2012 Nebraska Groundwater Quality Monitoring Report

Prepared Pursuant
to Neb. Rev. Stat. §46-1304
(LB329 – 2001)

Nebraska Department of Environmental Quality
Water Quality Assessment Section
Groundwater Unit

December 2012

Photo on front cover:

The photo on the front cover shows the impact that drought can have on Nebraska's agriculture, especially where groundwater is not abundant.

Acknowledgements:

This report would not be possible without the cooperation of the agencies and organizations contributing groundwater data to the "Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater", most notably the State's 23 Natural Resources Districts. The University of Nebraska must be thanked for their on-going work on the Database and attention to detail in assessing the quality of data presented for inclusion. The staff of the Nebraska Association of Resources Districts, notably Pat O'Brien, was invaluable providing text and map graphics assistance. Thanks to Marty Link and Ryan Chapman, NDEQ, for most of the maps and data analysis for this report, while Marty Link and Tom Lamberson, NDEQ helped with editing. Direct any questions regarding this report to David Miesbach, Groundwater Unit, NDEQ, at (402) 471-4982.

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Introduction

The 2001 Nebraska Legislature passed LB329 (Neb. Rev. Stat. §46-1304) which, in part, directed the Nebraska Department of Environmental Quality (NDEQ) to report on groundwater quality monitoring in Nebraska. Reports have been issued annually since December 2001. The text of the statute applicable to this report follows:

> "The Department of Environmental Quality shall prepare a report outlining the extent of ground water quality monitoring conducted by natural resources districts during the preceding calendar year. The department shall analyze the data collected for the purpose of determining whether or not ground water quality is degrading or improving and shall present the results to the Natural Resources Committee of the Legislature beginning December 1, 2001, and each year thereafter. The districts shall submit in a timely manner all ground water quality monitoring data collected to the department or its designee. The department shall use the data submitted by the districts in conjunction with all other readily available and compatible data for the purpose of the annual ground water quality trend analysis."

The section following the statute quoted above (§ 46-1305), requires the State's Natural Resources Districts to submit an annual report to the legislature with information on their water quality programs, including financial data. That report has been prepared by the Nebraska Association of Resources Districts and is being issued concurrently with this groundwater quality report.

Groundwater in Nebraska

Groundwater can be defined as water that occurs in the open spaces below the surface of the earth (Figure 1). In Nebraska (as in many places worldwide), useable groundwater occurs in voids or pore spaces in various layers of geologic material such as sand, gravel, silt, sandstone, and limestone. These layers are referred to as aquifers where such geologic units yield sufficient water for human use. In parts of the state, groundwater may be encountered just a few feet below the surface, while in other areas, it may be a few hundred feet underground. This underground water "surface" is usually referred to as the water table, while water which soaks downward through overlying rocks and sediment to the water table is called recharge (Figure 1). The amount of water that can be obtained from a given aquifer may range from a few gallons per minute (which is just enough to supply a typical household) to many hundreds or even thousands of gallons per minute (which is the yield of large irrigation, industrial or public water supply wells).

Public Water Supply well capable of pumping thousands of gallons per minute (Hastings, NE).

Groundwater Velocity

In general, groundwater flows very slowly, especially when compared to the flow of water in streams and rivers. Many factors determine the speed of groundwater and most of these factors cannot be measured or observed directly. The most important geologic characteristics that impact groundwater movement are as follows:

- The sediments in the saturated zone of the aquifer – for example, groundwater generally flows faster through gravel sediments than clay sediments.
- The 'sorting' of the sediments. Groundwater in aquifers with a mix of clay, sand, and gravel (poor sorting) generally does not flow as fast as in aquifers that are composed of just one sediment, such as gravel (good sorting).
- The 'gradient' of the water table. Groundwater flows from higher elevations toward lower elevations under the force of gravity. In areas of high relief, groundwater flows faster. A typical groundwater gradient in Nebraska is 10 feet of drop over a mile (0.002 ft/ft).
- Well pumping influences. In areas of the State with numerous high capacity wells (mainly irrigation wells), groundwater velocity and direction can be changed seasonally as water is pumped toward these wells.

Ultimately, groundwater scientists have determined that groundwater in Nebraska can flow as fast as one to two feet per day in areas like the Platte River valley and as slow as one to two inches per year in areas like the Pine Ridge in northwest Nebraska or the glacially deposited sediments in southeast Nebraska.

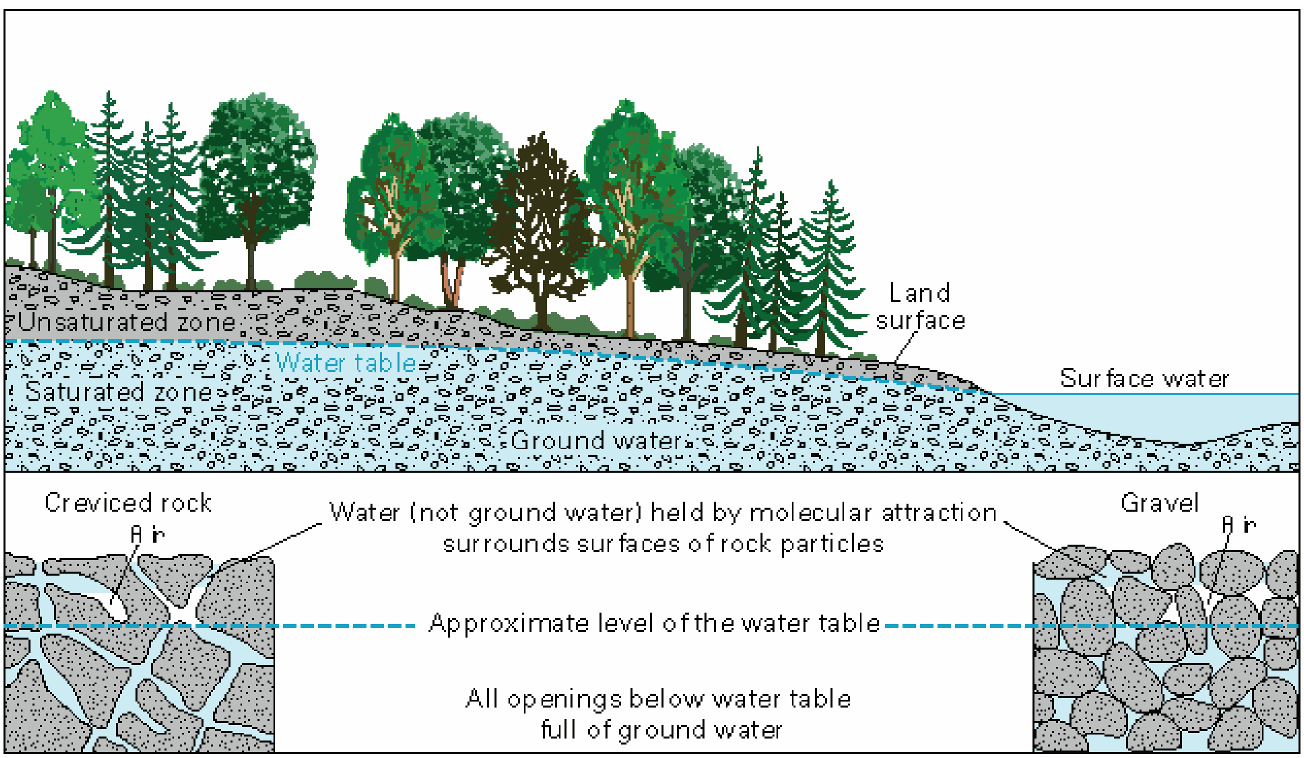


Figure 1. Basic groundwater features and terms (U.S. Geological Servey).

Depth to Groundwater

The depth to groundwater plays a very important role in Nebraska's valuable water resource. Obviously, a shallow well is cheaper to drill, construct, and pump. Conversely, shallow groundwater is more at-risk from impacts from human activities. Surface spills, application of agricultural chemicals, effluent from septic tank leach fields, and other sources of contamination will impact shallow groundwater more quickly than groundwater found at depth. The map in Figure 2 shows the great variation of depth to water across the State.

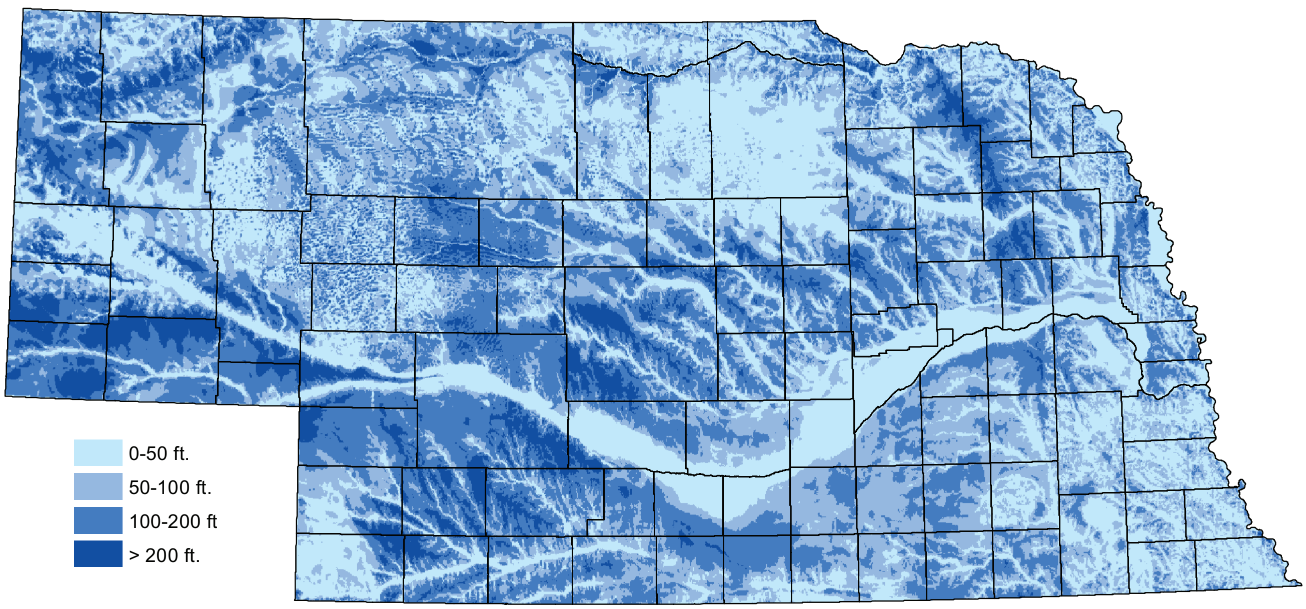
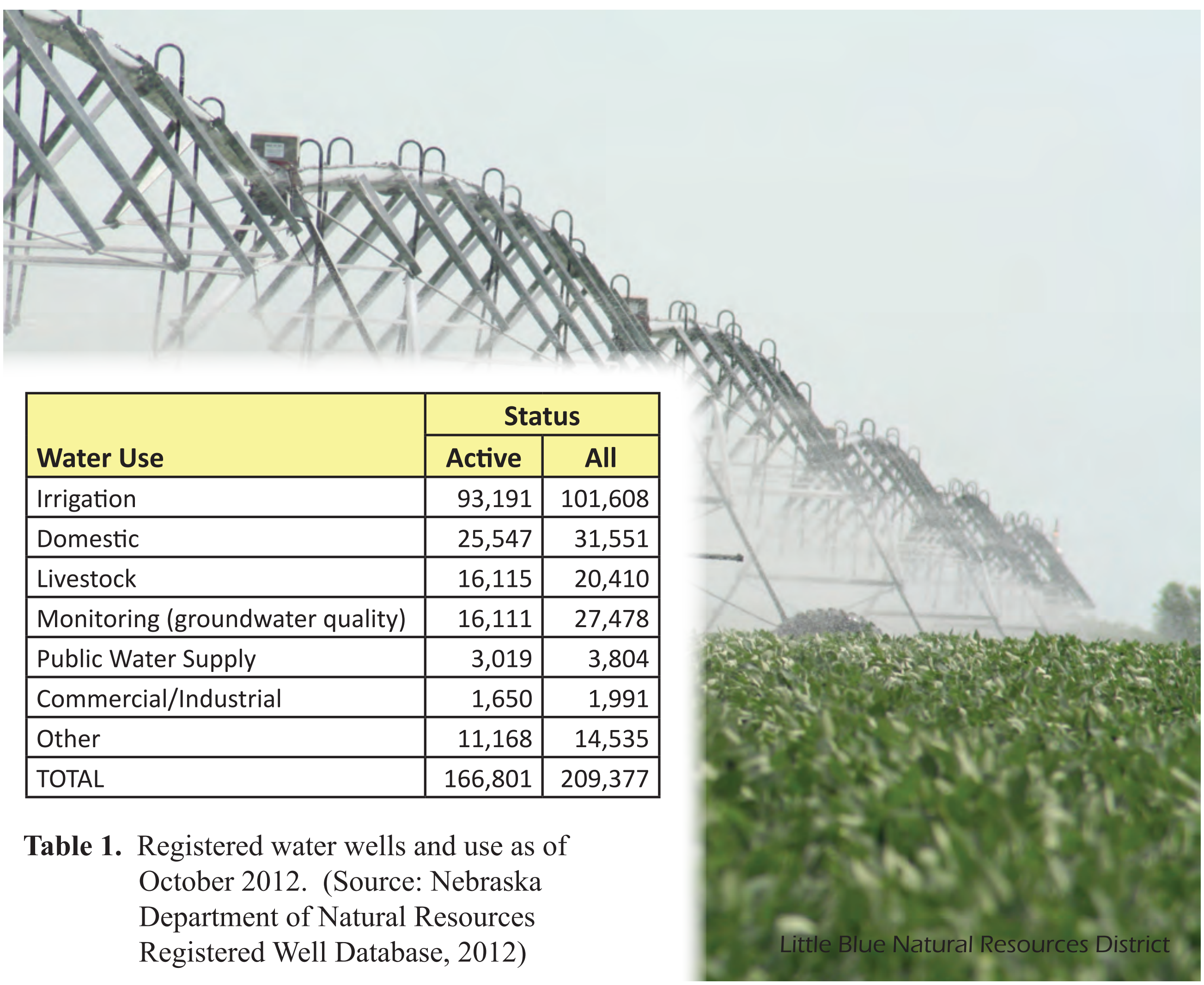


Figure 2. Generalized depth to groundwater. (Source: University of Nebraska, Conservation and Survey Division, 1998)

Importance of Groundwater

Nebraska is one of the most groundwater-rich places in the entire world. Approximately 88% of the state's residents use groundwater as their source of drinking water. If the public water supply for the Omaha metropolitan area (which gets about a third of its water supply from the Missouri River) isn't counted, this rises to nearly 99%. Essentially all of the rural residents of the state use groundwater for their domestic supply. Not only does Nebraska depend on groundwater for its drinking water supply, the state's agricultural industry utilizes vast amounts of groundwater to irrigate crops. Most of Nebraska experiences variable amounts of precipitation throughout the year, so irrigation is used, where possible, to ensure adequate amounts of moisture for raising such crops as corn, soybeans, alfalfa, and edible beans. As of October 2012, the Nebraska Department of Natural Resources (NDNR) listed 93,191 active irrigation wells and 25,547 active domestic wells registered in the state. Domestic wells were not required to be registered with the state prior to September 1993, therefore thousands of domestic wells exist that are not registered with the NDNR.

Figure 3. Registered active water wells as of October 2012. (Source: Nebraska Department of Natural Resources Registered Well Database, 2012)



Water Use	Status	
	Active	All
Irrigation	93,191	101,608
Domestic	25,547	31,551
Livestock	16,115	20,410
Monitoring (groundwater quality)	16,111	27,478
Public Water Supply	3,019	3,804
Commercial/Industrial	1,650	1,991
Other	11,168	14,535
TOTAL	166,801	209,377

Table 1. Registered water wells and use as of October 2012. (Source: Nebraska Department of Natural Resources Registered Well Database, 2012)

Groundwater Monitoring

The above information clearly shows that groundwater is vital to the well-being of all Nebraskans. Fortunately, our state has a long tradition of progressive action in monitoring, managing, and protecting this most precious resource. Several agencies perform monitoring of groundwater for a variety of purposes.

Those entities include:

- Natural Resources Districts (23)
- Nebraska Department of Agriculture
- Nebraska Department of Environmental Quality
- Nebraska Department of Health and Human Services
- University of Nebraska-Lincoln
- United States Geological Survey

Groundwater monitoring performed by these organizations meets a variety of needs, and therefore is not always directly comparable. For instance, the state's 23 Natural Resources Districts (NRDs) perform groundwater monitoring primarily to address contaminants over which they have some jurisdiction; mainly nitrates and agricultural chemicals. In contrast, the state's 1325 public water suppliers monitor groundwater for a large number of possible pollutants. These include basic field parameters, agricultural compounds, and industrial chemicals. Not only are these samples analyzed for many different parameters, the methods used for sampling and analysis vary widely as well.

Flowing artesian irrigation well near Verdel, NE.

Lower Platte South Natural Resources District staff sampling an irrigation well.

Partly in response to this situation, the Nebraska Departments of Agriculture (NDA) and Environmental Quality and the University of Nebraska - Lincoln (UNL) began a project in 1996 to develop a centralized data repository for groundwater quality information that would allow comparison of data obtained at different times and for different purposes. The result of this project is the Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater (referred to as The Database in this publication). The Database brings together groundwater data from many different sources and provides public access to this data.

The Database serves two primary functions. First, it provides to the public the results of groundwater monitoring for agricultural compounds in Nebraska as performed by a variety of entities. At present, agricultural contaminants (mainly nitrate and pesticides) are the focus of The Database because of their widespread use, and also because historical data suggests that these compounds pose the greatest threat to the quality of groundwater across Nebraska. Second, The Database provides an indicator of the methodologies that were used in sampling and analysis for each of the results. UNL staff examines the methods used for sampling and analysis to assign a quality "flag" consisting of a number from 1 to 5 to each of the sample results. The flag depends upon the amount and type of quality assurance/quality control (QA/QC) that was identified in obtaining each of the results. The higher the "flag" number, the better the QA/QC, and the higher the confidence in that particular result.

During the past several years, UNL staff have worked vigorously to establish contact with all the entities performing groundwater monitoring of agricultural chemicals (namely nitrates and pesticides) in Nebraska. Groundwater data is submitted to UNL by these entities each year, where it is assigned a quality "flag" and entered into The Database. The updated information is then forwarded to the Nebraska Department of Natural Resources (NDNR), which places the data on its website (http://www.dnr.ne.gov/ or more specifically http://dnrdata.dnr.ne.gov/clearinghouse/). The Database can be accessed at NDNR's website, where The Database may be searched or 'queried' for numerous subsets of data, such as results by county, type of well, Natural Resources District, etc.

Groundwater Quality Data

Groundwater quality data presented in the remainder of this report reflect the data present in The Database as of October 1, 2012. The dates for these data range from mid-1974 to mid-2010. Some groundwater results from some of The agencies working in Nebraska have not been submitted to UNL to be entered into the Database, but NDEQ is confident that the information presented represents the majority of sample results available. Table 1 lists each agency producing groundwater quality data for this report.

Agency	
Central Platte NRD	Nebraska Department of Health and Human Services
Hastings Utilities	
Lewis & Clark NRD	Nemaha NRD
Little Blue NRD	North Platte NRD
Lower Big Blue NRD	Papio-Missouri River NRD
Lower Elkhorn NRD	South Platte NRD
Lower Loup NRD	Tri-Basin NRD
Lower Niobrara NRD	Twin Platte NRD
Lower Platte North NRD	U.S. Geological Survey
Lower Platte South NRD	University of Nebraska
Lower Republican NRD	Upper Big Blue NRD
Middle Niobrara NRD	Upper Elkhorn NRD
Middle Republican NRD	Upper Loup NRD
Nebraska Department of Agriculture	Upper Niobrara-White NRD
Nebraska Department of Environmental Quality	Upper Republican NRD

Table 2. Various agencies providing groundwater analyses in Nebraska to be used in The Database. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Types of Wells Sampled

The data summarized in Table 2 represent the quantity of water samples analyzed from a variety of well types. Historically, most wells that have been sampled are irrigation or domestic supply wells. Irrigation and domestic wells are constructed to yield adequate supplies of water, not to provide water quality samples. However, in recent years, monitoring agencies have been installing increasing numbers of dedicated groundwater monitoring wells designed and located specifically to produce samples. By utilizing such varied sources, groundwater data from a wide range of geologic conditions can be obtained.

Well Type	Number of Analyses
Monitoring	248,872
Irrigation	95,919
Domestic	73,839
Public Water Supply	26,851
Commercial/Industrial	2,087
Livestock/Other	1,782
Total	449,350

Table 3. Total number of groundwater analyses by well type. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Lower Loup Natural Resources District staff utilizing a passive diffusion sampler to sample a monitoring well near Duncan, NE.

Monitoring Parameters

As already mentioned, numerous entities across Nebraska have been monitoring groundwater quality for many years, for a wide variety of possible contaminants. However, much of this monitoring has been for area-specific (part of an NRD), or at most, regional purposes (entire NRDs), and it has been difficult to assess data on a statewide basis for more than a short period of time. Creation of the Database has provided an important tool for such analysis. Appendix A lists the compounds for which groundwater has been sampled and analyzed since 1974. Table 4, found on page 9 lists the compounds from Appendix A (Pages A-1 and A-2) for which at least 2 percent of the samples collected exceeded the **Reporting Limit (RL) ***. This comparison gives an indication of which compounds are more prevalent than others in Nebraska's groundwater. Only 16 of the 238 compounds sampled met the 2 percent criteria (when more than 50 samples were collected).

> ***Reporting Limit (RL)** *refers to the concentration a laboratory has indicated their analysis method can be validated. For example, if a contaminant were at a level below the reporting limit, the laboratory's analysis method could not detect it and the concentration would be reported as "below the reporting limit".*

Throughout this report, the number of sample analyses for any one contaminant refers only to the number of analyses as reported **in the Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater**, and not for the total number of analyses for that contaminant taken in the state. As already mentioned, data which are currently in the process of being submitted to UNL to be entered into the database are not reflected in this report. In addition, there are undoubtedly samples for various contaminants taken by entities other than the agencies referred to in this report (for instance, private consulting firms, or other programs within some of the reporting agencies), which are not included in this database.

The table in Appendix A shows a wide variety of compounds for which groundwater samples have been analyzed, all of which are used in agricultural production. As mentioned previously, there is a significant effort in monitoring groundwater for other, non-agricultural contaminants. Examples of such compounds include petroleum products and additives, industrial chemicals, hazardous wastes, contaminants associated with landfills and other waste disposal sites, and effluent from wastewater treatment facilities. Such issues are beyond the scope of §46-1304, and information about such monitoring data is not contained in any centralized database at present.

Compound	Number of Samples Collected	Percent of Samples that exceed the Reporting Limit (RL)
nitrate-N	93,140	92.69%
alachlor ethane sulfonic acid	127	51.97%
deethylatrazine	5,173	30.27%
metolachlor ethane sulfonic acid	127	29.13%
atrazine	10,016	22.45%
metolachlor	9,085	11.49%
alachlor ethane sulfonic acid, secondary amide	75	9.33%
deisopropylatrazine	4,791	7.87%
metolachlor oxanilic acid	127	7.09%
cyanazine	9,585	4.40%
alachlor	9,620	3.17%
alachlor oxanilic acid	127	3.15%
2-[(2-ethyl-6-methylphenyl0amino]-2-oxoethane sulfonic acid	71	2.82%
acetochlor ethane sulfonic acid	127	2.36%
propazine	5,065	2.35%
simazine	5,594	2.23%

Table 4. Compounds listed in Appendix A that at least 2% of the samples collected were detected above the Reporting Limit and at least 50 total samples were collected. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Discussion and Analysis

The information presented previously in this report shows that a considerable amount of effort has gone into groundwater quality monitoring in Nebraska since the mid-1970s, especially in areas that are heavily farmed. **It is worth noting that the majority of samples taken during this period show that groundwater in the State is of very high quality.** A comparison of Appendix A and Table 4 shows that most parameters that have been analyzed have never been detected in the samples more than 2 percent of the time. However, these same data show that several contaminants have been detected in numerous samples throughout the monitoring period. Levels and distribution of these compounds are issues of concern to Nebraskans.

As Table 4 shows, the compounds that have been detected more than just a few times throughout the period of record include nitrate-nitrogen (nitrate-N), atrazine, metolachlor, and degradation products of atrazine, alachlor, and metolachlor. Nitrate is a form of nitrogen common in human and animal waste, plant residue, and commercial fertilizers. Atrazine, alachlor, and metolachlor are herbicides used for weed control in crops such as corn and sorghum while deethylatrazine, deisopropylatrazine, and metolachlor ethane sulfonic acid are degradation products, or metabolites of atrazine and metolachlor. Cyanazine is a trizine herbicide similar to atrazine but its use has been discontinued. In addition to atrazine and metolachor, the Nebraska Department of Agriculture identified two other priority compounds (alachlor and simazine) for development of pesticide State Management Plans, following guidance produced by the U.S. Environmental Protection Agency. While these compounds (alachlor and simazine) were not identified in any significant quantities in Nebraska's groundwater, (alachlor ethane sulfonic acid is a degradation product of alachlor) they will be discussed later in this report.

University of Nebraska Conservation and Survey Division staff installing a monitoring well near Clearwater, NE.

Ord canal, property of Twin Loups Irrigation District, located near Elyria, NE.

Occurrence of elevated levels of nitrate and herbicides in groundwater has been associated with the practice of irrigated agriculture, especially corn production. A good summary of this can be found in Exner and Spalding (1990). The Natural Resources Districts have instituted Groundwater Management Areas (GWMAs) over all or parts of nearly all of the 23 districts based on NRD and NDEQ groundwater sampling. The NRDs' institution of these GWMAs indicates a concern and recognition of nonpoint source groundwater contamination. Additionally, NDEQ's Groundwater Management Area program (Title 196, 2002) has completed 20 studies across the state since 1988 identifying areas of nonpoint source contamination from the widespread application of commercial fertilizer and animal waste.

The State of Nebraska is a large geographic area, over 77,000 square miles. Accurately showing the quality of Nebraska's groundwater is becoming an easier task, but this highly complex system is still difficult to characterize. The acquisition of more data is making a trend analysis more viable. However, practices of sampling the "problem" areas have skewed the data and make it very difficult to show the areas in Nebraska where the contaminant levels are decreasing through better management and farming practices.

Another difficulty is obtaining the resources and the logistics of collecting groundwater samples. There are approximately 166,000 active registered wells in Nebraska and only enough resources to collect samples from 3,100 (1.9%) to 4,500 (2.7%) annually (since 2000). Also, not all water well owners are receptive to having their well sampled. Figure 3 is a map showing all active registered water wells in Nebraska as of October 2012. As discussed earlier in this document, not all water wells are registered and these will not show up on this map. Later figures should be compared to Figure 3 as an indicator of where there is a need for additional wells to be sampled. An example of this would be to compare the water wells registered in Cherry County (the largest county) in Figure 3 to the wells that were actually sampled in Figure 4.

Nitrates and Trends Utilizing all Clearinghouse Data

Several different methods will be used in an attempt to present and interpret the nitrate data collected over the last 38 years.

First, Table 5 below uses all of the nitrate data collected for each year's report and shows the percentage of analyses that are greater than 10 mg/l, which is the U.S. Environmental Protection Agency's (USEPA) maximum contaminant level (MCL) on which the federal drinking water standard for nitrate-nitrogen is based. Table 5 also indicates that since the 2005 report, the percent of analyses greater than 10 mg/l (the federal drinking water standard) has decreased by nearly 3 percent.

Years	Total # Analyses	> 0 - < 7.5 mg/l	7.5 - 10 mg/l	10 - 20 mg/l	> 20 mg/l	% > 10 mg/l
1974 - 2001 (2002 Report)	33,075	21,504	2,707	5,554	3,310	26.80%
1974 - 2002 (2003 Report)	44,721	28,394	3,931	8,128	4,268	27.70%
1974 - 2003 (2004 Report)	52,798	33,100	4,606	9,857	5,027	28.20%
1974 - 2004 (2005 Report)	66,822	37,346	5,603	12,244	11,629	35.70%
1974 - 2005 (2006 Report)	74,522	42,916	6,573	13,161	11,872	34.20%
1974 - 2006 (2007 Report)	77,820	44,901	6,407	13,864	12,648	34.10%
1974 - 2007 (2008 Report)	83,002	48,010	6,971	14,949	13,072	33.80%
1974 - 2008 (2009 Report)	86,765	50,450	7,300	15,609	13,406	33.40%
1974 - 2009 (2010 Report)	91,184	53,307	7,691	16,374	13,812	33.10%
1974 - 2010 (2011 Report)	96,053	56,327	8,109	17,303	13,955	32.50%
1974 - 2011 (This Report)	101,735	59,677	8,623	18,448	14,987	32.86%

Table 5. Nitrate – nitrogen concentrations sorted by concentration categories. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012).

Note: The colored dots used in the heading will be used in subsequent figures indicating the nitrate concentration.

Second, the data in Table 5 will be shown geographically in Figures 5 and 7 to get a sense of where nitrate concentrations are within the state. It should be noted that a single well could have been sampled more than one time per reporting year. For example, 101,735 samples were collected for nitrate from 24,535 wells over the "life" of the Database. Because there would be overlapping "dots" when creating a state wide map if all 101,735 nitrate analyses were used, Figure 4 indicates the locations of all the wells sampled for nitrate since 1974 and Figure 5 indicates the most current nitrate concentration for each of those wells, no matter what year the last sample was collected.

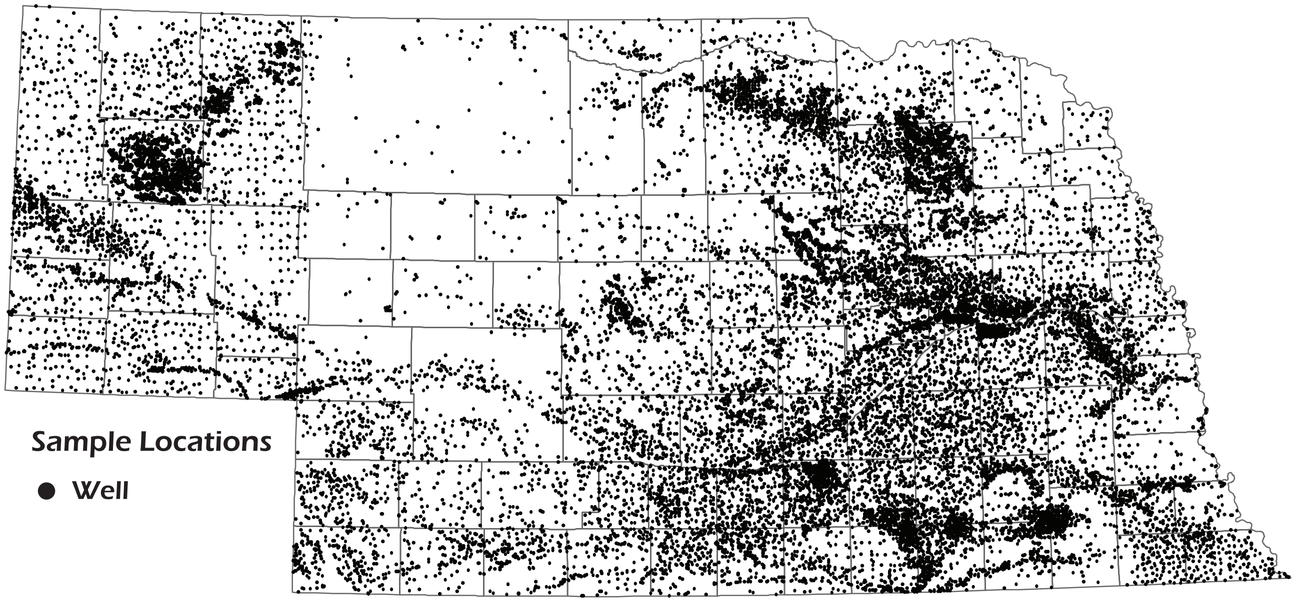


Figure 4. Location of 24,535 wells that have been analyzed for nitrate from 1974 - 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Please note that 'empty' areas only denote areas where samples have not been taken or have not yet been reported. In other words, there is no way to tell anything about the groundwater quality in the 'empty' parts of the state. 'Empty' areas indicate no data, not an absence of nitrate in the groundwater.

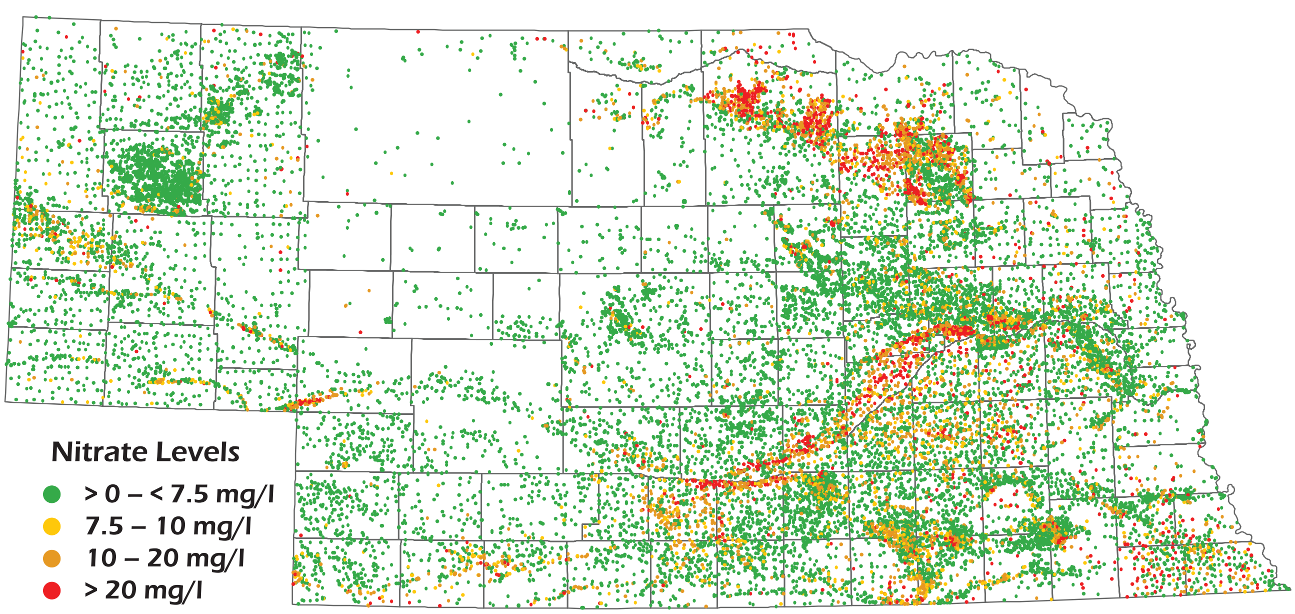


Figure 5. Last recorded concentration of nitrate from 1974 - 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Figure 6 indicates where sampling was conducted in 2011, and Figure 7 indicates the nitrate concentration for each well. Again, 'empty' areas indicated that no data was collected in those areas in 2011, or the data collected has not yet been submitted to the Database.

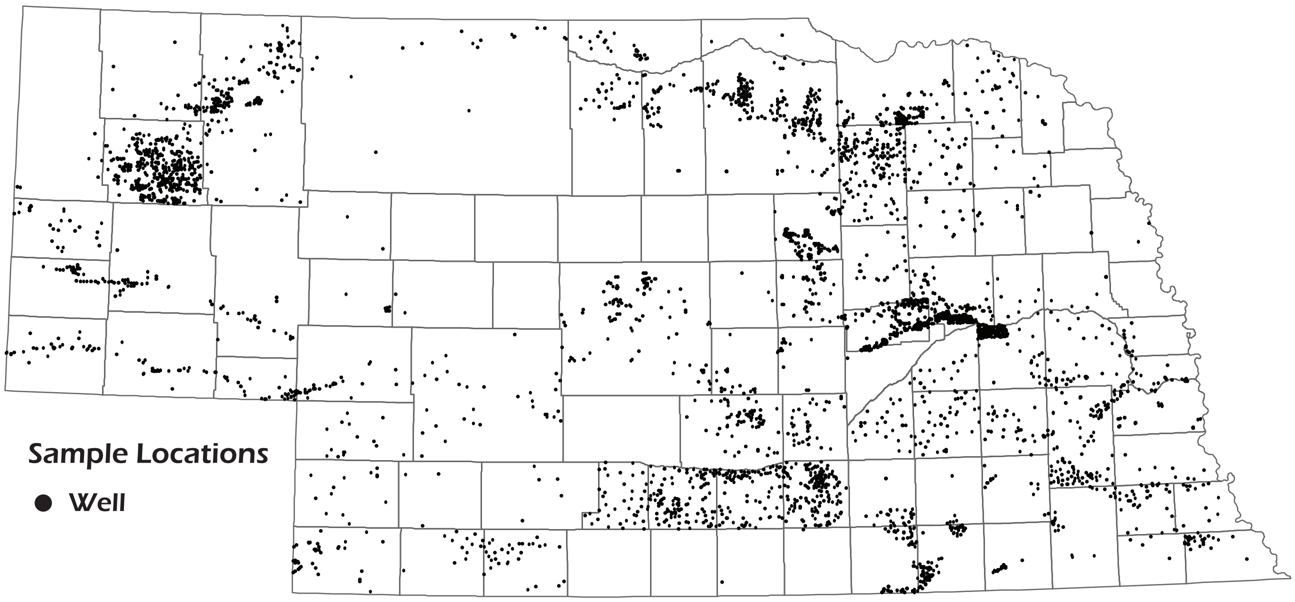


Figure 6. Location of 4,614 wells sampled for nitrate in 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

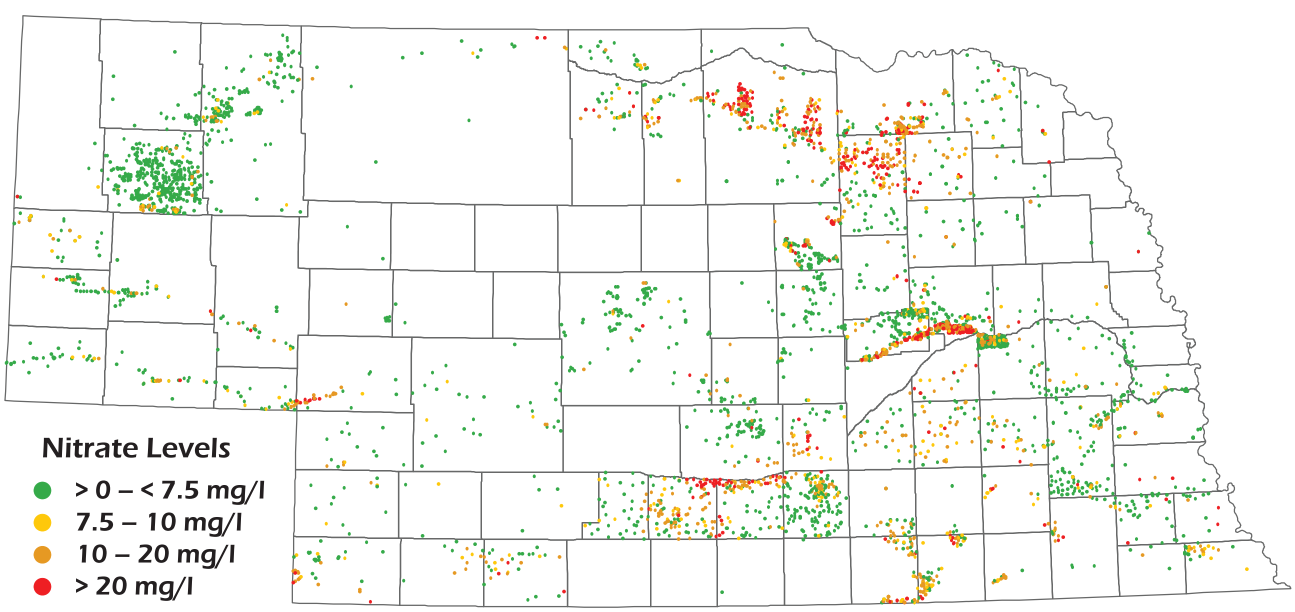


Figure 7. Nitrate concentrations of wells sampled in 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

The data will be used to show any trends in nitrate concentrations. Since there is a large number of analyses, the arithmetic mean or average would normally be used to represent the data for any given time period. However, the groundwater sampling program in Nebraska started out by sampling mainly areas in which an NRD was considering institution of a Groundwater Management Area (refer to Pages B-1 through B-4 in Appendix B). As a result, more data was collected from known problem areas with high nitrates which skew the mean. Therefore, it was determined that a better way to describe the data would be to use the median of the analyses. The median is simply the center of the data set.

An example of how the median is more representative than the mean can be shown by using the data from 1981. In 1981, there were 197 analyses collected from 143 wells with a low concentration of 0.0 mg/l and a high concentration of 121 mg/l. The median of the data set is 6.0 mg/l, while the mean (average) is 12.16 mg/l. Figure 8 below shows a visual representation of this data.

Figure 8. Median and mean of nitrate from 1981.

In simple terms, 50 percent of the sample set is both greater and lesser than the median of 6 mg/l. However, only 26 percent of the samples are greater than the calculated mean. In that 26 percent, 17 of the 197 analyses are greater than 40 mg/l which skews the mean much higher than the median.

To complicate matters even more, not only were samples collected from very specific locations, but multiple samples were collected from the same well during the same year. Again, here is an example from the 1981 data set. There were 197 samples collected from 143 wells, as shown in Figure 9 below. However, 40 percent of the samples were collected from only 17 percent of the wells in the same location. The red circle on Figure 9 below shows the location of these wells in Central Nebraska. By reviewing the data, one can see how a single location impacts the entire state's nitrate statistics.

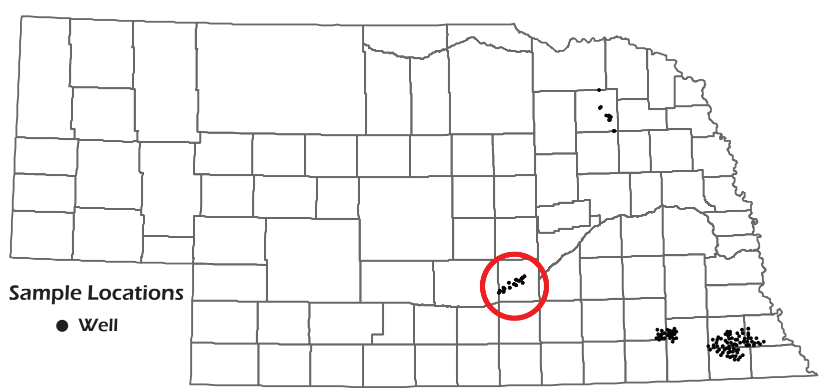


Figure 9. Sampling locations for nitrate in 1981. Red Circle indicates location of 24 wells sampled in Central Nebraska. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2011)

If we review all of the samples collected from the 24 wells in Central Nebraska during 1981, it can be seen that there is a wide range of nitrate concentrations (Figure 10).

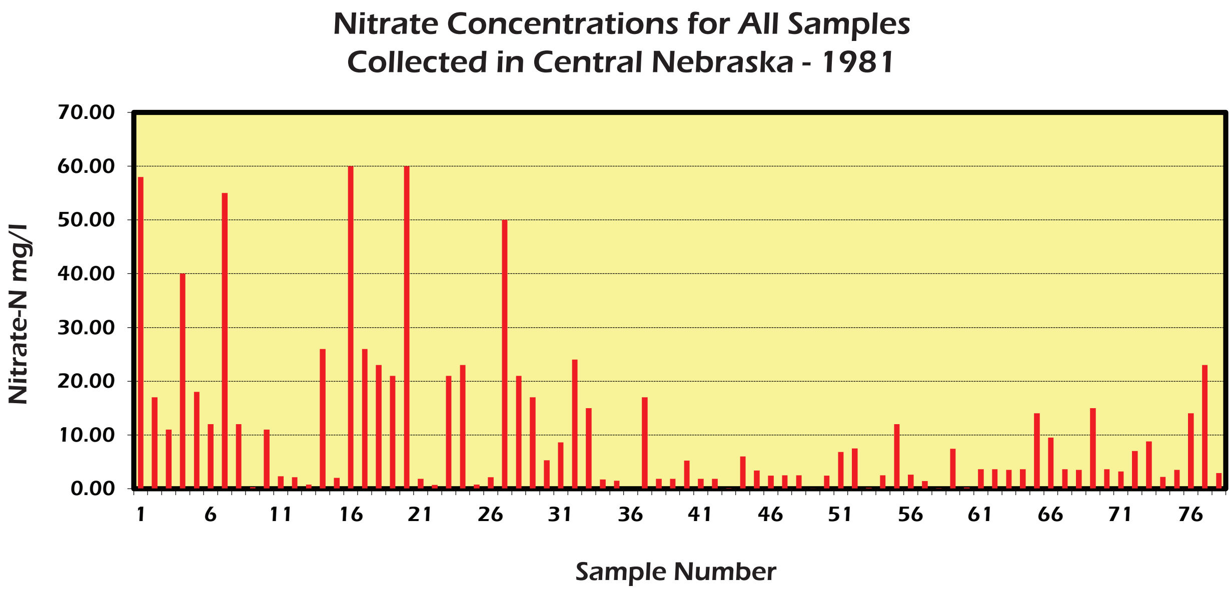


Figure 10. All 80 samples collected from 24 wells in Central Nebraska in 1981. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

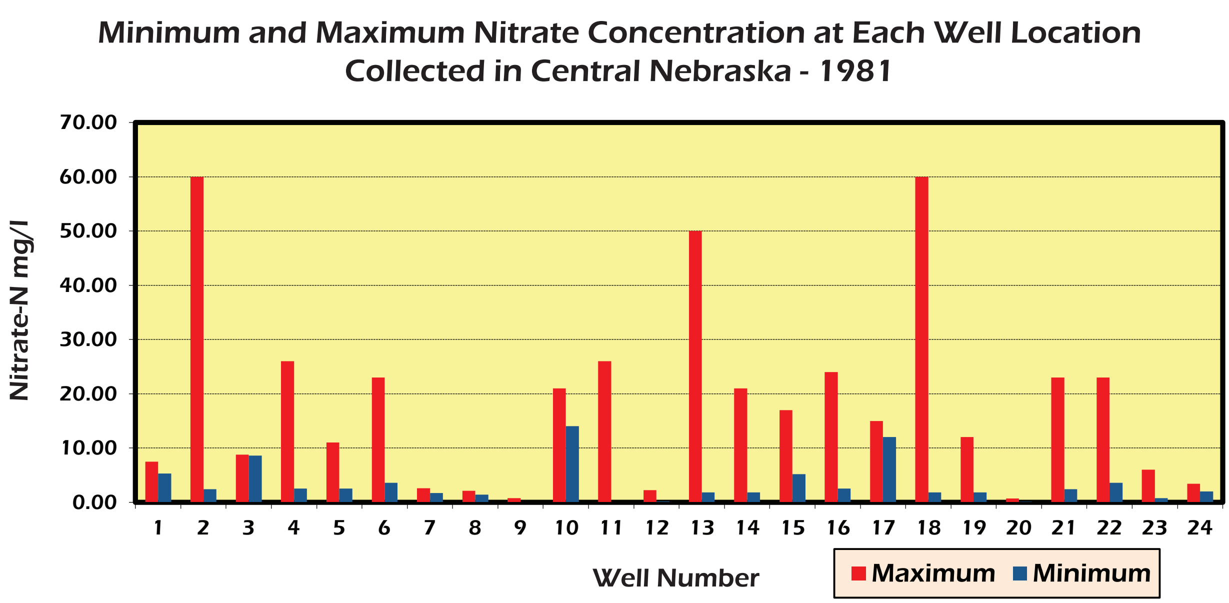


Figure 11. Samples collected from 24 wells in Central Nebraska in 1981 indicating the high and low concentration from each well. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Figure 12 was taken from Appendix B of this report and represents the highest (1981) and lowest (1983) median nitrate concentration from the 1974 to 1993. As can be seen from these two maps, sample locations for this time period are not statewide. Pagesk B-1 through B-4 in Appendix B also indicate how the data from these years is not very representative of “statewide” based on sampling location alone.

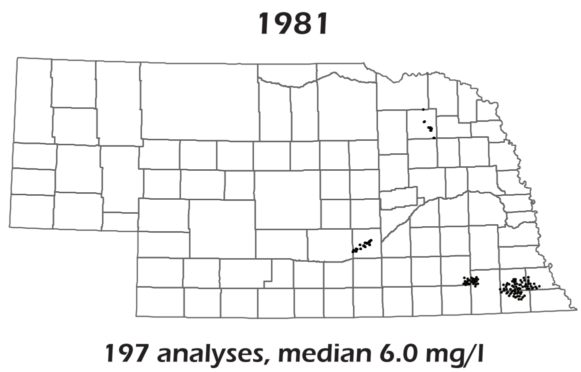


Figure 12. Location of nitrate analyses for highest and lowest annual nitrate median in Nebraska, 1981 and 1983. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

In the past, the median concentrations for **ALL** analyses were used to show a trend in nitrates statewide as presented in Figure 13, with the exception of a set of research wells in the Central Platte Natural Resources District which were removed from the statewide median analysis because they unfairly skewed the data. A low number of samples from 1974 to 1993 led to a very inconsistent nitrate median during those years.

Little Blue Natural Resources District

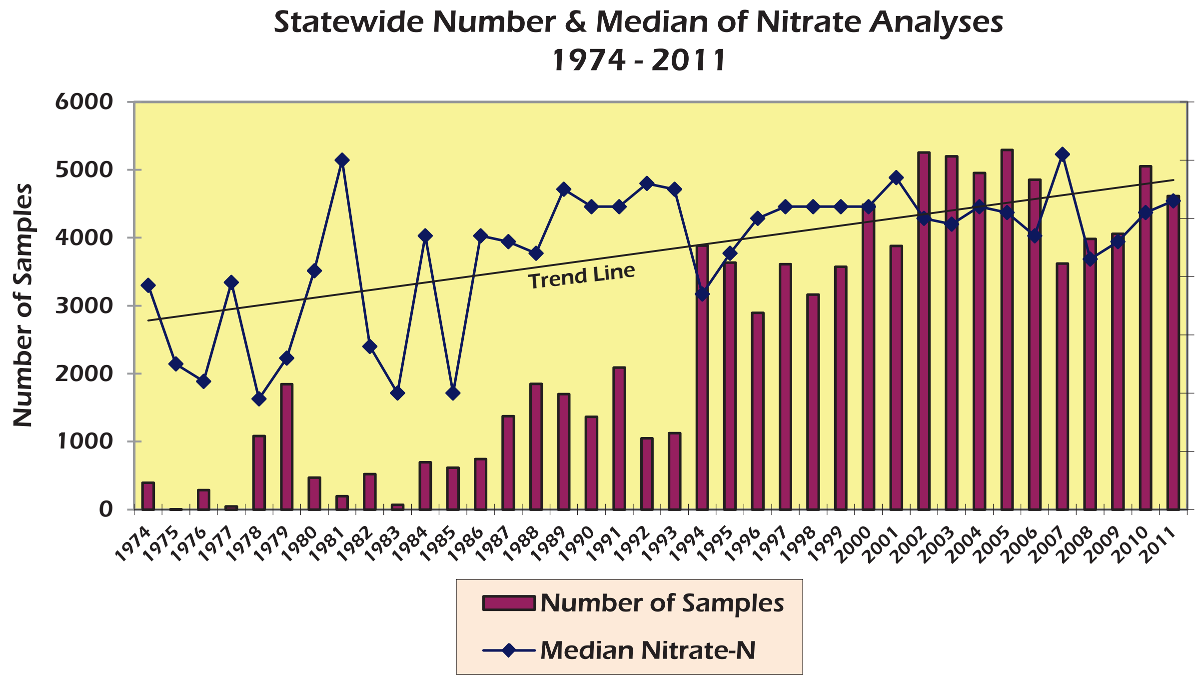


Figure 13. All 93,518 analyses and median nitrate-nitrogen levels for Nebraska, 1974-2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Charting the data from 1974 to 1993 shows the sporadic nature of the median concentration when the number of samples is relatively small (Figure 14). For example, the 1,845 analyses collected in 1979 have a median of 2.6 mg/l versus 197 samples collected in 1981 with a median of 6.0 mg/l. From 1991 to 1993, the median starts to level off as a steady number of samples are being collected. The increasing median trend is also relatively steep for this time period.

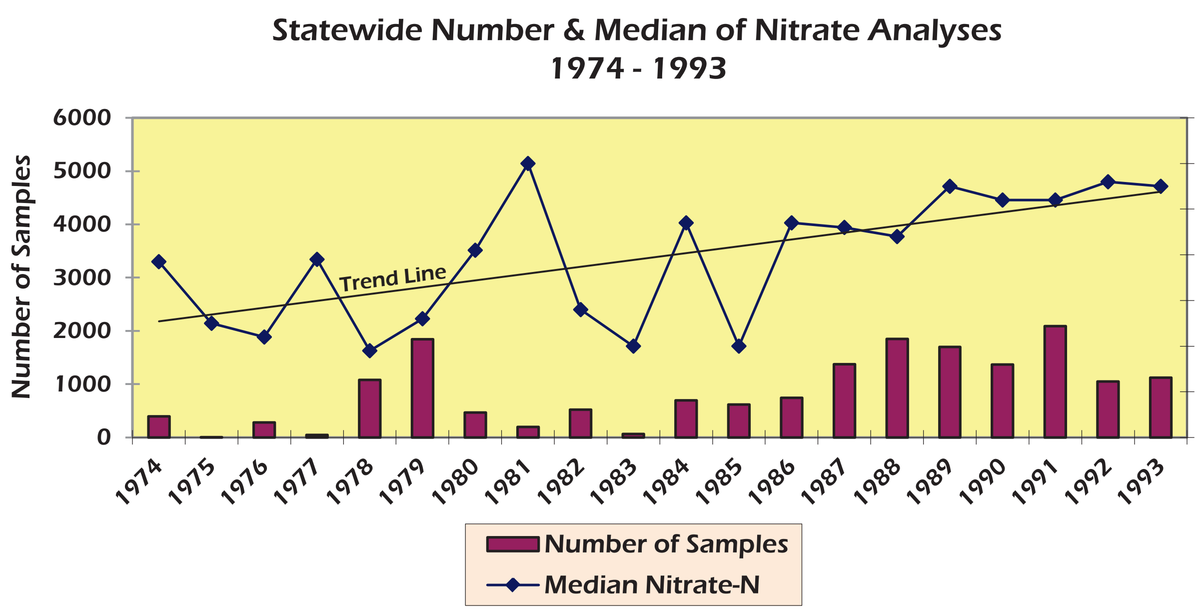


Figure 14. All 17,514 analyses and median nitrate-nitrogen levels for Nebraska, 1974-1993. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

A more representative picture of the statewide median nitrate concentration is from the time period 1994 to 2011. Figure 15 below shows the number of analyses and median nitrate concentration for that time period. The overall trend indicates only a slight increase in nitrate median concentrations statewide.

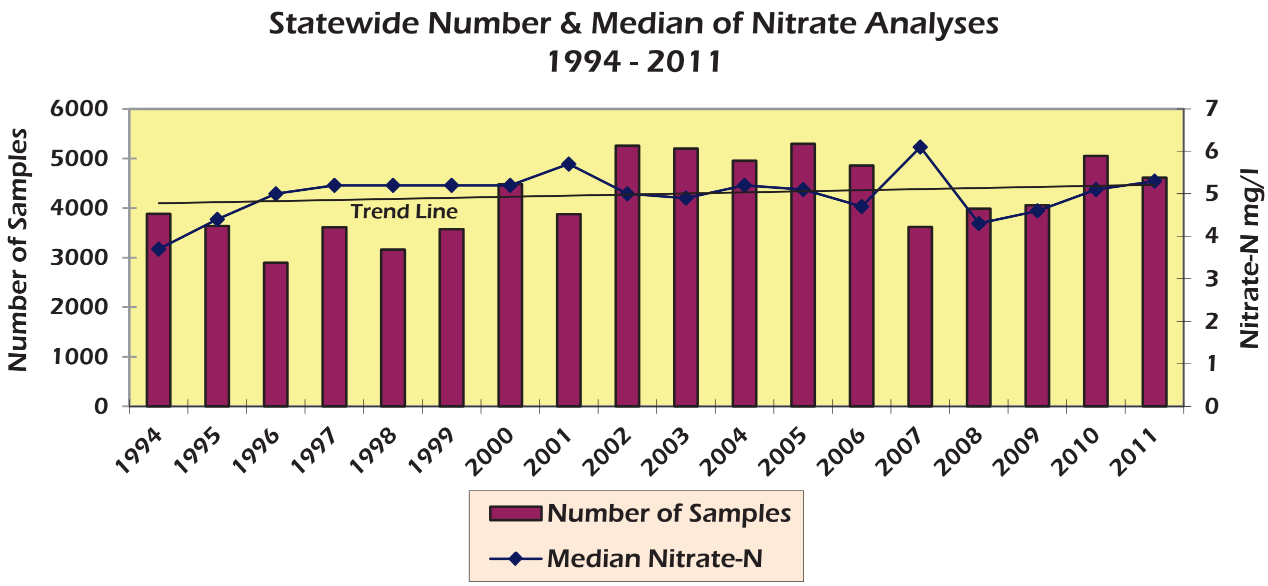


Figure 15. All 76,004 analyses and median nitrate-nitrogen levels for Nebraska, 1994-2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Figure 16 represents the highest (2007) and lowest (1994) median nitrate concentration from the 1994 to present. As can be seen from these two maps, sample locations for this time period are statewide. The Statewide Groundwater Monitoring Network (Figure 18 on page 22) was started in 2004 and is very similar to locations sampled throughout 1994 to present.

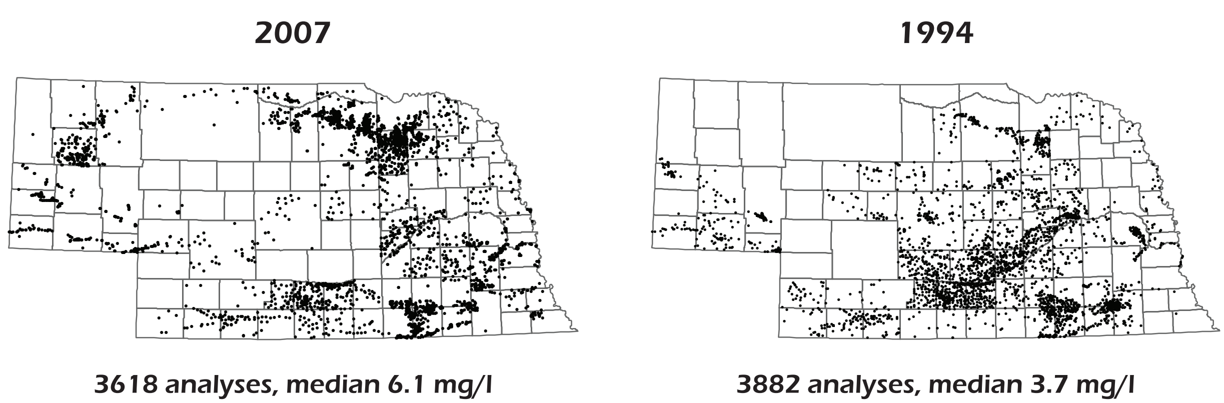


Figure 16. Location of nitrate analyses for highest and lowest nitrate median in Nebraska between 1994 and present, 1994 and 2007. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Nitrates in Public Water Supplies

Reverse Osmosis treatment plant to remove nitrates (Seward, NE).

Public water supply systems are required to test for a variety of potential contaminants in the drinking water that they serve to the public. When a contaminant in the drinking water is over the federal Safe Drinking Water Act limit (also known as the maximum contaminant level [MCL]), the water system will receive an Administrative Order for that contaminant from the Nebraska Department of Health and Human Services (DHHS) and must somehow 'fix' the problem. The MCL for nitrate-nitrogen is 10 mg/l, but public water supply systems with wells or intakes testing over 5 mg/l may be required to perform quarterly sampling. Of the nearly 550 groundwater based community public water supply systems in Nebraska that supply their own water, 137 of those must perform quarterly sampling for nitrates. Common methods to solve a nitrate Administrative Order include drilling a new or deeper well, hooking on to a neighboring water system, or building a treatment plant. Figure 17 shows the location of active community public water supply systems with an administrative order for nitrates, systems required to preform quarterly sampling, and systems treating for nitrates. Please note that the public water supply system data from DHHS is not in the Database. Also note that nitrate Administrative Orders do not necessarily fall in the areas of highest nitrate problems, as indicated in Figures 5 and 7 and the figures in Appendix B.

Ion Exchange plant to remove nitrates (McCook, NE).

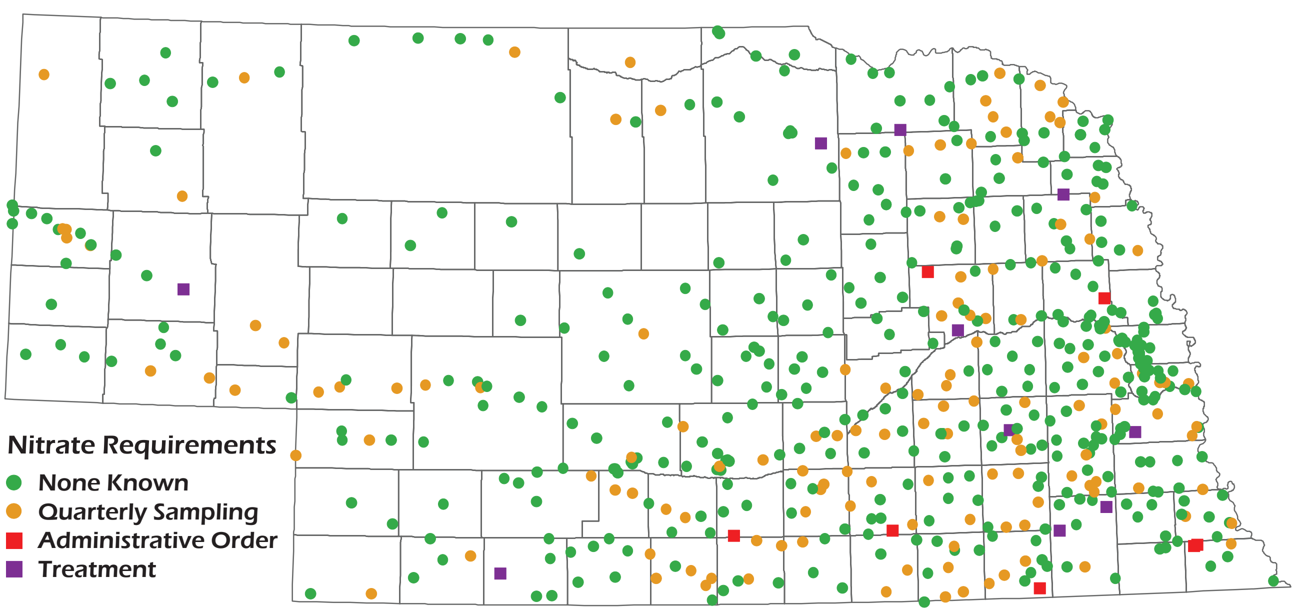


Figure 17. Seven groundwater based community public water supply systems on DHHS Administrative Order for nitrate above the 10 mg/l MCL, 137 systems required to perform quarterly sampling for nitrates above 5 mg/l, and 10 systems treating for nitrates. (Source: DHHS, November 2012)

Nitrates and Trends Utilizing the Statewide Groundwater Monitoring Network

The development of a trend analysis for the entire State of Nebraska using The Database would not be practical. Of specific concern is the lack of data collected from year to year at all locations. Nitrate concentration data exists where specific areas were monitored and not necessarily repeated, with the program goal being a statewide coverage. In contrast, accurate and statistically significant trend analysis should be based on data collected from the same site(s) over a long period of time. While unpractical, the need for the assessment and reporting of groundwater nitrate concentrations remained.

In response to the need for more the more consistent collection of nitrate data and trend assessment, the Natural Resources Districts (NRDs) developed a Statewide Groundwater Monitoring Network (Figure 18). 2011 was the seventh year of utilizing the network to characterize groundwater nitrate concentrations. Thus far, not all network wells are sampled annually; however, there are efforts towards this.

According to the Nebraska Department of Natural Resources there are approximately 160,000 active registered wells in the state (Figure 3) with many more existing unregistered wells. Sampling these wells is unfeasible due to resources constraints, logistics, and access issues. Each NRD annually monitors groundwater to meets the objectives established by their district-specific Groundwater Management Plan and locally driven goals. To allow flexibility for the NRDs while maintaining a consistent network, a target subset of wells to be monitored annually was set at 1,500 when the network was established. Over the course of the last 7 years, modifications have been made and the current network consists of 1,386 (Figure 18) wells. It is anticipated that future review and assessment of the selected wells will continue with the goal of having a 1,500 well network. Table 6 on page 23 presents the number and type of wells assorted by each NRD.

As stated, trend assessment could be accomplished but would not be practical at this time given the nature of the groundwater data. In the future, as the network continues, a more thorough trend analysis and assessment will be pursued. Until then, there is still a need to assess nitrate changes over time. In lieu of trends, nitrates changes over the short term and long term are calculated for this report. “Short-term change” refers to the positive or negative difference in the last two reported nitrate concentrations for an individual well. “Long-term change” refers to the positive or negative difference in the first and last concentration reported for an individual well. Figure 19 found on page 24 presents the 2011 short term change assessment and Figure 20 found on page 25 presents the 2011 long term change assessment.

Most Recent Nitrate-N Concentrations in Network Wells

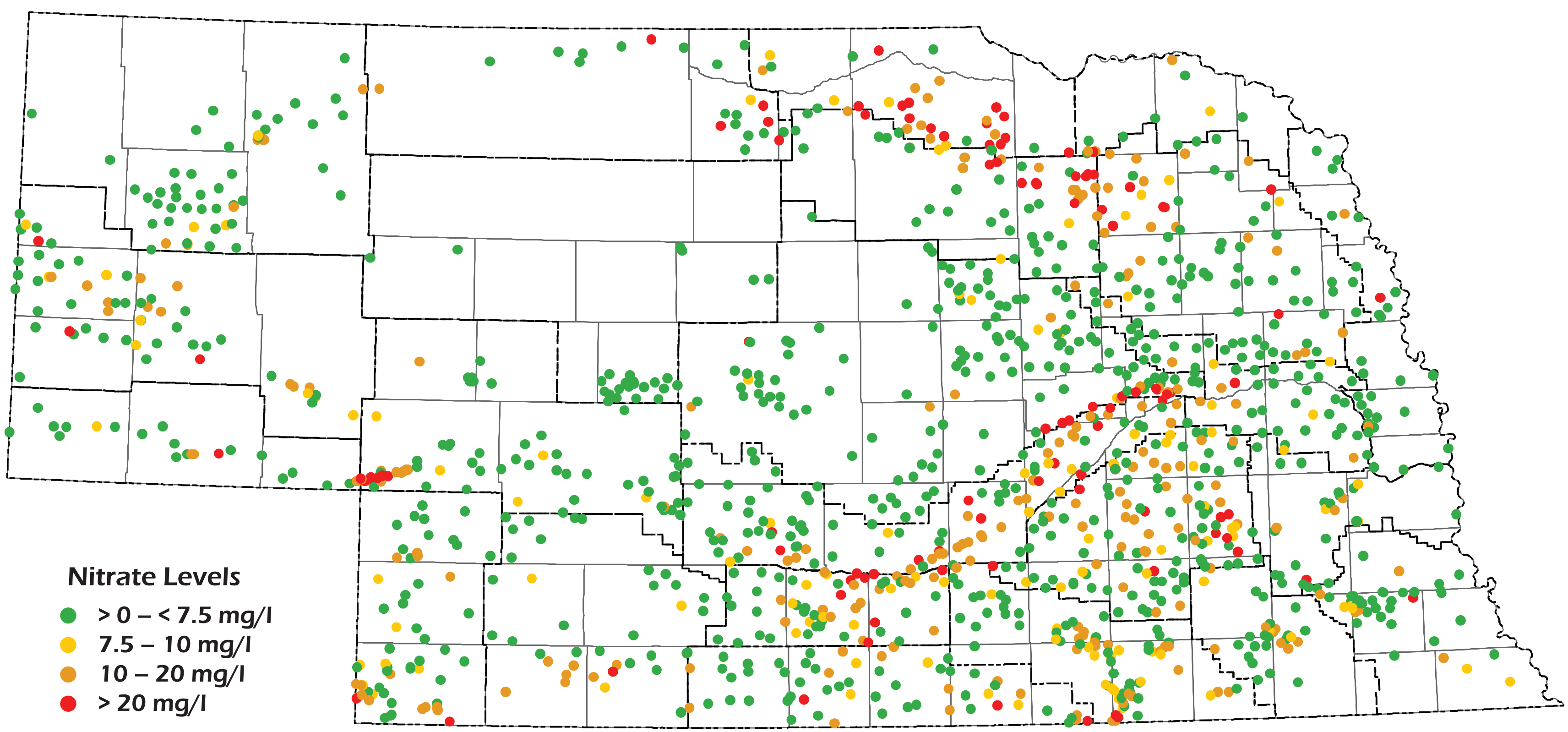


Figure 18. Nitrate concentrations of wells in the Statewide Groundwater Monitoring Network. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Natural Resources District	Total Wells	Irrigation	Monitoring	Domestic	Stock	Commercial
Central Platte	110	104		4		
Lewis and Clark	15	9	6			
Little Blue	81	81				
Lower Big Blue	30	30				
Lower Elkhorn	86	86				
Lower Loup	142	138		2	2	
Lower Niobrara	33	33				
Lower Platte North	52	52				
Lower Platte South	36	11	24			1
Lower Republican	63	54	9			
Middle Niobrara	29	10	17	1	1	
Middle Republican	46	31	15			
Nemaha	41	28	1	11	1	
North Platte	76	15	60	1		
Papio-Missouri River	45	17	26	1		1
South Platte	25	9	16			
Tri-Basin	63	63				
Twin Platte	73	63	8	2		
Upper Big Blue	134	112	18	4		
Upper Elkhorn	64	47	17			
Upper Loup	25	23		2		
Upper Niobrara-White	58	43	15			
Upper Republican	59	59				
Totals	**1386**	**1120**	**232**	**28**	**4**	**2**

Table 6. Well numbers, types, and totals by Natural Resources District for the Statewide Groundwater Monitoring Network.

Figures 19 and 20 show the changes in nitrate-nitrogen levels in the 1386 network wells. Figures 19 and 20 show those wells where nitrate levels were increasing, decreasing, or showed no change or insufficient data. Figure 19 shows changes in nitrate levels between the last two monitoring events for each well, giving a general idea of the most recent changes in those levels. This can be considered a map of "short-term" changes in nitrate levels, in most cases showing how nitrates have changed over the last few years. Figure 20 shows changes in nitrate levels over the entire record of each well, which gives a better indication of "long-term" changes in those levels. This "long-term" change usually represents variations in nitrate levels over several years or even a few decades.

Short Term Nitrate-N Changes in Network Wells

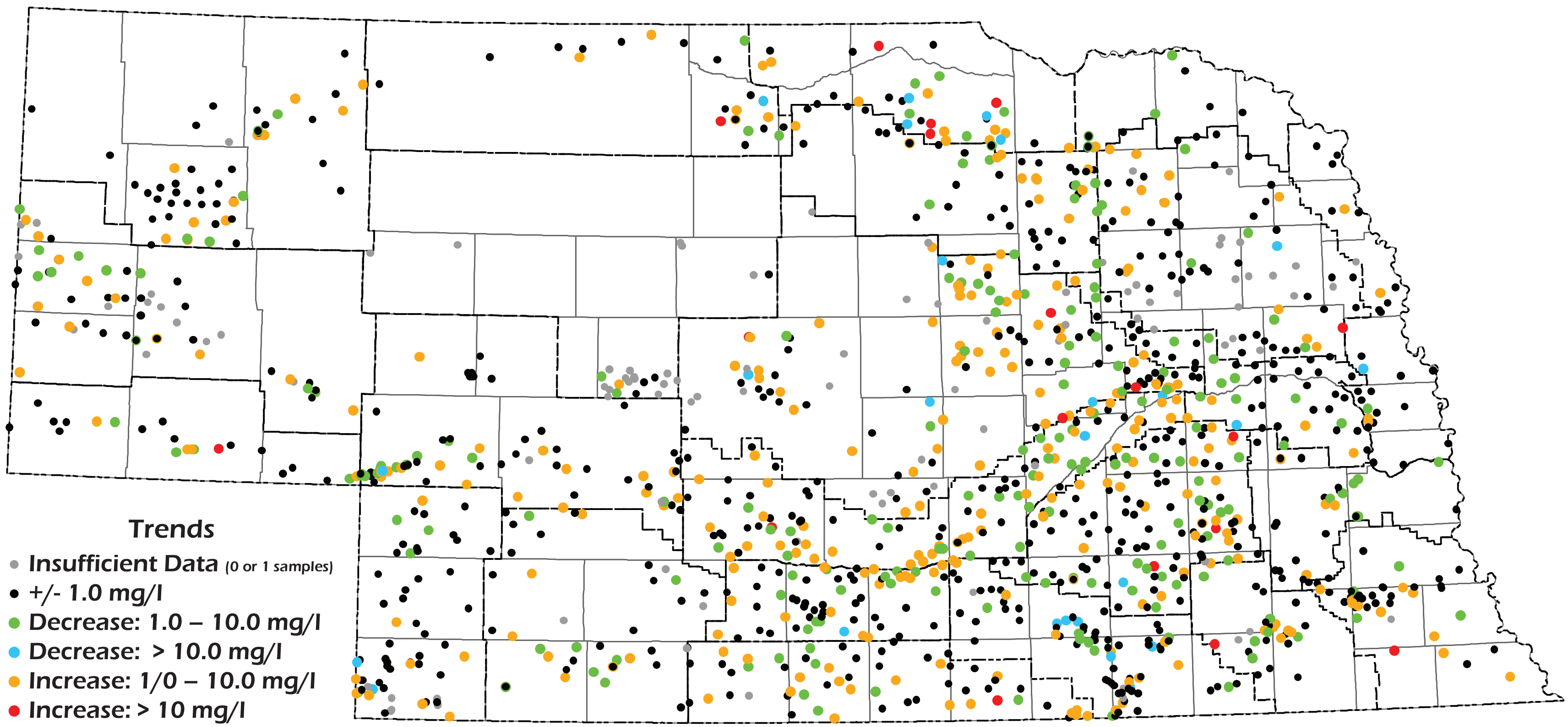


Figure 19. Change in nitrate-N levels between the last two monitoring events ("short-term"). (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Long Term Nitrate-N Changes in Network Wells

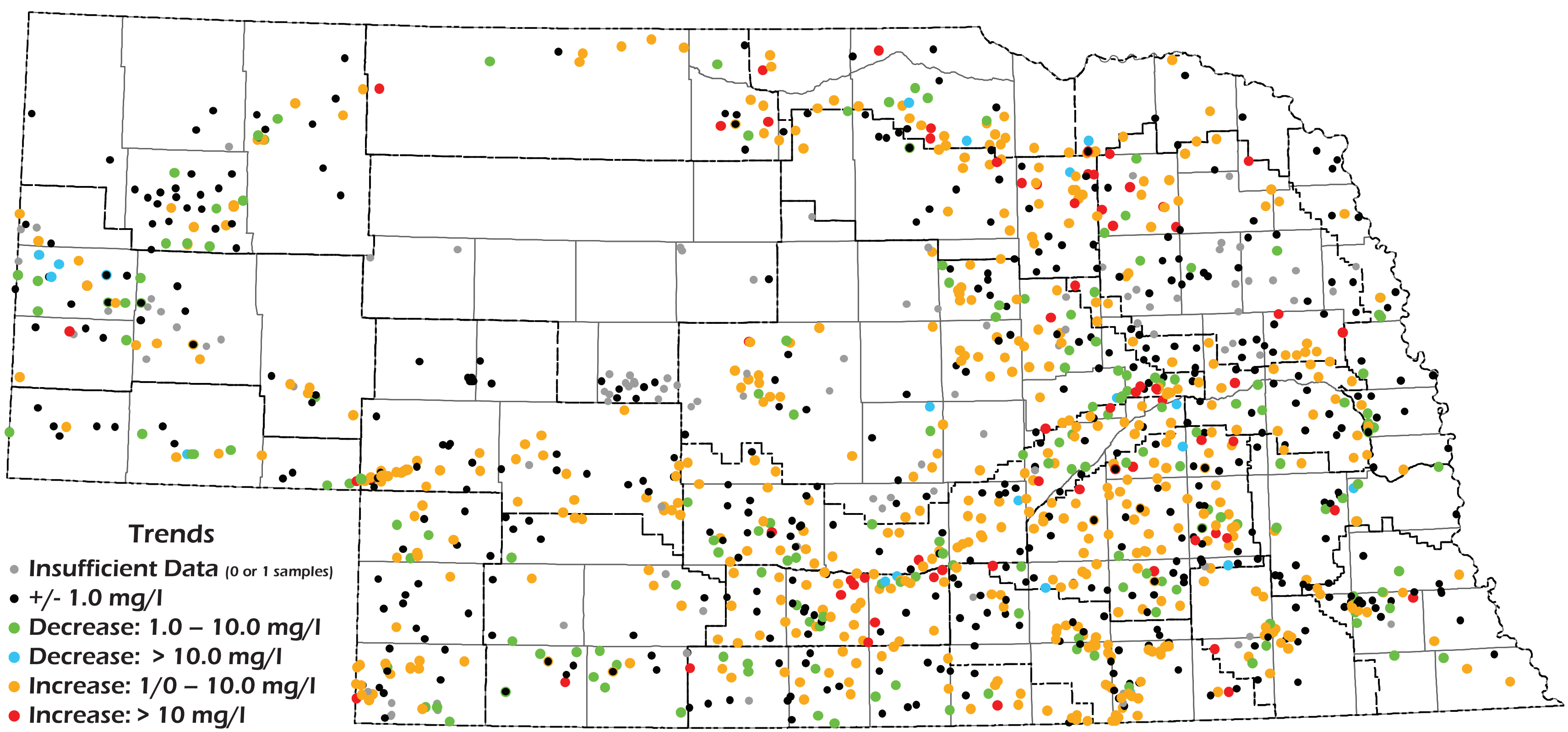


Figure 20. Change in nitrate-N levels between the first and last monitoring events ("long-term"). (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

Figure 21 gives a more detailed breakdown of the magnitude of the "short-term" and "long-term" changes in nitrate levels. It shows the numbers of wells for each category of increase, decrease, no change/no trend, and insufficient data.

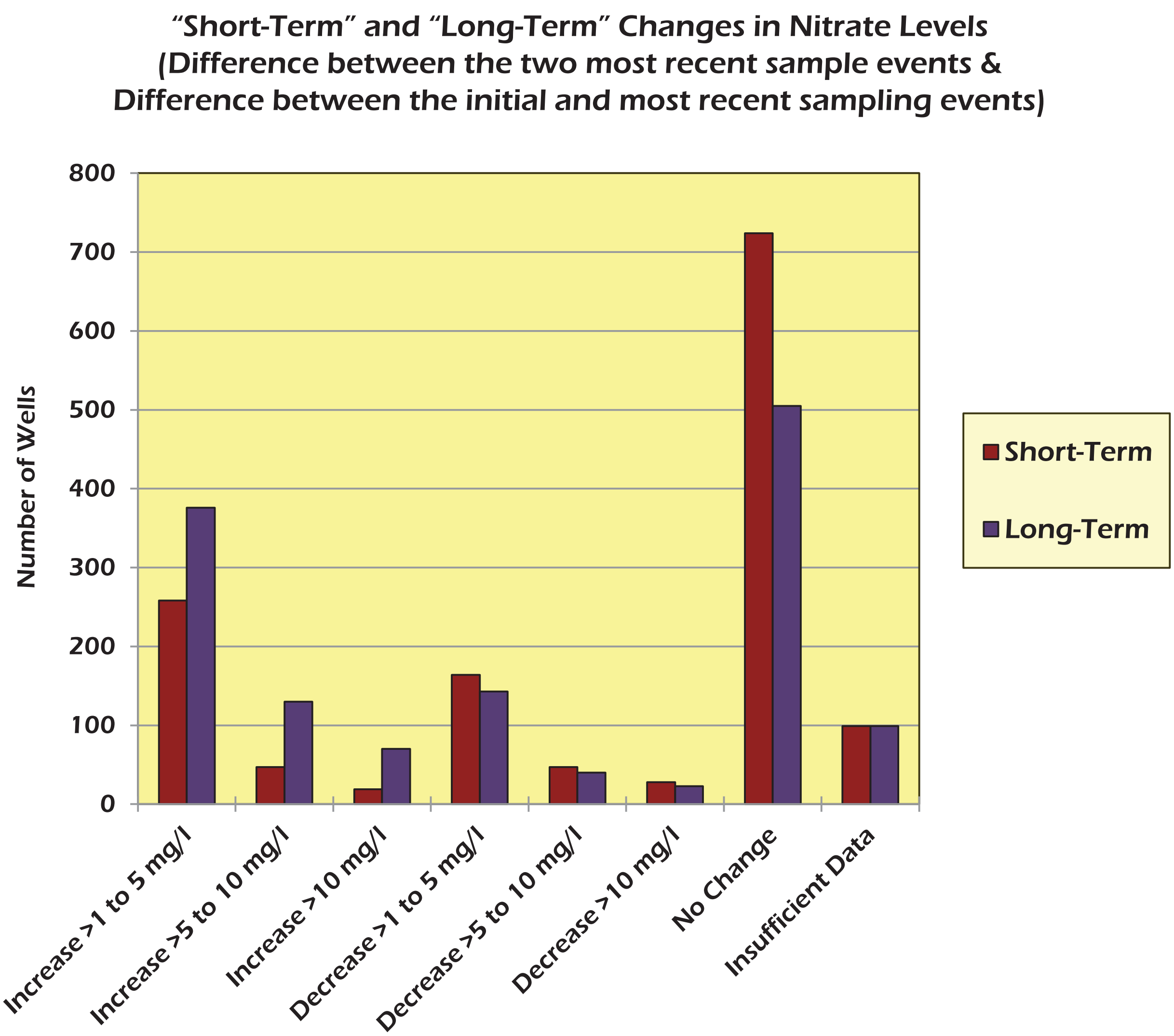


Figure 21. Numbers of "short-term" and "long-term wells in the Statewide Groundwater Monitoring Network showing increases, decreases, or no change in nitrate levels (this information is illustrated in Figures 19 and 20).

It is important to keep some qualifications in mind when interpreting these maps. Since each NRD has its own schedule for monitoring, individual samples may not have been taken at the same time as other samples within the same District or between Districts. Thus, at this point, each map does not necessarily represent a “snapshot” in time of nitrate levels or changes, but they do give a general indication of how nitrate levels are changing over time. However, as time passes and the network becomes more well-established, samples will be more representative of equivalent time periods, and will be more directly comparable. It is also important to remember that aquifer systems and nitrate-nitrogen levels within them are very dynamic, complex, and variable. Although care was taken to select wells that were fairly representative of the geologic conditions present in various areas of the state, it is impossible to extrapolate conditions in a given well to a large area. Therefore, the several hundred wells in the statewide network give a general indication of how nitrate levels are changing over time across the state as a whole, but it would be inappropriate to use one or a few wells in the network to try to analyze nitrate levels in a specific part of the state.

In mid-2004, the NRDs, working with NDEQ and the Nebraska Department of Agriculture (NDA), also began two new monitoring efforts. Using funding from USEPA Region 7, NDEQ, and NDA placed in-house monitoring equipment for the analysis of priority herbicides (atrazine, alachlor, metolachlor, and acetochlor) in several District offices, and for the analysis of coliform bacteria in 22 offices. In 2005, NDEQ obtained additional funding from USEPA to place herbicide units in four additional NRD offices.

Monitoring for these parameters continues as resources allow. The data and information are being compiled, reviewed, and analyzed. The pesticide data received from this project can be considered qualitative or semi-quantitative, and the results have been roughly similar to the pattern of detections discussed in the sections dealing with pesticides in this report. A section on this data and information is expected in a future Groundwater Monitoring Report.

Bacteria data from wells comes mostly from domestic and stock wells, and serves mostly as an indicator of point source contamination and/or poor well construction. This data is being used to assist well owners in decontaminating their wells and/or locating new wells, but it doesn‘t reflect on overall groundwater quality of the state.

Future efforts will concentrate on evaluating these methodologies for inclusion of data in the Clearinghouse, improving quality and comparability of data, and obtaining further funding for ongoing sampling and analysis.

Atrazine

The locations of all wells sampled for atrazine from 1974 to 2011 and then the last recorded concentration of that herbicide are presented in Figures 22 and 23. Atrazine is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include, but are not limited to Aatrex and Bicep.

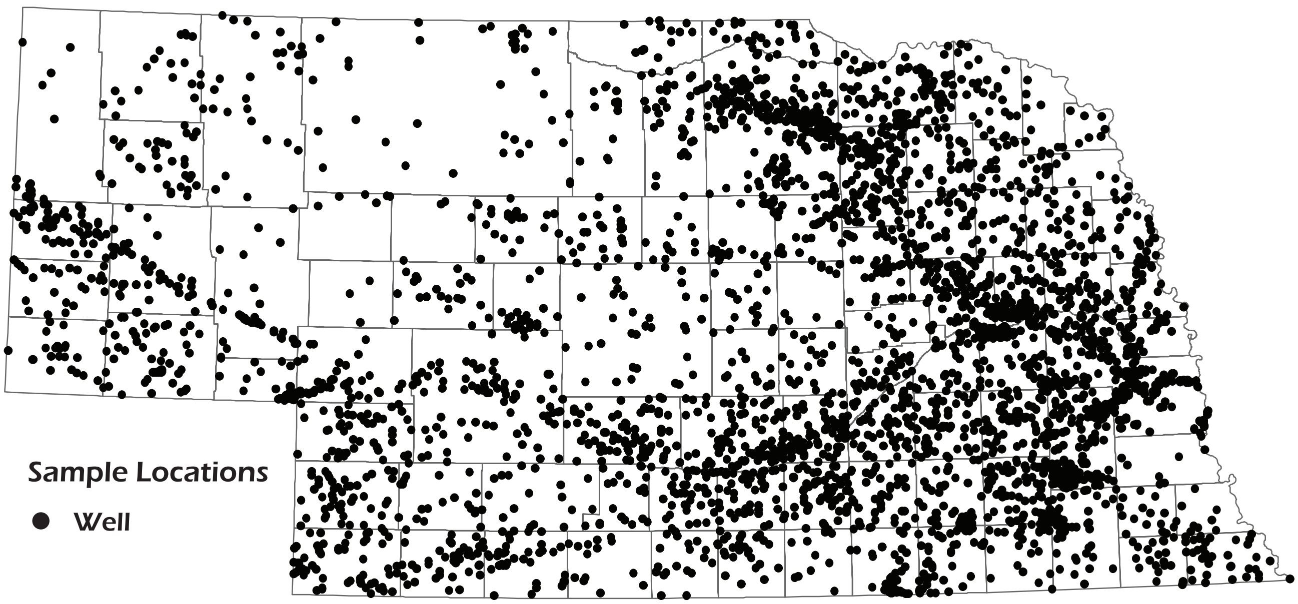


Figure 22. Location of 4,876 wells sampled for atrazine from 1974 – 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

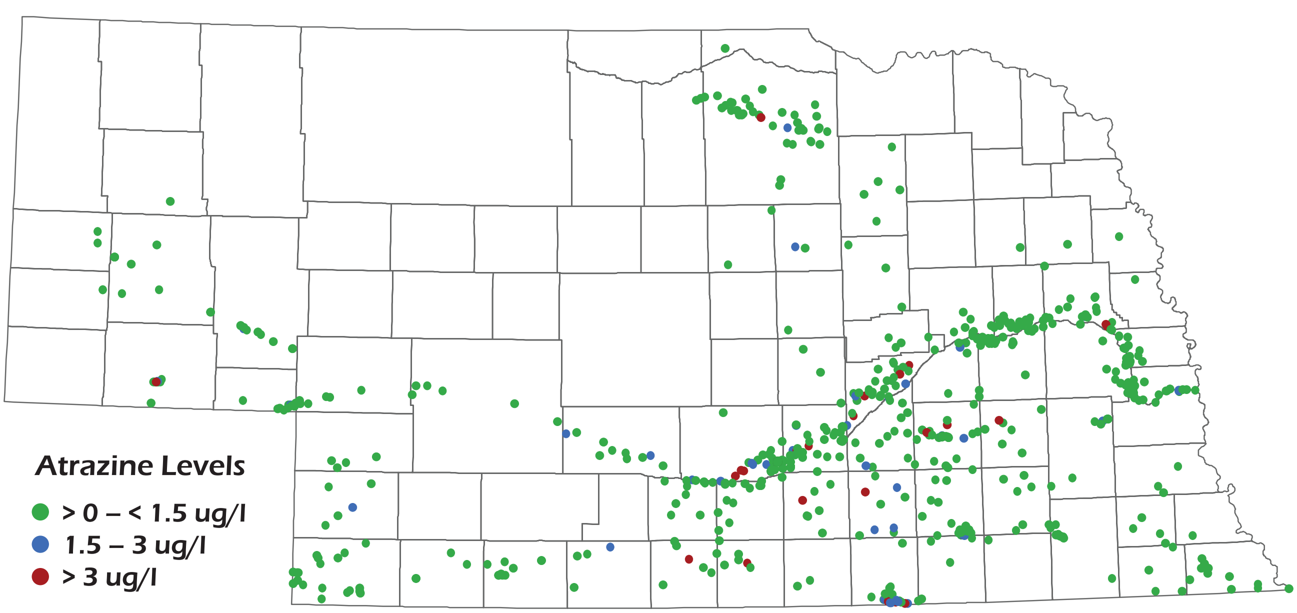


Figure 23. Last recorded detected concentration of atrazine from 1974 – 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

The locations of all wells sampled for atrazine in 2011 are presented in Figure 24, there were 8 detections for a herbicide in the 2011 sampling.

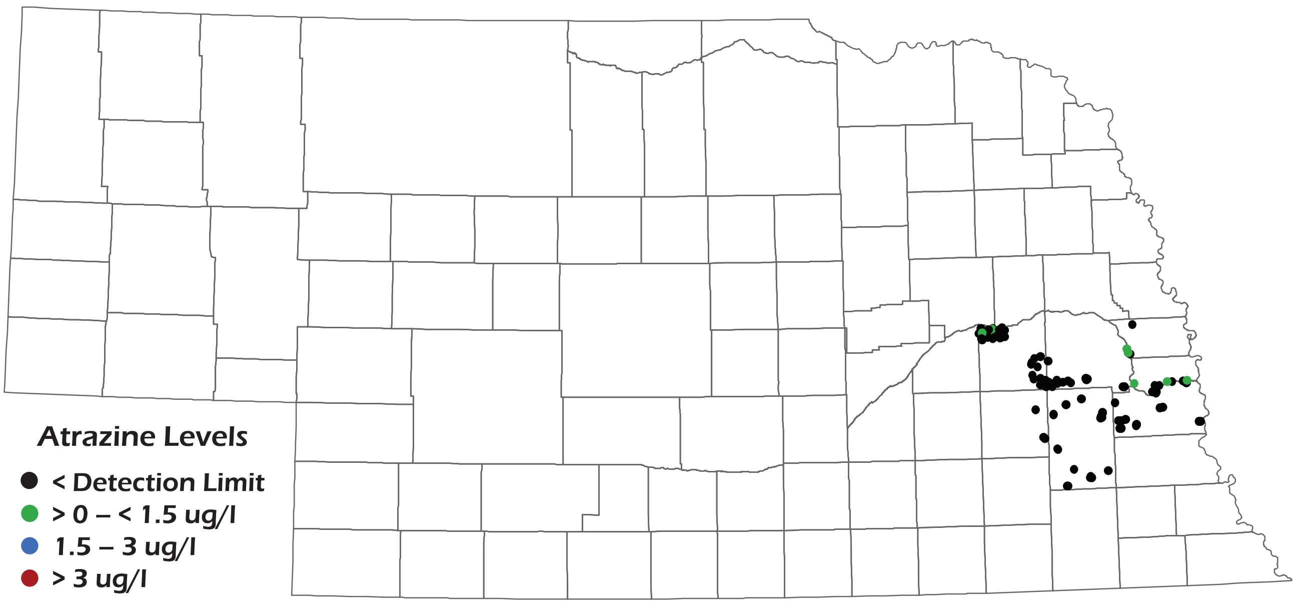


Figure 24. Location of 152 wells sampled for atrazine in 2011. (Source: Quality-Assessed Agrichemical Database for Nebraska Groundwater, 2012)

The mean atrazine concentration calculated from the Database for all wells sampled has been less than 1 μg/L since 1979, compared to the USEPAs MCL of 3 μg/L. Fourteen of the 23 NRDs are currently using the in-house analysis described on page 27, and that data is not yet in the Database.

Alachlor

Alachor is used as an herbicide to eradicate broad leaf weeds and grasses. Common commercial trademark names include, but are not limited to, Lasso, Bullet, and Lariat. There have been 18,533 samples collected since 1974 and no reported concentrations of Alachlor in the 1,104 samples collected since 2004.

The mean alachlor concentration calculated from the Database for the entire record from 1974 is 0.008 μg/L, compared to the USEPAs MCL of 6 μg/L. Fourteen of the 23 NRDs are currently using the in-house analysis described on page 27, but that data is not yet in the Database.

Metolachlor

Metoloachlor is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include, but are not limited to, Bicep and Dual. There have been 18,001 samples collected since 1974 and no reported concentrations of Metolachlor in the 578 samples collected since 2007.

The mean metolachlor concentration calculated from the Database for the entire record from 1974 is 0.164 μg/L. There is no USEPA MCL for metolachlor. Fourteen of the 23 NRDs are currently using the in-house analysis described on page 27, but that data is not yet in the Database.

Simazine

Simazine is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include, but are not limited to, Princep and Aladdin. There have been 14,060 samples collected and no reported concentrations of Simazine in the 1,103 samples collected since 2004.

The mean simazine concentration calculated from the Database for the entire record from 1974 is 0.004 μg/L, compared to the USEPAs MCL of 4 μg/L. Fourteen of the 23 NRDs are currently using the in-house analysis described on page 27, but that data is not yet in the Database.

Pesticides and Trends

An in-depth analysis of statewide trends for any of the pesticides has not been attempted this year because the number of detections in separate wells for these compounds was too small to permit a reliable trend analysis. Many of the detections for these compounds were in the same wells or a series of closely spaced wells. Therefore, an analysis for trends in these parameters would not be valid. In general, the greater numbers of detections of pesticides in groundwater follows the same overall pattern of higher nitrates in groundwater.

As mentioned previously in this report, 14 of the 23 NRDs continue to sample for atrazine, metolachlor, and acetochlor and analyze on a case-by-case basis using the in-house technology described on page 27. The Nebraska Department of Agriculture (NDA) has authority to manage pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The NDA can be contacted at (402) 471-2351.

Conclusions

Groundwater is a valuable resource for Nebraska. The majority of Nebraska's residents rely on groundwater for drinking water, agriculture, and industry. Most public water supplies that utilize groundwater do not require any form of treatment for drinking water before serving it to the public. There are some limited areas in Nebraska where the nitrate concentration is greater than the drinking water standard of 10 mg/L. The state's reliance on groundwater alone makes it important to continue to monitor groundwater quality and to coordinate and share monitoring techniques, to enable decision makers to make more informed management decisions.

The Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater has been invaluable to decision makers in managing Nebraska's groundwater resource. This report authorized by Neb. Rev. Stat. § 46-1304 (LB 329, 2001) would be extremely difficult, if not impossible, to prepare were it not for the existence of The Database. More importantly, The Database has made it possible to quickly and confidently retrieve both recent and historic groundwater quality data for the entire state. These data not only are utilized to make regulatory decisions to protect groundwater quality, but can also be used by the private sector to identify alternate sources of groundwater for drinking water purposes. Most of the 23 NRDs and several state and federal agencies are conducting or analyzing groundwater monitoring, resulting in a large number of analyses spread across the entire state. It is imperative that The Database continue to be implemented and updated for the foreseeable future.

Nebraska's Natural Resources Districts are conducting extensive groundwater quality monitoring, focusing on nitrate and pesticides and have instituted many Groundwater Management Areas (GWMAs). Most of the NRDs have submitted groundwater quality monitoring data to The Database. The other NRDs are submitting data through a cooperative agreement with USGS. In addition, the NRDs have also developed a Statewide Groundwater Monitoring Network that has been sampled for seven years. Not only are the NRDs data vital to The Database, but their implementation of GWMAs is essential in the protection of groundwater quality in Nebraska. NRDs with GWMAs have instituted farm operator certification, soil testing for nitrogen, irrigation water management, and other best management practices. It will be through these GWMA and related practices that Nebraskans will see a decrease in contaminants such as nitrate over the next several decades.

Concentrations and trends of contaminants. As with previous reports, an attempt has been made to show the trends of several of the agricultural related contaminants detected in the states groundwater. Utilizing all of the data to show realistic trends has been proven to be at best, difficult. The data does indicate that overall, since the 2005 report the number of analyses for nitrate greater than 10 mg/l has decreased. As discussed previously in this report, data from 1994 to 2012 is more representative of the "statewide" concentration of nitrogen and indicates a slight upward trend. Utilizing the data from the NRDs' Statewide Groundwater Monitoring Network, (Figures 18, 19, 20, and 21) for both short term and long term analysis, there are a greater number of wells that show an increase than show a decrease. There is not enough recent data for atrazine, alachlor, metolachlor, or simazine to conduct any trend analyses. Even with the future inclusion of data sets, it will be only through a continued identification of a set of wells that are sampled on an on-going basis, similar to the NRDs' Statewide Groundwater Monitoring Network, and coordination of monitoring activities that will help manage and protect groundwater.

The Future. There has been a significant amount of time and effort expended to populate The Database and the importance of its merits cannot be emphasized enough. The NRDs' Statewide Groundwater Monitoring Network has been very useful and consists of many dedicated monitoring wells. However, the NRDs' network has limitations and the resources are not available to improve the dedicated monitoring well network or maintain the necessary yearly sampling routine. A Statewide Groundwater Monitoring Network requires dedicated monitoring wells with strict well construction, and standards for sample collection and reporting. Continued attention and resources (i.e. local and state time, funding, and staff) directed toward monitoring to implement the Statewide Groundwater Monitoring Network are crucial for the successful management of Nebraska's valuable natural resource, groundwater.

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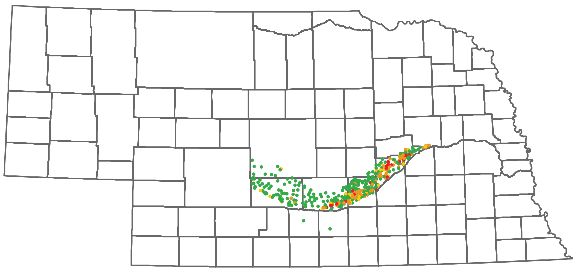
Appendix A. Compounds for which groundwater samples have been analyzed

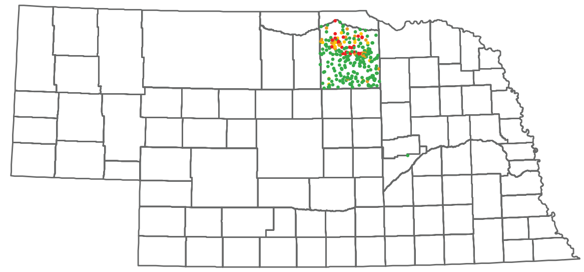
Compound	Compound	Compound
1,1,1-trichloroethane	aldrin	dechloroalachlor
1,2,4-trichlorobenzene	alpha-HCH	dechlorodimethenamid
1,2-dibromo-3-chloropropane	ametryn	dechlorometolachlor
1,2-dibromoethane	atrazine	deethylatrazine
1,2-dichlorobenzene	azinphos-methyl	deethylcyanazine
1,2-dichloroethane	azinphos-methyl oxon	deethylcyanazine acid
1,2-dichloropropane	bendiocarb	deethylcyanazine amid
1,3-dichloropropane	benfluralin	deethylhydroxyatrazine
1,4-dichlorobenzene	benomyl	deisopropylatrazine
1-naphthol	bensulfuron-methyl	deisopropylhydroxyatrazine
2,4,5-T	bentazon	delta-HCH
2,4,6-trichlorophenol	benzo(a)pyrene	demethylfluometuron
2,4-D	beta-HCH	desulfinylfipronil
2,4-D methyl ester	bromacil	desulfinylfipronil amide
2,4-DB	bromomethane	di(2-ethylhexyl)adipate
2,4-dinitrophenol	bromoxynil	di(2-ethylhexyl)phthalate
2,6-diethylaniline	butachlor	diazinon
2-[(2-ethyl-6-methylphenyl) amino]-1-propanol	butylate	diazoxon
	carbaryl	dicamba
2-[(2-ethyl-6-methylphenyl) amino]-2-oxoethane sulfonic acid	carbofuran	dichlobenil
	carbon disulfide	dichlorprop
2-chloro-2',6'-diethylacetanilide	carbon tetrachloride	dichlorvos
2-ethyl-6-methlyaniline	carboxin	dicrotophos
3,4-dichloroaniline	chloramben methyl ester	didealkyl atrazine
3-hydroxycarbofuran	chlordane	dieldrin
4,6-dinitro-o-cresol	chlorimuron-ethyl	dimethenamid
4-chloro-2-methylphenol	chloroform	dimethenamid ethane sulfonic acid
4-chloro-3-methylphenol	chlorothalonil	
4-nitrophenol	chlorpyrifos	dimethenamid oxalinic acid
acenaphthene	chlorpyrifos oxon	dimethoate
acetochlor	cis-1,3-dichloropropene	dinoseb
acetochlor ethane sulfonic acid	cis-permethrin	diphenamid
acetochlor oxanilic acid	clopyralid	disulfoton
acetochlor sulfynilacetic acid	cyanazine	diuron
acifluorfen	cyanazine acid	endosulfan I
acrylonitrile	cyanazine amide	endosulfan II
alachlor	cycloate	endosulfan sulfate
alachlor ethane sulfonic acid	cyfluthrin	endrin
alachlor ethane sulfonic acid, secondary amide	cypermethrin	endrin aldehyde
	cyprazine	EPTC
alachlor oxanilic acid	DCPA	esfenvalerate
alachlor sulfynilacetic acid	DCPA monoacid	ethalfluralin
aldicarb	DDD	ethion
aldicarb sulfone	DDT	ethion monoxon
aldicarb sulfoxide	dechloroacetochlor	ethoprop

Appendix A. Compounds for which groundwater samples have been analyzed

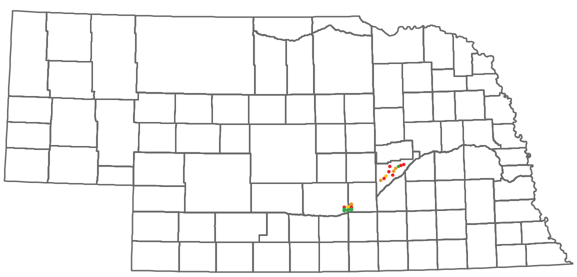
Compound	Compound	Compound
ethyl parathion	linuron	phosmet
fenamiphos	malathion	phosmet oxon
fenamiphos sulfone	malathion oxon	picloram
fenamiphos sulfoxide	MCPA	propachlor ethane sulfonic acid
fenuron	MCPB	propachlor oxalinic acid
fipronil	metalaxyl	propanil
fipronil sulfide	methidathion	propargite
fipronil sulfone	methiocarb	propazine
flufenacet	methomyl	propham
flufenacet ethane sulfonic acid	methoxychlor	propiconazole
flufenacet oxalinic acid	methyl paraoxon	propoxur
flumetsulam	methyl parathion	propyzamide
fluometuron	methylene chloride	prometon
fonofos	metolachlor	prometryn
fonofos oxon	metolachlor ethane sulfonic acid	propachlor
heptachlor		siduron
heptachlor epoxide	metolachlor oxalinic acid	silvex
hexachlorobenzene	metribuzin	simazine
hexachlorocyclopentadiene	metsulfuron-methyl	simetryn
hexazinone	molinate	sulfometuron-methyl
hydroxyacetochlor	myclobutanil	tebuthiuron
hydroxyalachlor	naphthalene	terbacil
hydroxyatrazine	napropamide	terbufos
hydroxydimethenamid	neburon	terbufos oxon sulfone
hydroxymetolachlor	nicosulfuron	terbuthylazine
hydroxysimazine	nitrate-N	terbutryn
imazaquin	norflurazon	tetrachloroethene
imazethapyr	oryzalin	thiobencarb
imidacloprid	oxamyl	toxaphene
iodomehtane	p,p'-DDE	trans-1,3-dichloropropene
iprodione	pebulate	triallate
isofenphos	pendimethalin	trichloroethene
isoxaflutole	pentachlorophenol	triclopyr
isoxaflutole benzoic acid	permethrin	trifluralin
isoxaflutole diketonitrile	phorate	vernolate
lindane	phorate oxon	



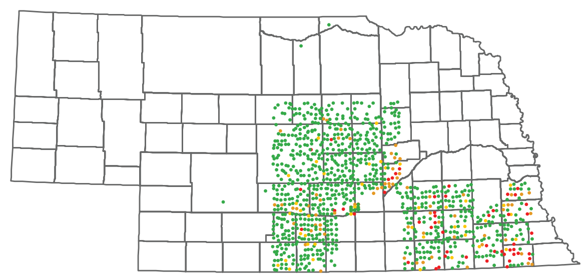
1974 - 1975 (397 wells, 397 analyses)



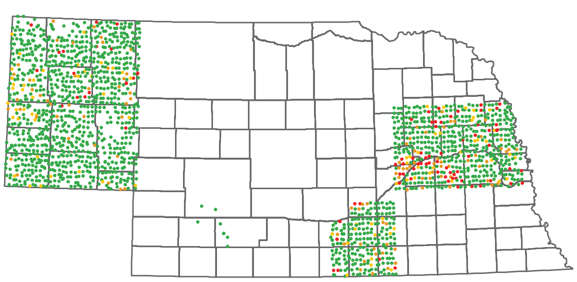
1976 (283 wells, 283 analyses)



1977 (45 wells, 45 analyses)



1978 (1057 wells, 1082 analyses)

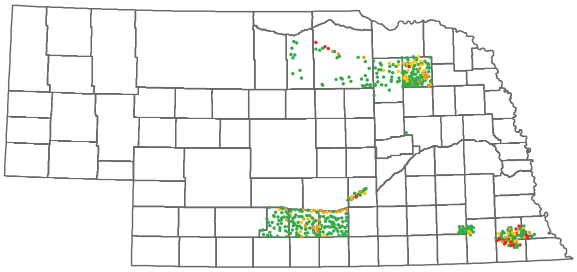


1979 (1844 wells, 1845 analyses)

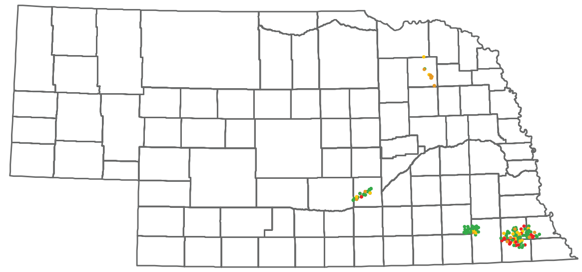
Figure B-1
Nitrate analyses for years 1974 - 1979
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- < 7.5 mg/l
- 7.5 – 10 mg/l
- 10 – 20 mg/l
- > 20 mg/l

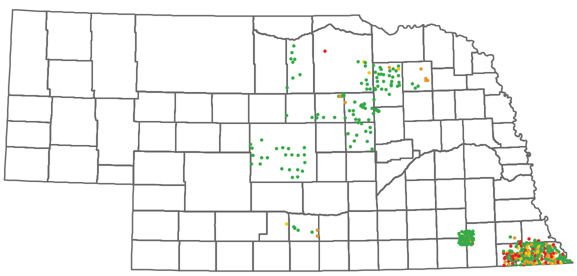
Empty areas indicate no data reported. These Maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ’s web site (http://deq.ne.gov/) and use your Adobe Acrobat reader to enlarge individual maps.



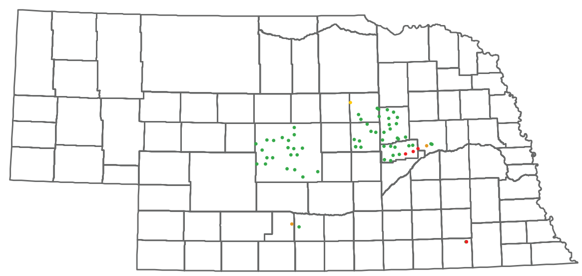
1980 (403 wells, 470 analyses)



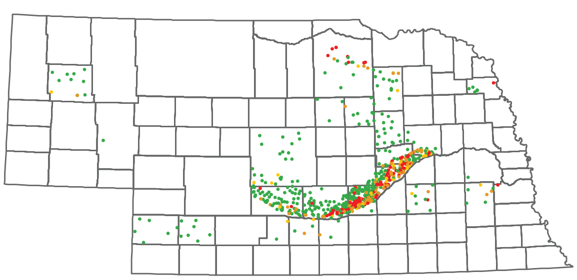
1981 (143 wells, 197 analyses)



1982 (506 wells, 519 analyses)



1983 (65 wells, 67 analyses)



1984 (691 wells, 695 analyses)

Figure B-2
Nitrate analyses for years 1980 - 1984
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- < 7.5 mg/l
- 7.5 – 10 mg/l
- 10 – 20 mg/l
- > 20 mg/l

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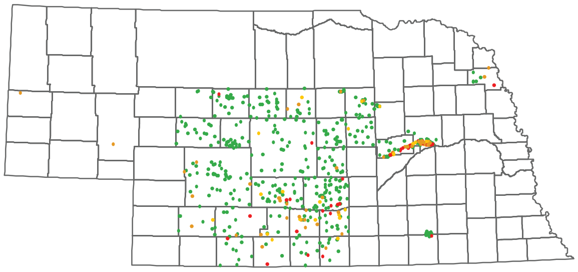
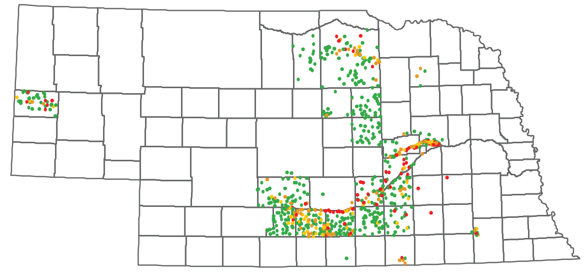
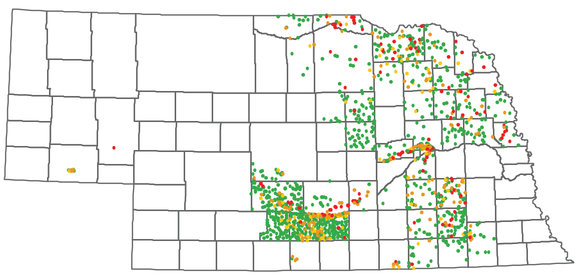


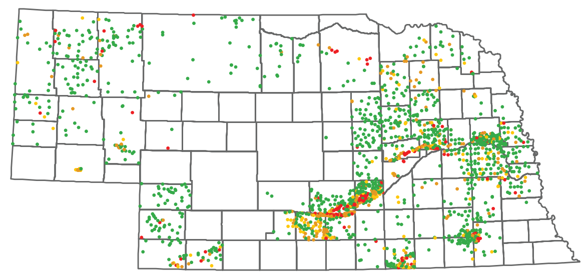
1985 (616 wells, 616 analyses)



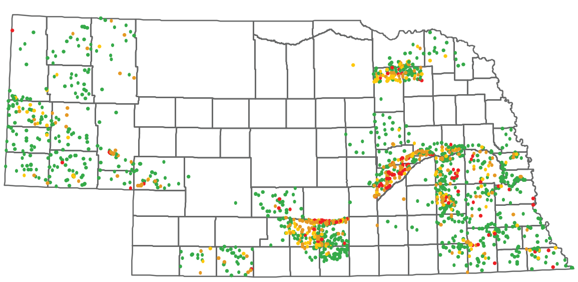
1986 (743 wells, 743 analyses)



1987 (1325 wells, 1373 analyses)



1988 (1795 wells, 1851 analyses)



1989 (1665 wells, 1700 analyses)

Figure B-3
Nitrate analyses for years 1985 - 1989
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- **< 7.5 mg/l**
- **7.5 – 10 mg/l**
- **10 – 20 mg/l**
- **> 20 mg/l**

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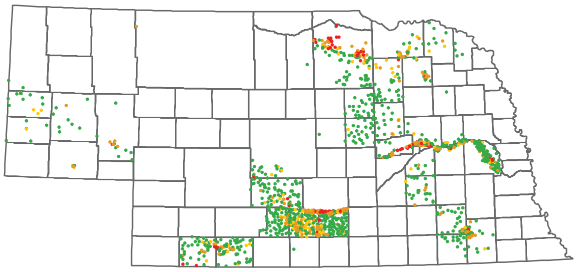
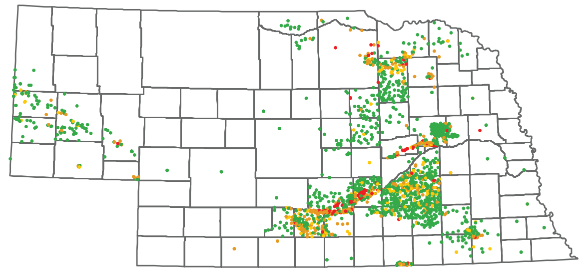
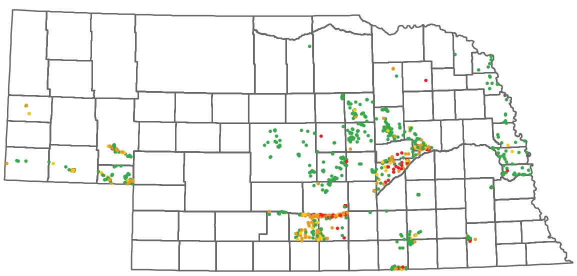


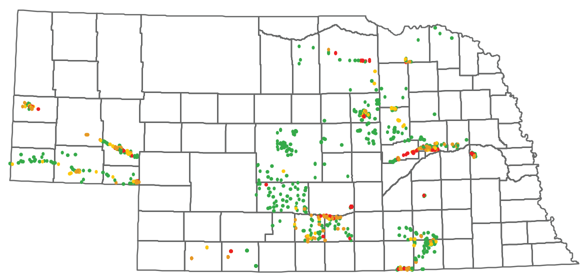
1990 (1337 wells, 1366 analyses)



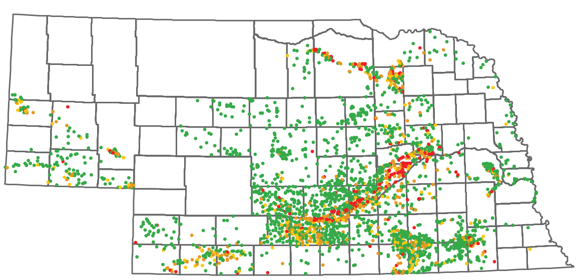
1991 (2344 wells, 2872 analyses)



1992 (1327 wells, 2490 analyses)



1993 (1437 wells, 2862 analyses)



1994 (3778 wells, 5719 analyses)

Figure B-4
Nitrate analyses for years 1990 - 1994
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- < 7.5 mg/l
- 7.5 – 10 mg/l
- 10 – 20 mg/l
- > 20 mg/l

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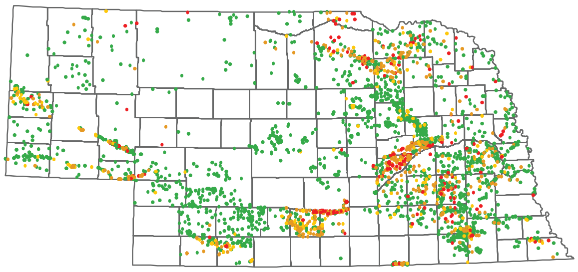
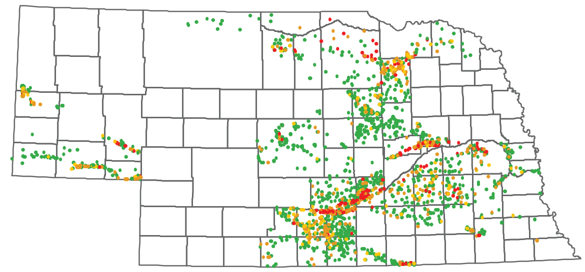
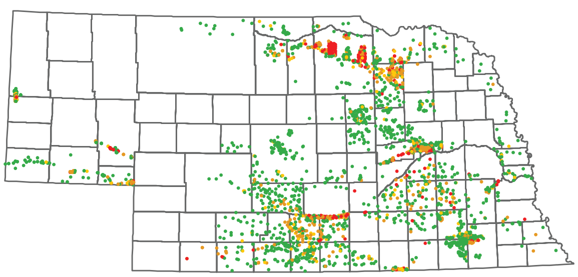


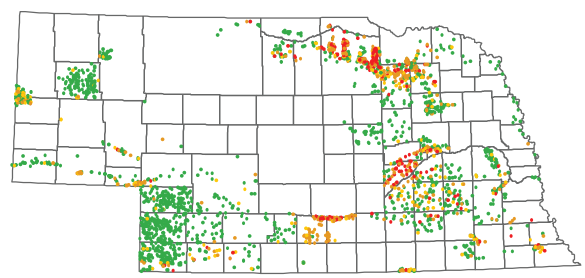
1995 (3390 wells, 4745 analyses)



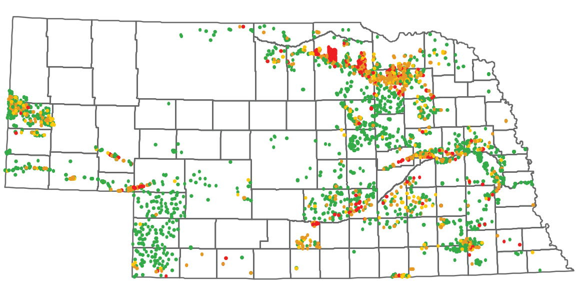
1996 (2582 wells, 4208 analyses)



1997 (2630 wells, 3611 analyses)



1998 (2429 wells, 3161 analyses)



1999 (2893 wells, 3575 analyses)

Figure B-5
Nitrate analyses for years 1995 - 1999
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- **< 7.5 mg/l**
- **7.5 – 10 mg/l**
- **10 – 20 mg/l**
- **> 20 mg/l**

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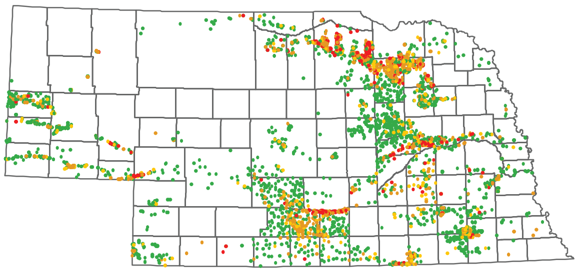
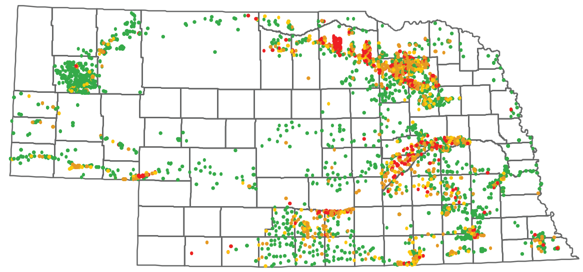
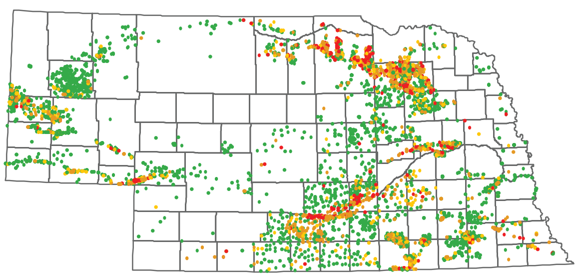


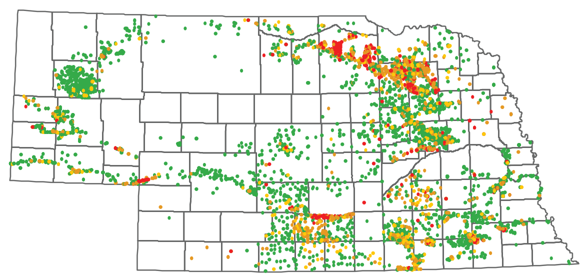
2000 (3513 wells, 4485 analyses)



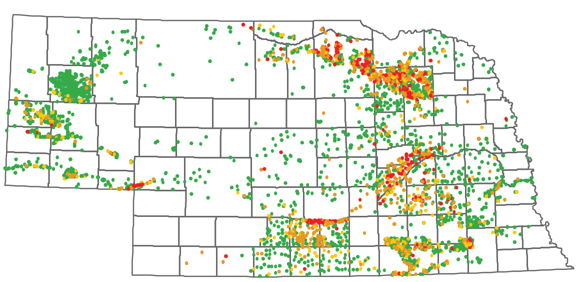
2001 (3252 wells, 3877 analyses)



2002 (4328 wells, 5256 analyses)



2003 (4429 wells, 5198 analyses)



2004 (3983 wells, 4951 analyses)

Figure B-6
Nitrate analyses for years 2000 - 2004
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- < 7.5 mg/l
- 7.5 – 10 mg/l
- 10 – 20 mg/l
- > 20 mg/l

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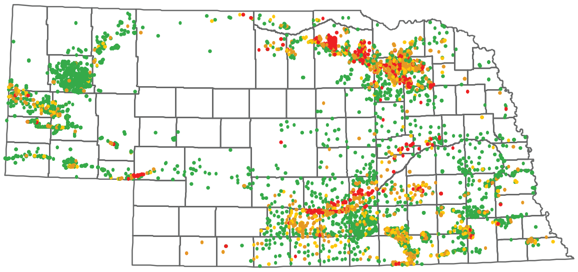
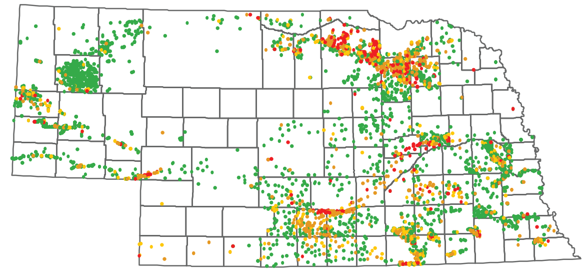
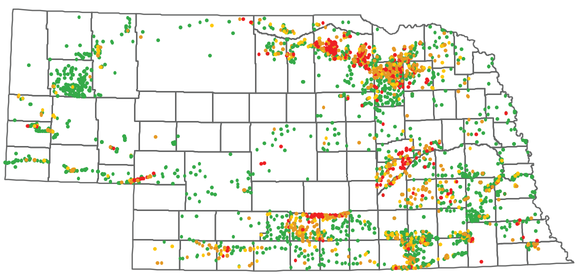


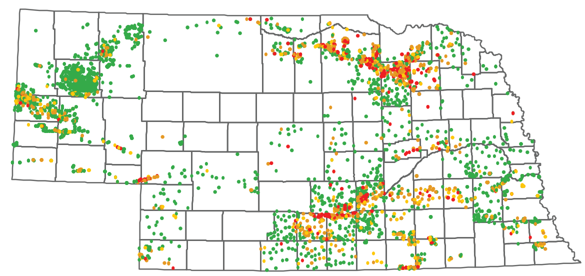
2005 (4283 wells, 5293 analyses)



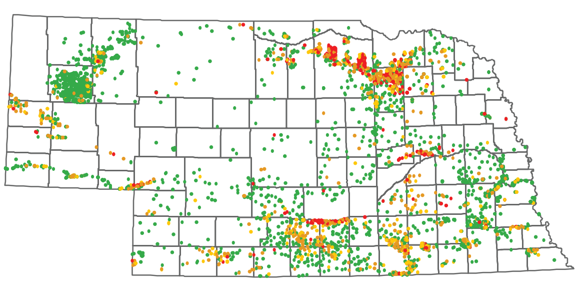
2006 (3899 wells, 4855 analyses)



2007 (3106 wells, 3618 analyses)



2008 (3473 wells, 3985 analyses)



2009 (3436 wells, 4059 analyses)

Figure B-7
Nitrate analyses for years 2005 - 2009
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- < 7.5 mg/l
- 7.5 – 10 mg/l
- 10 – 20 mg/l
- > 20 mg/l

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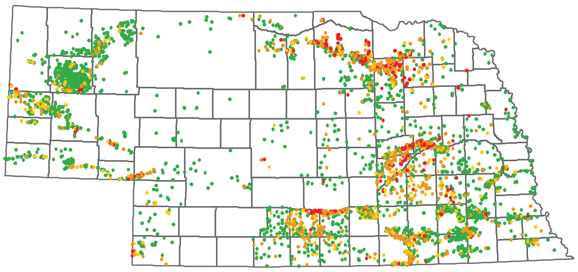
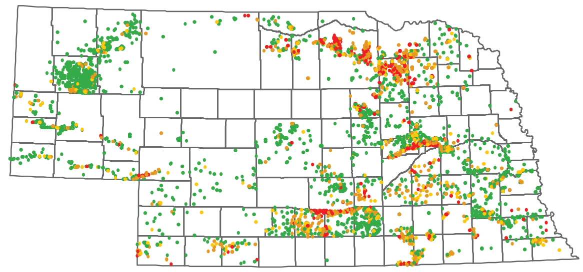


2010 (4497 wells, 5052 analyses)



2011 (4117 wells, 4614 analyses)

Figure B-8
Nitrate analyses for years 2010 - 2011
(Source: Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater)

Nitrate Levels
- **< 7.5 mg/l**
- **7.5 – 10 mg/l**
- **10 – 20 mg/l**
- **> 20 mg/l**

Empty areas indicate no data reported. These Maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (http://deq.ne.gov/) and use your Adobe Acrobat reader to enlarge individual maps.