



INITIAL TOWNSHIP TESTING OF NITRATE
IN PRIVATE WELLS
WASHINGTON COUNTY 2014 SUMMARY

November 2015

Minnesota Department of Agriculture

Pesticide and Fertilizer Management Division

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TABLE OF CONTENTS

Acknowledgements.....	2
Table of Contents.....	3
Executive Summary.....	5
Introduction	5
Background.....	6
Methods.....	17
Results.....	18
Summary	24
Future Work	24
References.....	25
Appendix A: Private Well Survey Questions.....	27
Appendix B: Private Well Survey Answers	28

LIST OF FIGURES

Figure 1. Statewide Geomorphology Layer, Sediment Association, Washington County	9
Figure 2. Bedrock Geology of Washington County.....	10
Figure 3. Water Table Aquifer Vulnerability for Washington County	11
Figure 4. Washington County Pollution Sensitivity Rating of the Water Table Aquifers.....	13
Figure 5. Townships with Vulnerable Groundwater and Row Crop Production.....	16
Figure 6. Washington County Private Well Township Sampling Results 2014	19

LIST OF TABLES

Table 1. Vulnerability Ratings Based on the Geomorphology of Minnesota, Sediment Association Layer	12
Table 2. Aquifer Type Distribution of Wells in the County Well Index	15
Table 3. Township Households, Sample Kit Distribution and Return Rate	17
Table 4. Washington County Township Sampling Summary Statistics, Does Not Include Known Hand Dug Wells	20
Table 5. Township Nitrate Results Summary Related to Vulnerable Groundwater and Row Crop Production	21
Table 6. Nitrate Concentration within Sampled Groundwater Aquifers	23
Table 7. Property Setting for Well Location	28
Table 8. Well Construction Type	28
Table 9. Age of Well	28
Table 10. Depth of Well	29
Table 11. Unique Well ID Known	29
Table 12. Livestock Located on Property	29
Table 13. Fertilizer Stored on Property	30
Table 14. Farming on Property	30
Table 15. Distance to an Active or Inactive Feedlot	30
Table 16. Distance to Septic System	31
Table 17. Distance to Agricultural Field	31
Table 18. Drinking Water Well	31
Table 19. Treatment System Present	32
Table 20. Last Tested for Nitrate	32
Table 21. Last Nitrate Test Result	32

EXECUTIVE SUMMARY

In 2014, one township and one city in Washington County, Minnesota, were selected for private well nitrate sampling in support of the Nitrogen Fertilizer Management Plan. This selection was based on historically elevated nitrate conditions, aquifer vulnerability and row crop production. Samples were collected from private wells using homeowner collection and mail-in methods. Well log information was obtained when available and correlated with nitrate results.

Information collected indicated approximately 96 percent of wells in Cottage Grove and Denmark Township were finished in the Paleozoic sedimentary deposits. Samples were collected from 526 wells in these two communities representing a 39 percent response rate from homeowners.

Results showed that across the two communities, 22 percent of private wells sampled were above the health standard of 10 mg/L for nitrate as nitrogen (nitrate-N). In Cottage Grove, 28 percent were above 10 mg/L, and in Denmark 14 percent of the private wells tested were above the 10 mg/L standard for nitrate-N. The maximum nitrate values ranged from 20.9 to 34.1 mg/L. The 90th percentiles ranged from 11.8 to 15.8 mg/L and the mean nitrate values found were 3.8 to 6.0 mg/L for Denmark Township and Cottage Grove, respectively.

This initial testing was followed by a second sampling offered to homeowners with wells that had a detectable nitrate result. This work will be discussed further in a follow-up report in 2016.

INTRODUCTION

The Minnesota Department of Agriculture (MDA) has recently updated the 1990 Nitrogen Fertilizer Management Plan (NFMP), which is the state's blueprint for prevention or minimization of the impacts of nitrogen fertilizer on groundwater. One of the goals of the NFMP is to minimize or mitigate the source of pollution from nitrogen fertilizer. Updating the NFMP provided an opportunity to restructure the County's and the State's strategies for reducing nitrate contamination of water resources, with more specific, localized accountability for nitrate contamination associated with row crop agricultural production.

To effectively manage nitrate contamination of water resources, it is appropriate to focus on areas of greatest risk. Testing private wells for nitrate is one method for identifying areas and wells at greatest risk. For this, the MDA has developed the "Township Testing Program". In the Township Testing Program (TTP) the MDA works

with local partners (counties and Soil and Water Conservation Districts) to collect and analyze water samples from private drinking water wells within townships that either had high nitrate results or exist in an area with high aquifer vulnerability and a high percentage of row crop production.

This testing conducted in Washington County will be used to guide future work as the MDA plans to offer nitrate tests to approximately 70,000 private well owners (within 250-350 townships) between 2014 and 2019. As of spring 2015, 60 townships in eight counties have been completed.

For further information on this program, please visit the project webpage at:

<http://www.mda.state.mn.us/protecting/cleanwaterfund/gwdwprotection/townshiptesting.aspx>

BACKGROUND

In many rural areas of the state, nitrate is one of the most common contaminants in Minnesota's groundwater. In some areas of the state, a significant number of wells have high nitrate levels.

Nitrate is a naturally occurring, water soluble molecule that is made up of nitrogen and oxygen. Although nitrate occurs naturally, it typically originates from man-made sources such as fertilizer, animal manure, and human waste. Nitrate is a concern because it can have a negative effect on human health at elevated levels. The U.S. Environmental Protection Agency (USEPA) has established a drinking water Maximum Contaminant Level (MCL) of 10 mg/L for nitrate as nitrogen (nitrate-N) (U.S. EPA, 2009) in municipal water systems. Minnesota Department of Health (MDH) has also established a Health Risk Limit (HRL) of 10 mg/L for private drinking water wells in Minnesota.

Nitrogen present in groundwater can be found in several forms including nitrite and nitrate. Nitrite concentration is commonly less than the reporting level of 0.01 mg/L, resulting in negligible contribution to the nitrate plus nitrite concentration (Nolan and Stoner, 2000). In the environment, nitrite rapidly converts to nitrate, which means nitrite occurs very rarely in groundwater. Measurements of nitrate plus nitrite as nitrogen and measurements of nitrate as nitrogen will hereafter be referred to as "nitrate".

NITRATE FATE AND TRANSPORT

Nitrate is considered a conservative anion and is highly mobile in many shallow coarse-textured groundwater systems. Once in groundwater, nitrate is often very stable and can move large distances from its source. However in some settings, nitrate in groundwater may be converted to nitrogen gas in the absence of oxygen and the presence of organic carbon, through a natural process called denitrification. Denitrification occurs when oxygen levels are depleted and nitrate becomes the primary

oxygen source for microorganisms. Shallow groundwater in coarse-textured soils (glacial outwash) generally has low concentrations of organic carbon and is well oxygenated, so denitrification is often limited in these conditions. Areas with glacial outwash and intensive row crop agriculture are particularly vulnerable to elevated nitrate concentrations. However, geochemical conditions can be highly variable within an aquifer or region and can also change over time (MPCA, 1998).

GEOLOGY AND HYDROGEOLOGY

The surficial geology in Washington County is dominated by Quaternary glacial deposits such as outwash, till, drift and terrace deposits (Figure 1). Glacial outwash is relatively coarse-textured compared to other glacial deposits such as till and drift deposits. Outwash material in Southern Washington County consists primarily of sand, loamy sand and gravel that was deposited by melt water that flowed from the Superior Lobe deposit in Cottage Grove and the Keewatin deposit in Denmark Township (Swanson and Meyer, 1990). The terrace deposits are also comprised of sand and gravel. Coarse-textured deposits often allow contaminants from the surface to travel rapidly to the water table aquifers. Statewide geomorphological mapping conducted by the Department of Natural Resources, Minnesota Geological Survey (MGS) and the University of Minnesota at Duluth (MDNR, MGS, and UMD, 1997) indicates the extent of glacial deposits in Washington County as presented in Figure 1.

The bedrock geology consists of early Paleozoic sedimentary deposits (Figure 2). The St. Peter Sandstone is the uppermost deposit and is present in the northern part of the two communities. Beneath the St. Peter lies the Prairie du Chien Group which is comprised of dolostone. The Prairie du Chien outcrops in bluffs along the St. Croix and Mississippi Valley. The Jordan Sandstone underlies the Prairie du Chien and consists of medium to coarse grained sands in the upper portion and finer grains toward the bottom (Swanson and Meyer, 1990).

Water table aquifers and buried Quaternary aquifers occur in locations throughout the county where quaternary deposits of sand and gravel occur. These aquifers are not spread uniformly over the county and have varying thickness.

The main source of groundwater in Washington County is the Prairie Du Chien-Jordon Aquifer. The Prairie du Chien-Jordon Aquifer is composed of the Prairie du Chien Group and Jordon Sandstone. These two bedrock aquifers have distinctly different compositions. In many areas they function as a singular aquifer because there is no confining unit between them. This aquifer complex underlies most of Washington County and is the most commonly utilized aquifer in the county. The aquifer is not used much in the northwest corner and along the eastern edge of the county because of low yields, but in the southwest this aquifer is more permeable and can yield more water (Swanson and Meyer, 1990).

The statewide geomorphological mapping also classified the state into aquifer sensitivity ratings. There are three ratings for aquifer sensitivity: low, medium, and high (Figure 3). The ratings are based upon guidance from the Geologic Sensitivity Project Workgroup's report, "Criteria and Guidelines for Assessing Geologic Sensitivity in Ground Water Resources in Minnesota" (MDNR, 1991). Sensitivity ratings are described in Table 1.

Washington County Geomorphology-Sediment Association

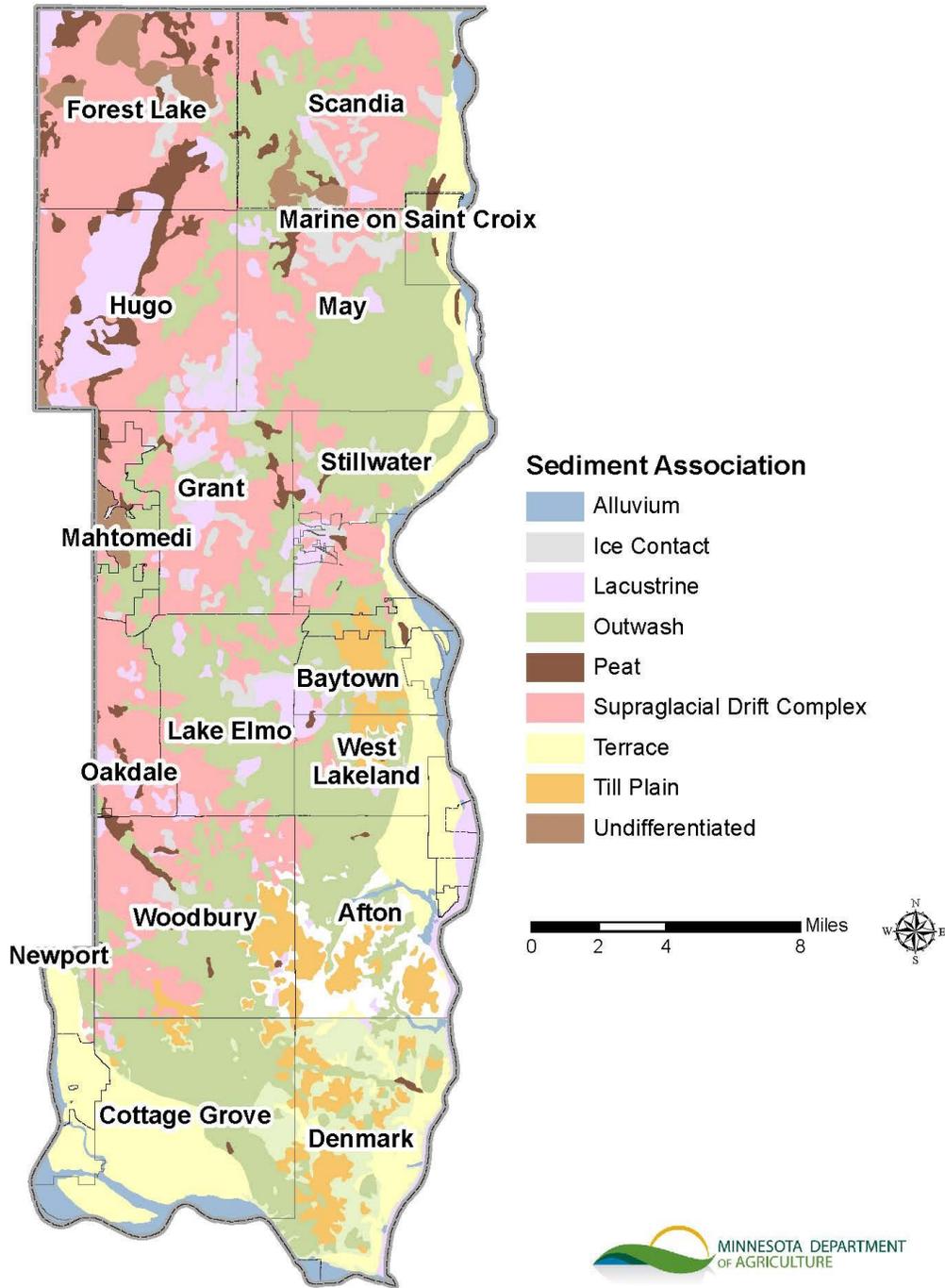


Figure 1. Statewide Geomorphology Layer, Sediment Association, Washington County.

Bedrock Geology of Washington County

(Adapted from Mossler, John H. 2013)

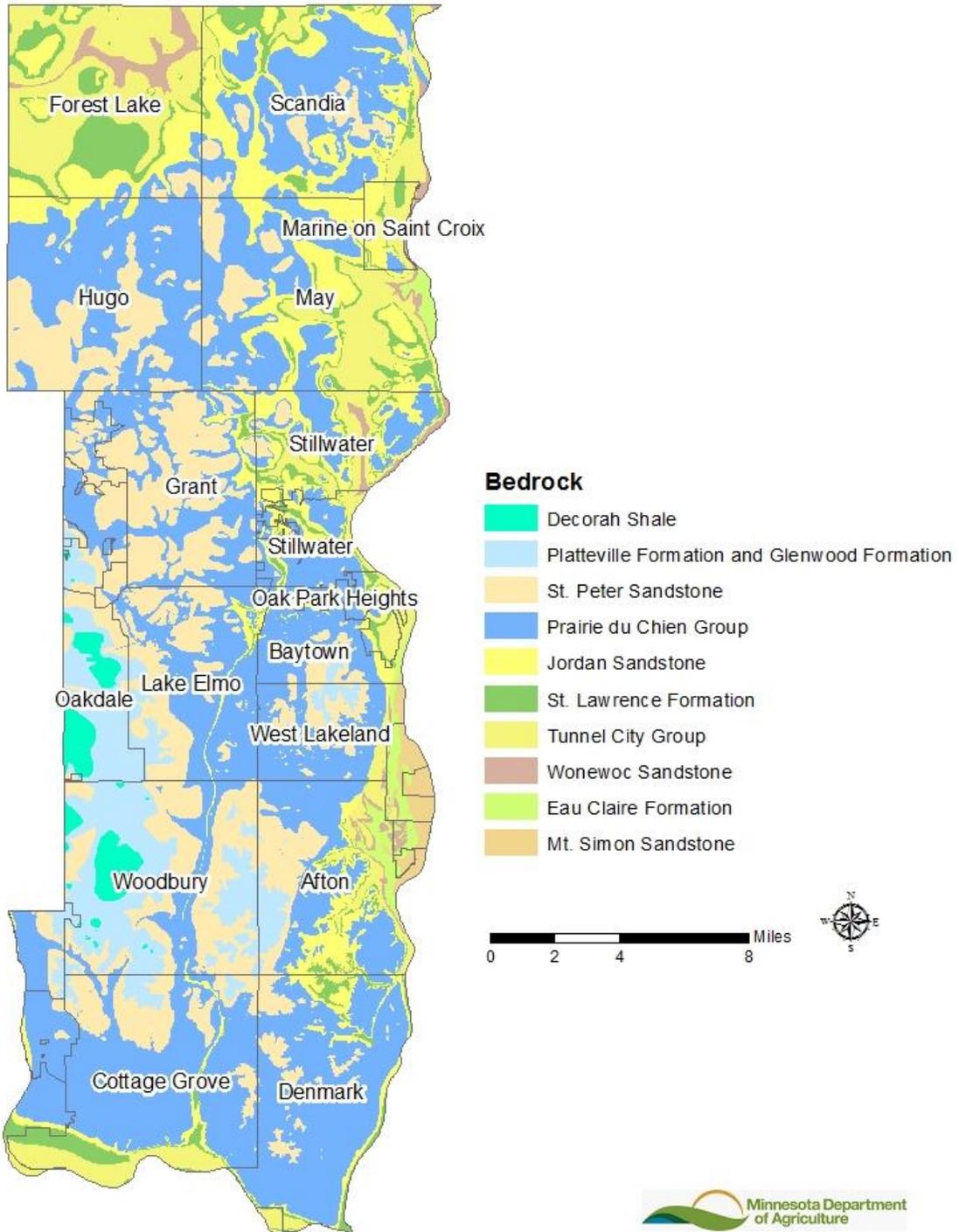


Figure 2. Bedrock Geology of Washington County.

Water Table Aquifer Vulnerability Rating for Washington County

Based on Reclassification of the Sediment Association Layer (DNR, MGS, UMD, 1997)

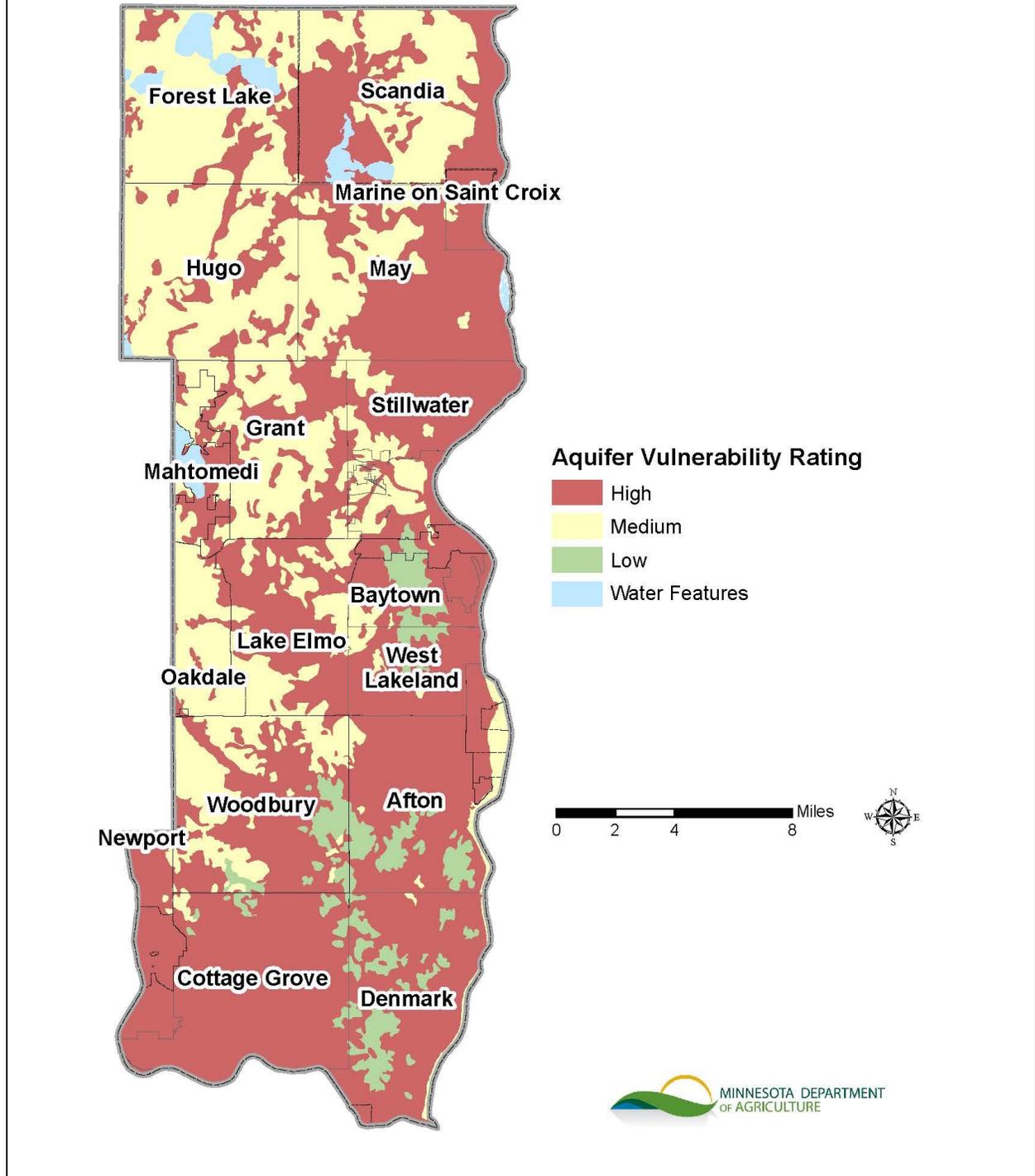


Figure 3. Water Table Aquifer Vulnerability for Washington County.

Table 1. Vulnerability Ratings Based on the Geomorphology of Minnesota, Sediment Association Layer.

Sediment Association	Sensitivity/Vulnerability Rating
Alluvium, Outwash, Ice Contact, Terrace, Bedrock: Igneous, Metamorphic, and Sedimentary	High
Supraglacial Drift Complex, Peat, Lacustrine	Medium
Till Plain	Low

GEOLOGIC ATLAS

The County Geologic Atlas examines a county’s geology and groundwater aquifers. The atlas describes bedrock and surficial geology, hydrogeology of the aquifer and the connection of land surface to groundwater (MGS, 2015). This information is an important resource for groundwater management. It can aid in activities such as monitoring, appropriation, permitting, remediation, and well construction.

A complete geologic atlas typically consists of two parts:

- Part A (prepared by MGS), which includes the water well database and 1:100,000 scale geologic maps. These maps focus on the geology of the county, and
- Part B (developed by the Minnesota MDNR Division of Ecological and Water Resources) contains maps on hydrogeology; including aquifer sensitivity to pollution, groundwater chemistry and aquifer delineations.

The geologic atlas for Washington County was completed in 1990 and was not divided into these two parts. However, this atlas still contains much of the data that can typically be found in Parts A and B. An important analysis provided in the Atlas is called the Sensitivity of Ground-Water Systems to Pollution. This map has a rating system based on the estimated time for water to travel from the land surface to the water table system (Figure 4). The water table aquifer vulnerability map (Figure 3) is somewhat similar to the pollution sensitivity map when comparing at a one-dimensional level. The MDNR pollution sensitivity map has a higher level of detail and rates all of Denmark Township at some level of “high” sensitivity, while the water table vulnerability map, rates some of the same area as “low”. Since the MDNR pollution sensitivity map is mapped at a higher resolution it is likely a better representation of sensitivity/vulnerability to groundwater.

Washington County Geologic Atlas: Water Table Sensitivity to Pollution

Information Adapted from C-05 Geologic Atlas of Washington County, Minnesota (Meyer, 1990)

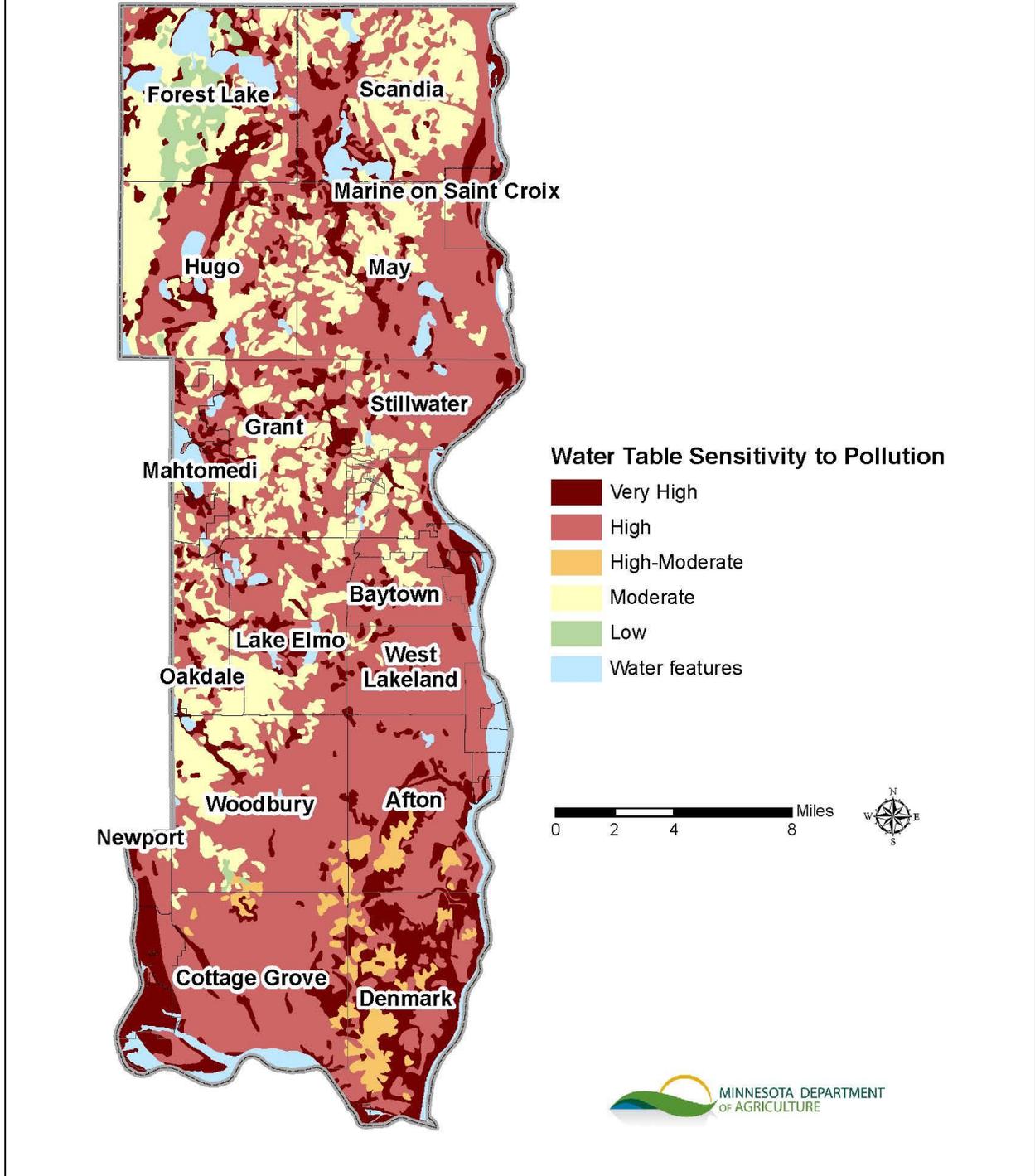


Figure 4. Washington County Pollution Sensitivity Rating of the Water Table Aquifers.

COUNTY WELL INDEX

The County Well Index (CWI) is a database system developed by the MGS and the MDH for the storage, retrieval, and editing of water well information. The database contains basic information (e.g. location, depth, static water level) for wells drilled in Minnesota. The database also contains information on the geology and the well construction for many private drinking water wells. The CWI is instrumental in the development of the County Geologic Atlas described in the previous section. The CWI is the most comprehensive Minnesota well database available, but contains only information for wells in which a well log is available. It is important to note that most records in the CWI are for wells drilled after 1974, when water well construction code required well drillers to submit records to the MDH. The CWI does contain data for some records obtained by the MGS for wells drilled before 1974 (MGS, 2015).

The CWI was used to gather information about the two communities, Cottage Grove and Denmark Township, in Washington County included in this Pilot Study.

Table 2 summarizes the general aquifer types, while the following section is a brief summary of the major aquifer types with the average well depth. According to the information from the CWI (MDH, 2015):

In the two communities, there are 917 documented wells:

- Approximately one percent of wells are completed in the shallow Quaternary Water Table Aquifer (QWTA) and are 119 feet deep on average.
 - QWTA wells are defined as having less than ten feet of confining material (clay) between the land surface and the well screen (MPCA, 1998). When there is less than ten feet of clay, it allows surface contaminants to travel more quickly to the water table aquifers. In general, shallower wells completed in the QWTA may be more susceptible to nitrate contamination.
- One percent of the wells are completed in a Quaternary buried aquifer and are 163 feet deep on average.
 - Buried aquifer wells have more than ten feet of confining material (typically clay) between the land surface and the well screen.

- In both communities, the Paleozoic aquifers (over 90 percent) are utilized the most frequently. These bedrock wells average 248 feet deep.
 - In Washington County the majority of the used Paleozoic aquifers are part of the Prairie du Chien Group or the Jordan Sandstone complex. These aquifers are confined by the shaley base of the St. Peter Sandstone (Swanson and Meyer, 1990), which provides protection from pollution to these aquifers.

Table 2. Aquifer Type Distribution of Wells in the County Well Index.

Community	Wells	Aquifer Type				
		Water Table	Quaternary Buried	Paleozoic	Undesignated	Other
Cottage Grove	501	2%	1%	94%	2%	<1%
Denmark Township	416	<1%	<1%	97%	2%	<1%
Average	917*	1%	1%	96%	2%	<1%

* Represents a total

NITRATE PROBABILITY MAPPING

In many areas, nitrate probability maps have been developed by the MDH to assist in local water quality planning efforts. These maps identify areas of a county with relatively high, moderate, and low probability of having elevated nitrate concentrations in groundwater. The goal of nitrate probability mapping is to help protect public and private drinking water supplies, to help prevent further contamination by raising awareness and to assist in local planning and prevention. The nitrate probability map is similar in appearance compared to the updated aquifer vulnerability map; however it shows less area categorized in the high rating. Washington County's report was published in 2002 and can be accessed here:

<http://www.health.state.mn.us/divs/eh/water/swp/nitrate/reports/2011method/washington.pdf>

TOWNSHIP TESTING

The MDA has recently updated the 1990 NFMP which is the state's blueprint for prevention or minimization of the impacts of nitrogen fertilizer on groundwater. Updating of the NFMP provides an opportunity to restructure county and the state strategies for reducing nitrate contamination of groundwater, with more specific, localized accountability for nitrate contamination from agriculture. In order to effectively reduce nitrate contamination of groundwater resources, it is necessary to identify areas of concern. Areas of concern tend to be fairly localized, so township and city boundaries were selected for nitrate testing. Factors such as aquifer vulnerability, row crop production, and previous nitrate results are being used to prioritize townships for sampling. Townships with at least 30 percent of the area characterized with vulnerable groundwater and at least 20 percent of the area in row crop production are shown in Figure 5. This map serves as a starting point for planning sample locations and is modified based on local expertise.

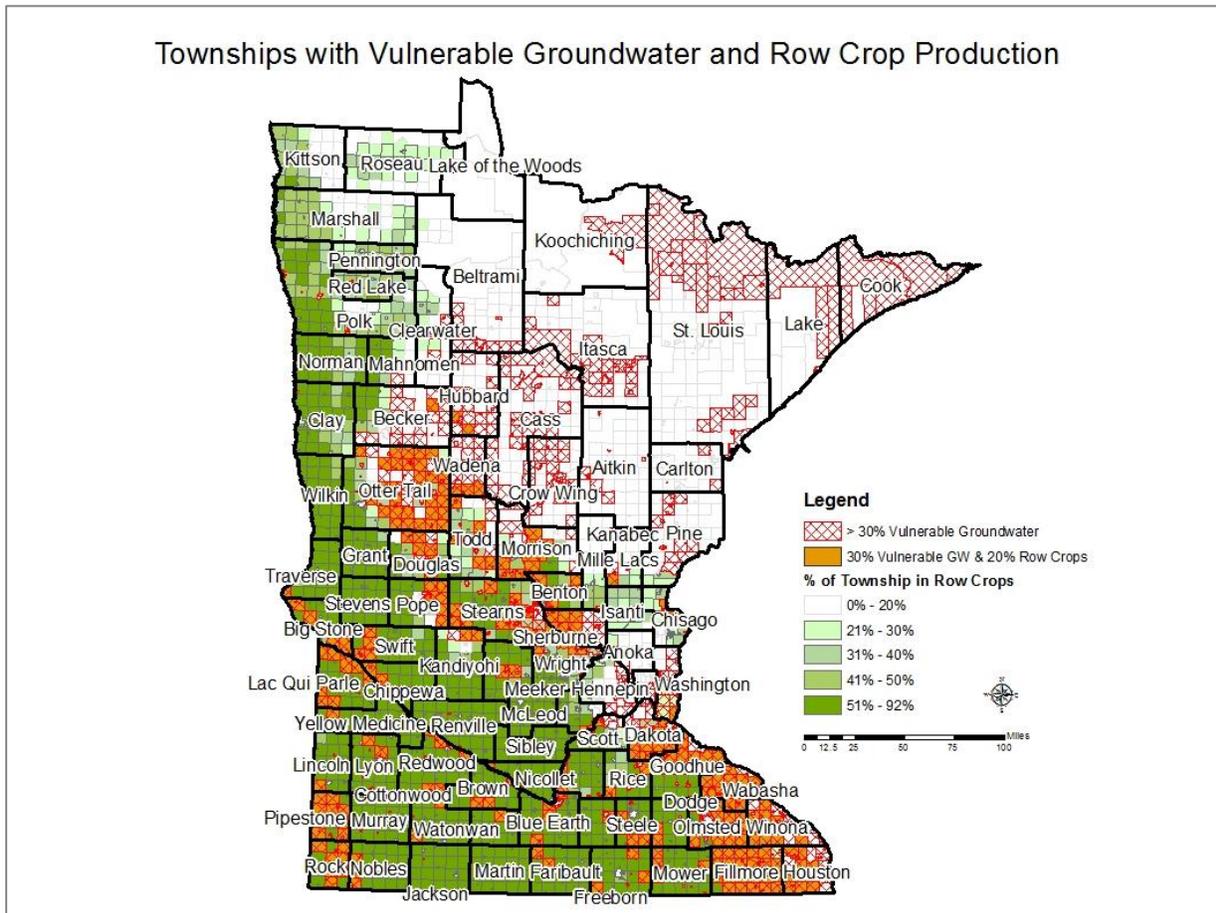


Figure 5. Townships with Vulnerable Groundwater and Row Crop Production.

METHODS

The City of Cottage Grove and Denmark Township, two communities from Washington County, were chosen for sampling based on the following criteria: local expertise from Washington County and Washington Conservation District, past high nitrate results, vulnerable groundwater, and row crop production.

The goal of this program is to characterize current nitrate conditions at the highest density level possible. Most households with private wells received an invitation letter from the local partner to participate in the free nitrate testing supported by MDA. Homeowners with private wells were sent a water sample kit (by a certified lab) which included a survey about their well, sample bottle, sample instructions, and a pre-paid return mailer. All costs of the kit are paid by the MDA using Clean Water Funds. Homeowners were asked to complete the well survey, fill the sample bottle, and mail the sample to the certified lab in the prepaid mailer. Once the sample was analyzed, the lab sent homeowners their results in the mail. Table 3 presents the responses received from the homeowners.

Table 3. Township Households, Sample Kit Distribution and Return Rate.

Community	Estimated Number of Households on Private Wells*	Approximate Number of Test Kits Sent	Water Samples returned to Lab (not including QA or extra kit requests)	Return Rate
Cottage Grove	800	780	300	38%
Denmark Township	625	567	226	43%
Total	1425	1347	526	39%

* Estimate provided by Washington County.

RESULTS

Homeowners returned 526 water samples for analysis across the two communities (Figure 6). On average, 39 percent of households responded to the free nitrate test offered by the MDA (Table 3). The results of the township nitrate sampling are displayed in Figure 6.

The summary statistics for all well construction types *except* known hand dug wells are shown in Table 4. Hand dug wells are often very shallow, typically just intercepting the water table, and therefore are much more sensitive to local surface runoff contamination (feedlot runoff), point source pollution (septic system effluent), or chemical spills. The following paragraphs provide a brief discussion of the statistics presented in Table 4, which does *not* include hand dug wells.

The minimum values of nitrate-N for each community were less than the detection limit, which is 0.03 mg/L. The maximum values ranged from 20.9 to 34.1 mg/L, with Cottage Grove having the highest result. The 90th percentiles range from 11.8 to 15.8 mg/L, with Cottage Grove having the higher 90th percentile. The mean nitrate-N values found were 3.8 to 6.0 mg/L for Denmark Township and Cottage Grove, respectively. Results from the sampling revealed that in Denmark Township and Cottage Grove 10 percent or more of the wells were over 10 mg/L nitrate-N. These results contrast findings from a 2010 USGS report on nitrate concentrations in private wells in the glacial aquifer systems across the upper United States in which less than five percent of sampled private wells had nitrate concentrations greater than 10 mg/L (Warner and Arnold, 2010).

The data collected in the TTP are similar to the historical results from the Washington County well water program. This program has a database that contains historical sampling results from over 14,000 well samples collected by Washington County from 1978 to 2013. These results show the mean nitrate-N level in Washington County is 2.05 mg/L. The historical database results also show that the southern communities had higher groundwater nitrates than other parts of Washington County (PHE, 2014).

Table 5 shows township results compared with percent of the area in row crop production and in vulnerable geology.

Washington County Township Testing Results 2014

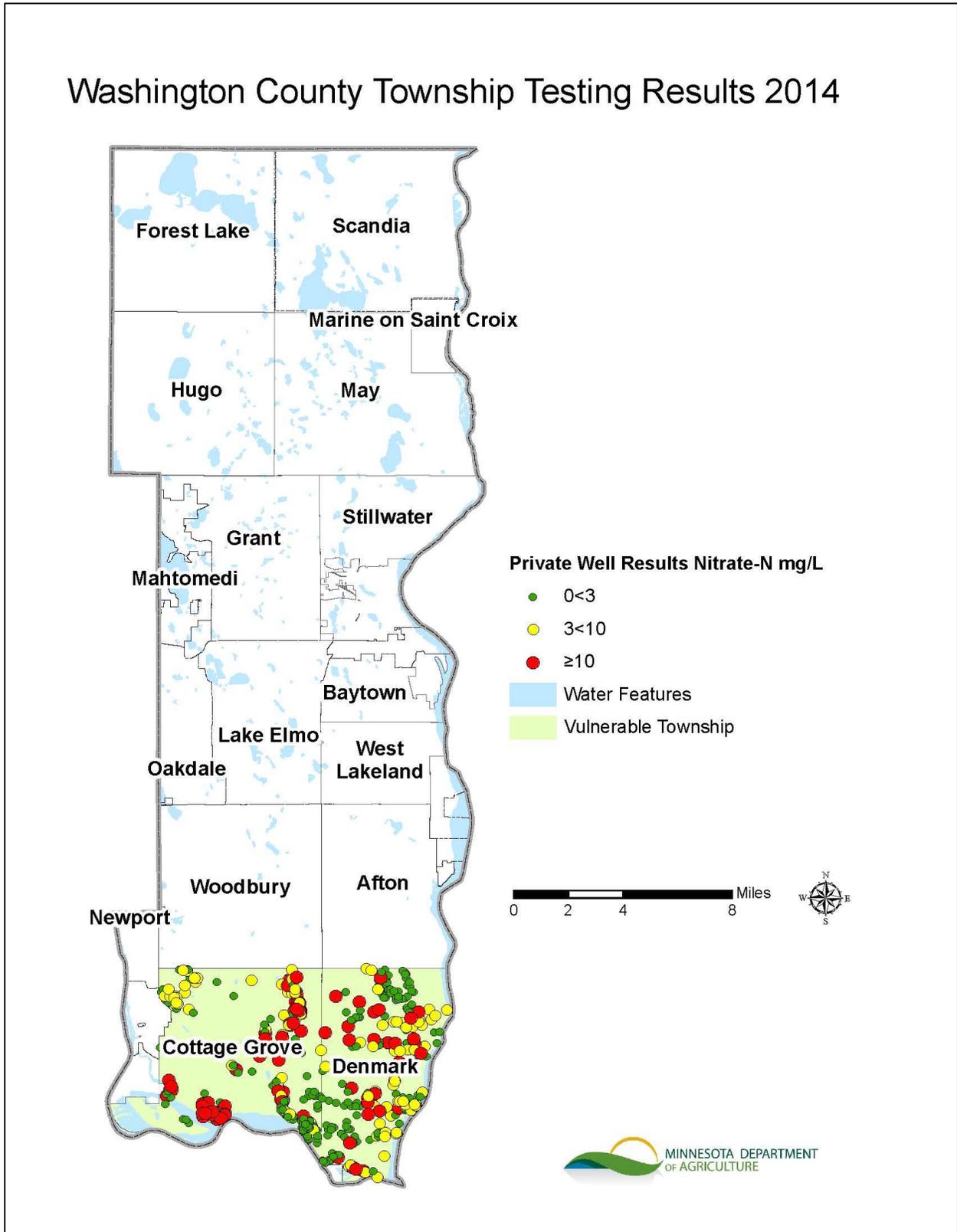


Figure 6. Washington County Private Well Township Sampling Results 2014.

Table 4. Washington County Township Sampling Summary Statistics, Does Not Include Known Hand Dug Wells.

Community	Wells	Values				Percentiles				Number of Wells				Percentiles			
		Min	Max	Mean	Median	75th	90th	95th	99th	<3	3<10	≥7	≥10	<3	3<10	≥7	≥10
		Nitrate-N mg/L or parts per million (ppm)															
Cottage Grove	300	<DL	34.1	6.0	4.3	11.0	15.8	17.8	22.9	137	78	111	85	46%	26%	37%	28%
Denmark Township	226	<DL	20.9	3.8	0.2	6.6	11.8	14.0	17.2	133	62	53	31	59%	27%	23%	14%
Total	526	<DL	34.1	5.0	2.7	9.3	14.2	16.6	21.2	270	140	164	116	51%	27%	31%	22%

< DL stands for less than a detectable limit. The DL is less than 0.03 mg/L. The 75th percentile (90th, 95th, and 99th) is the value below which 75 percent (90%, 95%, and 99%) of the observed values fall.

Table 5. Township Nitrate Results Summary Related to Vulnerable Groundwater and Row Crop Production.

Community	Total Wells	Percent of Land in Row Crop Production	Percent of Land in Vulnerable Geology	Percent of Wells Nitrate-N \geq 10 mg/L	90th Percentile mg/L
Cottage Grove	300	27%	36%	29%	15.8
Denmark Township	226	47%	23%	13%	11.8
Total	526	37%*	30%*	21%*	14.2

* Represents an average

WELL SETTING AND CONSTRUCTION

WELL OWNER SURVEY

The well owner survey, sent out with the sampling kit, requested additional information about private wells that were to be sampled. The survey included questions about the well construction, depth and age, and nearby land use. A blank survey can be found in Appendix A. It is important to note that well information was provided by the well owners and may be approximate or potentially erroneous. The following section is a summary of information gathered from the well owner survey (complete well survey results are located in Appendix B at the end of this document, Tables 7-21).

The majority of wells in each township were identified by the homeowner as “rural” property. Approximately 82 percent of sampled wells are drilled construction and two percent are sand point wells. There were no hand dug wells sampled.

Sand point (drive-point) wells are typically completed at shallower depths than drilled wells. Sand point wells are also usually installed in areas where sand is the dominant geologic material and where there are no thick confining units such as clay. This makes sand point wells more vulnerable to contamination from the surface.

Most of the sampled wells are greater than 100 feet deep, with the majority between 100 and 299 feet below ground surface.

POTENTIAL NITRATE SOURCE DISTANCES

The following response summary relates to isolation distances of potential point sources of nitrate that may contaminate wells. This information was obtained from the well surveys completed by the homeowner.

- On average, farming takes place on twelve percent of the properties.
- Agricultural fields are greater than 300 feet from wells at 64 percent of the properties.
- Only two percent of the well owners across the communities responded that they have livestock (greater than ten head of cattle or other equivalent) on their property.
- Most wells (75 percent) are more than 300 feet from an active or inactive feedlot.
- Very few well owners (less than one percent) store more than 500 pounds of fertilizer on their property.
- A small minority of wells (six percent) are less than 50 feet away from septic systems.

WELL LOGS

In some cases, well owners were able to provide Unique Well Identification Numbers (Unique ID) for their wells. When the correct Unique IDs are provided, a well log can be used to obtain well construction information and to identify the aquifer that the well withdraws water from. In this study, 85 wells were identified in the CWI and the well logs were obtained (Table 6). This represents 16% of the sampled wells in this township testing.

According to the well logs, the most commonly utilized aquifers were from the Paleozoic aquifers. This reflects the overall findings for all documented wells in the focus area (Table 2). Only one of the documented wells was in the Quaternary water table aquifer.

Table 6. Nitrate Concentration within Sampled Groundwater Aquifers.

Aquifer	Total Wells	Ave Depth** (Feet)	Number			Percent		
			<3	3<10	≥10	<3	3<10	≥10
			Nitrate-N mg/L					
Quaternary Water Table	1	157	1	0	0	100%	0%	0%
Paleozoic	84	258	66	13	5	79%	15%	6%
Total	85	257*	67	13	5	79%*	15%*	6%*

* Represents a weighted average value.

** The depths were obtained from well logs in the CWI database.

SUMMARY

The City of Cottage Grove and Denmark Township were chosen for sampling based on the following criteria: local expertise from Washington County and Washington Conservation District, past high nitrate results, vulnerable groundwater, and row crop production.

Samples were collected from private wells using homeowner collection and mail-in methods. Samples were collected from 526 wells in these two communities representing a 39 percent response rate from homeowners.

According to the well logs and CWI, the most commonly utilized aquifers were from the Paleozoic aquifers. Specifically, the Prairie Du Chien-Jordon Aquifer is the main source of groundwater.

Results showed that across the two communities, 22 percent of private wells sampled were above the health standard of 10 mg/L for nitrate as nitrogen (nitrate-N). In Cottage Grove, 28 percent were above 10 mg/L, and in Denmark 14 percent of the private wells tested were above the 10 mg/L standard for nitrate-N.

FUTURE WORK

Well owners with detectable nitrate results from this township testing were offered a free pesticide sample and a follow-up nitrate sample taken by MDA staff. At the time of this resampling, a well site visit is performed (when possible) in order to rule out well construction issues and likely point sources of nitrate. In preparation for the well site visits, every effort is made to obtain well log information so that nitrate results and the aquifer designation can be compared in a more comprehensive fashion. Washington Conservation District offers to meet with homeowners to discuss potential well construction issues and possible nitrogen point sources on the homeowner property. This work will be discussed further in a follow-up report in 2016.

The testing conducted in Washington County will be used to guide future work as the MDA plans to offer nitrate tests to approximately 70,000 private well owners (within 250-350 townships) between 2014 and 2019. As of spring 2015, 60 townships in eight counties have been completed.

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APPENDIX A: PRIVATE WELL SURVEY QUESTIONS

Private Well Survey Questions

1. What setting did the water sample come from? Please choose only one.
Answers choices: Sub-division, Lake Home, River Home, Country, Municipal/city, or Other.
2. Are there livestock on this property? Yes or No
3. Do you mix or store fertilizer (500lbs or more) on this property? Yes or No
4. Does farming take place on this property? Yes or No

Well Information Section

5. Does your well have a Unique Well ID number? Yes or No
6. If yes, what is the Unique ID?
(6 digit number found on a metal tag attached to your well casing)
7. Type of well construction?
Answer choices: Drilled, Sand point, Hand dug, Other, Other, and don't know.
8. Approximate age (years) of your well?
Answer choices: 0-10 years, 11-20 years, 21-40 years, and over 40 years old.
9. Approximate depth of your well
Answer choices: 0-50 feet, 51-99 feet, 100-299 feet, and 300 or more feet.
10. Distance to an active or inactive feedlot
Answer choices: 0-50 feet, 51-99 feet, 100-299 feet, and 300 or more feet.
11. Distance to a septic system
Answer choices: 0-50 feet, 51-99 feet, 100-299 feet, and 300 or more feet.
12. Distance to an agricultural field
Answer choices: 0-50 feet, 51-99 feet, 100-299 feet, and 300 or more feet.
13. Is this well currently used for human consumption? Yes or no
14. Please check any water treatment you have other than a water softener.
Answer choices: None, Reverse osmosis, distillation, filtering system and other.
15. When did you last have your well tested for nitrates?
Answer choices: Never, with the last year, within the last 3 years, the last 10, or 10 or more.
16. What was the result of your last nitrate test?
Answer choices: 0<3, 3<10, 10 or greater, or don't know.

APPENDIX B: PRIVATE WELL SURVEY ANSWERS

Table 7. Property Setting for Well Location

Property Setting			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Setting	Percent		
Country	48.0%	74.9%	59.1%
Lake	0.0%	0.9%	0.4%
River	11.3%	7.5%	9.7%
Sub-division	27.3%	9.7%	19.8%
Other	6.3%	3.1%	4.9%
Not Available	7.0%	4.9%	6.1%

Table 8. Well Construction Type

Well Construction Type			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Well Type	Percent		
Drilled	79.0%	85.4%	81.7%
Sand Point	2.0%	11.3%	1.7%
Other	1.0%	0.0%	0.6%
Not Available	18.0%	13.3%	16.0%

Table 9. Age of Well

Well Age			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Age	Percent		
0-10 years	4.7%	12.8%	8.2%
11-20 years	18.0%	23.9%	20.5%
21-40 years	51.0%	37.2%	45.1%
Over 40 years	21.3%	19.5%	20.5%
Not available	5.0%	6.6%	5.7%

Table 10. Depth of Well

Well Depth			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Depth	Percent		
0-50 feet	1.0%	0.9%	1.0%
51-99 feet	5.7%	4.4%	5.1%
100-299 feet	56.7%	47.3%	52.7%
Over 300 feet	19.0%	28.3%	23.0%
Not available	17.7%	19.0%	18.3%

Table 11. Unique Well ID Known

Does the Well Have a Unique ID			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Unique ID	Percent		
No	22.0%	20.4%	21.3%
Yes	15.7%	18.8%	18.8%
Not Available	63.3%	55.4%	59.9%

Table 12. Livestock Located on Property

Livestock on Property			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Livestock	Percent		
No	93.0%	92.9%	93.0%
Yes	1.7%	2.7%	2.1%
Not Available	5.3%	4.4%	4.9%

Table 13. Fertilizer Stored on Property

Fertilizer Stored on the Property			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Fertilizer	Percent		
No	95.0%	94.7%	94.9%
Yes	0.0%	0.9%	0.4%
Not Available	5.0%	4.4%	4.8%

Table 14. Farming on Property

Does Farming Take Place on the Property			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Farming	Percent		
No	91.3%	72.6%	83.3%
Yes	3.7%	23.0%	12.0%
Not Available	5.0%	4.4%	4.8%

Table 15. Distance to an Active or Inactive Feedlot

Distance to Feedlot			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Feedlot	Percent		
0-50 feet	3.0%	7.1%	4.8%
51-99 feet	2.3%	2.2%	2.3%
100-299 feet	1.7%	5.8%	3.4%
Over 300 feet	78.0%	69.9%	74.5%
Not available	15.0%	15.0%	15.0%

Table 16. Distance to Septic System

Distance to Septic System			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Septic	Percent		
0-50 feet	7.3%	4.0%	5.9%
51-99 feet	35.0%	23.5%	30.0%
100-299 feet	44.3%	54.9%	48.9%
Over 300 feet	7.7%	9.3%	8.4%
Not available	5.7%	8.4%	6.8%

Table 17. Distance to Agricultural Field

Distance to Agriculture Field			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Distance to Field	Percent		
0-50 feet	1.3%	6.2%	3.4%
51-99 feet	4.7%	6.6%	5.5%
100-299 feet	16.3%	25.7%	20.3%
Over 300 feet	72.0%	53.5%	64.1%
Not available	5.7%	8.0%	6.7%

Table 18. Drinking Water Well

Is the Well Used for Drinking Water			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Drinking Water	Percent		
No	0.7%	4.9%	0.6%
Yes	94.0%	94.7%	94.3%
Not Available	5.3%	4.9%	5.1%

Table 19. Treatment System Present

Treatment System Used for Drinking Water			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Treatment System	Percent		
None	45.3%	48.7%	46.8%
Filtering System	26.7%	22.7%	24.5%
Reverse Osmosis	21.7%	19.0%	20.5%
Distillation	0.0%	0.4%	0.2%
Other	0.7%	0.4%	0.6%
Not Available	5.7%	9.7%	7.4%

Table 20. Last Tested for Nitrate

When was the Well Last Tested for Nitrate			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Last Tested	Percent		
Within the last year	3.3%	3.5%	3.4%
Within the last 3 years	14.0%	16.4%	15.0%
Within the last 10 years	20.7%	20.8%	20.7%
Greater than 10 years	15.3%	17.3%	16.2%
Never Tested	18.3%	18.1%	18.3%
Not Sure	25.0%	19.5%	22.6%
Not Available	3.3%	4.4%	3.8%

Table 21. Last Nitrate Test Result

What was the Last Nitrate Result			
Community	Cottage Grove	Denmark Township	Total
Total Wells	300	226	526
Last Nitrate-N Result	Percent		
<3 mg/L	9.0%	13.7%	11.0%
3<10 mg/L	9.0%	9.3%	9.1%
≥10 mg/L	4.7%	3.1%	4.0%
Not Available	77.3%	73.9%	75.9%