

2023 Nebraska Groundwater Quality Monitoring Report



NEBRASKA

Good Life. Great Resources.

DEPT. OF ENVIRONMENT AND ENERGY

**Groundwater Section
November 2023**

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

Image on front cover:

Sunset in Nebraska. Photo by Marty Link.

Acknowledgements:

This report would not be possible without the cooperation of the agencies and organizations contributing groundwater data to the “Clearinghouse” (formerly 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. Thanks to Amanda Woita for compiling the report, and Laura Johnson for editing (both with NDEE). Direct any questions regarding this report to David Miesbach, Groundwater Section, NDEE, at (402) 471-4982.

*This report is dedicated to Jeffrey J. Gottula, PG
1955-2023*



Table of Contents

Introduction	1
Groundwater in Nebraska	2
Depth and Velocity of Groundwater	2
Geology and Groundwater	4
Importance of Groundwater	6
Groundwater Quality Data	7
Types of Wells Sampled	7
Monitoring Parameters	7
Discussion and Analysis	8
Nitrate Trends Utilizing the Database	9
Nitrate in Public Water Supplies	12
Herbicides	15
Atrazine	15
Alachlor	15
Metolachlor	15
Simazine	15
Conclusions	16
References	17

Tables

Table 1. Active registered water wells and use as of November 2023	6
Table 2. Total number of groundwater analyses by type	7



Figures

Figure 1. Basic aquifer concepts	2
Figure 2. Generalized hydrologic cycle	3
Figure 3. Generalized depth to groundwater	3
Figure 4. Map of High Plains aquifer identifying the Ogallala Group	5
Figure 5. Excerpts from the generalized geologic and hydrostratigraphic framework of Nebraska . . .	5
Figure 6. Map of valleys topographic region and paleovalley aquifers.	5
Figure 7. Active registered water wells as of November 2023	6
Figure 8. Location of groundwater management area studies completed by NDEE.	8
Figure 9. Graph and map of Nitrate-N concentration, domestic wells, 2000-2019.	10
Figure 10. Graph and map of Nitrate-N concentration, public water wells, 2000-2022	11
Figure 11. Map of Nitrate-N concentration median levels by township	12
Figure 12. Heatmap for Nitrate-N concentrations from water wells (all types) 2015-2020	13
Figure 13. Community public water supply systems with requirements for nitrate	14
Figure 14. Community public water supply systems with requirements for uranium.	14

Appendix

Appendix A. Compounds for which groundwater samples have been analyzed.	A-1 – A-2
Appendix B. Diagram of the nitrogen cycle	B-1

2023 Nebraska Groundwater Quality Monitoring Report

INTRODUCTION

The 2001 Nebraska Legislature passed LB329 (Neb. Rev. Stat. §46-1304) which, in part, directed the Nebraska Department of Environment and Energy (NDEE) 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 Environment and Energy 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 (NRDs) 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 monitoring was being conducted years before LB329 was passed. Many entities performed monitoring of groundwater besides the 23 NRDs for a variety of purposes.

Those entities include:

- Nebraska Department of Agriculture
- Nebraska Department of Environment and Energy
- Nebraska Department of Health and Human Services
- Public Water Suppliers
- University of Nebraska-Lincoln
- United States Geological Survey

The Nebraska Departments of Agriculture (NDA), Environmental Quality (currently NDEE) 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 was the Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater (referred to as the Database in this publication). The Database brought together groundwater data from different sources and provided public access to this data.

In 2019, the NDEE and UNL staff worked with a contractor sponsored by the Ground Water Protection Council (GWPC) to develop a new application to present the Database to the public. The Nebraska Groundwater Quality Clearinghouse (referred to as the Clearinghouse in this publication) was developed using the Database as an interactive interface that features data, maps, well construction details and statistics.

The Clearinghouse serves two primary functions. First, it provides the public the results of groundwater monitoring for agricultural compounds in Nebraska as performed by a variety of entities. Second, it provides an indicator of the methodologies that were used in sampling and analysis for each of the results. UNL staff examined 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.

This year’s publication utilized the Clearinghouse to present over 1,748,000 samples tested for 321 potential contaminants from over 34,000 public and private wells. Below is information on the groundwater in Nebraska to help the user better understand the data presented in the Clearinghouse and what it means to our State.

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 as shown in Figure 2. 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).

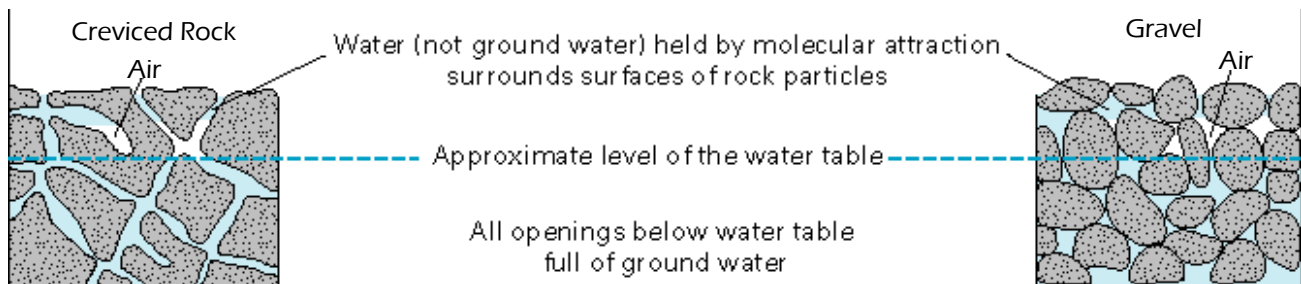


Figure 1. Basic aquifer concepts (U.S. Geological Survey).

Depth & Velocity of Groundwater

The depth to groundwater plays a very important role in Nebraska’s valuable water resource. A shallow well is cheaper to drill, construct, and pump. However, 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 3 shows the great variation of depth to water across the State.

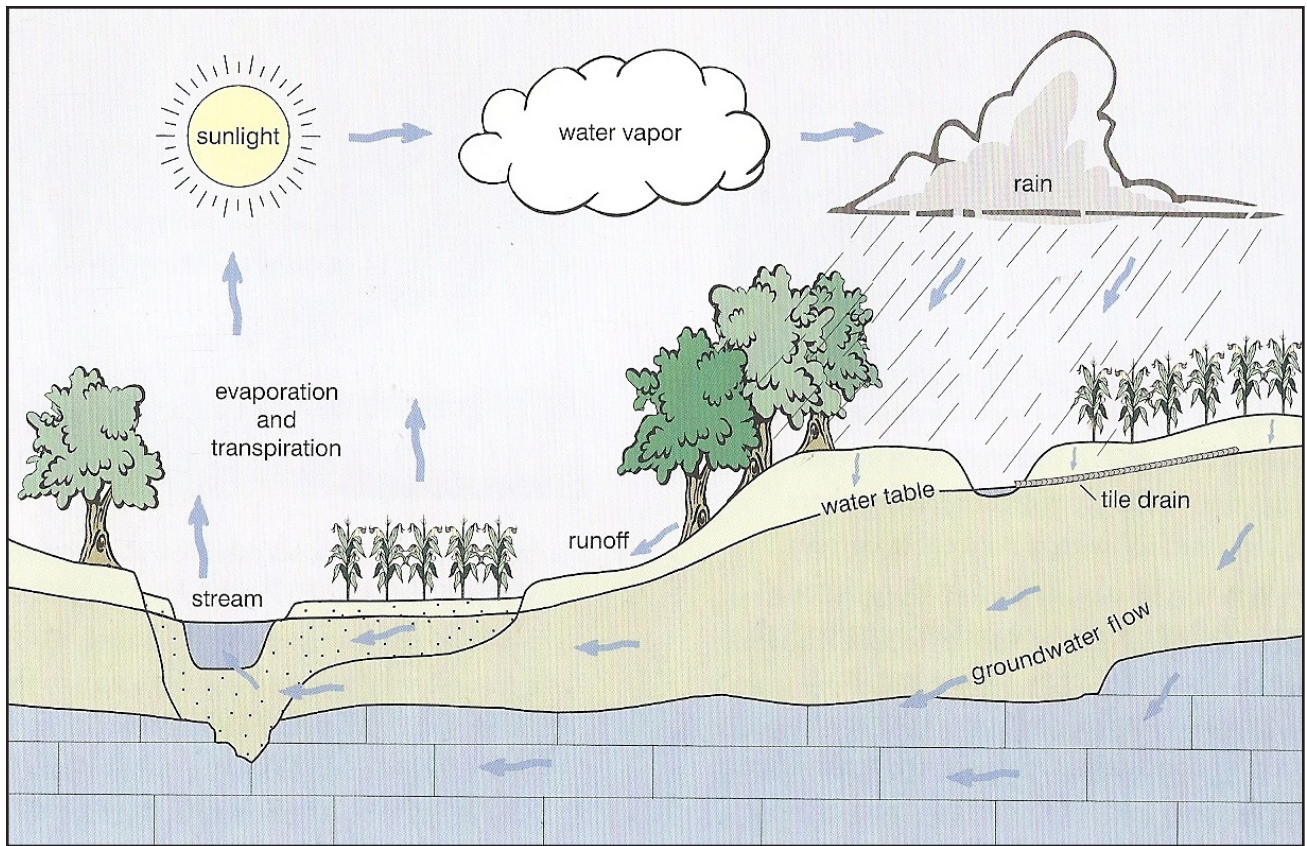


Figure 2. Generalized hydrologic cycle. (Prior, 2003).

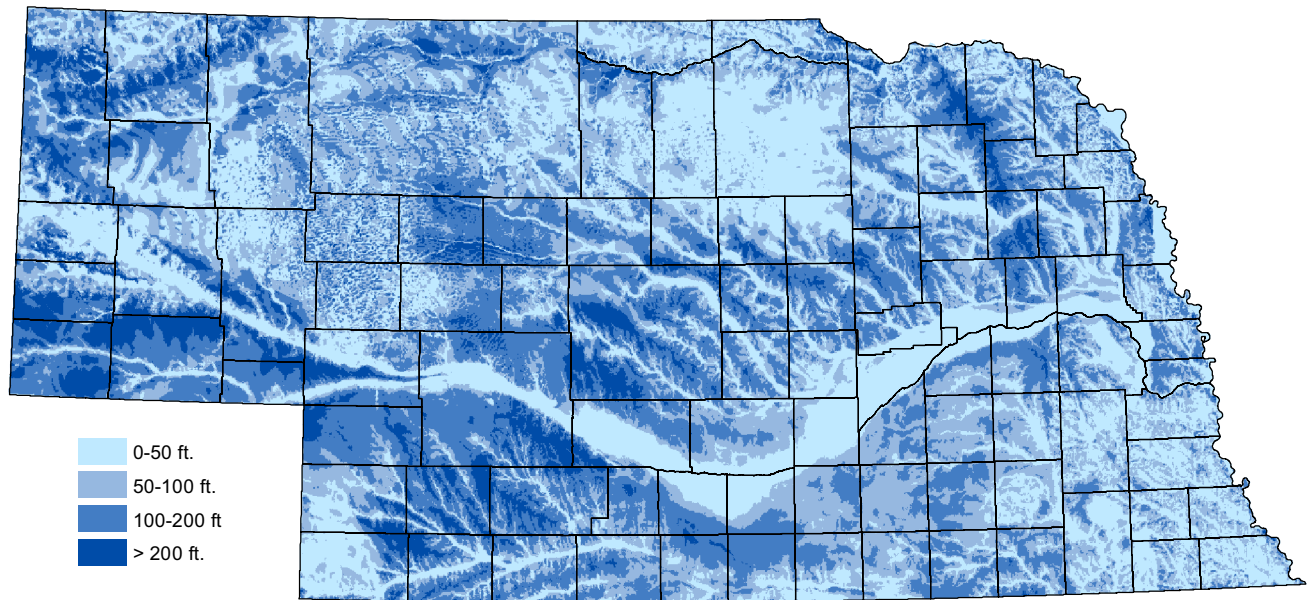


Figure 3. Generalized depth to groundwater.
(Source: University of Nebraska, Conservation and Survey Division, 1998)

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. Basic groundwater features are shown in Figures 1 and 2. The most important geologic characteristics that impact groundwater movement are as follows:

- The sediment in the saturated zone of the aquifer. Groundwater generally flows faster through gravel sediments than clay sediments.
- The ‘sorting’ of the sediment. 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.

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.

Geology and Groundwater

Nebraska has been “underwater” most of its history. Ancient seas deposited multiple layers of marine sediments that eventually formed sandstone, shale, and limestone. These geologic units are now considered “bedrock” and underlie the entire State. Limited fresh water supplies can be found in this bedrock mainly in the eastern portion of the State. After the seas retreated, huge river systems deposited sand and gravel eroded from mountain building to the west to form groundwater bearing formations such as the lower Chadron, Ogallala (Figures 4 and 5) and Broadwater. Next, the combination of erosion (statewide) and glaciation in the east introduced new material that was deposited by wind, water, and ice to form the remainder of the High Plains Aquifer (Figure 4 and 5).

The High Plains Aquifer is a conglomeration of many separate groundwater bearing formations such as the Brule, Arikaree, Ogallala, Broadwater, and many more recent unnamed deposits (including the Sand Hills). Many of the unnamed deposits are found mainly within the stream valleys (recent or ancient) and are a common source of groundwater (Figure 6, left pane). No single formation completely covers the entire state. However, when these numerous formations and deposits are combined, they form the High Plains Aquifer, covering almost 90% of Nebraska.

There are parts of eastern Nebraska where the High Plains Aquifer is not present. These areas rely heavily on groundwater from buried ancient river channels (paleovalleys) or recent alluvial valleys (Missouri, Platte, and Nemaha Rivers) (Figure 6, right pane).

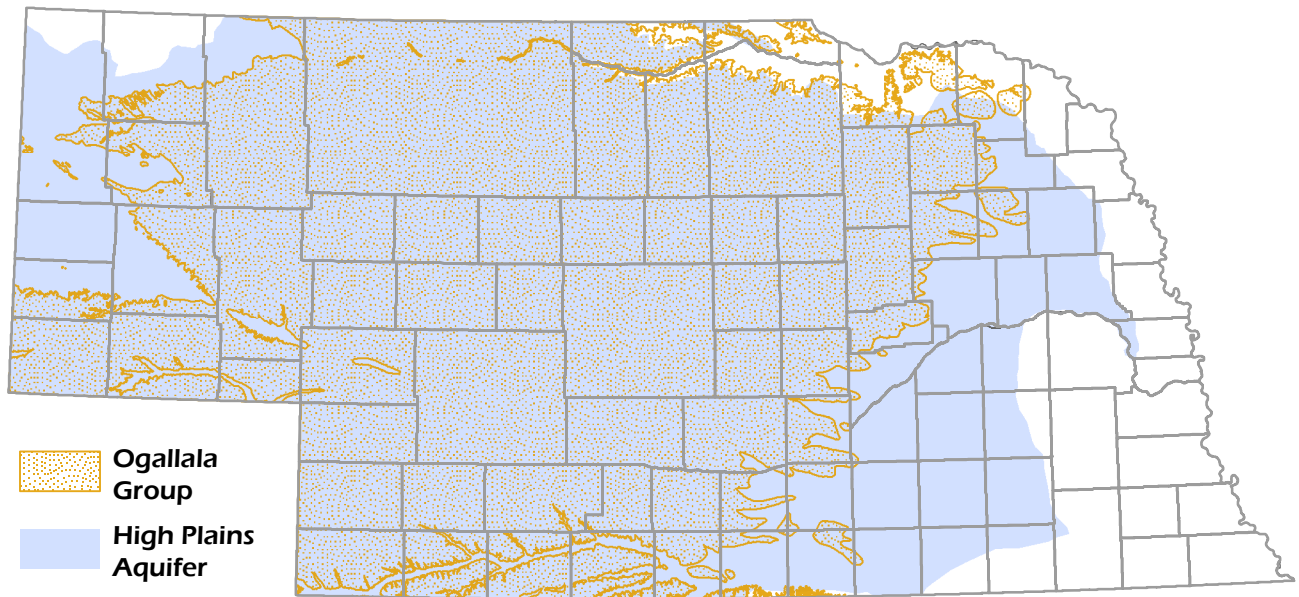


Figure 4. Map of the High Plains aquifer identifying the Ogallala Group.
 (Source: University of NE, Conservation and Survey Division, 2013)

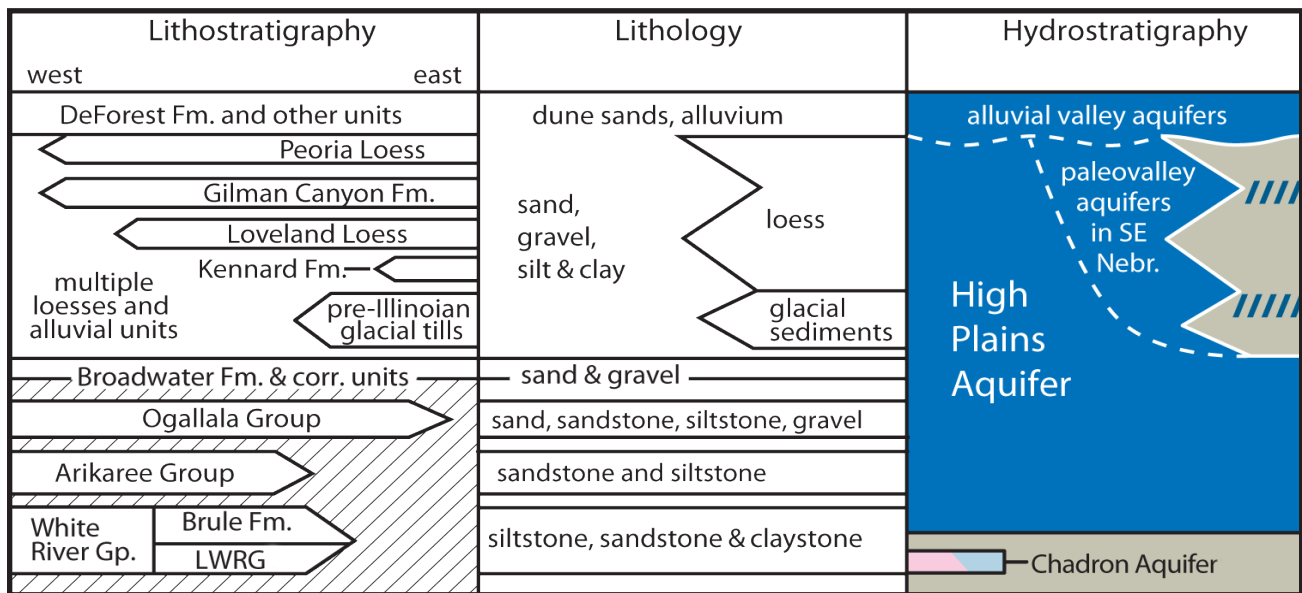


Figure 5. Excerpts from the generalized geologic and hydrostratigraphic framework of Nebraska.
 (Source: University of Nebraska, Conservation and Survey Division, 2013)

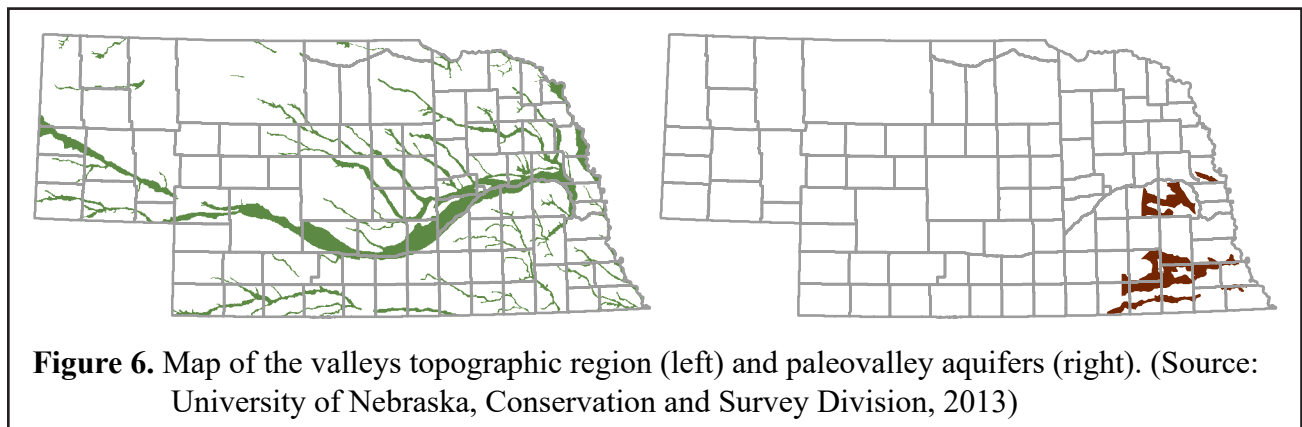


Figure 6. Map of the valleys topographic region (left) and paleovalley aquifers (right). (Source: University of Nebraska, Conservation and Survey Division, 2013)

Importance of Groundwater

Nebraska is one of the most groundwater-rich states in the United States. Approximately 88% of the state’s residents rely on 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%. There are over 1,950,000 people living in Nebraska. Of that total just over 1,600,000 are served water by community water systems (including rural water systems). That leaves just over 360,000 Nebraskans that depend on private domestic wells for their drinking water supply. Not only does Nebraska depend on groundwater for its drinking water supply, but also the state’s agricultural industry utilizes vast amounts of groundwater to irrigate crops and water livestock. 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 November 2023, the Nebraska Department of Natural Resources (NDNR) listed over 96,400 active irrigation wells and over 34,600 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. A tabletop exercise was performed this year comparing known residences in a county to registered wells. It was calculated that only 23.8% of the domestic wells were registered in that county. Using that ratio statewide, it calculates out to approximately 145,000 domestic wells. In 2022 it was estimated that there were 2.5 people per household in the United States. If there were 145,000 domestic wells and each well represented one household, domestic wells would be serving approximately 362,500 people. Figure 7 and information shown in Table 1 help illustrate this.

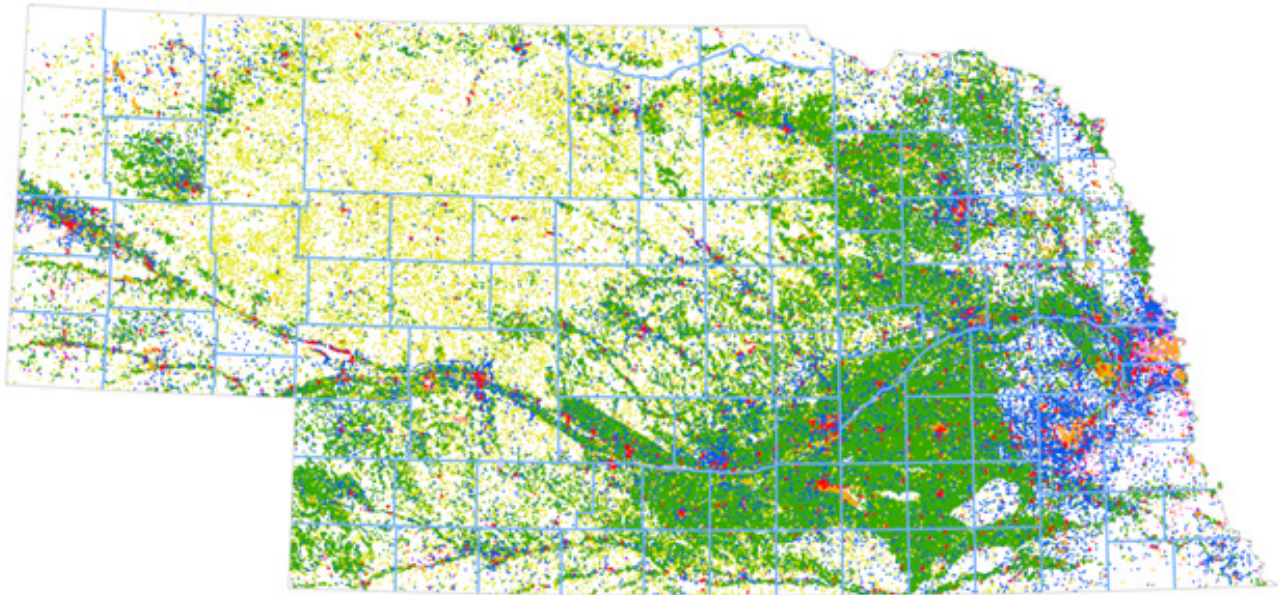









Figure 7. Active registered water wells as of November 2023.

(Source: Nebraska Department of Natural Resources Registered Well Database, 2022)

Table 1. Active registered water wells and use as of November 2023.

(Source: Nebraska Department of Natural Resources Registered Well Database, 2022)

	Water Use	Active
	Irrigation	96,439
	Domestic	34,647
	Livestock	24,670
	Monitoring (groundwater quality)	18,317
	Public Water Supply	3,051
	Commercial/Industrial	1,830
	Other	12,456
	Total	191,410

GROUNDWATER QUALITY DATA

Groundwater quality data presented in the remainder of this report reflect the data present in the Clearinghouse as of October 1, 2023. The dates for these data range from mid-1974 to 2022. Groundwater results for 2020, 2021, and 2022 can be found in the Clearinghouse, but the data sets are not complete due to issues still being resolved for entering the data. The NDEE is confident that the information presented in this report represents the majority of sample results available.

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 (longer screens across large portions of the aquifer). However, in recent years, monitoring agencies have been installing increasing numbers of dedicated groundwater monitoring wells designed and located specifically to produce samples (shorter screens in distinct portions of the aquifer). By utilizing such varied sources, groundwater data from a range of geologic conditions can be obtained.

Well Type	Number of Analyses	Number of Wells
Irrigation	127,558	18,875
Domestic	77,790	6,245
Public Water Supply	1,278,571	5,200
Monitoring	259,955	2,907
Commercial/Industrial	2,592	83
Heat Pump (GW source)	8	5
Other	2,182	728
Total	1,748,656	34,043

Table 2. Total number of groundwater analyses by well type.
(Source: Nebraska Groundwater Quality Clearinghouse, 2023)

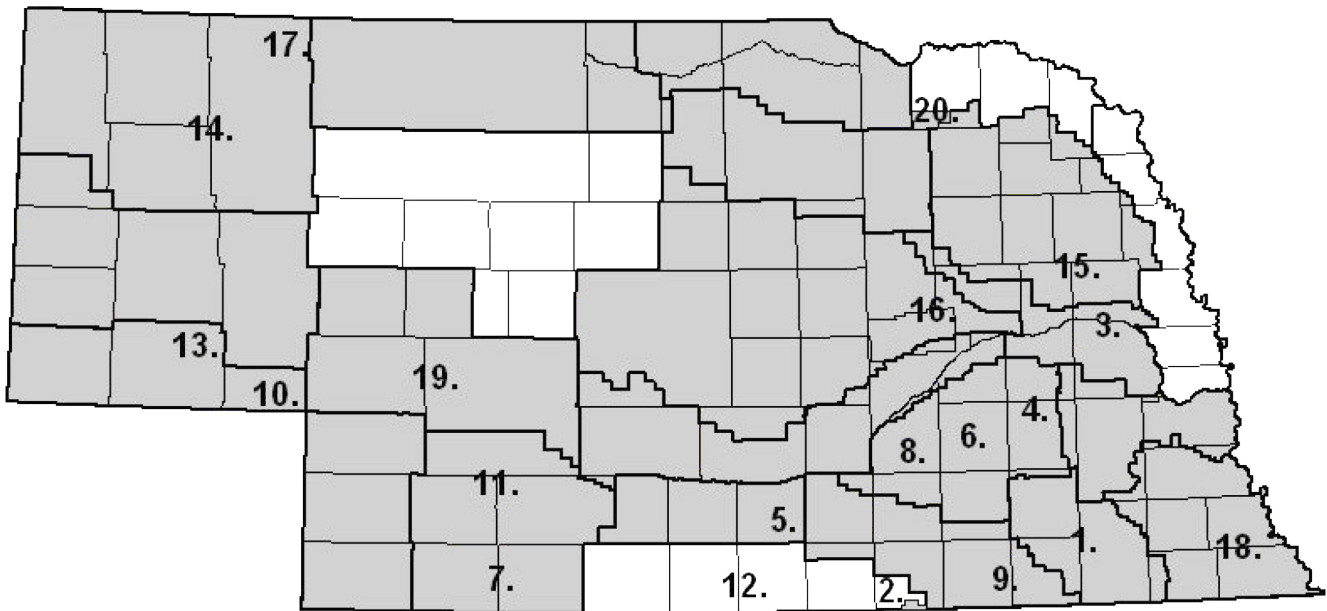
Monitoring Parameters

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 Clearinghouse has provided an important tool for such analysis. Appendix A lists the compounds for which groundwater has been sampled and analyzed since 1974.

The table in Appendix A shows a wide variety of compounds for which groundwater samples have been analyzed, the majority of which are used in agricultural production. Since the creation of the Clearinghouse, analytes which Public Water Systems test for have also been added (approximately 30) to the list. The Clearinghouse has been set up so that new analytes may be added in the future. Currently, there are 321 analytes in the Clearinghouse.

DISCUSSION AND ANALYSIS

This report highlights the presence of elevated levels of nitrate and herbicides in groundwater and the occurrence is associated with the practice of irrigated agriculture, especially corn production (Exner and Spalding 1990). In response, the Natural Resources Districts have instituted Groundwater Management Areas (GWMAs) in nearly all the 23 districts based on the results of this data. The implementation of Groundwater Management Areas indicates a concern and recognition of nonpoint source groundwater contamination and a need to protect this State's most valuable natural resource. Additionally, NDEQ's (currently NDEE) Groundwater Management Area Program has completed 20 studies across the state since 1988, identifying areas of nonpoint source contamination mainly from



- | | |
|-----------------------------------|--------------------------------------|
| 1. Beatrice/DeWitt, 1988 | 11. N. Middle Republican, 1995 |
| 2. Superior, 1988 | 12. Lower Republican, 1996 - 97 |
| 3. Fremont, 1988 | 13. E. Cheyenne Co., 1996 |
| 4. E. Upper Big Blue, 1989 | 14. Box Butte Co./Mirage Flats, 1998 |
| 5. Wilcox/Hildreth, 1989 | 15. S. Lower Elkhorn, 1999 |
| 6. York/Polk Co., 1990 | 16. E. Lower Loup, 2000 |
| 7. Red Willow/Hitchcock Co., 1990 | 17. E. Sheridan Co., 2001 |
| 8. W. Upper Big Blue, 1991 | 18. Humboldt, 2001 |
| 9. E. Little Blue, 1992 - 1994 | 19. Keith-Lincoln Co., 2002 - 2003 |
| 10. Deuel Co., 1992 | 20. Bazile Triangle, 2004 |

Figure 8. Location of Groundwater Management Area studies completed by NDEE. the widespread application of commercial fertilizer and animal waste (Figure 8).

While irrigated agriculture has been documented as a source of nitrate in groundwater, there are many other sources that can contribute. The application of commercial fertilizer on green spaces such as yards or golf courses, septic systems, waste lagoons (municipal, private or livestock) or the

application of livestock waste are some examples (Appendix B, Nitrogen Cycle).

The State of Nebraska has a geographic area of over 77,000 square miles. Accurately characterizing the quality of Nebraska's groundwater in a complex aquifer system has always been challenging. Collaboration and taking a statewide view of all the groundwater data collected provides for robust trend analysis. The goal is to ascertain areas in Nebraska where groundwater contaminant levels are decreasing through better management and farming practices so that these positive trends can be spread across the State.

Though we have groundwater data, there are over 189,000 active registered wells in Nebraska and only enough resources to collect samples from less than 12% of them annually (since 2000). However, that data still can be utilized to determine where there are water quality issues in Nebraska. Figure 11 clearly shows where there are areas of high nitrate. Both Figures 9 and 10 identify areas in Nebraska where people are currently drinking the groundwater. It should be noted that Figure 9 illustrates only the domestic wells that have been sampled and entered into the Clearinghouse since 2000. Only 1638 domestic wells (converts to 4,095 people) have been sampled of the 33,754 registered domestic wells. There are most likely domestic wells within the area of high nitrate shown in Figures 11 and 12 that are not identified on Figure 9. Both the NRDs and the NDEE are working together to try and fill those gaps.

Nitrate Trends Utilizing the Database

Nitrate monitoring data have been collected from wells for many years, and the purpose of collection has varied by the agency or organization performing the work. For instance, public water system operators sample their drinking water wells to ensure they are in compliance with the Safe Drinking Water Act while the NRDs have been collecting data to make groundwater management decisions.

The Clearinghouse now makes accessing and reviewing groundwater data relatively straightforward, but users need to be aware that differences in wells may result in incorrect assumptions. Data may be collected from:

- deep wells (bottom of the aquifer) vs. shallow wells (top of the aquifer) or
- irrigation wells (potentially screened across multiple aquifers) vs. dedicated monitoring wells (with perhaps only 10 feet of screen) or
- wells located near potential sources of contamination such as septic tanks or past chemical spills vs. wells located in pristine rangeland or
- wells used for measuring water levels (observation) vs. wells used for water quality.

Several different methods have been used to present and interpret the nitrate data collected since the early 1970's. Reviewing the entire Clearinghouse shows that consistent sampling events and locations have occurred since about 2000. Charts and maps are used to help "visualize" the data and were generated using the Clearinghouse. Figures 9 and 10 present the median (center of the data) nitrate concentration and simple trends during that time period. Figure 9 is nitrate data collected from domestic wells (untreated), while figure 10 is nitrate data collected from public water supply wells

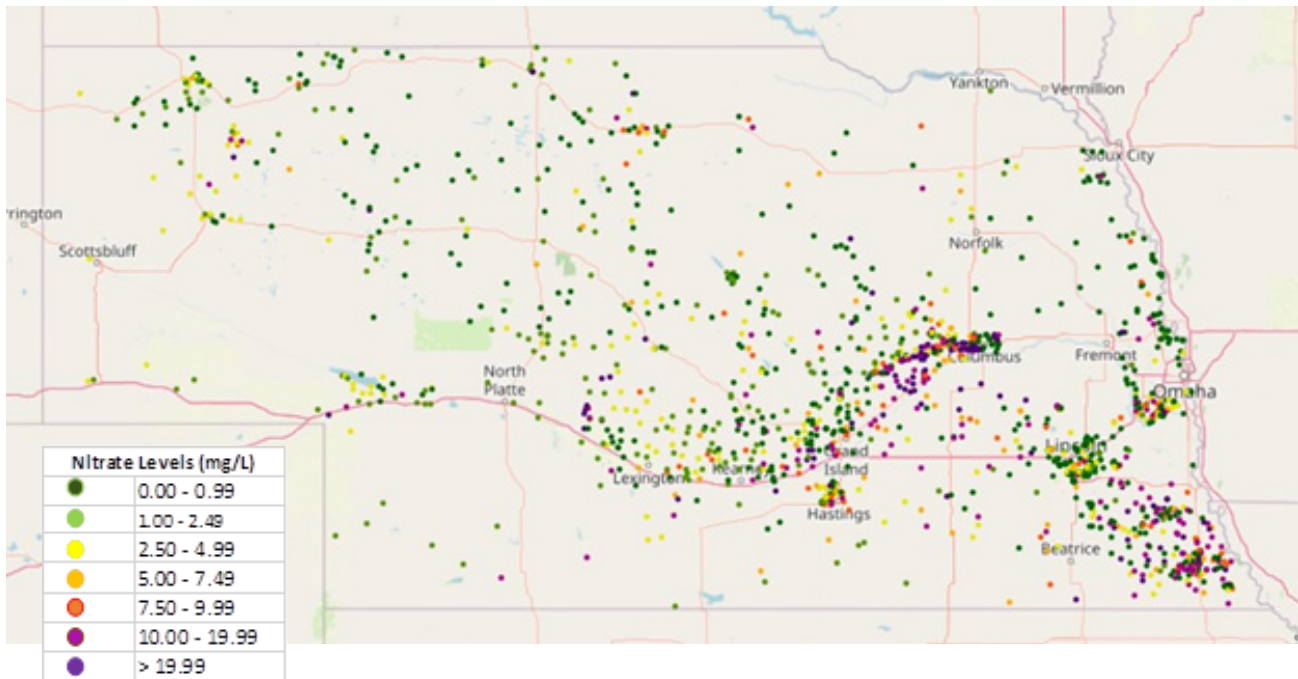
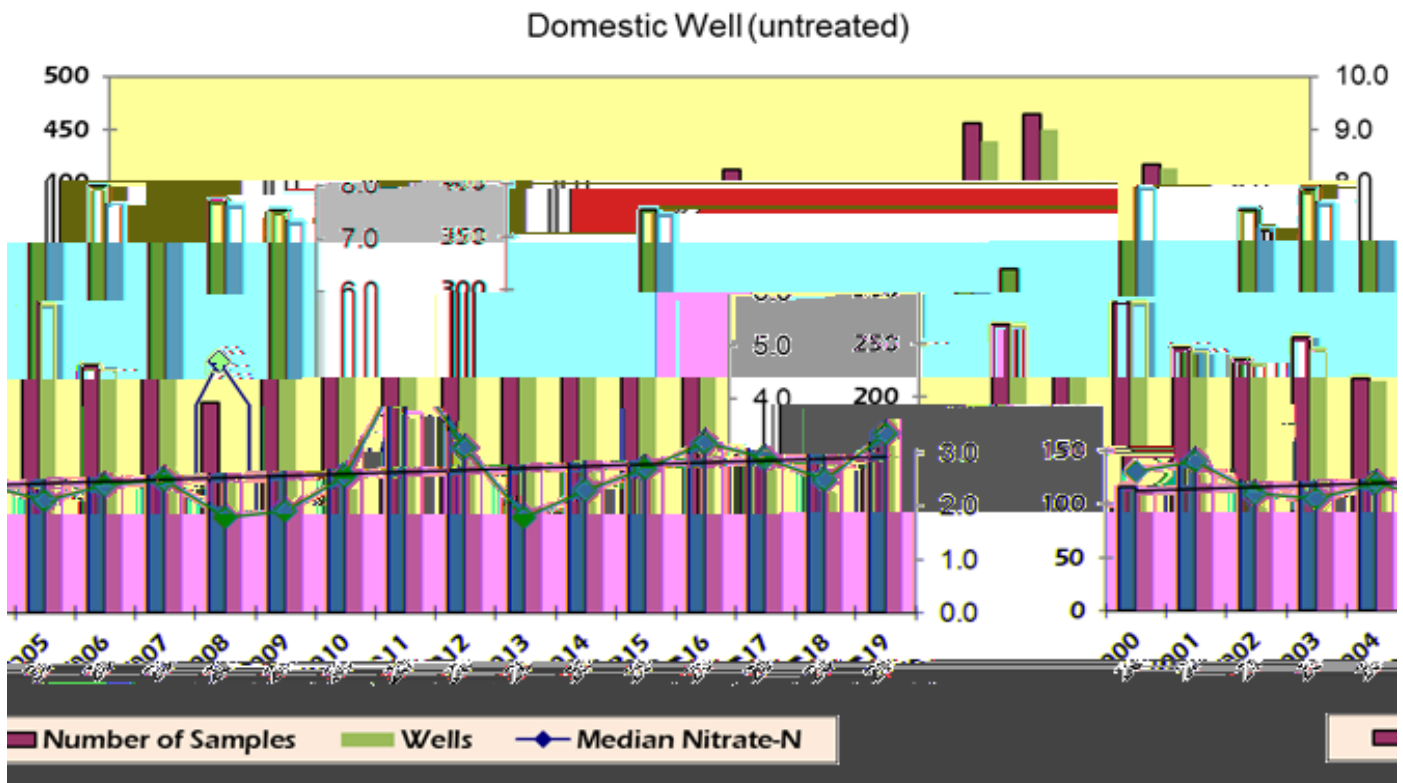


Figure 9. Graph and map of Nitrate-N concentration of 6,435 samples from an average of 312 domestic wells during 2000 – 2019. (Source: Nebraska Groundwater Quality Clearinghouse, 2023) *Empty areas indicate no data reported, not the absence of nitrate in groundwater.*

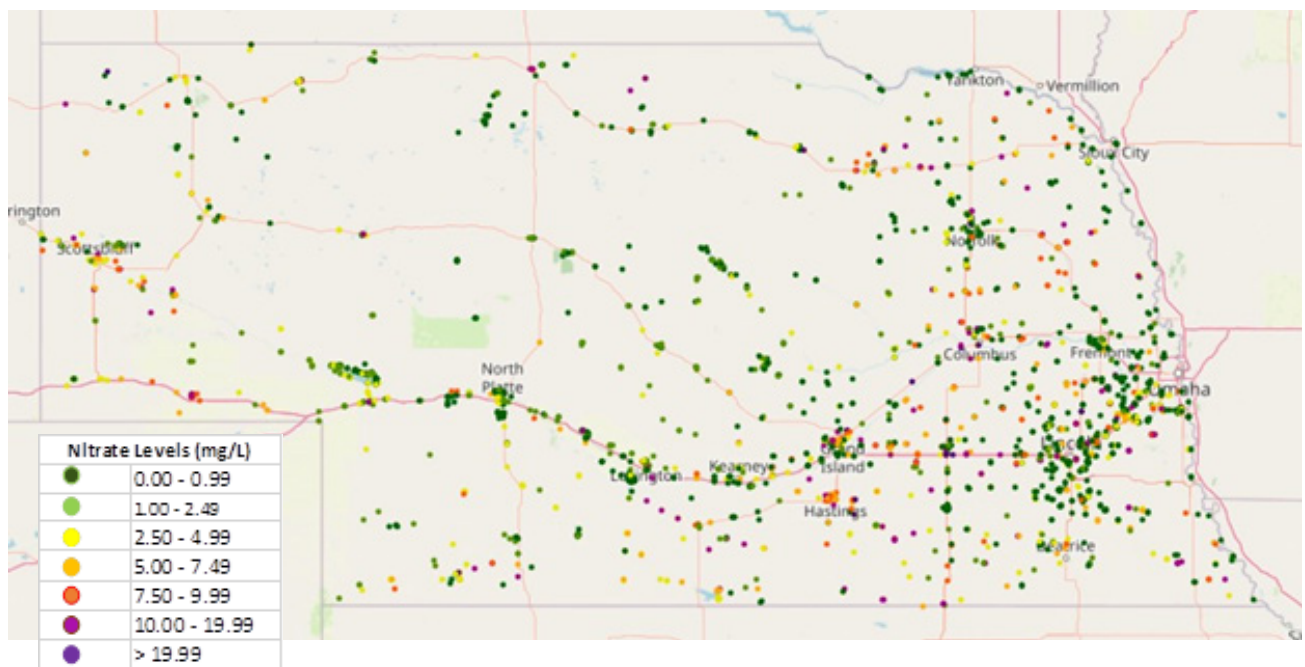
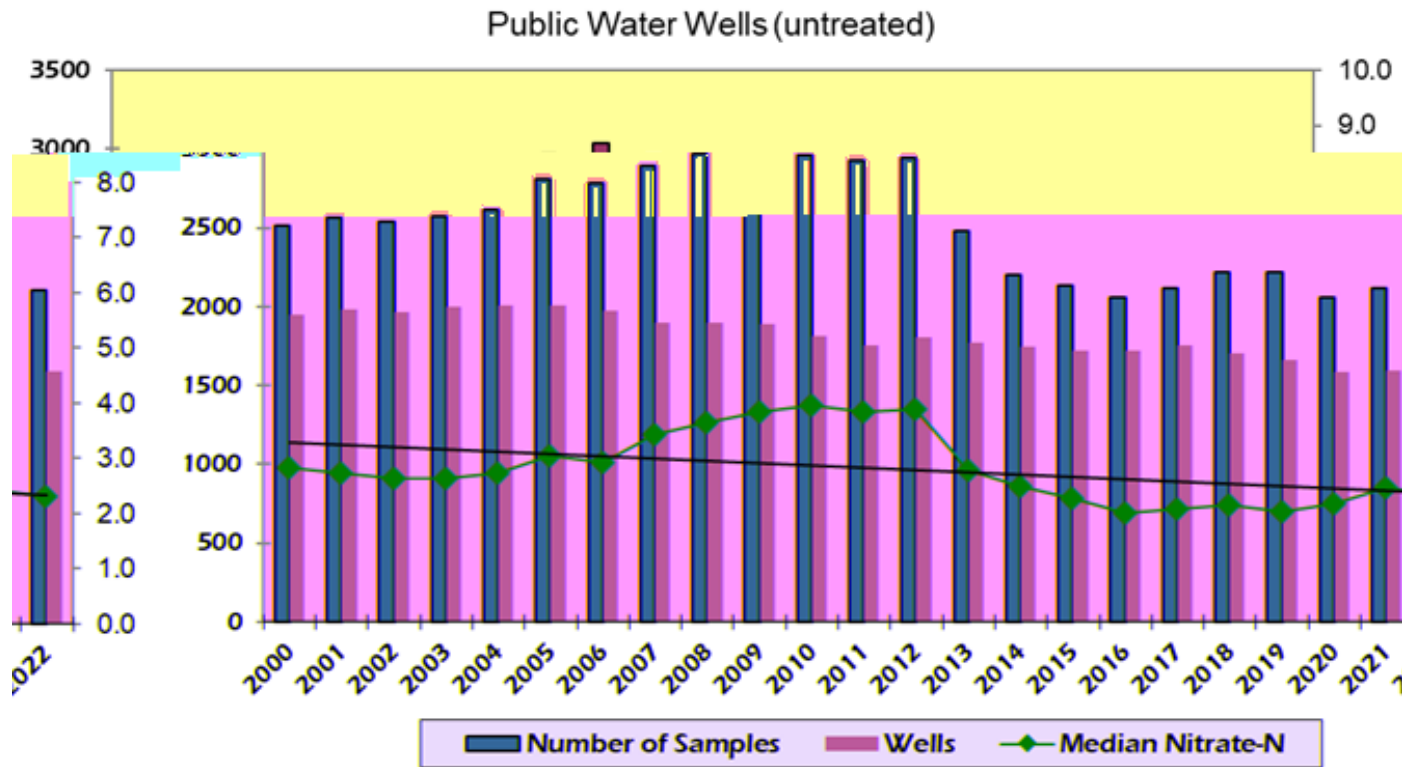


Figure 10. Graph and map of Nitrate-N concentration of 57,840 samples from an average of 1,816 public water wells during 2000 – 2022. (Source: Nebraska Groundwater Quality Clearinghouse, 2023) Empty areas indicate no data reported, not the absence of nitrate in groundwater.

(untreated).

Maps are used in an attempt to show “current” statewide groundwater quality from the most recent time the well had been sampled (aiming to show the most current water quality at that location). A township (36 square miles) map was developed using the entire data set from the Clearinghouse. The most recent sample for each well analyzed since 2000 was used to calculate the median value of

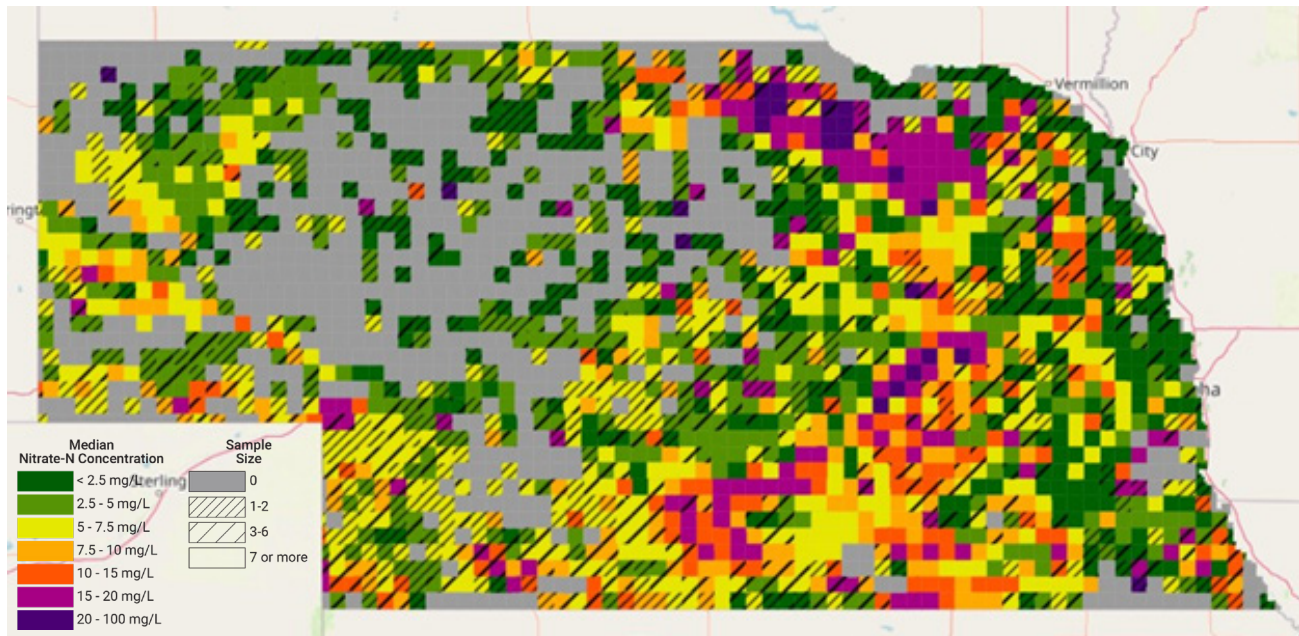


Figure 11. Median of the most recent Nitrate-N concentration by township of 34,043 water wells (all types) during 2000 – 2022. (Source: Nebraska Groundwater Quality Clearinghouse, 2023) *Gray areas indicate no data reported, not the absence of nitrate in groundwater.*

nitrate for each township (Figure 11).

Another method is called “kriging” or sometimes called a heatmap. Kriging predicts the value of a function at a given point by computing a weighted average of the known values of the function in the neighborhood of the point. Figure 12 was created using kriging using all of the nitrate data in the Clearinghouse from 1974 to 2022.

Nitrate in Public Water Supplies

In an effort to protect the drinking water quality of America’s public water systems, the federal Safe Drinking Water Act authorizes the EPA to set national drinking water standards. These standards include maximum contaminant levels based on health effects due to exposure of both naturally occurring and man-made contaminants. When a Public Water System (PWS) exceeds the Maximum Contaminant Level (MCL) for a regulated contaminant, Public Notification to the customers of the system is mandatory. If exceedances continue, an Administrative Order (AO) will be issued. This AO will mandate that the PWS make changes to their water system to bring the contaminant results consistently below the MCL for that contaminant.

The MCL for nitrate-nitrogen is 10 mg/L, but PWS systems with wells or intakes testing over 5 mg/L may be required to perform quarterly sampling. Of the nearly 550 groundwater based community PWS systems in Nebraska that supply their own water, 157 of those must perform quarterly sampling for nitrate. If a PWS exceeds the nitrate-nitrogen MCL two times in a rolling 9 month

Illustrative Heatmap: Nitrate Hotspots

Note: Predicted values are an estimate based on nitrate sample data from the groundwater clearinghouse, historic land use, soil vulnerability, and well density. Predictions have a margin of error of approximately +/- 3 and are not intended to represent definite values at any one location. Results provided for illustrative purposes.

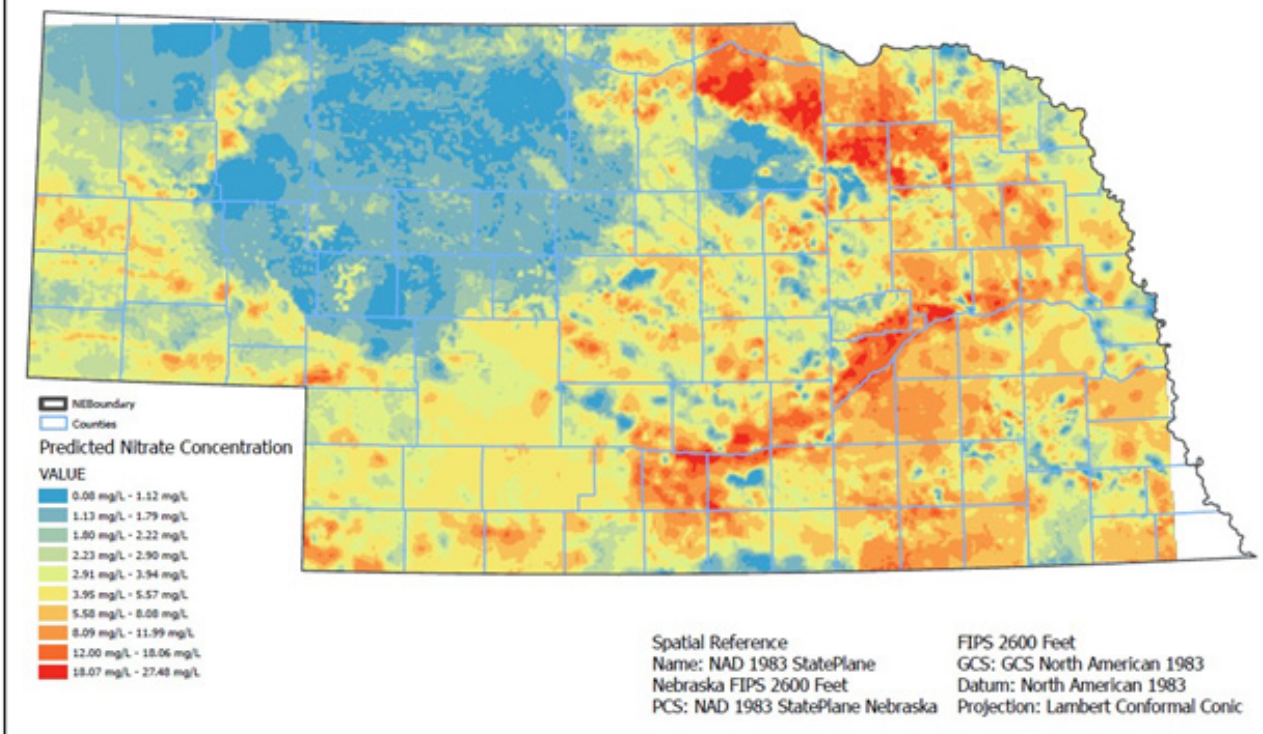


Figure 12. Illustrative Heatmap for Nitrate-N concentrations from 8,943 water wells (all types) during 2015-2020. (Source: Nebraska Groundwater Quality Clearinghouse, 2023). *White areas indicate no data reported, not the absence of nitrate in groundwater.*

period, an AO will be issued. A nitrate AO will mandate that the PWS take steps to bring their nitrate results consistently below the MCL such as drilling a new or deeper well, hooking on to a neighboring water system, blending, or building a water treatment plant. Figure 13 shows the location of active community PWS systems that have their own source of water. Colors indicate if there is an administrative order for nitrate, systems required to perform quarterly sampling, and systems treating water because of high levels of nitrate. AOs due to high levels of nitrate do not necessarily fall in the areas of highest nitrate problems, as indicated in Figures 11 and 12.

Several recent studies considered the relationship of nitrate leaching into the subsurface and uranium concentrations found in groundwater. Research indicates that natural uranium in the subsurface may be oxidized and mobilized as the nitrate (in many forms) moves through the root zone and eventually to groundwater. Uranium is found naturally in sediment deposited mainly by streams and rivers.

Some public water supply systems treat not only nitrate, but also uranium. The MCL for uranium is 0.030 mg/L. Figure 14 shows the location of active community public water systems with uranium requirements.

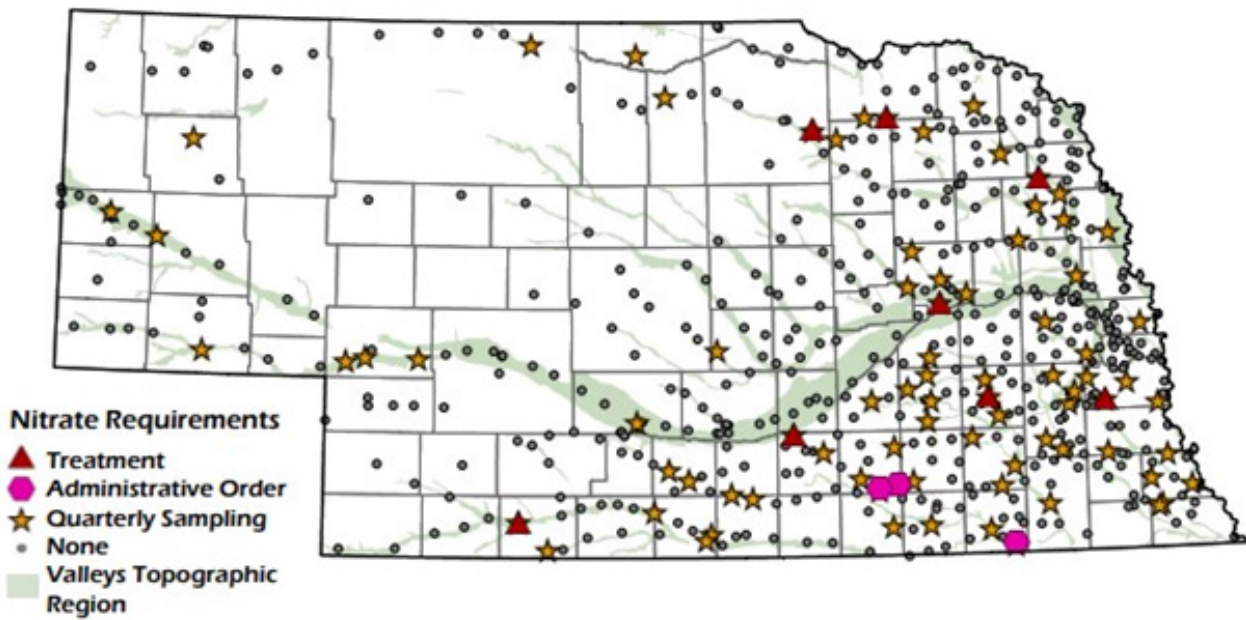


Figure 13. Community public water supply systems with requirements for nitrate. (Source: NDEE Drinking Water and Groundwater Division, 2023)

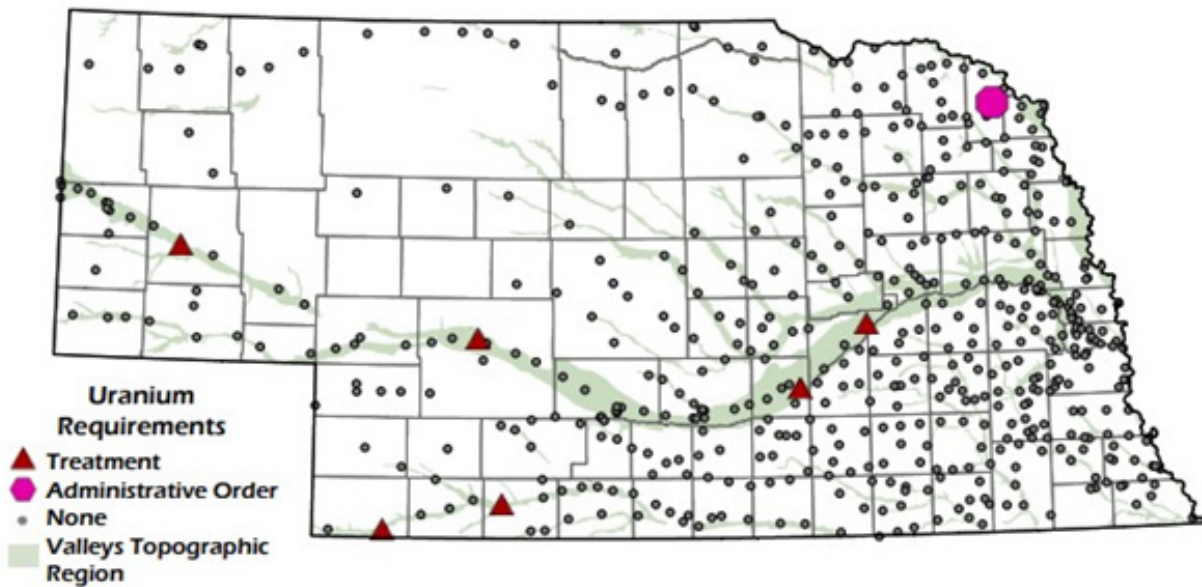


Figure 14. Community public water supply systems with requirements for uranium. (Source: NDEE Drinking Water and Groundwater Division, 2023)

HERBICIDES

Atrazine, alachlor, and metolachlor are herbicides used for weed control in crops such as corn and sorghum. In addition, the Nebraska Department of Agriculture identified alachlor and simazine as priority compounds for development of pesticide State Management Plans, following guidance produced by the U.S. Environmental Protection Agency.

Atrazine

Atrazine is used as an herbicide to eradicate broad leaf weeds. There have been 19,474 groundwater samples collected and analyzed for atrazine in the last 22 years. The mean atrazine concentration is 0.08 micrograms per liter or $\mu\text{g/L}$, compared to the USEPA's Maximum Contaminant Level of 3 $\mu\text{g/L}$, as established in the Safe Drinking Water Act.

Alachlor

Alachlor is used as an herbicide to eradicate broad leaf weeds and grasses. There have been 16,597 groundwater samples collected and analyzed for alachlor in the last 22 years. The mean alachlor concentration is 0.08 $\mu\text{g/L}$, compared to the USEPA's MCL of 6 $\mu\text{g/L}$.

Metolachlor

Metolachlor is used as an herbicide to eradicate broad leaf weeds. There have been 17,228 groundwater samples collected and for metolachlor in the last 22 years. The mean metolachlor concentration is 0.12 $\mu\text{g/L}$. There is not USEPA MCL for metolachlor, however Minnesota developed a guidance value of 300 $\mu\text{g/L}$ for metolachlor in drinking water.

Simazine

Simazine is used as an herbicide to eradicate broad leaf weeds. There have been 16,498 groundwater samples collected and analyzed for simazine in the last 22 years. The mean simazine concentration is 0.07 $\mu\text{g/L}$. The USEPA's MCL for simazine is 4 $\mu\text{g/L}$.

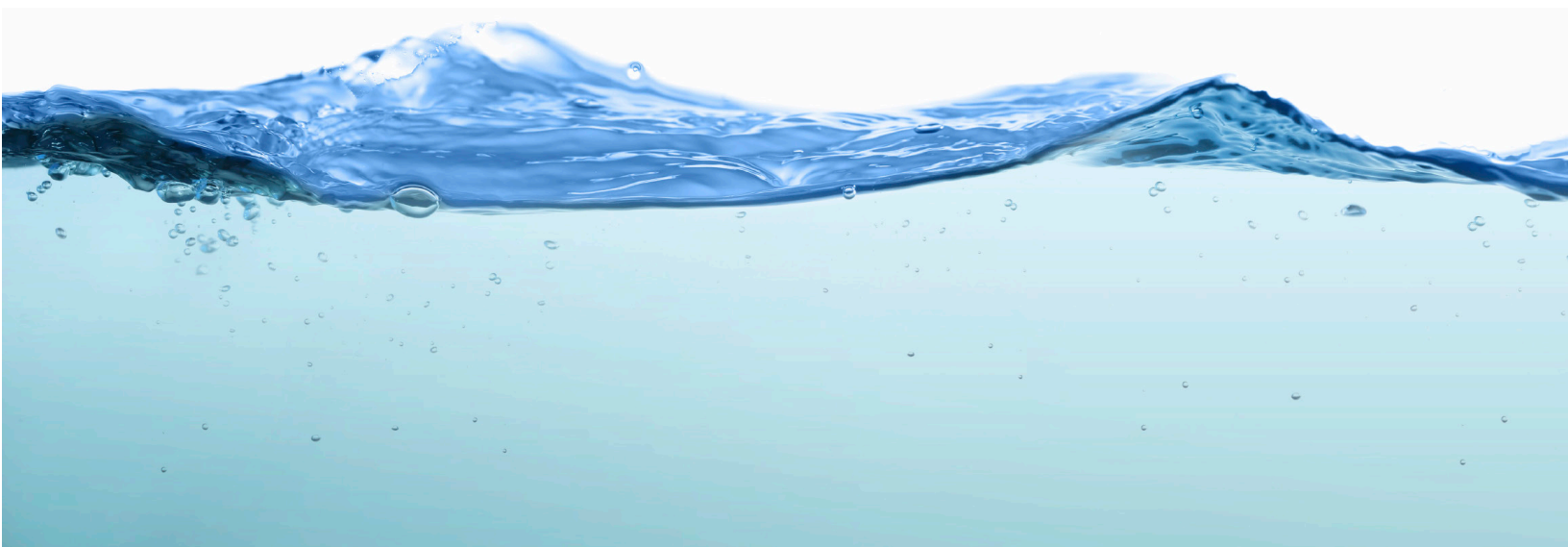
CONCLUSIONS

Groundwater is Nebraska's most valuable natural resource. 93% of Nebraska's ~1,300 public water systems serve populations under 3,300 and 95% of those systems rely solely on groundwater. Most public water supplies that utilize groundwater in Nebraska, do not require any form of treatment. The rest of the rural population relies solely on groundwater as their source of drinking water. Agriculture and industry in Nebraska rely on heavily on groundwater for production. The State's reliance on groundwater highlights the important of maintaining the quantity and quality of this resource. Monitoring groundwater contaminant trends statewide helps to ensure this.

The Clearinghouse is available to aid in managing Nebraska's valuable groundwater resource. The report authorized by Neb. Rev. Stat. § 46-1304 (LB 329, 2001) lead the way to the development of the Clearinghouse. All 23 of the NRDs are vital contributors of quality data to the Clearinghouse. Now both recent and historic groundwater quality data can be easily viewed in one location for analysis, mapping, or other uses.

Concentrations and trends of contaminants. Figures 9 and 10, pages 10 and 11 present the median nitrate concentration in groundwater for each year, and this data was utilized in a simple trend analysis from the two groundwater sources of drinking water in Nebraska. Figures 11 and 12, pages 12 and 13 highlight the areas where nitrate concentrations exceed the drinking water MCL of 10 mg/L. Over 81% of the population receives drinking water that meets the drinking water standard while the rest of the population relies on groundwater from domestic wells. Data in the Clearinghouse only represents a small fraction (6,245 domestic wells sampled since 1974) of the probable 145,000 domestic wells in use. Until more data can be obtained from domestic users, they must assume that if their domestic well is located in an area of high nitrate as illustrated in Figures 11 and 12 that they may also have high nitrate and should have their groundwater tested. Once the USGS network can be utilized along with the Clearinghouse, more detailed trend analyses for nitrate will be conducted. There is not enough recent data statewide for atrazine, alachlor, metolachlor, or simazine to conduct any trend analyses.

The Future. Continued attention and resources directed toward groundwater monitoring data for the Clearinghouse and implementation of the USGS National Groundwater Monitoring Network will be crucial for the successful management of Nebraska's groundwater. Best-Management practices, such as adjusting fertilizer application rates and timing must continue to see improvements in Nebraska's groundwater quality.



REFERENCES

- Exner, M.E., and R.F. Spalding. 1990. Occurrence of pesticides and nitrate in Nebraska's groundwater. University of Nebraska Water Center publication WC-1, 34 p.
- Nebraska Department of Environmental Quality. 2001a. Comprehensive study of water quality monitoring in Nebraska—LB 1234 Phase I Report. NDEQ, 23 p.
- Nebraska Department of Environmental Quality. 2001b. Comprehensive study of water quality monitoring in Nebraska—LB 1234 Phase II Report. NDEQ, 50 p.
- Nebraska Groundwater Quality Clearinghouse (Clearinghouse), November 2022. Database available online at <http://clearinghouse.nebraska.gov>.
- Prior, J.C. 2003. Iowa's Groundwater Basics. Iowa Department of Natural Resources, 6 p.
- University of Nebraska, Conservation and Survey Division. 1998. The Groundwater Atlas of Nebraska. Resource Atlas No. 4a, 44 p.
- Waller, R.M. 1982. Ground Water and the Rural Homeowner. USGS.

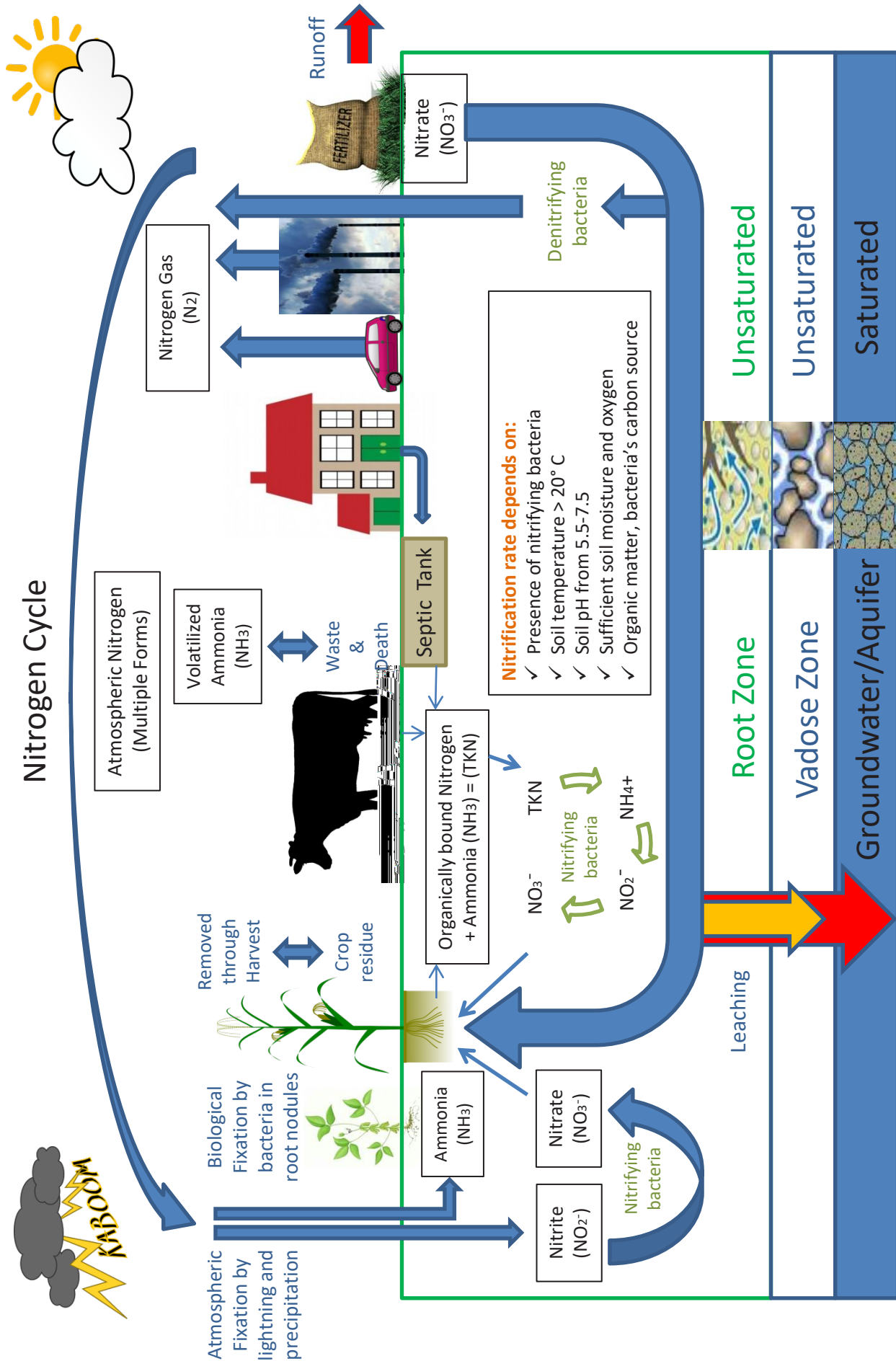


Appendix A. Compounds for which groundwater samples have been analyzed

Description		
1,1,1-Trichloroethane	Acetochlor ethane sulfonic acid	Butylate
1,1,2-Trichloroethane	Acetochlor oxanilic acid	Cadmium
1,1-Dichloroethene	Acetochlor sulfynilacetic acid	Calcium
1,2,4-Trichlorobenzene	Acifluorfen	Carbaryl
1,2-Dibromo-3-chloropropane	Acrylamide	Carbofuran
1,2-Dibromoethane (Ethylene dibromide)	Acrylonitrile	Carbon disulfide
1,2-Dichlorobenzene	Alachlor	Carbon tetrachloride
1,2-Dichloroethane	Alachlor ethane sulfonic acid	Carboxin
1,2-Dichloropropane	Alachlor ethane sulfonic acid secondary amide	Chloramben methyl ester
1,3-Dichloropropane	Alachlor oxanilic acid	Chlordane
1,4-Dichlorobenzene	Alachlor sulfynilacetic acid	Chloride
1-Naphthol	Aldicarb	Chlorimuron-ethyl
2,3,7,8-TCDD	Aldicarb sulfone	Chlorobenzene
2,4,5-T	Aldicarb sulfoxide	Chloroform
2,4,6-Trichlorophenol	Aldrin	Chlorothalonil
2,4-D	Alkalinity	Chlorpyrifos
2,4-D Methyl ester	Alpha-HCH	Chlorpyrifos Oxon
2,4-DB	Ametryn	Chromium
2,4-Dinitrophenol	Antimony	Chromium VI
2,6-Diethylaniline	Arsenic	Cis-1,2-dichloroethene
2-(Methylsulfonyl)-4-(Trifluoromethyl benzoic acid	Asbestos	Cis-1,3-dichloropropene
2-[(2-Ethyl-6-methylphenyl)-amino]-1-propanol	Atrazine	Cis-permethrin
2-[(2-Ethyl-6-methylphenyl), amino]-2-oxoethane sulfonic acid	Azinphos-methyl	Clopyralid
2-Chloro-2,6-diethylacetanilide	Azinphos-methyl oxon	Clothianidin
2-Ethyl-6-methylaniline	Azoxystrobin	Combined Radium (-226 & -228)
226 Radium	Barium	Conductivity
228 Radium	Bendiocarb	Conductivity, field
3,4-Dichloroaniline	Benfluralin	Copper
3,5-Dichloroaniline	Benomyl	Cyanazine
3-Hydroxycarbofuran	Bensulfuron-methyl	Cyanazine acid
4,6-Dinitro-o-cresol	Bentazon	Cyanazine amide
4-Chloro-2-methylphenol	Benzene	Cyanide
4-Chloro-3-methylphenol	Benzo(A)pyrene	Cycloate
4-Nitrophenol	Beryllium	Cyfluthrin
6-Chloro-N-methylnicotinamide	Beta-HCH	Cypermethrin
6-Chloronicotinic acid	Boron	Cyprazine
6-Chloronicotinic aldehyde	Bromacil	Dalapon
Acenaphthene	Bromomethane	DCPA
Acetamidprid	Bromoxynil	DCPA Monoacid
Acetochlor	Butachlor	DDD
		DDT
		Dechloroacetochlor
		Dechloroatlachlor
		Dechlorodimethenamid
		Dechlorometolachlor
		Deethylatrazine
		Deethylcyanazine
		Deethylcyanazine acid
		Deethylcyanazine amide
		Deethylhydroxyatrazine
		Deisopropylatrazine
		Deisopropylhydroxyatrazine
		Delta-HCH
		Demethylfluometuron
		Desulfnylfipronil
		Desulfnylfipronil amide
		Di(2-ethylhexyl)phthalate
		Diazinon
		Diazoxon
		Dicamba
		Dichlobenil
		Dichlorprop
		Dichlorvos
		Dicrotophos
		Didealkylatrazine
		Dieldrin
		Dimethenamid
		Dimethenamid ethane sulfonic acid
		Dimethenamid oxalic acid
		Dimethoate
		Dinoseb
		Dinotefuran
		Diphenamid
		Diquat
		Dissolved Oxygen, field
		Disulfoton
		Disulfoton sulfone
		Diuron
		Endosulfan I

Appendix A. Compounds for which groundwater samples have been analyzed

Description			
Endosulfan li	Hydroxydimethenamid	Naphthalene	Silver
Endosulfan sulfate	Hydroxymetolachlor	Napropamide	Silvex
Endothal	Hydroxysimazine	Neburon	Simazine
Endrin	Imazaquin	Nicosulfuron	Simetryn
Endrin aldehyde	Imazethapyr	Nitrate-N	Sodium
Epichlorohydrin	Imidacloprid	Nitrite as NO2	Strontium
Epic	Imidacloprid desnitro	Norflurazon	Styrene
Esfenvalerate	Imidacloprid olefin	Oryzalin	Sulfate
Ethafluralin	Imidacloprid urea	Oxadiazon	Sulfometuron-methyl
Ethion	Indoxacarb	Oxamyl	Sulfoxaflor
Ethion monoxon	Iodomethane	Oxyfluorfen	Tebuthiuron
Ethoprop	Iprodione	P,P-DDE	Temperature, field
Ethyl parathion	Iron	Febutate	Terbacil
Ethylbenzene	Isofenphos	Pendimethalin	Terbufos
Fenamiphos	Isoxaflutole	Pentachlorophenol	Terbufos oxon sulfone
Fenamiphos sulfone	Isoxaflutole diketonitrile	Permethrin	Terbutylazine
Fenamiphos sulfoxide	Lead	pH	Terbutryn
Fenuron	Lindane	pH, field	Tetrachloroethene
Fipronil	Linuron	Phorate	Thallium
Fipronil sulfide	Magnesium	Phorate oxon	Thiacloprid
Fipronil sulfone	Malathion	Phosmet	Thiamethoxam
Flufenacet	Malathion oxon	Phosmet oxon	Thiamethoxam urea
Flufenacet ethane sulfonic acid	Manganese	Picloram	Thiobencarb
Flufenacet oxanilic acid	MCPA	Picoxystrobin	Toluene
Flumetsulam	MCPB	Polychlorinated biphenyls	Total Dissolved Solids
Flumeturon	Mercury	Potassium	Total Xylenes
Fluoride	Metaxyl	Prometon	Toxaphene
Fonofos	Methodathion	Prometryn	Trans-1,2-dichloroethene
Fonofos oxon	Methiocarb	Propachlor	Trans-1,3-dichloropropene
Glyphosate	Methomyl	Propachlor ethane sulfonic acid	Triallate
Gross alpha	Methoxychlor	Propachlor oxanilic acid	Trichloroethene
Gross beta	Methyl paraoxon	Propanil	Triclopyr
Hardness (calc.)	Methyl parathion	Propargite	Trifloxystrobin
Heptachlor	Methylene chloride	Propazine	Trifluralin
Heptachlor epoxide	Metolachlor	Propham	Turbidity, field
Hexachlorobenzene	Metolachlor ethane sulfonic acid	Propiconazole	Uranium
Hexachlorocyclopentadiene	Metolachlor oxanilic acid	Propoxur	Vermolate
Hexazinone	Metribuzin	Propyzamide	Vinyl chloride
Hydroxyacetochlor	Metsulfuron-methyl	Pyraclostrobin	
Hydroxylachlor	Molinate	Selenium	
Hydroxyatrazine	Myclobutanil	Siduron	



Nebraska Department of Environment and Energy, 2022