Drinking Water Quality Report
for
Nicollet County

2002

compiled
by

Brown-Nicollet Environmental Health
&
Minnesota Department of Health

January 2002

Dear Reader:

After monitoring and studying the county's groundwater since 1988, we are pleased to introduce this report summarizing the condition of today's drinking water resources.

Recent technological advances in data management have enabled the Environmental Health staff and the Minnesota Department of Health to produce graphic representations of the influences on our aquifers and to summarize the results of thirteen years tracking the county's water quality.

We hope this information can be used to help individuals in protecting wells on a family-by-family basis, and also to help the county, townships, and cities better understand the influences on the drinking water of today and tomorrow.

Chair, Brown-Nicollet-Cottonwood Water Quality Board

and

Chair, Nicollet County Board of Commissioners

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INTRODUCTION

The Groundwater Projects

Township Testing began in 1988 as an attempt to bring low-cost analysis of drinking water for rural families in Brown and Nicollet Counties. Between June 1988 and April 1989, all townships had sponsored clinics for their families; water had been analyzed for nitrate-nitrogen levels and for the presence of coliform bacteria.

This testing has been repeated at 3-year intervals since 1991 with various levels of support from the townships and counties.

Beginning in 1990, funding from the Minnesota Pollution Control Agency enabled Brown, Nicollet, and Cottonwood counties to take a closer look at the sources and extent of groundwater contamination and to begin programs to protect and improve the groundwater. This project, the Brown-Nicollet-Cottonwood Clean Water Partnership Groundwater Analysis and Improvement Project, extended through 1998; many of its activities are still underway today.

In 1998, a grant from the Minnesota Department of Health enabled the counties to finalize a database of all the water quality results. The Minnesota Geological Survey assisted the project by field locating 2,188 wells throughout Nicollet County. Well construction information, geological data, and water testing results have been entered into a computer database. Geographic Information System technology made possible the creation of maps and charts showing the status of the groundwater. This work was recently completed, and these "portraits" of our drinking water influences are included in this report.

This Report

The purpose of this report is to summarize the years of analysis. Capitalizing on newly developed technologies to identify and make vivid depictions of influences on water quality; and looking ahead to potential uses of this data are important by-products of the database. The report is intended to provide summary information about groundwater quality in Nicollet County to county and area governments, students, and individuals concerned about groundwater today and in the future.

Uses of this Information

A summary can be important for surveying the "big picture"; but we must take care not to lose sight of our goal of providing safe drinking water for every family and industry in the county. It is most important that the readers gain a complete understanding of the status of our groundwater and its vulnerability to contamination. Protection of the resource will be the next step.

Water Quality Conditions

Nitrate-Nitrogen Results

The county has sponsored several nitrate-nitrogen water testing opportunities since 1988. The water quality database has 1,468 wells with nitrate analysis results.

This contaminant, which can cause serious problems for infants and pregnant women, has a number of sources ranging from natural processes, to excess nitrogen fertilizer and human or animal waste infiltrating the water supply.

The federal government has established a national public drinking water standard of 10 parts per million. The Minnesota Department of Health has determined that these levels should also be considered when determining a course of action for wells with elevated nitrates:

* from 0 to ,99 ppm — this range is considered natural
* from 1.5 to 2.99 ppm — this range is considered to be a possible indication of contamination
* from 3.0 to 9.99 ppm — this range is considered to be a probable indication of contamination
* 10 ppm & over — the well is contaminated; its water should not be consumed by infants or women who are pregnant

About 5 % (83 wells) of the 1,468 wells with nitrate results in the water quality data base have average nitrate concentrations over 10 ppm. (An average was calculated if a well was analyzed more than once over the twelve year period.) The percentage of wells showing elevated levels of nitrate varies as to the aquifers available, the depth and construction of the well, and the presence or absence of a source of contamination near the wellhead. If an aquifer is near the ground surface or is overlain with sandy soils, it is more vulnerable to contamination, including nitrates. If a family's well is shallow, constructed with a cement tiles, located in a pit, or in poor repair, nitrates and/or bacteria may be present.

The township summaries in the next section of this report generally illustrate that townships using shallow glacial aquifers, those with wells near the Minnesota River, and those using the Jordan Aquifer, are more likely to have a high percentage of wells with nitrate contamination.

Coliform Detection Results

Coliform bacteria are a group of several different species of bacteria that are commonly found in human and animal wastes. They are easy and inexpensive to test for, and are usually present when disease causing organisms such as other bacteria, viruses, and protozoans are present. The presence of coliform bacteria may indicate contamination from a septic system, abandoned outhouse, feedlot, wastewater application, or manure. Wells with construction problems mentioned above may be at risk for contamination by coliform and other bacterial.

The water testing program was instituted in 1988 and repeated at three year intervals. In 1993, after widespread record rainfall, the federal government financed additional water testing to check for well contamination from ground runoff.

The following table shows the total number of analyses for coliform bacteria, and the number and percent of samples positive for coliform. The table is cumulative—it contains analyses from all

wells—including some that have been replaced after initial tests showed contamination from construction problems. These statistics do not include analyses for newly drilled wells.

Nicollet County Coliform Analysis Results – 1988-2001

Township	Total Coliform Analyses*	Total Positive for Coliform	Percent Positive for Coliform
Belgrade	382	102	27%
Bernadotte	180	67	37%
Brighton	99	45	45%
Courtland	394	110	28%
Granby	125	44	35%
Lafayette	323	109	34%
Lake Prairie	352	94	27%
New Sweden	199	73	37%
Nicollet	267	62	23%
Oshawa	330	100	30%
Ridgely	109	34	31%
Traverse	128	43	34%
West Newton	203	84	41%
Nicollet County Totals	**3,091**	**966**	**31%**

***includes repeat samples for many wells**

Well Construction

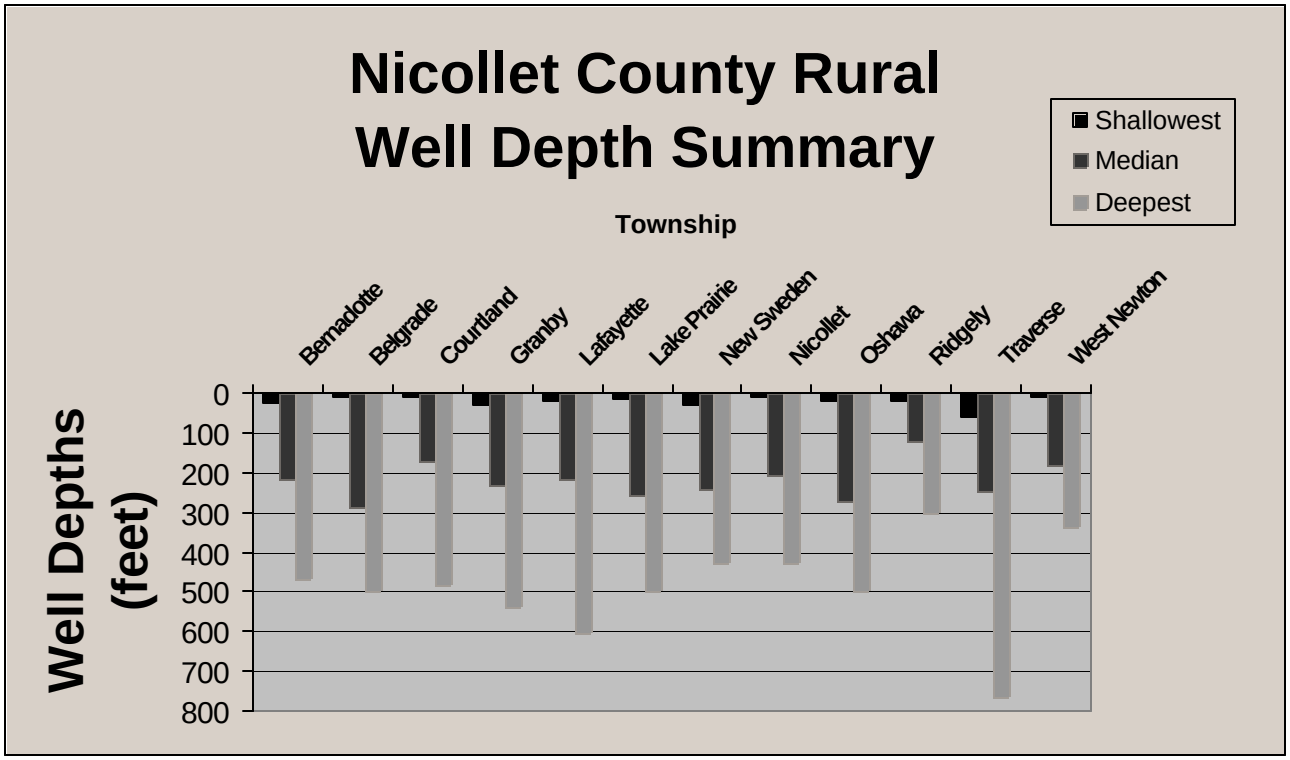
Since 1974, Minnesota has been operating under the Minnesota Well Code (MN Rules Chapter 4725) administered by the Department of Health. Under this code, wells must be drilled and constructed according to standards designed to protect both individual sources of drinking water and the aquifers used. Water well contractors and well repair businesses must be licensed and bonded and must meet current standards for experienced knowledge of well construction in order to be licensed.

After wells are completed, the water is tested to be sure it is safe to drink. Specifically, the newly completed well must yield water that is free from coliform bacteria and low in nitrate-nitrogen.

Well records must include a location of the well, information about drilling methods, a record of the underground formations encountered, information on the level at which water is found (static water level), and details on the casing, screen, and pump.

Another source of well information is provided by well owners at county-sponsored well testing clinics. Here, well depth, diameter, and year of construction are provided. This information, well record data, and water testing analyses have been entered into a computer database called the County Well Index.

This figure illustrates the depths of wells by township. It shows the shallowest, deepest, and median (average) wells in each township. The data is taken from the Minnesota County Well Index.



Well construction practices are very important when it comes to obtaining safe drinking water. Most wells drilled since the well code went into effect generally show little contamination. However, some old wells are not "up to code" because they were constructed using practices and materials that pre-date the standards established by the adoption of the Minnesota Well Code in 1974. Some Nicollet County wells are constructed in pits, which may be subject to overland flooding during wet years. These wells may become contaminated by yard waste, fertilizer, or pesticides when excess water stands in the pit and eventually seeps down the sides of the well casing.

Some old wells were constructed using cement tiles for casing and are easily subject to contamination because contaminants can seep through the spaces between the tiles.

Some wells are completed at very shallow depths (less than 50 feet) whereas, many others are much deeper. Generally, the deeper the well, the less likely it will be susceptible to contamination caused by people's activities. The exception to this statement occurs when wells are completed in exposed bedrock. Nicollet County has several aquifers, with varying levels of susceptibility to contamination. The ability to find safe drinking water depends on the aquifer situation. But another problem in east Nicollet County is that the Jordan Aquifer is contaminated with nitrate-nitrogen.

The following section is a general summary of the types of aquifers used in Nicollet County. Later in this report, the drinking water situation is summarized for each township and city.

Aquifers in Nicollet County

The residents of Nicollet County are fortunate to have a variety of aquifers to use although local geologic conditions may impact the quality and quantity of water available to them. The eastern part of the county has more aquifers to use than the west. This is the result of the geologic history and the distribution of glacial deposits and bedrock formations. Nicollet County has some of the most diverse subsurface geologic conditions of any county in Minnesota. You may not realize this by driving over the relatively flat, rural landscape because it is out of sight. However, it should not be out of mind if you are wondering where your drinking water comes from.

Glacial Aquifers

The thickness of glacial deposits in Nicollet County varies considerably because of the long geologic history of Minnesota. The deposits left behind by the earliest glacier were exposed to wind and stream erosion before being covered by the next ice sheet. The sequence of deposition and erosion of glacial deposits has been repeated many times over the long period of the Pleistocene Epoch (Ice Age). As a result, the geologic record of the county's glacial deposits is fragmented and difficult to piece together. In some places, the accumulation of glacial deposits is greater than 400 feet, whereas, in other places less than 50 feet remains.

Many wells obtain their water from sediment layers left behind by the glaciers. Sand and gravel layers form some of the highest yielding aquifers in Nicollet County and are often referred to as "outwash deposits" because they were formed by meltwater draining from glaciers as they advanced and retreated across the landscape. Groundwater is stored in these deposits in the spaces between the sand and gravel particles. These types of aquifers may contain as much as 25 to 30% pore space, so they may contain a lot of water. Outwash deposits supply the high capacity wells used by communities and are used by many farm wells. Wells constructed into outwash deposits have a screen (slotted cylinder) at the bottom of the casing to keep sand from plugging the pump or the plumbing system.

Glaciers also left behind unsorted debris called till that was either plastered onto the countryside at the base of the ice or formed as mudflows when the ice melted. The till layers in Nicollet County contain a high percentage of clay and silt, and therefore do not yield large amounts of water. Wells constructed into till were originally hand dug and lined with wood or masonry. Later on, holes were drilled with a bucket auger and lined with cement tiles. These wells collect water that seeps out of the till and generally, do not yield large amounts of water.

The surface of Nicollet County is part of a till plain formed by the advance and retreat of the last glacier to cover south central Minnesota. Called the Des Moines Lobe, it advanced as far as central Iowa by about 20,000 years ago but had completely melted from Minnesota by about 11,000 years ago. Many of the rich soils that we farm today developed in the clay-rich till that is attributed to this ice sheet. Before settlement, much of the till plain was poorly drained and covered with wetlands and shallow lakes. The aquifers that exist beneath the Des Moines Lobe till tend to be recharged slowly and are not very susceptible to contamination from land uses. However, because

groundwater in these areas moves slowly, it may contain higher levels of dissolved minerals such as iron, manganese, and sulfate than groundwater that is in more direct contact with surface water.

Geologic information contained in well records indicates that two sand and gravel "horizons" occur in the glacial deposits between the Des Moines deposits and the bedrock surface. One of these horizons occurs at elevations of about 760' to 900' above sea level and the other occurs on top of the bedrock surface. These sand and gravel horizons are not present everywhere in the county, but occur frequently enough to be noted as significant aquifers used by domestic and community water supply wells.

The Minnesota River valley forms the border of much of Nicollet County and also causes groundwater in the glacial deposits to move toward it. The valley was eroded by a river that drained a large glacial lake located in western Minnesota, the eastern Dakotas, and southern Manitoba. As it drained toward the Twin Cities area, this river, called Glacial River Warren, cut the valley now occupied by the Minnesota River. Generally, the water levels in wells completed in glacial deposits in the north and central parts of the county have high elevations than such wells located in the townships that border the Minnesota River valley. As a result, groundwater is slowly moving from the higher elevation in the northern and central parts of the county toward the valley.

The Cretaceous Aquifer

At the end of the Cretaceous Period (about 75 to 65 million years ago), Nicollet County was a much different place than today. Slow moving rivers carried sediment westward toward a large, shallow ocean that extended from eastern Colorado into western Minnesota. During heavy rainstorms and wet periods, these streams overflowed their banks and deposited clay and silt as well as thin layers of sand. Slowly, the meandering of these streams left behind a mantle of clay, silt, and some sand over parts of the bedrock surface. However, where these deposits are covered by glacial deposits, it is very difficult to determine where Cretaceous deposits occur using only well records because well contractors refer to both as "clay".

The climate during the late Cretaceous was much warmer too, and tropical weathering of the landscape occurred for long periods of time. Much of the bedrock surface was reduced to clay and minerals that resisted this type of weathering. Today, weathered bedrock in the western part of the county is encountered by well contractors who refer to it as "marl" even though marl is actually formed in lakes.

Collectively, the sediments that were deposited during the Cretaceous Period are referred to as the Cretaceous Aquifer even though they do not form a single aquifer. The Cretaceous deposits are either covered by glacial deposits or were completely eroded. It is very difficult to predict whether Cretaceous deposits are present in the subsurface because of the lack of good information describing their distribution. However, the existing subsurface data for the county indicates that many wells in the western third of the county which are completed in bedrock obtain their water from Cretaceous deposits.

Paleozoic Aquifers

From about 500 to 425 million years ago during the Paleozoic Era, Nicollet County was covered by an ocean. Sand dunes formed at or near the water's edge and lime-rich mud was deposited in lagoons and quiet water far from shore. Clay and silt were deposited in tidal flats or were washed onto the seabed by storms; and they were also deposited by streams that drained into the ocean. Small changes in the sea level resulted in the deposition of very different kinds of sediments which today form bedrock aquifers and the layers that separate them. The layers of sand deposited as dunes now form the sandstone aquifers that are a principle source of groundwater in the east part of the county. The layers of lime mud consolidated to form carbonate rocks such as dolomite, and the silt and clay now make up mudstones and shales. These types of bedrock do not yield as much water as sandstone. The layers that are mostly shale hydraulically separate the sequence of Paleozoic sediments into a series of aquifers.

The uppermost Paleozoic aquifer is called the Jordan Sandstone and it is named after the city of Jordan in Scott County where geologists first described it. It consists mostly of sand that has not been cemented, and therefore provides an excellent source of groundwater. The Jordan occurs mostly in the eastern townships that border the Minnesota River valley.

The Jordan overlies the St. Lawrence formation which is composed of mudstone, shale, fine-grained sandstone, and some dolomite. The St. Lawrence is named after St. Lawrence Township in Scott County where it was quarried for building stone back in pioneer days. The St. Lawrence formation does not readily let water move through it into the underlying Franconia formation, and therefore it is called a confining layer.

The Franconia formation consists of a mixture of fine-grained sandstone, shale, mudstone, and dolomite and serves as both a confining layer and an aquifer, depending on what part of it is encountered by a well. Underlying the Franconia are the Ironton and Galesville Sandstone formations. These two sandstones are difficult to tell apart; they were named after cities in Wisconsin. They are composed of mostly un-cemented sand. Like the Jordan Sandstone, they are a good source of groundwater. Together with the Franconia, they form an aquifer that is named after the stratigraphic sequence in which they occur: Franconia-Ironton-Galesville or FIG. This aquifer is used by many domestic wells in the eastern half of the county.

The Eau Claire Formation underlies the Galesville Sandstone and consists of mudstone and shale. It is named after the area near Eau Claire, Wisconsin and is not a good source of groundwater. It hydraulically separates the Franconia-Ironton-Galesville aquifer from the Mt. Simon Sandstone. The Mt. Simon Sandstone is named after an area near Madison, Wisconsin and consists mostly of un-cemented sandstone. It provides a good yield to high capacity wells where it is still covered by the Eau Claire Formation. However, few wells use it because it occurs at a great depth and glacial aquifers exist at a much shallower depth. Also, the water in it may contain higher levels of sulfate, iron, and manganese than glacial or stratigraphically younger Paleozoic aquifers.

Generally, the Paleozoic aquifers occur in the eastern two-thirds of the county because of the interaction between the processes of erosion and the manner in which these aquifers are folded. If you look at the geological cross sections in this report (pages 30-31), notice that the elevation of the bedrock surface remains fairly constant throughout the county. That was caused by eons of stream, wind, and glacial erosion that tended to reduce the bedrock landscape to a relatively flat surface. Also, notice that the rock formations dip gradually toward the east. The Mt. Simon formation is stratigraphically the oldest Paleozoic formation in the county and is the only one of these rock formations that exists in the west part of the county. However, a succession of additional rock formations gradually covers the Mt. Simon going in an easterly direction because the dip of the formations places them at a lower elevation than that of the eroded bedrock surface. Only municipal wells in St Peter and North Mankato, and one irrigation well in Traverse Township are currently drawing from the Mt. Simon.

SUMMARIES BY TOWNSHIP

Belgrade Township

Located in southern Nicollet County, Belgrade is the county's most populous township. The Minnesota River forms its east and southwest borders; the city of North Mankato is adjacent to the south.

Population 1,033 (male: 522 female: 511) Households: 371
Population under 5 yrs: 63 over 85 years: 7
Median age: 38.0 years Density: 28 people / sq mi

Wells Wells in database: 236 Median Depth for all wells: 274 feet
Shallowest: 26 feet Deepest: 485 feet
# of wells with casing or tiles over 10" in diameter: 4 (2%)

Water Quality # of wells sampled 1989-2000: 187
# of Bacteria samples: 382
with positive coliform bacteria: 102 (27%)
of Nitrate-nitrogen samples: 429
# of nitrate samples at 10 ppm or higher: 9 (2%)
Highest nitrate reading: 31.1 ppm
Median nitrate level: 1.0 ppm

Belgrade residents have the fewest problems with nitrates of any township in the three county area. Wells in glacial drift aquifers and those tapping the sandstone aquifers show good groundwater quality. Much of Belgrade is in agricultural production, but industry and housing developments are on the increase.

Bernadotte Township

Located in north-central Nicollet County, there are no cities in this mostly agricultural township. According to the median age data in the 2000 census, average age of the residents of Bernadotte is the youngest in the county.

Population 346 (male: 183 female: 163) Households: 110
Population under 5 years: 18 over 85 years: 0
Median age: 34.3 years Density: 9.5 people / sq mi
Wells Wells in database: 96 Median Depth for all wells: 214 feet
Shallowest: 26 feet Deepest: 468 feet
# of wells with casing or tiles over 10" in diameter: 15 (16%)

Water Quality # of wells sampled 1989-2000: 89
# of Bacteria samples: 180
with positive coliform bacteria: 67 (37%)
of Nitrate-nitrogen samples: 245
# of nitrate samples at 10 ppm or higher: 47(19%)
Highest nitrate reading: 90.8 ppm
Median nitrate level: 3.5 ppm

Bernadotte residents have a number of shallow wells in the glacial drift; many of these show contamination from nitrate-nitrogen. Fortunately, the area also has abundant water of good quality from deeper, more protected depths.

Brighton Township

Brighton is Nicollet County's smallest and least populous township. It is in the center of the county, and contains no cities. Farming is the predominant land use except for a small area on the shores of Swan Lake in the southeast part of Brighton.

Population 169 (male: 91 female: 78) Households: 60
Population under 5 yrs: 12 over 85 years: 1
Median age: 35.5 years Density: 5 people / sq mi

Wells Wells in database: 50 Median Depth for all wells: 211 feet
Shallowest: 18 feet Deepest: 400 feet
# of wells with casing or tiles over 10" in diameter: 3 (6%)

Water Quality # of wells sampled 1989-2000: 44
# of Bacteria samples: 99
with positive coliform bacteria: 45 (45%)
of Nitrate-nitrogen samples: 107
# of nitrate samples at 10 ppm or higher: 6 (6%)
Highest nitrate reading: 19.8 ppm
Median nitrate level: 2.2 ppm

Brighton is an area of former and current wetlands and prairie vegetation succeeded by agriculture. Most of the wells are finished in shallow glacial drift, with only a few wells showing nitrate-nitrogen contamination.

Courtland Township

Courtland is in southern Nicollet County; the Minnesota River forms the southern boundary. It surrounds the city of Courtland, which is discussed in the next section. Farming & recreation are the predominant land uses. Swan Lake in the northeast part of the township is North America's largest prairie pothole lake.

Population 715 (male: 372 female: 343) Households: 235
Population under 5 yrs: 56 over 85 years: 7
Median age: 38.6 years Density: 18.5 people / sq mi

Wells Wells in database: 204 Median Depth for all wells: 172 feet
Shallowest: 8 feet Deepest: 485 feet
# of wells with casing or tiles over 10" in diameter: 3 (1%)

Water Quality # of wells sampled 1989-2000: 169

# of Bacteria samples:	394
# with positive coliform bacteria:	110 (28%)
# of Nitrate-nitrogen samples:	447
# of nitrate samples at 10 ppm or higher:	25 (6%)
Highest nitrate reading:	88.4 ppm
Median nitrate level:	2.5ppm

Courtland Township has a variety of well depth situations that generally reflect the topography—deeper aquifers are tapped in the northern, upland part of the township, while on the sandy terraces nearer the river, shallower sand & gravel aquifers are used. The shallow wells are much more likely to show contamination by nitrate-nitrogen.

Granby Township

Granby is located in central Nicollet County. Although it has no communities and is predominantly agricultural, recreation is important in the southwest corner of the township in and around Swan Lake.

Population 259 (male: 127 female: 132) Households: 91
Population under 5 yrs: 8 over 85 years: 4
Median age: 40.4 years Density: 9 people / sq mi

Wells Wells in database: 76 Median Depth for all wells: 229 feet
Shallowest: 30 feet Deepest: 540 feet
# of wells with casing or tiles over 10" in diameter: 3 (4%)

Water Quality # of wells sampled 1989-2000: 69

# of Bacteria samples:	125
# with positive coliform bacteria:	44 (35%)
# of Nitrate-nitrogen samples:	145
# of nitrate samples at 10 ppm or higher:	15 (18%)
Highest nitrate reading:	111.8 ppm
Median nitrate level:	2.5 ppm

Granby continues to exhibit wells that produce high quality water—the township is virtually untouched by nitrate-nitrogen contamination. This may be a consequence of the natural filtration effects of former and current wetlands, as well as the thick organic soils. Deeper wells have high levels of minerals, but these are not health hazards.

Lafayette Township

Lafayette is Nicollet County's second largest township in both area and population. It lies in the west part of the county, with the Minnesota River as its southern border, and Sibley County to the north. The unincorporated community of Klossner and the City of Lafayette lie within the township. Klossner's statistics are included here; the City of Lafayette is described in the next section. Agriculture and agri-business are the dominant industries.

Population 724 (male: 389 female: 335) Households: 265
Population under 5 yrs: 45 over 85 years: 3
Median age: 38.4 years Density: 14.5 people / sq mi

Wells Wells in database: 177 Median Depth for all wells: 217 feet
Shallowest: 20feet Deepest: 604 feet
# of wells with casing or tiles over 10" in diameter: 17 (10%)

Water Quality # of wells sampled 1989-2000: 132
# of Bacteria samples: 323
with positive coliform bacteria: 109 (34%)
of Nitrate-nitrogen samples: 404
# of nitrate samples at 10 ppm or higher: 42 (10%)
Highest nitrate reading: 40.0 ppm
Median nitrate level: 2.4 ppm

Lafayette Township exhibits some uneven water quality—some medium depth wells contain moderate levels of nitrate-nitrogen, but there is also an abundance of wells with good water quality. Most of Lafayette's wells utilize glacial drift aquifers.

Lake Prairie Township

Lake Prairie is Nicollet County's largest township in area. It is in the northeast corner of the county, bounded on the east by the Minnesota River and on the north by Sibley County. Agriculture and agribusinesses are the predominant land uses; there are no cities in Lake Prairie.

Population 652 (male: 354 female: 209) Households: 235
Population under 5 yrs: 32, over 85 years: 3
Median age: 41.1 years Density: 12 people / sq mi

Wells Wells in database: 182 Median Depth for all wells: 255 feet
Shallowest: 15 feet Deepest: 500 feet
# of wells with casing or tiles over 10" in diameter: 8 (4%)

Water Quality # of wells sampled 1989-2000: 155
# of Bacteria samples: 352
with positive coliform bacteria: 94 (27%)
of Nitrate-nitrogen samples: 454
# of nitrate samples at 10 ppm or higher: 22 (5%)
Highest nitrate reading: 24.3 ppm
Median nitrate level: 1.6 ppm

Lake Prairie is an area of former wetlands, forests, and prairie vegetation succeeded by agriculture. Most of the wells are finished in shallow glacial drift; some located in the eastern part of the township are drawing from the Jordan Aquifer have a history of elevated nitrates. There is also an area near Norseland where wells show nitrate

contamination; this may be due to a buried sand channel where contaminants can infiltrate the aquifer.

New Sweden Township

New Sweden Township is located in northern Nicollet County; Sibley County borders New Sweden on the north. Farming is the predominant land use in this area of former prairie vegetation. There are no towns in New Sweden.

Population	326 (male: 171 female: 155)	Households: 112
	Population under 5 yrs: 15, over 85 years: 3	
	Median age: 37.3 years	Density: 9 people / sq mi

Wells	Wells in database: 95	Median Depth for all wells: 242 feet
	Shallowest: 30 feet	Deepest: 430 feet
	# of wells with casing or tiles over 10" in diameter:	11 (12%)

Water Quality	# of wells sampled 1989-2000:	89
	# of Bacteria samples:	199
	# with positive coliform bacteria:	73 (37%)
	# of Nitrate-nitrogen samples:	222
	# of nitrate samples at 10 ppm or higher:	14 (6%)
	Highest nitrate reading:	74.4 ppm
	Median nitrate level:	2.3ppm

New Sweden's glacial drift aquifers are generally well protected; the quality of groundwater is among the best in the county. In the past, many farms relied on two wells: one deep and one shallow. Although deep wells have "harder" water, the shallow wells were usually dug, tiled wells with elevated nitrates.

Nicollet Township

Nicollet Township is in south-central Nicollet County. Farming is the predominant land use in this area of former prairie vegetation, which is peppered with current and former wetlands. The City of Nicollet is located in northern Nicollet Township; its statistics follow in the city section of this report.

Population	511 (male: 269 female: 242)	Households: 186
	Population under 5 yrs: 18, over 85 years: 4	
	Median age: 40.2 years	Density: 15 people / sq mi

Wells	Wells in database: 143	Median Depth for all wells: 204 feet
	Shallowest: 10 feet	Deepest: 428 feet
	# of wells with casing or tiles over 10" in diameter:	9 (6%)
Water Quality	# of wells sampled 1989-2000:	122

# of Bacteria samples:	267
# with positive coliform bacteria:	62 (23%)
# of Nitrate-nitrogen samples:	202
# of nitrate samples at 10 ppm or higher:	14 (7%)
Highest nitrate reading:	69.1 ppm
Median nitrate level:	1.9 ppm

Nicollet's groundwater is generally of excellent quality; only a few of the shallow, tile wells show high nitrates. The predominant aquifers are in deep glacial drift; the thick organic soils provide effective filtration of contaminants

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Oshawa Township

Oshawa lies in eastern Nicollet County, with the Minnesota River and the city of St. Peter as its eastern boundaries. Although it is primarily agricultural, there is quite a lot of non-farm housing, plus Seven Mile Creek County Park provides for recreation (including fishing, horseback riding, and picnicking).

Population 525 (male: 269 female: 256) Households: 295
Population under 5 yrs: 21, over 85 years: 6
Median age: 37.4 years Density: 18 people / sq mi

Wells Wells in database: 156 Median Depth for all wells: 271 feet
Shallowest: 20 feet Deepest: 500 feet
# of wells with casing or tiles over 10" in diameter: 4 (3%)

Water Quality	
# of wells sampled 1989-2000:	154
# of Bacteria samples:	330
# with positive coliform bacteria:	100 (30%)
# of Nitrate-nitrogen samples:	461
# of nitrate samples at 10 ppm or higher:	106 (23%)
Highest nitrate reading:	38.3 ppm
Median nitrate level:	2.4 ppm

Oshawa is primarily an area of former wetlands and prairie vegetation succeeded by agriculture. Most of the wells are drawing from glacial drift aquifers or the deeper, protected sandstone aquifers; some located in the eastern part of the township are finished in the Jordan Aquifer and have a history of elevated nitrates. Eastern Oshawa is part of the St Peter Wellhead Protection area, so nitrogen management is very important.

Ridgely Township

This small township is located in extreme western Nicollet County. Renville County borders Ridgely on the north; the Minnesota River forms its southern boundary. Farming is the predominant land use in this township. There are no towns in Ridgely, but Fort Ridgely State Park provides recreation, history, and scenic interest.

Population 126 (male: 72 female: 54) Households: 44
Population under 5 yrs: 8, over 85 years: 1
Median age: 38.3 years Density: 7 people / sq mi

Wells Wells in database: 48 Median Depth for all wells: 120 feet
Shallowest: 18 feet Deepest: 300 feet
# of wells with casing or tiles over 10" in diameter: 3 (6%)

Water Quality # of wells sampled 1989-2000: 47
# of Bacteria samples: 109
with positive coliform bacteria: 34 (31%)
of Nitrate-nitrogen samples: 161
# of nitrate samples at 10 ppm or higher: 49 (25%)
Highest nitrate reading: 62.3 ppm
Median nitrate level: 4.8 ppm

Ridgely exhibits a variety of well situations, many show influences of the Minnesota River Valley. Where wells are shallow, or extend into sand prairies along the river terraces, nitrates are elevated.

Traverse Township

Traverse lies in eastern Nicollet County, with the Minnesota River and the city of St. Peter as its eastern boundaries. Although it is primarily agricultural, there is quite a lot of non-farm housing.

Population 367 (male: 206 female: 161) Households: 127
Population under 5 yrs: 15, over 85 years: 4
Median age: 36.9 years Density: 16 people / sq mi

Wells Wells in database: 79 Median Depth for all wells: 249 feet
Shallowest: 59 feet Deepest: 765 feet
# of wells with casing or tiles over 10" in diameter: 1 (1%)

Water Quality # of wells sampled 1989-2000: 61
# of Bacteria samples: 128
with positive coliform bacteria: 43 (34%)
of Nitrate-nitrogen samples: 320
# of nitrate samples at 10 ppm or higher: 176 (55%)
Highest nitrate reading: 30.3 ppm
Median nitrate level: 5.2 ppm

Traverse is primarily an area of former wetlands and prairie vegetation replaced by agriculture. Most of the wells are finished in either the Jordan Aquifer or the deeper, protected sandstone aquifers. Wells finished in the Jordan Aquifer have a history of rising nitrates. Eastern Traverse is part of the St Peter Wellhead Protection area, so nitrogen management is very important.

West Newton Township

West Newton is a large township in western Nicollet County. Renville County borders West Newton on the north; the Minnesota River forms its southern boundary. Farming is the predominant land use in this township. St. George is the only community in West Newton.

Population	517 (male: 261 female: 256)	Households: 180
	Population under 5 yrs: 27, over 85 years: 3	
	Median age: 38.7 years	Density: 14 people / sq mi

Wells	Wells in database: 121	Median Depth for all wells: 183 feet
	Shallowest: 9 feet	Deepest: 338 feet
	# of wells with casing or tiles over 10" in diameter:	13 (11%)

Water Quality	# of wells sampled 1989-2000:	104
	# of Bacteria samples:	203
	# with positive coliform bacteria:	84 (41%)
	# of Nitrate-nitrogen samples:	233
	# of nitrate samples at 10 ppm or higher:	20 (8%)
	Highest nitrate reading:	69.8 ppm
	Median nitrate level:	3.3 ppm

Most West Newton wells show have good water quality; they draw from deep glacial drift aquifers, which are protected from contaminants.

SUMMARIES BY CITY

Courtland

Courtland is located about 8 miles east of New Ulm, in southern Nicollet County. It encompasses several terraces running uphill from the shoreline of the Minnesota River.

Population 538 (male: 270 female: 268) Households: 188
Population under 5 yrs: 32, over 85 years: 6
Median age: 35.1 years Area: 1.9 square miles

Wells Wells in database: 4 Median Depth for all wells: 253feet
Shallowest: 101 feet Deepest: 432 feet

The Courtland wells draw from two aquifers—one shallow glacial drift aquifer, and a deeper sandstone aquifer with high levels of minerals.

Lafayette

Lafayette is located about north of New Ulm, near the Sibley County border. It is situated in Lafayette Township, in an area that was formerly native prairie.

Population 529 (male: 253 female: 276) Households: 202
Population under 5 yrs: 47 over 85 years: 33
Median age: 37.6 years Area: 1.2 square miles
Wells Wells in database: 2 Shallowest: 371 feet Deepest: 374 feet

The Lafayette wells draw from a deep Quaternary (glacial drift) aquifer which is well protected from contaminant sources

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Nicollet

Nicollet is located in central Nicollet County. Nicollet is close to Swan Lake, North America's largest prairie pothole lake, in an area that was formerly native prairie.

Population 889 (male: 454 female: 435) Households: 344
Population under 5 yrs: 58, over 85 years: 22
Median age: 34.4 years Area: .8 square miles

Wells Wells in database: 2 Shallowest: 212 feet Deepest: 229 feet

Nicollet's wells tap into a protected, glacial drift aquifer.

North Mankato

North Mankato is located in southern Nicollet County. It is surrounded on the north by Belgrade Township, and on the west and east by the Minnesota River, which forms a

ninety-degree bend, changing its course from southeasterly to northeasterly. North Mankato is the biggest city in Nicollet County.

Population	11,998 (male: 5,782 female: 6,016)	Households: 4,744
	Population under 5 yrs: 827	over 85 years: 95
	Median age: 33.3 years	Area: 3.9 square miles
Wells	Wells in database: 4	Median depth: 765
	Shallowest: 677 feet	Deepest: 860 feet

North Mankato uses three "grandfathered" multiple aquifer wells and one Mt. Simon-Hinckley Aquifer well. The water is treated to reduce minerals (including Radium) found in wells drawing from deep aquifers.

St. Peter

St. Peter is located on the east side of Nicollet County. St Peter is a riverfront community continuing to rebuild after the 1998 tornado.

Population	9,747 (male: 4,791 female: 4,956)	Households: 2,978
	Population under 5 yrs: 471	over 85 years: 239
	Median age: 24.7 years	Area: 5.0 square miles
Wells	Wells in database: 7	Median depth: 469
	Shallowest: 130 feet	Deepest: 798 feet

In the last ten years, St. Peter has drilled three new wells; the well fields now include two "grandfathered" multiple aquifer wells, two Jordan Aquifer wells (which show nitrate-nitrogen levels) two Ironton Galesville Aquifer wells, and one Mt. Simon Hinckley Aquifer wells. The water is blended to reduce nitrate levels picked up from the Jordan and multiple aquifer wells, and to minimize minerals found in wells drawing from the deeper aquifers.

Nitrates over Time

The next four pages feature selected wells and their nitrate levels over a period of years. These examples are taken from wells owned by citizens who have participated in voluntary well testing in Nicollet County. Most of the examples are taken from records of the Township Water Testing program, in which citizens bring in water samples every few years. Some of the charts with more entries show the fluctuations for wells in the Clean Water Partnership project, during which water was tested several times a year.

It is important to note that these wells were selected to show the fluctuations in nitrate levels. There are hundreds of wells in the county which have never shown detections of nitrate contamination. Please note that the scales on each graph vary—the left side (also known as the Y-axis) shows nitrate ranges from 0 to 80 ppm, 0 to 14 ppm, 0 to 0.6 ppm, etc.

Shallow Hand Dug Well

This is one of the wells which represents how water was supplied in the past—it was probably dug by hand. The casing is wood, and the well is only 33 feet deep. It's located in the northern part of the county.

Protected Glacial Aquifer Well

This west-central well is 265 feet deep. The only detection of nitrate (in 1990) might have been due to a heavy rainfall with ponding around the well casing, or it might have been a sampling error.

Shallow, Tiled Well

This is another west-central well; it is only 30 feet deep with a casing made of cement tiles. While the nitrates have been much lower recently, they are always over the drinking water standard of 10 parts per million.

Vulnerable Glacial Sand Well

This 164' well is located on a sandy terrace near the Minnesota River. It is drawing from An aquifer which is not protected from contam-ination.

Protected Glacial Aquifer Well

This well in east-central Nicollet County is 275' deep. The aquifer supplying this well is protected by a thick layer of glacial drift, so no nitrates have ever been detected.

Vulnerable Jordan Sandstone Well

This well is in east Nicollet County. Although the well is 220' deep, it draws from the Jordan Aquifer, which has been contaminated by nitrates.

Protected Glacial Aquifer Well

This well is 200' deep. Its location in east-central Nicollet County insures that the aquifer it draws water from is protected from nitrate contamination.

Jordan Sandstone Well

This well is 160' deep. It was tested as part of the Clean Water Partnership project. Although there are always nitrates, in recent years, the levels are more stable.

Jordan Sandstone Well

This 161' well is located less than one mile from the 160' well described above, but the nitrate levels are consistently over the drinking water standard of 10 parts per million.

Protected Glacial Aquifer Well

This 200' deep well is located in the northern part of Nicollet County. The aquifer it draws from is protected from contamination by thick glacial drift.

Vulnerable Glacial Aquifer Well

This chart shows the nitrate levels found in a well that is 180' deep, located near the community of Norseland. Underground drilling records show that there may be a buried sand channel from an ancient river where contamination can enter the aquifer.

Vulnerable Jordan Aquifer Well

This chart represents nitrate levels in a 76' deep well in east Nicollet County, near the Minnesota river. The well is drilled into the Jordan aquifer which is contaminated by low levels of nitrate in this area.

B. County Maps & Explanations

In this section, a series of maps illustrating different factors affecting nitrate vulnerability are shown with brief explanations about the science and technology involved in their creation. The five individual maps are combined to create a sixth map showing Nitrate-Nitrogen Probability levels in Nicollet County. This map represents our best estimate, at this time, about the vulnerability of the groundwater to contamination by nitrates.

Nitrate-Nitrogen Probability Map Data Inputs

Each of the maps on page 27 are described below; compositing these individual maps results in the nitrate-nitrogen probability map on page 29.

Landforms: This map was derived from the Minnesota Geological Survey Landform Association of Minnesota database in which landforms indicate geologic sensitivity: most permeable, permeable, and least permeable. These classifications only apply to the surface geology; it is important to realize that the geology of underlying layers may significantly affect geologic sensitivity.

Land Use: The Minnesota Department of Health reclassified the land use database developed by the International Coalition for Land and Water Stewardship in the Red River Basin in accordance with the "Guidance for Mapping Nitrate in Minnesota Groundwater". The categories are 1) Forested or Undeveloped, 2) Residential or Commercial, and 3) Agricultural.

Percent Clay above the Static Water Level: This map was developed using a program that calculated the percent of clay above the static water level in 795 well logs from Nicollet County submitted by well drillers. MDH used a reclassification scheme to rate various lithologies (descriptions of layers of rock or soil encountered during drilling) as to permeability. The lithologies termed clay, hardpan, peat, regolith, shale, or silt are nonpermeable; all other terms are rated as permeable.

Depth to Static Water Level: This map was developed using 429 well logs containing information on the natural, non-pumping level that water rises to within the well casings. Since water closer to the ground surface is more susceptible to contamination, wells with shallow static water levels received the highest scores.

Average Nitrate-Nitrogen Concentrations: This map was developed using data from 966 wells with diameters less than 10 inches and completed at 50 or more feet in depth. Using the Spatial Analyst extension in ArcView, the grid for this database was reclassified into three categories (from the Guidance for Mapping Nitrate in Minnesota Groundwater). Less than 3 parts per million nitrate-nitrogen represent background water quality. Three to 10 ppm represent water that probably has been impacted by human activity. Nitrate-nitrogen over 10 ppm is above the drinking water quality standard.

Copies of the MDH report explaining the map inputs are available, see the reference section on page 36.

The Nitrate-Nitrogen Probability Map

The map identifies areas of the county with relatively high, moderate, and low probability of having elevated nitrate concentrations in groundwater drinking water supplies. This mapping effort is the combination of scores from the previously mentioned map layers.

There are a few important points to consider regarding the county map:

- Although nitrate can be a valuable indicator of areas that are susceptible to contamination, elevated nitrate concentrations may result from contamination of the aquifer or more localized well problems, such as surface water drainage into the well, poor well construction, or location of the well near a pollution source. Localized well problems may occur anywhere and cannot be predicted by using the probability map.

- Drinking water without nitrates also can be found in areas labeled medium and high probability. The absence of nitrate in groundwater may indicate that 1) the nitrogen loading was small, 2) the nitrogen is in another form (such as ammonia), or 3) the nitrate has been denitrified (reduced to nitrogen gas).

- MDH conducted a statistical evaluation of the water quality information with respect to the probability map. Almost 82 percent of the wells that have average nitrate concentrations above 3 ppm are located in areas ranked as medium or high probability of nitrate contamination. In addition, 78% of the wells with average nitrate concentrations above 10 ppm are located in areas designated as hiving a high probability of nitrate contamination.

- High probability areas constitute 20 percent of the total area of the county. Medium and high areas constitute less than 50 percent of the total area in the county.

- Drinking water with low or no detectable nitrate is available in areas designated as having high or medium probability of nitrate contamination. Only 8.5% of the wells in areas designated high probability have average nitrate concentrations above 10 ppm. Good water quality, in regards to nitrate-nitrogen, generally can be found by using a deeper well installed by a licensed well driller.

Number of Wells in Probability Map Areas

Nitrate-Nitrogen Level	Low Probability Area	Medium Probability Area	High Probability Area	Total Wells
# of wells with nitrates less than 3 ppm	511	183	201	895
# of wells with nitrates between 3 & 10 ppm	10	10	24	44
# of wells with nitrates over 10 ppm	3	3	21	27
Total Wells	524	196	246	966

C. Cross Section Representations

The geologic cross sections below are taken from the Nicollet County Geologic Atlas compiled by the Water Resources Center of Mankato State University in July, 1991. The cross sections combine surface topography, bedrock topography and information contained in the geologic portions of water well driller's logs. The vertical scale is a twenty-time exaggeration of the horizontal scale so thin rock units would be mapable.

The Nicollet County cross sections show the geologic differences between the east and west parts of the county; with the east exhibiting "layer cake" geology and the west dominated by glacial drift.

Part II: Potential Uses of Groundwater Vulnerability Information

A. County Level: Zoning Decisions & Planning

Because Nicollet County is 100% dependent on groundwater for its drinking water, programs to protect and enhance groundwater are valued highly by county residents and officials. The newly developed database and maps bring a fresh perspective to long-term protection efforts. By helping visualize the effects of current and changing practices on existing water resources, it may be possible to design new residential, agricultural, and industrial developments so that the changes have minimal impact.

With that goal in mind, a pilot project—the Groundwater Vulnerability Zoning Project—is now in progress. The GWVZ Project has developed Nitrate-nitrogen Probability Maps based on six criteria (these are illustrated in Part I Section B) that can be reproduced on a township level to help determine a location's susceptibility to contamination. The project will also provide developers, neighbors, county advisory committees, and decision-makers with written information about underground conditions for any proposed sites. It is hoped that the maps and information will be helpful in determining conditions for permits, in selecting sites with variable factors, and in providing long-term protection for areas of vulnerability.

During 2002, this project will provide information for zoning decisions on request. After the pilot year, an evaluation phase will determine the usefulness of the maps and database information for future zoning operations.

B. Townships, Cities & Systems: Wellhead Water Protection

The Minnesota Department of Health (MDH) is charged with cooperative work with communities to protect their sources of drinking water. This cooperative effort is called the "Source Water Protection Program". In our area, the effort comes under the heading "Wellhead Protection Program" because all our drinking water comes from groundwater through wells.

The first step in wellhead protection is to find out where the water comes from. Next, possible sources of pollution are identified. Finally, the community develops a plan to manage contaminant sources so they will not pose a threat to drinking water.

To systematically address the over 8,000 community water systems in the state that use wells, MDH has developed a prioritization strategy based on each community water supply's vulnerability to contamination. The most vulnerable communities are listed in order of risk in Tier 1, the next level of vulnerability is Tier 2, and so on to communities with very protected water supplies, which are placed in Tier 5.

Community water systems in Nicollet County were ranked this way:

Nicollet	Tier 1	Rank 148
St Peter Regional Treatment Center	Tier 1	Rank 171
Minnesota Valley Lutheran School	Tier 1	Rank 321

Immanuel Lutheran School	Tier 1	Rank 449
St Peter	Tier 2	Rank 613
North Mankato	Tier 2	Rank 619
Courtland	Tier 2	Rank 723
Lafayette	Tier 2	Rank 1332
Klossner Water Association	Tier 2	Rank 1435

The City of St. Peter was a leader among Minnesota communities to enact a formal Wellhead Protection program, and was among the very first in the state to have an approved plan to enact protective programming in its Drinking Water Supply Management Area. Because of this leadership, the project was awarded a US Environmental Protection Agency grant to develop agricultural demonstrations to show the efficacy of University of Minnesota nitrogen fertilizer application recommendations (which were being greatly exceeded), determine crop yields, and provide profitability statistics on fields with lower application rates.

Lafayette also has completed the wellhead assessment program and has an approved Wellhead Protection Plan.

County non-transient, non-community wells are also required to assess sources of possible contamination and to develop a plan for protection of their water source. Examples of such wells are those supplying rural churches, restaurants, and schools. In the meantime, these wells are tested annually for contaminants to ensure short-term drinking water safety.

C. Protection for Individual Wells

Despite the fact a safe water supply can usually be obtained in Nicollet County, a majority of wells can be vulnerable to contamination. Protection of the "wellhead" (area near the well) is critical to have and maintain a safe supply of drinking water.

Bacterial Contamination

Bacteria is the most common water quality problem in rural water supplies. Overall, roughly one-third of all individual well water samples test positive for coliform bacteria. Coliform bacteria are a group of several different species which are commonly found in human and animal wastes. Because it is relatively easy to test water for coliforms, they are considered as "indicator" organisms. They are usually present when disease causing organisms such as salmonella or shigella are present.

The presence of coliform may indicate contamination from a sewer, septic system, feedlot, wastewater application or animal yard. Because coliform bacteria will generally not survive for long periods of time in groundwater, their presence usually means that the contamination source is nearby. An improperly constructed or sealed well, a defect or failure in the well or plumbing system, or a well drilled into a vulnerable aquifer may result in coliform contamination.

If coliform bacteria are found, the well, plumbing and water storage systems should be disinfected with a product such as chlorine bleach. If, after disinfection and

resampling the well continues to show the presence of coliform, an evaluation of the wellhead area should be made.

A well located in a pit, a well without a watertight cap, or a well with a poor seal can be corrected. In some cases, the well might be in poor enough repair that it may need to be properly sealed, and a new well drilled.

Nitrate-nitrogen Contamination

As noted in earlier sections, nitrate contamination is a serious problem in many parts of the county.

There are many possible sources of nitrates in groundwater. Decayed vegetation, atmospheric nitrogen from rainfall, and minerals found in certain soils and rock are considered "natural" sources of nitrate; they contribute only small concentrations of nitrate to the groundwater. The major sources of nitrate are animal and human wastes, chemical fertilizers, manure, and to a much lesser extent in this area, industrial wastes, wastewater, and landfills. Nitrate can enter the groundwater from improper management of wastes, over-application of nitrogen fertilizers, or failing septic systems.

Nitrate can also act as an early warning of contamination, or it may indicate the possible presence of other contaminants.

If a well water sample tests at over 3 parts per million of nitrate-nitrogen, several cautionary steps can be taken.

1. The well should be inspected to determine if repair or reconstruction might be needed.

2. Nearby sources of nitrate contamination should be reduced or eliminated. This may include better management of fertilizers and animal wastes, modification or repair of septic systems, or removal of contamination sources.

3. Sometimes, only minor adjustments to the wellhead protection area may be needed. These include regrading so that excess overland runoff runs away from the well. Seeding or planting in the area around the well may also help keep any overland water that could be contaminated from pet waste or fertilizer from ponding around the top of the well.

4. Sometimes, it may be necessary to take structural steps. These include the use of filtration water treatment devices, replacing a faulty septic system with a new code-compliant sewage treatment system, or drilling a new well into a deeper, more protected, uncontaminated aquifer.

PART III: INFORMATION & REFERRAL

A. For More Information

This list of state and local agencies can be used for questions, problems, or more information on water quality in Nicollet County.

Nicollet County

Water Planning
St Peter phone 507-931-6800

Soil & Water Conservation District
St Peter phone 507-931-2550

University of Minnesota Extension Service
St Peter phone 507-931-6800

Brown-Nicollet-Cottonwood Water Quality
St. Peter phone 507-934-4140

Minnesota Department of Health

Well Management Division – SE District
Marshall phone 507-537-7151

Source Water Protection Unit-South
Mankato phone 507-389-5563

Source Water Protection Unit - Metro
St Paul phone 651-215-0768

Minnesota Board of Water & Soil Resources

Area Conservationist
New Ulm phone 507-359-6047

Minnesota Pollution Control Agency

Clean Water Partnership Program
Rochester phone 507-281-7345

Regional Environmental Management
St Paul phone 651-296-7363

Minnesota Department of Natural Resources

Waters Division
New Ulm phone 507-359-6053

Fisheries Division
New Ulm phone 507-359-359-6046

Minnesota Department of Agriculture

Agronomy Services
St. Paul phone 651-297-2200

Minnesota Geological Survey

Minneapolis phone 612-627-4780

B. References

Brown-Nicollet-Cottonwood Clean Water Partnership Groundwater Implementation Project 1993-1997, Brown-Nicollet-Cottonwood Water Quality Board, St. Peter, MN

Nicollet County Comprehensive Water Plan 2002-2007
Nicollet County Environmental Office, St. Peter, MN

Nicollet County Nitrate-Nitrogen Probability Map Report – 2002
Minnesota Department of Health, St. Paul, MN

Guidance for Mapping Nitrate in Minnesota Groundwater – 1998
Minnesota Department of Health, St Paul, MN

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Nitrate in Minnesota Groundwater – a GWMAP Perspective - 1998
Minnesota Pollution Control Agency, St Paul, MN

Nitrogen in Minnesota Ground Water – a LCMR Report – 1991
Minnesota Pollution Control Agency & Minnesota Department of Agriculture, St Paul, MN

Shorter Contributions to the Geology of the Sioux Quartzite, Southwestern MN - 1984
DL Southwick, Editor; Minnesota Geologic Survey, University of Minnesota, St Paul, MN

Township Water Testing Reports 1988-2000
Brown-Nicollet Environmental Health, St Peter, MN

C. Acknowledgements

As the editor of this report, I wish to express my appreciation and gratitude to three sets of people and three individuals.

First, to the citizens of Nicollet County who participated in water testing programs, who keep us on our toes with questions and their interest, and who are striving to preserve water resources for future generations.

Next to the Nicollet County Board and the staff of the Environmental Office for their dedicated public service, their support, and their hard work on these innovative projects to protect the groundwater of the county.

Next to the governments, departments, organizations, schools, and agencies at all levels (city, township, state, and federal) who support groundwater protection.

Three individuals stand out in the effort of compiling and using groundwater data. Without the help and hard work of these three, the county would still be in the very dark ages for water quality data—several shelves of dusty water test results and a vague understanding of geologic problem areas but no way to use the data or make improvements.

Thanks to

Bruce Olsen – Source Water Protection Unit Supervisor for the Environmental Health Division of the Minnesota Department of Health. Bruce is the godfather of these projects. He has freely bestowed his technical assistance, staff and financial resources, and moral support to groundwater projects in the county since 1989.

Sheila Grow – Hydrogeologist for the Source Water Protection Unit, Environmental Health Divison of the Minnesota Department of Health. Sheila is pioneering the use of new technology to understand, interpret, and use water data and mapping systems. She's given tremendous support to Nicollet County groundwater projects, actually developing the data base and maps while working out problem after problem with total cheerfulness since 1997.

Marcy Pengilly – Environmental Health Assistant for the Brown-Nicollet-Cottonwood Water Quality Board. Since 1989 when she assisted with the birth of the Board, she's been a constant source of hard work, enthusiasm, and joy in the development, carrying out, and completion of the many groundwater projects. Her personal entry of over 4,000 pages of water quality data has made the programs relevant and usable today and in the future.

With sincere gratitude,

Bonnie Holz
Water Quality Administrator
December 2001