Metz Farms 2 Ltd.

Summary of Surface Water and Groundwater Monitoring

2000 - 2003

Acknowledgments

The following are thanked for their contributions to this project: D. Fox, A. Daigle, E. Foster, M. Dickson, D. Bourgeois, R.N. Hughes, R. Theriault.

For copies of this, and previous reports and requests for data, please contact the Sciences and Reporting Branch, Department of the Environment and Local Government, P.O. Box 6000, Fredericton, New Brunswick, E3B 5H1; Tel: (506) 457-4844.

Table of Contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

The New Brunswick Department of the Environment and Local Government (DELG) conducted a monitoring program of surface and well water quality in the vicinity of Sainte-Marie-de-Kent, New Brunswick, between 2000 and 2003. The purpose of the program was to assess the possible effects of land application of liquid manure generated at Metz Farms 2 Ltd. on local surface and well water quality.

This report presents a summary of data collected between 2000 and 2003. For surface water, results from sites in three representative areas are included. The parameters presented are concentrations of nutrients (total phosphorus and total nitrogen), and bacteria, including fecal coliforms and Escherichia coli (E. coli). For groundwater, results for total coliforms, E. coli, and general chemistry are included.

As stated in previous reports, there was difficulty in distinguishing between various possible sources of the chemical and biological components found in the water. Also, the variability of surface water quality during rainfall events presented an obstacle to interpretation. However, there remained a clear correlation of increasing concentration of all parameters after major rain events. This correlation existed in all areas regardless of whether or not Metz manure was applied.

Results for surface water and groundwater were consistent with nutrients and bacteria originating from multiple sources, including manure (from Metz and other farms), livestock pasturing, septic systems and other sources such as wild animals. There was no overall increasing trend in nutrient or bacteria concentrations over the four-year monitoring period. For groundwater, the general chemistry results obtained in Spring, 2003 were not significantly different from those obtained in 2000, prior to Metz manure spreading.

INTRODUCTION

On August 30, 1999, Metz Farms 2 Ltd. was issued a license (#LO-0006) to operate a piggery at Sainte-Marie-de-Kent, near Bouctouche (Figure 1) under Section 5(1) of the New Brunswick Livestock Operations Act administered by the New Brunswick Department of Agriculture, Fisheries and Aquaculture (DAFA).

Figure 1. Location of Metz Farms 2 Ltd. In Eastern New Brunswick.

Manure management involved applying stored liquid manure on nearby farm fields. Applications of liquid manure occurred in the spring and fall of 2000, spring, summer and fall of 2001, spring and fall of 2002 and 2003. The license required certain restrictions on manure application to minimize impacts on water quality including: timing of application, setbacks near watercourses, restrictions on slope and soil characteristics where spreading was to take place, and specified application rates.

A Ministerial Monitoring Committee was formed in the fall of 1999 and made up of staff from the New Brunswick departments of: Environment and Local Government; Agriculture, Fisheries and Aquaculture; Natural Resources and Energy; and Health and Wellness. Other organizations represented included Fisheries and Oceans Canada, the Local Service District, the Cooperative des Huîtres de Bouctouche, the Agri-Conservation Club, Sustainable Development at Northumberland Strait and the Southeastern Angler’s Association.

The mandate of this committee was to develop a surface and groundwater quality monitoring plan. Ultimately, the plan would help to determine if, and to what extent, manure applications affected surface and groundwater quality in the area. The surface water sampling stations were chosen by this committee, and the monitoring plan called for sites to be sampled routinely, as well as after a rainfall of 25 mm or greater within a 24 hour period. For the groundwater monitoring, homeowner wells were sampled three to four times per year.

The Department of the Environment and Local Government (DELG) conducted the water sample program between 2000 and 2003 to investigate the effects of manure management on both surface water and groundwater. The first report (NBDELG, 2001) entitled "Metz Farms 2 Ltd. Surface Water & Groundwater Monitoring Results April to October, 2000" presented the findings of fecal coliform bacteria in surface water, and total coliform, E. coli, and additional chemical parameters for groundwater for samples taken between April and October 2000.

The second report (NBDELG, 2002) entitled "Metz Farms 2 Ltd. Surface Water & Groundwater Monitoring Results 2000-2001" presented surface water data on total phosphorus (TP), potassium (K), nitrate + nitrite (NOX) and copper (Cu) for the year 2000, and total phosphorus (TP), potassium (K), total nitrogen (TN), copper (Cu) and fecal coliform bacteria for the year 2001. For groundwater, the report presented data on total coliform and E. coli bacteria for the sampling year 2001.

This report presents results of TP, TN, fecal coliform, and E. coli in surface waters in three areas around sites DF1, MG1-MG2, and 10-13 (Figure 2) between 2000 and 2003. For groundwater, results for total coliforms, E.coli, and general chemistry are included for all areas sampled.

ADDITIONAL DATA

Details of liquid manure spreading (volumes, dates, and field identification) were provided by DAFA, Moncton Regional Office (see Tables 1 to 4). DAFA staff were on hand to witness most of the spreading activity to ensure that the application adhered to the manure management plan.

Rainfall data at Moncton airport (year 2000), and Bouctouche (years 2001, 2002, and 2003) were obtained from Environment Canada (see Figures 3 to 6). Moncton airport data was used in 2000 because Bouctouche rainfall data was not available for that year.

Figure 2. Surface Water Sampling Stations, 2000 - 2003

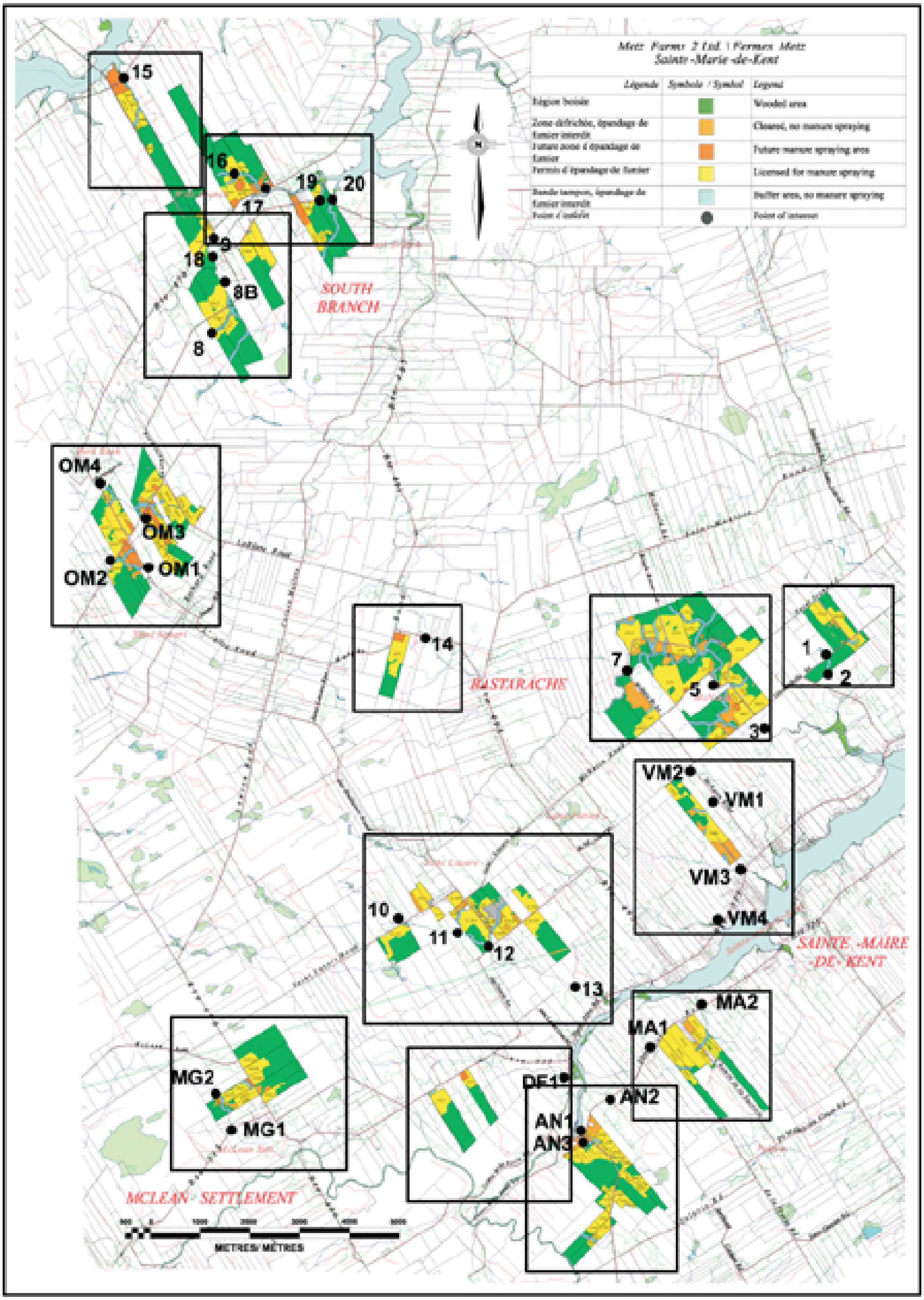


Figure 2. Surface Water Sampling Stations, 2000 - 2003

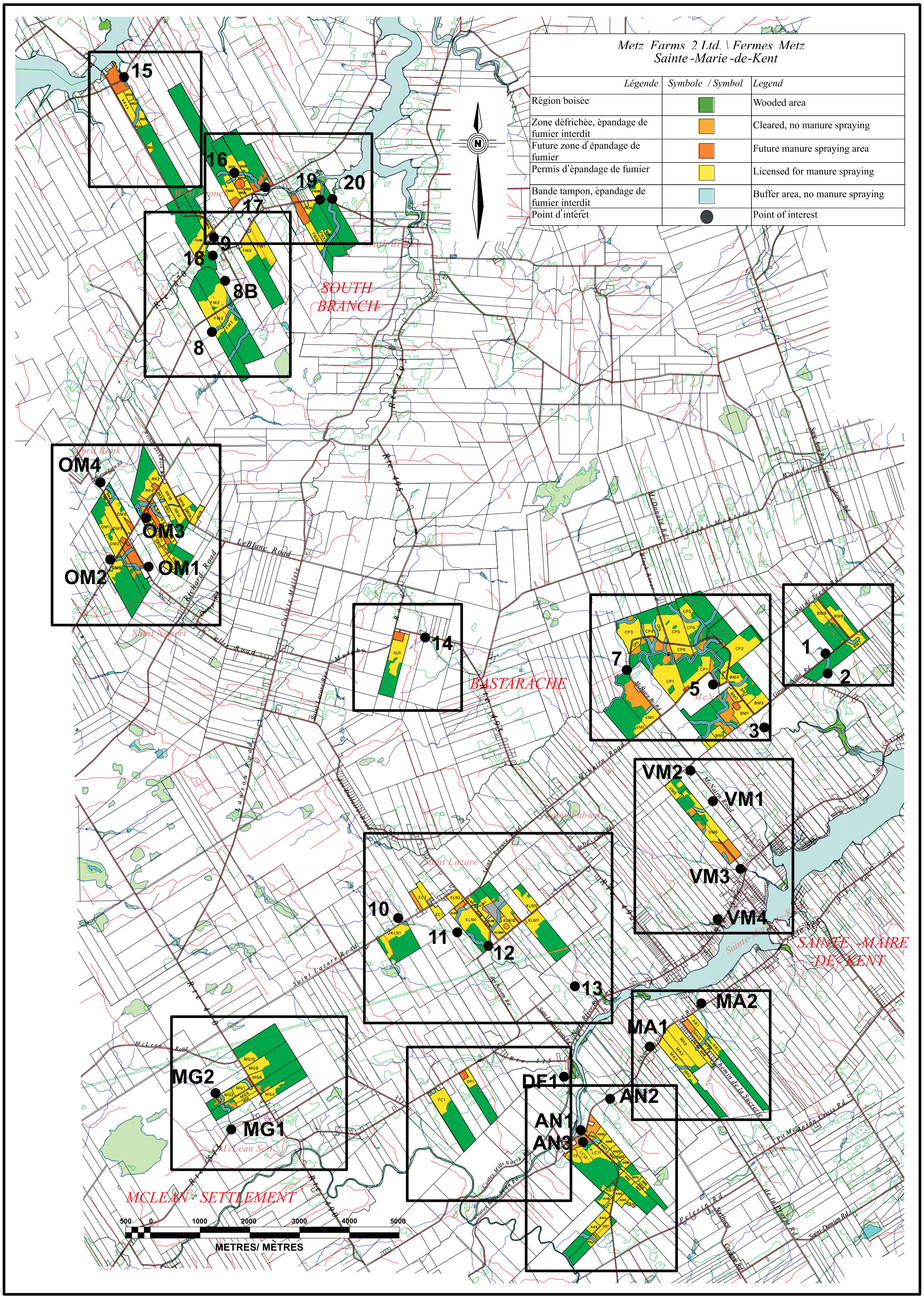


Table 1. Manure Spreading Information, Year 2000.

Field Identification	Volume (Imperial Gallons)	Date
Part of CP3	22,500	June 1
FW2	311,250	June 6, 12
BM8, BM9, part of BM 7	232,500	June 13
Part of BM5, BM6	56,250	June 13 (night)
Last of BM7, BM3, north side of BM 2	240,000	June 14
Section of CP3	93,750	June 14 (night)
CP2	198,750	June 15
BM4	26,250	June 15
VM1	90,000	October 12, 23, 24, 25
VM5	22,500	October 24
VM6	142,500	October 23, 24
CP1	300,000	October 11, 12
MA2, MA3, MA8	322,500	October 13, 14, 18, 23
MA10	45,000	October 13
AN1, AN2, AN3, AN4	150,000	October 26, 27
LC11, LC12, LC13	108,750	October 25, 26
AN 20, AN21, AN22	60,000	October 25, 26
AN19, AN23	37,500	October 25, 26
AN16	26,250	October 26
AN8, AN9, AN10	22,500	October 27
Total	**2,508,750**	

Table 2. Manure Spreading Information, Year 2001.

Field Identification	Volume (Imperial Gallons)	Date
BM-8, BM-9, BM-2, BM-3	180,000	June 11
BM-1, BM-2, BM-4, BM-3, EC-2	240,000	June 13
KLN-4, KLN-8, KLN-9, KLN-6, KLN-5, KLN-8A	273,750	June 14
KLN-8A, KLN-11, KLN-1	202,500	June 15
MG-8, MG-9	131,250	June 19
MG-10, MG-1, MG-9, KL-11	232,500	June 20
KL-11, BM-5, BM-6	217,500	June 21
FW-2	168,750	July 16
FW-2, FW-1	165,000	July 17
FW-1, FW-3, FW-26	198,750	July 18
FW-26, FW-25	93,750	July 19
FW-25, FW-14, FW-26, SR-29	93,750	July 20
SR-29, FW-40	187,500	July 23
SR–21A, SR-21B, SR-22, SR-23, SR-24, SR-20, FW-12 FW-13	191,250	July 24
FW-12, FW-13, FW-3, FW-35	176,250	July 25
RR-14, RR-3, RR-2, RR-4, RR-1B	273,750	July 26
OM-4, OM- 3, OM-1, OM-2	277,500	July 27
OM - 3	108,750	July 30
OM - 5, SR-16, SR-17A, SR-17B	198,750	July 31
SR - 13, SR-14, SR-12, SR-10, SR-8, SR-11	202,500	August 1
VM-1, VM-6	183,750	Sept 25
VM-6, VM-5, LC-13	131,250	Sept 26
LC-12, LC-11	60,000	Sept 27
AN-11, AN- 2, AN-13, AN-14, AN-15, LC-11	150,000	Sept 28
AN-8, AN- 9, AN-10, AN-1, AN-2, AN-3, AN-4	161,250	October 1
AN-1, AN-2, AN-3, AN-4, AN-5, AN-6 AN-7, AR-1	138,750	October 2
AR-1, CP-1	86,250	October 3
CP-1	108,750	October 4
CP-1	116,250	October 5
CP-3	105,000	October 9
CP-3, CP-4	112,500	October 10
CP-4, CP-5	78,750	October 11
CP-5	75,000	October 19
BM-5, BM-6, CP-2	112,500	October 22
CP-2	131,250	October 23
CP-2, CP-5	67,500	October 24
Total	**5 632,500**	

Table 3. Manure Spreading Information, Year 2002.

Field Identification	Volume (Imperial Gallons)	Date
OM-3, OM-4, FW-2	172,500	May 29
FW-2, BM-4, BM-2	123,750	May 30
BM-2, BM-1, BM-3	255,000	May 31
BM-7, BM-8, BM-9	172,500	June 03
BM-8, FW-2	150,000	June 04
Fw-2, OM-4, OM-3	217,500	June 05
OM-3, OM-1, OM-2	210,000	June 07
MA-3	116,250	Sept 18
MA-3, MA-2, MA-8	180,000	Sept 19
MA-8, MA-10, AR-1, EC-1, EC-2	183,750	Sept 20
EC-2, KLN-6, KLN-9, KLN-8 KLN-4	270,000	Sept 21
KLN-4, KLN-8A, KLN-10	123,750	Sept 23
KLN-10, KLN-11, KLN-12	240,000	Sept 25
KL-11, CP-2	228,750	Sept 26
CP-2	153,750	Sept 27
CP-5	210,000	Sept 30
VM-1, BM-6, BM-5, CP-3	153,750	Oct 01
BM-5, CP-3, CP-4, CP-5, RR-1A, RR-3	213,750	Oct 02
CP-3, RR-3, RR-2, RR-4, RR-1B, SR-16, SR-17A, SR-17B	303,750	Oct 03
CP-3, SR-16, SR-17A, SR-17B, OM-5, OM-4	255,000	Oct 04
CP-3, CP-4, OM-3, OM-4	198,750	Oct 05
CP-1, OM-3, OM-2	255,000	Oct 07
CP-1, OM-1, OM-2, SR-14, SR-13, SR-10	262,500	Oct 08
CP-1, SR-10, SR-8, SR-11, SR-12	153,750	Oct 09
VM-5, VM-6	60,000	Oct 10
Total	**4,863,250**	

Table 4. Manure Spreading Information, Year 2003.

Field Identification	Volume (Imperial Gallons)	Date
FW-1, FW-3, BM-4, BM-2	195,000	June 10
BM-2, BM-3, FW-1, FW-3, FW-12,13, FW-25, FW-26	405,000	June 11
FW-26, FW-25, SR-29, BM-2, BM-1	198,750	June 12
SR-29, SR-21B, SR-22, SR-24, SR-23, BM-1, VM-6	352,500	June 13
SR-20, SR-21A, SR-23, FW-2	243,750	June 18
FW-2, BM-8, BM-9	108,750	June 19
BM-9, BM-8, BM-7	202,500	June 23
LC-11, AN-19, 23, AN-16,20,21,22, AN-11,12, AN-13,14	258,750	June 24
AN-11,12, AN-3,4, AN-7,8,9,10 AN-13,14	258,750	June 25
AN-1,2, AN-5,6, AN-7, FC-1, DF-1	240,000	June 26
FW-2	161,250	June 27
RR-1A, RR-3, RR-4, RR-2	183,750	Sept 03
RR-2, RR1B	101,250	Sept 04
OM-4, OM-1,2	236,250	Sept 05
OM-2, OM-3	168,750	Sept 08
OM-5, FW-3, FW-1	225,000	Sept 09
FW-2, FW-1	225,000	Sept 10
FW-2, FW25/26	135,000	Sept 11
FW-26, FW-14, FW-12/13, KL-11	165,000	Sept 12
KL-11	138,750	Sept 13
KLN-10, KLN-8A, KLN-12, KLN-11	168,750	Sept 15
KLN-12, KLN-11, KLN-9, KLN-8, KLN-6, KLN-5	236,250	Sept 16
KLN-4, BM-9	202,500	Sept 17
BM-9, BM-8, BM-7	240,000	Sept 18
BM3,4, BM-2	153,750	Sept 19
CP-5	15,000	Nov 06
CP-5	90,000	Nov 07
CP-5	82,500	Nov 08
CP-1, VM-1, VM-6	90,000	Nov 10
VM-6	101,250	Nov 11
VM-6, VM-5, BM-6, BM-5	135,000	Nov 12
BM-5, BM-4	63,750	Nov 13
CP-3	131,250	Nov 14
CP-3, CP-2	146,250	Nov 15
CP-2, BM-2, BM-1	123,750	Nov 17
BM-1, CP-1	176,250	Nov 18
CP-1	142,500	Nov 19
Total	**6,502,500**	

Figure 3. Daily Rainfall at Moncton, 2000.

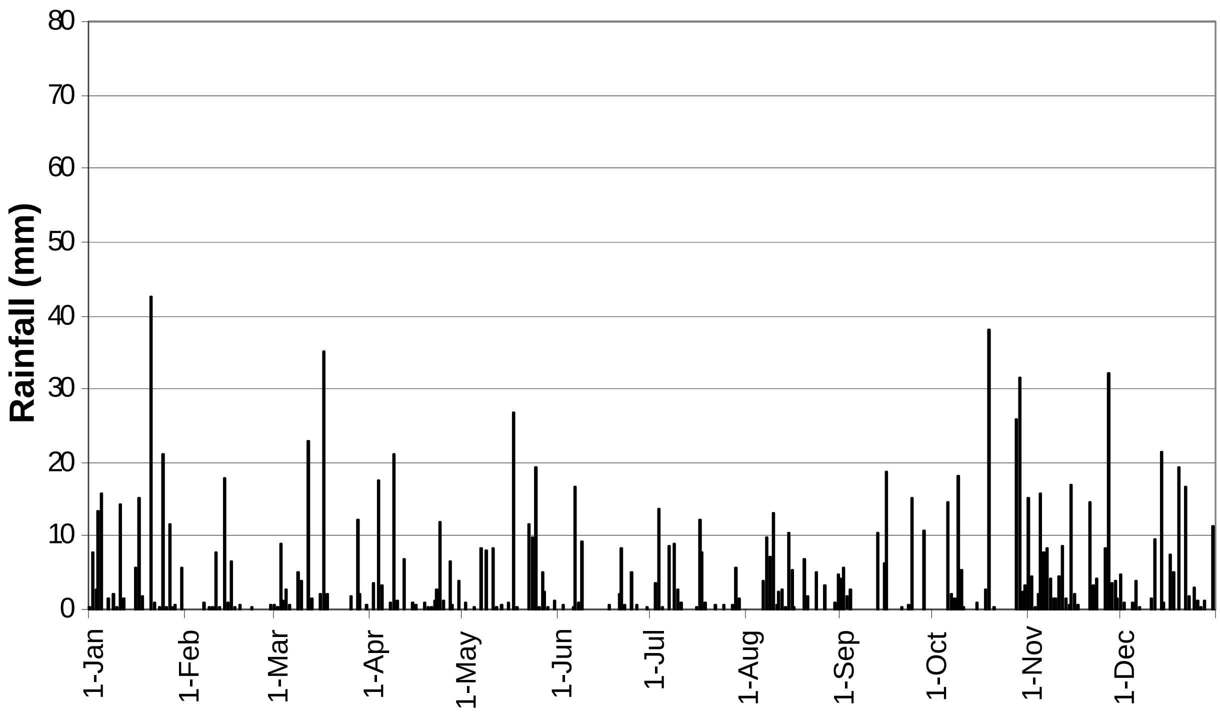


Figure 4. Daily Rainfall at Bouctouche, 2001.

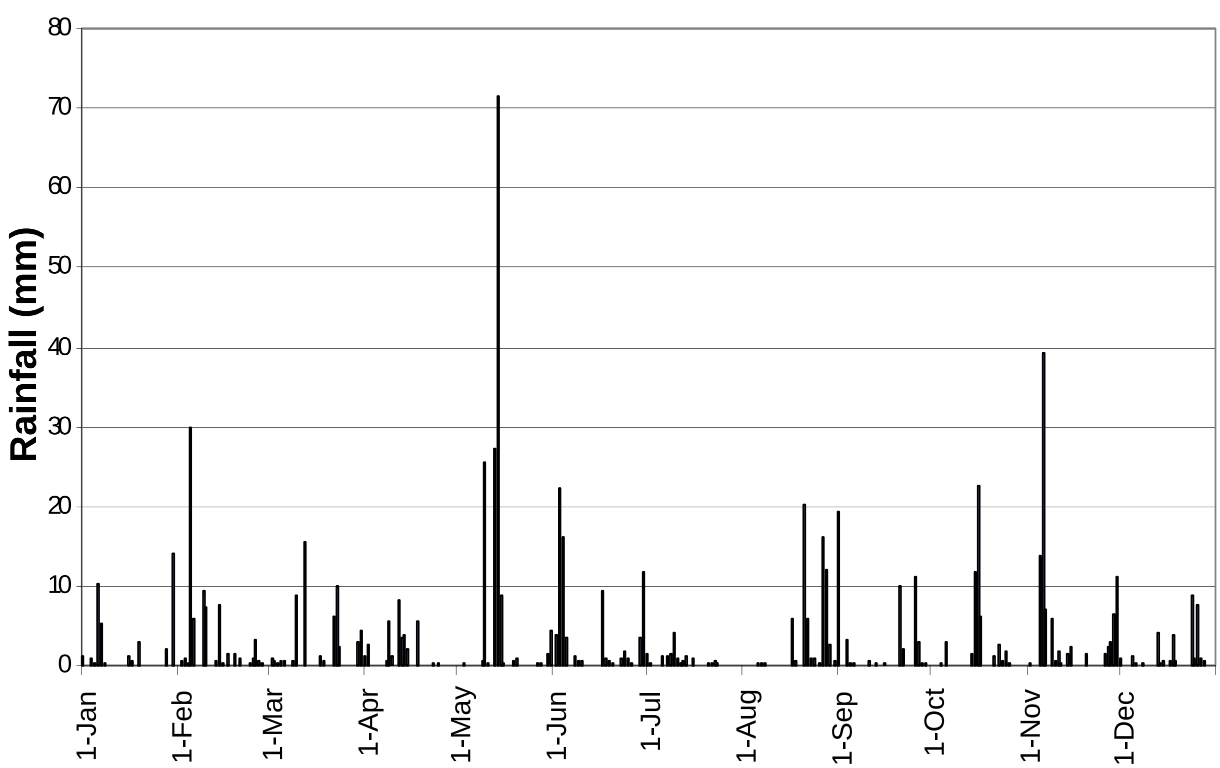


Figure 5. Daily Rainfall at Bouctouche, 2002.

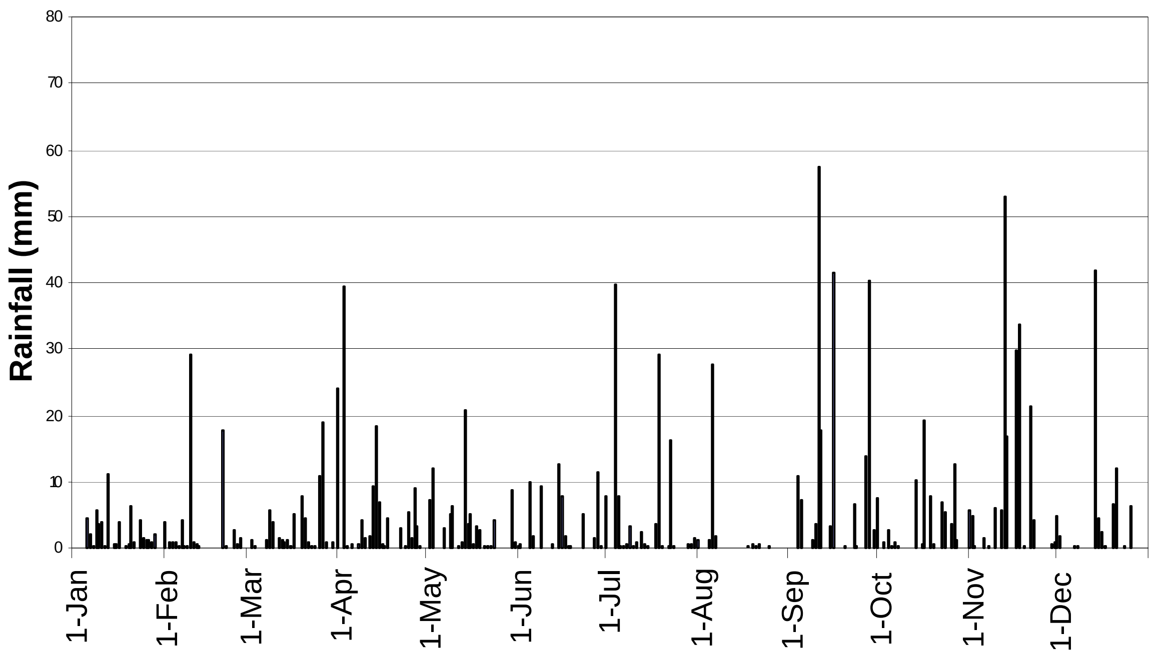
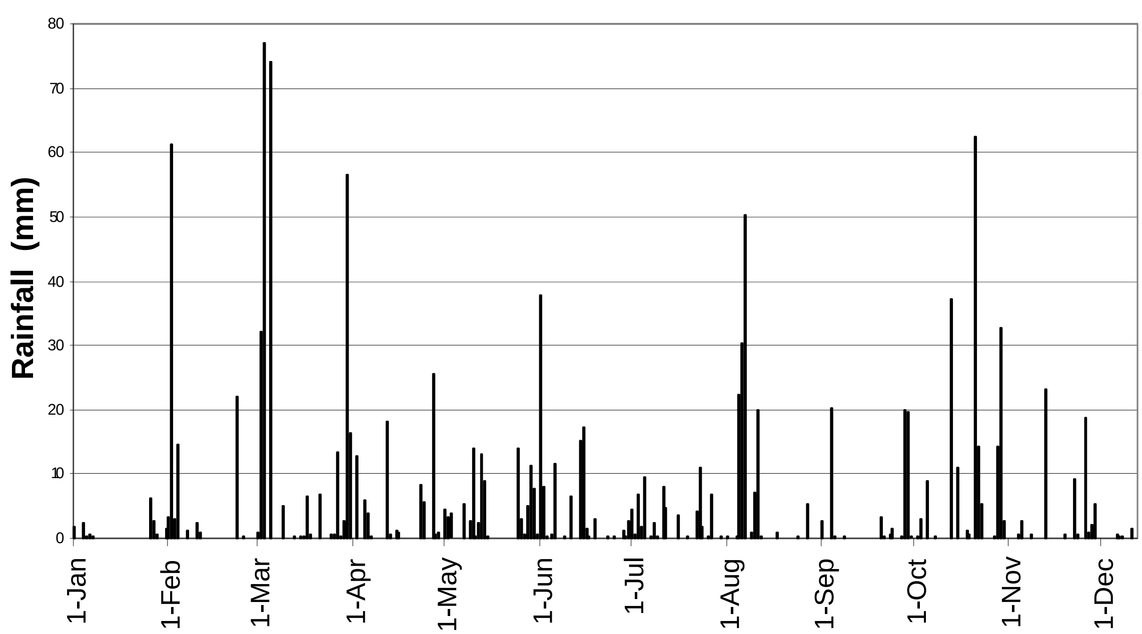


Figure 6. Daily Rainfall at Bouctouche, 2003.



SURFACE WATER

METHODOLOGY

The sampling stations were established to monitor the quality of water upstream and downstream from the land areas as presented in Figure 2. Typically, samples were taken in areas where Metz manure spreading occurred. For comparison, several other areas were sampled where no Metz manure spreading occurred, however in some cases these areas were utilized by local farmers for spreading of manure from their operations. Samples were submitted to the DELG laboratory and analyzed for major ions, metals, nutrients, physical characteristics, and bacteria. Analyses were conducted using standard methodologies and all data are available upon request.

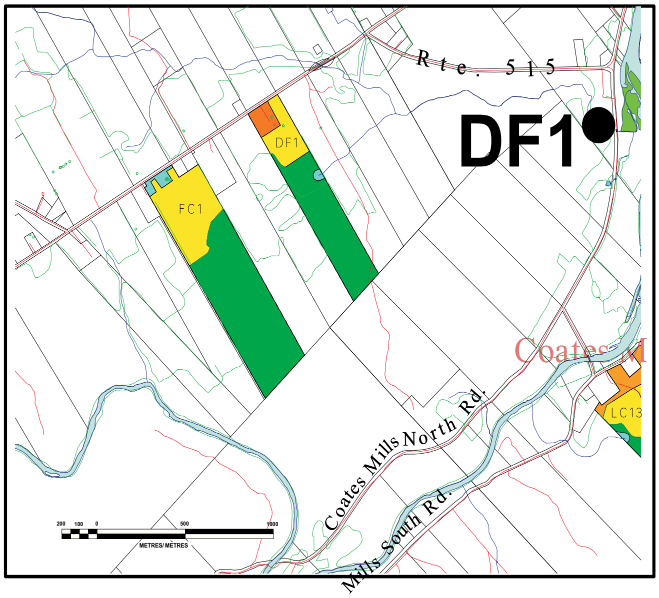
In this report, results are presented for TP, TN, fecal coliform and E.coli bacteria. Phosphorus and nitrogen, as well as bacteria, are abundant in hog manure. In year 2000, TN was not a standard parameter in the general water chemistry package used for this project. Therefore TN is presented only for the years 2001 to 2003. Also, E.coli was added in 2002 (to replace fecal coliforms) because E. coli is a better indicator of fecal contamination. The following charts reflect these changes. Major rain events are presented on the charts as filled circles. These represent the total rainfall for the 72-hour period before and including the day of sampling.

Note that for all parameters where the concentration is less than the detection limit of the analytical instrument, the detection limit value has been used.

In the following sections, data are presented for areas DF1, MG1-MG2, and 10-13 (Figure 2). These areas were chosen to represent three different livestock pasturing and Metz manure spreading situations. Area DF1 was a control site with no Metz manure spreading until 2003 when Metz manure was spread. No livestock were known to be pastured in this area. Area MG1-MG2 represents an area where no livestock were known to be pastured but Metz manure spreading occurred. Area 10-13 is an area where livestock are known to be pastured and Metz manure spreading has occurred.

2000 TO 2003 RESULTS - SURFACE WATER

AREA DF1



At station DF1 there were no livestock known to be pastured within the area and no Metz manure was spread in years 2000, 2001, or 2002; however, Metz manure was spread in June, 2003.

The results are shown in chart format in Figures 7, 8, 9, and 10. The highest values for TP, TN, fecal coliforms, and E.coli were associated with heavy rain events. Overall, the results show that the concentrations of these parameters were variable over the monitoring period and there did not appear to be a trend of increasing concentration with time. No obvious increase in TP, TN, or E.coli occurred after manure spreading in June, 2003.

Figure 7

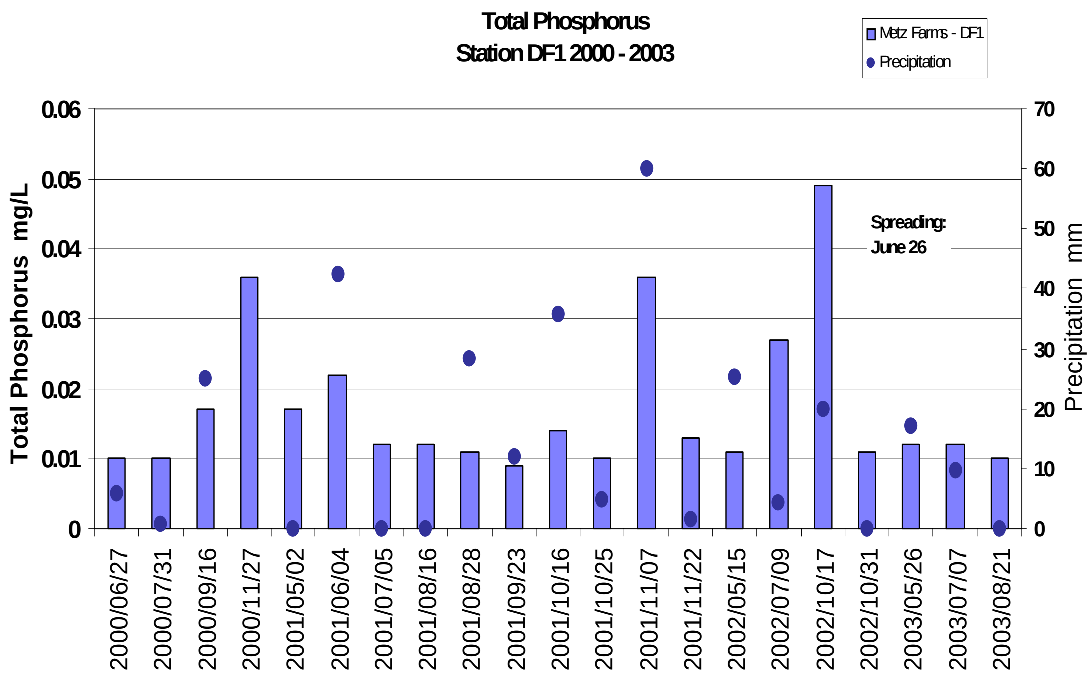


Figure 8

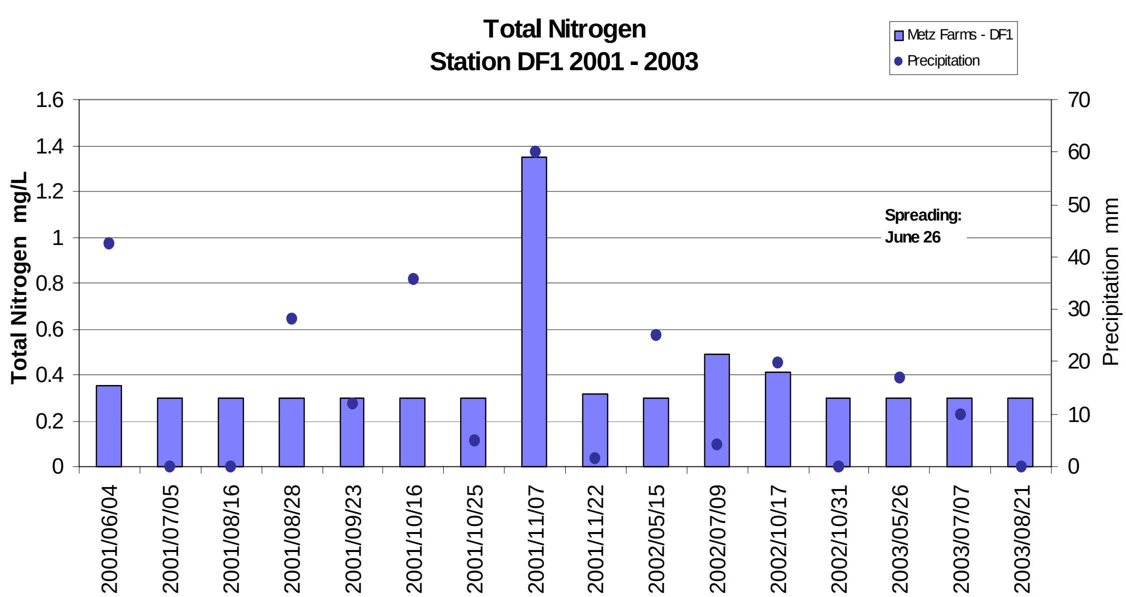


Figure 9

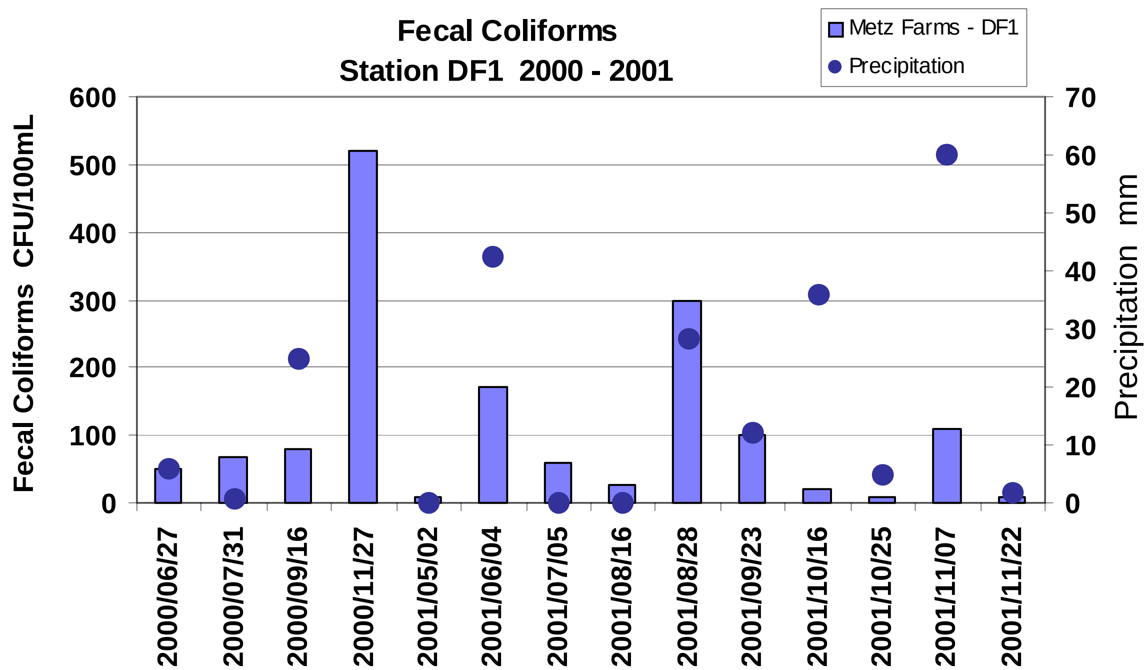
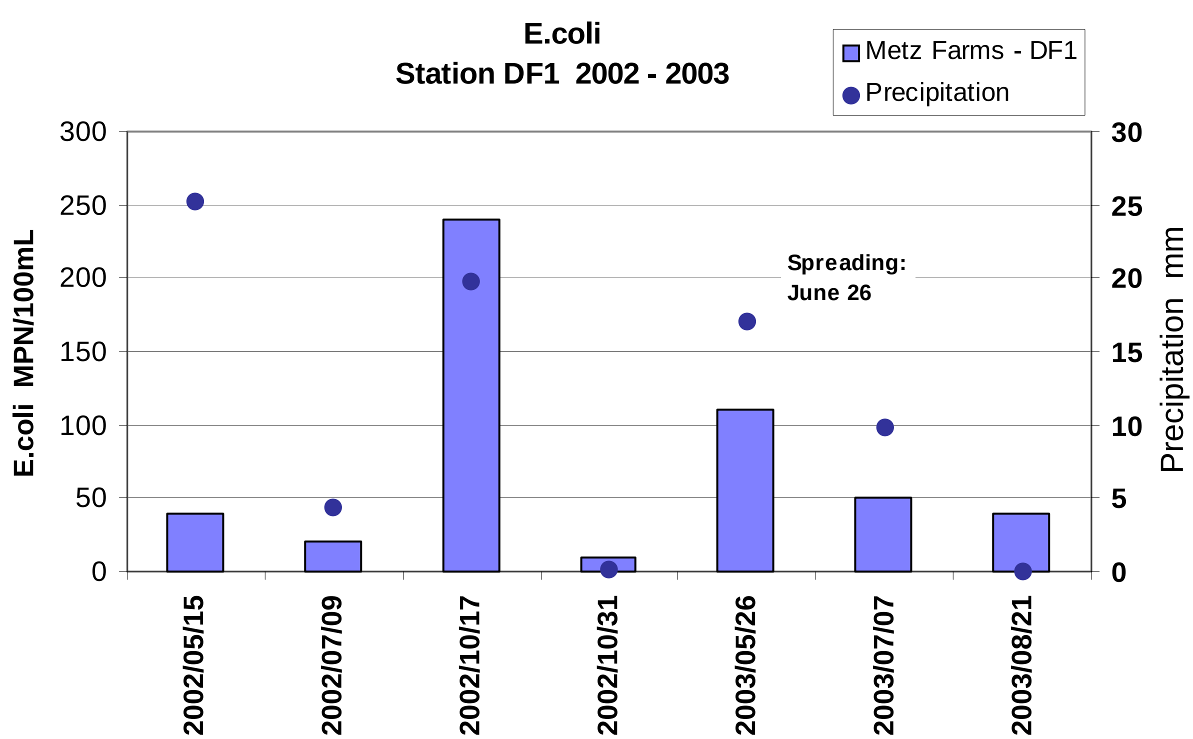
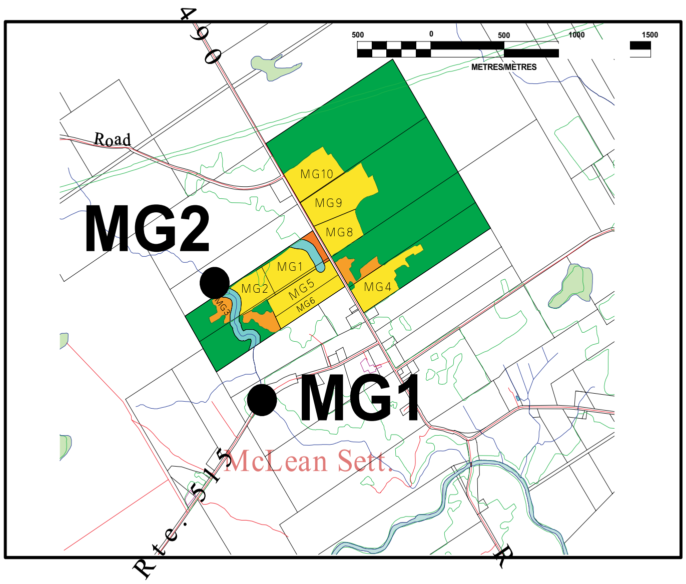


Figure 10



AREA MG1 - MG2



In this area no livestock were pastured between 2000 and 2003. Metz manure was spread within the watershed on June 19 and 20, 2001. Results from the sampling at stations MG1 (downstream) and MG2 (upstream) are shown in Figures 11, 12, 13, and 14.

In general, the pattern of increasing/decreasing concentrations over time was similar for upstream and downstream samples for TP, TN, fecal coliforms and E.coli. This indicates that there are upstream sources within the watershed for all components. However, some differences in concentration did exist. For example, on November 7, 2001 TP was slightly higher in the downstream sample than in the upstream sample. On October 17, 2002 the opposite was true and TP was higher in the upstream sample. In some cases, as with E. coli on October 29, 2002, the upstream concentration was significantly higher than the downstream concentration.

Because of this variability in concentration, it is difficult to assess the effect of Metz manure spreading on the watercourse. It is clear that the watershed contains other sources for nutrients and bacteria.

Figure 11

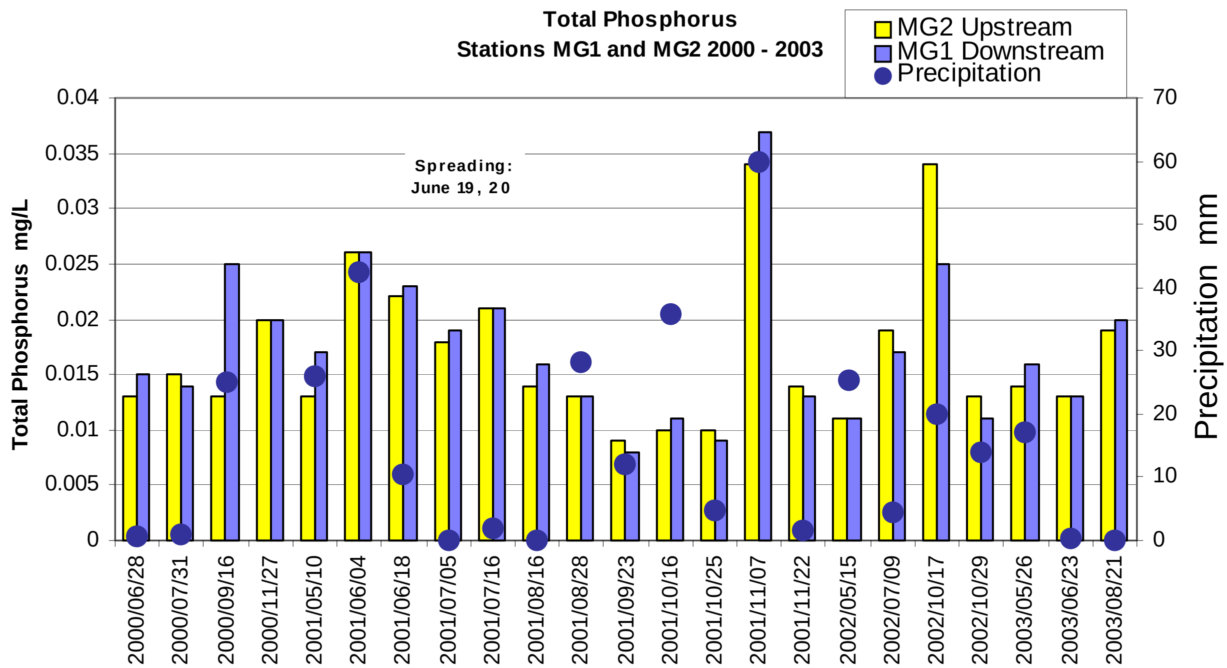


Figure 12

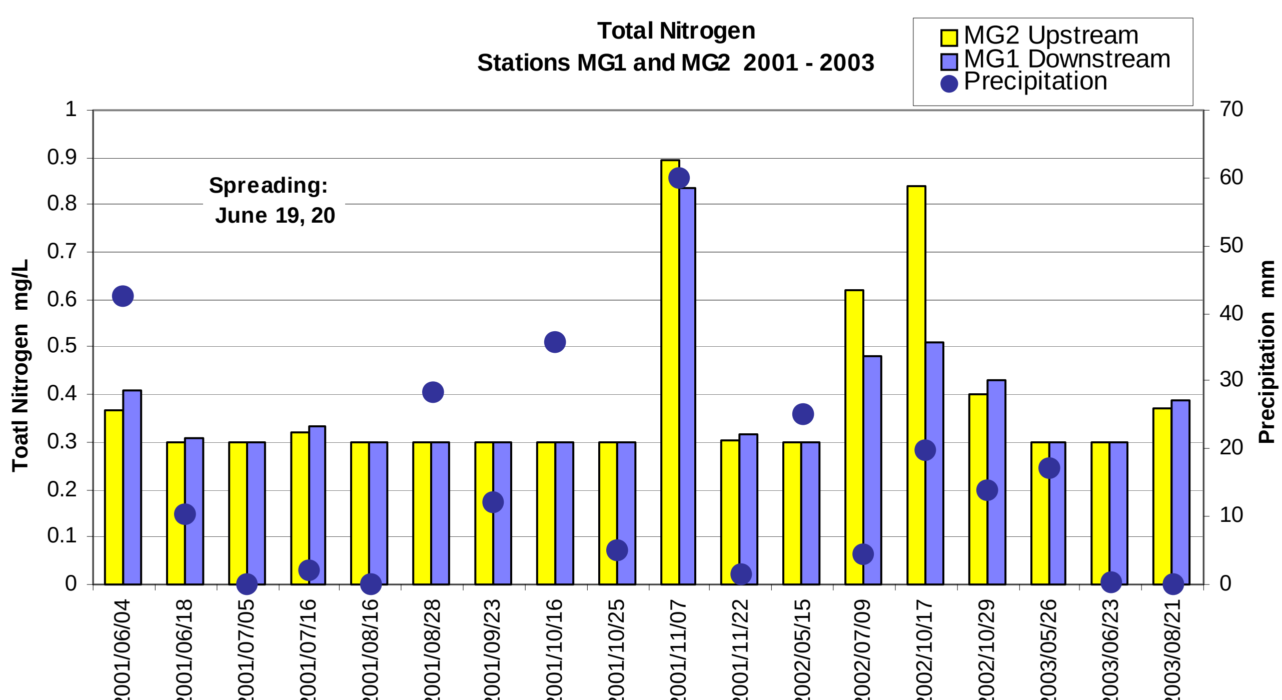


Figure 13

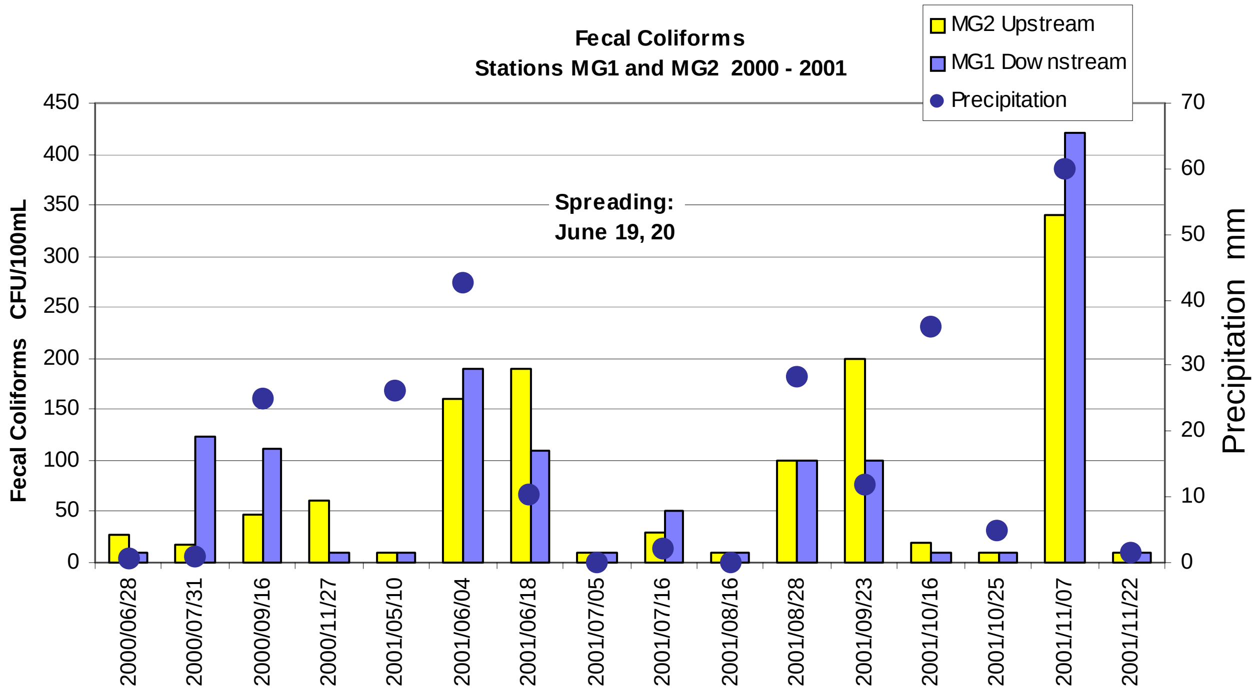
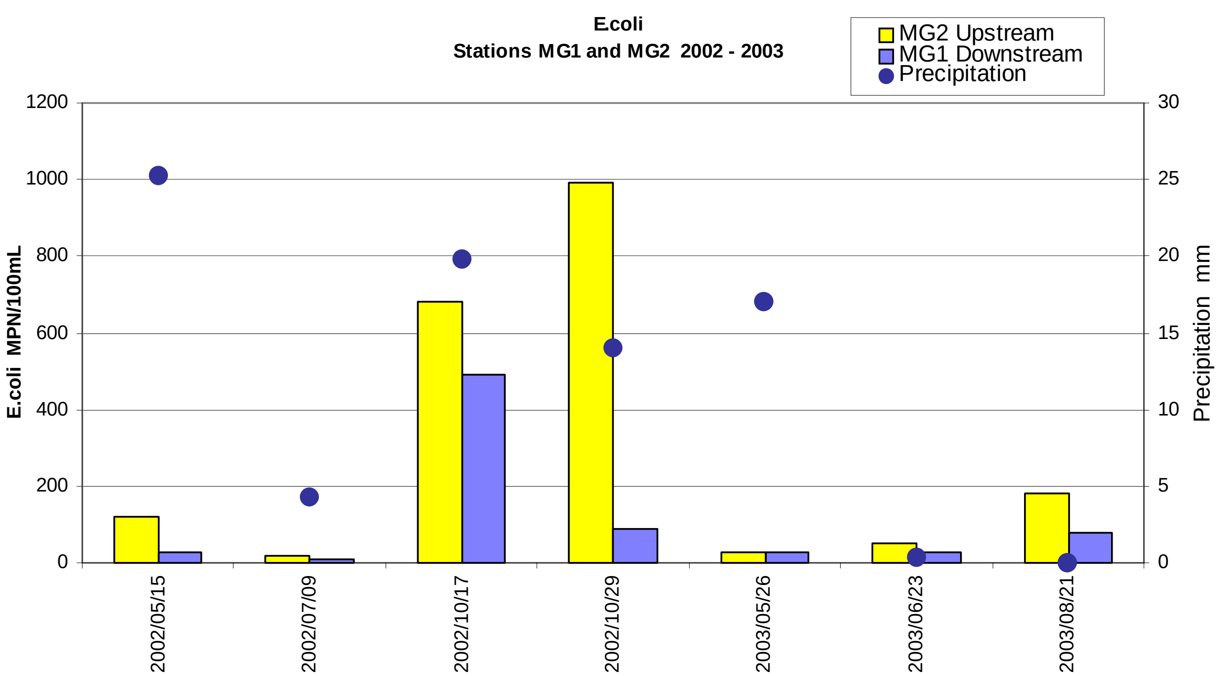
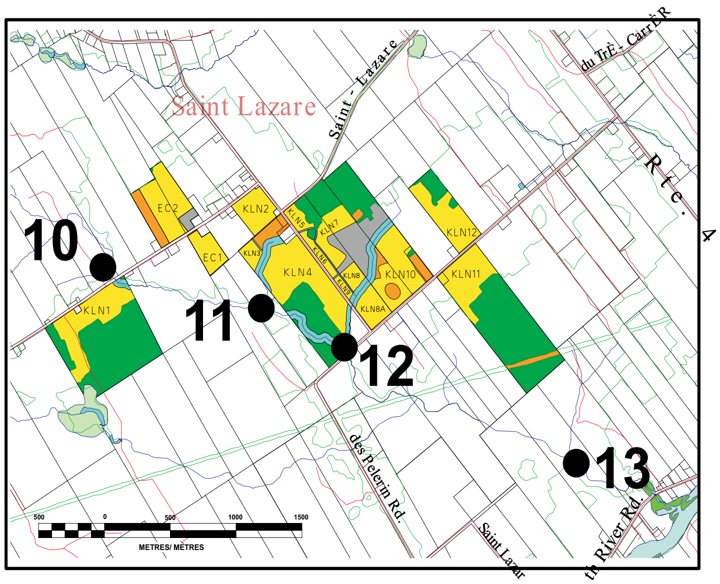


Figure 14



AREA 10 - 13



In this area, four stations were sampled that represent upstream, middle, and downstream sites. Station 10 is the upstream site and station 13 is the downstream site located near the confluence with the Bouctouche River. Results of TP, TN, fecal coliforms, and E.coli are presented in Figures 15, 16, 17, and 18 respectively. The highest concentrations over the entire monitoring program occurred on September 28, 2002 as a result of an intense rain event. Manure spreading occurred just prior to this wet period. However, it is important to note that high concentrations also occurred in the upstream sample indicating sources other than Metz manure.

Figure 15

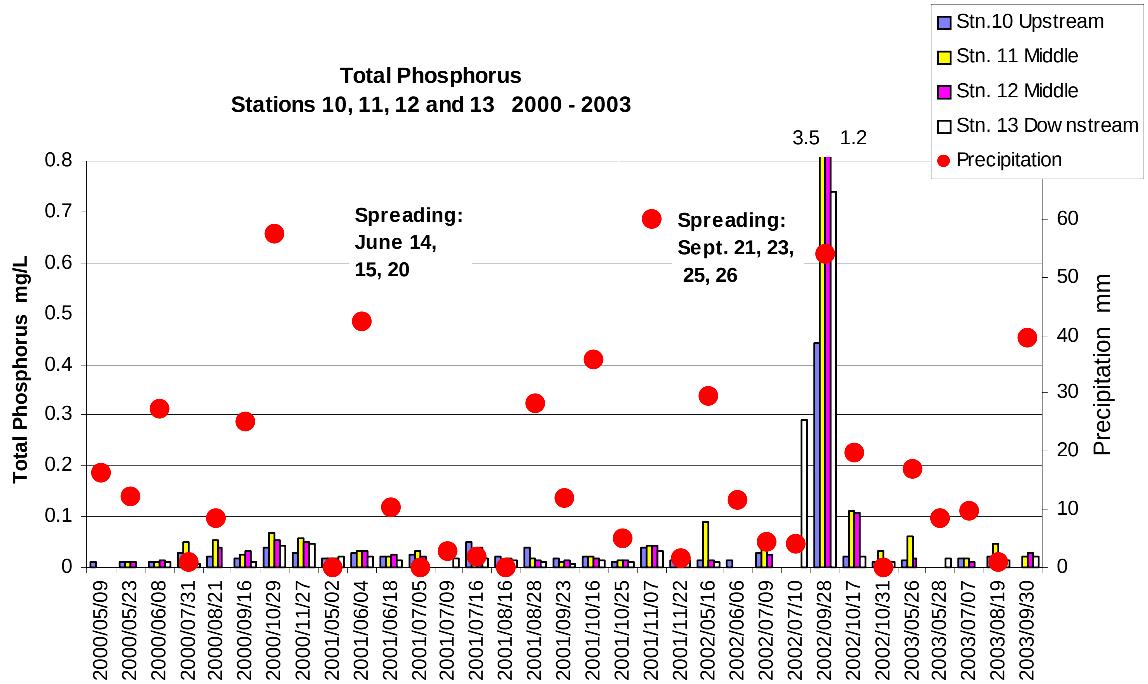


Figure 16

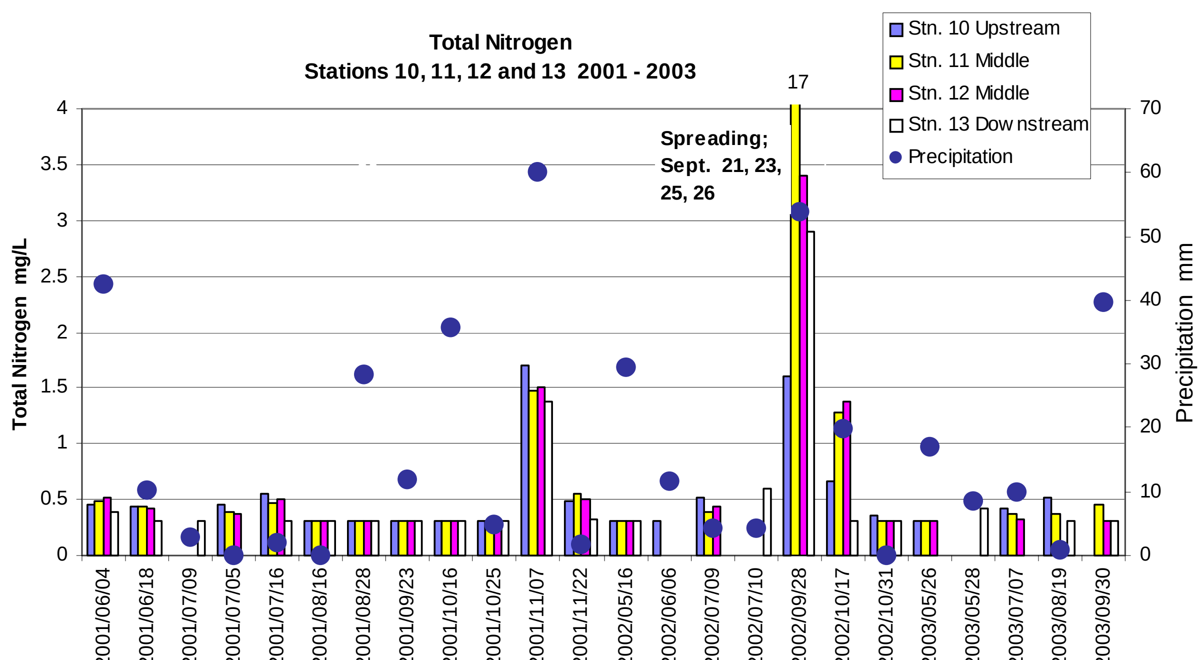


Figure 17

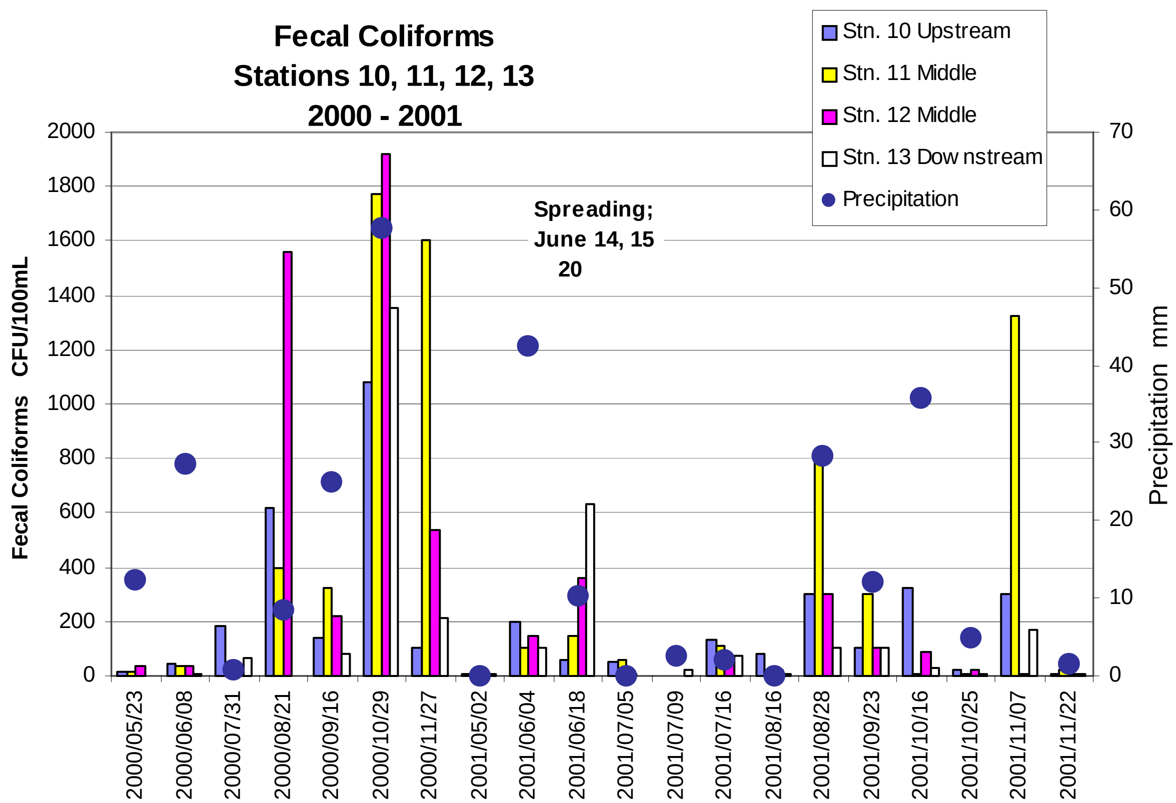
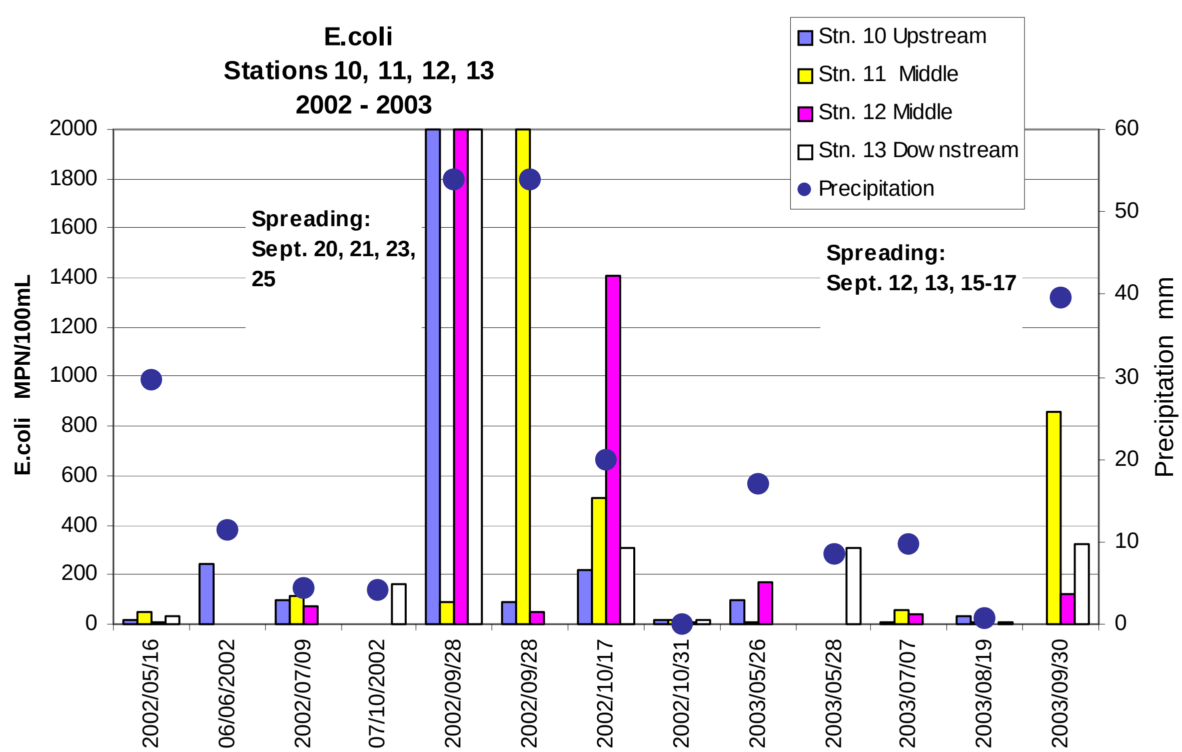


Figure 18



DISCUSSION - SURFACE WATER

Water quality may change a great deal over the course of a rainfall event and samples collected during this monitoring program were taken at various points in the runoff cycle. Therefore results for specific stations and/or dates were not directly comparable. Conclusions were tempered by the fact that results obtained during any individual event could be as much related to the timing of sample collections as to the effects of manure application or other influences.

Also, livestock were pastured on some of the spreading areas. When bacteria and other parameters were detected in drainage from these areas, the portion originating from Metz manure, manure from livestock, or other sources could not be determined by this monitoring program.

CONCLUSIONS - SURFACE WATER

Nutrients (phosphorus and nitrogen) and bacteria (fecal coliforms and E.coli) all showed increasing concentrations with increased rainfall regardless of whether or not Metz manure was spread in the adjacent area. In cases where the concentration of certain parameters increased downstream of Metz manure spreading, it was not possible to quantify the proportional influence of Metz manure spreading. There was no overall increasing trend in nutrients or bacteria concentrations over the four-year monitoring period. Results are consistent with nutrients and bacteria originating from multiple sources, including manure from Metz and other farms, livestock pasturing, septic systems, and other sources such as wild animals.

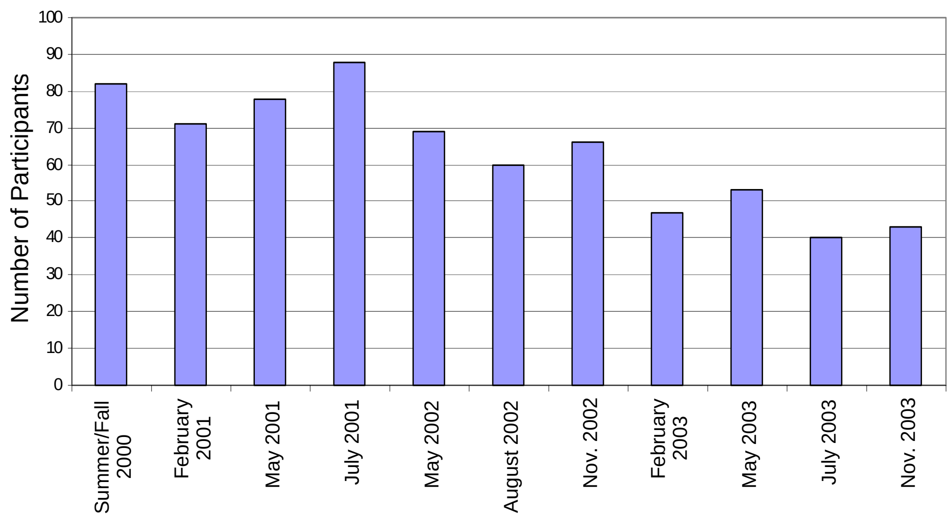
GROUNDWATER

INTRODUCTION

Between 2000 and 2003, a survey of groundwater quality was conducted by collecting well-water samples from homes in the vicinity of Sainte-Marie-de-Kent. The data collected in the first and second years (2000 and 2001) have been reported previously (NBDELG, 2001; NBDELG, 2002). In 2002 and 2003, an additional seven groundwater sampling events were undertaken: Spring 2002, Summer 2002, Fall 2002, Winter 2003, Spring 2003, Summer 2003, and Fall 2003. Results for both years (2002 and 2003) are presented in Appendix I.

Of the homes surveyed , Figure 19 shows the homeowner participation by sampling event. Participation in the groundwater monitoring program was voluntary and gradually decreased since the program's inception in 2000.

Figure 19. Homeowner participation by sampling event over the four-year monitoring period.



The following sections are a summary of the groundwater monitoring program for the overall four-year period.

METHODOLOGY

Samples were collected in accordance with accepted techniques at all sites and analyzed for total coliforms and E. coli bacteria. Analyses of general chemistry were conducted on samples taken in 2000 (before spreading) and during the Spring 2003 sampling event. All analyses were conducted at the DELG laboratory in Fredericton using standard techniques. Results were compared to the Health Advisory Limits (HAL) set by the New Brunswick Department of Health and Wellness and mailed or hand-delivered to the homeowner. If a sample tested positive for bacteria, the Department of Health and Wellness was contacted and homeowners were advised on the appropriate procedures to follow.

2000 TO 2003 RESULTS - GROUNDWATER

Results for E. coli and total coliforms for 2000 to 2003 are presented in Table 5.

E. coli bacteria were detected in 6% of the wells in 2000, 11% of the wells in 2001, 15% of the wells in 2002, and 4% of the wells in 2003. Over the four-year period the largest percentage of positive results was in 2002. In wells where E. coli was detected, some were located in areas where no Metz manure had been spread.

Based on monitoring results by season, there was an increase in total coliform and E. coli occurrences during fall sampling events.

The general chemistry results (including nutrients) obtained in 2003 (see Appendix I) did not differ significantly from those obtained in 2000 prior to Metz manure spreading.

DISCUSSION - GROUNDWATER

E. coli bacteria originate exclusively in the intestines of warm-blooded animals, including humans, and their presence is the most specific indicator of fecal contamination. The presence of total coliforms, in the absence of E. coli, does not definitively indicate fecal contamination. However, it could indicate that a well is receiving surface water infiltration and is at risk of fecal contamination (Federal-Provincial-Territorial Committee on Drinking Water, 2002).

Although the presence of E. coli in water indicates fecal contamination, it does not identify the specific source of fecal matter. Possible sources include manure (from Metz and other farms), livestock pasturing, septic systems and other sources such as wild animals.

CONCLUSIONS - GROUNDWATER

The four-year groundwater monitoring program indicated the majority of wells did not contain E. coli bacteria. Of the wells testing positive for E. coli, the results were consistent with multiple sources of bacteria.

The increase of positive results in the fall was probably a result of increased rainfall during that season.

There was no overall increasing trend in nutrient or bacteria concentrations over the four-year monitoring period.

Table 5. Summary of groundwater sampling results from 2000 to 2003. Due to the confidential nature of water quality analyses from private wells, the names and addresses of owners and spreading area codes have been removed from the sample results. The table is arranged by spreading area; each area has been given a random unique letter identifier and is shaded grey if Metz manure was not applied on fields in the area during the sampling year.

Area	2000				2001								2002								2003							
	Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall	
	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.
A	1	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND					ND	ND				
	8	ND			ND	ND	ND	ND	2	ND					ND	ND	6	ND	12	ND	3	ND	ND	ND	6	ND	ND	ND
			144	1	27	ND	>200	ND	74	ND					ND	ND	ND	ND	ND	ND	6	ND	ND	ND			12	ND
					ND	ND	ND	ND	ND	ND					34	ND	200	1	70	1	59	ND	32	ND	ND	ND	>200	11
	31	ND			>200	4	>200	ND	ND	ND					1	ND	ND	ND	2	ND	3	ND	ND	ND	41	ND		
	45	1							165	1															118	ND		
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
B	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND			ND	ND	ND	ND	ND	ND	ND	ND		
	>200	ND			ND	ND	6	ND	14	ND							ND	ND										
C	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	ND	ND																										
	1	ND			3	ND	>200	18	ND	ND					62	ND												
D	ND	ND			ND	ND	ND	ND	ND	ND																		
																	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	3	ND	1	ND	ND	ND	ND	ND	ND	ND
	ND	ND			ND	ND	ND	ND	ND	ND																		
			2	ND	15	ND			1	ND					ND	ND	ND	ND	41	2	1	ND	ND	ND			3	ND
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
			56	1	6	ND			4	ND					3	ND			>200	ND					3	ND		
	ND	ND			6	2	>200	15	ND	ND					25	ND	ND	ND							2	ND		
	14	ND			ND	ND	3	ND	4	ND					1	ND	ND	ND										
	1	ND							1	ND																		
E									ND	ND					ND	ND			ND	ND	ND	ND			ND	ND		
									ND	ND															ND	ND		
									4	ND													ND	ND				
									ND	ND									ND	ND								
									109	ND							ND	ND	1	ND			ND	ND				
									ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	11	ND			1	ND	ND		ND	ND					ND	ND			ND	ND	ND	ND	ND	ND			ND	ND
	ND	ND			ND	ND	3	ND	ND	ND					2	ND			3	1	ND	ND	6	ND			ND	ND
	2	ND			1	ND	101	ND	29	ND	2	ND			27	2	ND	ND	200	32	5	ND	>200	45	1	ND	25	ND
F	ND	ND			2	ND	4	ND	2	ND											3	ND	ND	ND			ND	ND
	>200	ND					1	ND	ND	ND					ND	ND	ND	ND	1	ND			ND	ND	ND	ND	1	ND
			3	ND	ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	1	ND			ND	ND
					ND	ND	ND	ND	200	ND					4	ND	41	ND	21	ND	3	ND	ND	ND			ND	ND
			2	ND	ND	ND	ND	ND	25	ND					ND	ND					74	ND						
			29	ND	1	ND	1	ND	ND	ND					1	ND			144	1	ND	ND	3	ND	ND	ND	ND	ND
			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND	ND	ND					ND	ND				
			>200	ND											ND	ND	>200	ND					ND	ND				
			4	ND	ND	ND	12	ND	ND	ND					ND	ND	ND	ND										
			>200	ND	ND	ND	ND	ND	ND	ND					ND	ND	2	ND	ND	ND			ND	ND			ND	ND
			>200	ND			12	ND	70	ND					62	ND			>200	ND	>200	ND	21	ND			>200	ND
									144	ND							>200	130										
	ND	ND			ND	ND	>200	ND	ND	ND					ND	ND	ND	ND	>200	31	ND	ND	ND	ND	ND	ND	2	2
	19	ND			32	ND	56	ND	41	ND					14	ND			165	ND	32	ND	6	ND			109	ND

Area	2000				2001								2002								2003							
	Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall	
	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.
F			>200	4	41	ND																						
			ND	ND	ND	ND	ND	ND	4	1					>200	ND	ND	ND									ND	ND
			ND	ND	ND	ND	ND	ND	ND	ND					1	ND			2	ND	1	ND					9	ND
			36	ND	1	ND	>200	ND	8	ND					1	ND	>200	38	144	ND	31	ND						
			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND								
	>200	ND			88	ND	74	ND																			32	ND
															ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND	ND
			ND	ND	ND	ND	ND	ND	ND	ND																		
			ND	ND			ND	ND	ND	ND																		
	ND	ND					59	ND	ND	ND					18	ND	ND	ND	101	9	1	ND					ND	ND
G			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND			ND	ND			ND	ND	ND	ND	ND	ND
	ND	ND					ND	ND	ND	ND					ND	ND	ND	ND	ND	ND							ND	ND
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND
	ND	ND	ND	ND			ND	ND	ND	ND							ND	ND										
	>200	ND	>200	ND	19	ND	>200	ND	165	1																		
			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND			ND	ND								
	1	ND	ND	ND	ND	ND	ND	ND	ND	ND															ND	ND		
	ND	ND	2	ND	ND	ND	ND	ND	2	ND					ND	ND	10	ND	ND	ND			ND	ND			ND	ND
	109	ND	1	ND	ND	ND	1	ND	ND	ND											3	ND						
	165	ND	16	ND	ND	ND	ND	ND	16	ND					25	ND			2	ND	ND	ND	ND	ND				
	ND	ND															ND	ND										
	>200	ND	>200	ND																								
			ND	ND	ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	1	1	ND	ND	ND	ND	ND	ND	>200	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND				
H	ND	ND			ND	ND			50	ND																		
			24	ND	2	ND	165	ND	ND	ND					36	ND												
							29	8	ND	ND					9	ND	10	ND	>200	ND	9	ND						
I	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND			1	ND	ND	ND	ND	ND	ND	ND
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND					ND	ND				
	3	ND			25	ND	14	ND	4	ND					3	ND			83	ND							144	ND
															4	ND												
					9	ND	3	ND	3	ND					1	ND												
			ND	ND			ND	ND	ND	ND									ND	ND			ND	ND				
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND			ND	ND	ND	ND	ND	ND
	1	ND			1	ND	ND	ND	1	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		
	ND	ND			2	ND	ND	ND	2	ND					4	ND			11	ND			1	ND	1	ND		
			3	ND	ND	ND	ND	ND	ND	ND					ND	ND	24	ND			ND	ND	ND	ND	ND	ND		
							ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
							12	ND	3	ND					18	ND	1	ND	31	ND	ND	ND	2	ND	34	ND	94	ND
					3	ND	27	ND	ND	ND					6	ND	3	ND	94	ND	3	ND			19	ND		
	9	ND					2	ND	1	1					9	2	6	ND	130	4			ND	ND	ND	ND	ND	ND
							2	ND									4	ND										
			2	ND	5	ND	>200	2	6	ND					83	27	3	1	>200	130	9	ND	ND	ND	ND	ND		
			ND	ND	ND	ND	ND	ND	ND	ND					1	ND	ND	ND	ND	ND			1	ND	ND	ND	ND	ND

Area	2000				2001								2002								2003							
	Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall		Winter		Spring		Summer		Fall	
	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.	T.C.	E.C.
I	ND	ND			ND	ND	2	ND	ND	ND					ND	ND			ND	ND	ND	ND			ND	ND	24	2
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND										
	ND	ND			ND	ND	12	1	ND	ND					ND	ND	ND	ND	31	ND	ND	ND	1	ND			2	ND
	ND	ND			ND	ND	ND	ND	ND	ND													ND	ND				
J	10	ND			ND	ND	2	ND	ND	ND					ND	ND			ND	ND					ND	ND	ND	ND
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ND	ND			1	ND			118	ND					ND	ND	1	ND	45	ND	5	ND	9	ND				
															ND	ND	ND	ND	ND	ND			ND	ND				
	ND	ND			ND	ND	ND	ND	ND	ND					ND	ND	ND	ND	ND	ND			ND	ND			ND	ND
	ND	ND					ND	ND	ND	ND					ND	ND	ND	ND	29	27	ND	ND	ND	ND	ND	ND	ND	ND

(Shaded) Areas with surrounding fields not spread with Metz liquid hog manure during monitoring year

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Appendix I

2002 and 2003 Groundwater Monitoring Results

2002 Groundwater Monitoring Results

Sampling events were carried out during Spring, Summer, and Fall 2002. Summaries of total coliforms and E. coli results are presented in Tables A, B, and C. Each individual sample result for the 2002 monitoring period is reported in Table D.

The New Brunswick Department of Health and Wellness has set the Health Advisory Limit (HAL) at 0 counts per 100 mL for E. coli, and at less than 10 counts per 100 mL for total coliforms. If a result of 1 to 10 counts per 100 mL for total coliforms is obtained, re-sampling is recommended, and the sample is deemed to be below the HAL if no two consecutive samples show the presence of total coliforms. In the following tables ND is non-detect.

Table A. Summary of groundwater sampling results, Spring 2002.

Parameter	**Number of sites sampled**	**Range of results**	**HAL**	**Number of sites with samples exceeding HAL**
Total coliforms	72	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	28 showed presence on first sample, 14 of these were greater than or equal to 10 counts per 100mL
E. coli	72	ND to 2 Counts per 100mL	0 counts per 100mL	3 showed presence on first sample

Table B. Summary of groundwater sampling results, Summer 2002.

Parameter	**Number of sites sampled**	**Range of results**	**HAL**	**Number of sites with samples exceeding HAL**
Total coliforms	58	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	17 showed presence on first sample, 9 of these were greater than or equal to 10 counts per 100mL
E. coli	58	ND to 130 Counts per 100mL	0 counts per 100mL	4 showed presence on first sample

Table C. Summary of groundwater sampling results, Fall 2002.

Parameter	Number of sites sampled	Range of results	HAL	Number of sites with samples exceeding HAL
Total coliforms	60	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	29 showed presence on first sample, 22 of these were greater than or equal to 10 counts per 100mL
E. coli	60	ND to 130 Counts per100mL	0 counts per100mL	11 showed presence on first sample

Table D (following 3 pages). Due to the confidential nature of water quality analyses from private wells, the names and addresses of owners and spreading area codes have been removed from the sample result. The table is arranged by spreading area; each area has been given a random unique letter identifier. Even though Metz manure was not applied on fields in areas A, D and H during 2002, and C, G and H in 2003, groundwater samples were collected and analyzed for consistency with the 2001 report. Listed site numbers do not necessarily correlate with those used in previous reports.

Area	Site	SPRING 2002			SUMMER 2002			FALL 2002			WINTER 2003			SPRING 2003			SUMMER 2003			FALL 2003		
	No.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.
A	1	08-May-02	ND	ND	06-Aug-02	ND	ND							21-May-03	ND	ND						
	2	14-May-02	ND	ND	06-Aug-02	6	ND	02-Dec-02	12	ND	12-Feb-03	3	ND	21-May-03	ND	ND	09-Jul-03	6	ND	20-Nov-03	ND	ND
	3	14-May-02	34	ND	06-Aug-02	200	1	02-Dec-02	70	1	12-Feb-03	59	ND	21-May-03	32	ND	09-Jul-03	ND	ND	20-Nov-03	>200	11
	4	14-May-02	ND	ND	06-Aug-02	ND	ND	02-Dec-02	ND	ND	12-Feb-03	6	ND	21-May-03	ND	ND				20-Nov-03	12	ND
	5	14-May-02	1	ND	06-Aug-02	ND	ND	02-Dec-02	2	ND	12-Feb-03	3	ND	21-May-03	ND	ND	09-Jul-03	41	ND			
		22-May-02	3	ND																		
	6																09-Jul-03	118	ND			
	7	22-May-02	ND	ND	06-Aug-02	11	ND	02-Dec-02	ND	ND	12-Feb-03	ND	ND	21-May-03	ND	ND	09-Jul-03	ND	ND	20-Nov-03	ND	ND
					21-Aug-02	14	ND															
					10-Sep-02	53	ND															
B	8	07-May-02	ND	ND				26-Nov-02	ND	ND	12-Feb-03	ND	ND	03-Jun-03	ND	ND	14-Jul-03	ND	ND			
	9				07-Aug-02	ND	ND															
C	10	07-May-02	ND	ND	07-Aug-02	ND	ND	26-Nov-02	ND	ND	12-Feb-03	ND	ND	03-Jun-03	ND	ND	14-Jul-03	ND	ND			
	11	07-May-02	62	ND																		
D	12				06-Aug-02	ND	ND	25-Nov-02	ND	ND	04-Feb-03	ND	ND	20-May-03	ND	ND	09-Jul-03	ND	ND	19-Nov-03	ND	ND
	13	13-May-02	ND	ND	06-Aug-02	ND	ND	25-Nov-02	3	ND	04-Feb-03	1	ND	20-May-03	ND	ND	09-Jul-03	ND	ND	18-Nov-03	ND	ND
								09-Dec-02	ND	ND												
	14	08-May-02	ND	ND	06-Aug-02	ND	ND	25-Nov-02	41	2	04-Feb-03	1	ND	20-May-03	ND	ND				18-Nov-03	3	ND
								05-Dec-02	ND	ND												
								05-Dec-02	2	ND												
	15	08-May-02	ND	ND	06-Aug-02	ND	ND	25-Nov-02	ND	ND	04-Feb-03	ND	ND	20-May-03	ND	ND	09-Jul-03	ND	ND	18-Nov-03	ND	ND
	16	08-May-02	3	ND				25-Nov-02	>200	6							09-Jul-03	3	ND			
		16-May-02	5	ND																		
	17	08-May-02	25	ND	06-Aug-02	ND	ND										09-Jul-03	2	ND			
	18	08-May-02	1	ND	06-Aug-02	ND	ND															
	19							26-Nov-02	ND	ND												
	20				15-Aug-02	ND	ND	26-Nov-02	1	ND				29-May-03	ND	ND						
								12-Dec-02	ND	ND												
E	21	27-May-02	ND	ND				25-Nov-02	ND	ND	10-Feb-03	ND	ND				14-Jul-03	ND	ND			
	22																14-Jul-03	ND	ND			
	23													03-Jun-03	ND	ND						
	24	13-May-02	ND	ND	08-Aug-02	ND	ND	25-Nov-02	ND	ND	10-Feb-03	ND	ND	29-May-03	ND	ND				19-Nov-03	ND	ND
	25	13-May-02	ND	ND				05-Dec-02	ND	ND	10-Feb-03	ND	ND	29-May-03	ND	ND	14-Jul-03	ND	ND	04-Dec-03	ND	ND
	26	13-May-02	2	ND				15-Nov-02	3	1	10-Feb-03	ND	ND	29-May-03	6	ND				19-Nov-03	ND	ND
		22-May-02	ND	ND																		
	27	13-May-02	27	2	08-Aug-02	ND	ND	25-Nov-02	200	32	09-Jan-03	5	ND	03-Jun-03	>200	45	14-Jul-03	1	ND	19-Nov-03	25	ND
		27-May-02	ND	ND							10-Feb-03	ND	ND									
F	28										04-Feb-03	3	ND							18-Nov-03	29	ND
	29	08-May-02	ND	ND	07-Aug-02	ND	ND	25-Nov-02	1	ND				21-May-03	ND	ND	10-Jul-03	ND	ND	18-Nov-03	1	ND
	30	07-May-02	ND	ND	07-Aug-02	ND	ND	25-Nov-02	ND	ND	04-Feb-03	ND	ND	21-May-03	1	ND	10-Jul-03	ND	ND	18-Nov-03	3	ND
	31	07-May-02	4	ND	07-Aug-02	41	ND	26-Nov-02	21	ND	04-Feb-03	3	ND	21-May-03	ND	ND				18-Nov-03	ND	ND
		14-May-02	18	ND																		
	32	14-May-02	ND	ND							04-Feb-03	74	ND									
	33	07-May-02	1	ND				25-Nov-02	144	1	22-Jan-03	ND	ND	27-May-03	3	ND	10-Jul-03	ND	ND	18-Nov-03	ND	ND
		14-May-02	ND	ND				19-Dec-02	1	ND	04-Feb-03	ND	ND									
	34	07-May-02	ND	ND	07-Aug-02	ND	ND							21-May-03	ND	ND						

Area	Site	SPRING 2002			SUMMER 2002			FALL 2002			WINTER 2003			SPRING 2003			SUMMER 2003			FALL 2003		
	No.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.
F	35	22-May-02	ND	ND	10-Sep-02	>200	ND															
	36	07-May-02	ND	ND	07-Aug-02	ND	ND															
	37	07-May-02	ND	ND	07-Aug-02	2	ND	02-Dec-02	ND	ND				22-May-03	ND	ND				18-Nov-03	ND	ND
	38	07-May-02	62	ND				25-Nov-02	>200	ND	04-Feb-03	>200	ND	22-May-03	21	ND				18-Nov-03	>200	ND
	39				07-Aug-02	>200	130															
	40	07-May-02	ND	ND	07-Aug-02	ND	ND	25-Nov-02	>200	31	04-Feb-03	ND	ND	22-May-03	ND	ND	10-Jul-03	ND	ND	18-Nov-03	2	2
								19-Dec-02	ND	ND												
	41	08-May-02	14	ND				25-Nov-02	165	ND	04-Feb-03	32	ND	22-May-03	6	ND				18-Nov-03	109	ND
	42	06-Jun-02	>200	ND	07-Aug-02	ND	ND													18-Nov-03	ND	ND
																				19-Nov-03	ND	ND
	43	13-May-02	1	ND				25-Nov-02	2	ND	04-Feb-02	1	ND							18-Nov-03	9	ND
		22-May-02	ND	ND				19-Dec-02	ND	ND	04-Feb-02	1	ND							04-Dec-03	11	ND
	44	07-May-02	1	ND	07-Aug-02	>200	38	25-Nov-02	144	ND	04-Feb-03	31	ND									
		14-May-02	1	ND																		
	45	07-May-02	ND	ND	07-Aug-02	ND	ND	25-Nov-02	ND	ND												
	46																			18-Nov-03	32	ND
	47	27-May-02	ND	ND	07-Aug-02	ND	ND	25-Nov-02	ND	ND	05-Feb-03	ND	ND	03-Jun-03	ND	ND	10-Jul-03	1	ND	18-Nov-03	ND	ND
	48	08-May-02	18	ND	07-Aug-02	ND	ND	03-Dec-02	101	9	25-Feb-03	1	ND							19-Nov-03	ND	ND
G	49	22-May-02	ND	ND				02-Dec-02	ND	ND				29-May-03	ND	ND	09-Jul-03	ND	ND	20-Nov-03	ND	ND
	50	08-May-02	ND	ND	06-Aug-02	ND	ND	02-Dec-02	ND	ND										20-Nov-03	ND	ND
	51	08-May-02	ND	ND	06-Aug-02	ND	ND	02-Dec-02	ND	ND	12-Feb-03	ND	ND	29-May-03	ND	ND	09-Jul-03	ND	ND	24-Nov-03	10	ND
	52				07-Aug-02	ND	ND															
	53	22-May-02	ND	ND				05-Dec-02	ND	ND												
	54																09-Jul-03	ND	ND			
	55	08-May-02	ND	ND	06-Aug-02	10	ND	02-Dec-02	ND	ND				21-May-03	ND	ND				24-Nov-03	ND	ND
	56										12-Feb-03	3	ND									
	57	08-May-02	25	ND				02-Dec-02	2	ND	12-Feb-03	ND	ND	21-May-03	ND	ND						
	58				07-Aug-02	ND	ND															
	59	08-May-02	ND	ND	07-Aug-02	ND	ND	02-Dec-02	ND	ND	12-Feb-03	ND	ND	21-May-03	ND	ND	09-Jul-03	ND	ND			
	60	05-May-02	ND	ND	06-Aug-02	ND	ND	02-Dec-02	ND	ND	12-Feb-03	ND	ND	21-May-03	ND	ND						
	61	08-May-02	36	ND																		
H	62	08-May-02	9	ND	06-Aug-02	10	ND	25-Nov-02	>200	ND	10-Feb-02	9	ND									
		16-May-02	2	ND																		
I	63	13-May-02	1	ND	08-Aug-02	ND	ND	25-Nov-02	ND	ND				29-May-03	1	ND	14-Jul-03	ND	ND	19-Nov-03	ND	ND
		23-May-02	ND	ND																		
	64	22-May-02	ND	ND				25-Nov-02	ND	ND	10-Feb-03	ND	ND				14-Jul-03	ND	ND	19-Nov-03	24	2
	65	16-May-02	ND	ND	13-Aug-02	ND	ND															
	66	13-May-02	ND	ND	08-Aug-02	ND	ND	25-Nov-02	31	ND	10-Feb-03	ND	ND	29-May-03	1	ND				04-Dec-03	2	ND
	67													29-May-03	ND	ND						
	68	13-May-02	ND	ND	08-Aug-02	ND	ND				10-Feb-03	1	ND	27-May-03	ND	ND	10-Jul-03	ND	ND	19-Nov-03	ND	ND
	69	13-May-02	ND	ND	08-Aug-02	ND	ND							27-May-03	ND	ND						
	70	22-May-02	83	27	08-Aug-02	3	1	25-Nov-02	>200	130	10-Feb-03	9	ND	29-May-03	ND	ND	14-Jul-03	ND	ND			
	71	13-May-02	3	ND				25-Nov-02	83	ND										19-Nov-03	144	ND
		23-May-02	8	ND																		
	72	13-May-02	1	ND																		

Area	Site	SPRING 2002			SUMMER 2002			FALL 2002			WINTER 2003			SPRING 2003			SUMMER 2003			FALL 2003		
	No.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.	date	T.C.	E.C.
I		23-May-02	14	ND																		
	73	13-May-02	1	ND																		
		23-May-02	3	ND																		
	74							25-Nov-02	ND	ND				22-May-03	ND	ND						
	75	13-May-02	ND	ND	08-Aug-02	ND	ND	25-Nov-02	ND	ND				22-May-03	ND	ND	10-Jul-03	ND	ND	19-Nov-03	ND	ND
	76	13-May-02	ND	ND	08-Aug-02	ND	ND	26-Nov-02	ND	ND	10-Feb-03	ND	ND	22-May-03	ND	ND	10-Jul-03	ND	ND			
	77	13-May-02	4	ND				25-Nov-02	11	ND				22-May-03	1	ND	10-Jul-03	1	ND			
		22-May-02	1	ND				05-Dec-02	5	ND												
	78	13-May-02	ND	ND	08-Aug-02	24	ND				10-Feb-03	ND	ND	22-May-03	ND	ND	10-Jul-03	ND	ND			
	79	13-May-02	ND	ND	08-Aug-02	ND	ND	25-Nov-02	ND	ND	10-Feb-03	ND	ND				10-Jul-03	ND	ND	19-Nov-03	ND	ND
	80	13-May-02	18	ND	08-Aug-02	1	ND	25-Nov-02	31	ND	10-Feb-02	ND	ND	29-May-03	2	ND	14-Jul-03	34	ND	19-Nov-03	94	ND
	81	13-May-02	6	ND	08-Aug-02	3	ND	25-Nov-02	94	ND	10-Feb-03	3	ND				14-Jul-03	19	ND			
		22-May-02	6	ND																		
	82				08-Aug-02	4	ND															
	83	13-May-02	9	2	08-Aug-02	6	ND	26-Nov-02	130	4				29-May-03	ND	ND	14-Jul-03	ND	ND	19-Nov-03	ND	ND
J	84	08-May-02	ND	ND				26-Nov-02	ND	ND							09-Jul-03	ND	ND	18-Nov-03	ND	ND
								26-Nov-02	ND	ND												
	85	08-May-02	ND	ND	06-Aug-02	ND	ND	26-Nov-02	ND	ND	04-Feb-03	ND	ND	22-May-03	ND	ND	09-Jul-03	ND	ND	20-Nov-03	ND	ND
	86	08-May-02	ND	ND	06-Aug-02	1	ND	26-Nov-02	45	ND	04-Feb-03	5	ND	20-May-03	9	ND						
	87	23-May-02	ND	ND	06-Aug-02	ND	ND	05-Dec-02	ND	ND				20-May-03	ND	ND				18-Nov-03	ND	ND
	88	27-May-02	ND	ND	07-Aug-02	ND	ND	02-Dec-02	29	27	09-Jan-03	ND	ND	20-May-03	ND	ND	09-Jul-03	ND	ND	18-Nov-03	ND	ND
											05-Feb-03	ND	ND									
	89	27-May-02	ND	ND	06-Aug-02	ND	ND	26-Nov-02	ND	ND				20-May-03	ND	ND						

The distribution and occurrence of total coliforms and E. coli above the HAL are presented in Figure A. Percentile distributions for the occurrence of total coliforms and E. coli are presented in Table E. Examination of percentile distribution by season shows an increasing trend of E. coli occurrences from 4 % in the spring to a maximum of 18 % in the fall.

Figure A. The distribution and occurrence of total coliforms and E. coli above the HAL in 2002.

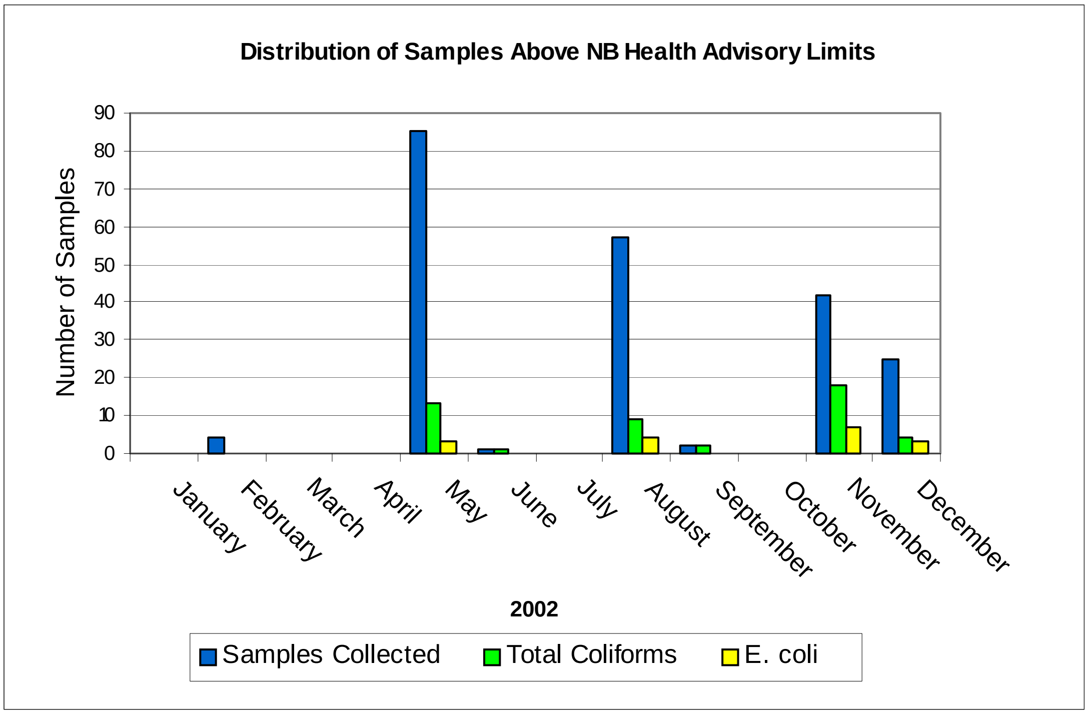

Table E. Percentile distribution of total coliforms and E. coli from all wells sampled in 2002.

Parameter	Spring 2002	Summer 2002	Fall 2002
Total coliforms present	39%	29%	48%
Total coliforms above HAL	20%	16%	37%
E. coli above HAL	4%	7%	18%

2003 Groundwater Monitoring Results

In 2003 four sampling events took place: Winter, Spring, Summer and Fall. Summaries of total coliforms and E. coli results are presented in Tables F, G, H, and I with individual 2003 sample results reported in Table D.

Table F. Summary of groundwater sampling results, Winter 2003.

Parameter	Number of sites sampled	Range of results	HAL	Number of sites with samples exceeding HAL
Total coliforms	47	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	21 showed presence on first sample, 5 of these were greater than or equal to 10 counts per 100mL
E. coli	47	ND Counts per 100mL	0 counts per 100mL	0 showed presence on first sample

Table G. Summary of groundwater sampling results, Spring 2003.

Parameter	Number of sites sampled	Range of results	HAL	Number of sites with samples exceeding HAL
Total coliforms	52	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	12 showed presence on first sample, 4 of these were greater than or equal to 10 counts per 100mL
E. coli	52	ND to 45 Counts per 100mL	0 counts per 100mL	1 showed presence on first sample

Table H. Summary of groundwater sampling results, Summer 2003.

Parameter	**Number of sites sampled**	**Range of results**	**HAL**	**Number of sites with samples exceeding HAL**
Total coliforms	40	ND to >118 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	10 showed presence on first sample, 4 of these were greater than or equal to 10 counts per100mL
E. coli	40	ND Counts per 100mL	0 counts per 100mL	0 showed presence on first sample

Table I. Summary of groundwater sampling results, Fall 2003.

Parameter	**Number of sites sampled**	**Range of results**	**HAL**	**Number of sites with samples exceeding HAL**
Total coliforms	43	ND to >200 counts per 100mL	<10 counts per 100mL on first sample, no two consecutive samples with presence detected	17 showed presence on first sample, 12 of these were greater than or equal to 10 counts per100mL
E. coli	43	ND to 11 Counts per 100mL	0 counts per 100mL	3 showed presence on first sample

The distribution and occurrence of total coliforms and E. coli above the HAL are shown in Figure B. Percentile distributions for the occurrence of total coliforms and E. coli are presented in Table J. Examination of percentile distribution by season shows that both E.coli and total coliform occurrences were highest in the fall.

Figure B. The distribution and occurrence of total coliforms and E. coli above the HAL in 2003.

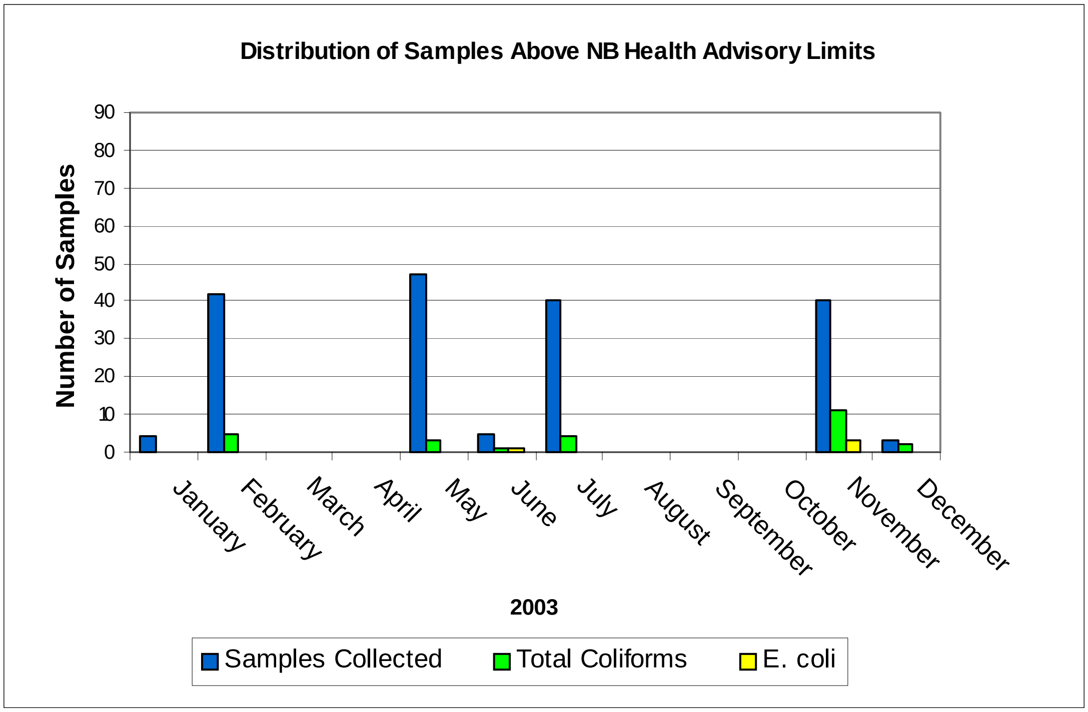

Table J. Percentile distribution of total coliforms and E. coli from all wells sampled in 2003.

Parameter	Winter 2003	Spring 2003	Summer 2003	Fall 2003
Total coliforms present	45%	23%	25%	40%
Total coliforms above HAL	11%	8%	10%	28%
E. coli above HAL	0%	2%	0%	7%

During the Spring 2003 sampling event the analysis of an additional 27 parameters (general chemistry) was also conducted on 51 wells. These results are summarized in Table K. Compared to the pre-spreading general chemistry results presented in the April 2001 report (NBDELG, 2001), concentrations were not significantly different.

Table K. General chemistry results of groundwater, Spring 2003.

Parameter	Range of results	Guideline[1] (mg/L)	Number of samples exceeding Guideline
Alkalinity	10.7 – 176 mg/L		
Aluminum	<LOQ[2] – 0.082 mg/L		
Arsenic	<LOQ – 0.0042 mg/L	0.025 mg/l	
Boron	<LOQ – 0.027 mg/L	5 mg/L	
Barium	<LOQ – 1.42 mg/L	1.0 mg/L	1
Bromide	<LOQ – 0.172 mg/L		
Calcium	<LOQ – 62 mg/L	200 mg/L	
Cadmium	<LOQ mg/L	0.005mg/L	
Chloride	0.897 – 114 mg/L	LE 250 mg/L	
Conductivity	130 – 552 μS/cm		
Chromium	<LOQ – 0.034 mg/L	0.05 mg/L	
Copper	<LOQ – 0.140 mg/L	LE1.0 mg/L	
Fluoride	<LOQ – 0.27 mg/L	1.5 mg/L	
Iron	<LOQ – 0.224 mg/L	LE 0.3 mg/L	
Magnesium	<LOQ – 14.8 mg/L		
Manganese	<LOQ – 1.25 mg/L	LE 0.05 mg/L[3]	10
Nitrate	<LOQ – 8.55 mg/L	10 mg/L	
Lead	<LOQ – 0.0047 mg/L	0.010 mg/L	
Potassium	0.13 – 2.98 mg/L		
pH	5.81 – 8.53	6.5 - 8.5	1
Selenium	<LOQ mg/L	0.01 mg/L	
Sodium	3.84 – 66.6 mg/L	LE 200 mg/L	
Sulphate	1.32 – 17.9 mg/L	LE 500 mg/L	
Total dissolved solids (TDS)	68.139 – 270.539 mg/L	LE 500 mg/L	
Turbidity	0.04 – 1.87 NTU	1 NTU	3
Uranium	<LOQ – 0.0092 mg/L	0.02 mg/L	
Zinc	<LOQ – 0.052 mg/L	LE 5.0 mg/L	

Notes:
1. **Guidelines for Canadian Drinking Water Quality (April 2003)**
2. **LOQ = limit of quantification**
3. **The manganese guideline is based on aesthetic objectives (AO). Manganese concentrations above the AO are common in New Brunswick and do not constitute a health hazard.**

LE is less than or equal to.