0.03	0.27	0.04	0.20	0.10	0.08	0.08	0.07	0.02									
	incorporated	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00									

LIVESTOCK WASTE MANAGEMENT SYSTEMS (con't)
 (% livestock under each management system)

Abbotsford / large farms 1991 Management

BEEF WASTE MANAGEMENT SYSTEMS

BEEF WASTE MANAGEMENT SYSTEMS		STORAGE	contained	uncontained
HOUSING	bedded housing	1.00		
	non-bedded housing	0.00		
EXPORTED	before storage	0.00		
	after storage	0.00		
		slurry, concrete/tank	0.00	
		slurry, earth lagoon	0.00	
		semi-solid	0.00	
		solid	1.00	0.50
				0.50

YARD AND PASTURE - fraction time in yard or on pasture

LAND APPLICATION - fraction applied, from storage

HORSE WASTE MANAGEMENT SYSTEMS

Housing Waste Management Systems		
HOUSING	bedded housing	1.00
	non-bedded housing	0.00
EXPORTED	before storage	0.00
	after storage	0.00

Storage Systems		
STORAGE	contained storage	0.50
	semi-contained storage	0.25
	uncontained storage	0.25

PASTURE - fraction time on pasture

LAND APPLICATION - fraction applied, from storage

OTHER WASTE MANAGEMENT SYSTEMS

HOUSING	bedded housing	1.00
	non-bedded housing	0.00
EXPORTED	before storage	0.00
	after storage	0.00

STORAGE	contained storage	0.50
	semi-contained storage	0.25
	uncontained storage	0.25

PASTURE - fraction time on pasture

LAND APPLICATION - fraction applied, from storage

Abbotsford / large farms 1991 Management														
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
background inputs	kg/ha	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	9
background inputs	tonnes	5	5	5	5	5	5	5	5	5	5	5	5	60
atmospheric losses	small farms	4	4	4	8	8	9	9	5	5	5	5	4	70
atmospheric losses	large farms	61	48	48	51	109	56	115	77	70	70	71	49	826
atmospheric losses	tonnes *	65	52	52	59	117	65	124	82	75	75	76	53	896
atmospheric losses	tonnes **	60	48	48	55	108	60	115	76	70	70	70	49	829
atmospheric returns	%	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
atmospheric returns	tonnes	18	14	14	16	32	18	34	23	21	21	21	15	249
Total atmos. inputs	tonnes	23	19	19	21	38	23	39	28	26	26	26	20	309

Table 7

NITROGEN

Abbotsford / large farms 1991 Management

HOUSING AND STORAGE LOSS FACTORS

Table 7 (con't)		NITROGEN											Abbotsford / large farms 1991 Management			7
		(fraction lost)														
Beef	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	slurry/tank	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/earth	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	infiltration	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	semi-solid	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.02	0.05	0.05	0.05
solid	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05	0.05	0.05
	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.03
Horses	infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.02
	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Other	contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	semi-contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.03
	infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.05	0.05	0.04	0.04	0.02
	uncontained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.05
	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05	0.05	0.05
	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.00	0.00	0.02	0.02	0.05
	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05	0.05	0.05

Table 8		YARD AREA LOSS FACTORS														
		air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.00	0.02	0.02	0.05
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05	0.05

Table 9		PASTURE LOSS FACTORS														
		air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
		runoff	0.04	0.04	0.04	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02

Table 10		LAND APPLICATION LOSS FACTORS															
		incorporated	air	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		unincorporated	dairy	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	
		poultry (meat)	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		poultry(layers)	air	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
		swine	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20
		beef	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20
		horses	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20
		other	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20
		runoff	0.06	0.06	0.06	0.06	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.03

Table 11

NITROGEN HOUSING, STORAGE AND APPLICATION LOSSES												Abbotsford / large farms 1991 Management	8	
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Dairy	excreted	114	114	114	114	114	114	114	114	114	114	114	114	1369
	yard - air	2	2	2	2	2	2	2	2	2	2	2	2	26
	- runoff	1	1	1	1	1	1	0	0	0	0	0	1	6
	- infiltration	0	0	0	0	1	1	1	1	1	1	1	1	7
	pasture - air	0	0	0	0	0	1	1	1	1	1	1	0	6
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	housing - air	16	16	16	16	16	14	14	14	14	14	14	16	177
	milking centre - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	2
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	3
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	95	95	95	95	95	87	87	87	87	87	87	95	1092
	storage - air	10	10	10	10	10	10	10	10	10	10	10	10	120
	- runoff	1	1	1	1	0	0	0	0	0	0	0	0	3
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	4
	net storage	84	84	84	84	84	77	77	77	77	77	77	84	965
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	68	19	19	19	261	29	203	97	77	77	77	19	965
	application - air	14	4	4	4	52	9	58	29	23	23	23	4	246
	- runoff	4	1	1	1	8	1	2	1	0	0	1	1	20
	net application and pasture	50	14	14	14	201	27	150	75	62	62	61	15	746
Poultry (meat)	excreted	10	10	10	10	10	10	10	10	10	10	10	10	124
	housing - air	2	2	2	2	2	2	2	2	2	2	2	2	25
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	3	3	3	3	3	3	3	3	3	3	3	3	36
	to storage	5	5	5	5	5	5	5	5	5	5	5	5	63
	storage - air	1	1	1	1	1	1	1	1	1	1	1	1	16
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	1
	net storage	4	4	4	4	4	4	4	4	4	4	4	4	46
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	3	1	1	7	7	7	7	1	1	1	3	3	46
	application - air	0	0	0	1	1	1	1	0	0	0	0	0	7
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	1
	net application	3	1	1	6	6	6	6	1	1	1	3	3	38
Poultry (layers)	excreted	9	9	9	9	9	9	9	9	9	9	9	9	104
	housing - air	3	3	3	3	3	3	3	3	3	3	3	3	41
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	5	5	5	5	5	5	5	5	5	5	5	5	63
	storage - air	2	2	2	2	2	2	2	2	2	2	2	2	22
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	1
	net storage	3	3	3	3	3	3	3	3	3	3	3	3	40
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	3	1	1	6	6	6	6	1	1	1	3	3	40
	application - air	1	0	0	2	2	2	2	0	0	0	1	1	10
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	1
	net application	2	1	1	4	5	5	5	1	1	1	2	2	29
Pork	excreted	23	23	23	23	23	23	23	23	23	23	23	23	272
	housing - air	3	3	3	3	3	3	3	3	3	3	3	3	41
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	19	19	19	19	19	19	19	19	19	19	19	19	231
	storage - air	2	2	2	2	2	2	2	2	2	2	2	2	29
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	1
	net storage	17	17	17	17	17	17	17	17	17	17	17	17	200
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	14	4	4	6	54	8	40	20	16	16	16	14	200
	application - air	3	1	1	1	11	2	12	6	5	5	4	1	51
	- runoff	1	0	0	0	2	0	0	0	0	0	0	0	4
	net application	10	3	3	4	42	5	28	14	11	11	10	3	145

Table 11 (con't)		NITROGEN HOUSING, STORAGE AND APPLICATION LOSSES (con't)											Abbotsford / large farms 1991 Management				9
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total			
Beef	excreted	1	1	1	1	1	1	1	1	1	1	1	1	18			
	yard - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0			
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	1			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	2			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	1	1	1	1	1	1	1	1	1	1	1	1	9			
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	1			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	1	1	1	1	1	1	1	1	1	1	1	1	8			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	2	2	2	2	0	0	0	0	0	8			
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	2			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	1	1	2	2	1	1	1	1	0	11			
Horses	excreted	0	0	0	0	0	0	0	0	0	0	0	0	5			
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	1			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	3			
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	2			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	2			
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	1			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	0	0	0	0	0	0	0	0	0	3			
Other	excreted	0	0	0	0	0	0	0	0	0	0	0	0	1			
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	0			
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	0			
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	0	0	0	0	0	0	0	0	0	0			
TOTAL	excreted	158	158	158	158	158	158	158	158	158	158	158	158	1892			
	exported	3	3	3	3	3	3	3	3	3	3	3	3	36			
	air - housing/yard	27	27	27	27	27	25	25	25	25	25	25	25	314			
	- pasture	0	0	0	0	0	1	1	1	1	1	1	1	8			
	- storage	16	16	16	16	16	15	15	15	15	15	15	15	188			
	- application	18	5	5	8	66	14	73	36	29	29	29	29	317			
	runoff - housing/yard	1	1	1	1	1	1	0	0	0	0	0	0	8			
	- pasture	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- storage	1	1	1	1	0	0	0	0	0	0	0	0	3			
	- application	5	2	2	2	10	2	2	1	0	0	1	1	28			
	infiltration - housing/yard	0	0	0	0	1	1	1	1	1	1	1	1	10			
	- storage	0	0	0	0	1	1	1	1	1	1	1	1	8			
	net application and pasture	65	20	20	31	255	46	192	92	77	77	77	23	973			

NITROGEN

Abbotsford / large farms 1991 Management

10

SOIL AND ATMOSPHERE NUTRIENT BALANCE

Table 12

Table 13

SOIL RELEASE FACTORS

Table 14

SOIL RELEASES

Table 15 (con't)

PHOSPHORUS

Abbotsford / large farms 1991 Management

12

HOUSING AND STORAGE LOSS FACTORS (con't)

HOUSING AND STORAGE LOSS FACTORS (cont.)														
	(fraction lost)		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beef	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/tank	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/earth	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	semi-solid	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05
Horses	solid	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.02
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	semi-contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.02
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	uncontained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05
	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sheep	semi-contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.02
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	uncontained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03
Pigs		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05
	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	semi-contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cattle		runoff	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.01	0.02
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	uncontained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05

Table 16

YARD AREA LOSS FACTORS

air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03	0.03
infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05	0.05

Table 17

PASTURE LOSS FACTORS

air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
runoff	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01

Table 18

LAND APPLICATION LOSS FACTORS

incorporated	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<hr/>													
unincorporated	dairy	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	poultry (meat)	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	poultry(layers)	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	swine	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	beef	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	horses	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	other	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.02

Table 19 PHOSPHORUS HOUSING, STORAGE AND APPLICATION LOSSES												Abbotsford / large farms 1991 Management				13
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total		
Dairy	excreted	35	35	35	35	35	35	35	35	35	35	35	35	35	415	
	yard - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	milking centre - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	34	34	34	34	34	31	31	31	31	31	31	31	34	393	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	net storage	34	34	34	34	34	31	31	31	31	31	31	31	34	391	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
gross application	application - air	27	8	8	8	105	12	82	39	31	31	31	31	8	391	
	air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	1	0	0	0	2	0	0	0	0	0	0	0	0	4	
	net application and pasture	27	8	8	8	104	14	84	42	34	34	34	34	8	403	
	pasture															
Poultry (meat)	excreted	4	4	4	4	4	4	4	4	4	4	4	4	4	47	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	1	1	1	1	1	1	1	1	1	1	1	1	1	17	
	to storage	3	3	3	3	3	3	3	3	3	3	3	3	3	30	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	net storage	2	2	2	2	2	2	2	2	2	2	2	2	2	30	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	2	1	1	5	5	5	5	5	1	1	1	2	2	30	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	air															
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	net application	2	1	1	5	5	5	5	5	1	1	1	2	2	29	
Poultry (layers)	excreted	3	3	3	3	3	3	3	3	3	3	3	3	3	30	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	3	3	3	3	3	3	3	3	3	3	3	3	3	30	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	net storage	2	2	2	2	2	2	2	2	2	2	2	2	2	29	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	2	1	1	5	5	5	5	5	1	1	1	2	2	29	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	air															
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	net application	2	1	1	5	5	5	5	5	1	1	1	2	2	29	
Pork	excreted	7	7	7	7	7	7	7	7	7	7	7	7	7	89	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	7	7	7	7	7	7	7	7	7	7	7	7	7	89	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	net storage	7	7	7	7	7	7	7	7	7	7	7	7	7	89	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	6	2	2	3	24	4	18	9	7	7	7	6	2	89	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	air															
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	net application	6	2	2	3	24	3	18	9	7	7	7	6	2	88	

Table 19 (con't) PHOSPHORUS		Abbotsford / large farms											14	
		1991 Management												
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Beef	excreted	0	0	0	0	0	0	0	0	0	0	0	0	4
	yard - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	3
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	3
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	0	0	0	1	1	1	1	0	0	0	0	0	3
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	net application and pasture	0	0	0	1	1	1	1	0	0	0	0	0	4
Horses	excreted	0	0	0	0	0	0	0	0	0	0	0	0	1
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	1
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	1
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	1
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	net application and pasture	0	0	0	0	0	0	0	0	0	0	0	0	1
Other	excreted	0	0	0	0	0	0	0	0	0	0	0	0	0
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	housing -air	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	0
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	0
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	0
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0
	net application and pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	excreted	49	49	49	49	49	49	49	49	49	49	49	49	587
	exported	1	1	1	1	1	1	1	1	1	1	1	1	17
	air - housing/yard	0	0	0	0	0	0	0	0	0	0	0	0	0
	- pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
	- storage	0	0	0	0	0	0	0	0	0	0	0	0	0
	- application	0	0	0	0	0	0	0	0	0	0	0	0	0
	runoff - housing/yard	0	0	0	0	0	0	0	0	0	0	0	0	2
	- pasture	0	0	0	0	0	0	0	0	0	0	0	0	0
	- storage	0	0	0	0	0	0	0	0	0	0	0	0	1
	- application	1	0	0	1	2	0	1	0	0	0	0	0	6
	infiltration - housing/yard	0	0	0	0	0	0	0	0	0	0	0	0	4
	- storage	0	0	0	0	0	0	0	0	0	0	0	0	3
	net application and pasture	37	11	11	20	137	28	112	53	43	43	45	14	554

PHOSPHORUS

Abbotsford / large farms 1991 Management

SOIL AND ATMOSPHERE NUTRIENT BALANCE

Table 20

Table 21

SOIL RELEASE FACTORS

Table 22

SOIL RELEASES

Table 23

POTASSIUM

Abbotsford / large farms 1991 Management

HOUSING AND STORAGE LOSS FACTORS

Table 23 (con't)

POTASSIUMAbbotsford / large farms
1991 Management

17

HOUSING AND STORAGE LOSS FACTORS (con't)

		(fraction lost)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beef	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/tank	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/earth	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	semi-solid	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.15	0.15	0.15	0.15	0.08	0.08	0.03	0.03	0.00	0.00	0.03	0.08
Horses	solid	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05
	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	semi-contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.08	0.08	0.08	0.08	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.05
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	uncontained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.15	0.15	0.15	0.15	0.08	0.08	0.03	0.03	0.00	0.00	0.03	0.08
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05
	bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	non-bedded housing	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	semi-contained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.08	0.08	0.08	0.08	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.05
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.02
	uncontained	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		runoff	0.15	0.15	0.15	0.15	0.08	0.08	0.03	0.03	0.00	0.00	0.03	0.08
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05

Table 24

YARD AREA LOSS FACTORS

air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
runoff	0.15	0.15	0.15	0.15	0.08	0.08	0.03	0.03	0.00	0.00	0.00	0.03	0.08
infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05	0.00

Table 25

PASTURE LOSS FACTORS

air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
runoff	0.06	0.06	0.06	0.06	0.03	0.03	0.02	0.00	0.00	0.00	0.02	0.03	0.03

Table 26

LAND APPLICATION LOSS FACTORS

incorporated	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
unincorporated	dairy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	poultry (meat)	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	poultry(layers)	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	swine	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	beef	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	horses	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	other	air	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
		runoff	0.09	0.09	0.09	0.09	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.05

Table 27 POTASSIUM HOUSING, STORAGE AND APPLICATION LOSSES												Abbotsford / large farms 1991 Management			18
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	
Dairy	excreted	96	96	96	96	96	96	96	96	96	96	96	96	1157	
	yard - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	1	1	1	1	1	1	0	0	0	0	0	1	8	
	- infiltration	0	0	0	0	0	0	1	1	1	1	1	0	5	
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	milking centre - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	3	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	5	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	94	94	94	94	95	87	87	87	87	87	87	95	1089	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	1	1	1	1	0	0	0	0	0	0	0	0	5	
	- infiltration	0	0	0	0	0	0	1	1	1	1	1	0	4	
	net storage	94	94	94	94	94	86	86	86	87	87	86	94	1080	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	76	22	22	22	292	32	227	108	86	86	86	22	1080	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	7	2	2	2	13	1	3	2	0	0	0	1	34	
	net application and pasture	69	20	20	20	279	38	231	114	94	94	93	21	1092	
Poultry (meat)	excreted	5	5	5	5	5	5	5	5	5	5	5	5	58	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	2	2	2	2	2	2	2	2	2	2	2	2	21	
	to storage	3	3	3	3	3	3	3	3	3	3	3	3	37	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	1	
	net storage	3	3	3	3	3	3	3	3	3	3	3	3	36	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	3	1	1	6	6	6	6	1	1	1	1	3	36	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	1	0	0	0	0	0	0	0	0	2	
	net application	2	1	1	5	6	6	6	1	1	1	3	2	35	
Poultry (layers)	excreted	3	3	3	3	3	3	3	3	3	3	3	3	36	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	3	3	3	3	3	3	3	3	3	3	3	3	36	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	1	
	net storage	3	3	3	3	3	3	3	3	3	3	3	3	36	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	3	1	1	6	6	6	6	1	1	1	1	3	36	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	1	0	0	0	0	0	0	0	0	2	
	net application	2	1	1	5	5	5	6	1	1	1	2	2	34	
Pork	excreted	13	13	13	13	13	13	13	13	13	13	13	13	159	
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	to storage	13	13	13	13	13	13	13	13	13	13	13	13	159	
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	
	net storage	13	13	13	13	13	13	13	13	13	13	13	13	158	
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	
	gross application	11	3	3	5	43	6	32	16	13	13	11	3	158	
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	
	- runoff	1	0	0	0	2	0	0	0	0	0	0	0	5	
	net application	10	3	3	4	41	6	31	16	13	13	11	3	153	

Table 27 (con't)		POTASSIUM HOUSING, STORAGE AND APPLICATION LOSSES (con't)												Abbotsford / large farms 1991 Management				19
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total				
Beef	excreted	1	1	1	1	1	1	1	1	1	1	1	1	1	11			
	yard - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	1	1	1	1	1	0	0	0	0	0	0	0	0	1	7		
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	1	1	1	1	1	0	0	0	0	0	0	0	0	1	7		
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	1	1	1	1	0	0	0	0	0	0	7			
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	1	2	2	2	1	1	1	1	1	0	11			
Horses	excreted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3		
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3		
Other	excreted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	pasture - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	housing - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	to storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	storage - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- infiltration	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	exported	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	gross application	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	application - air	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	net application and pasture	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
TOTAL	excreted	119	119	119	119	119	119	119	119	119	119	119	119	119	1425			
	exported	2	2	2	2	2	2	2	2	2	2	2	2	2	21			
	air - housing/yard	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- pasture	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	- application	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
	runoff - housing/yard	2	2	2	2	1	1	1	1	0	0	0	0	1	1	11		
	- pasture	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		
	- storage	1	1	1	1	0	0	0	0	0	0	0	0	0	0	5		
	- application	8	2	2	4	16	2	4	2	0	0	0	2	1	43			
	infiltration - housing/yard	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10		
	- storage	0	0	0	0	1	1	1	1	1	1	1	1	1	1	6		
	net application and pasture	84	25	25	36	332	58	276	133	110	110	110	29	1327				

POTASSIUM

Abbotsford / large farms 1991 Management

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SOIL AND ATMOSPHERE NUTRIENT BALANCE

Table 28

NUTRIENT APPLICATIONS

Table 29

SOIL RELEASE FACTORS

Table 30

SOIL RELEASES

APPENDIX C
NUTRIENT MODEL
CALCULATIONS

Agricultural Land Base

Cropped Area
Non-cropped area
Total Agricultural Land Base

TABLE 3

Estimated Annual Nutrient Balance (tonnes)

N P K

Manure Produced

Dairy
Poultry (meat)
Poultry (layers)
Swine
Beef
Other

TABLE 2

Total**Exported**

TABLE 12

Management Losses

air
runoff
infiltration

TABLE 12

Net Manure Application

TABLE 12

Crop Requirement
Fertilizer Applied

TABLE 5

Net Crop-Fertilizer**Net Atmospheric Input**

TABLE 6

Applied Surplus (Deficit)

TABLE 12

Estimated Annual Nutrient Balance (kg / cropped hectare)

N P K

Manure Produced - Total**Manure Exported****Manure Management Losses**

air
runoff
infiltration

= values summarized above / cropped area above

Net Manure Application

Crop Requirement
Fertilizer Applied

Net Crop-Fertilizer**Net Atmospheric Input****Applied Surplus (Deficit)**

INVENTORY AND LIVESTOCK NUTRIENT PRODUCTION

Nutrient Model Calculations

2

Table 3 LAND BASE INVENTORY

(from Project 1 Inventory)

hectares

Grass hay	
Improved Pasture	
Unimproved Pasture	
Silage corn	
Grain	
Vegetables	potatoes peas corn beans cole crops other
Berries	raspberries strawberries blueberries other
Other field crops	
Tree Fruits	
Nursery Crops	
Sod	
Summerfallow	
Catch crops	
Total cropped area	0
Total non-cropped land	
Total agricultural land	0

Table 4

LIVESTOCK WASTE MANAGEMENT SYSTEMS
(fraction livestock under each management system)

**Nutrient Model
Calculations**
DAIRY WASTE MANAGEMENT SYSTEMS

HOUSING	free stall
	tie stall
	bedded housing

STORAGE	contained	uncontained
slurry, concrete/tank		
slurry, earth lagoon		
semi-solid		
solid		

MILKING CENTRE	with manure
	tile fields
	discharge

EXPORTED	before storage
	after storage

YARD AND PASTURE - fraction time in yard or on pasture

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
yard												
pasture												

LAND APPLICATION - fraction applied, from storage

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
applied												
incorporated												

input variables:

- * ratio of total manure nutrient production occurring within each housing system to total manure nutrient production, for each commodity group
- * ratio of milking centre waste water nutrients handled by each disposal system to total milking centre waste water nutrients, dairy only
- * ratio of manure nutrients exported before storage to total manure nutrients produced, for each commodity
- * ratio of manure nutrients exported after storage to total manure nutrients leaving storage, for each commodity
- * ratio of total manure nutrients entering each storage system to total manure nutrients entering storage, for each commodity group
- * ratio of total manure nutrient production occurring in yard areas to total manure nutrient production, by month, dairy and beef
- * ratio of total manure nutrient production occurring on pasture to total manure nutrient production, by month, dairy, beef, horses and other
- * ratio of amount of manure nutrients applied to land each month to total annual manure nutrients applied to land, for each commodity
- * ratio of applied manure nutrients incorporated to total manure nutrients applied to land, by month, for each commodity

Table 5 CROP NUTRIENT REQUIREMENTS AND INORGANIC FERTILIZER APPLICATIONS					Nutrient Model Calculations	5													
	cropped area (hectares)	crop requirements (kg/ha/yr)			inorganic fertilizer applications (kg/ha/yr)	crop - inorganic fertilizer balance (tonnes/year)													
		N	P	K	N	P	K	N	P	K									
Grass hay																			
Improved Pasture																			
Unimproved Pasture																			
Silage corn																			
Grain																			
Vegetables																			
potatoes		* crop nutrient removal - inorganic fertilizer applications, by crop																	
peas		* total crop nutrient removal, all crops																	
corn		* total inorganic fertilizer applications, all crops																	
beans		* total crop nutrient removal - total inorganic fertilizer applications, all crops																	
cole crops																			
other																			
Berries																			
raspberries																			
strawberries																			
blueberries																			
other																			
Other field crops																			
Tree Fruits																			
Nursery Crops																			
Sod																			
Summerfallow																			
Catch crops																			
Total - Surplus (Deficit)					(tonnes/year)			(tonnes/year)		(tonnes/year)									
Total non-cropped land																			
Total agricultural land																			
Note: this nutrient balance does not account for manure applications																			
Note: negative value for balance indicates crop requirement exceeds inorganic fertilizer application																			

Table 6 ATMOSPHERIC NITROGEN BALANCE			Nutrient Model Calculations
background inputs	kg/ha	* background rate of nitrogen deposition	
background inputs	tonnes	* background inputs = background deposition x total cropped area	
atmospheric losses	small farms	* total losses to air on small farms, TABLE 12 of corresponding small farm model	
atmospheric losses	large farms	* total losses to air on large farms, TABLE 12	
atmospheric losses	tonnes	* total losses to air = losses to air small farms + losses to air large farms	
atmospheric losses	tonnes **	= total losses to air x ratio cropped area large farms to total cropped area	
atmospheric returns	%	*ratio of nitrogen deposition to total nitrogen losses to air	
atmospheric returns	tonnes	= total losses to air x ratio cropped area large farms to total cropped area x ratio of nitrogen deposition	
Total atmos. inputs	tonnes		
*total for the Zone (large farms + small farms)			
** prorated share for large farms		* ratio cropped area large farms to total cropped area (large farms + small farms)	

Table 7

NITROGEN**Nutrient Model
Calculations****HOUSING AND STORAGE LOSS FACTORS**

		(fraction lost)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Dairy	free stall	air												
	tie stall	air												
	bedded housing	air												
	slurry/tank	air												
		runoff												
		infiltration												
	slurry/earth	air												
		runoff												
		infiltration												
	semi-solid	air												
		runoff												
		infiltration												
	solid	air												
		runoff												
		infiltration												
	tile field	air												
		runoff												
		infiltration												
	discharge	air												
		runoff												
		infiltration												
Poultry (Meat)	concrete floor	air												
	dirt floor	air												
		runoff												
		infiltration												
	contained	air												
	semi-contained	air												
		runoff												
		infiltration												
	uncontained	air												
		runoff												
		infiltration												
Poultry (Layers)	pit, fans	air												
	pit, no fans	air												
	pit, outside	air												
	concrete floor	air												
	dirt floor	air												
		runoff												
		infiltration												
	contained	air												
	semi-contained	air												
		runoff												
		infiltration												
	uncontained	air												
		runoff												
		infiltration												
Pork	slatted floor	air												
	partially slatted floor	air												
	bedded floor	air												
	tank, covered	air												
		runoff												
		infiltration												
	tank, uncovered	air												
		runoff												
		infiltration												
	earth lagoon	air												
		runoff												
		infiltration												
	solid	air												
		runoff												
		infiltration												
	compost	air												
		runoff												
		infiltration												

input variables: (for each commodity group)

* ratio of loss of nutrient to total total

amount of nutrient entering each manure management system

component

(by month for each loss destination and manure management system component as shown in TABLES 7 TO 10)

Table 7 (con't)

NITROGEN**Nutrient Model
Calculations**

7

HOUSING AND STORAGE LOSS FACTORS (con't)

		(fraction lost)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beef	bedded housing	air												
	non-bedded housing	air												
	slurry/tank	air												
		runoff												
		infiltration												
	slurry/earth	air												
		runoff												
		infiltration												
	semi-solid	air												
		runoff												
		infiltration												
	solid	air												
		runoff												
		infiltration												
Horses	bedded housing	air												
	non-bedded housing	air												
	contained	air												
	semi-contained	air												
		runoff												
		infiltration												
	uncontained	air												
		runoff												
		infiltration												
Other	bedded housing	air												
	non-bedded housing	air												
	contained	air												
	semi-contained	air												
		runoff												
		infiltration												
	uncontained	air												
		runoff												
		infiltration												

Table 8

YARD AREA LOSS FACTORS

air
runoff
infiltration

Table 9

PASTURE LOSS FACTORS

air
runoff

Table 10

LAND APPLICATION LOSS FACTORS

incorporated	air
	runoff
unincorporated	
dairy	air
poultry (meat)	air
poultry(layers)	air
swine	air
beef	air
horses	air
other	air
	runoff

**Table 11 NITROGEN
HOUSING, STORAGE AND APP**

Nutrient Model Calculations

Table 11 (con't)		NITROGEN HOUSING, STORAGE AND APPLICATION LOSSES (con't)												Nutrient Model Calculations	9
	(tonnes)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total	
Beef	excreted														
	yard - air														
	- runoff														
	- infiltration														
	pasture - air														
	- runoff														
	housing - air														
	exported														
	to storage														
	storage - air														
	- runoff														
	- infiltration														
	net storage														
	exported														
	gross application														
	application - air														
	- runoff														
	net application and pasture														
Horses	excreted														
	pasture - air														
	- runoff														
	housing - air														
	exported														
	to storage														
	storage - air														
	- runoff														
	- infiltration														
	net storage														
	exported														
	gross application														
	application - air														
	- runoff														
	net application and pasture														
Other	excreted														
	pasture - air														
	- runoff														
	housing - air														
	exported														
	to storage														
	storage - air														
	- runoff														
	- infiltration														
	net storage														
	exported														
	gross application														
	application - air														
	- runoff														
	net application and pasture														
TOTAL	excreted														
	exported														
	air - housing/yard														
	- pasture														
	- storage														
	- application														
	runoff - housing/yard														
	- pasture														
	- storage														
	- application														
	infiltration - housing/yard														
	- storage														
	net application and pasture														

= totals from each commodity above

NITROGEN

Nutrient Model Calculations

SOIL AND ATMOSPHERE NUTRIENT BALANCE

Table 12

Table 13

SOIL RELEASE FACTORS

Table 14

SOIL RELEASES

APPENDIX D
NUTRIENT MODEL INPUT VARIABLES
IMPROVED FERTILIZATION AND MANURE HANDLING

Table 4

LIVESTOCK WASTE MANAGEMENT SYSTEMS
 (fraction livestock under each management system)

 Abbotsford / large farms
 Reduced fert + improved storage

3

DAIRY WASTE MANAGEMENT SYSTEMS

HOUSING	free stall	0.94
	tie stall	0.03
	bedded housing	0.03
MILKING CENTRE	with manure	1.00
	tile fields	0.00
	discharge	0.00
EXPORTED	before storage	0.00
	after storage	0.00

STORAGE	contained	uncontained
slurry, concrete/tank	0.80	1.00
slurry, earth lagoon	0.08	1.00
semi-solid	0.09	1.00
solid	0.03	1.00

YARD AND PASTURE - fraction time in yard or on pasture

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
yard	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.09
pasture	0.00	0.00	0.00	0.00	0.00	0.08	0.08	0.08	0.08	0.08	0.08	0.00

LAND APPLICATION - fraction applied, from storage

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
applied	0.00	0.00	0.00	0.00	0.33	0.08	0.30	0.13	0.08	0.08	0.00	0.00
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00

POULTRY (MEAT) WASTE MANAGEMENT SYSTEMS

HOUSING	concrete floor	0.74
	dirt floor	0.26
EXPORTED	before storage	0.36
	after storage	0.00

STORAGE	contained storage	1.00
	semi-contained storage	0.00
	uncontained storage	0.00

LAND APPLICATION - fraction applied, from storage

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
applied	0.00	0.00	0.00	0.00	0.33	0.08	0.30	0.13	0.08	0.08	0.00	0.00
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

POULTRY (LAYERS) WASTE MANAGEMENT SYSTEMS

HOUSING	pit	0.73	fans	0.16
			no fans	0.81
			outside	0.03
	floor	0.27	concrete	0.97
			dirt	0.03
EXPORTED	before storage	0.00		
	after storage	0.00		

STORAGE	contained storage	1.00
	semi-contained storage	0.00
	uncontained storage	0.00

LAND APPLICATION - fraction applied, from storage

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
applied	0.00	0.00	0.00	0.00	0.33	0.08	0.30	0.13	0.08	0.08	0.00	0.00
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PORK WASTE MANAGEMENT SYSTEMS

HOUSING	slatted floor	0.45
	partially slatted floor	0.50
	bedded floor	0.05
EXPORTED	before storage	0.00
	after storage	0.00

STORAGE	contained	uncontained
tank, covered	0.50	1.00
tank, uncovered	0.25	1.00
earth lagoon	0.20	1.00
solid	0.03	1.00
compost	0.03	1.00

LAND APPLICATION - fraction applied, from storage

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
applied	0.00	0.00	0.00	0.00	0.33	0.08	0.30	0.13	0.08	0.08	0.00	0.00
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00

LIVESTOCK WASTE MANAGEMENT SYSTEMS (con't)											Abbotsford / large farms Reduced fert + improved storage			
(% livestock under each management system)														
BEEF WASTE MANAGEMENT SYSTEMS														
HOUSING	bedded housing	1.00						STORAGE						
	non-bedded housing	0.00						slurry, concrete/tank	0.00	contained	uncontained			
EXPORTED	before storage	0.00						slurry, earth lagoon	0.00					
	after storage	0.00						semi-solid	0.00					
								solid	1.00	1.00	0.00			
YARD AND PASTURE - fraction time in yard or on pasture														
yard	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
pasture	0.25	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.25		
LAND APPLICATION - fraction applied, from storage														
applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.05	0.05	0.05	0.05	0.00		
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
HORSE WASTE MANAGEMENT SYSTEMS														
HOUSING	bedded housing	1.00						STORAGE						
	non-bedded housing	0.00						contained storage	1.00					
EXPORTED	before storage	0.00						semi-contained storage	0.00					
	after storage	0.00						uncontained storage	0.00					
PASTURE - fraction time on pasture														
pasture	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.25	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.25		
LAND APPLICATION - fraction applied, from storage														
applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.05	0.05	0.05	0.05	0.00		
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
OTHER WASTE MANAGEMENT SYSTEMS														
HOUSING	bedded housing	1.00						STORAGE						
	non-bedded housing	0.00						contained storage	1.00					
EXPORTED	before storage	0.00						semi-contained storage	0.00					
	after storage	0.00						uncontained storage	0.00					
PASTURE - fraction time on pasture														
pasture	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.25	0.25	0.25	0.25	0.25	0.50	0.50	0.50	0.50	0.50	0.50	0.25		
LAND APPLICATION - fraction applied, from storage														
applied	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	0.00	0.00	0.00	0.20	0.20	0.20	0.20	0.05	0.05	0.05	0.05	0.00		
incorporated	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		

Table 7

NITROGEN

Abbotsford / large farms

6

HOUSING AND STORAGE LOSS FACTORS

Table 7 (con't)		NITROGEN										Abbotsford / large farms Reduced fert + improved storage		7
HOUSING AND STORAGE LOSS FACTORS (con't)														
		(fraction lost)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beef	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	slurry/tank	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/earth	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
	runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	infiltration	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	semi-solid	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.05	0.05
	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.05	0.05
Horses	solid	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.01	0.00	0.00	0.01	0.03
	infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.04	0.02
	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	semi-contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.01	0.00	0.00	0.01	0.03
	infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.04	0.02
	uncontained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02	0.05	0.05
	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05
Other	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	semi-contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.00	0.01	0.03
	infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04	0.04	0.02
	uncontained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.00	0.02	0.05
	infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08	0.08	0.05

Table 8		YARD AREA LOSS FACTORS												
air														
		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 9		PASTURE LOSS FACTORS												
air														
		0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	
		runoff	0.04	0.04	0.04	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.02

Table 10		LAND APPLICATION LOSS FACTORS												
incorporated														
		air	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unincorporated														
	dairy	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
	poultry (meat)	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	poultry(layers)	air	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	swine	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
	beef	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
	horses	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
	other	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
		runoff	0.06	0.06	0.06	0.06	0.03	0.03	0.01	0.01	0.00	0.00	0.01	0.03

APPENDIX E

NUTRIENT MODEL INPUT VARIABLES

IMPROVED FERTILIZATION, MANURE HANDLING AND FEED RATIONS

INVENTORY AND LIVESTOCK NUTRIENT PRODUCTION
Abbotsford / large farms
2
Improved fertilization, storage and feeding

Table 2			LIVESTOCK NUTRIENT PRODUCTION								
LIVESTOCK INVENTORY (from Project 1 Inventory)			unit nutrient production (kg/animal/year)			total nutrient production (tonnes/year)			total by commodity and percentage		
		number	N	P	K	N	P	K	N	P	K
Dairy	bulls	53	84.0	20.1	76.4	4.5	1.1	4.0			
	cows	9435	87.0	13.1	97.1	820.8	123.6	916.1	1030	415	1157
	heifers	4305	31.5	47.2	37.4	135.6	203.2	161.0	72%	77%	81%
	calves	3570	15.0	21.9	14.9	53.0	78.2	53.2			
	milking centre		1.7	1.0	2.4	16.0	9.4	22.6			
Poultry (meat)	chickens (1000's)	185.0	0.45	0.16	0.28	83.3	29.6	51.8	93	33	58
	turkeys (1000's)	6.0	0.65	0.19	0.43	3.9	1.1	2.6	7%	6%	4%
	other (1000's)	12.8	0.45	0.16	0.28	5.8	2.0	3.6			
Poultry (layers)	pullets (1000's)	37.1	0.26	0.07	0.12	9.6	2.6	4.5	78	21	36
	layers (1000's)	114.4	0.60	0.16	0.28	68.6	18.3	32.0	5%	4%	3%
Swine	boars	144	18.2	5.3	9.5	2.6	0.8	1.4	204	63	159
	sows	3131	13.7	3.9	7.1	42.9	12.2	22.2	14%	12%	11%
	other	29349	5.4	1.7	4.6	158.5	49.9	135.0			
Beef	bulls	18	112.0	20.1	76.4	2.0	0.4	1.4			
	cows	104	78.0	13.5	39.8	8.1	1.4	4.1	18	4	11
	heifers	54	44.0	14.4	33.2	2.4	0.8	1.8	1%	1%	1%
	steers	105	50.0	16.2	36.5	5.3	1.7	3.8			
	calves	0	20.0	21.9	14.9	0.0	0.0	0.0			
Horses		112	45.5	7.6	28.4	5.1	0.9	3.2	5	1	3
Sheep	rams	4	11.0	1.6	8.0	0.0	0.0	0.0	1	0	0
	ewes	28	11.0	1.6	8.0	0.3	0.0	0.2	0%	0%	0%
	lambs	42	4.4	0.6	3.2	0.2	0.0	0.1	0	0	0
Goats		12	11.0	1.6	8.0	0.1	0.0	0.1	0%	0%	0%
						Total	1429	537	1425		

Table 3		LAND BASE INVENTORY
(from Project 1 Inventory)		hectares
Grass hay		3008
Improved Pasture		380
Unimproved Pasture		212
Silage corn		1137
Grain		173
Vegetables	potatoes	9
	peas	306
	corn	178
	beans	25
	cole crops	586
	other	178
Berries	raspberries	198
	strawberries	55
	blueberries	28
	other	14
Other field crops		0
Tree Fruits		17
Nursery Crops		55
Sod		67
Summerfallow		61
Catch crops		0
Total cropped area		6687
Total non-cropped land		345
Total agricultural land		7032

Table 7

NITROGEN

Abbotsford / large farms

6

HOUSING AND STORAGE LOSS FACTORS

Table 7 (con't)		NITROGEN											7
		Abbotsford / large farms Improved fertilization, storage and feeding											
HOUSING AND STORAGE LOSS FACTORS (con't)													
	(fraction lost)	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Beef	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	slurry/tank	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	slurry/earth	air	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	semi-solid	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
		runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08
Horses	solid	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04
	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	semi-contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04
	uncontained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Other		runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08
	bedded housing	air	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
	non-bedded housing	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	semi-contained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
		runoff	0.05	0.05	0.05	0.05	0.03	0.03	0.01	0.01	0.00	0.00	0.01
		infiltration	0.00	0.00	0.00	0.00	0.02	0.02	0.04	0.04	0.05	0.05	0.04
	uncontained	air	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
		runoff	0.10	0.10	0.10	0.10	0.05	0.05	0.02	0.02	0.00	0.00	0.02
		infiltration	0.00	0.00	0.00	0.00	0.05	0.05	0.08	0.08	0.10	0.10	0.08

Table 8		YARD AREA LOSS FACTORS												
air														
		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		infiltration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 9		PASTURE LOSS FACTORS												
air														
		0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	
		runoff	0.04	0.04	0.04	0.04	0.02	0.02	0.01	0.00	0.00	0.00	0.01	0.02

Table 10		LAND APPLICATION LOSS FACTORS											
incorporated													
		air	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
		runoff	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unincorporated													
	dairy	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.20
	poultry (meat)	air	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	poultry(layers)	air	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	swine	air	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.30	0.20
	beef	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.20
	horses	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.20
	other	air	0.20	0.20	0.20	0.20	0.20	0.30	0.30	0.30	0.30	0.30	0.20
		runoff	0.06	0.06	0.06	0.06	0.03	0.03	0.01	0.01	0.00	0.00	0.01