Use of a Triazine Immunoassay Method in a Volunteer Drinking Water Monitoring Network in Southeast Minnesota to Screen for Atrazine Compounds

MINNESOTA DEPARTMENT OF AGRICULTURE
PESTICIDE AND FERTILIZER MANAGEMENT

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Abstract

In the spring of 2009, the Minnesota Department of Agriculture (MDA) conducted triazine immunoassay analyses for water samples collected from a pre-existing network of volunteered, private drinking water wells in Minnesota's southeastern karst region to screen for atrazine. Previous work indicated that wells with high nitrate-nitrogen concentrations had a higher likelihood of pesticide contamination. Therefore available wells in the network with high nitrate levels were selected for sampling and the results should be viewed as representative of vulnerable wells rather than all wells in southeast Minnesota. All samples were collected by the well owner and MDA provided the immunoassay analysis at no charge to the well owner. Ninety-two of the 100 sample kits mailed out were returned for analysis. Of the 92 samples, 44 had detectable levels of triazine compounds that were assumed to be atrazine compounds. The median triazine concentration across the region was <0.05 ug/L, the 90th percentile was 0.22 ug/L, and the maximum was 1.26 ug/L. All 92 samples results were below the currently applicable Minnesota Department of Health (MDH) drinking water standard of 3 ug/L for atrazine. The results were analyzed in conjunction with additional information on nitrate-nitrogen concentration in the well, well installation date, and the presence, or lack, of an overlaying confining layer.

Introduction

In 1987 Minnesota Legislature amended the Minnesota Pesticide Control Law (Chapter 18B of Minnesota State Statutes). Minnesota Statute 18B.04 requires: "*The commissioner shall:*

- *Determine the impact of pesticides on the environment, including the impacts on surface water and groundwater in this state;*
- *Develop best management practices involving pesticide distribution, storage, handling, use, and disposal; and*
- *Cooperate with and assist other state agencies and local governments to protect public health and the environment from harmful exposure to pesticides*."

In response to this charge the MDA initiated a groundwater monitoring program in 1987. In 1989 the Minnesota Comprehensive Groundwater Protection Act expanded groundwater protection responsibilities of the MDA, including specific direction regarding monitoring for agricultural chemicals and the management of those chemicals when found to impact groundwater. Through 2009, MDA maintains 155 groundwater monitoring locations. These locations include monitoring wells, often nested in 2 or more wells, and springs.

The most frequently found triazine pesticide in Minnesota groundwater is atrazine, a corn herbicide, and its breakdown products. This study targeted only atrazine compounds using a low-cost triazine immunoassay method. The triazine immunoassay method is active to a class of triazine compounds, not just atrazine, however, atrazine and its breakdown products are the only triazine compounds detected by the triazine immunoassay method that are commonly found in Minnesota groundwater. Knowing

this, the concentration returned from the laboratory was assumed to be atrazine compounds only. See “Laboratory Method” for more information.

Atrazine has a Maximum Contaminant Level (MCL) of 3 micrograms per liter (ug/L). An MCL is defined as the maximum permissible level of a contaminant in water that is delivered to any user of a public water system under the Federal Safe Drinking Water Act. The Minnesota Department of Health (MDH) has currently adopted this MCL in its evaluations of health risk from atrazine in private drinking water supplies. Additionally, MDH includes atrazine break down products in its evaluations. In this report, the drinking water standard for atrazine and its break down products will be referred to as the “currently applicable standard of 3 ug/L for atrazine”.

The following results are not suitable for detailed extrapolation across the region or aquifers or for use in current trend analysis. The results are not considered representative of all wells across southeast Minnesota. The sampling targeted available wells with elevated nitrate-nitrogen which previous work indicated to have a higher likelihood of having pesticide contamination. However, the results are a measure of atrazine concentration in each specific well at the distinct collection time. The intent of this screen was to take a low-cost snapshot of groundwater conditions using a pre-existing monitoring network. The following results should not be used for any other purpose.

Background

MDA groundwater monitoring is focused on the most susceptible areas of the state. The karst bedrock region of southeast Minnesota is one such area. Figure 1, below, shows a region-wide assessment of the groundwater contamination susceptibility in southeastern Minnesota.

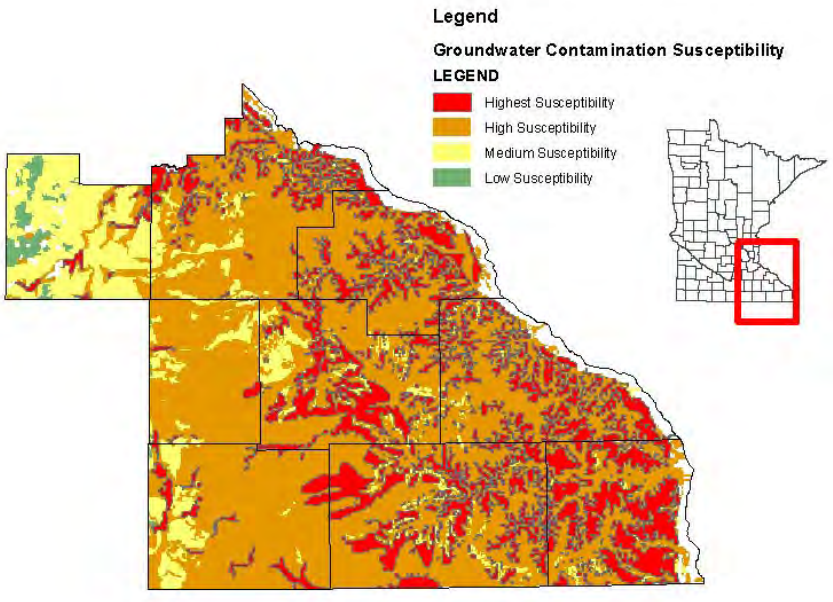

Figure 1. Assessment of groundwater contamination susceptibility levels across the project area.

The karst bedrock region provides a unique monitoring challenge. Monitoring wells are extremely expensive to drill and maintain in karst areas and many existing drinking water wells are completed in deep, confined aquifers. Aquifers that are the most susceptible to pesticides in this region typically contain older wells with inaccurate or missing well logs, do not have an overlaying confining unit, and/or have open drill holes through multiple aquifers. Due to these issues, a region-wide approach to monitoring naturally occurring, perennial springs was implemented by the MDA in 2006. Some of these springs exhibit strong sinkhole connections and have periods of increased flow directly connected to sinkholes that have elevated cloudiness. These periods may not be representative of regional groundwater conditions. Sampling domestic wells completed in the upper carbonate formations (Galena, Dubuque, Wapsipinicon, and Cedar Valley) could serve as a measure of comparison against the sampled springs, providing potential validation for using springs as a representation of broader groundwater sampling locations in an area susceptible to groundwater contamination.

In 2006, MDA released a report titled, "Analysis of the Co-occurrence of Nitrate-Nitrogen and Pesticides in Minnesota Groundwater". This paper highlighted the use of relatively inexpensive nitrate-nitrogen data as a medium to discuss the probability of detecting pesticides in a particular well. The paper was not meant to serve as a predictor of pesticide concentration; but, it was meant as a starting point to link relatively inexpensive nitrate-nitrogen data to the presence of pesticides for guiding additional pesticide analytical efforts. The paper grouped wells into four categories and examined the co-occurrence of nitrate-nitrogen and all pesticides in karst wells. The four categories of nitrate concentrations were:

- Non-detect;
- 0.1 to 3 milligrams per liter (mg/L);
- 3 to 10 mg/L; and
- Greater than 10 mg/L.

Using this grouping allowed for nitrate values to be classified as background, background to elevated, elevated, and highly elevated (above the currently applicable standard of 10 mg/L for nitrate-nitrogen).

The Southeast Minnesota Water Resources Board was awarded a 319 Demonstration Grant to develop a cost-effective, locally driven, and sustainable means of obtaining long-term trend data for nitrate-nitrogen occurrence in private drinking water supplies. Four nitrate-nitrogen sampling rounds occurred in 2008 and 2009. The project covered nine counties in southeast Minnesota. Through a grid selection process, each county had roughly 50 to 100 volunteer well owners that cooperated with the project. Further, each county had a "Well Network Coordinator" that managed the sampling in their county. Well owners, and project leaders, were concerned about groundwater quality and sought out additional analytes that utilized the network.

Purpose

In an effort to further expand monitoring capabilities in southeast Minnesota, atrazine immunoassay sampling was completed in the spring of 2009. The atrazine immunoassay study was developed for the sensitive karst region in southeast Minnesota using the co-occurrence methodology and established using the nitrate study volunteer participants. Atrazine was selected as the analyte of interest based on previous monitoring results. Due to capacity constraints at the MDA laboratory, coupled with the high cost of the routine pesticide gas chromatography/mass spectrometry (GCMS) analysis, a relatively inexpensive immunoassay screening for atrazine was contracted with an outside laboratory.

The atrazine immunoassay pilot project provided the following benefits:

- Examination of the immunoassay methodology as a screening tool for specific compounds;
- Validation of the atrazine immunoassay sampling and methodology with results for samples collected from regional springs that were analyzed with a different laboratory method;
- Continuation of nitrate-nitrogen and pesticide co-occurrence analysis; and
- Provide data that may be helpful for homeowners in the region to use when considering future testing of private drinking water wells;

Well Selection

Wells were selected for the atrazine immunoassay study from the list of well owners involved in the nitrate-nitrogen water quality study that were interested in having their well tested for atrazine. Using this group of wells allowed for the use of information already collected and allowed access to a coordinator from each county. This coordinator was able to serve as a liaison between the nitrate-nitrogen study participants and the MDA.

MDA had the following goals for the well selection process:

- Extend eligibility to everyone in the nitrate-nitrogen study that was interested in having their well water analyzed for atrazine compounds;
- Exclude uninterested well owners who would simply receive sample collection kits and discard them; and
- Develop a selection methodology that allowed for more samples to be collected from wells with elevated nitrate levels in the water, thereby targeting the areas of greatest concern.

The following steps were implemented to streamline the selection procedure:

1. MDA prepared and distributed a short letter in all nitrate-nitrogen sampling kits that was sent to the volunteers. If interested, the well owner printed their name on the letter and returned it with the nitrate-nitrogen sample to the county. Each county coordinator was responsible for their volunteers' letters.

2. Each county collected the returned letters and developed a list of interested well owners. The county forwarded these to MDA.
3. MDA entered the information into a region-wide dataset. Wells were grouped according to the method used in the 2006 MDA report, "Analysis of the Co-occurrence of Nitrate-Nitrogen and Pesticides in Minnesota Groundwater".
4. MDA selected 100 well owners to be included in the study, including all available wells with nitrate-nitrogen concentrations above background levels (> 3 mg/L).
5. Atrazine sampling kits were created and sent directly to the well owners.
6. The well owner sampled their well and returned the sample in the mail.
7. Upon receiving the returned sample, MDA sent the sample to the contract laboratory for analysis.

The interest level among well owners was expected to be at least 50% of the volunteers (675 total) in the nitrate-nitrogen study. This level of interest was not observed for several reasons. From discussions with the county staff, four primary reasons were identified:

- Many of the volunteers were not continuing to sample their well since this was the third round of samples for the nitrate-nitrogen study and there was declining interest for additional samples;
- Many of the selected wells were on summer vacation properties and the sampling period occurred in February;
- Many of the volunteers lost interest when their well was tested and had water with low or consistent levels of nitrate-nitrogen; and
- Many of the volunteers that had well water with elevated nitrate-nitrogen results, or above the currently applicable standard of 10 mg/L for nitrate-nitrogen did not continue to be active in the study.

Eventually MDA received 218 (32.3%) of the 675 interest letters back. Table 1, below, shows the interest letter return rate by county. It became apparent that in order to target the areas with the greatest susceptibility and target the wells most at risk, a heavy focus was going to have to be used on wells with elevated nitrates. To be most protective of human health, all eligible wells that had water concentrations for nitrate-nitrogen above 3 mg/L were automatically selected (78 total). Five wells were selected from the list of wells with non-detectable water concentrations for nitrate-nitrogen, and 17 wells, having water concentrations for nitrate-nitrogen between 0.1 to 3 mg/L, were selected randomly from all eligible wells. Table 1 also shows the nitrate-nitrogen results among the selected wells.

Table 1. Interest letter return statistics and nitrate-nitrogen results among selected wells.

						Nitrate-nitrogen Results Among Selected Wells			
County	Total Volunteers in Nitrate-Nitrogen Study	Atrazine Screen Interest Letter Returned	% of Volunteers Who Returned Letter	Number of Wells Selected	% of Selected Wells Among Interested	Non-detect	0.1 - 3 mg/L	3 - 10 mg/L	> 10 mg/L
Dodge	56	21	38%	5	24%	2	3	0	0
Fillmore	96	39	41%	19	49%	0	1	13	5
Goodhue	92	26	28%	12	46%	0	1	8	3
Houston	66	16	24%	8	50%	1	1	4	2
Mower	88	15	17%	7	47%	1	2	4	0
Olmsted	72	17	24%	10	59%	0	2	4	4
Rice	67	27	40%	8	30%	1	5	1	1
Wabasha	64	28	44%	17	61%	0	1	10	6
Winona	74	29	39%	14	48%	0	1	5	8
Total	675	218	32%	100	46%	5	17	49	29

Overall, 32% of all volunteers in the nitrate-nitrogen study showed interest in the atrazine testing. There was interest across all of the counties, and across all ranges of nitrate-nitrogen values. All original volunteers in the nitrate-nitrogen network were considered in these statistics even if they were inactive at the time of the atrazine immunoassay screen.

With a selection protocol that focused on wells with elevated nitrate-nitrogen, counties with more volunteers with wells having elevated nitrate-nitrogen had more wells selected. Between 24% and 61% of the total interested volunteers in each county were selected. Forty-six percent of all volunteers who expressed interest in having their well tested for atrazine had the analysis completed. All wells with elevated nitrate-nitrogen were selected for the triazine immunoassay screen. Many of the wells that were selected were located in the “highest” and “high” areas on the regional groundwater susceptibility map (Figure 1).

Of the 100 sample kits that were mailed out to well owners, 92 were returned to MDA for laboratory submission. The high return percentage can be directly related to selecting only well owners that showed interest by returning a letter expressing their desire for additional testing.

Laboratory Method

The samples were analyzed at a contracted laboratory using triazine immunoassay methodology developed by Strategic Diagnostics, Inc. The method had a level of detection of 0.053 ug/L and a level of quantification of 0.10 ug/L. Values between 0.053 ug/L and 0.10 ug/L were not quantifiable; however, an estimated concentration was reported for those samples with concentration values in that range. These values reported from the laboratory were used in all statistics. Any result that was below 0.053 ug/L were reported from the laboratory as <0.05 ug/L. To limit confusion and unnecessary concern of well owners, MDA reported this value as "non-detect" to the well owners in a follow up letter.

The method does not differentiate between atrazine and closely related compounds, including atrazine breakdown products, but quantifies them at a percentage less than the actual concentration for all compounds except atrazine. Table 2 shows the triazine compounds that have been sold in Minnesota since 2000 for crop applications, and are reported with the associated immunoassay method lower limit of detection (LDD). The MDA tracks pesticides sold in Minnesota. Only three parent triazine compounds are reactive to the triazine immunoassay method were sold in Minnesota since 2000 and atrazine accounts for 99.3% of the total pounds of active ingredient between those three compounds. Simazine accounts for less than 0.01% of the total pounds of active ingredients, and is over 50 times less reactive to the triazine immunoassay test than atrazine. Prometon had 9323 pounds sold in Minnesota since 2000. The triazine immunoassay method reports a concentration that can be assumed to be atrazine and atrazine breakdown products.

Additional information regarding pesticide testing methods can be viewed at http://www.mda.state.mn.us/licensing/watertesting/testinfo.htm

Table 2. EnviroGard Triazine Test Cross-Reacting Compounds, Lower Limits of Detections (LDD), and Amount of Pesticide Sold in Minnesota since 2000.

Compound	Lower Limit of Detection (LDD) (ug/L)	Amount of Pesticide Sold in Minnesota Since 2000 (pounds)
Atrazine	0.053	18,132,607
Deethyl Atrazine	0.017	Breakdown of atrazine
Deisopropyl Atrazine	2.31	Breakdown of atrazine
2-Hydroxy Atrazine	0.120	Breakdown of atrazine
Simazine	3.17	122,700
Prometon	0.044	9,323

Results

Table 3 below displays summary statistics for the atrazine immunoassay analysis. It should be noted that because well selection focused on wells with a high likelihood of detecting a pesticide the following results are not suitable for detailed extrapolation across aquifers or for use in trend analysis; however, the results are a measure of atrazine concentration in each specific well at the distinct time of collection. The intent of the atrazine immunoassay analysis was to take a low-cost snapshot of groundwater conditions using a pre-existing monitoring network. The following results should not be used for any other purpose.

Table 3. Summary statistics for the atrazine immunoassay analysis.

County	Samples	Mean (ug/L)	Minimum (ug/L)	25th Percentile (ug/L)	Median (ug/L)	75th Percentile (ug/L)	90th Percentile (ug/L)	Maximum (ug/L)
Dodge	4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fillmore	17	0.09	<0.05	<0.05	0.06	0.10	0.12	0.53
Goodhue	12	0.06	<0.05	<0.05	<0.05	0.11	0.16	0.25
Houston	7	0.24	<0.05	<0.05	0.11	0.17	0.17	1.26
Mower	6	0.05	<0.05	<0.05	<0.05	<0.05	0.30	0.30
Olmsted	9	0.07	<0.05	<0.05	0.07	0.12	0.15	0.15
Rice	8	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.07
Wabasha	16	0.15	<0.05	<0.05	0.12	0.20	0.47	0.68
Winona	13	0.08	<0.05	<0.05	0.06	0.16	0.21	0.24
All Samples	*92*	*0.09*	*<0.05*	*<0.05*	*<0.05*	0.12	0.22	*1.26*

From review of the results, there were variations between each county. Counties that have limited karst features and deeper, heavier soils had lower percentile values than counties with many areas of active karst features and shallow soils. Of the 92 samples that were returned to MDA from well owners and submitted for analysis, no samples exceeded the currently applicable standard of 3.00 ug/L for atrazine. For the nine county region, the 90th percentile was 0.22 ug/L, which is less than 10% of the currently applicable standard of 3.00 ug/L for atrazine. Atrazine was detected in 44 of 92 samples, with 32 samples having quantifiable concentrations (> 0.10 ug/L). Five samples exceeded levels above 10% of the MCL and one sample was above 1.00 ug/L.

In order to validate the atrazine immunoassay methodology, and to provide additional information to the well owner, the study design provided for samples that had a concentration above 1.00 ug/L to be retested utilizing gas chromatography/mass spectrophometry (GCMS). This sample was to be collected by MDA staff and submitted to MDA laboratory as a check sample. This process would ensure the original sample was not contaminated during collection and that the method was only detecting atrazine for the well that exceeded 1.00 ug/L. Unfortunately the well owner did not extend permission for MDA to resample this location. Thus, no additional check samples were collected from the wells.

A validation component was incorporated into the atrazine immunoassay study by utilizing the remaining contracted amount for laboratory sample analysis. Since eight out of 100 kits were not returned to MDA for analysis, eight samples were collected as replicate samples from springs across southeastern Minnesota. The spring samples were analyzed with the complete MDA base neutral gas chromatography/mass spectrometry (GCMS) method and the atrazine immunoassay method. The GCMS method allows for detection of 26 pesticide compounds including atrazine, deethylatrazine, and deisopropylatrazine, among others. The immunoassay method reports a single result that is assumed to be a cumulative concentration value for atrazine compounds. The GCMS method results can be compared to the immunoassay results by combining the results for atrazine, deethylatrazine, and deisopropylatrazine. Table 4 below shows results from the replicate samples for compounds that have reactivity to the immunoassay method. The only other two detected parent compounds in the samples collected from springs were acetochlor and metolachor. Neither of these compounds reacts with the triazine immunoassay method, and the concentrations were not considered in this analysis.

Atrazine also breaks down into diaminochlorotriazine (DACT). This breakdown product provides an analytical challenge, and the current GC/MS laboratory method does not include DACT as a target analyte. DACT is not a reactive compound for the triazine immunoassay method. MDA has implemented additional DACT monitoring using an immunoassay method that is specific to DACT alone. DACT samples were collected at the springs and are included in the table.

Table 4. Laboratory results of atrazine compounds from GC/MS and immunoassay methodologies.

	MDA GCMS Base Neutral Method Results (ug/L)				**Triazine Immunoassay Method Results (ug/L)**	**DACT Method Results (ug/L)**
Spring Name	Atrazine	Deethyl-atrazine	Deisopropyl-atrazine	Total Atrazine	Atrazine Compounds	DACT
BCVSP Big	0.09	0.09	ND	0.18	0.10	0.11
Burr Oak	P	0.07	P	0.07 + P +P	0.08	0.27
Canfield	0.10	0.19	ND	0.19	0.13	0.20
Cold South	0.07	0.10	ND	0.17	0.11	0.19
Fountain East	P	P	ND	P + P	ND	ND
Fountain West	0.06	0.05	ND	0.11	0.10	0.13
Moth	P	0.05	ND	0.05 + P	0.06	0.11
Rainy	P	0.06	P	0.06 + P	0.06	0.27

- "ND" represents non-detectable at method reporting limit
- "P" represents compound detected, but not at quantifiable levels (GCMS only)

The immunoassay and base GCMS methods had comparable results for the springs; however, spring sample concentrations were all low compared to some of the immunoassay results from the drinking water wells. All samples collected through the volunteer network were from drinking water sources and did not require filtering during laboratory analysis. The samples from the springs had elevated cloudiness, and may have required filtering at the laboratory. Replicate samples from the entire population of immunoassay samples collected from the private wells would have been preferred in this type of validation, but this was within the scope of the project. The small data set and limited range of detected concentrations should be considered when trying to validate a method.

Other Findings Using the Atrazine Immunoassay Results

Co-occurrence with Nitrate-Nitrogen

The availability of data from the nitrate-nitrogen volunteer network study allows for comparison between the presence of atrazine and nitrate-nitrogen levels. Nitrate-nitrogen should not be used as a predictor of atrazine concentration, but rather as a means to suggest an increased likelihood that atrazine compounds are present. The data was analyzed region-wide for this comparison.

A distinct line can be seen when the atrazine results were paired with their nitrate-nitrogen value. Well water that did not have detectable amounts of nitrate-nitrogen and levels considered to be background (0.1 to 3 mg/L) had no detections of atrazine compounds. Fifty six percent of the wells with nitrate-nitrogen concentrations of 3 to 10 mg/L in well water had detectable amounts of atrazine. Seventy percent of the wells with nitrate-nitrogen concentrations above the currently applicable standard of 10 mg/L for nitrate-nitrogen in well water had some amount of detectable atrazine. Table 5 below shows summary statistics for the co-occurrence analysis.

Table 5. Summary statistics for co-occurrence of nitrate-nitrogen and atrazine presence.

Nitrate Result (mg/L)	Total Wells Sampled	Wells with Atrazine Detection	Percent of Wells with Atrazine Detected	Atrazine Minimum (ug/L)	Atrazine Median (ug/L)	Atrazine Maximum (ug/L)
ND	4	0	0%	ND	ND	ND
0.1 to 3	16	0	0%	ND	ND	ND
3 to 10	45	25	56%	ND	0.06	0.68
Over 10	27	19	70%	ND	0.08	1.26

The above results indicate that wells with water having nitrate-nitrogen concentrations above background levels (> 3 mg/L) have a much higher likelihood of containing atrazine. These results corroborate the co-occurrence of nitrate-nitrogen and pesticides study performed by MDA in 2006. Thus, a nitrate-nitrogen test can serve as a starting point to begin further water quality testing considerations. Wells with low nitrate-nitrogen concentrations appear to have a low likelihood of having atrazine present. An estimate of atrazine concentration from a nitrate-nitrogen result is not possible, but wells with water having elevated nitrate-nitrogen concentration levels, or above the currently applicable standard of 10 mg/L for nitrate-nitrogen may warrant further testing for additional compounds. Nitrate-nitrogen analysis is offered by MDA at many county fairs and local events for no cost to the well owner. MDA also maintains a list of commercial laboratories that can analyze private water samples for atrazine on its website.

Examination of Well Information

An advantage of selecting wells that were in the regional nitrate study was that additional information was available about the wells. Many of the wells did not have documented well logs. To gain well information, each county had staff that visited the wells in the nitrate network to verify the well location, identify potential contamination points, and question the well owner about well construction if a well log was not available. Ultimately, two well characteristics were selected for further examination: the date when the well was installed relative to the creation of the Minnesota Well Code and if the well is less vulnerable to contamination due to overlaying confining layers above the well screen.

The Minnesota Department of Health (MDH) promulgated rules in 1974 regarding well construction and management. These rules were intended to improve well construction methods, reduce the risk from contamination, and protect groundwater and human health. Wells constructed prior to the code were installed with only the well drillers' specifications. Table 6 below shows summary statistics for the 92 wells that had an atrazine immunoassay sample collected. The wells were analyzed based on their construction dates relative to promulgation of the well code.

Table 6. Statistics of atrazine concentration relative to well code.

			Atrazine Concentration (ug/L)				
Well Construction	**Number of Wells**	**% Wells with Atrazine Detection**	**Mean**	**Median**	**75th Percentile**	**90th Percentile**	**Maximum**
Pre-code	67	51%	0.09	0.05	0.12	0.23	0.68
Post-code	12	33%	0.06	ND	0.06	0.18	0.28
Unknown	13	46%	0.15	ND	0.15	0.17	1.26

Atrazine concentrations were also examined relative to the geologic protection of the wells through overlaying confining layers. Table 7 below shows well water atrazine concentrations for the wells with and without geologic protection.

Table 7. Statistics of atrazine concentration relative to overlaying confining layers

			Atrazine Concentration (ug/L)				
Overlaying Confining Layer Above Well Screen	**Number of Wells**	**% Wells with Atrazine Detection**	**Mean**	**Median**	**75th Percentile**	**90th Percentile**	**Maximum**
No	58	50%	0.09	ND	0.14	0.26	0.68
Yes	21	43%	0.05	ND	0.10	0.12	0.24
Unknown	13	46%	0.15	ND	0.15	0.17	1.26

The atrazine concentration in a water sample cannot be predicted by knowing when a particular well was drilled or if there is this an overlaying confining unit, but the likelihood of detecting atrazine in any well water is increased for older, pre-code wells and for wells that do not have overlaying geologic confining layers. As anticipated, newer, deeper wells had fewer detections in well water; however, atrazine was still found in 33 percent of well water for wells drilled post code. The highest concentration observed in the pilot project was from a well that did not have a known installation date, or geologic setting. Wells that do not have a known well installation date or unknown geologic conditions may also have little protection.

Conclusions

The use of a triazine immunoassay method in a volunteer drinking water monitoring network to screen for atrazine compounds provided a low-cost snapshot of atrazine contamination in vulnerable wells across southeast Minnesota. MDA does not intend to replace historical monitoring activities or laboratory methods with the immunoassay method, but realizes the potential to incorporate the use of immunoassay methods in areas that are known to be vulnerable from a specific compound. The study provided information for well owners to review when considering pesticide analysis of their well water.

The study provided the following results:

- All available wells with elevated (> 3 mg/L) nitrate-nitrogen concentrations were selected (78 out of 100 total wells) for atrazine immunoassay analysis
- 72 of 92 wells that submitted samples for atrazine immunoassay analysis had elevated (> 3 mg/L) nitrate-nitrogen concentrations
- 44 of 92 wells had detectable levels of atrazine, while 32 of 92 had atrazine concentrations above 0.10 ug/L
- 0 of 92 wells had atrazine levels above the currently applicable standard of 3 ug/L for atrazine and atrazine breakdown products
- 1 of 92 wells had atrazine levels above 1 ug/L
- The 90th percentile atrazine concentration for the region was 0.22 ug/L
- Wells that have elevated nitrate-nitrogen concentrations (> 3 mg/L) have a higher likelihood of having atrazine compounds present

- Wells installed prior to the MDH well code (1974) have a higher likelihood of having atrazine compounds present
- Wells that do not have an overlaying confining unit have a higher likelihood of having atrazine compounds present
- Atrazine compounds were detected in wells that were installed after the MDH well code (1974) and in wells with an overlaying confining layer
- Wells with unknown installation date and unknown geologic conditions may not have protection from surface activities, including pesticide applications.

Additional information for homeowners regarding testing their private wells for pesticides including laboratory contact information and approximate costs is available at **http://www.mda.state.mn.us/licensing/watertesting/pesticides.htm**

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