

Know Your H₂O

Domestic Water Quality Monitoring

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Executive Summary

In 2001, a pilot project was set up to promote testing of drinking water from private wells in New Brunswick and to raise awareness of wells and maintenance procedures concerning water quality. As a follow-up, the “Know Your H₂O” program was initiated in 2006 to continue to promote drinking water quality awareness, to better understand provincial groundwater quality, and to determine whether well water quality improved since 2001.

During the period from July 2006 to November 2007, all private well owners in New Brunswick could submit a water sample to test for total coliforms and E. coli at no cost. In total, 14,338 wells were sampled and 5,565 wells were re-sampled for a total of 19,903 samples. Results were reviewed based on 14 different regions throughout New Brunswick. The regions were selected to correspond to local Public Health offices. In total, 35.6% of the 14,338 wells sampled were contaminated with total coliform bacteria, ranging from a high contamination rate of 53% in Campbellton (Region 5), to a low contamination rate of 24% in Miramichi (Region 7). Overall, 4.4% of the samples were contaminated with E. coli bacteria, ranging from 9% in Edmunston (Region 4) to 2% in Miramichi (Region 7).

Unacceptable water test results were followed up by Department of Health. Homeowners whose well water was contaminated with total coliforms and E. coli were advised to re-submit a sample to confirm the result and plan remedial action.

Results indicate that time of year might play a role in the presence of coliform bacteria (total and E. coli) in drilled wells. Wells without adequate protection from surface water infiltration or groundwater closely connected to a surface water body may also play a role in the presence of coliform bacteria.

Information relating to the construction of the wells was only available for 13% of the 14,338 wells and therefore, caution should be taken with interpretation of the data. One factor possibly relating to the presence of bacteria was casing depth. Wells having casing between 0-19 feet had the highest contamination rate with E. coli at 8% compared to an average of approximately 3% for all other depths.

Acknowledgements

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Data analysis and report text by Cindy Breau and Don Fox, Sciences and Reporting Branch.

Feedback

Your feedback on this report or any aspects of the water testing program, would be greatly appreciated. You may send comments at any time via email to information-env@gnb.ca, or call 457-4846, fax 457-7823.

Environmental Reporting Series

This series of reports is intended to provide information on environmental quality in New Brunswick. Reports in this series have a technical or scientific theme, and may be general in nature, or deal with specific projects. For more information, please contact the Sciences and Reporting Branch of the Department of Environment at 506 457-4844.

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Introduction

New Brunswick has a large and scattered rural population, 40% of which obtains its water from domestic wells. The responsibility for maintaining these wells to provide safe drinking water lies with the property owner. These wells vary considerably in age, type and standard of construction and maintenance. The well types most commonly found include dug and drilled wells. Both kinds may be of variable depth, and may have a casing (or metal liner) which helps prevent collapse and infiltration of sand and rock fragments, or surface water seepage. Older wells may have casing of inadequate length, or no casing at all, and, depending on local water chemistry, old casings are often found to be corroded and may not be performing as they should.

Well water is at risk of contamination from a variety of sources. The most common threats are biological or organic cross-contamination from malfunctioning or improperly maintained sewage disposal systems; grey-water infiltration areas on the same or adjacent property; petroleum contamination from leaking oil or gasoline storage tanks; spills of petroleum products, or spills of pesticides.

The state of physical construction of domestic wells is highly variable. Many were installed before construction standards were in place, and many are seldom inspected or maintained. Very few rural homeowners have their water quality tested regularly. Lending institutions ask for a one-time bacteriological test before a loan or mortgage will be approved for the purchase of a property, but this is not a legal requirement by government. For wells drilled since September 1994, a voucher system for an initial bacteriological and inorganic water test has been in place. Prior to well construction, the property owner pays for the test as part of the well drilling fee and receives a voucher. After the well is constructed and receives some normal usage, the homeowner collects the water sample and redeems the voucher. This is a requirement under legislation.

In 2001, a pilot water testing survey was carried out because of the following factors:

- a relatively high percentage of private wells in rural areas, installed before standards were in place, are suspected of being constructed to an inadequate standard;
- well owners probably do not test their water quality often enough to note when maintenance is needed;
- well owners are probably not adequately informed about the potential risks to the safety and quality of their water supplies as it relates to flooding events;

- well owners may not be sufficiently aware of the importance of testing water regularly to ensure the safety of their drinking water.

The 2001 survey was designed to address these concerns by:

- raising public awareness about water testing and quality issues;
- making it easier for the public to have their water tested;
- gathering information about rural well age, construction and related factors;
- improving the redemption rate of testing vouchers.

A report on the 2001 survey results was released in 2003. In 2006-2007, an expanded follow-up program entitled “Know Your H₂O” was conducted to:

- assess the province-wide presence or absence of coliform bacteria in private wells;
- determine whether there has been an improvement in the number of wells of acceptable bacteriological quality since the 2001 project;
- improve the drinking water quality database currently available to Department of Environment (DENV) staff for ongoing management and assessment of private water supplies across the province;
- increase awareness.

Sources of drinking water in New Brunswick

Drinking water in New Brunswick comes from various sources. Municipal water supplies service about 60% of the population of the province. The larger municipalities have controlled water treatment and distribution systems, with the water source being either surface or groundwater, or a combination. Water quality in such systems is regularly tested, and trained staff are employed to operate treatment and distribution systems.

In some incorporated areas there is both a public water supply system and individual wells on other properties within the municipality (for example, New Maryland, south of Fredericton).

In rural areas, people obtain their water almost exclusively from private wells. This method serves approximately 40% of the population of New Brunswick (about 300,000 people). Water supplies of this type are generally not treated or regularly tested. There are many well-drilling companies in operation within the province, collectively drilling over 2,000 new wells annually.

Regulation of water quality

Water supplies in New Brunswick are regulated by a number of Acts and Regulations. These are listed in Table 1, which notes the principal features of each piece of legislation. All provincial legislation is also available via the Internet at:

<http://www.gnb.ca/0062/index.htm>

Over the years, New Brunswick legislation for the management and protection of municipal water in the province has become increasingly comprehensive, to the point where it is regarded as one of the best legal drinking water frameworks in Canada. In addition to the Acts and Regulations listed in Table 1, a number of other pieces of legislation are also important in protecting water quality, such as the Petroleum Product Storage and Handling Regulation, and the Pesticides Control Act. Despite this relatively comprehensive system of legal management tools, there are still weaknesses where rural water supplies are concerned. For example, homeowners frequently know little about their wells and water supply systems and there is no legal requirement for the owners of existing private wells to have them routinely tested.

Table 1. New Brunswick water quality legislation.

Act or Regulation	Principal Features
Clean Water Act, C-6.1	Provides authority to regulate water quality and quantity and make related regulations. Allows Minister to issue orders to protect water quality, and control use of water supplies. Prohibits the contamination of water. Provides authority to designate water supply protected areas by order.
Potable Water Regulation, 93-203	Regulates the voucher system for testing of new private/domestic wells, the tagging of wells, and the testing of municipal water supplies.
Wellfield Protected Area Designation Order, 2000-47	Controls land-use activities in the vicinity of water supply wells for selected wellfields.
Water Well Regulation, 90-79	Regulates the drilling of water supply wells via licensing of well drillers and contractors, water well location, construction, testing, and distance from potential sources of contamination.
Water Classification, 2002-13	Defines standards for classifying surface waters and maintaining their water quality and other characteristics, such as trophic status, and defines a public

	process for setting water quality goals.
Fees for Industrial Approvals, 93-201	Regulates how major sources of water pollution are managed through a system of permits.
Clean Environment Act	Provides authority to control contaminants in the environment, and to make regulations in respect of the management of substances or operations which may affect water quality.
Watershed Protected Area Designation Order, 2001-83	Controls many activities in designated watersheds, to protect public drinking water supplies.
Water Quality Regulation, 82-126	Sets the framework for issuing approvals to operate industrial facilities, typically setting limits for the discharge of contaminants to the environment.
Health Act, H-2	Provides the authority for issuing boil orders or closing down a water supply.
Health Act -General Regulation, 88-200	Regulates private sewage disposal systems to protect groundwater.

Methodology

In an effort to gain an improved understanding of the state of domestic water quality supplies across the province, DENV coordinated this extensive project during the period of July 2006 to November 2007. The project was carried out in collaboration with Department of Health and various provincial watershed groups. Homeowners of the province were encouraged to submit samples to DENV for analysis. DENV also issued news releases about the project, and issued advertisements in different newspapers across the province to promote the study. The program provided free water testing for presence of total coliforms and E. coli bacteria. Information and description of the bacteria are presented in Table 2.

In instances where samples failed the total coliform test, results were sent from the DENV laboratory to the Department of Health. A listing of NB Health offices with a breakdown of samples for each office is presented in Table 3. Health staff then informed the property owners of the results and provided advice on how to address the water quality problem. Typically this would consist of disinfecting the well system with chlorine bleach and then re-testing. When the water continues to fail the total coliform test, this usually indicates an ongoing pathway of contamination, which requires a more detailed assessment.

Table 2. Parameters tested in drinking water during the study.

Parameters	Description
Coliform bacteria, total coliforms (TC)	Occur naturally in surface water, soil and in the human digestive system; most do not cause disease; higher coliform counts can be associated with a greater risk of other harmful organisms being present.
Escherichia coli (E. coli)	Bacteria which belong to the coliform group of microorganisms and are found in the intestines of humans and animals. The presence of E. coli in water indicates a strong likelihood of recent sewage or animal waste contamination. Although there are hundreds of different strains, only a few are harmful to human health. The strain O157:H7, for example, produces a powerful toxin and can cause serious illness such as kidney failure. Symptoms of E. coli infection may include diarrhea, abdominal pain and nausea. Possible routes of E. coli infection are ingestion of contaminated water, meat, unpasteurized milk or fruit juices. E. coli can also be transmitted from person to person or animal to person in the absence of proper hand-washing and hygiene practices.

Table 3. Location of fourteen New Brunswick Health offices.

Location	Offices	Number of Samples
Moncton	1	2,638
Saint John	2	1,642
Fredericton	3	2,620
Edmundston	4	935
Campbellton	5	474
Bathurst	6	1,392
Miramichi	7	994
Caraquet	8	321
Perth-Andover	9	43
St Stephen	10	729
Sussex	11	1,019
Tracadie	12	1,017
Woodstock	13	489
Shippagan	14	25
	total	14,338

Precipitation (rain and snow) data was also downloaded from the Canadian Daily Climate Data of Environment Canada (http://www.climate.weatheroffice.ec.gc.ca/advanceSearch/searchHistoricDataStations_e.html). Data is available for different regions of New Brunswick. For the analysis, each local health office was linked to the nearest gauging station thereby obtaining a level of precipitation in the general area of each office.

Results

Participation

Participation in the “Know Your H₂O” program occurred in all regions of the province as shown by the distribution of sampled wells in Figure 1. The overall response to the project varied between region, ranging from 2,638 households participating in the Moncton region to only 25 in the Shippagan region. In total, 14,338 well water samples were analyzed at the DENV laboratory during this project and 5,565 of these samples were re-submitted for follow-up testing due to contamination.

Positive Bacterial Tests

Total Coliforms

The percentage of wells testing positive for total coliforms ranged from 24% in the Miramichi region (region 7) to 53% in the Campbellton (region 5) with an overall average of 35.6% province-wide (Figure 2). Results from 12 regions are statistically reliable based on the large number of samples analyzed. However, regions 9 (Perth-Andover) and 15 (Shippagan) should be treated with caution based on the smaller number of samples tested.

E. coli

Overall, 4.4% of the wells tested for E. coli were contaminated province-wide with values varying between 9% in Edmundston (region 4) and 2% in Miramichi (region 7; Figure 3). Of the 35.6% of the wells contaminated with total coliforms, 12% tested positive for E. coli.

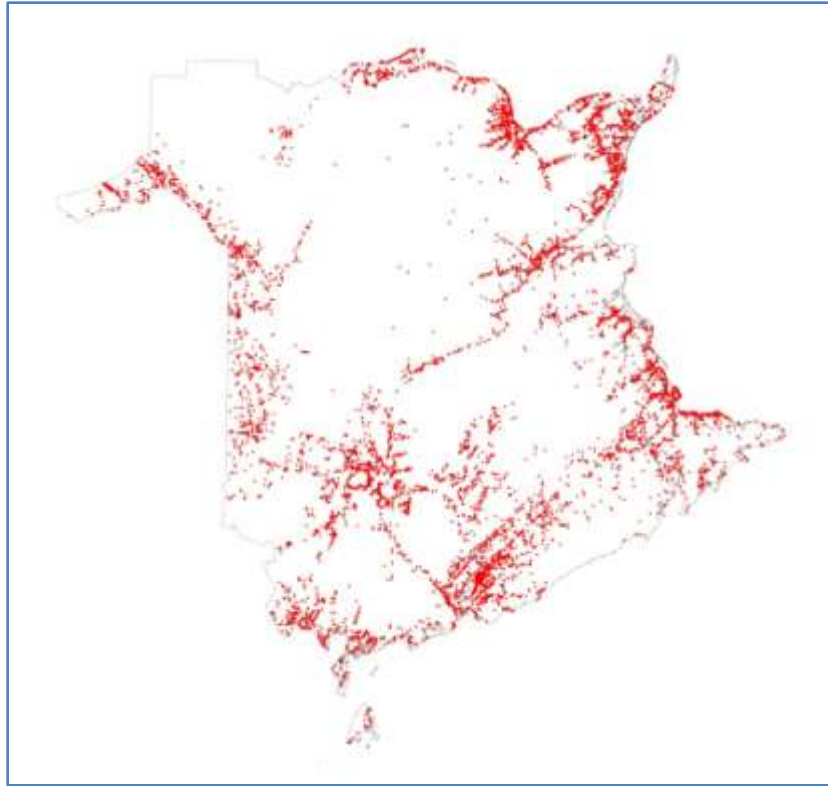


Figure 1. Map of New Brunswick illustrating the distribution of the well water samples submitted for testing during the period of July 2006 to July 2007.

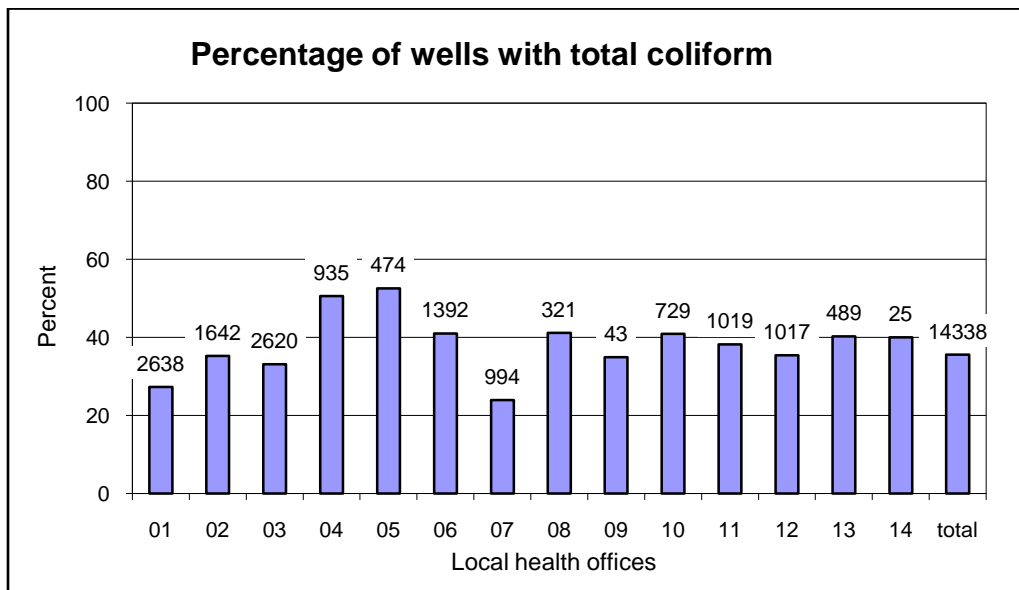


Figure 2. Percentage of wells testing positive for presence of total coliforms in relation to local health offices. The numbers on the bars indicate the total number of wells sampled in each region. A list of health offices is provided in Table 3.

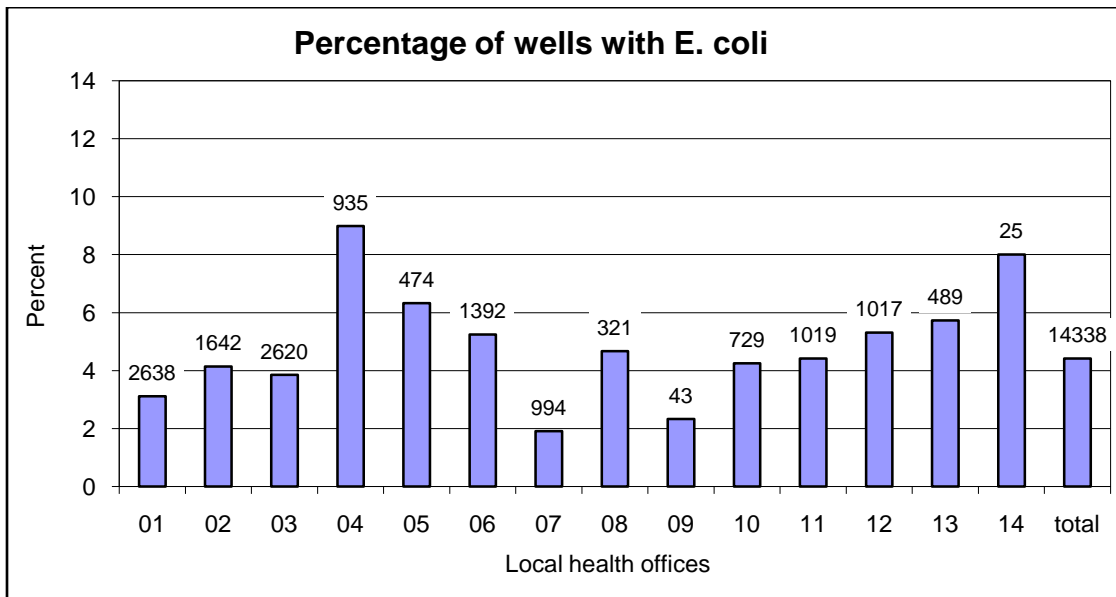


Figure 3. Percentage of wells contaminated with E. coli in relation to local health offices. The numbers on the bars indicate the total number of wells sampled in each region. A list of the local health regions is provided in Table 3.

Re-sampling of wells testing positive for total coliforms

Total Coliforms

Re-sampling of wells was prompted by positive testing for total coliforms (not necessarily testing positive for E. coli). A total of 5,565 samples were re-submitted for analysis between one and six times. Only results of the second testing, which consists of 3,805 samples are presented. Presence of total coliforms was confirmed in 62% of the 3,805 samples submitted during the second round of testing (Figure 4). Of the samples testing positive for total coliforms in the initial sampling, Campbellton, Bathurst and Caraquet (regions 5, 6 and 8) still showed high levels of total coliforms during the second testing.

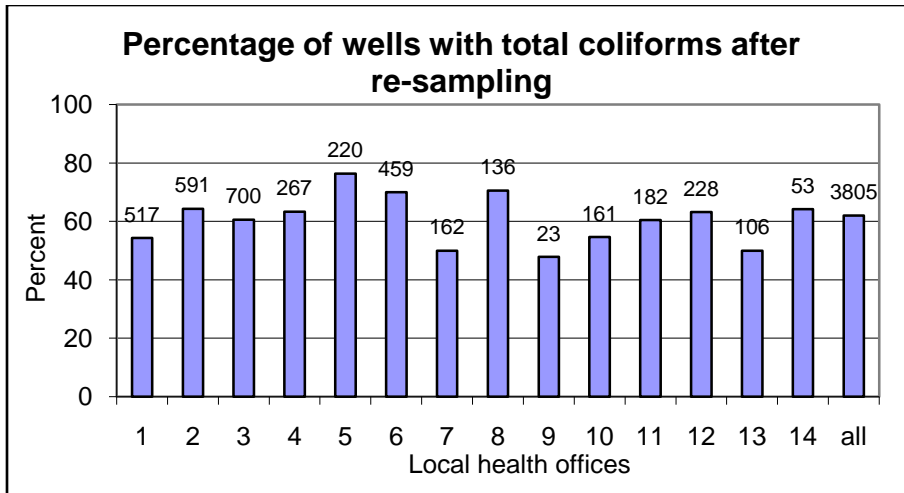


Figure 4. Percentage of wells with total coliforms after re-sampling in relation to local health offices. The numbers on the bars indicate the total number of wells sampled in each region.

E. coli

Considering the second round of samples re-submitted, 7% still showed presence of E. coli. Consequently, 93% of the wells showing contamination during the first submission did not contain E. coli the second time. Three regions had presence of E. coli in the 10-12% range: Edmundston, Caraquet and Tracadie (Figure 5).

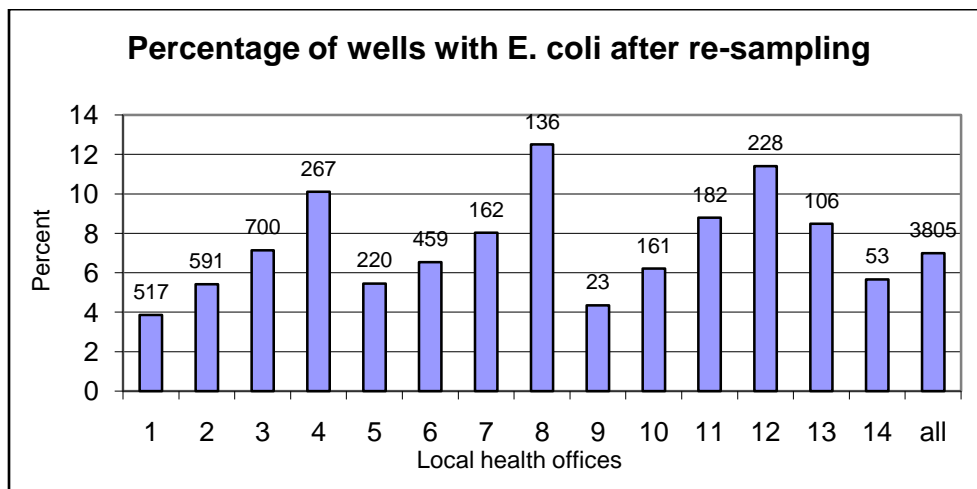


Figure 5. Percentage of wells with E. coli after re-sampling in relation to local health offices. The numbers on the bars indicate the total number of wells sampled in each region.

Contamination rate in relation to environmental factors

Total Coliforms

Presence of total coliform varied according to the time of year samples were taken (Figure 6). Indeed, well samples submitted for analysis during the summer and fall months, July to December 2006 and July to September 2007, resulted in a greater percentage of positive testing for total coliforms (35 - 53%) than during the winter and spring seasons (24 - 27%).

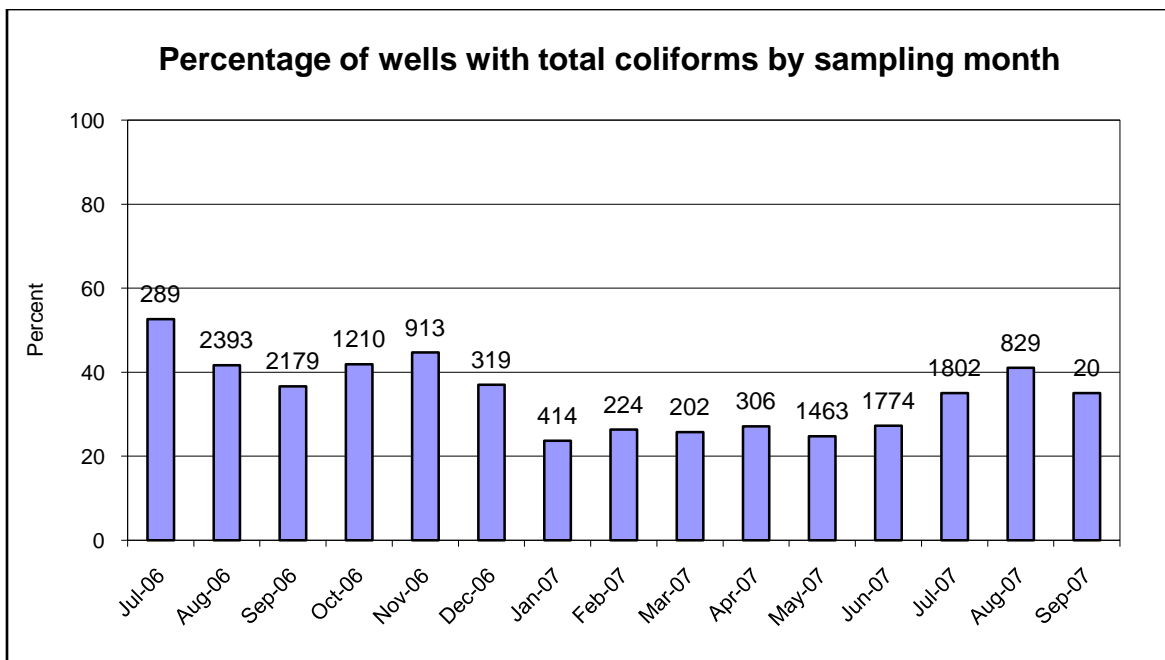


Figure 6. Percentage of wells with total coliforms by sampling month. The numbers on the bars indicate the total number of wells sampled by month.

E. coli

The percentage of wells testing positive for E. coli was highly variable across the study period (Figure 7). Positive testing for E. coli was generally greater during July to December 2006 than for January to June 2007.

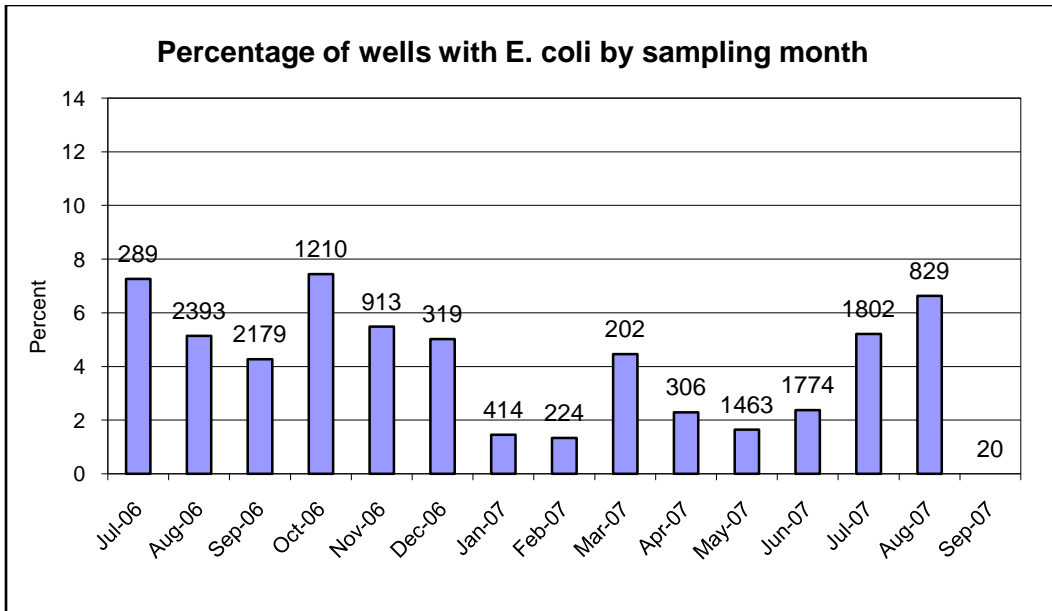


Figure 7. Percentage of wells with E. coli by sampling month. The numbers on the bars indicate the total number of wells sampled in each month. In Sept-07, 0% were contaminated.

Contamination rate in relation to construction characteristics of wells

General information regarding well characteristics such as well depth, year drilled, and casing depth was available for only 13% of the dataset. The casing is the metal pipe used to line the upper part of the borehole and is important for the integrity of a water well. Wells with casing located at shallow depths (0-19 ft) showed a higher frequency of E. coli present (Figure 8). Caution should be taken with interpretation of this figure because of the low sample size in the three deepest categories. It is worth noting here that current regulations in New Brunswick (Water Well Regulation) require approximately 20 feet (6 meters) of casing for each well drilled and in addition, each well must have an inside diameter that is at least 5 inches (12.7 centimeters).

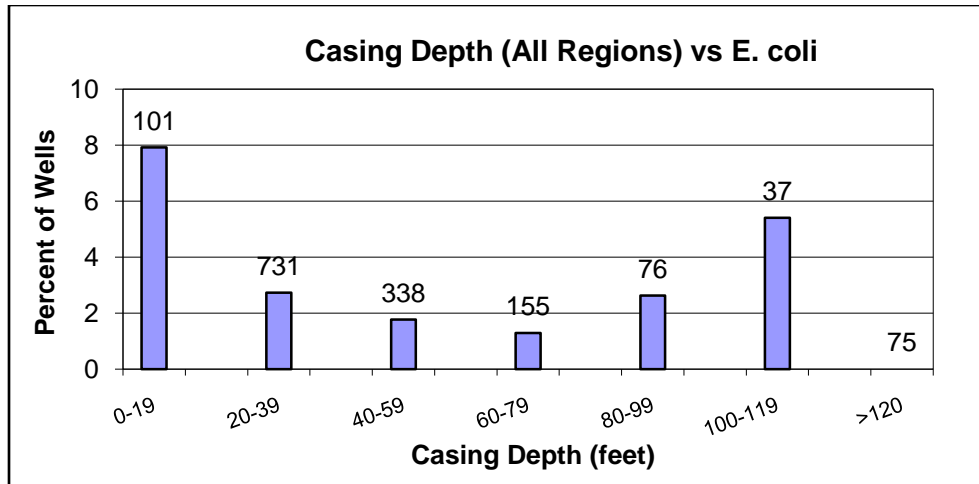


Figure 8. Percentage of wells testing positive for E. coli by casing depth. The numbers on the bars indicate the total number of wells sampled in each category. At greater than 120 feet casing depth, 0% of wells were contaminated.

Discussion

Positive Bacteria Tests

Total Coliforms

The average percentage of wells that tested positive for coliform bacteria (35.6%) was slightly lower in 2006-2007 as compared to results in the 2001 Pilot Project (44%). Compared to the average of 35.6%, the percent values were similar between the regions and did not deviate much from the average. As in 2001, results suggest once again that on average approximately one third of private wells in the province may be affected at any given time.

There are a number of possible explanations for the slight decrease in percentage of wells having coliform bacteria during the 2006-2007 project: larger sample size (more representative of the true average), larger spatial coverage of the sampling area (province-wide), yearly differences, a true decline in the contamination rate resulting from more public awareness and therefore higher levels of well maintenance, or a combination of these factors.

Presence of total coliforms naturally occurs and therefore, presence does not necessarily result from human activities. Regular maintenance and chlorination of wells is important for reducing bacterial contamination.

E. coli

The overall contamination rate of private wells with E. coli (4.4%) was lower than in the 2001 project (7%). Regional variation in presence of E. coli was much more prevalent than observed for total coliforms. For example, Edmunston (region 4) had twice the percentage of wells testing positive for E. coli compared to the average of all regions. As for Miramichi (region 7) and Perth-Andover (region 9; caution low numbers), half the percentage of wells tested positive compared to the average of all regions.

Owners of contaminated wells were advised to chlorinate their wells and re-submit a water sample for analysis. A procedure for well chlorination can be found at:

<http://www.gnb.ca/0009/0371/0010/index-e.asp>

The present project was not detailed enough to address pathways of contamination. However, the results suggest that casing depth might play an important role for presence of coliform bacteria. Caution should be taken when interpreting the data because details on well construction were only available for 13% of the samples.

E. coli in groundwater usually results from the presence of warm-blooded organisms and humans in the area. Hence, agricultural activities, farming, and inadequate or malfunctioning septic systems are all sources leading to E. coli contamination.

Seasonal differences

The percentage of wells testing positive for total coliforms was greater during the summer and fall months. This may be partly explained by variations in rainfall events.

Conclusions

The “Know Your H₂O” program was regarded as successful because 14,338 private well owners, distributed in all regions of New Brunswick, submitted a well water sample for analysis.

Total coliform results indicate that approximately one third (35.6%) of private wells are contaminated. Compared to the 2001 pilot project, this is a reduction in contamination rate (35.6% compared to 44% in 2001).

E. coli results show that approximately 4.4% of the wells are contaminated. These results are lower than the 2001 pilot project (7%).

Specific conclusions of the project are:

- Percentage of wells testing positive for total coliforms was 35.6% with small deviation from the average between regions;
- Presence of E. coli was detected in 4.4% of the wells;
- Wells with shallow casing (0 - 19 feet) had the highest percent contamination from E. coli;
- Continued education efforts towards residents regarding the need for regular well testing and maintenance is needed. In particular, water testing should be conducted on occasions when flood water reaches and inundates a well.

Additional Information

For more information about your well, domestic well water quality or related issues, please contact the Sustainable Planning Branch of the Department of Environment at (506)-457-4846. You may also contact the regional office nearest you:

DENV Regional Offices

Bathurst: telephone (506) 547-2092;

Miramichi: telephone (506) 778-6032;

Moncton: telephone (506) 856-2374;

Saint John: telephone (506) 658-2558;

Fredericton: telephone (506) 444-5149;

Edmundston - Grand Falls: telephone (506) 473-7744.

Information Brochures

The following information brochures are available from any DENV office:

Facts on water

- Describes water testing, what is tested, what to do if you are drilling a new well, testing fees, and responsibilities of well drillers.

Your well water, a safety checklist

- Explains how to take care of your well, how to collect a water sample, and how to interpret test results.

How to chlorinate your well water

- Explains in detail the procedure to use if chlorination is recommended to treat a domestic well for bacterial contamination.

All about your well

- Information brochure produced by the New Brunswick Environmental Industries Association available online at:
<http://www.nbeia.nb.ca/pdf/WEll%20pubeng.pdf>

A variety of information on water quality is also available on the DENV web site:

<http://www.gnb.ca/0009/index-e.asp>

Testing your water:

If you want to get your water tested, contact your nearest DENV regional office. The staff will advise you on the most convenient and appropriate approach to take.

References

Department of Environment, 2003. Domestic Water Quality Monitoring Pilot Project, Environmental Reporting Series, T2002-03, 37pp.