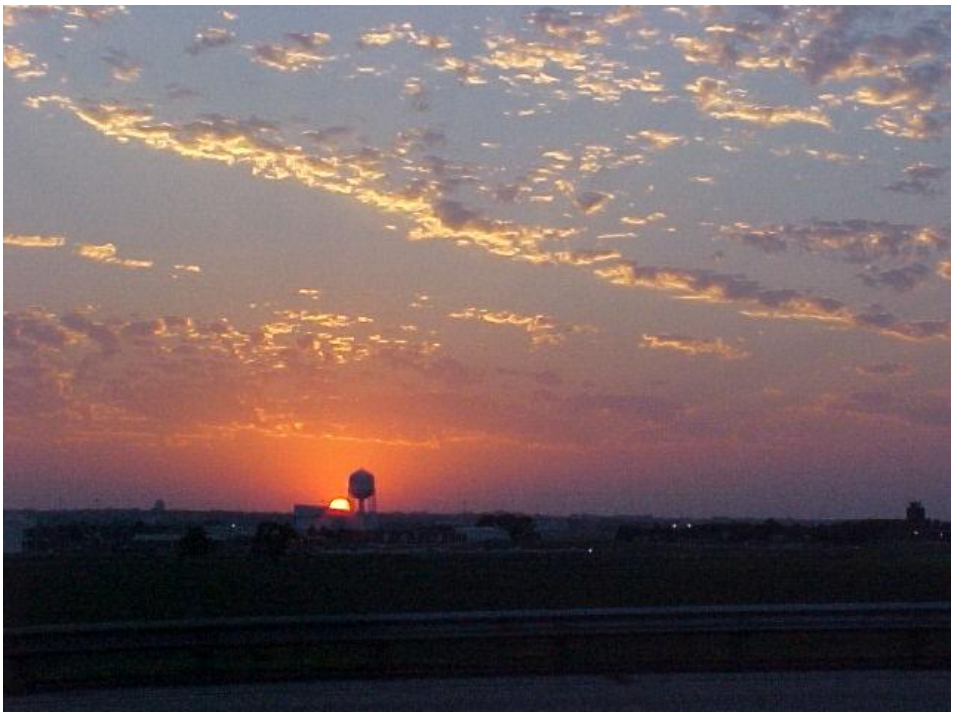
# 2009 Nebraska Groundwater Quality Monitoring Report

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



Nebraska Department of Environmental Quality
Water Quality Assessment Section
Groundwater Unit

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# Photo on front cover:

Lincoln Air Park. (Mr. Dave Carlson, Rural Chadron)

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# 2009 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 Environmental Quality (NDEQ) to report on groundwater quality monitoring in Nebraska. Reports have been issued 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. This 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).

**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 velocity 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 pulled 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.

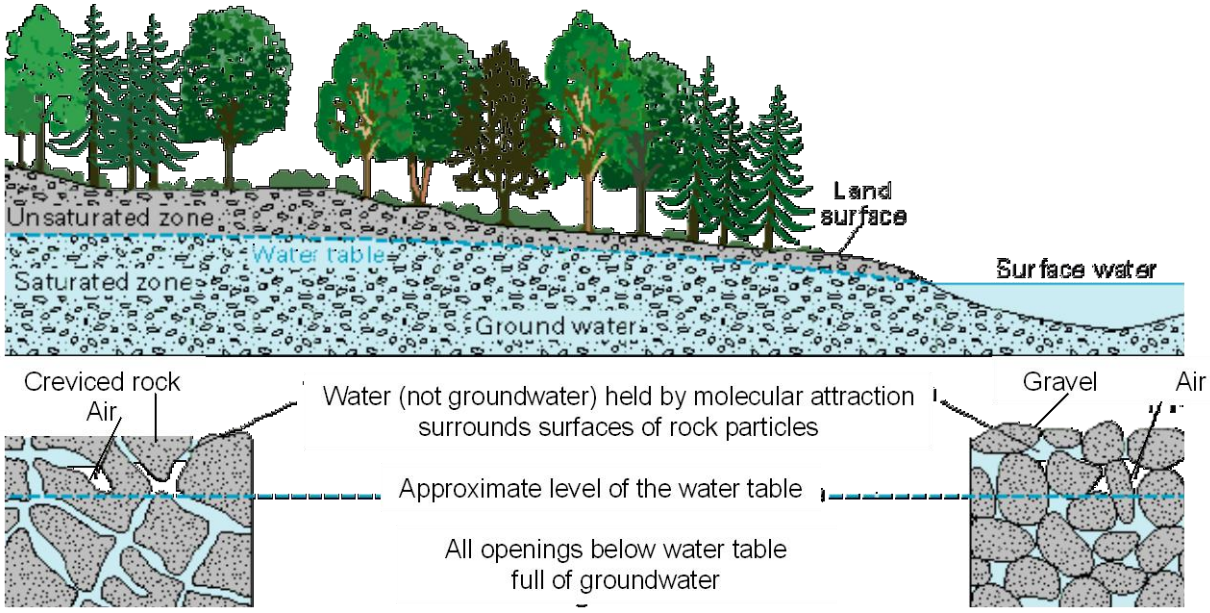



**Figure 1.** Basic groundwater features and terms (U.S. Geological Survey).

## 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.

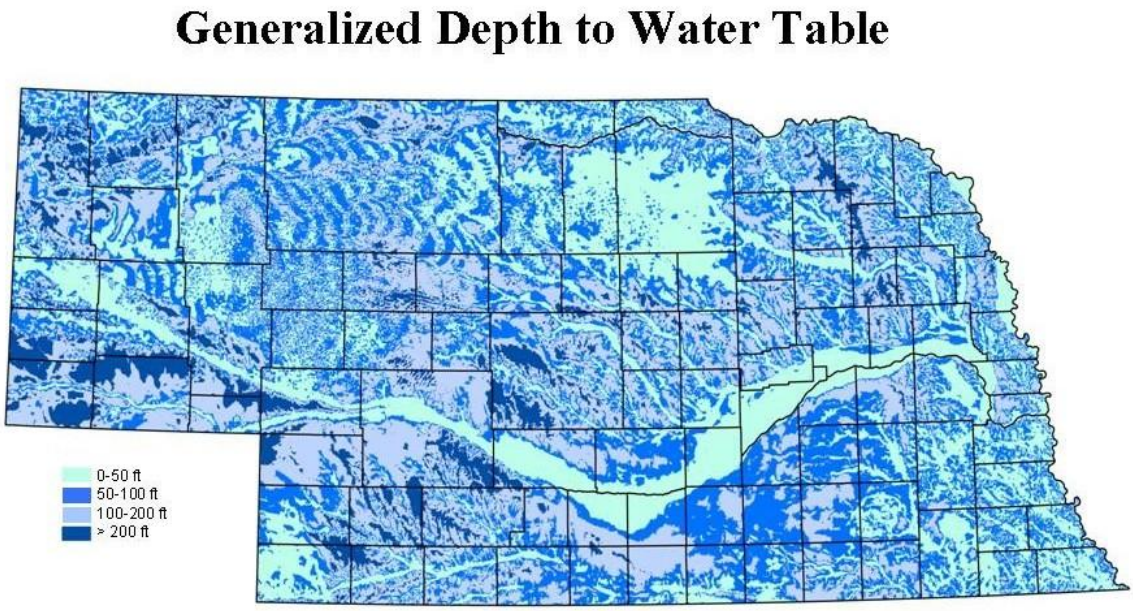



**Figure 2.** Generalized Depth to Groundwater (University of Nebraska, Conservation and Survey Division, 1998)

## Importance of Groundwater

Nebraska is one of the most groundwater-rich places in the entire world. Nearly 85% of the state's residents use groundwater as their source of drinking water. If the public water supply for the City of Omaha (which gets about half of its water supply from the Missouri River) isn't counted, this rises to nearly 100%. 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 2009, the Nebraska Department of Natural Resources (NDNR) listed over 92,200 active irrigation wells and nearly 23,100 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.

## Groundwater Monitoring

The above information shows clearly 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 nearly 1300 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.

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 http://dnrdata.dnr.ne.gov/clearinghouse/). The entire 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, 2009. The dates for these data range from mid-1974 to mid-2008. Some groundwater results from some of the agencies working in Nebraska have not to date been entered into the Database, but NDEQ is confident that the information presented represent the majority of sample results available. Table 1 lists **each agency** producing groundwater quality data for Nebraska.

| Agency | |
|---|---|
| Central Platte NRD | Nebraska Health & Human Services/CDC |
| 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 | University of Nebraska - Lincoln |
| Lower Platte South NRD | Upper Big Blue NRD |
| Lower Republican NRD | Upper Elkhorn NRD |
| Middle Niobrara NRD | Upper Loup NRD |
| Middle Republican NRD | Upper Niobrara-White NRD |
| Nebraska Dept. of Agriculture | Upper Republican NRD |
| Nebraska Dept. of Environmental Quality | U.S. Geological Survey |

**Table 1.** Various agencies providing groundwater analyses in Nebraska to be used in the Database. (Source: The Database, 2009)

## Types of Wells Sampled

The data summarized in Table 1 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. Table 2 shows the number of analyses from the Database for each type of well.

| Well Type | Number of Analyses |
|---|---|
| Monitoring | 229,123 |
| Irrigation | 83,916 |
| Domestic | 58,039 |
| Public Water Supply | 19,742 |
| Commercial/Industrial | 1,919 |
| Livestock | 1,692 |
| **Total** | **394,431** |

**Table 2.** Total number of groundwater analyses by well type. (Source: The Database, 2009)

## 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. Table 3 lists the compounds for which groundwater has been sampled and analyzed since 1974. Table 4 lists the compounds from Table 3 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. For example, only 12 of the 151 compounds sampled met the 2 percent criteria.

***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 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.

Table 3 shows the number of analyses of groundwater samples for a wide variety of compounds, all of which are used in agricultural production. As mentioned previously, there is a large 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.

Collecting a groundwater sample using direct-push technology.

| Compound | Compound | Compound | Compound |
|---|---|---|---|
| 1,1,1-trichloroethane | carbaryl | ethion | phorate |
| 1,2,4-trichlorobenzene | carbofuran | ethoprop | picloram |
| 1,2-dibromo-3-chloropropane | carbon tetrachloride | ethyl parathion | prometon |
| 1,2-dibromoethane | carboxin | fenuron | prometryn |
| 1,2-dichlorobenzene | chlordane | fluometuron | pronamide |
| 1,2-dichloroethane | chloroform | fonofos | propachlor |
| 1,2-dichloropropane | chlorothalonil | heptachlor | propanil |
| 1,4-dichlorobenzene | chlorpyrifos | heptachlor epoxide | propargite |
| 1-naphthol | cis-permethrin | hexachlorobenzene | propazine |
| 2,4,5-T | clopyralid | hexachlorocyclopentadiene | propham |
| 2,4,6-trichlorophenol | cyanazine | hexazinone | propoxur |
| 2,4-D | cycloate | isofenphos | propyzamide |
| 2,4-DB | cyprazine | isoxaflutole | silvex |
| 2,4-dinitrophenol | DCPA | isoxaflutole benzoic acid | simazine |
| 2,4-DP | DCPA mono and diacids | isoxaflutole diketonitrile | simetryn |
| 2,6-diethylaniline | DDD | lindane | tebuthiuron |
| 3-hydroxycarbofuran | DDE | linuron | terbacil |
| 4,6-dinitro-o-cresol | DDT | malathion | terbufos |
| 4-chloro-3-methylphenol | deethylatrazine | MCPA | terbuthylazine |
| 4-nitrophenol | deisopropylatrazine | MCPB | terbutryn |
| acenaphthene | delta-HCH | methiocarb | tetrachloroethene |
| acetochlor | diazinon | methomyl | thiobencarb |
| acifluorfen | dicamba | methoxychlor | toxaphene |
| acrylonitrile | dichlobenil | methyl azinphos | triallate |
| alachlor | dichlorprop | methyl parathion | trichloroethene |
| aldicarb | didealkyl atrazine | methylene chloride | triclopyr |
| aldicarb sulfone | dieldrin | metolachlor | trifluralin |
| aldicarb sulfoxide | dimethenamid | metribuzin | vernolate |
| aldrin | dimethoate | molinate | |
| alpha-HCH | dinoseb | naphthalene | |
| ametryn | diphenamid | napropamide | |
| atrazine | disulfoton | neburon | |
| azinphos-methyl | diuron | nitrate-N | |
| benfluralin | endosulfan I | norflurazon | |
| bentazon | endosulfan II | oryzalin | |
| beta-HCH | endosulfan sulfate | oxamyl | |
| bromacil | endrin | parathion | |
| bromomethane | endrin aldehyde | pebulate | |
| bromoxynil | EPTC | pendimethalin | |
| butachlor | esfenvalerate | pentachlorophenol | |
| butylate | ethalfluralin | permethrin | |

**Table 3.** Compounds for which groundwater samples have been analyzed. Record runs from May 1974 through mid - 2008. (Source: The Database, 2009)

| Compounds | Percent of Samples that exceeded the Reporting Limit (RL) |
|---|---|
| cyanazine | 2% |
| alachlor | 3% |
| simazine | 3% |
| propazine | 7% |
| metolachlor | 22% |
| metolachlor oxanilic acid | 26% |
| deisopropylatrazine | 60% |
| atrazine | 61% |
| alachlor ethane sulfonic acid | 72% |
| deethylatrazine | 77% |
| nitrate-N | 94% |
| metolachlor ethane sulfonic acid | 99% |

**Table 4.** Compounds listed in Table 3 that at least 2% of the samples collected were detected above the Reporting Limit. (Source: The Database, 2009)

## 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. An examination of Table 3 and Table 4 shows that most parameters that have been analyzed have never been detected in the samples. 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, atrazine, alachlor, metolachlor, and simazine. Nitrate is a form of nitrogen common in human and animal waste, plant residue, and commercial fertilizers. Atrazine, alachlor, metolachlor, and simazine are herbicides used for weed control in a variety of crops such as corn and soy beans. In addition, these four herbicides have been identified as priority compounds by the Nebraska Department of Agriculture for development of pesticide State Management Plans, following guidance produced by the U.S. Environmental Protection Agency. Note that several compounds have fairly large numbers of detections but are not included as part of the priority compounds. Cyanazine and propazine are both triazine herbicides (like atrazine and simazine), and their use pattern is similar (the use of cyanazine has been discontinued). Desethyl atrazine and deisopropyl atrazine are degradation products, or metabolites, of atrazine. The three acids are degradation products of alachlor and metolachor.

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 NRD's 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 158,358 active registered wells in Nebraska and only enough resources to collect samples from 3,758 wells in 2008. Also, not all water well owners are receptive to having their well sampled. Figure 3 below is a map showing all registered wells in Nebraska as of October 2009. As discussed earlier in this document, not all water wells are registered and 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.

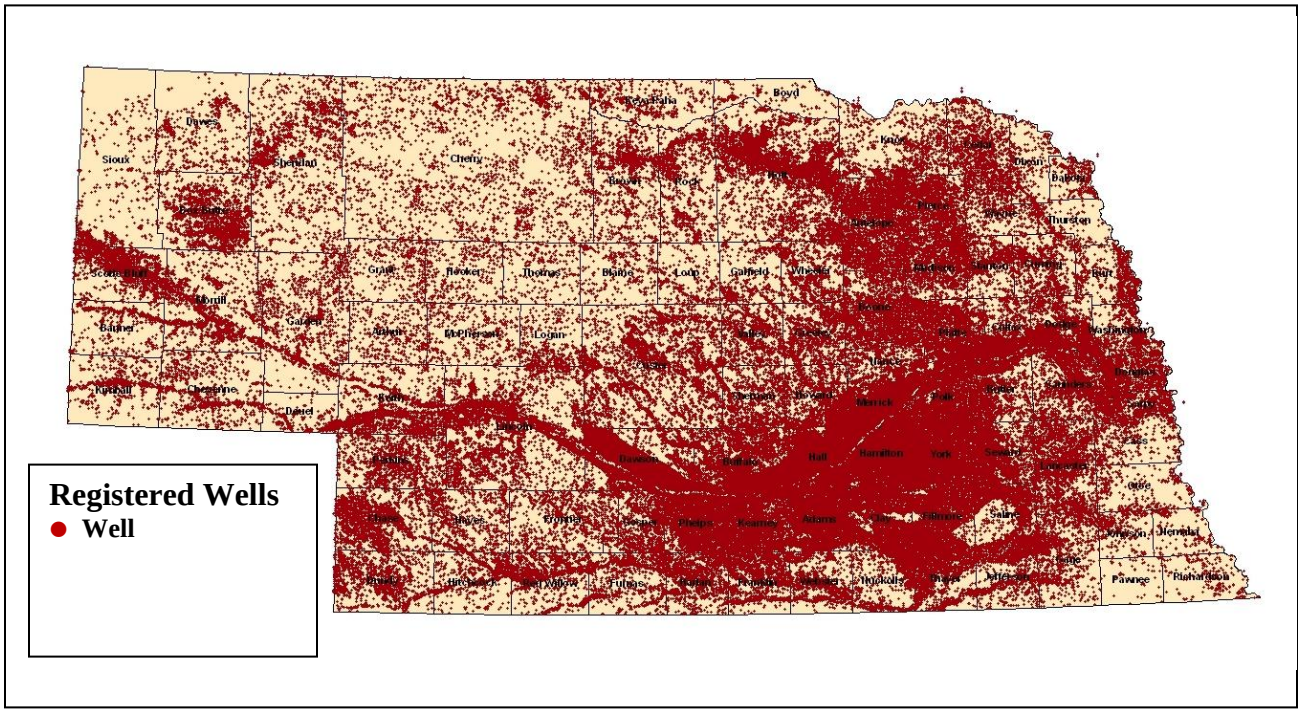



**Figure 3.** Registered Water Wells as of October 2009. (Source: Nebraska Department of Resources Registered Well Database, 2009)

**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 34 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 Agencies (USEPA) maximum contaminant level (MCL) on which the federal drinking water standard for nitrate-nitrogen is based.

| 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 | 26.8% |
| 1974 – 2002 (2003 Report) | 44,721 | 28,394 | 3,931 | 8,128 | 4,268 | 27.7% |
| 1974 – 2003 (2004 Report) | 52,798 | 33,100 | 4,606 | 9,857 | 5,027 | 28.2% |
| 1974 – 2004 (2005 Report) | 66,822 | 37,346 | 5,603 | 12,244 | 11,629 | 35.7% |
| 1974 – 2005 (2006 Report) | 74,522 | 42,916 | 6,573 | 13,161 | 11,872 | 34.2% |
| 1974 – 2006 (2007 Report) | 77,820 | 44,901 | 6,407 | 13,864 | 12,648 | 34.1% |
| 1974 – 2007 (2008 Report) | 83,002 | 48,010 | 6,971 | 14,949 | 13,072 | 33.8% |
| 1974 – 2008 (This Report) | 86,765 | 50,450 | 7,300 | 15,609 | 13,406 | 33.4% |

**Table 5.** Nitrate – nitrogen concentrations sorted by concentration categories. (Source: The Database, 2009) *Note: The colored dots used in the heading will be used in subsequent figures indicating the nitrate concentration.*

Table 5 indicates that since 2004, the percent of analyses greater than 10 mg/l (the federal drinking water standard) has decreased by over 2 percent.

Second, the data in Table 5 will be shown geographically in Figures 4 and 5to get a sense of where that 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, 86,765 samples were collected for nitrate from 22,113 wells over the "life" of the Database. Because there would be overlapping "dots" when creating a state wide map if all 86,765 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.

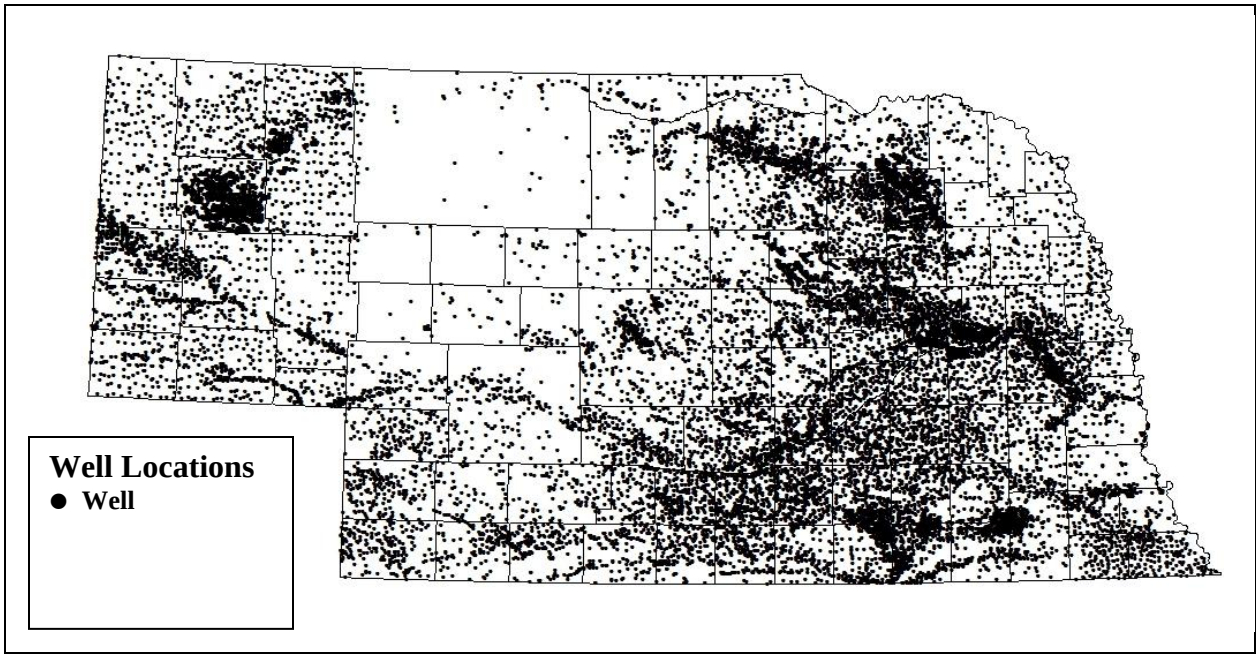



**Figure 4.** Location of 22,113 wells that have been analyzed for nitrate from 1974 - 2008. (Source: The Database, 2009)

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 a lack of nitrate in the groundwater.**

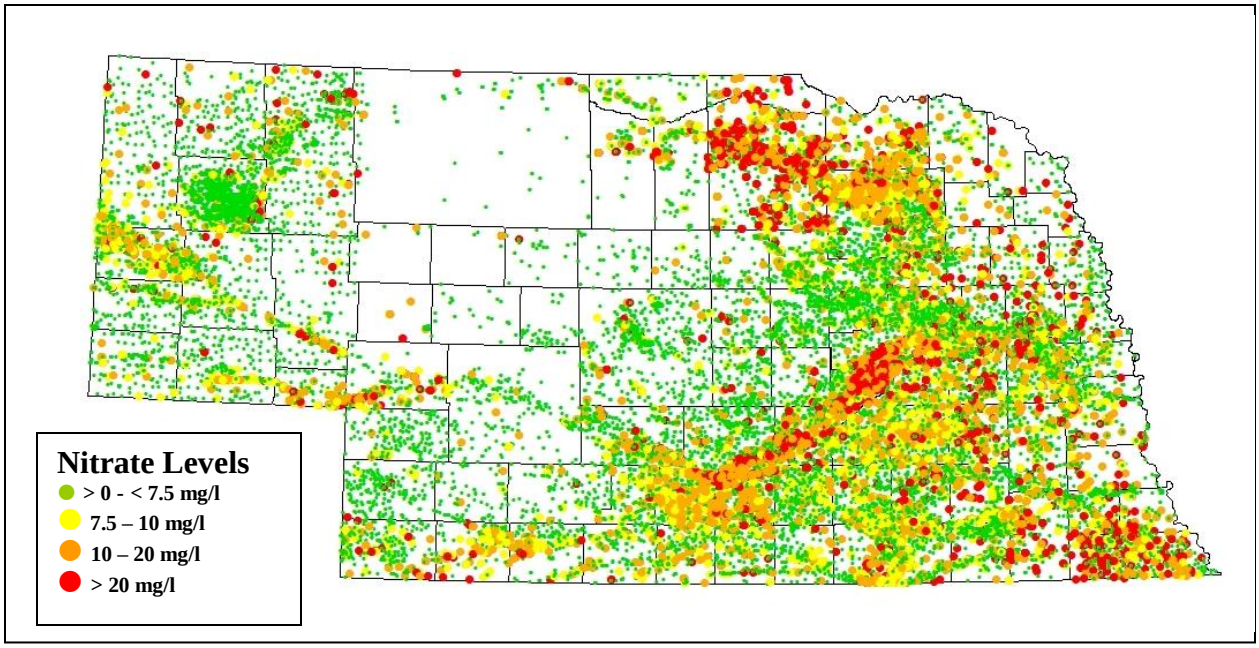



**Figure 5.** Last recorded concentration of nitrate from 1974 - 2008. (Source: The Database, 2009)

Third, Figure 6 indicates what sampling was conducted in 2008, and Figure 7 indicates the nitrate concentration for each well. Again, 'empty' areas indicated that no data was collected in those areas in 2008, or the data collected has not yet been entered into the Database.

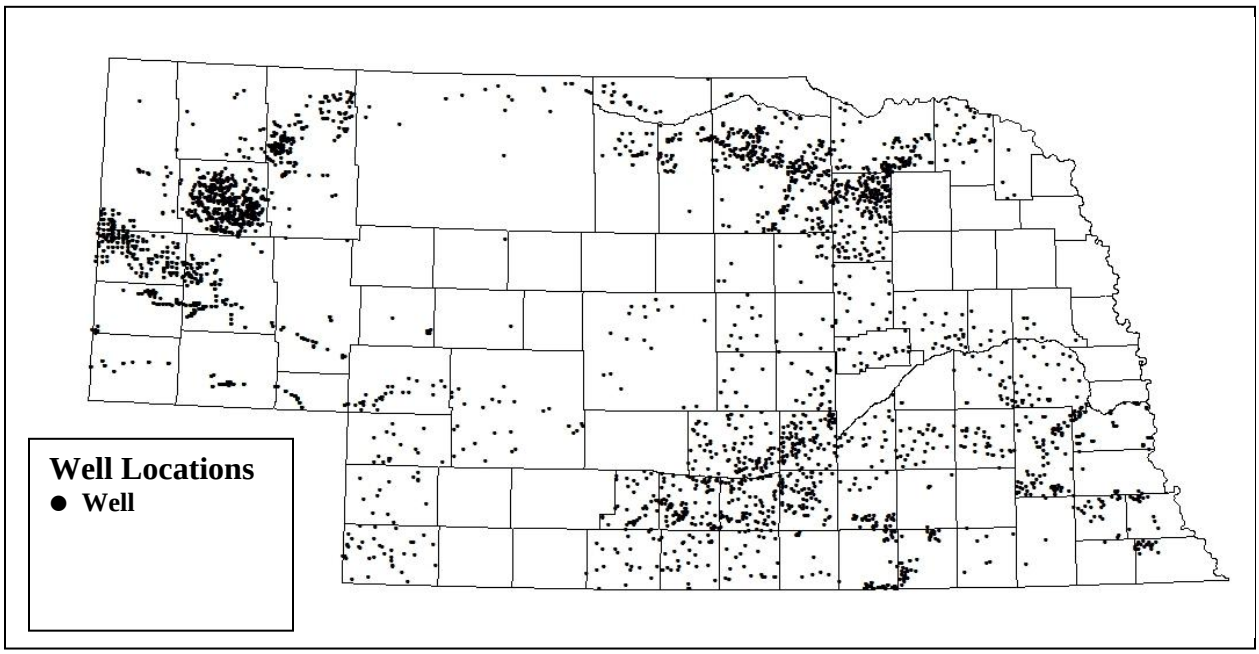



**Figure 6.** Location of 3,758 wells sampled for nitrate in 2008. (Source: The Database, 2009)

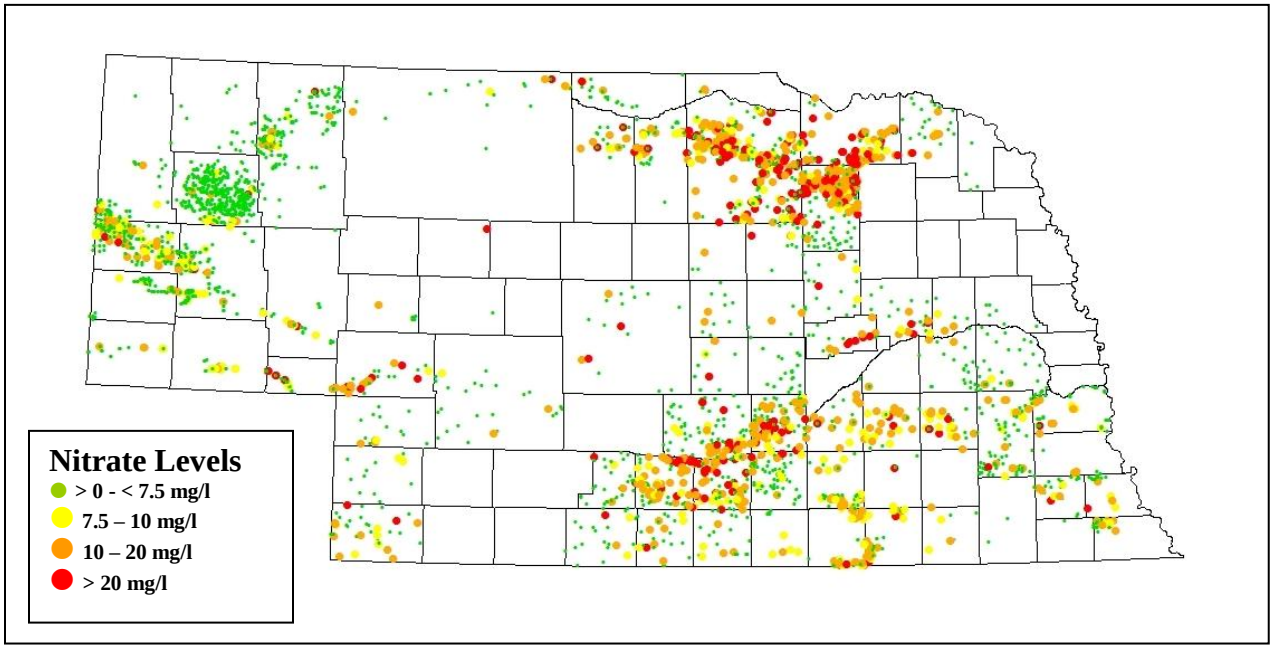



**Figure 7.** Nitrate concentrations of wells sampled in 2008. (Source: The Database, 2009)

Last, 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 a Groundwater Management Area (refer to Figures A-1 through A-4 in Appendix A). As a result, more data was collected from areas of high nitrates and would tend to 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.

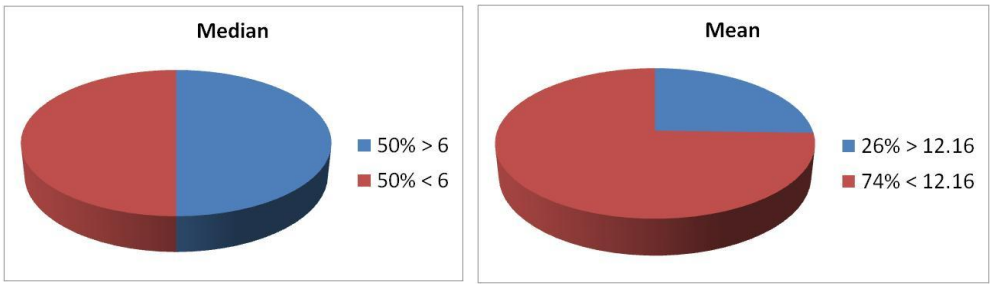



**Figure 8.** Median and mean.

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, 80 of the 197 samples were collected from 24 wells in the same location. The red circle on Figure 9 below shows the location of these wells in Central Nebraska. Reviewing the data one can see how a single location impacts the entire state.

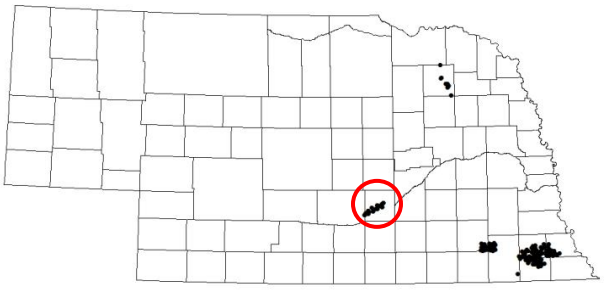


**Figure 9.** Sampling locations for nitrate in 1981. Red Circle indicates location of 24 wells sampled in Central Nebraska. (Source: The Database, 2009)

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).

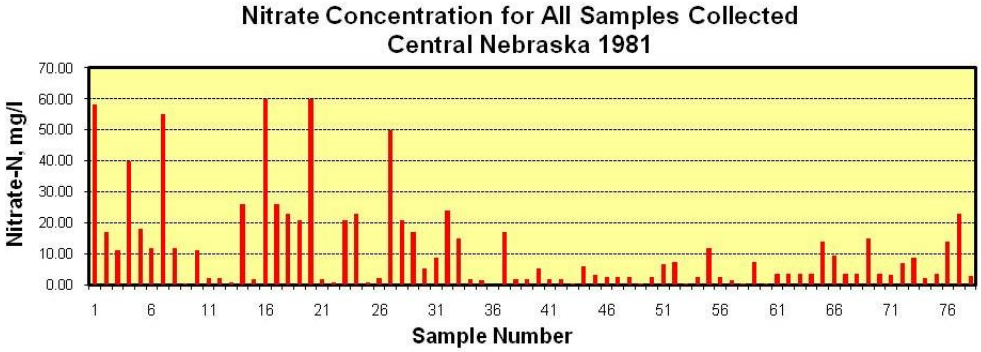



**Figure 10.** All 80 samples collected from 24 wells in Central Nebraska in 1981. (Source: The Database, 2009)

A closer look at the results from each well not only shows a wide range between samples, but the wells themselves. In Figure 11 below, wells 2, 13 and 18 have variation of greater than 50 mg/l.

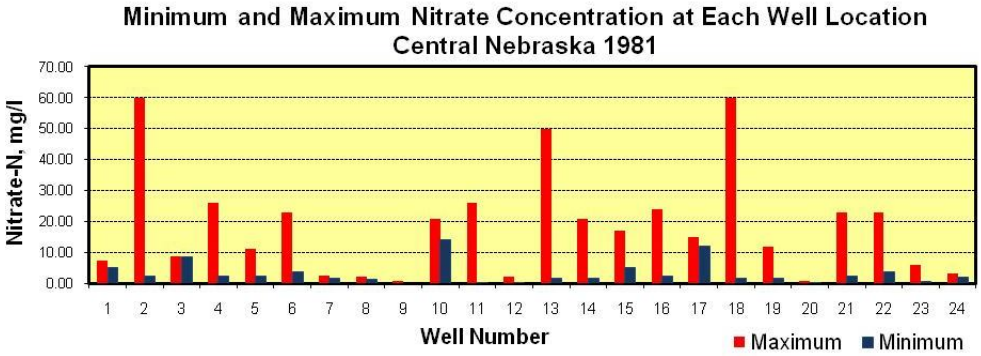
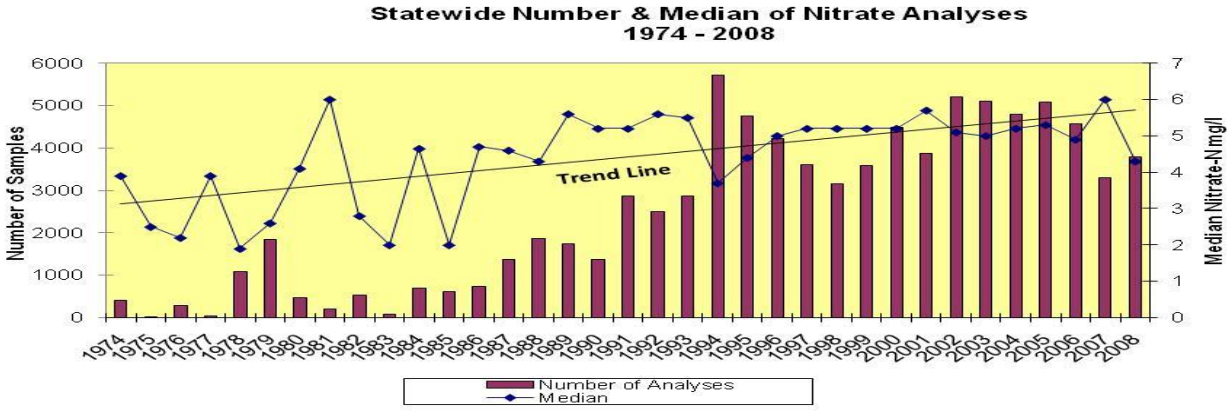



**Figure 11.** Samples collected from 24 wells in Central Nebraska in 1981 indicating the high and low concentration from each well. (Source: The Database, 2009)

In the past the median concentrations for **ALL** analyses were used to show a trend in nitrates statewide as presented in Figure 12 below. The data indicates a low number of samples results in




an inconsistent mean from 1974 to 1993.

**Figure 12.** All 86,765 analyses and median nitrate-nitrogen levels for Nebraska, 1974-2008. (Source: The Database, 2009)

If we just chart the data from 1974 to 1993 it becomes even more evident of the sporadic nature of the data (Figure 13). An example would be the 1,845 analyses collected in 1979 with a median of 2.6 mg/l versus 197 samples collected in 1981 with a median of 6 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.

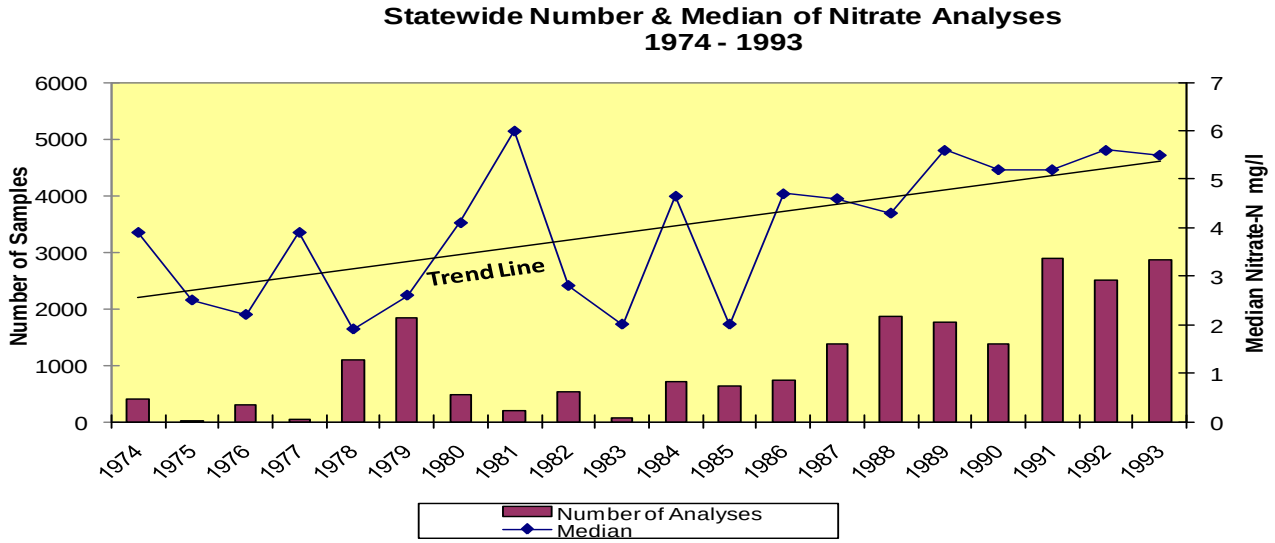



**Figure 13.** All 21,529 analyses and median nitrate-nitrogen levels for Nebraska, 1974-1993. (Source: The Database, 2009)

Figure 14 was taken from Appendix A 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. Figures A-1 through A-4 in Appendix A also indicate how the data from these years is not very representative of "statewide" based on sampling location alone.

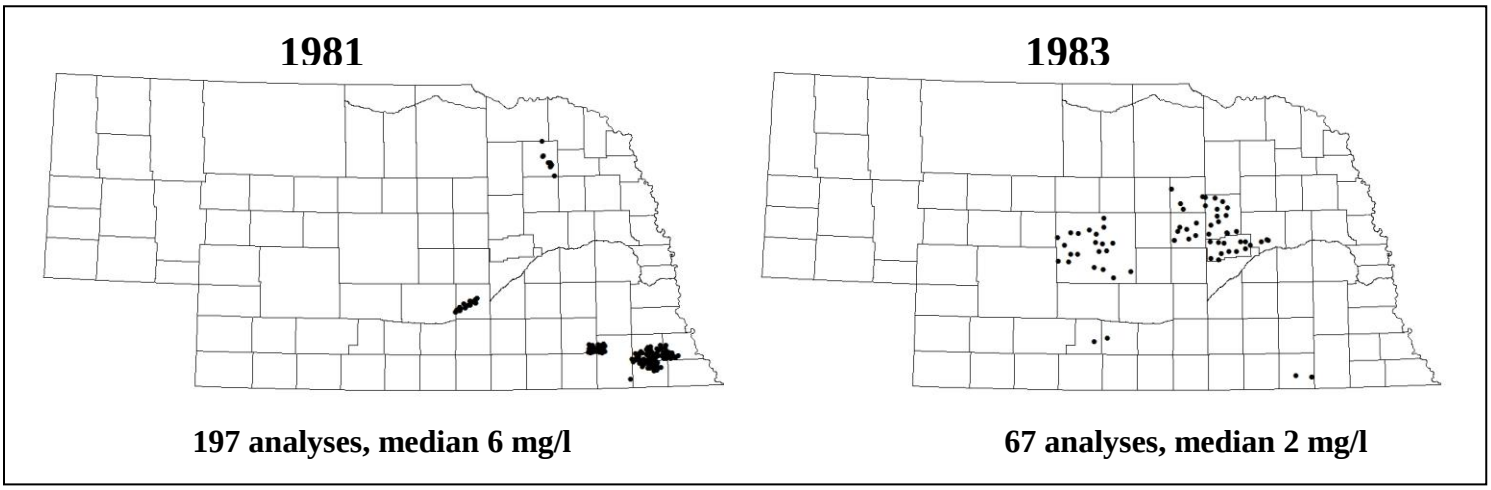



**Figure 14.** Location of nitrate analyses for highest and lowest nitrate median in Nebraska, 1981 and 1983. (Source: The Database, 2009)

A more representative picture of the statewide median nitrate concentration is from the time period 1994 to 2008. 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.

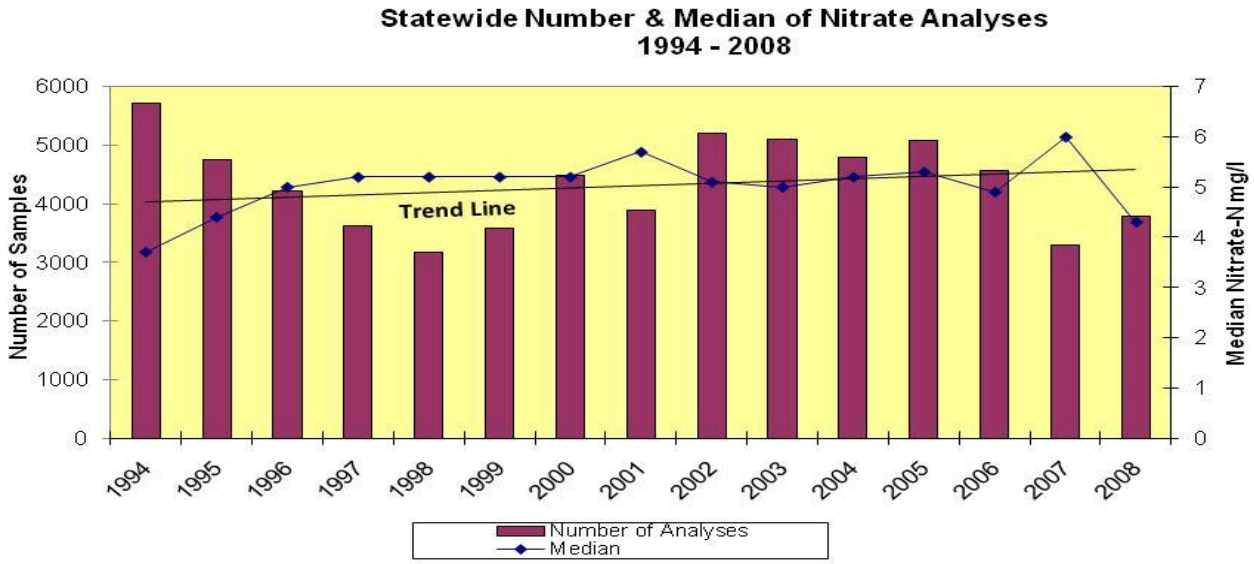



**Figure 15.** All 65,236 analyses and median nitrate-nitrogen levels for Nebraska, 1994-2008. (Source: The Database, 2009)

Figure 16 was taken from Appendix A of this report and represents the highest (2007) and lowest (1994) median nitrate concentration from the 1994 to 2008. As can be seen from these two maps, sample locations for this time period are statewide. The Statewide Groundwater Monitoring Network was started in 2004 and is very similar to locations sampled throughout 1994 to 2008.

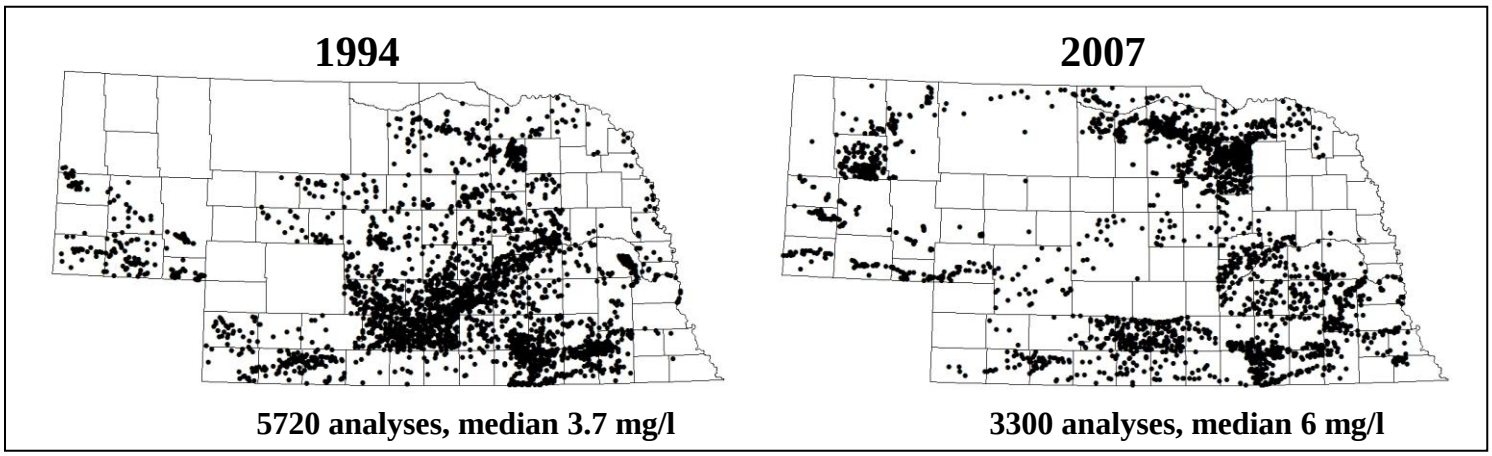



**Figure 16.** Location of nitrate analyses for highest and lowest nitrate median in Nebraska, 1994 and 2007. (Source: The Database, 2009)

## Nitrates in Public Water Supplies

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. Approximately 574 of the nearly 1300 groundwater based community water systems in Nebraska 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 14 community public water supply systems with Administrative Orders for nitrate, as of October 2009. 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 Figure 7 and the figures in Appendix A.

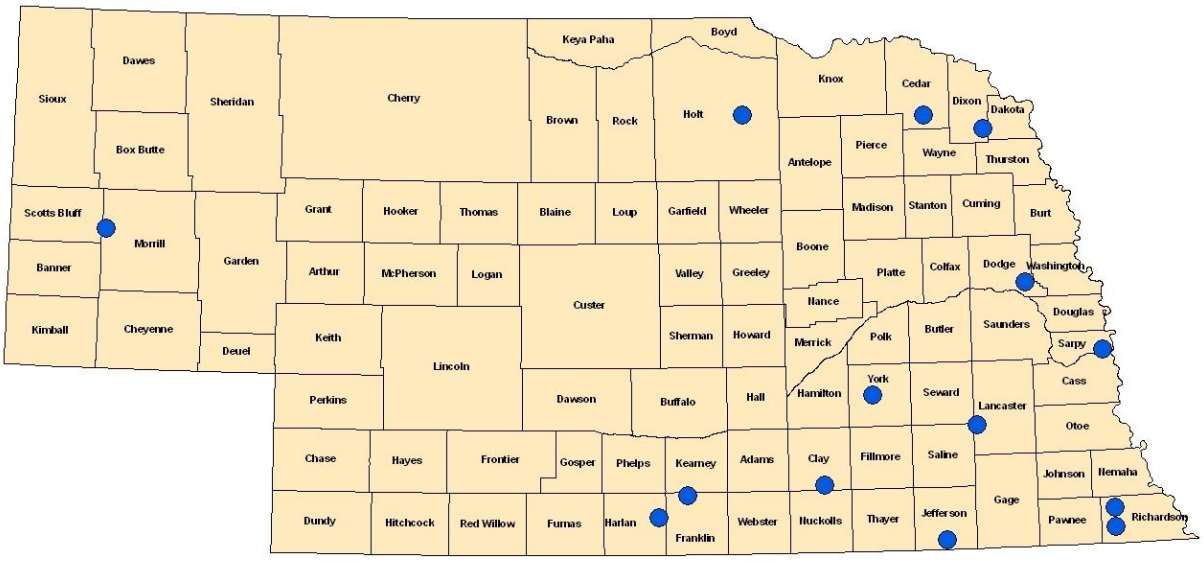



**Figure 17.** Fourteen groundwater based community public water supply systems on DHHS Administrative Order for nitrate above the 10 mg/l MCL. (Source: DHHS, October 2009)

**Nitrates and Trends Utilizing the Statewide Groundwater Monitoring Network**

Presenting trend analysis for the entire State of Nebraska using the Database would not be representative due to the lack of data for the entire state on a year-to-year basis (see Appendix A, A-1 – A-7). Nitrate studies were completed for specific areas and were not necessarily repeated the next year in an attempt to eventually cover the entire state. Accurate trends for the state as a whole should be based on large quantities of repeated data collected over a long period of time. In response to this need, the Statewide Groundwater Monitoring Network (Figure 18) has been established by the NRDs and has completed the third year of sampling. Nitrate trends from this report forward will be estimated using the information gathered from this network. The several thousand "active" wells, which have already been documented, are likely to continue to be sampled on a more-or-less regular basis by the NRDs. However, this is a large number of well locations to track on a statewide basis, thus the estimated number of network wells which will initially be used in annual analysis has been reduced to approximately 1500. Locations of 1404 network wells have been documented for the state's twenty-three NRDs. Figure 18 shows the locations of network wells in the NRDs; Table 6 shows the number and type of wells being utilized by NRD. It should be noted that the general target number of approximately 1500 wells will vary from year to year. This is due to the fact that, with such a large number of wells spread over the entire state, and with those wells in varying states of activity and ownership, some of the wells in a given year will be eliminated from the network while others will be added. Thus, from year to year, the precise number of wells in the network will change slightly, and this is to be expected in the future.

# Statewide Groundwater Monitoring Network

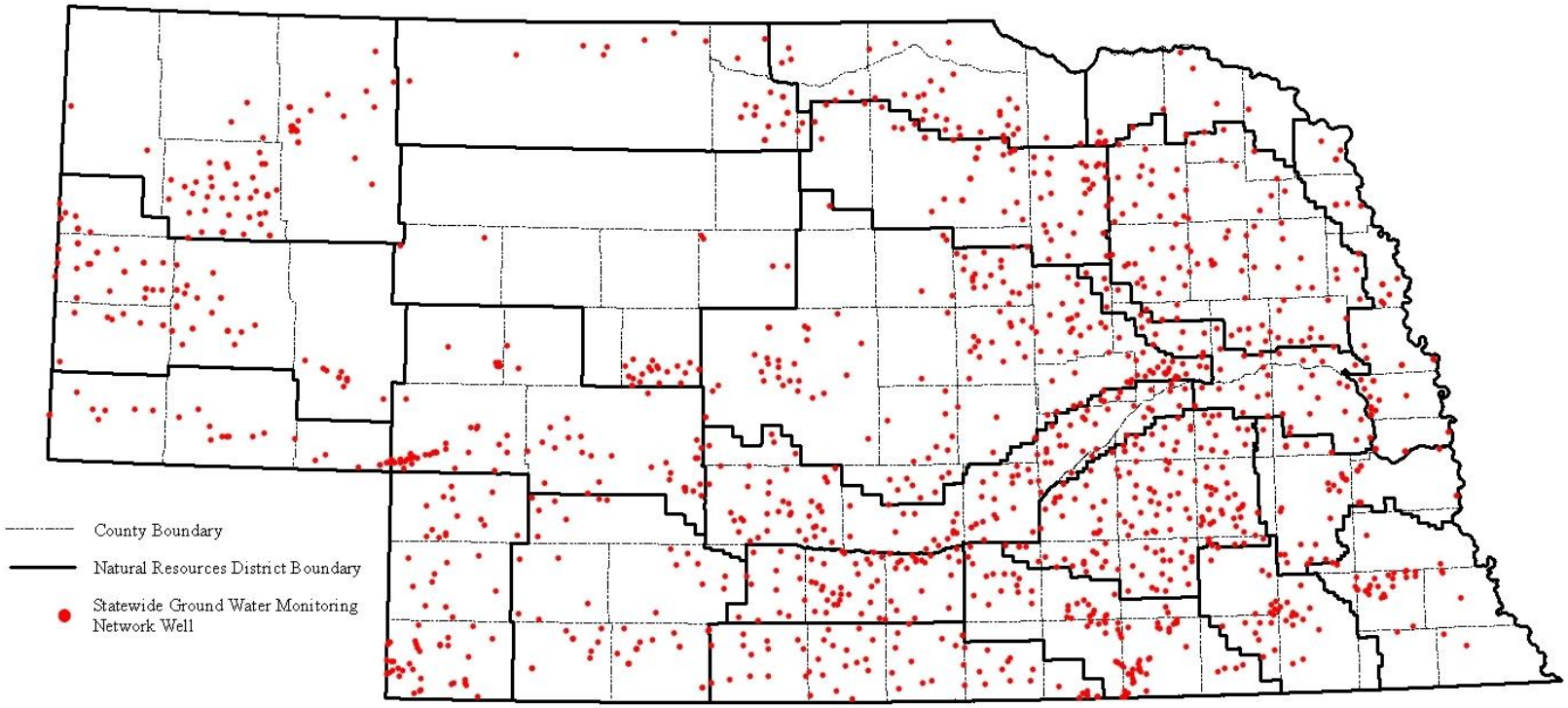



**Figure 18.** Statewide Groundwater Monitoring Network

| Natural Resources District | Total Wells | I | Q | D | S | C |
|---|---|---|---|---|---|---|
| Central Platte | 108 | 104 | | 4 | | |
| Lewis & Clark | 15 | 9 | 6 | | | |
| Little Blue | 78 | 78 | | | | |
| Lower Big Blue | 30 | 30 | | | | |
| Lower Elkhorn | 90 | 90 | | | | |
| Lower Loup | 142 | 138 | | 2 | 2 | |
| Lower Niobrara | 33 | 33 | | | | |
| Lower Platte North | 49 | 49 | | | | |
| Lower Platte South | 37 | 12 | 24 | | | 1 |
| Lower Republican | 63 | 54 | 9 | | | |
| Middle Niobrara | 29 | 10 | 17 | 1 | 1 | |
| Middle Republican | 46 | 31 | 15 | | | |
| Nemaha | 35 | 26 | | 8 | 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 | 150 | 128 | 18 | 4 | | |
| Upper Elkhorn | 64 | 47 | 17 | | | |
| Upper Loup | 25 | 23 | | 2 | | |
| Upper Niobrara White | 69 | 44 | 25 | | | |
| Upper Republican | 59 | 59 | | | | |
| **TOTALS** | **1404** | **1132** | **241** | **25** | **4** | **2** |

**Explanation:**

**I** Irrigation Well
**Q** Monitoring Well
**D** Domestic Well
**S** Stock Well
**C** Commercial Well

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

Figures 19 and 20 and Tables 7 and 8 show the changes in nitrate-nitrogen levels in the 1404 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.

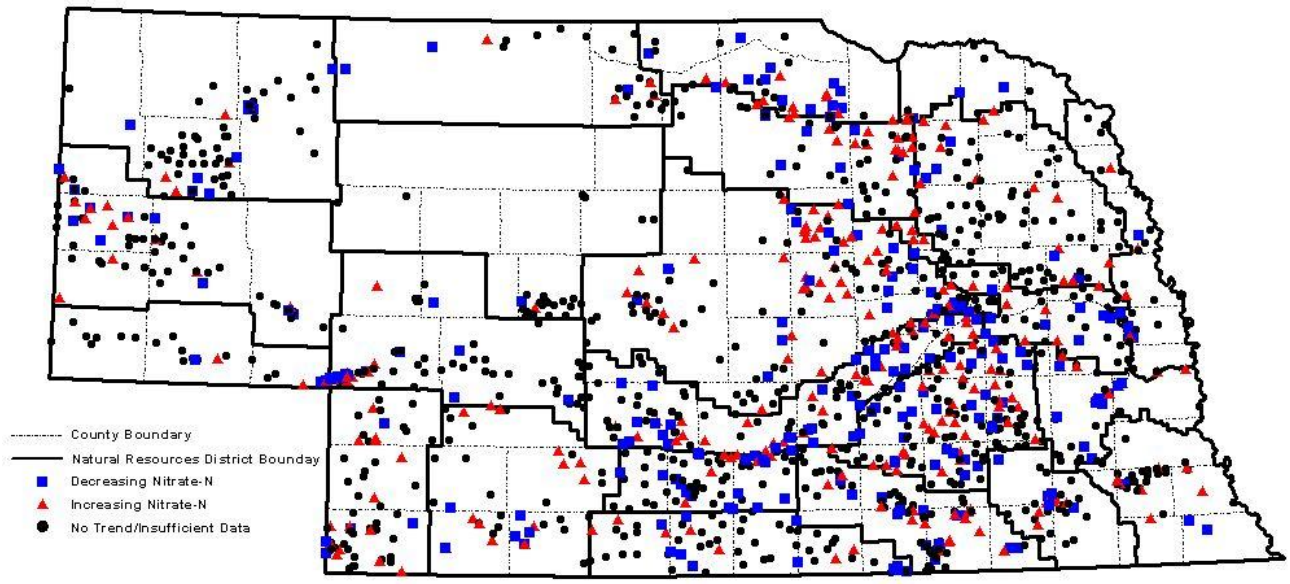



**Figure 19.** Change in nitrate-N levels between the last two monitoring events ("short-term").

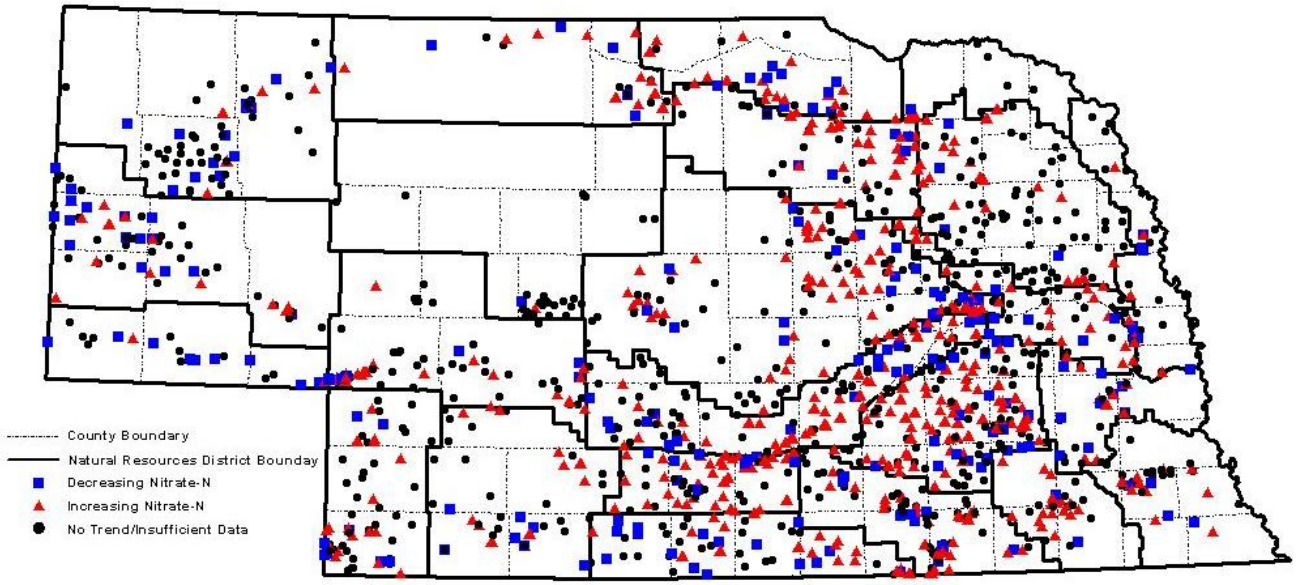



**Figure 20.** Change in nitrate-N levels between the first and last monitoring events ("long-term").

Tables 7 and 8 give a more detailed breakdown of the magnitude of the "short-term" and "long-term" changes in nitrate levels. Table 7 shows the numbers of wells for each category of increase, decrease, no change/no trend, and insufficient data for the "short-term" wells, while Table 8 shows the numbers for the same categories in the "long-term" wells.

| **"Short-Term" Changes in Nitrate Levels (Difference between the two most recent sampling events)** | |
|---|---|
| Category | # |
| ***Total Number of Wells Showing "Short-Term" Increases*** | **286** |
| Increase >1 to 5 mg/l | 214 |
| Increase >5 to 10 mg/l | 48 |
| Increase >10 mg/l | 24 |
| ***Total Number of Wells Showing "Short-Term" Decreases*** | **247** |
| Decrease >1 to 5 mg/l | 179 |
| Decrease >5 to 10 mg/l | 42 |
| Decrease > 10 mg/l | 26 |
| ***Total Number of Wells Showing No "Short-Term" Trend*** | **718** |
| ***Total Number of Wells w/ Insufficient Data to Determine Trend*** | **153** |
| ***Total Number of Wells*** | **1404** |

**Table 7.** Numbers of "short-term" wells in the Statewide Groundwater Monitoring Network showing increases, decreases, or no change in nitrate levels (this information is summarized in Figure 19).

| **"Long-Term" Changes in Nitrate Levels (Difference between the initial and most recent sampling events)** | |
|---|---|
| Category | # |
| ***Total Number of Wells Showing "Long-Term" Increases*** | **500** |
| Increase >1 to 5 mg/l | 326 |
| Increase >5 to 10 mg/l | 100 |
| Increase >10 mg/l | 74 |
| ***Total Number of Wells Showing "Long-Term" Decreases*** | **227** |
| Decrease >1 to 5 mg/l | 153 |
| Decrease >5 to 10 mg/l | 50 |
| Decrease > 10 mg/l | 24 |
| ***Total Number of Wells Showing No "Long-Term" Trend*** | **524** |
| ***Total Number of Wells w Insufficient Data to Determine Trend*** | **153** |
| ***Total Number of Wells*** | **1404** |

**Table 8.** Numbers of "long-term" wells in the Statewide Groundwater Monitoring Network showing increases, decreases, or no change in nitrate levels (this information is summarized in Figure 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 very 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 10 of the 23 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. As of this writing, three monitoring seasons for these parameters have been completed and data is being analyzed. Progress is being made, but since these technologies are still somewhat new to the NRDs, the main focus on the past seasons has been on getting the equipment in place and providing basic training for the staff who operate it. As of now, most of 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. In addition, due to changing use patterns and budget concerns, alachlor has not typically been analyzed, and numbers of analyses of metolachlor and acetochlor are generally declining. 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.

Windmill in eastern Nebraska, an aerial geophysical study is being conducted in the background using HEM (helibourne electromagnetic survey).

## Atrazine

The locations of all wells sampled for atrazine from 1974 to 2008 and then the last recorded concentration of that herbicide is presented in Figures 21 and 22. Atrazine is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include (but are not limited to) Aatrex and Bicep.

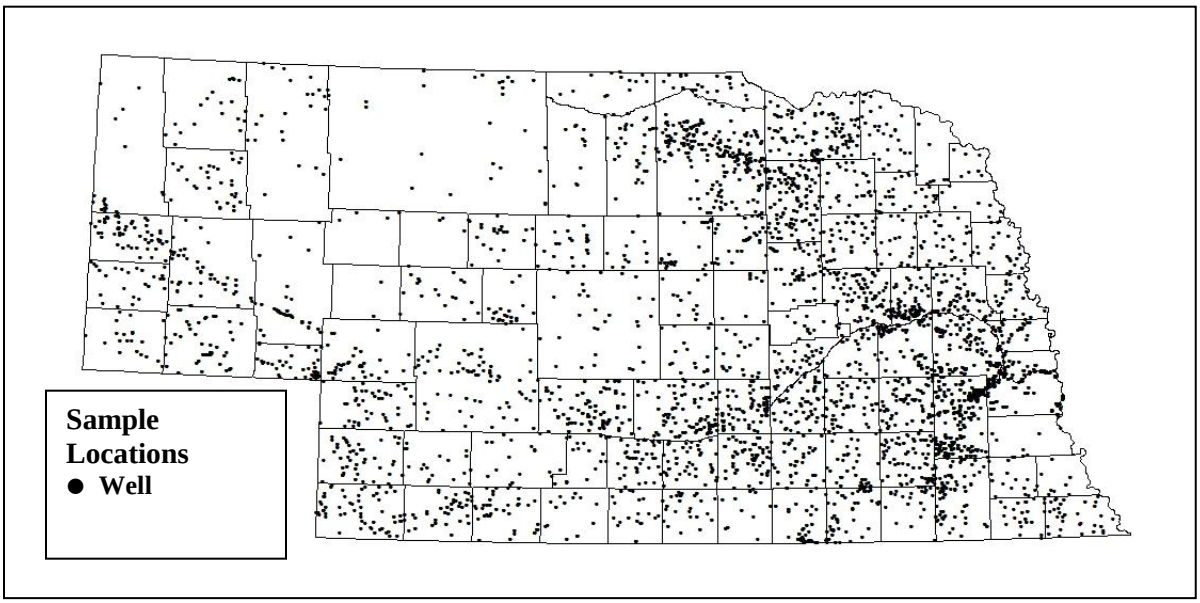



**Figure 21.** Location of 4,599 wells sampled for atrazine from 1974 – 2008. (Source: The Database, 2009)

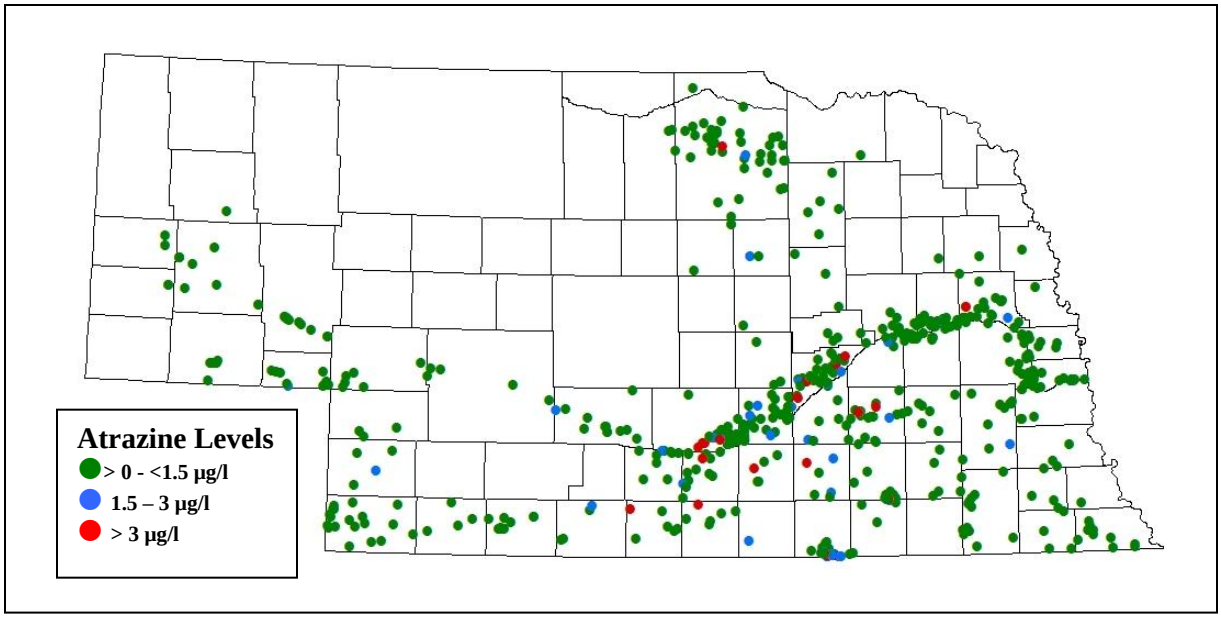



**Figure 22.** Last recorded concentration of atrazine from 1974 – 2008. (Source: The Database, 2009)

The locations of all wells sampled for atrazine in 2008 and then the concentration of that herbicide is presented in Figures 23 and 24.

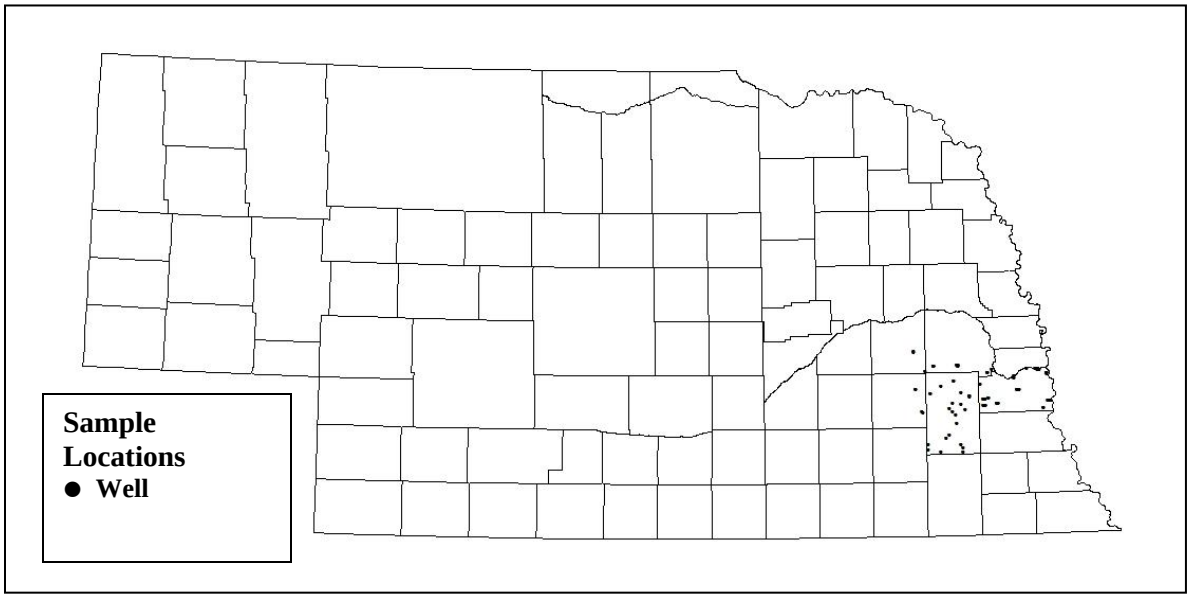



**Figure 23.** Location of 101 wells sampled for atrazine in 2008. (Source: The Database, 2009)

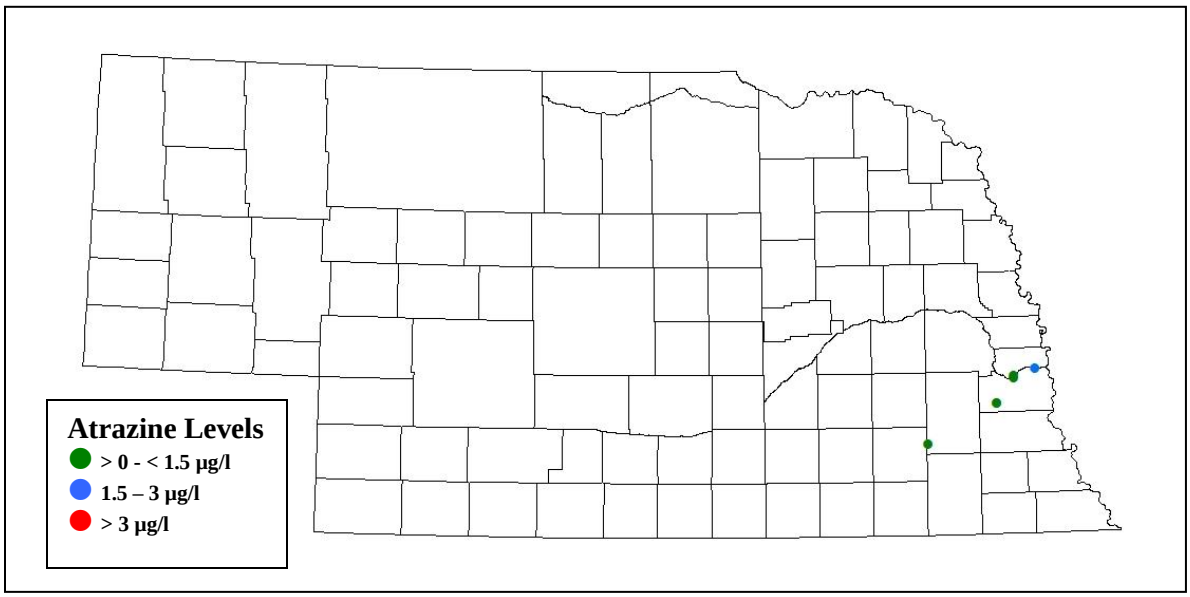



**Figure 24.** Atrazine concentrations of wells sampled in 2008. (Source: The Database, 2009)

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 22, but that data is not yet in the Database. Figures 23 and 24 reflect atrazine data generated by analysis at a laboratory.

## Alachlor

The locations of all wells sampled for alachlor from 1974 to 2008 and then the last recorded concentration of that herbicide is presented in Figures 25 and 26. 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.

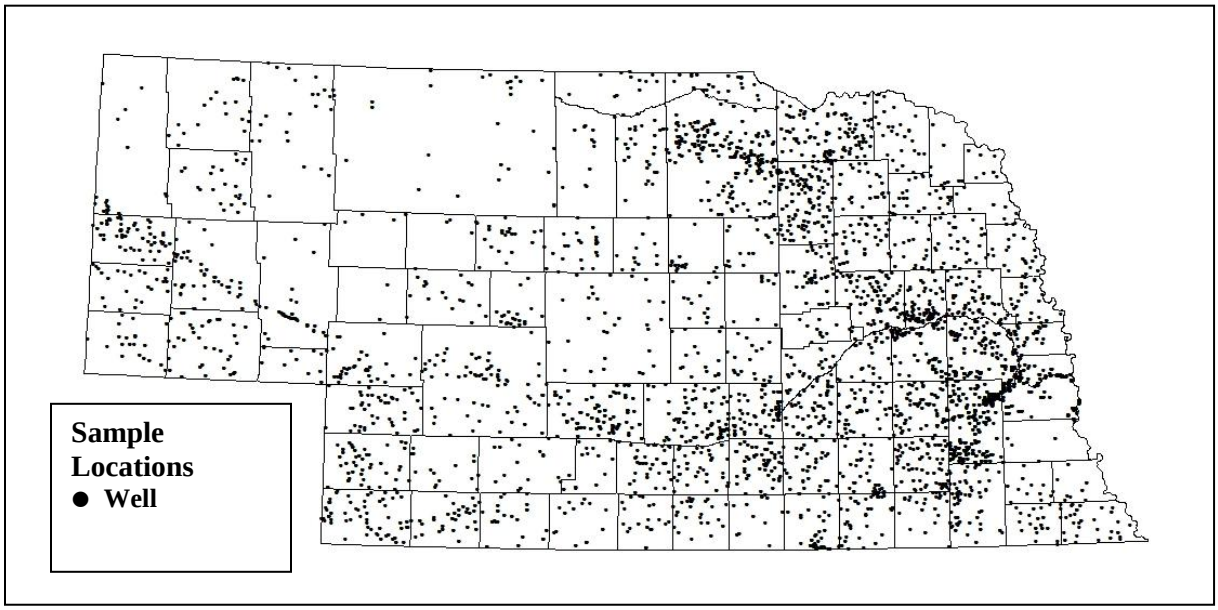



**Figure 25.** Location of 4,337 wells sampled for alachlor from 1974 – 2008. (Source: The Database, 2009)

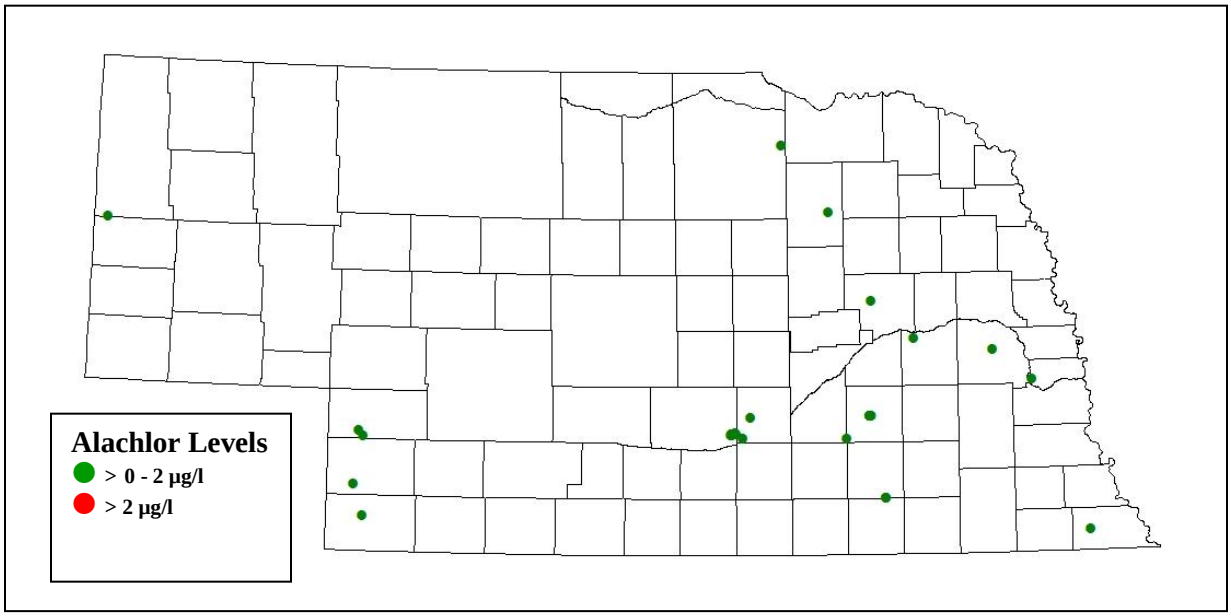



**Figure 26.** Last recorded concentration of alachlor from 1974 – 2008. (Source: The Datatbase, 2009)

The locations of all wells sampled for alachlor in 2008 and then the concentration of that herbicide is are presented in Figures 27 and 28.

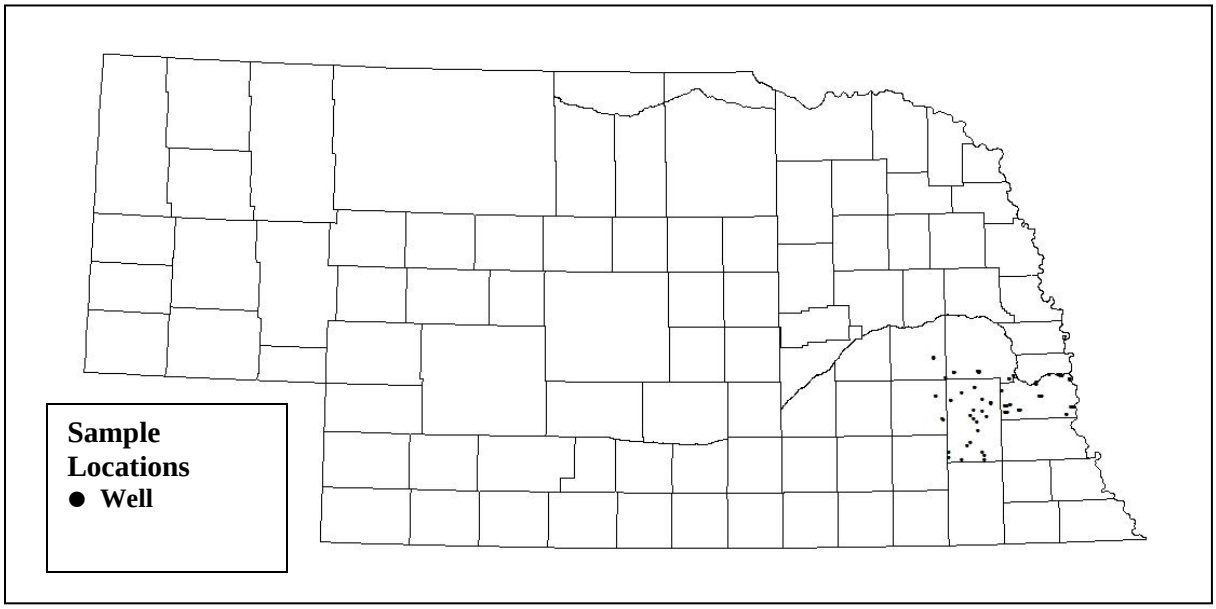



**Figure 27.** All 101 wells sampled for alachlor in 2008. (Source: The Database, 2009)

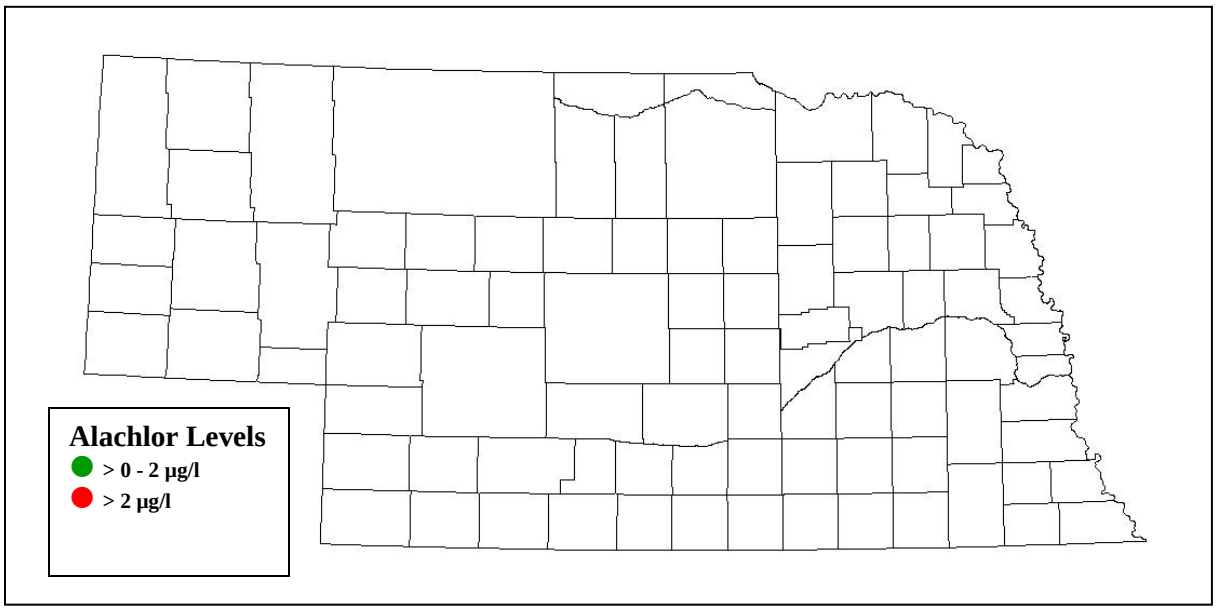



**Figure 28.** Alachlor concentrations of wells sampled in 2008. (Source: The Database, 2009)

The mean alachlor concentration calculated from the Database for the entire record from 1974 is 0.006 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 22, but that data is not yet in the Database. Figures 27 and 28 reflect alachlor data generated by analysis at a laboratory.

**Metolachlor**

The locations of all wells sampled for metolachlor from 1974 to 2008 and then the last recorded concentration of that herbicide is presented in Figures 29 and 30. Metoloachlor is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include (but are not limited to) Bicep and Dual.

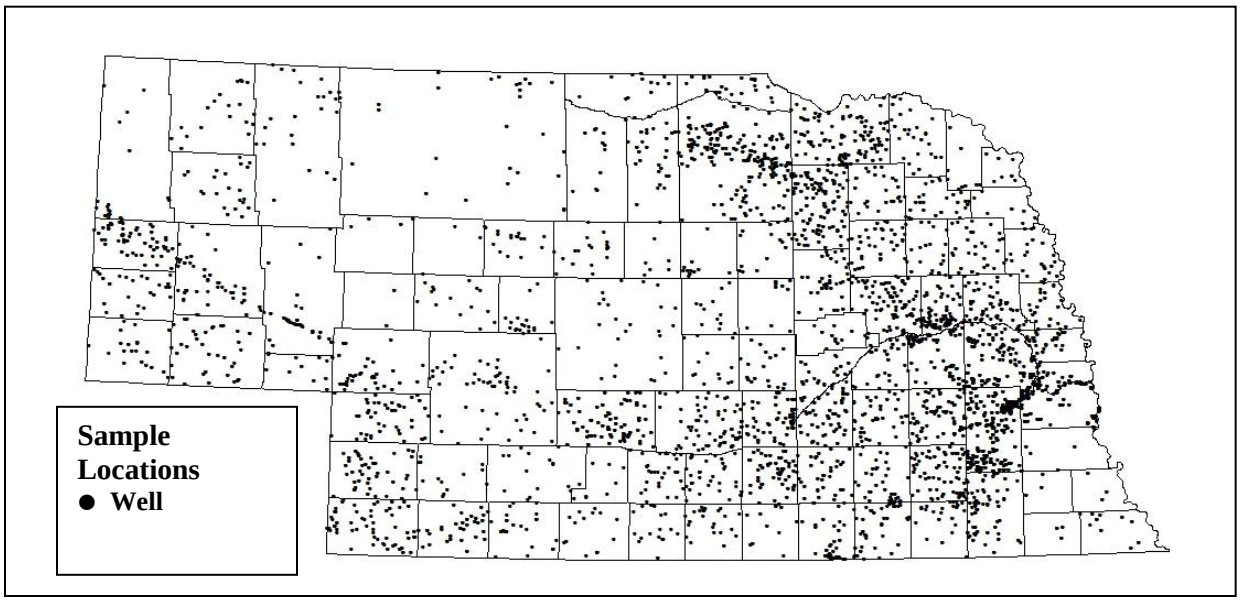



**Figure 29.** Location of 4,155 wells sampled for metolachlor from 1974 – 2008. (Source: The Database, 2009)

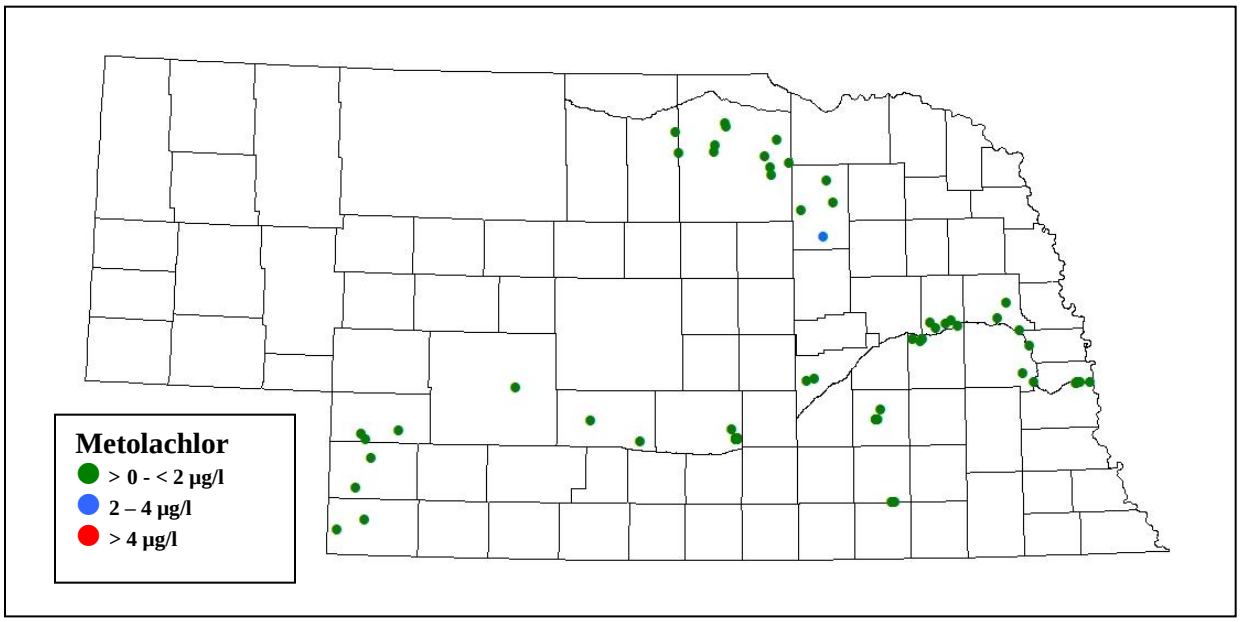



**Figure 30.** Last recorded concentration of metolachlor from 1974 – 2008. (Source: The Database, 2009)

The locations of all wells sampled for metolochlor in 2008 and then the concentration of that herbicide is are presented in Figures 31 and 32.

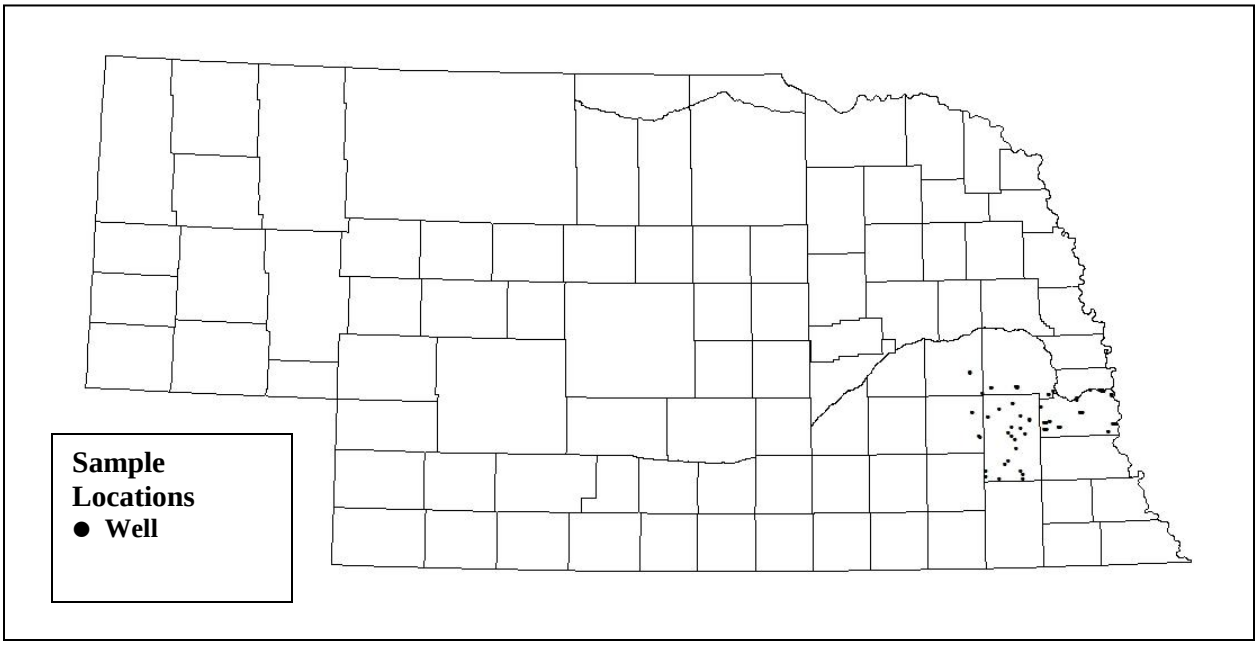



**Figure 31.** Location of 99 wells sampled for metolachlor in 2008. (Source: The Database, 2009)

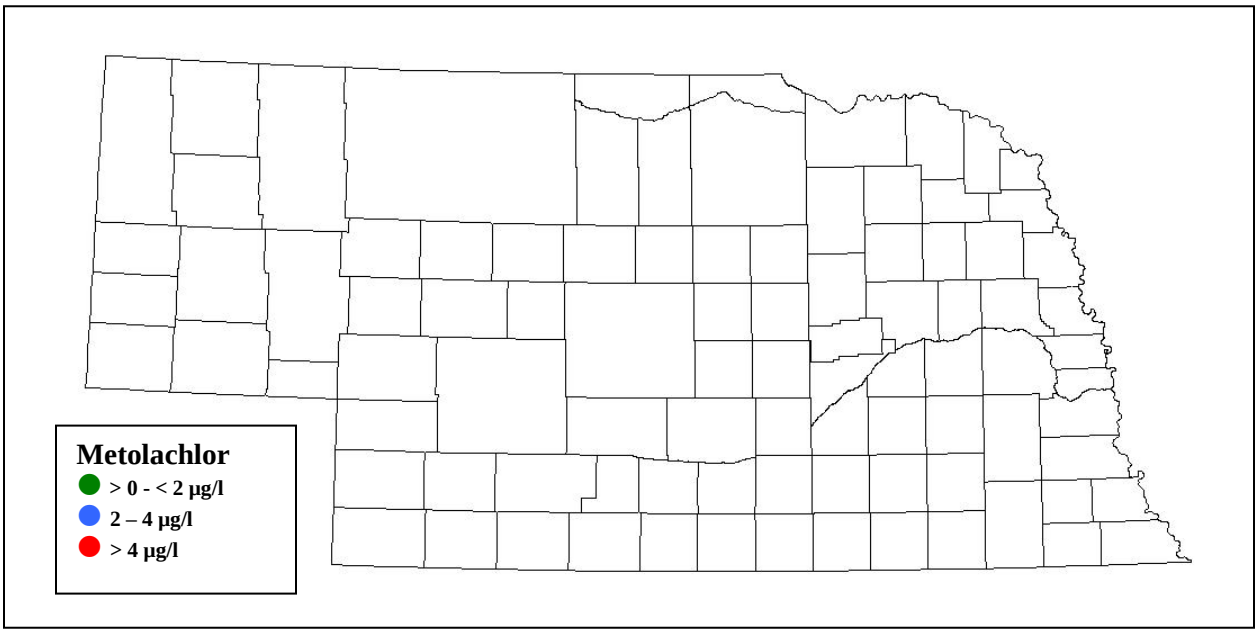



**Figure 32.** Metolachlor concentrations of wells sampled in 2008. (Source: The Database, 2009)

The mean metolachlor concentration calculated from the Database for the entire record from 1974 is 0.15 µg/L. There is no USEPA MCL for metolachlor. Fourteen of the 23 NRDs are currently using the in-house analysis described on page 22, but that data is not yet in the Database. Figures 31 and 32 reflect metolachlor data generated by analysis at a laboratory.

**Simazine**

The locations of all wells sampled for simazine from 1974 to 2008 and then the last recorded concentration of that herbicide is presented in Figures 33 and 34. Simazine is used as an herbicide to eradicate broad leaf weeds. Common commercial trademark names include (but are not limited to) Princep and Aladdin.

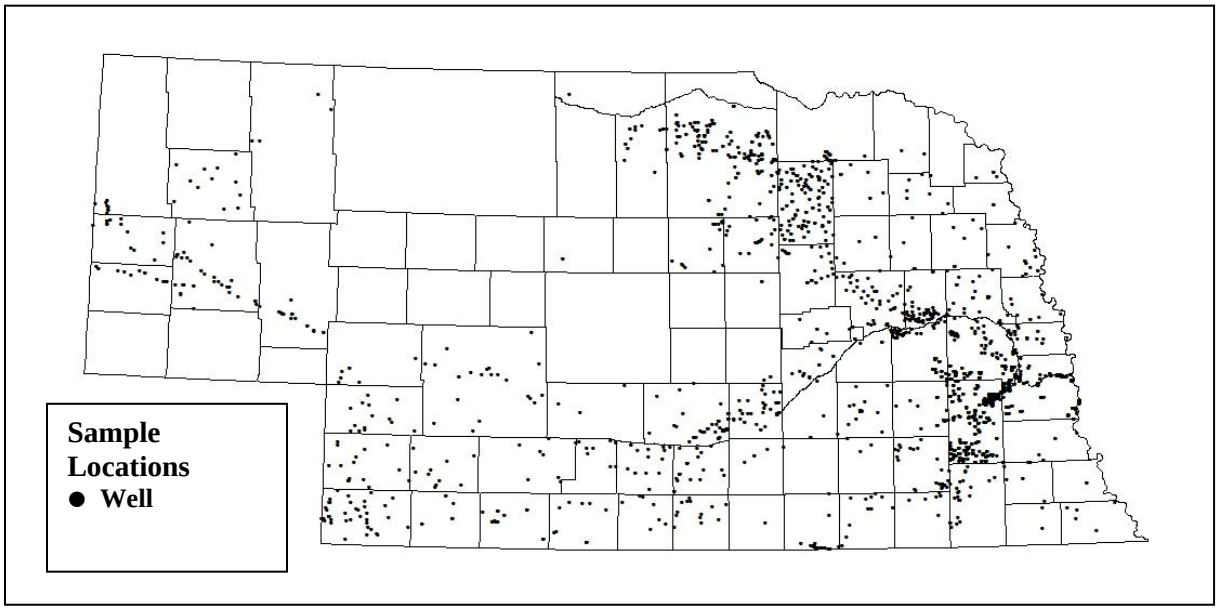



**Figure 33.** Location of 2,219 wells sampled for simazine from 1974 – 2008. (Source: The Database, 2009)

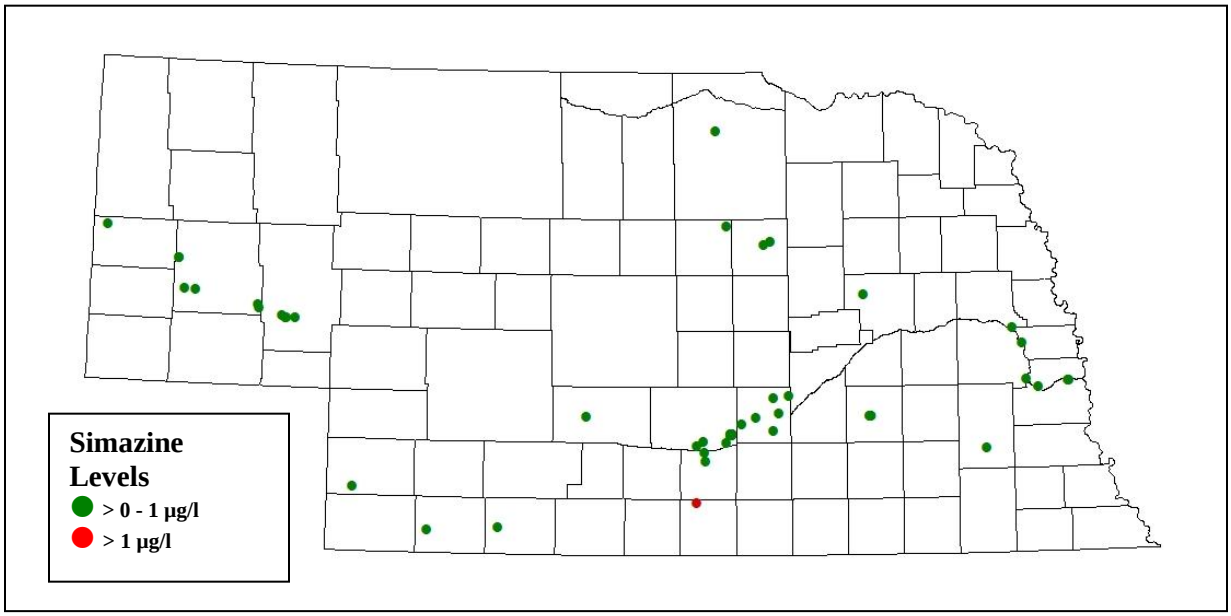



**Figure 34.** Last recorded concentration of simazine from 1974 – 2008. (Source: The Database, 2009)

The locations of all wells sampled for simazine in 2008 and then the concentration of that herbicide is are presented in Figures 35 and 36.

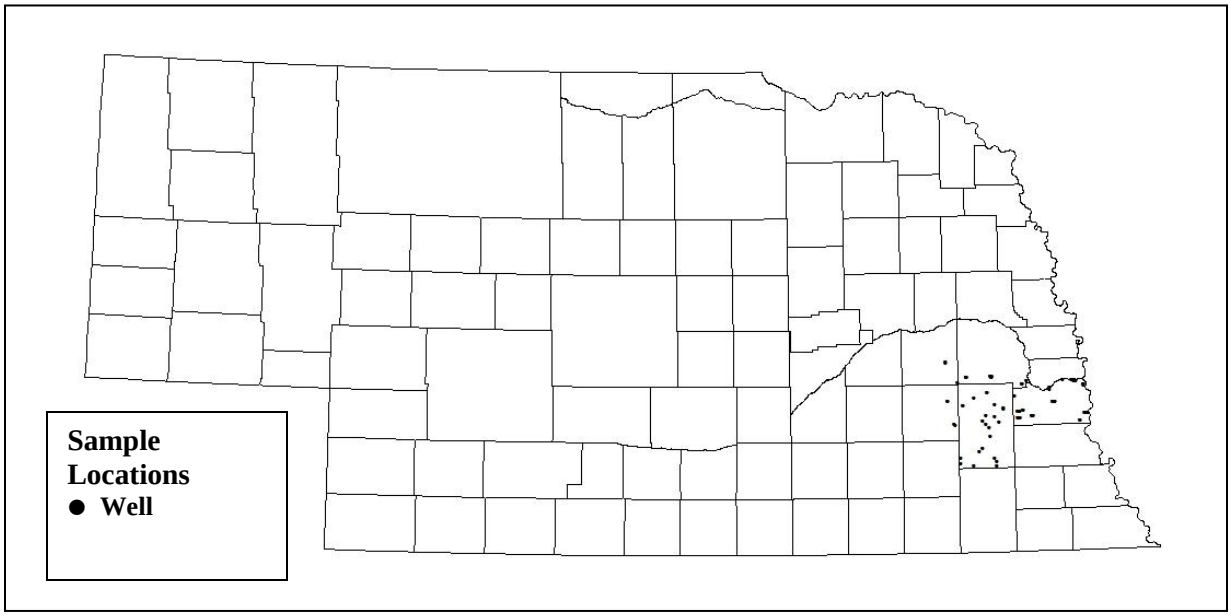



**Figure 35.** Location of 99 wells sampled for simazine in 2008. (Source: The Database, 2009)

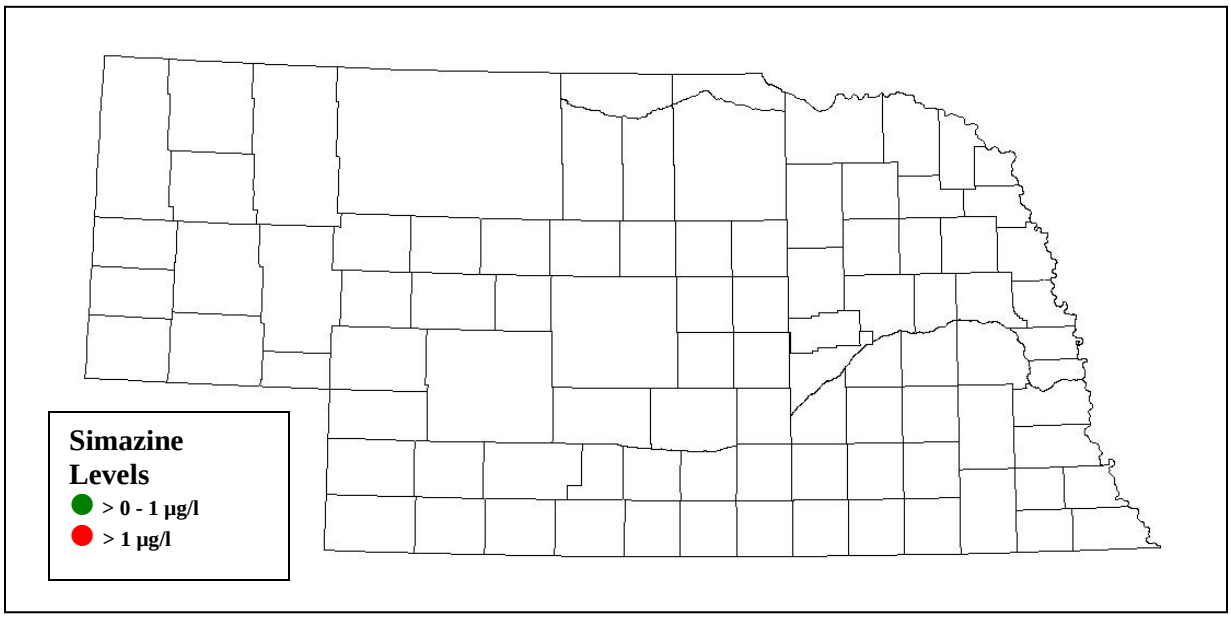



**Figure 36.** Simazine concentrations of wells sampled in 2008. (Source: The Database, 2009)

The mean simazine concentration calculated from the Database for the entire record from 1974 is 0.0006 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 22, but that data is not yet in the Database. Figures 35 and 36 reflect simazine data generated by analysis at a laboratory.

**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 22. Once the ongoing sampling and analysis of pesticides are entered into the Database, an assessment of the changes in levels of these compounds over time can be completed.

## 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 four 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 all 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 2001 the number of analyses greater than 10 mg/l has decreased. As discussed previously in this report, data from 1994 to 2008 is more representative of the "statewide" concentration of nitrogen and indicates a slight upward trend. Utilizing just the data from the NRDs' Statewide Groundwater Monitoring Network (Figures 19, 20 and Tables 7 and 8) for both the "short-term" and "long-term" analyses, there are more wells showing increases in nitrate levels than decreases. However, in both cases, the number of wells in the network show neither increase nor decrease is greater than either category. There is not enough recent data for atrazine, alachlor, metolachlor, or simazine to conduct any trend analyses. It should be noted that not all of the NRD's pesticide/herbicide data has been entered into the

Database at this time. Even with the future inclusion of these 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 monumental 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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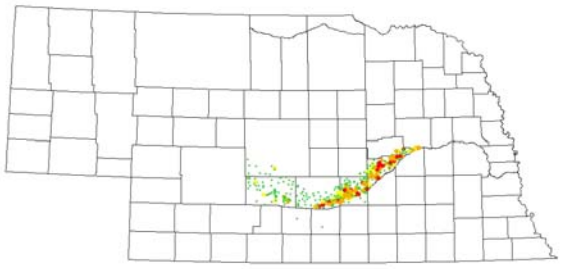
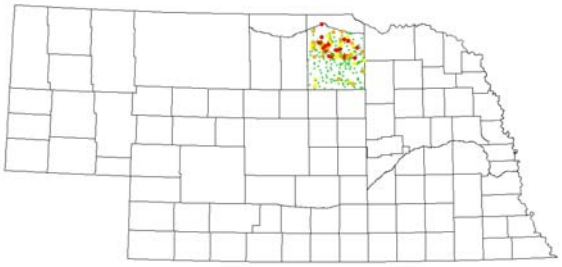
Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater. October 2008. Database available online from University of Nebraska-Lincoln and Nebraska Department of Natural Resources at http://www.dnr.ne.gov.

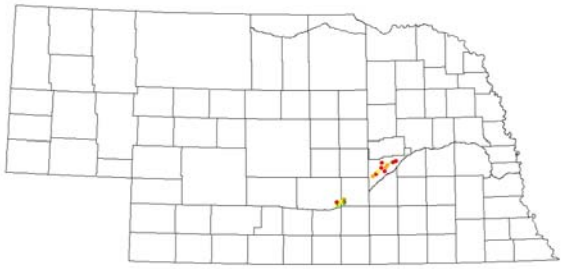
University of Nebraska, Conservation and Survey Division. 1998. The Groundwater Atlas of Nebraska. Resource Atlas No. 4a, 44 p.



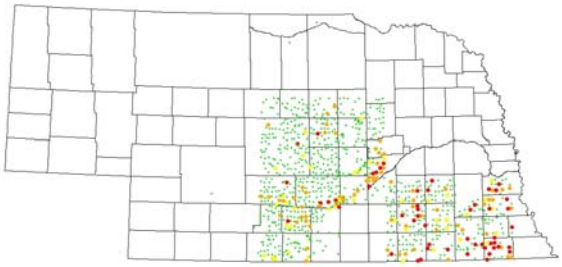
**1974 - 1975** (398 wells, 398 analyses)



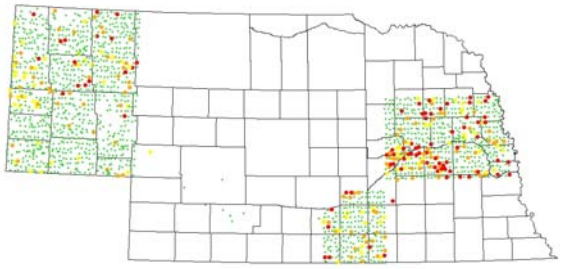
**1976** (281 wells, 283 analyses)



**1977** (43 wells, 45 analyses)



**1978** (1074 wells, 1082 analyses)



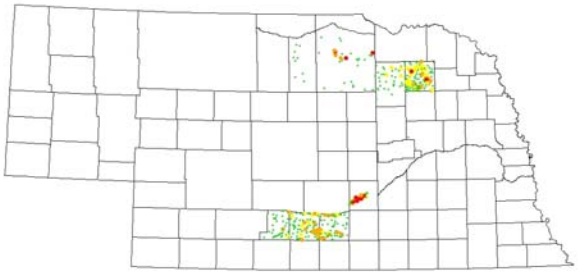
**1979** (1829 wells, 1845 analyses)

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

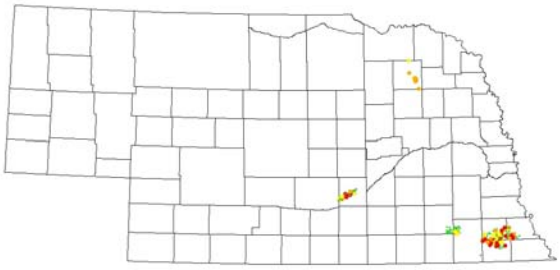
**Nitrate Levels**

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

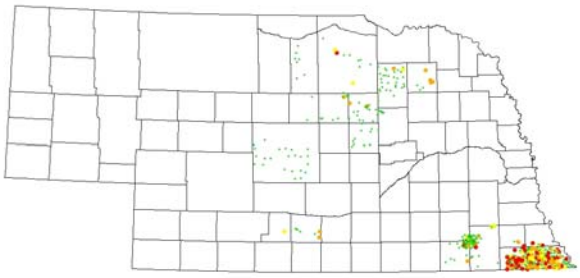
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



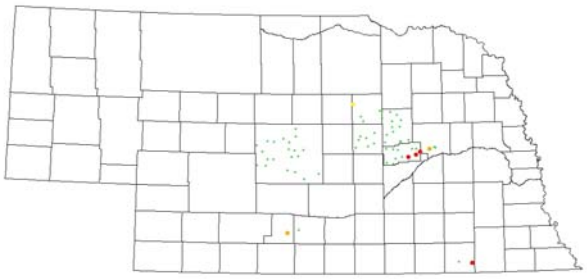
**1980** (469 wells, 470 analyses)



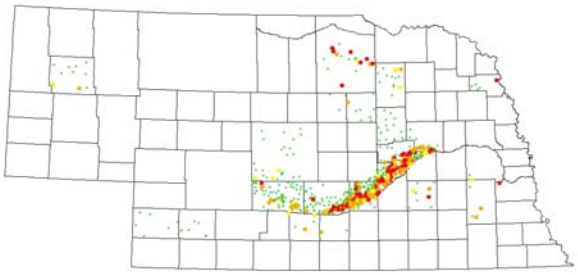
**1981** (143 wells, 197 analyses)



**1982** (508 wells, 519 analyses)



**1983** (67 wells, 67 analyses)



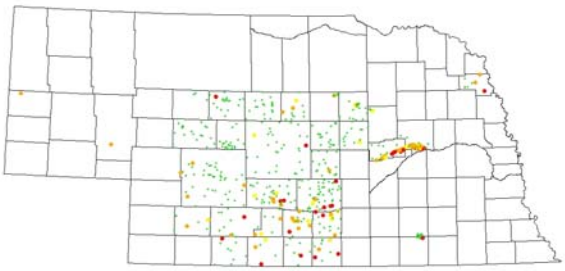
**1984** (696 wells, 696 analyses)

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

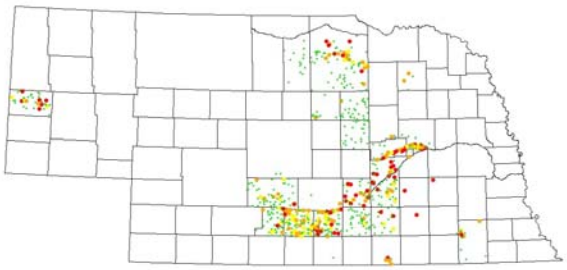
**Nitrate Levels**

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

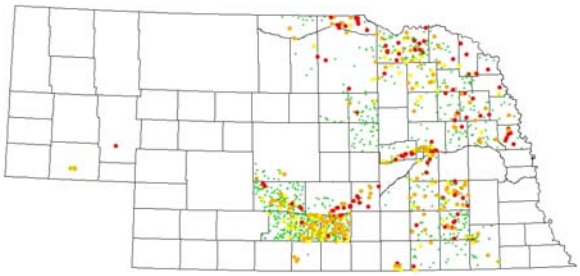
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



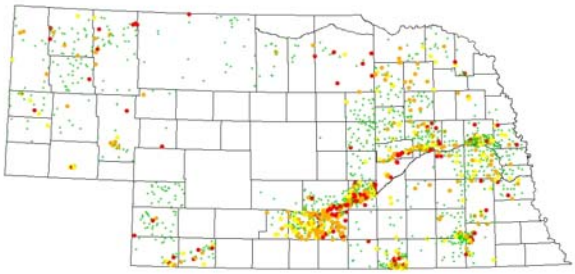
**1985** (594 wells, 616 analyses)



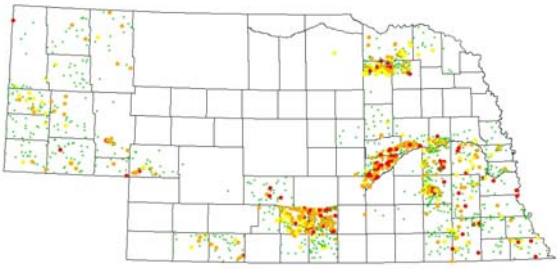
**1986** (743 wells, 743 analyses)



**1987** (1373 wells, 1373 analyses)



**1988** (1851 wells, 1853 analyses)



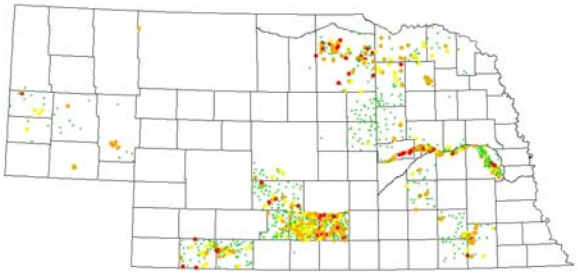
**1989** (1741 wells, 1747 analyses)

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

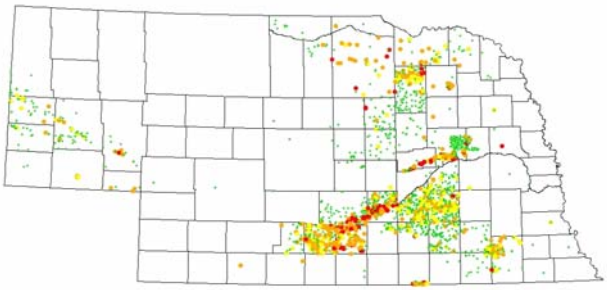
**Nitrate Levels**

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

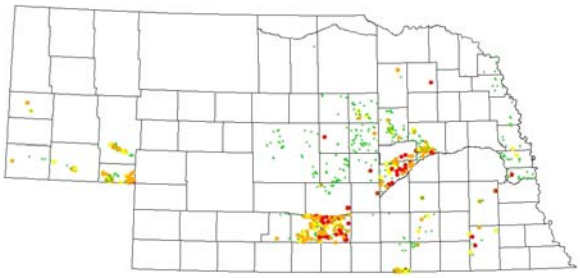
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



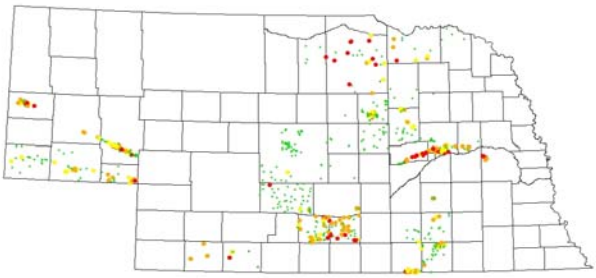
**1990** (1355 wells, 1367 analyses)



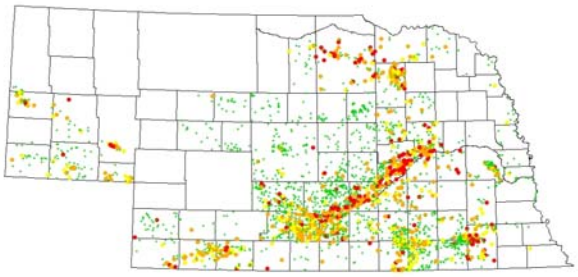
**1991** (2282 wells, 2874 analyses)



**1992** (1402 wells, 2490 analyses)



**1993** (1790 wells, 2864 analyses)



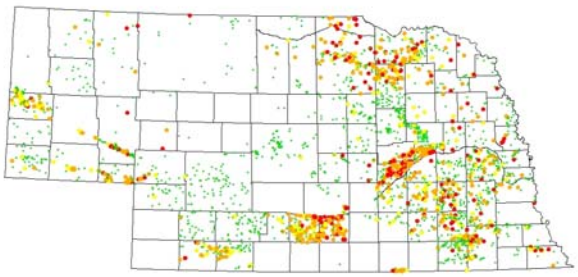
**1994** (4380 wells, 5720 analyses)

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

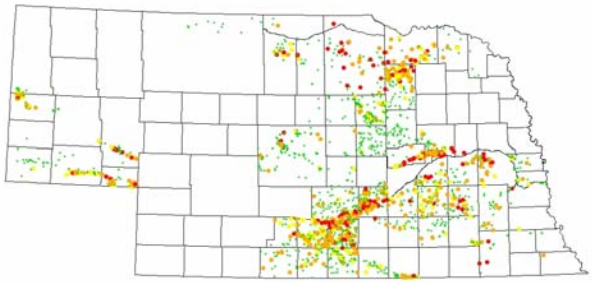
**Nitrate Levels**

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

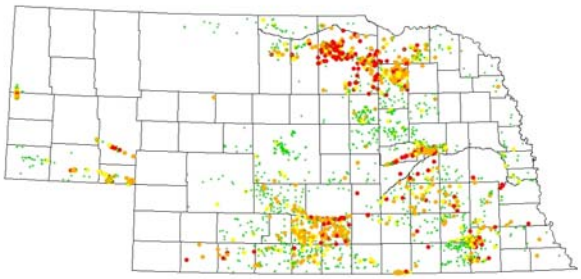
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



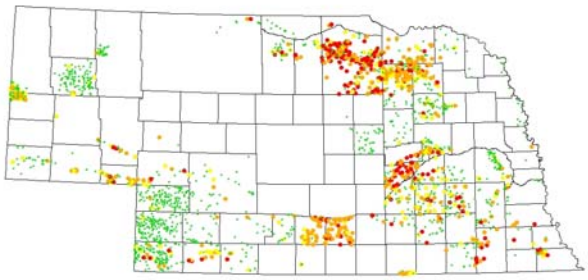
**1995** (4039 wells, 4746 analyses)



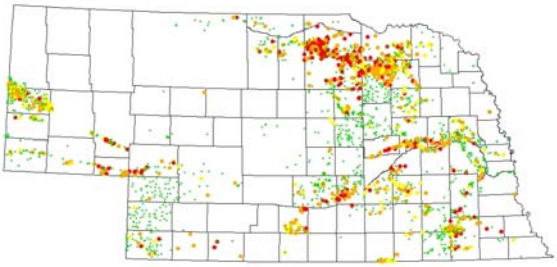
**1996** (3304 wells, 4211 analyses)



**1997** (3588 wells, 3613 analyses)



**1998** (3139 wells, 3164 analyses)



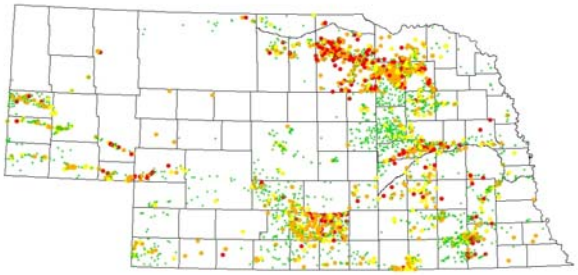
**1999** (3490 wells, 3576 analyses)

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

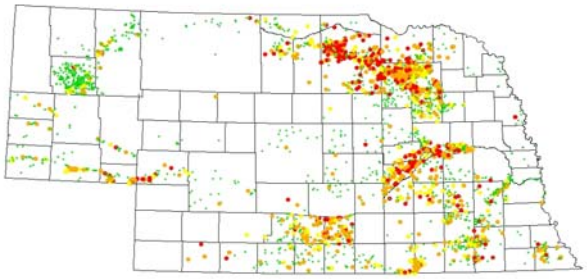
**Nitrate Levels**

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

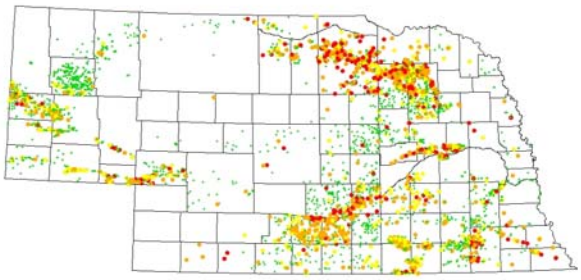
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



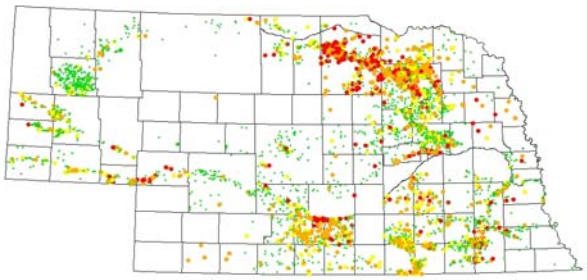
**2000** (4390 wells, 4486 analyses)



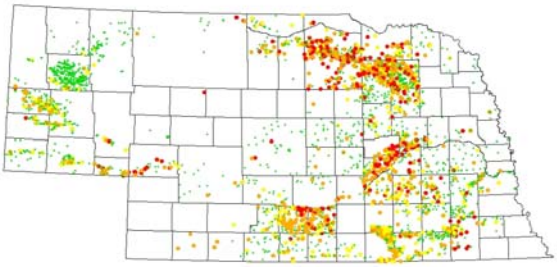
**2001** (3811 wells, 3881 analyses)



**2002** (5130 wells, 5208 analyses)



**2003** (5022 wells, 5106 analyses)



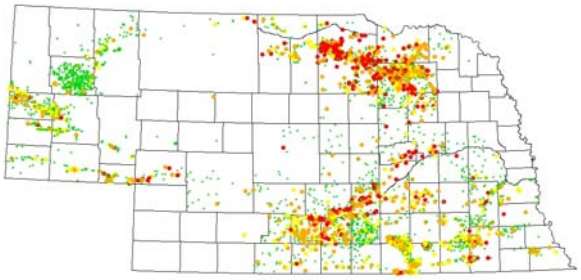
**2004** (4720 wells, 4787 analyses)

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

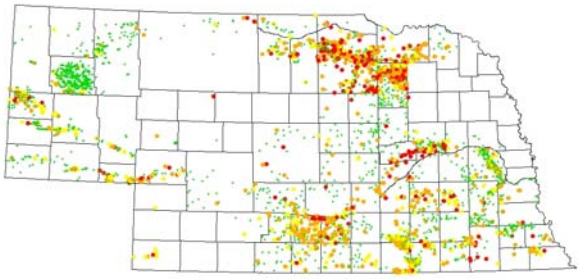
**Nitrate Levels**

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

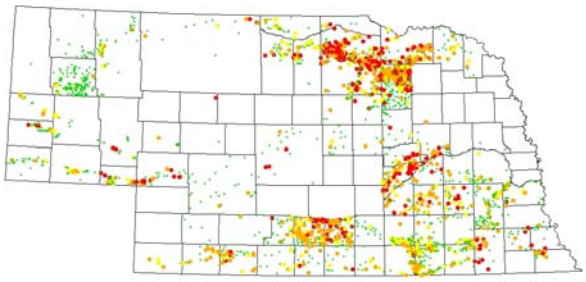
Empty areas indicate no data reported. These maps were provided to give you a snapshot of the data. To see them better, view the report on NDEQ's web site (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.



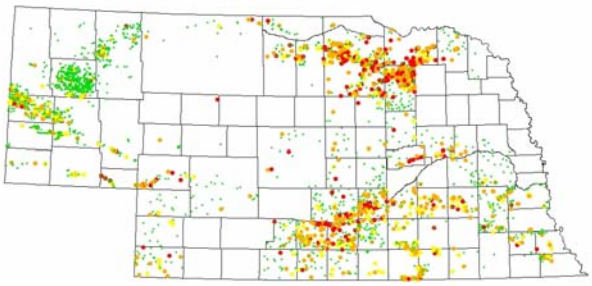
**2005** (2026 wells, 5081 analyses)



**2006** (4527 wells, 4573 analyses)



**2007** (3258 wells, 3300 analyses)



**2008** (3758 wells, 3784 analyses)

**Figure A-7. Nitrate analyses for years 2005 – 2007.** (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 (www.deq.state.ne.us) and use your Adobe Acrobat reader to enlarge individual maps.