

**Private Drinking Water Study  
Whatcom County**

**Sampling of Selected Private Drinking Water Wells for Coliform Bacteria, E.coli and  
Fluoride in Whatcom County**

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Bellingham, Washington

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## **Abstract**

Take first sentence of each heading.

## **Background**

Approximately 20% of Whatcom County's population rely on private wells as their drinking water source. In 1990, the Growth Management Act (GMA) required all new homes to demonstrate an adequate source of drinking water. In response to GMA, WCHHS (Whatcom County Health and Human Services) reviews the quality and quantity of drinking water sources intended for new construction and proposed subdivisions. The review process is called the Water Availability Notification (WAF) process. In 1998, WCHHS staff entered water quality and quantity information gathered from the WAF process into an Access database. From this database, we were able to track water quality trends by mapping drinking water parameters such as fluoride and coliform bacteria.

### **Background for Fluoride:**

From our mapping efforts, it appeared that Whatcom County had naturally occurring levels fluoride in private drinking water wells. The EPA set the primary MCL (maximum contaminant level) for fluoride in drinking water at 4.0 mg/L and the secondary MCL at 2.0 mg/l. With long term use, fluoride levels above 4.0 mg/L can cause skeletal fluorosis in adults and children. Fluoride levels above 2.0 mg/L can cause dental fluorosis in children, which is considered a cosmetic problem. The US Public Health Service recommends a fluoride level of 1.1 mg/L in drinking water for the Northwest region to protect teeth against tooth decay.

There are no on-going monitoring requirements for private well owners. However, WCHHS recommends well owners sample their well annually for coliform bacteria and every three years for nitrate. Well owners are not generally told to sample their well for fluoride as an on-going requirement. The combination of naturally occurring fluoride levels in drinking water wells and fluoride supplements given by dentists may result in children being overexposed to fluoride. In addition, children and adults may be exposed to other sources of fluoride in prepackage food and beverages, toothpaste and mouthwash.

In order to assess the possible over exposure to fluoride from private drinking water wells, our office sampled private wells with previous elevated levels of fluoride. Through this sampling we hoped to determine if fluoride levels in private drinking water wells changed over time or fluctuated seasonally. Determining the average level of fluoride in drinking water may protect families from excess exposure to fluoride. In addition, we could then tell the private well owner community how often to sample their well for fluoride and moreover, make a recommendation on a well owner's ability to use their private well as a fluoride supplement.

### **Background for Coliform Bacteria:**

The EPA has set the MCL for coliform bacteria in finished drinking water to be zero. Coliform bacteria are considered an indicator organism because while they, themselves are not harmful, they indicate that other disease causing organisms may be present in the water.

Through the WAF process the applicant must have a satisfactory coliform bacteria test. Therefore, most of our test results in the database only show satisfactory test results for most drinking water wells.

However, we wanted to know if these wells would still be satisfactory for coliform bacteria after normal household use. In particular we wanted to determine if shallow wells, which tend to be more vulnerable to contamination, were more likely to be unsatisfactory for coliform bacteria than deeper drilled wells.

Proper well construction and maintenance plays a large role in the safety of private drinking water. Poorly constructed wells or wells that are not properly maintained are more likely to become contaminated with disease causing organisms from surface water runoff. Wells that do have coliform bacteria present can be disinfected, and the well owner can usually obtain a satisfactory test result. However, if the well is poorly constructed, once the disinfectant dissipates, the well can become contaminated again. Since coliform bacteria in drinking water gives no indication of its presence through sight, smell or taste, the well owner cannot be warned if their well is contaminated. Occasional disinfection solves the immediate water quality problem, but does nothing to solve the actual problem of poor well construction and maintenance.

In order to assess the relationship between shallow wells and the presence of coliform bacteria, our office sampled wells that appeared to be vulnerable to contamination. Determining if shallow dug wells were at high risk for contamination, we would be able to develop policy limiting the use of shallow dug wells for new construction and possibly reduce the likelihood of illness from contaminated wells.

### **Purpose**

#### **Fluoride:**

This study was conducted to provide additional information on fluoride levels in private drinking water wells to the community and to the dental community. Fluoride water samples were taken three times over a 6 (six)-month period.

#### **Coliform:**

This study was conducted to provide additional information on the presence of coliform bacteria in shallow wells. Coliform bacteria water samples were taken once.

## **Materials**

### **Fluoride:**

Our office sent a letter to 279 homeowners asking them to volunteer their well for sampling. The homeowners were asked to be available in June, August and December for fluoride and in June for coliform.

Selection of wells for fluoride based on:

1. The availability of an approved Water Availability Form for the well.
2. The depth of well.
3. The type of well construction.
4. The original fluoride level was equal to or greater than 0.5 mg/L.
5. The availability of water sample tap after any treatment.
6. Homeowners consent.

From the mailing, we received thirty-two (32) responses. Our office selected twenty-nine (29) private drinking water wells to be sampled for fluoride and coliform. One well was not selected due to late response time and another well owner did not want their well sampled. Two of the homeowners shared the same well. All other letters sent out were either returned by the postmaster or the homeowner did not respond. Location of wells selected for testing can be seen in attached map.

### **Coliform Bacteria:**

Our office sent out 335 letters to homeowners asking them to volunteer their well for sampling. The homeowners were asked to be available in June.

Selection of wells for coliform testing based on:

1. The availability of an approved Water Availability Form for the well.
2. The depth of well is 25 ft deep or less.
3. The type of well construction.
4. The availability of water sample tap after any treatment.
5. Homeowners consent.

From the mailing, we received thirty-four (34) responses. Our office selected thirty-two (32) private drinking water wells to be sampled for coliform bacteria. One well owner did not want their well sampled and another well was not sampled because we were not able to reach the well owner. Thirty-one wells were actually tested. One was disregarded due to the unavailability of a sample before the treatment system. The postmaster either returned all other letters or the well owner did not respond. Location of wells can be seen in attached map.

## **Method**

### **Coliform:**

We sampled each well for coliform bacteria in June. The samplers ran cold water for a minimum of 4 minutes before collecting the sample. If the water sample was taken outside, the samplers washed down the faucet with a strong bleach solution and then washed down the faucet with unchlorinated water before taking sample. Samples taken from frost-free faucets were allowed to purge for a longer period of time. Avocet supplied 100-mL coliform bacteria bottle with sodium thiosulfate to collect water samples. The coliform bacteria slip was considered a chain of custody form for each sample bottle.

Quality Control samples included a trip blank for each day of coliform bacteria sampling. Samples were carried on ice to the lab and either taken to the laboratory or placed under refrigeration for a maximum of 24 hours and then taken to the laboratory.

### **Fluoride:**

We sampled each well for coliform bacteria and fluoride in June, August and December of 2000. The samplers ran cold water for a minimum of 2 minutes before collecting the sample. 100-mL inorganic bottles were used for fluoride. A chain of custody form was completed for each day of sampling.

Quality Control samples included a trip blank for each day of sampling. Samples were carried on ice to the lab and either taken to the laboratory or placed under refrigeration for a maximum of 24 hours and then taken to the laboratory.

## **Analysis**

### **Coliform:**

Avocet Environmental Testing of Bellingham, Washington performed the coliform bacteria analysis using Colilert for presence/ absence test Standard Methods 9221D.

### **Fluoride:**

Avocet Environmental Testing of Bellingham, Washington performed the fluoride analysis using Standard Method 300.0.

## **Results**

### **Fluoride:**

Please see attached table titled Table 1: Fluoride Results 2000.

Of the four sampling events, which includes the original sample taken by the property owner for new construction, the original sample had the highest average level of fluoride in the drinking water at 0.96 mg/L. From the three sampling events conducted by our office in 2000, December had the highest average level of fluoride in the drinking water at 0.76 mg/L. Please see Table A: Fluoride Results. All but four wells had the original fluoride sample taken at the time the well was drilled. The samples taken by our office occurred after normal household use of the water. The decrease in the average fluoride level from the original sample may indicate that normal household use may stabilize the fluoride levels over time, however there still may be some minimal seasonal fluctuations.

Table A: Fluoride Results

<b>Sampling Event</b>	<b>Average Levels of Fluoride in mg/L*</b>
Original samples	0.96
June 2000	0.67
August 2000	0.72 **
December 2000	0.76

\* Fluoride levels <0.2 mg/L were averaged as zero (0).

\*\* Only 28 wells sampled.

From the three sampling events taken by our office, December had the most wells with the highest level of fluoride. Please see Table B: Fluoride Results. In some cases the level of fluoride stayed consistent over the sampling events. For example, in August and December there were 5 wells in which the fluoride level remained the same in those two months. However the fluoride level in those 5 wells was higher in August and December than in the June sampling event. The higher fluoride levels in December may be related to the high amount of recharge the groundwater receives during the winter months. The amount of water coming in contact with geological formations may increase the amount of fluoride dissolved into the groundwater.

Table B: Fluoride Results

<b>Sampling Event</b>	<b>Number of Wells with Highest Fluoride Level during a Sampling Event*</b>
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June 2000	2
August 2000	2
December 2000	16
August 2000 and December 2000**	5
June 2000 and August 2000**	2

\* 2 wells had no fluoride change over all three sampling events.

\*\* The fluoride level in each month listed was the same, but higher than the month not listed.

Of the three sampling events, 19 of the wells fluoride levels varied by 0.1 mg/L between the highest and the lowest result. This would suggest that once a well is used with some regularity, the fluoride levels do not fluctuate significantly. The year the well was drilled and the amount the fluoride levels fluctuated did not appear to be correlated. That is to say the newer wells did not have any significantly fluoride fluctuations when compared older wells.

Table C: Fluoride Results

Difference Between the Highest and Lowest Fluoride Level for Each Well During 3 Sampling Events in mg/L	Number of Wells	Year Well Drilled
0	2	1992
		1995
0.1	19	UNK-2
		1978
		1987
		1991
		1992
		1993-6
		1994-3
		1995
		1996
		1997
		1998
0.2	5	1996
		1995
		1997
		1998
0.3	1	1994
0.5	1	1996
1.1	1	1996

When the original fluoride results taken by the property owner are compared with the results in 2000, there are more wells that have greater fluctuations. But a majority of wells did not fluctuate by more than 0.1 mg/L. This does not appear to be dependent on when the well was drilled. It does suggest however, when compared with Table C that once the well is used on a regular basis, the fluoride levels do not fluctuate as much.

Variables that come into play when looking at fluoride level fluctuations are how long the well drilled pumped the well prior to sampling when the well was drilled, how much water the well owner uses and if there is more water use during the summer months due to irrigation.

Table D: Fluoride Results

Difference Between the Highest and Lowest Fluoride Level for Each Well During 4 Sampling Events in mg/L*	Number of Wells	Year Well Drilled
0.0	1	1992
0.1	7**	UNK-1
		1987
		1993-3
		1995
		1997
0.2	10	UNK-1
		1978
		1992
		1993-2
		1994-2
		1995
		1996
1997		
0.24	1	1998
0.3	1	1998
0.4	3	1993
		1992
0.8	1	1998
0.9	1	1996
1.0	1	1995
1.1	1	1996
1.4	1	1995
2.63	1	1996

\* Includes original fluoride sample taken by the well owner for WAF.

\*\* One of the seven wells only had 3 sampling events.

In the three sampling events, 38% of the wells fluoride levels either increased or decreased by 0.4 mg/L or more with the largest difference between sampling events being 1.1 mg/L. In four sampling events, 31% of the wells fluoride levels either increased or decreased by 0.4 mg/L or more with the largest difference between sampling events for the same well equal to 2.63 mg/L

Overall, it appeared that fluoride levels tended to decrease after the initial water sample or at least stayed around the same level. Fluoride may stabilize over time with normal household use.

At this point it is unclear why some wells would show a significant change and other would not. Possible reasons include that when the well was drilled, it was not pumped very long before taking a sample. This may allow the water in the casing to come into contact with the fluoride in the surrounding materials for a longer period of time. According the National Weather Service rainfall for the Western Washington region has been 45-60% of normal for the year 2000. Lack of water recharge may impact the levels of fluoride in drinking water wells in some regions.

When determining what wells to select for sampling, we targeted wells that already showed elevated levels of fluoride. We wanted to determine if the fluoride levels decreased after normal household use and if the fluoride levels fluctuated seasonally.

### Coliform

Please see attached tables titled: Table 2: Coliform Results 2000 and Table 3: Coliform Results for Fluoride Wells 2000

Table A: Coliform Results

	Fluoride Wells June 2000	Fluoride Wells December 2000	Coliform Wells June 2000
<b>Coliform Bacteria Test Results</b>			
Satisfactory	22 (76 %)	18 (62%)	22 (71%)
Unsatisfactory	7 (24%)	11 (38%)	9 (29%)*

\* One of the nine unsatisfactory samples had E.coli present, with the follow up sample was unsatisfactory for coliforms only.

The average age of the wells sampled for coliform bacteria is 11 years old and the average for wells sampled for fluoride is 7 years old. The wells sampled for coliform bacteria were not significantly older than the wells tested for fluoride.

Table B: Coliform Results

Type of Well Construction	Number of Wells for Coliform June 2000		Numbers of Wells for Fluoride June 2000		Number of Wells for Fluoride December 2001	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
<b>Dug</b>	6	7	N/A	N/A	N/A	N/A
<b>Cable</b>	2	1	10	3	7	6
<b>Jetted</b>	10	1	1	1	1	1
<b>Rotary</b>	1	0	11	3	10	4
<b>Bored</b>	2	0	N/A	N/A	N/A	N/A
<b>Driven</b>	1	0	N/A	N/A	N/A	N/A
<b>Total</b>	<b>22 (76%)</b>	<b>9 (24%)</b>	22	7	18	11
			<b>Satisfactory</b>		<b>Unsatisfactory</b>	
		<b>Average Number of Fluoride Wells for 2 Sampling Events</b>	<b>20 (69%)</b>		<b>9 (31%)</b>	

Table C: Coliform Results

	Wells for Coliform June 2000	Wells for Fluoride June and December 2000
<b>Average Depth of Wells</b>	21.6 feet	177 feet

<b>Percent of Wells Satisfactory for Coliform Bacteria</b>	76%	69%
<b>Percent of Wells Unsatisfactory for Coliform Bacteria</b>	24%	31%

For our sampling events, shallow wells were only 7% more likely to have coliform bacteria present than deep wells. Factors that could have influenced sampling outcomes were how often wells were maintained by the well owners, and the presence of cracks or leaks in distribution pipes or supply lines.

**Conclusions**

May not have sampled enough wells to give a clearer picture of fluoride in drinking water.

**Fluoride:**

The concentration of fluoride in natural water depends principally on the solubility of the fluoride-containing rocks with which the water is in contact. 1 page 369 Drinking Water and Health.

1. Fluoride levels in drinking water tend to stay stable with after regular household use.
2. When the well is first drilled.

**Coliform:**

1. Although it was considered a risk to have a shallow well, it appears from our sampling that dug wells with a seal can be considered an adequate drinking water source. Even those wells that where it was not known if a seal was present, had satisfactory results. This could be due to the relatively young age of wells in our sample study. In order to obtain a building permit wells must be in good condition. Since only associated with new construction, wells may be newer.
2. In areas of the county, the only groundwater is at 20-40 ft deep. If a well is constructed property and maintained, the well can provide an adequate water source.

**Recommendations**

As a result of these findings, Whatcom County Health and Human Services offers the following suggestions.

**Fluoride:**

1. If homeowners have a deep well, they should have their well tested for fluoride first when the well is drilled and then after normal household use. Change wording because of WAF
2. Homeowner with young children should test their well how many times before giving their children fluoride supplements to insure they will not expose their children to too much fluoride.

How much fluoride is too much for exposure? It would not appear that changes by mg/L would be enough to cause damage to a child.

3. If well owners find fluoride in their drinking water, they should consult with their dentist to determine if fluoride supplements are needed.

**Coliform:**

1. Water availability forms should not be denied on the basis of well depth alone. The presence of a surface seal, the condition of the well construction, the date the well was drilled, the availability of the water well report, and wells location should also be considered when reviewing a well for water availability.
2. Owners of dug wells, as with all well owner, should test their well on an annual basis for coliform bacteria. More frequent testing should occur if well owners notice a change in the water such as color, turbidity, an increase in temperature or land use activities in the immediate area change.
3. If well owners experience ongoing coliform bacteria problems, it may be a sign of an improperly or poorly constructed well. In addition, wells may deteriorate over time due to roots, cracks or tiles separating due to shifts in geological conditions. Homeowners should determine if the existing well can be fixed, needs to be replaced, or a new well is drilled. Installing a treatment system, while temporally fixing the problem, does not guarantee safe water. Treatment system need regular maintenance in order to function properly.