NOVA SCOTIA
Environment

WELL WATER NITRATE MONITORING PROGRAM

2009 REPORT

Prepared: July 2009

TABLE OF CONTENTS

PAGE NO.

EXECUTIVE SUMMARY ii

ACKNOWLEDGMENTS iii

1.0 INTRODUCTION 1
1.1 Background and Objectives 1
1.2 Description of the Study Area 1
1.3 Nitrate in the Environment 3

2.0 METHODS 5
2.1 Field Methods 5
2.2 Data Assessment Methods 6

3.0 RESULTS 7

4.0 REFERENCES 12

APPENDICES
Appendix A: Nitrate Trend Analyses 13

FIGURES
Figure 1-1: Study Area and Well Locations 2
Figure 3-1: Box-Whisker Plots of Nitrate Concentrations in Well Water (1989-2008) 8
Figure 3-2: Annual Median Nitrate Concentration in Well Water (1989-2008) 9
Figure 3-3: Summary of Nitrate Concentrations in Well Water for 2008 10
Figure 3-4: Map of Nitrate Concentrations in Well Water for 2008 11

TABLES
Table 3-1: Summary of Nitrate Concentrations in Well Water (1989-2008) 7

EXECUTIVE SUMMARY

The Well Water Nitrate Monitoring Program is a long-term study that involves annual testing for nitrate at approximately 150 water wells in Kings County, Nova Scotia. The objectives of the program are to monitor nitrate levels in a group of randomly selected water wells to determine the number of wells that meet the Canadian drinking water guideline for nitrate and to identify any long-term trends in nitrate levels.

The monitoring program was initiated in 2002 as a follow-up to previous water quality studies that collected nitrate samples in 1989, 1999 and 2000. The wells have been sampled on a yearly basis since 2002. In total, the wells have been tested on 10 different years during the period between 1989 and 2008.

The monitoring results for the entire period of record indicate that 15% to 25% of the water wells tested exceeded the nitrate drinking water guideline on any given year since 1989. The results also show that nitrate levels in most of the wells have remained relatively consistent over time, with 66% of the wells showing no trend in nitrate levels. However, 31% showed a decreasing trend in nitrate levels and a small number of wells, approximately 3%, showed increasing trends in nitrate levels.

The results from 2008 showed that 19 % of the wells exceeded the nitrate drinking water guideline. This is less than the 22% that was observed previously in 2007, but is within the range of guideline exceedances that has been historically observed since the study began (i.e., 15% to 25%).

ACKNOWLEDGMENTS

The Well Water Nitrate Monitoring Program is a collaboration between Nova Scotia Environment (NSE), which oversees the program and collects the well water samples, and the Nova Scotia Agricultural College, which completes the nitrate laboratory analyses. This report was prepared by staff in the Water & Wastewater Branch of the Environment and Natural Areas Management Division of NSE. Both the report and the operation of the Well Water Nitrate Monitoring Program have benefited from the valuable input of many dedicated individuals. In particular, we gratefully acknowledge the cooperation of the well owners that volunteer their wells to be sampled each year. Their continued participation is vital to the success of this monitoring program.

1.0 INTRODUCTION

1.1 Background and Objectives

The Well Water Nitrate Monitoring Program is a long-term study that involves annual testing for nitrate at approximately 150 water wells in Kings County, Nova Scotia. The program was initiated in 2002 as a follow-up to water quality studies that carried out nitrate sampling in 1989 (Moerman and Briggins, 1994), 1999 and 2000 (Blair, 2001). Since 2002, the nitrate sampling has been completed each year on the same group of water wells.

The objectives of the monitoring program are to monitor nitrate levels in a group of randomly selected water wells to determine the number of wells that meet the Canadian drinking water guideline for nitrate and to identify any long-terms trends in nitrate levels.

This report presents the nitrate results from 1989 up to and including 2008. The report compares the results to the nitrate drinking water guideline, provides nitrate summary statistics for each year, presents a map of the 2008 nitrate results and provides statistical trend analyses.

1.2 Description of the Study Area

The study area is located in Kings County, Nova Scotia. It is found in the central part of Nova Scotia on the southern shore of the Bay of Fundy, approximately one hour west of Halifax. The study area and locations of the water wells that were sampled are shown in Figure 1-1. Much of the county is part of the fertile Annapolis Valley, one of the richest agricultural regions in the province. The study area encompasses four watersheds whose rivers ultimately empty into the Minas Basin. These include: the Cornwallis River, the Canard River, the Habitant River, and the Gaspereau River.

The bedrock in the study area is bordered by Triassic basalt of the North Mountain, and granite and Palaeozoic metasediments of the South Mountain. The valley between the North and South Mountains consists of red sandstone, siltstone, conglomerate and shale. These materials are a part of the Blomidon and Wolfville formations that comprise the majority of the land in the study area and where the main bedrock aquifers exist. Most of the surficial geology was deposited during the Pleistocene glaciation and consists of glacial till, glacio-fluvial sand and gravel deposits (Moerman and Briggins, 1994).

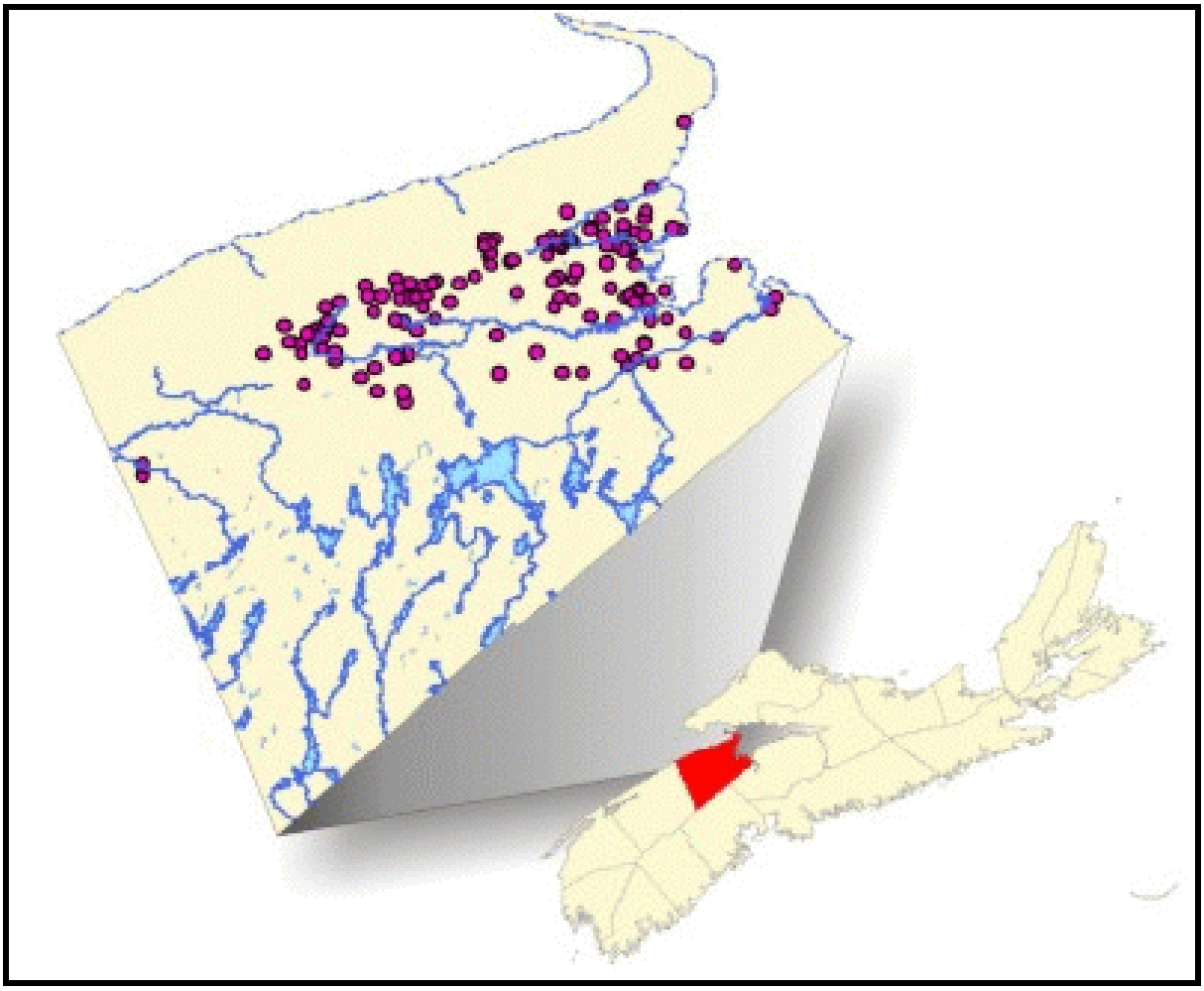

Figure 1-1: Study Area and Well Locations

1.3 Nitrate in the Environment

Nitrate is a naturally occurring ion that is ubiquitous in the environment. Sources of nitrate in groundwater include decaying plant or animal material, agricultural fertilizers, manure, domestic sewage and geological formations containing soluble nitrogen compounds (Health Canada, 1987). Because nitrate salts are very soluble, nitrate is highly mobile in soil and migrates readily to the water table when it is present in excess of the amount utilized by plants.

Nitrogen (N) is an essential nutrient both for plants and animals and it is commonly the limiting nutrient for plant growth. To maintain high yielding crops in agricultural operations it is important to provide non-limiting access to this nutrient, and this has been achieved through the use of fertilizers. Therefore, agricultural fertilizers and manures are often the most significant anthropogenic sources of nitrate in the environment.

Nitrate-impacted groundwater will migrate in an aquifer and can be captured by a water well or discharged to a surface water body as baseflow. Nitrate is a health concern in water wells used for drinking water if the nitrate concentration exceeds the Canadian drinking water guideline of 10 mg/L (expressed as nitrate-nitrogen). Nitrate itself is not highly toxic, as the normal acidity of the adult human stomach will minimize the reduction of nitrate (NO_3^-) to nitrite (NO_2^-), which is highly toxic. However, nitrate levels greater than 10 mg/L can be toxic to human babies. Infants six months and younger who are fed water, or formula made with water that contains a high concentration of nitrate, can develop methaemoglobinaemia (blue baby syndrome). Microbes within the infant's immature digestive system, naturally convert nitrate to nitrite. Nitrite reacts with hemoglobin to form methaemoglobin, which can diminish the oxygen-carrying capability of the infant's blood. This causes the skin to turn a bluish colour, and in cases where the nitrate level in the water is very high, the baby essentially suffocates as its body receives insufficient oxygen (Atlas and Bartha, 1998).

In addition to the direct health concerns associated with nitrate, elevated nitrate levels in well water can indicate that other contaminants may be present, such as microbial pathogens, which can also cause health problems.

Elevated nitrate levels are more commonly observed in shallow groundwater and, therefore, wells that draw shallow groundwater are more likely to have high nitrate levels. Wells that draw shallow

groundwater include: dug wells, well points, shallow drilled wells, and deep drilled wells with insufficient casing lengths.

If nitrate-impacted groundwater is not captured by a water well, it will continue to migrate in the aquifer and eventually either naturally attenuate, or discharge to a surface water body as base flow. High nitrate levels in surface water contributes to eutrophication, which results in a reduction of available oxygen for aquatic life.

2.0 METHODS

2.1 Field Methods

There are a total of 153 water wells in the Well Water Nitrate Monitoring Program. The majority of the wells are private water wells that are used as domestic or barn water supplies, however, the program also includes 10 municipal water wells. The wells were randomly selected during the initial 1989 study (Moerman and Briggins, 1994) and the same group of wells is now sampled each year, normally in August. Although sampling is attempted at all 153 wells each year, on any given year there are usually several wells that cannot be accessed because well owners cannot be reached when the sampling is being carried out. As a result, the total number of water wells sampled each year usually ranges between 130 and 140.

There is a general lack of information on well construction for the wells in the monitoring program, however, based on information provided from the initial 1989 study, the majority are drilled wells (approximately 69%), and the remainder are dug wells or sand points (16%), or unknown/other (15%). Most of the well depths are unknown (i.e., 76% unknown). However, of the 24% of wells with known well depths, approximately 14% are shallow (<31 m), 8% are moderately deep (31 m to 61 m), and 2% are deep (<61 m).

The initial water quality study in 1989 tested well water for a variety of parameters, including: nitrate, general chemistry, bacteria and pesticides. The current monitoring program has been refined to focus on nitrate because the results of the 1989 study indicated that nitrate was the parameter that most commonly exceeded its guideline for Canadian drinking water quality.

For the current monitoring program, the well water samples were collected by Nova Scotia Environment staff at an outdoor water tap, if possible. Prior to collecting the sample, the water was run for approximately five minutes to clear the lines of stagnant water to ensure a fresh sample. The samples were collected in 100 mL laboratory-supplied bottles and kept refrigerated for a maximum of three weeks until they were delivered to the Nova Scotia Agricultural College laboratory in Truro, Nova Scotia, for nitrate analysis.

During sample collection, field duplicates were also collected at approximately 5% of the wells. For wells where field duplicates were taken, the relative percent difference was calculated. For the 2008 monitoring event, the relative percent difference of the duplicate samples was less than 12%.

2.2 Data Assessment Methods

The nitrate concentration at each water well was assessed by comparing the result to the nitrate drinking water guideline (10 mg/L for nitrate-nitrogen). Each well was also assessed for changes and trends for the period of record, up to and including data collected in 2008. For those wells where over 95% of samples taken exceeded the drinking water guideline, graphs were generated and visually assessed for trends.

The Mann-Kendall trend test (Gilbert, 1987) was used to determine whether a statistically significant trend was present in the nitrate concentrations at each well (i.e. upward trend, downward trend or no trend). This test is one of the most commonly used statistical methods to evaluate trends in environmental data and has been used in other water studies in Nova Scotia. Trends were considered "statistically significant" if there was at least a 95% confidence level. Note that "statistically significant" means there is statistical evidence that there is a trend present, but does not indicate whether the trend is large or small.

For all statistical analyses presented in this report, non-detect results were included in the calculations by dividing the detection limit by two.

3.0 RESULTS

A summary of the nitrate data available from 1989 to 2008 is presented in Table 3-1 and Figure 3-1. In total there are 10 years that have data available. The maximum nitrate concentration during the period of record has varied between 25.5 and 46.9 mg/L, consistently exceeding the nitrate drinking water guideline of 10 mg/L. The percentage of wells exceeding the nitrate drinking water guideline has ranged from 15 to 25% and the median nitrate concentration has always remained below the drinking water guideline. Approximately 6% of wells which have been sampled since 1989 exceeded the nitrate drinking water guideline in every year of the study.

Table 3-1: Summary of Nitrate Concentrations in Well Water (1989-2007)

Year	Number of Wells Sampled	Nitrate Concentration (mg/L, expressed as NO_3-N)			Number of Wells Exceeding Drinking Water Guideline (10 mg/L)	% of Wells Exceeding Drinking Water Guideline (10 mg/L)
		Minimum	Median	Maximum		
1989	135	0.30	3.6	46.1	27	20%
1999	142	0.33	4.2	43.0	34	24%
2000	137	0.05	3.4	46.9	27	20%
2002	139	0.21	4.1	33.1	28	20%
2003	138	0.32	4.7	42.5	26	19%
2004	134	0.19	5.1	46.7	34	25%
2005	130	<0.30	2.2	39.3	19	15%
2006	133	<0.06	3.0	38.5	29	22%
2007	132	<0.08	2.9	34.9	29	22%
2008	135	<0.08	2.6	25.5	26	19%

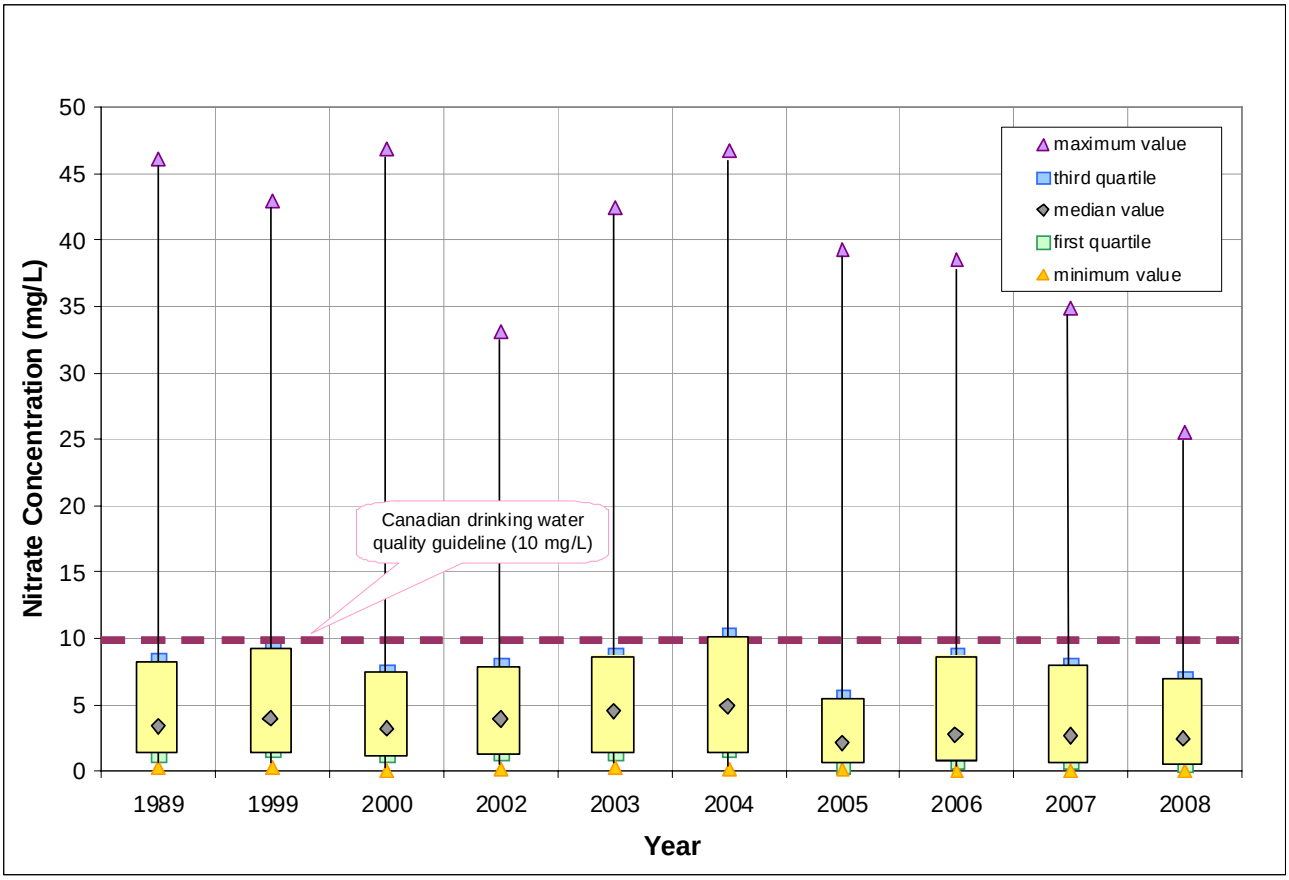

Figure 3-1: Box-Whisker Plots of Nitrate Concentrations in Well Water (1989 - 2008)

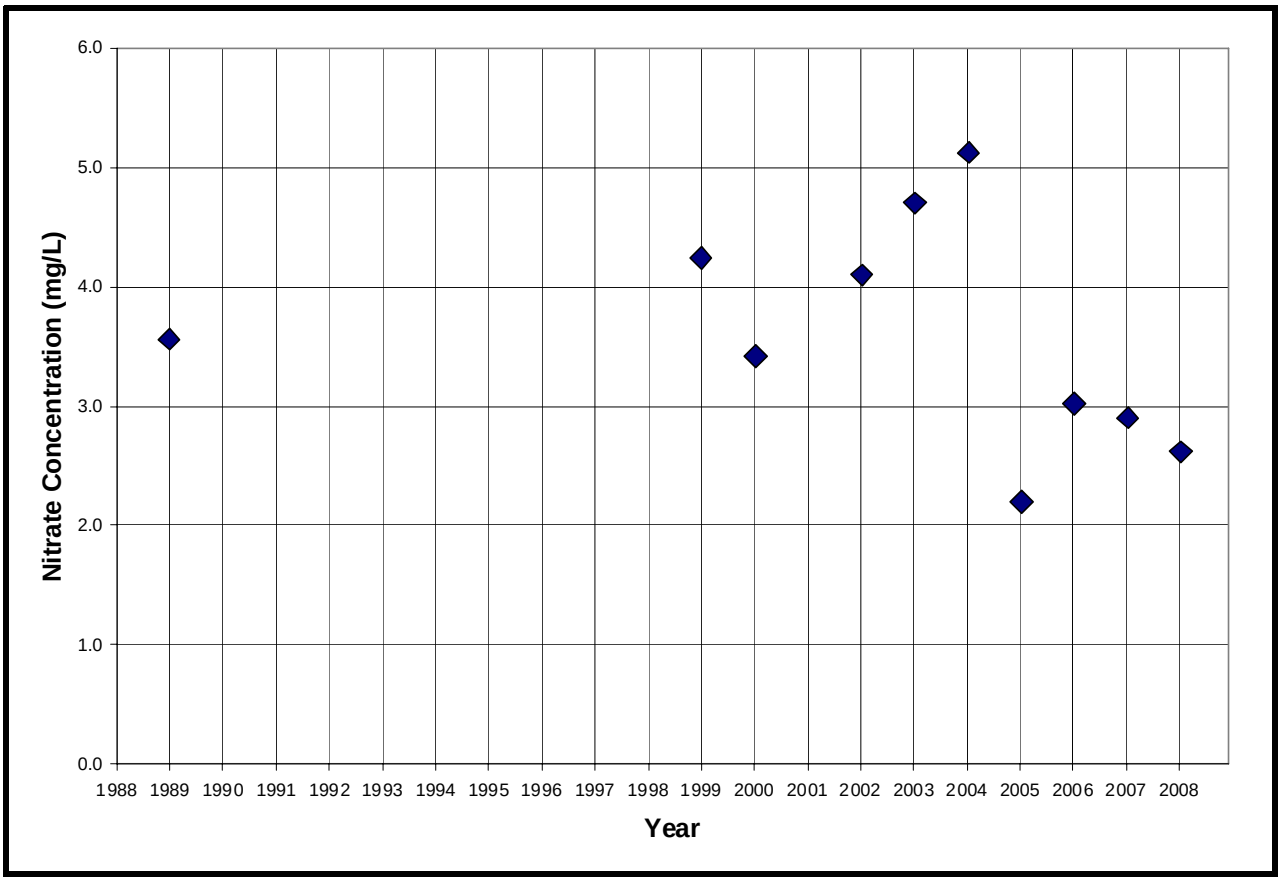

Figure 3-2: Annual Median Nitrate Concentration in Well Water (1989 - 2008)

A trend analysis was carried out on the annual median nitrate concentrations in Figure 3-2. The purpose of this analysis to see if there was an overall trend in nitrate levels in the entire dataset. One trend analysis was carried out for the period of 1989 to 2008 and another analysis was carried out for the period of 1999 to 2008. No statistically significant trends were identified. The results of the trend analyses are presented in Appendix A.

A trend analysis was also carried out on each individual well to determine if nitrate concentrations were changing over time on a well-by-well basis. The trend analyses were completed for all wells that had at least four years of data available, which was a total of 143 wells. The trend analyses indicated that 3% of the wells had an upward trend, 31% had a downward trend, and 66% had no statistically significant trend present. The results of the trend analyses are presented in Appendix A.

The 2008 nitrate data are presented Figure 3-3 and Figure 3-4. The 2008 data indicate that 19 % of the wells (i.e. 26 of 135 wells) exceeded the nitrate drinking water guideline. This is within the range of exceedances that has been observed historically (i.e., the range since 1989 is from 15% to 25%).

The map in Figure 3-4 shows that the majority of elevated nitrate results were detected in eastern portion of the study area. The elevated results also tend to occur in areas located near the centre of the valley.

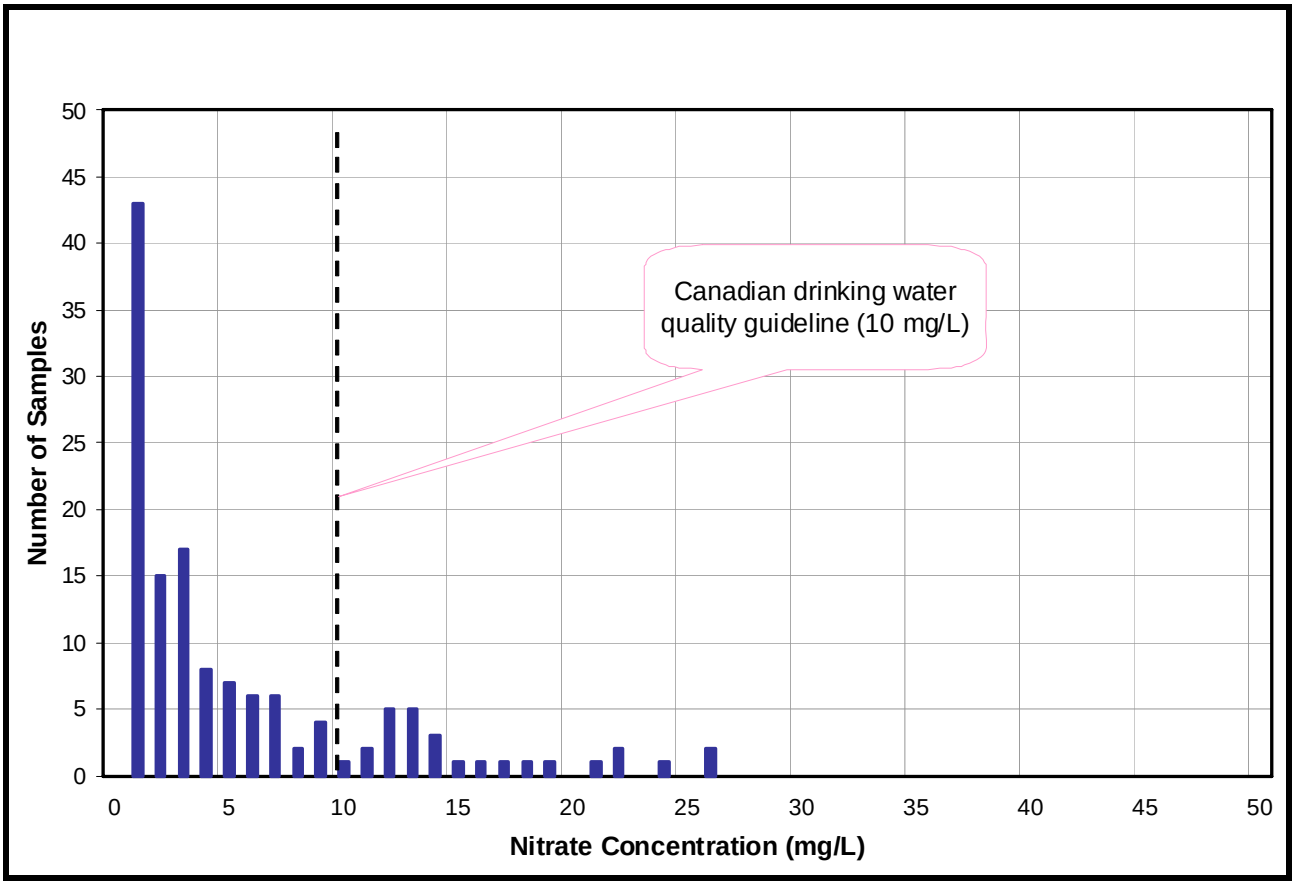

Figure 3-3: Summary of Nitrate Concentrations in Well Water for 2008

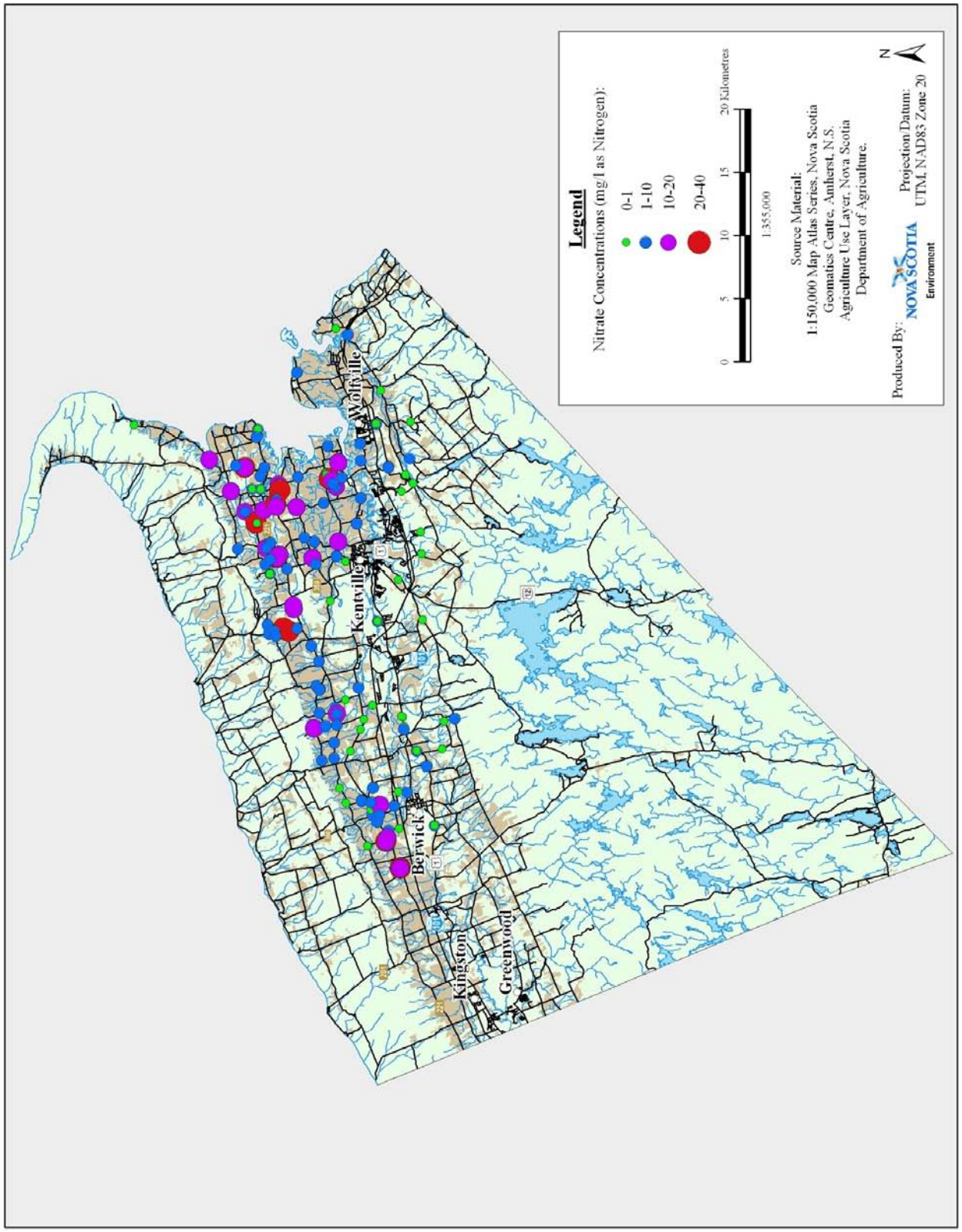

Figure 3-4: Map of Nitrate Concentrations in Well Water for 2008

4.0 REFERENCES

Atlas, R. and R. Bartha. 1998. Microbial Ecology: Fundamentals and Applications. 4th Edition. Addison Wesley Longman Inc.

Blair, K. R. 2001. Temporal and Spatial Profiles of Groundwater Nitrate Concentration in Kings County, Nova Scotia. Masters of Science thesis. Dalhousie University.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. John Wiley & Sons.

Health Canada. 1987. Guidelines for Canadian Drinking Water Quality, Supporting Document for Nitrate-Nitrite.

Moerman, D. and D. Briggins. 1994. Nova Scotia Farm Well Water Quality Assurance Study: Final Report. Province of Nova Scotia.

APPENDIX A

NITRATE TREND ANALYSES

No.	Well No.	First year	Last Year	Q	n	S	VAR(S)	Z	significance
1	1	1989	2008	0.11	9	2	92	0.10	54%
2	3	1989	2008	-0.38	10	-3	125	-0.18	57%
3	4	1989	2008	0.12	9	6	92	0.52	69%
4	6	1989	2008	-2.25	10	-25	125	-2.15	98%
5	7	1989	2008	0.91	10	13	125	1.07	85%
6	9	1989	2008	0.36	10	7	125	0.54	70%
7	10	1989	2008	-0.02	10	-4	125	-0.27	60%
8	17	1989	2008	-0.02	10	-13	125	-1.07	85%
9	18	1989	2008	-0.40	10	-32	125	-2.77	99%
10	19	1989	2008	-0.25	9	-11	92	-1.04	85%
11	22	1989	2008	-0.30	10	-32	125	-2.77	99%
12	25	1999	2008	0.86	8	14	65	1.61	94%
13	29	1989	2008	-0.05	9	-26	92	-2.61	99%
14	32	1989	2008	-0.22	10	-9	125	-0.72	76%
15	34	1989	2008	0.14	8	10	65	1.11	86%
16	35	1989	2008	-0.32	10	-11	125	-0.89	81%
17	37	1989	2008	-0.04	10	-4	125	-0.27	60%
18	38	1989	2008	-0.03	9	-10	92	-0.94	82%
19	39	1989	2008	-0.08	9	-12	92	-1.15	87%
20	40	1989	2006	-0.23	8	-12	65	-1.36	91%
21	41	1989	2008	-0.03	9	-15	92	-1.46	92%
22	42	1989	2008	-0.62	10	-26	125	-2.24	98%
23	43	1989	2008	-0.20	10	-7	125	-0.54	70%
24	45	1989	2008	-0.48	10	-13	125	-1.07	85%
25	46	1989	2008	-0.07	10	-30	125	-2.59	99%
26	47	1989	2008	-0.52	10	-11	125	-0.89	81%
27	51	1989	2008	-0.07	10	-15	125	-1.25	89%
28	55	1989	2008	-0.17	10	-17	125	-1.43	92%
29	57	1989	2008	-0.40	10	-19	125	-1.61	94%
30	59	1989	2008	0.04	10	1	125	0.00	50%
31	60	1989	2008	-0.21	10	-15	125	-1.25	89%
32	61	1989	2008	-0.11	10	-15	125	-1.25	89%
33	64	1989	2008	0.11	10	5	125	0.36	63%
34	65	1989	2003	0.36	5	2	17	0.24	59%
35	66	1989	2008	-0.92	10	-17	125	-1.43	92%
36	67	1989	2008	0.06	10	7	125	0.54	70%
37	70	1989	2008	-0.05	10	-5	125	-0.36	63%
38	71	1989	2006	-0.21	7	-13	44	-1.80	96%
39	74	1989	2008	-0.17	5	-6	17	-1.22	88%
40	75	1989	2008	-0.06	6	-3	28	-0.38	64%
41	76	1989	2008	0.13	10	13	125	1.07	85%
42	78	1989	2008	-0.05	10	-9	125	-0.72	76%
43	82	1989	2008	-0.02	10	-1	125	0.00	50%
44	84	1989	2008	-0.15	10	-26	125	-2.24	98%
45	87	1989	2008	-0.05	10	-33	125	-2.86	99%
46	88	1989	2008	0.01	10	3	125	0.18	57%
47	90	1989	2008	-0.22	10	-29	125	-2.50	99%
48	92	1989	2007	-0.23	6	-7	28	-1.13	87%
49	93	1989	2008	0.30	10	9	125	0.72	76%
50	94	1989	2008	-0.51	10	-28	125	-2.41	99%
51	98	1989	2008	-0.34	10	-32	125	-2.77	99%
52	100	1989	2008	0.01	9	2	92	0.10	54%
53	101	1989	2008	-0.02	9	-6	92	-0.52	69%
54	102	1989	2008	-0.01	8	-9	65	-0.99	83%
55	103	1989	2008	0.17	10	5	125	0.36	63%
56	107	1989	2008	-0.34	7	-9	44	-1.20	88%

No.	Well No.	First year	Last Year	Q	n	S	VAR(S)	Z	significance
57	108	*1989*	*2008*	-0.12	9	-18	*92*	-1.77	96%
58	109	*1989*	*2008*	0.11	9	14	*92*	1.36	91%
59	112	*1989*	*2008*	0.29	10	7	*125*	0.54	70%
60	113	*1989*	*2008*	0.02	10	2	*125*	0.09	53%
61	114	*1989*	*2008*	-0.14	10	-19	*125*	-1.61	94%
62	116	*1989*	*2008*	-0.09	10	-42	*125*	-3.67	99%
63	117	*1989*	*2008*	-0.05	10	-33	*125*	-2.86	99%
64	119	*1989*	*2008*	0.10	9	12	*92*	1.15	87%
65	120	*1989*	*2008*	-0.06	10	-32	*125*	-2.77	99%
66	125	*1989*	*2008*	-0.03	10	-22	*125*	-1.88	96%
67	126	*1989*	*2008*	0.22	9	6	*92*	0.52	69%
68	127	*1989*	*2008*	-0.20	9	-17	*92*	-1.67	95%
69	128	*1989*	*2008*	0.05	9	4	*92*	0.31	62%
70	132	*1989*	*2008*	-0.22	10	-21	*125*	-1.79	96%
71	137	*1989*	*2008*	0.37	9	8	*92*	0.73	76%
72	140	*1989*	*2008*	0.87	10	31	*125*	2.68	99%
73	141	*1989*	*2008*	0.22	10	11	*125*	0.89	81%
74	142	*1989*	*2008*	-0.10	10	-15	*125*	-1.25	89%
75	144	*1989*	*2008*	-0.02	10	-18	*125*	-1.52	93%
76	148	*1989*	*2008*	-0.36	10	-27	*125*	-2.33	98%
77	149	*1989*	*2008*	-0.65	10	-17	*125*	-1.43	92%
78	150	*1989*	*2008*	0.93	10	21	*125*	1.79	96%
79	153	*1989*	*2008*	-0.07	10	-31	*125*	-2.68	99%
80	208	*1989*	*2008*	0.07	10	10	*125*	0.80	78%
81	212	*1989*	*2008*	-0.14	10	-11	*125*	-0.89	81%
82	217	*1989*	*2008*	-0.13	10	-23	*125*	-1.97	97%
83	224	*1989*	*2008*	-0.16	10	-27	*125*	-2.33	98%
84	225	*1989*	*2008*	-0.22	9	-4	*92*	-0.31	62%
85	231	*1989*	*2008*	-0.44	10	-17	*125*	-1.43	92%
86	250	*1989*	*2008*	-0.03	10	-30	*125*	-2.59	99%
87	251	*1989*	*2008*	-0.03	10	-34	*125*	-2.95	99%
88	255	*1989*	*2008*	-0.13	10	-17	*125*	-1.43	92%
89	256	*1989*	*2008*	-0.18	8	-8	*65*	-0.87	80%
90	257	*1989*	*2008*	-0.19	10	-23	*125*	-1.97	97%
91	258	*1989*	*2008*	-0.04	10	-9	*125*	-0.72	76%
92	262	*1989*	*2008*	-0.04	10	-34	*125*	-2.95	99%
93	270	*1989*	*2008*	-0.07	10	-27	*125*	-2.33	98%
94	271	*1989*	*2008*	0.09	10	13	*125*	1.07	85%
95	301	*1989*	*2008*	0.21	9	10	*92*	0.94	82%
96	302	*1989*	*2008*	-0.10	9	-6	*92*	-0.52	69%
97	303	*1989*	*2008*	-0.03	9	-18	*92*	-1.77	96%
98	308	*1989*	*2008*	-0.73	10	-25	*125*	-2.15	98%
99	309	*1989*	*2008*	0.33	10	23	*125*	1.97	97%
100	310	*1989*	*2008*	-0.18	10	-23	*125*	-1.97	97%
101	312	*1989*	*2008*	-0.04	10	-15	*125*	-1.25	89%
102	313	*1989*	*2008*	-0.08	10	-28	*125*	-2.41	99%
103	316	*1989*	*2008*	-0.15	10	-11	*125*	-0.89	81%
104	317	*1989*	*2008*	-0.34	10	-21	*125*	-1.79	96%
105	318	*1989*	*2008*	-0.40	10	-31	*125*	-2.68	99%

No.	Well No.	First year	Last Year	Q	n	S	VAR(S)	Z	significance
106	330	*1989*	*2008*	0.18	10	11	*125*	0.89	81%
107	331	*1989*	*2008*	0.04	9	6	*92*	0.52	69%
108	333	*1989*	*2008*	-0.04	10	-19	*125*	-1.61	94%
109	335	*1989*	*2008*	-0.19	9	-23	*92*	-2.29	98%
110	350	*1989*	*2008*	-0.51	10	-7	*125*	-0.54	70%
111	364	*1989*	*2008*	-0.04	10	-22	*125*	-1.88	96%
112	380	*1989*	*2008*	0.11	9	8	*92*	0.73	76%
113	402	*1989*	*2008*	-0.11	9	-10	*92*	-0.94	82%
114	403	*1989*	*2008*	-0.35	10	-35	*125*	-3.04	99%
115	405	*1989*	*2008*	0.05	10	18	*125*	1.52	93%
116	407	*1989*	*2008*	-0.03	10	-5	*125*	-0.36	63%
117	409	*1989*	*2007*	0.00	9	0	*92*	0.00	50%
118	411	*1989*	*2008*	-0.08	10	-5	*125*	-0.36	63%
119	412	*1989*	*2008*	-0.42	9	-20	*92*	-1.98	97%
120	415	*1989*	*2008*	-0.06	10	-9	*125*	-0.72	76%
121	420	*1989*	*2008*	-0.08	10	-3	*125*	-0.18	57%
122	422	*1989*	*2008*	0.01	7	1	*44*	0.00	50%
123	423	*1989*	*2008*	-0.15	10	-16	*125*	-1.34	91%
124	424	*1989*	*2008*	-0.15	9	-22	*92*	-2.19	98%
125	428	*1989*	*2008*	0.33	9	24	*92*	2.40	99%
126	429	*1989*	*2008*	-0.66	10	-21	*125*	-1.79	96%
127	435	*1989*	*2008*	-0.15	10	-3	*125*	-0.18	57%
128	437	*1989*	*2008*	0.20	10	5	*125*	0.36	63%
129	439	*1989*	*2008*	-0.08	10	-7	*125*	-0.54	70%
130	500	*1999*	*2008*	-0.03	9	-17	*92*	-1.67	95%
131	501	*1999*	*2008*	-0.16	8	-12	*65*	-1.36	91%
132	502	*1999*	*2007*	-0.05	8	-7	*65*	-0.74	77%
133	503	*1999*	*2005*	-0.04	6	-5	*28*	-0.75	77%
134	504	*1999*	*2003*	0.03	4	2	*9*	0.34	63%
135	505	*1999*	*2007*	-0.09	8	-6	*65*	-0.62	73%
136	506	*1999*	*2008*	-0.14	8	-26	*65*	-3.09	99%
137	507	*1999*	*2008*	-0.31	9	-8	*92*	-0.73	76%
138	508	*1999*	*2008*	-0.07	9	-4	*92*	-0.31	62%
139	509	*1999*	*2008*	-0.31	8	-6	*65*	-0.62	73%
140	510	*1999*	*2008*	0.23	9	23	*92*	2.29	98%
141	511	*1999*	*2008*	-0.11	9	-20	*92*	-1.98	97%
142	512	*2002*	*2008*	-0.47	7	-13	*44*	-1.80	96%
143	513	*2000*	*2008*	-3.61	8	-18	*65*	-2.10	98%

Annual Median Nitrate Concentration									
1	All Wells	*1989*	*2008*	-0.09	10	-15	-	-	<95%
2	All Wells	*1999*	*2008*	-0.17	9	-14	-	-	<95%

Notes:

1. Q is Sen's slope.
2. n is the number of records.
3. S is the Mann-Kendall statistic.
4. VAR (S) is the variance of S.
5. Z is the test statistic.
6. Significance is the confidence level of the statistical trend.
7. A trend was considered to be statistically significant if it had a confidence level of at least 95%.
8. Please see Gilbert (1987) for further details on the Mann-Kendal trend test.