Nebraska Water Quality

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IN OUR GRIT, OUR GLORY™

Hi folks, my name is Katie Pekarek and I am an Extension Educator in the School of Natural Resources. By training I am an Agricultural Engineer and I farm in Butler County with my husband. Today we will broadly address the subject of water quality in Nebraska and take a deeper dive into some of your local water quality concerns and initiatives.

Why Water Quality? Because not only do our actions as producers and professionals impact our water, our water impacts how and where we live; how we farm; what we raise; and our ability to prosper individually and as a community.

Let's talk about who manages water in Nebraska. At the field scale, it is each one of you – but each aspect of the way we manage water at the field scale is significantly influenced by ***who*** is monitoring water quantity and water quality, who is making decisions for how we can use water at the field scale, and the goals of those making those decisions.

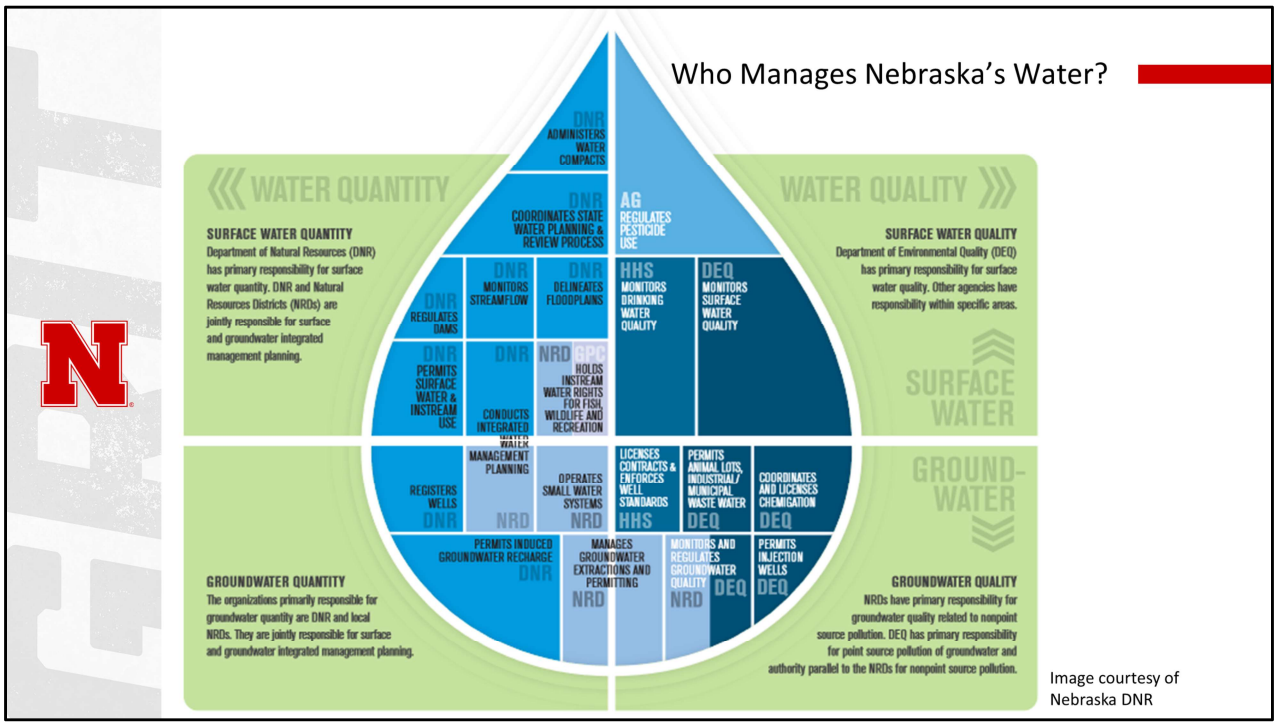


Image courtesy of Nebraska DNR

This graphic can help us understand the systems that are in place to manage water in Nebraska. It is divided into four quadrants: surface water quality, surface water quantity, groundwater quality, and groundwater quantity. You'll notice that each of these four quadrants has multiple entities involved in management. You may also notice that there is no entity that stays fully within one quadrant. This is because water management is a complex issue that is not easily *channeled* into one place.

Groundwater Quantity – Zoom into this quadrant

Groundwater quantity is managed by Natural Resources Districts (NRDs) and the Department of Natural Resources (DNR). There are 23 NRDs in Nebraska divided primarily based on watershed boundaries and managed by locally elected *Boards of Directors*. The NRDs conduct integrated water management planning, manage groundwater extractions, and operations with small water systems. The DNR works on primarily with Well Registration and groundwater recharge permits. However, the entities, in practice, work closely with each other on all of these issues and often share staff, time, and resources to accomplish this.

Groundwater Quality – Zoom into this quadrant

Groundwater Quality managed by three main entities: Nebraska Department of Environmental Quality (NDEQ), Health and Humana Services (HHS), and NRDs. NRDs monitor

and regulate ground water quality in conjunction with NDEQ. NDEQ additionally coordinates Chemigation, injection wells, industrial/municipal wastewater and animal feeding lots. HHS works with well standards.

Surface Water Quantity– Zoom into this quadrant

Surface Water Quantity is primarily managed by DNR, but also NRD and Nebraska Game and Parks Commission (GPC) when it relates to wildlife/recreation. DNR administers everything from water compacts, to surface water use- and instream use permits, to dam regulation. The NRD and GPC primarily work with instream water rights.

Surface Water Quality – Zoom into this quadrant

Surface Water Quality is managed by Nebraska Department of Agriculture (NDA), HHS, and NDEQ. NDA regulates pesticide use, HHS monitors drinking water quality and NDEQ monitors surface water quality. This seems like the simplest designation and in practice tends to simplest coordination between entities.

Note that the NRCS plays a significant role in how all of these management functions play out, but does not necessarily have a direct management role.

- Image courtesy of Nebraska DNR

Today we are focusing on the state of Nebraska's Water Quality. First looking at surface water, then looking at groundwater and finally taking a deeper dive into what is happening locally.

Pollution Sources

Point Source

Nonpoint Source

When we think about surface water quality and what is being monitored – we think of two different types of pollution 1) Point source pollution and 2) nonpoint source pollution.

- Point source pollution, as you know, being things you can “point to” such as water coming out of a pipe from factories, industries, lagoons, etc.
- Nonpoint source being things you can’t point to and that are more diffuse. This might include things like growing crops, animal waste from livestock or wildlife in pastures, oil from cars on the road and so on.

Ambient Stream Monitoring

- 100 sites statewide – Monthly
- Monitoring
  - 12 months per year
    - TSS, chloride, ammonia, nitrate+nitrite, kjeldahl nitrogen, total phosphorus, water temperature, dissolved oxygen(DO), pH, conductivity, turbidity, stream discharge
  - monthly pesticides, May-Sept.
    - Atrazine, acetochlor, metolachlor
  - quarterly metals, Jan, Apr, July, Oct,
    - Se, Hg, Na, Mg, Ca As, Ca, Cr, Cu, Pb, Ni, Ag, Zn

In Nebraska, we have 100 sites across the state which are under the ambient monitoring program. Ambient simply means that we are monitoring a water body to see if it is meeting the standard for an allowable amount of pollutant in the water. The allowable amount of pollutant in the water is determined based on the beneficial use. Beneficial Use refers to the intended use of water bodies:

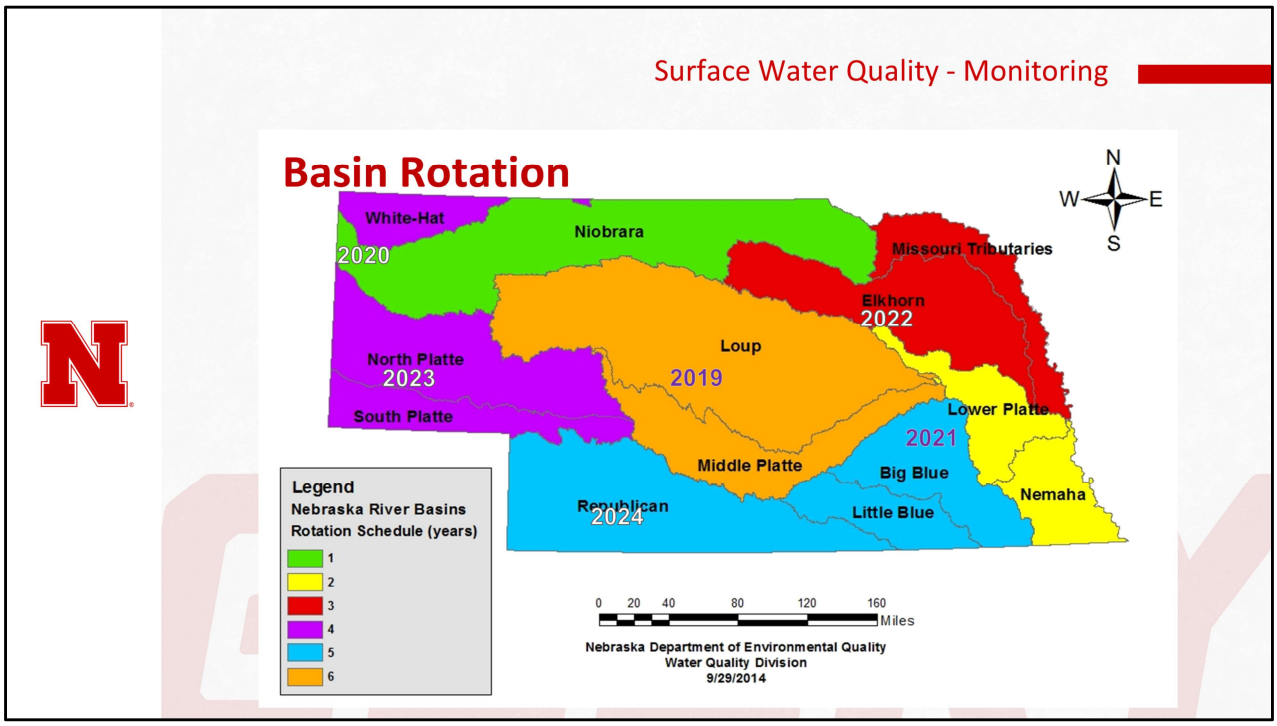
- Primary Contact Recreation
- Aquatic Life – Coldwater A, Coldwater B, Warmwater A and Warmwater B
- Water Supply – Public Drinking Water, Agriculture and Industrial
- Aesthetics

These 100 sites are monitored for Total Suspended Solids (TSS), chloride, and so forth as you can read in the slide. Additionally, three pesticides are monitored for from May through September. These three are selected because they are heavily used in Nebraska. They are only monitored for during the five month period as long term monitoring has shown they are generally non detectable in the other months of the year. This is primarily due to the growing period of crops in the state. Finally, metals are monitored for on a quarterly basis. These are an important part of the monitoring program, but are limited to quarterly sampling largely based on the consistency of sample levels and budget

Basin Rotation Monitoring

- 35-45 sites per year (Map) – 6 year schedule
- Weekly, May –Sept (22 weeks)
  - TSS, chloride, ammonia, nitrate+nitrite, kjeldahl nitrogen, total phosphorus
  - water temperature, dissolved oxygen (DO), pH, conductivity, turbidity, stream discharge
- weekly pesticides, May-June
  - Atrazine, acetochlor, metolachlor
- E. coli

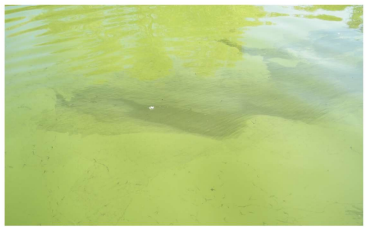
Basin rotation monitoring is more intensive than ambient stream monitoring and occurs on a six year schedule. It is conducted for 22 weeks at 35-45 sites per year. Water Quality monitoring program leads get together to decide priorities for monitoring and to select sites. Priorities might include National Water Quality Initiatives, Basin or Watershed Management Plans, or emerging areas or contaminants of concern. This monitoring and analysis is led by the NDEQ but only accomplished because of the many partners including local NRDs, university partners, local watershed groups and more.

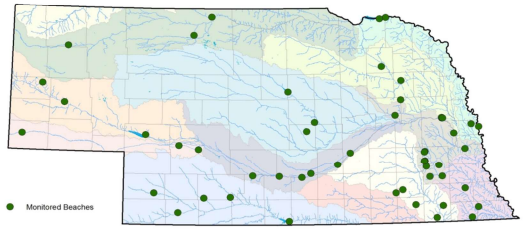


This is a map of the basin rotation schedule in Nebraska. 2019 was focused on the Loup and Middle Platte basins. 2020 will focus on the Missouri Tributaries and Elkhorn Basin. Multiple basins are often put together for the sake of efficient monitoring.

Public Beach Monitoring

- Public Beaches – 51 sites
- Weekly, May 1 – Sept. 30 (22 weeks)
- Bacteria, microcystin
- Weekly results posted http://dee.ne.gov





Lake monitoring is focused on maintaining a recreation benefit in lakes. This means that if a lake in Nebraska has a public beach where people may wade in the water, swim, or kayak, it is being monitored.

Fifty one (51) public beaches in Nebraska are monitored every week from May 1 – September 30 for bacteria and Microcystin toxin. This monitoring is done by the state in conjunction with partners. Most often, this means that either NDEQ or NRD staff is conducting sampling and the samples are analyzed in the state lab.

Of note here is that the microsystin, or toxic blue-green algae generally relates back to the nutrients in the water. Most often, our water in Nebraska already has a significant amount of nitrate present, which means Phosphorus is the limiting factor. So whenever there is a small addition of phosphorus to a Nebraska lake, it becomes a prime growing area for some vegetation. Sometimes that vegetation is a filamentous, or mossy, type algae. Sometimes its cattails. But when the conditions are right, it is toxic blue-green algae. We are seeing more and more cases of blue-green algae every year in Nebraska, which result in public beach closings.

Other Monitoring

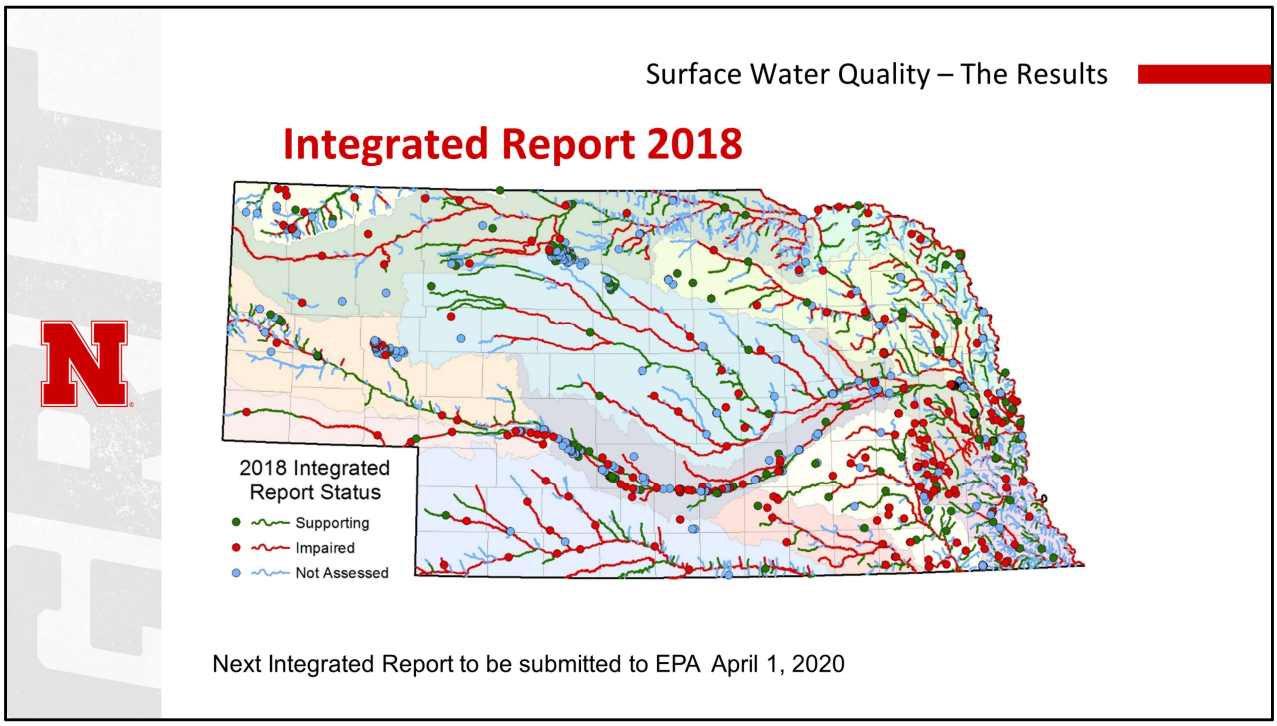
- Ambient Lake
  - 45 lakes
  - Monthly, May – Sept.
- Fish Tissue
  - 30-60 lakes and streams
  - typically 50-120 fish samples
  - Basis of fish consumption warnings
- Stream Biological ~ 30-40 sites
  - Habitat assessment
  - Bugs, fish
  - Field parameters

Ambient Lake Monitoring occurs Monthly May – Sept on approximately 45 lakes

In Nebraska, we have 45 lakes across the state which are under the ambient monitoring program. The lake ambient monitoring program is less in-depth than the stream ambient program. These sites are monitored from monthly from May through September and focus on pesticides, nutrients, and basic parameters like total suspended solids or dissolved oxygen.

Fish tissue sampling is also done at 30 – 60 lakes regularly throughout the year and used as the basis of fish consumption warnings. The sampling is done in conjunction with Game and Parks and focuses on the most heavily fished areas of the state.

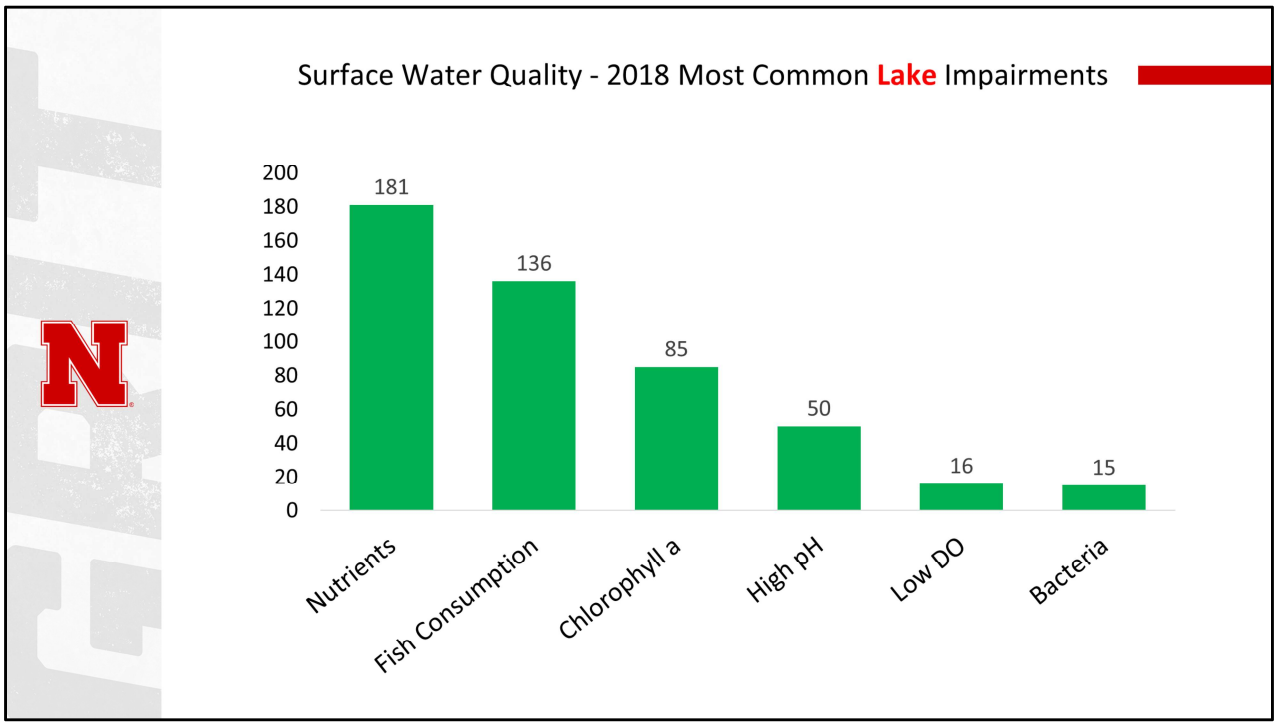
Stream Biological monitoring is conducted for habitat assessment, presence of bugs, fish, and other field parameters. It is conducted and 30-40 sites statewide that are considered areas of concern or areas for preservation. The data collected is used to help assess the quality of the sites.



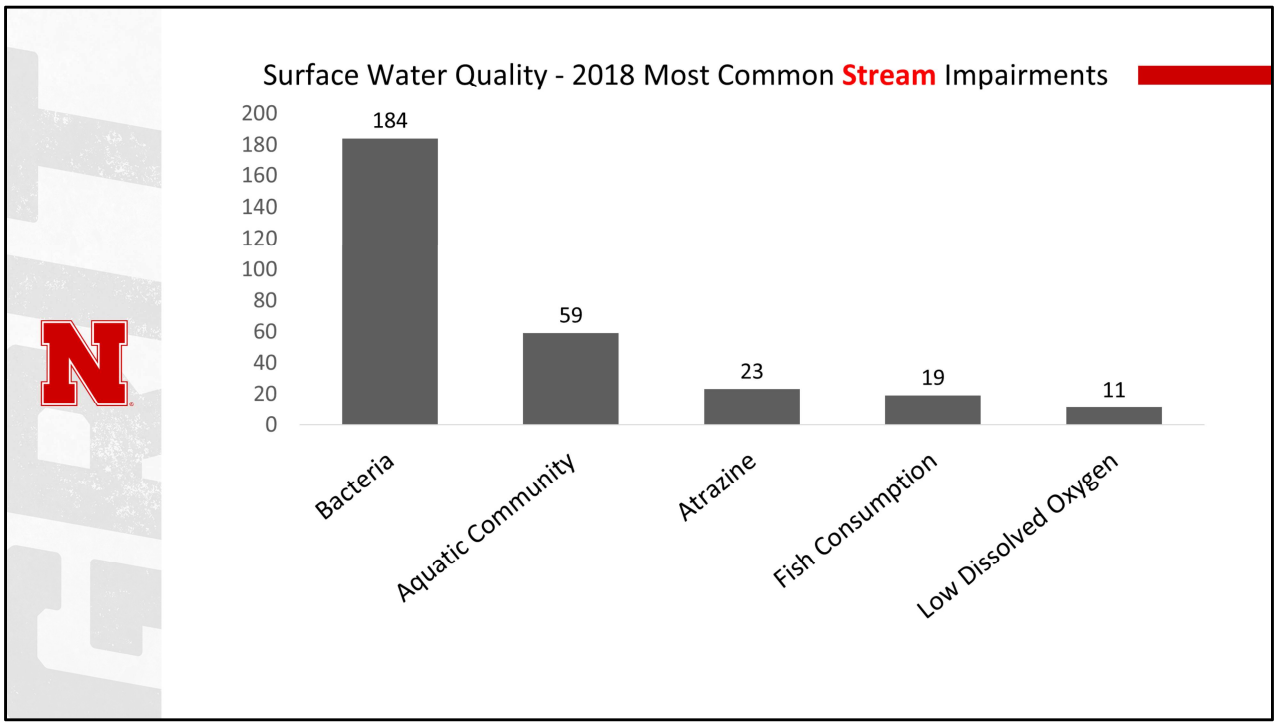
The results of all of the collected monitoring data are compiled and analyzed, then put into what we call the Integrated Report or "IR." The goal of this report is to goal for this report is to provide the general public with a comprehensive summary of state and national water quality.

Section 303(d) of the federal Clean Water Act (CWA) requires states, territories, and authorized tribes (states) to identify and establish a priority ranking for all waterbodies where applicable water quality standards apply. Section 305(b) of the CWA directs states to prepare a report every two (2) years that describes the status and trends of existing water quality. Section 314 of the CWA requires that each Section 305(b) submittal include an assessment of water quality trends of public owned lakes. These three sections of the clean water act are fulfilled in the Nebraska Water Quality Integrated Report.

If you take a look at the map, you will see anything in red is considered impaired. Anything in green is good to go. And all the blue is water where there is not enough water quality information to determine if it is impaired or supporting.

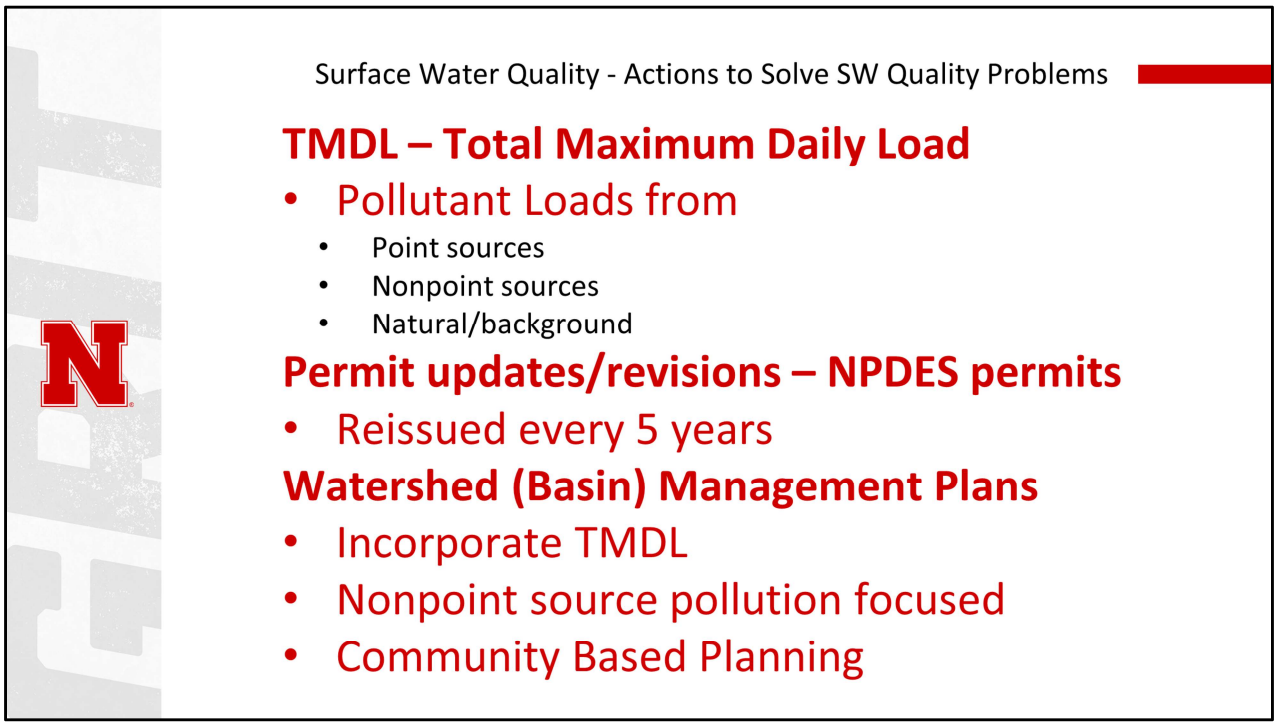


The most common impairments for lakes are generally nutrients – both nitrogen and phosphorus. Impairment simply means that the quality of the water is poor enough that it will not support its intended beneficial use. Note that although this does not say anything about soils, there is a strong implication to which ties soil erosion and the nutrients in lakes. The least common impairment noted here is bacteria (E. coli) but this will result in beach closings at public lakes. Also, microsystin is not reported in this report.



Here you can see that the most common stream impairments. Note that Bacteria is the cause of the majority of the stream impairments. The source of this bacteria is generally from livestock operations and faulty septic systems. It is largely a locally driven impairment. Atrazine is the third most common impairment. The source of atrazine is crop production and, like the bacteria impairment is locally driven. There is not a nutrient standard for most Nebraska streams, so you would not see that listed as an impairment here.

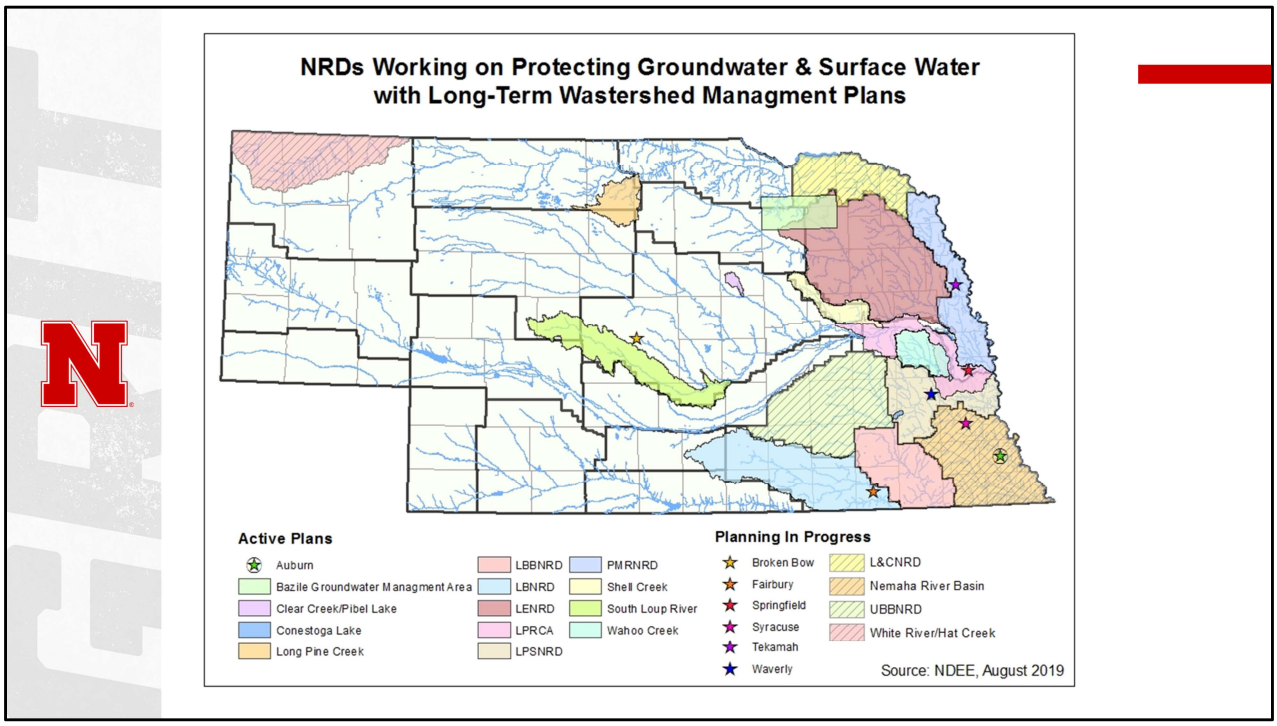
Aquatic community impairments usually mean that you can not support the aquatic habitat that was once presence. Typically this relates back to soil erosion – both in stream and on the watershed.



There three main ways that surface water quality issues are addressed by the state. The first is TMDLs. A TMDL is a calculation or equation that is used to determine the maximum amount of a pollutant that a waterbody (stream of lake) can receive and still achieve the assigned water quality goals. TMDLs will often identify pollutant sources and reductions necessary. These put into place restrictions on how much of a pollutant load can be contributed to the impaired water by point and nonpoint sources. It does take into account natural or background loadings.

The second way is through permit update and revisions to National Pollution Discharge Elimination System (NPDES) permits. These address water pollution by regulating point sources that discharge pollutants to waters of the United States. These are issued every 5 years. This generally goes to point sources. This includes our towns in Nebraska of 10,000+ population. It also includes industrial, wastewater, and construction permits.

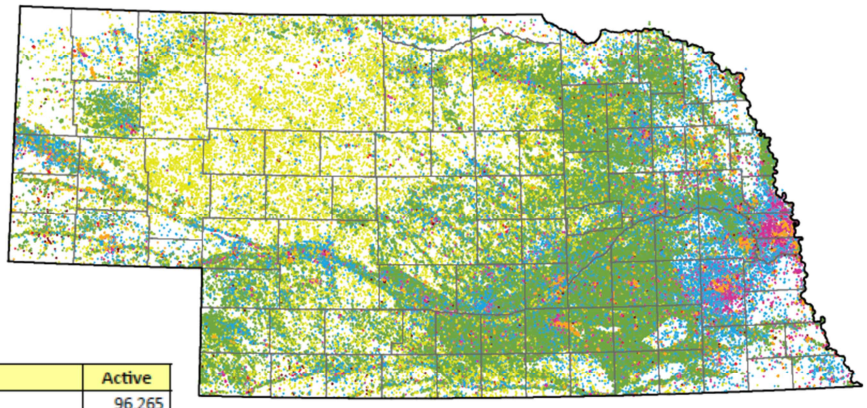
The third way is through voluntary development of Watershed (or Basin) Management Plans. These focus on nonpoint source pollution, utilize community based planning and incorporate information rom any existing TMDLs. These plans often overlap and interact with EQIP programs, NWQI areas, CSP, and other NRCS programs. Where applicable, funding from the local NRDs and NDEE will be used to supplement or support existing NRCS programs. So for example, if there is a strong push for no-till, NRD funds will be offered up to increase the cost-share opportunities for producers.



If take a look at this map, you will see that the bulk of the Watershed Management Plans have been coming out of the eastern portion of the state. Locally, you may be in one of four different Watershed Management Plans – the Bazile Groundwater Management Plan, the Shell Creek, Lower Elkhorn, or Lewis and Clark Watershed Management Plans.

Groundwater Quality in Nebraska

Ground Water Quality



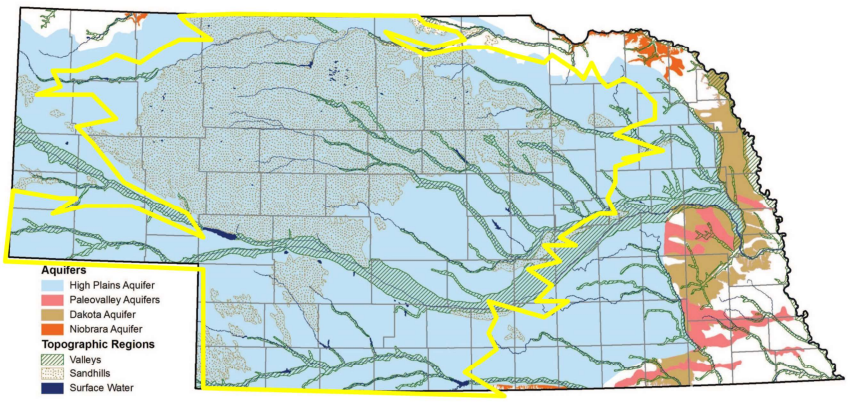
	Water Use	Active
●	Irrigation	96,265
●	Domestic	31,661
●	Livestock	22,048
●	Monitoring (groundwater quality)	16,780
●	Public Water Supply	3,029
●	Commercial/Industrial	1,769
●	Other	14,103
	TOTAL	185,628

Source: NDEE "2019 Nebraska Groundwater Quality Monitoring Report" Nov. 2019

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%. 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 and water livestock.

As of November 2018, the Nebraska Department of Natural Resources (NeDNR) listed 96,593 active irrigation wells and 30,932 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 NeDNR.

Ground Water Quality – Where does Ground Water come from?



Source: 2009 Nebraska Statewide Groundwater-Level Monitoring Report Nebraska Water Supply Paper 76. Conservation Survey Division, School of Natural Resources, University of Nebraska-Lincoln.

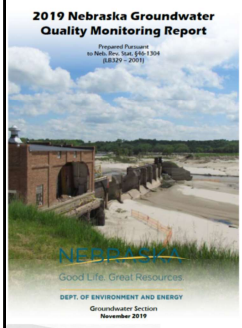
At this point, most people realize that the bulk of groundwater in Nebraska is from the Ogallala aquifer. It is interesting to note that there are, however several sources of groundwater that are not directly part of the Ogallala group. Yellow outline = Ogallala Group

Who Monitors Groundwater in Nebraska?

- Natural Resources Districts (23)
- Nebraska Department of Agriculture
- Nebraska Department of Environment and Energy (formerly NDEE)
- Nebraska Department of Health and Human Services
- Public Water Suppliers
- University of Nebraska-Lincoln
- United States Geological Survey

Who is monitoring groundwater? 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 1342 public water suppliers monitor groundwater for a large number of possible pollutants which could impact human health. 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.

Ground Water Quality – Quality- Assessed **Agrichemical** Contaminant **Database** for Nebraska Groundwater



Provides Groundwater Monitoring Results for Agricultural Compounds in Nebraska to the public.

Provides an indicator of the methodologies used in sampling and analysis for each of the results.

Partly in response to this situation, the Nebraska Departments of Agriculture (NDA) and 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 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 examine 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.

Types of Wells Sampled

Well Type	Number of Analyses
Monitoring	257,035
Irrigation	118,557
Domestic	76,874
Public Water Supply	38,244
Commercial/Industrial	2,514
Livestock/Other	2,065
Heat Pump (GW Source)	8
Total	495,297

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).

Ground Water Quality

Compound	Total Samples Collected	Number of Samples that exceed the Reporting Limit	Percent of Samples that exceed the Reporting Limit
nitrate-N	126,645	116,441	91.94%
alachlor ethane sulfonic acid	136	71	52.21%
deethylatrazine	5,847	1,571	26.87%
atrazine	10,768	2,291	21.28%
metolachlor	9,838	1,065	10.83%
deisopropylatrazine	5,159	381	7.39%
cyanazine	10,300	422	4.10%
alachlor	10,338	305	2.95%
propazine	5,741	119	2.07%
simazine	6,309	125	1.98%
prometon	6,095	55	0.90%
metribuzin	10,194	59	0.58%

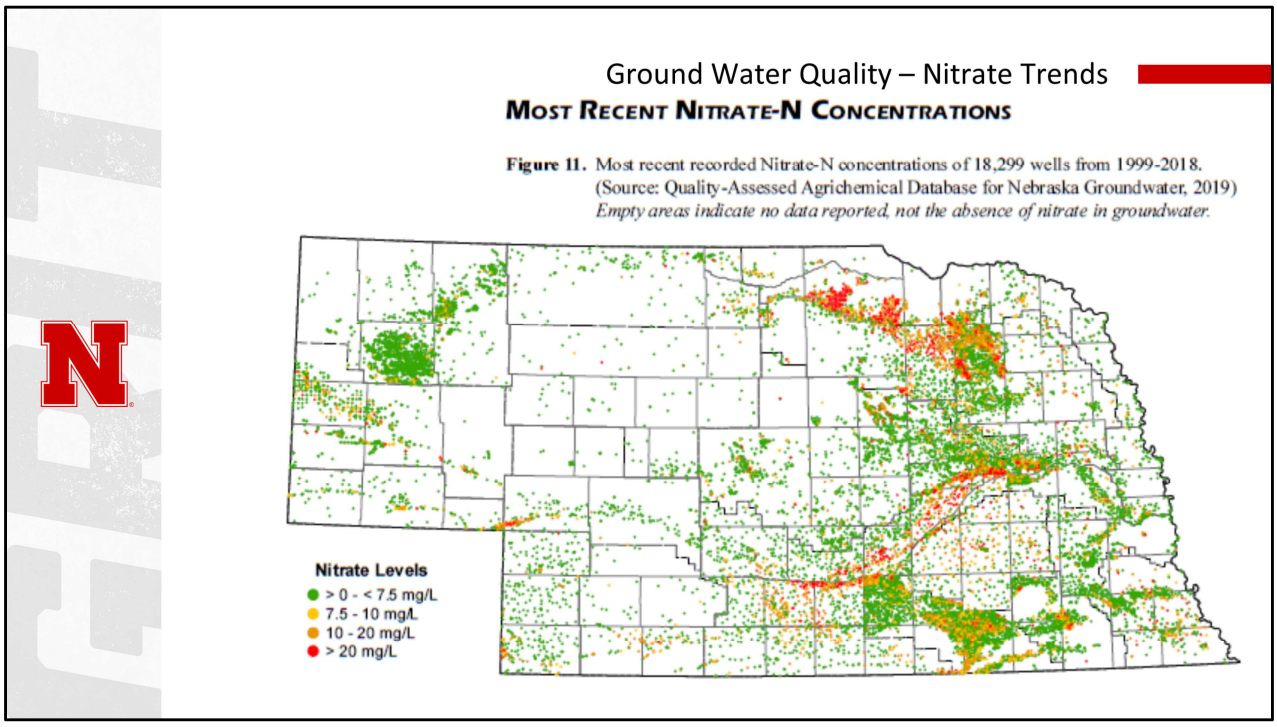
Since sampling reporting began, 241 different contaminants have been analyzed for in Nebraska. Of those 241 contaminants, this table shows those contaminants which recede the reporting limit for at least 50 samples. This table therefore gives an indication of the compounds most commonly detected in Nebraska's groundwater. Only 12 of the 241 compounds sampled met the criteria.

I'm going to linger here a bit more than most, because these are some really important numbers and things for you to mull over. We'll talk more about nitrate in a minute, but note that 91% of the samples exceed the reporting limit for Nitrate. Let's just run through these chemicals:

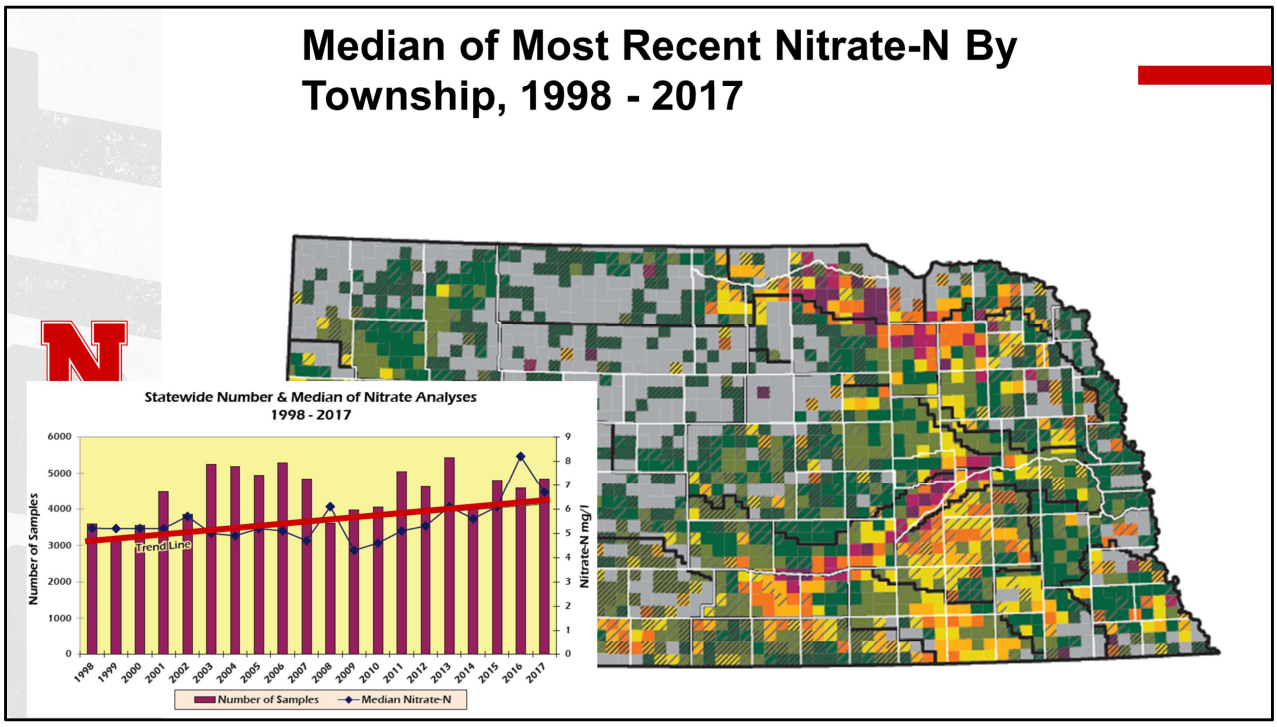
- Nitrate-N: fertilizer, regardless of form when applied: UAN, Anhydrous Ammonia, manure, etc.
- Alachlor: Lasso – often marketed mixed with atrazine, glyphosate, trifluralin and imazaquin – control grass and broadleaves
- Deethylatrazine: degradate of atrazine
- Atrazine: PRE and POST on broadleaves
- Metolachlor: found in Bicep, Dual, Pennant – PRE to control grasses and small broadleaves
- Deisopropylatrazine: degradate of atrazine
- Cyanazine: triazine similar to atrazine - Bladex
- Propazine: triazine similar to atrazine - Milogard
- Simazine: triazine similar to atrazine – aquazine, prince
- Prometon: Pramitol – POST for annual broadleaf/grasses
- Metribuzin: Sencor, Canopy

Groundwater Nitrate in Nebraska

Since Nitrate is the most prevalent of the contaminants noted above, let's dive deeper into groundwater Nitrate in Nebraska.



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 supply operators sample their drinking water wells to ensure that the public is offered good quality water through the municipal system. NRDs have been tasked by the Nebraska legislature to manage groundwater quality and quantity in order to preserve its usefulness into the future. Additionally, shallow groundwater may have different natural chemical characteristics than deep groundwater and is more easily and quickly affected by activities on the surface than deeper groundwater.

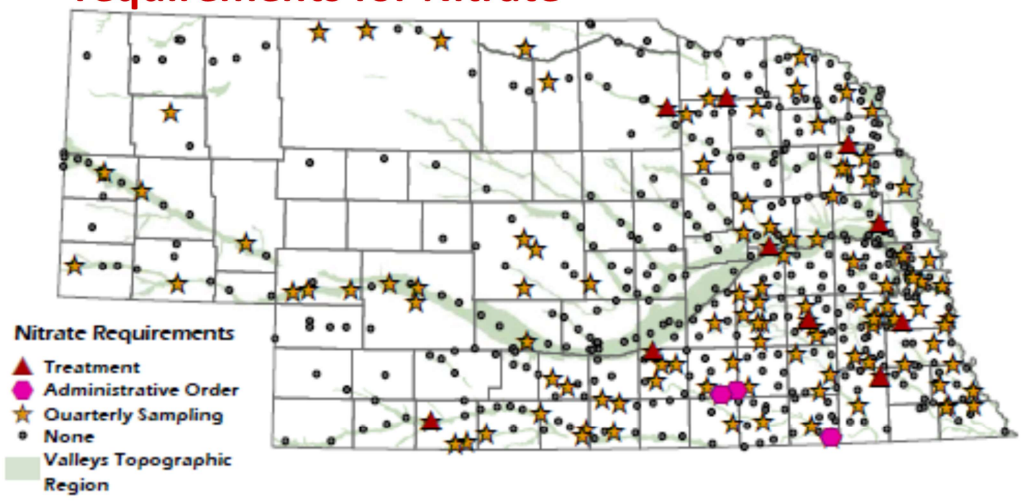


Here, you see the that since 1998, the general trend for nitrate concentrations in groundwater has continued to increase.

In the top map the median of the most recent nitrate sample is shown by township. Anything that is a dark orange, pink, or purple, exceeds the safe water drinking limit which then places financial and health implications on a community.

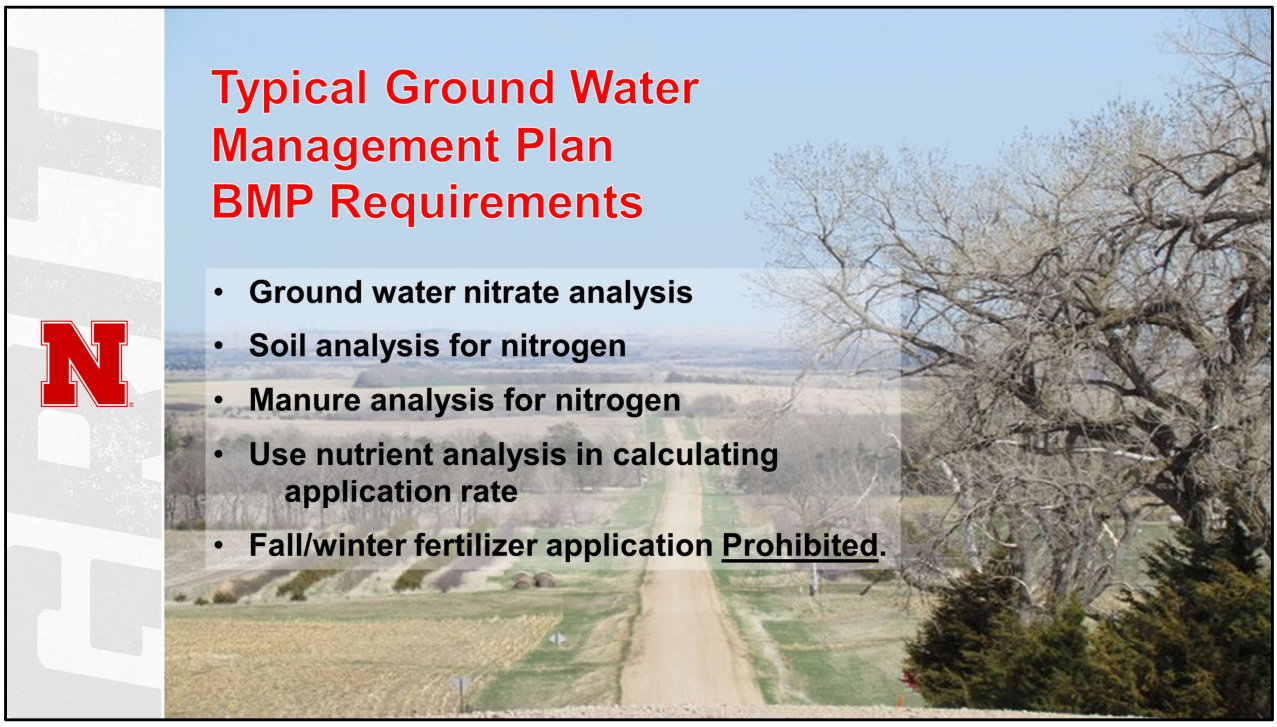
Ground Water Quality – Public Drinking Water Supply

Community Public Water Supply Systems with requirements for Nitrate



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.

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, 117 of those must perform quarterly sampling for nitrate.



So as ground water management plans become more common and NRDs put more emphasis on groundwater management areas, there are commonalities in typical ground water management plans. These include…

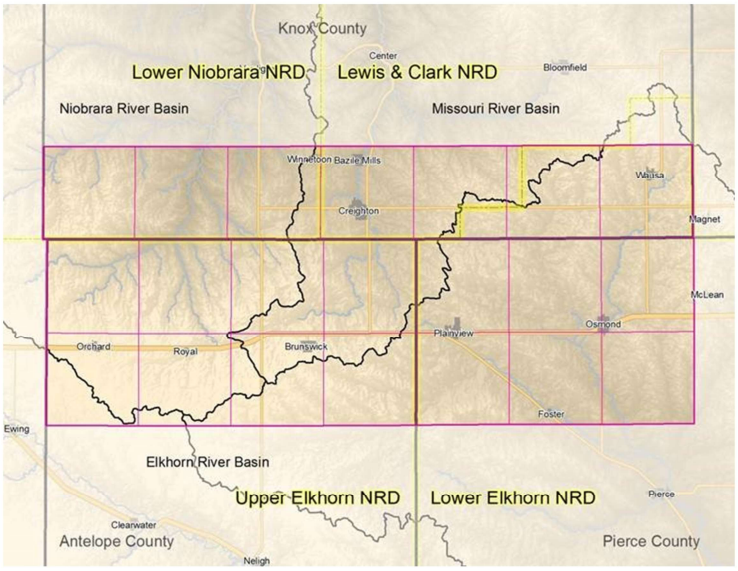
- Ground water nitrate analysis
- Soil analysis for nitrogen
- Manure analysis for nitrogen
- Use nutrient analysis in calculating application rate
- Fall/winter fertilizer application Prohibited.

They further include…

- Issue permit for drilling new wells > 50 gpm
- Use of nitrogen inhibitors
- Annual crop report
- Split fertilizer application
- Irrigation scheduling/management
- Farmer education/certification every 4 years

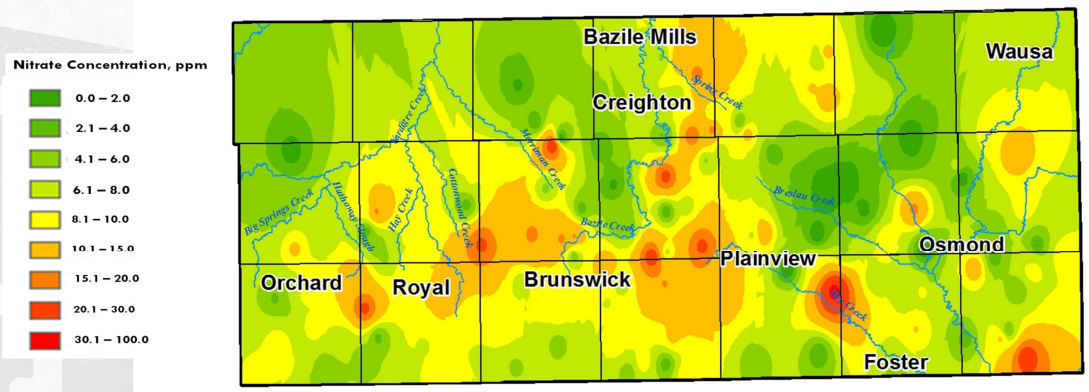
So let's talk a little bit about what is going on locally. Many of you in here will are part of the Bazile Groundwater Management Area (BGMA). Let's see a show of hands for who has heard of this? *Pause* Ok, if you haven't – I'd like you to pay close attention to the following map and see if you fall within this area.

Location



The BGMA covers four different NRDs, three different counties, and five communities. It was defined in an effort to address high nitrate levels in groundwater. The BGMA is a cooperation between four NRDs: Lower Niobrara, Lewis & Clark, Lower Elkhorn, and Upper Elkhorn, the NDEE, Nebraska Extension, NRCS, EPA, Nebraska Association of Resources Districts, and the Nebraska Environmental Trust.

BGMA: Nitrate Content In Groundwater 1980-89

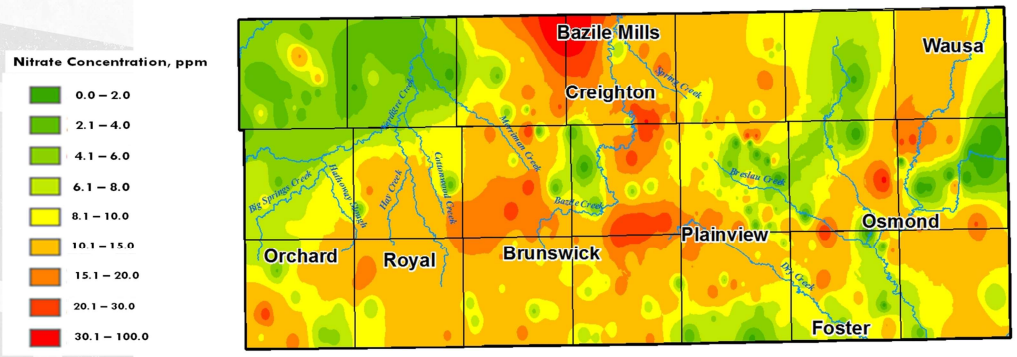


Data from the Nebraska Department of Natural Resource's Clearinghouse database

The safe drinking water level of nitrates is 10 ppm. I'm going to show you a series of graphics which illustrate nitrate levels in ground water over a period of almost 40 years. Notice that the orange color illustrates nitrate levels that are already considered "not safe" – or those levels over 10 ppm.

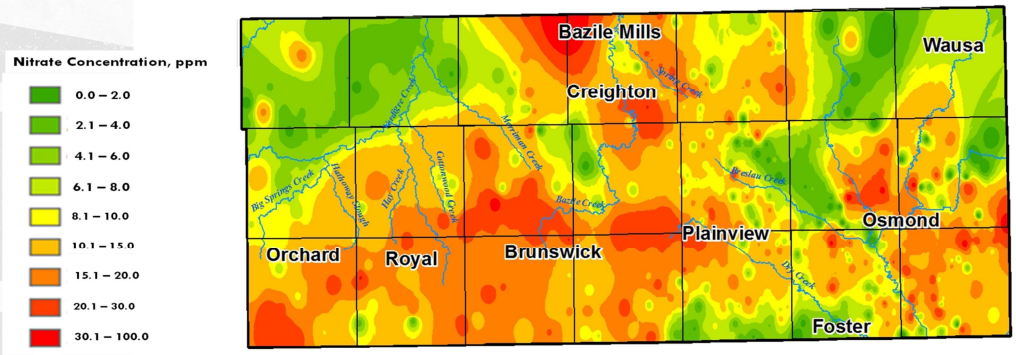
slowly go through the next three slides

BGMA: Nitrate Content In Groundwater 1990-1999



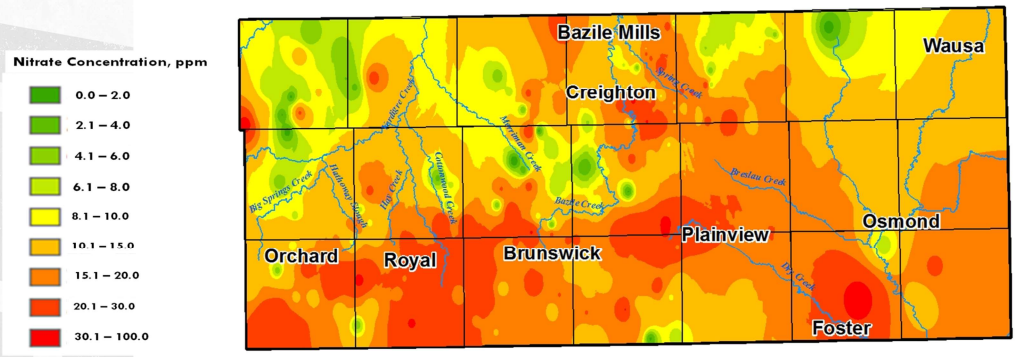
Data from the Nebraska Department of Natural Resource's Clearinghouse database

BGMA: Nitrate Content In Groundwater 2000-2009



Data from the Nebraska Department of Natural Resource's Clearinghouse database

BGMA: Nitrate Content In Groundwater 2010-2018



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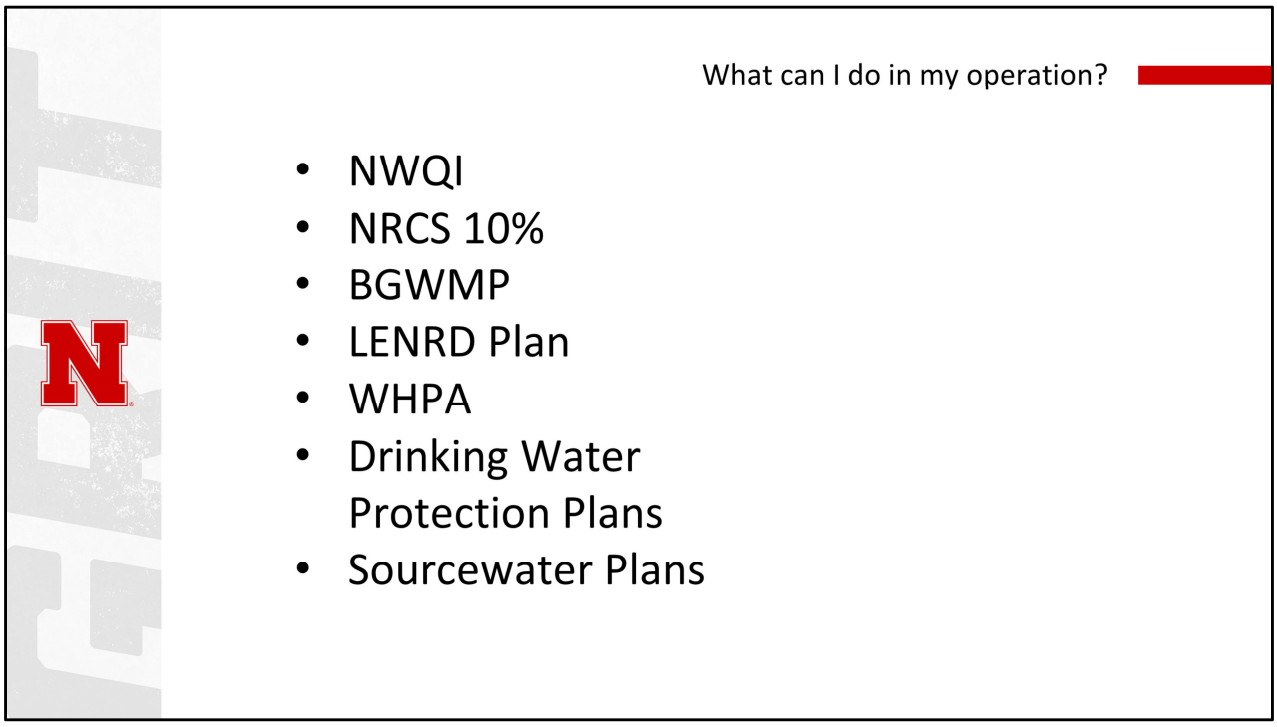
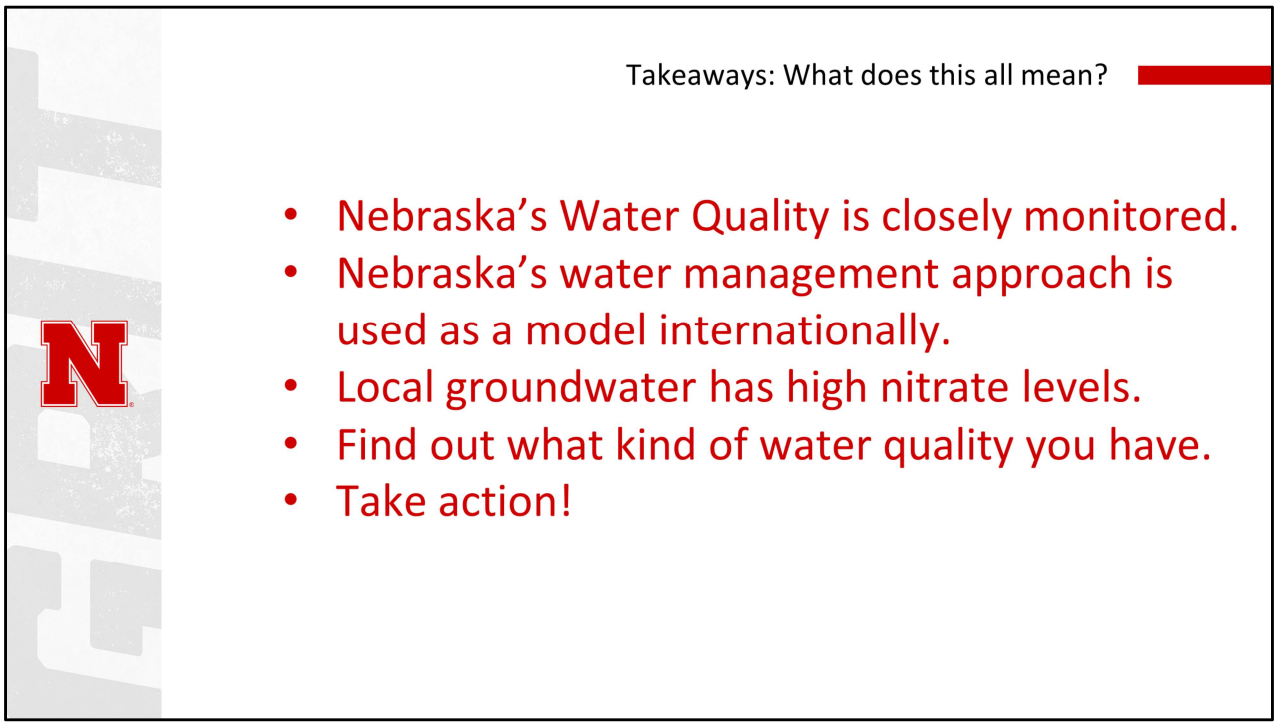
In a forty year period, this area has gone from a few hotspots of high nitrate levels, to most of the area having water quality levels that are considerd above the safe water drinking level of 10 ppm. This area has had several studies since the early 1980s to analyze the water quality levels and the source of the nitrate. There are to main sources to this nitrate issue – commercial fertilizer and livestock waste. This is not a guess. This is a statement of what was analyzed.

This is what is in your backyard. And while, communities with drinking water systems are responsible for providing safe drinking water to its consumers, if you are drinking water or water cattle from groundwater – you are responsible for the safety of your own water. Do you know what your water quality is?



So all this has you thinking that you want to do something in your operation to improve water quality. Or maybe you just have a project you want to do that will improve your operation like cover crops, nutrient management, crop diversification, grassed waterways, stream fencings for cattle and so forth. But what you want to do could also benefit water quality….

Specific to this area, there are several entities with technical resources, design assistance, or financial help that can benefit your operation. This includes a very neat initiative called the National Water Quality Initiative, an NRCS special initiative called the sourcewater initiative that focuses on sourcewater, four management plans: the Bazile Groundwater management plan, the Lower Elkhorn NRD Water Management Plan, the Shell Creek Water Management Plan, and the Lewis and Clark management plan. There are also several things in process from wellhead protection areas, to drinking water protection plans, and sourcewater plans.



So what does this all mean for you? The most important thing you can take away from today is that there are many people monitoring the state of Nebraska's water quality, but it is up to you to find out what your water quality is.

Nebraska's approach to water management is working well. It is used as a model for other states and countries around the world. There are several plans which influence your water management locally which could serve as a technical, financial, or informational resource.

Locally, groundwater nitrate levels are very high.

There are several ways you can make changes to your operation that will improve water quality in your area. The first step is to understand what the water quality looks like in your area. The second step is to take action.

If you would like more information on the quality of your water, let's talk. I will be available all day or at the contact information above.