Hastings Aquifer Storage and Restoration Project (ASR)

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ASR Project – Challenges and Innovations

Disclaimer: Larry said I could talk about whatever I wanted to discuss ☺

Some of you may recall the ASR presentation I made in 2017 - **"and now for something completely different"** (Monty Python's Flying Circus)

However, you may be interested to learn about our efforts to find novel solutions to address Nitrates in our aquifer – **"Project Persistence"**

Observation vs Misinformation

The institutional data that we could find on our Nitrate issues did not match with field observations – This proved to be our driving force for new ideas

We found we needed to do research and implement quality control on the data collected

Required finding actual data verses what people wanted or hoped to find – **Misinformation had become fact**

Lessons to be Learned

The takeaway is that we did not let neigh sayers stop us and that we let data direct our solutions

Developed an environment with staff that no idea was bad, provided the idea was intended to support the end goal

Challenges and Innovations

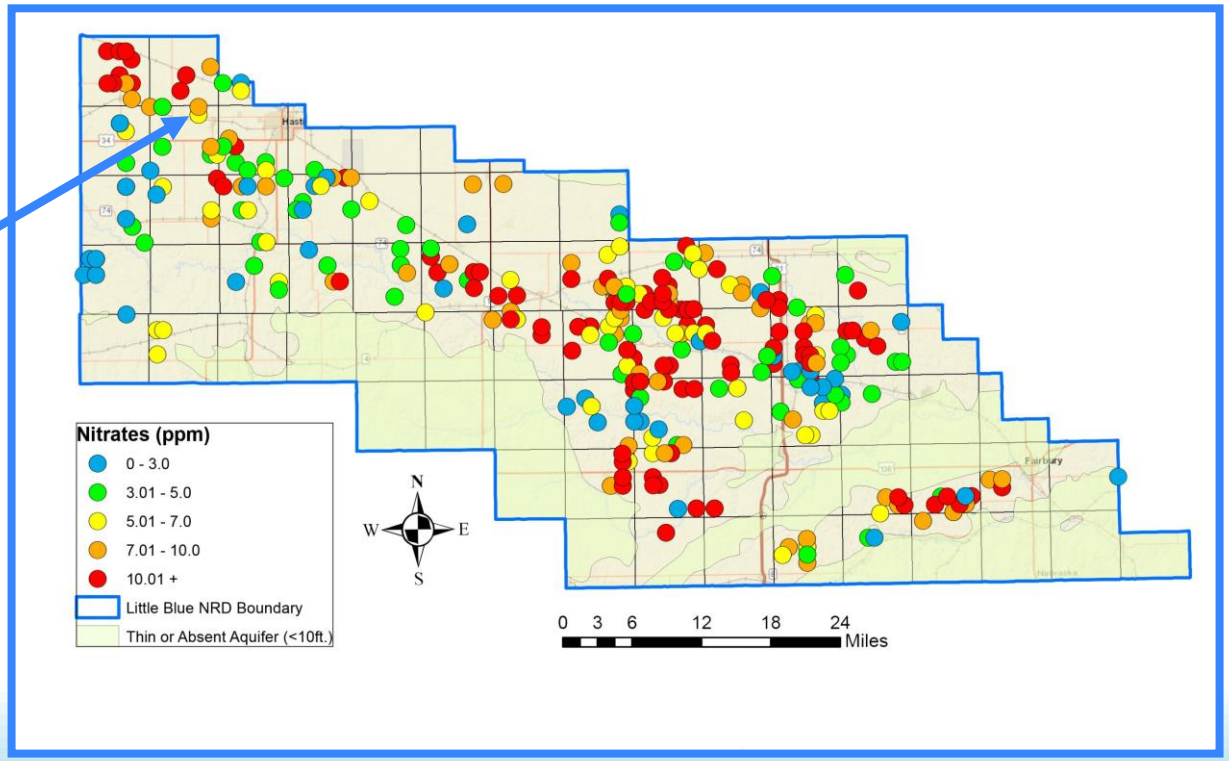
How we approached the ASR challenges may give you some ideas on how to develop new solutions for your projects

The ASR project is not a new kind of “Cookie” but a slightly revised recipe

Nitrate Legacy (The problem)

Hastings like many other NE communities are addressing nitrate legacy issues due to the application of commercial fertilizer (NH3) and irrigation

Hastings



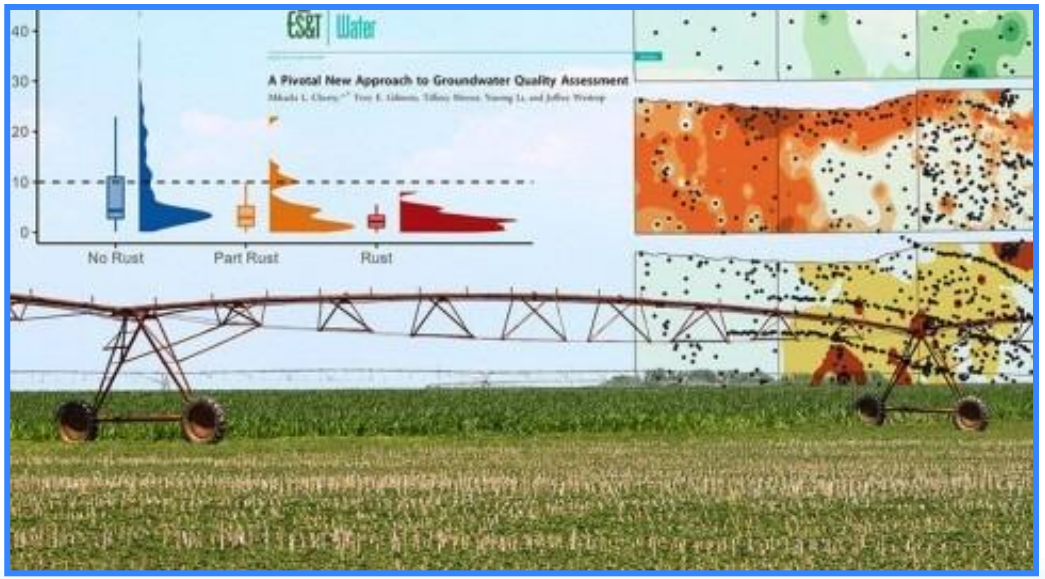
Water Supply Capacity

Due to the Nitrate Legacy, we had predicted by 2016 that we would be limited on water supply capacity and not able to meet peak demands

Uranium Mobilization!

Nitrates movement into the Vadose Zone and Groundwater, causing an increase in microbiological growth mobilizing naturally occurring Uranium, Chromium, and Selenium

UNL study confirms nitrate release uranium into the groundwater – Dr. Karrie Weber

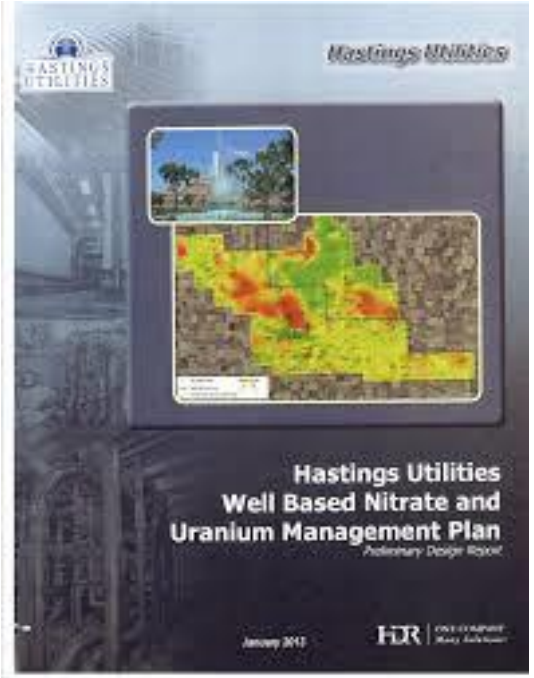


Nitrate and Uranium Management Plan

In 1996 management plan to address the nitrate legacy and uranium mobilization was developed

Water treatment to cost $72.3 Million - To expensive for Hastings

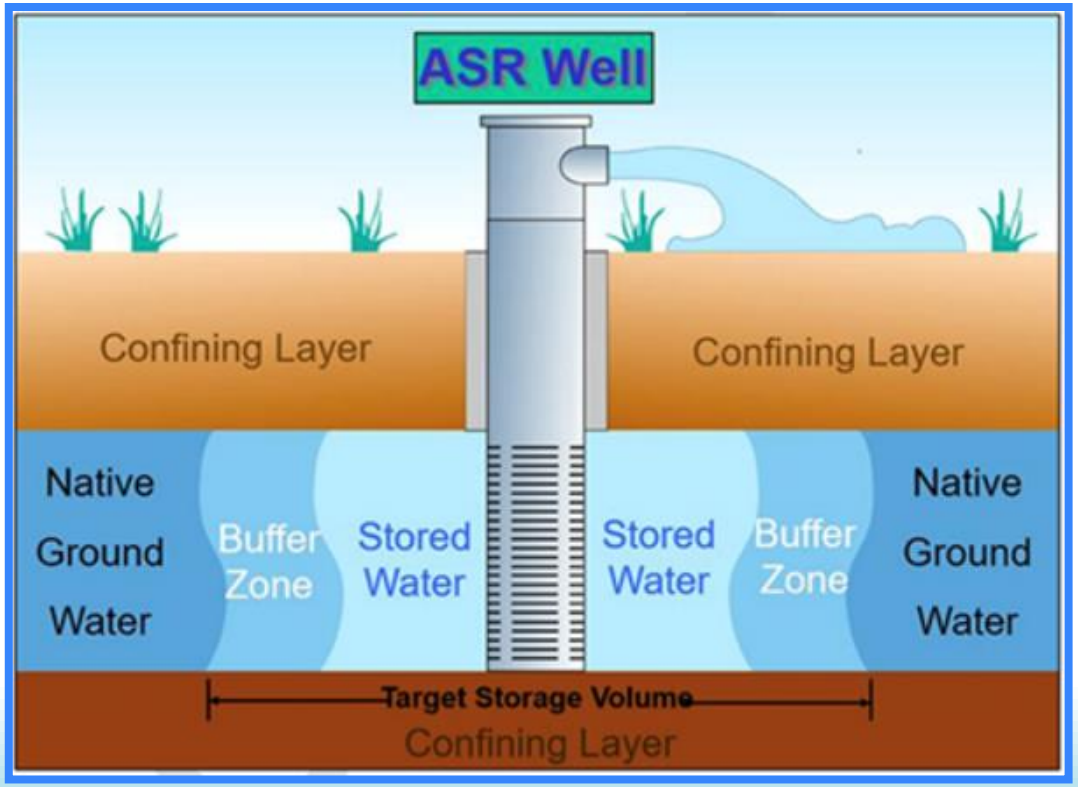
Staff **ordered** to find a cheaper solution – ASR was born



Aquifer Storage and Recovery

Typically, ASR is Aquifer Storage and Recovery when treated water is removed from the same well you injected treated water, just at different times.

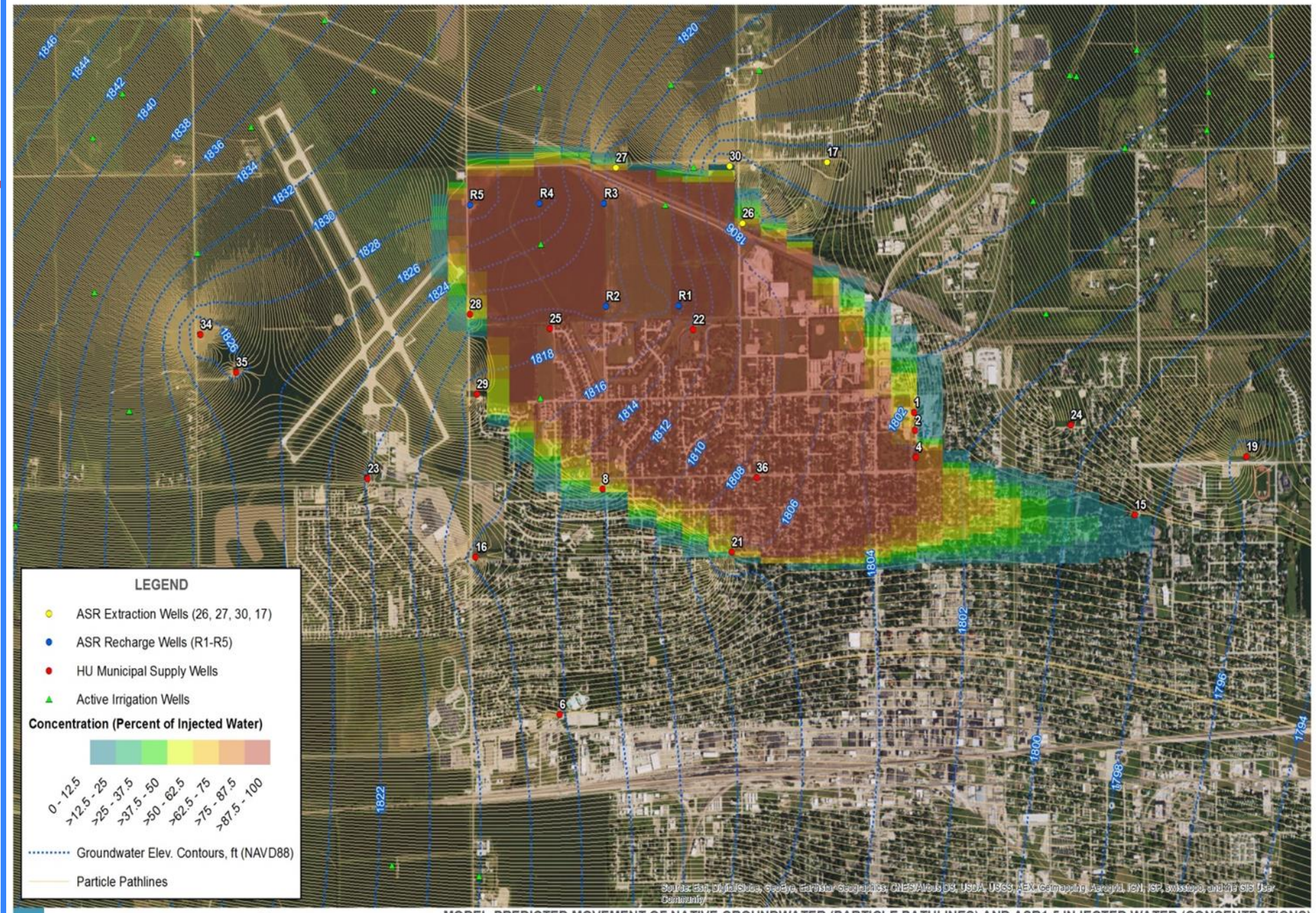
Basically, peak water storage



Aquifer Storage and Restoration

Hastings ASR is the removal of groundwater, treating the water and placing it back into the aquifer (stored) to be used by down gradient municipal wells – **Restoring the Aquifer**

We revised the recipe slightly



MODEL-PREDICTED MOVEMENT OF NATIVE GROUNDWATER (PARTICLE PATHLINES) AND ASR1-5 INJECTED WATER (CONCENTRATIONS)

FIGURE 16D

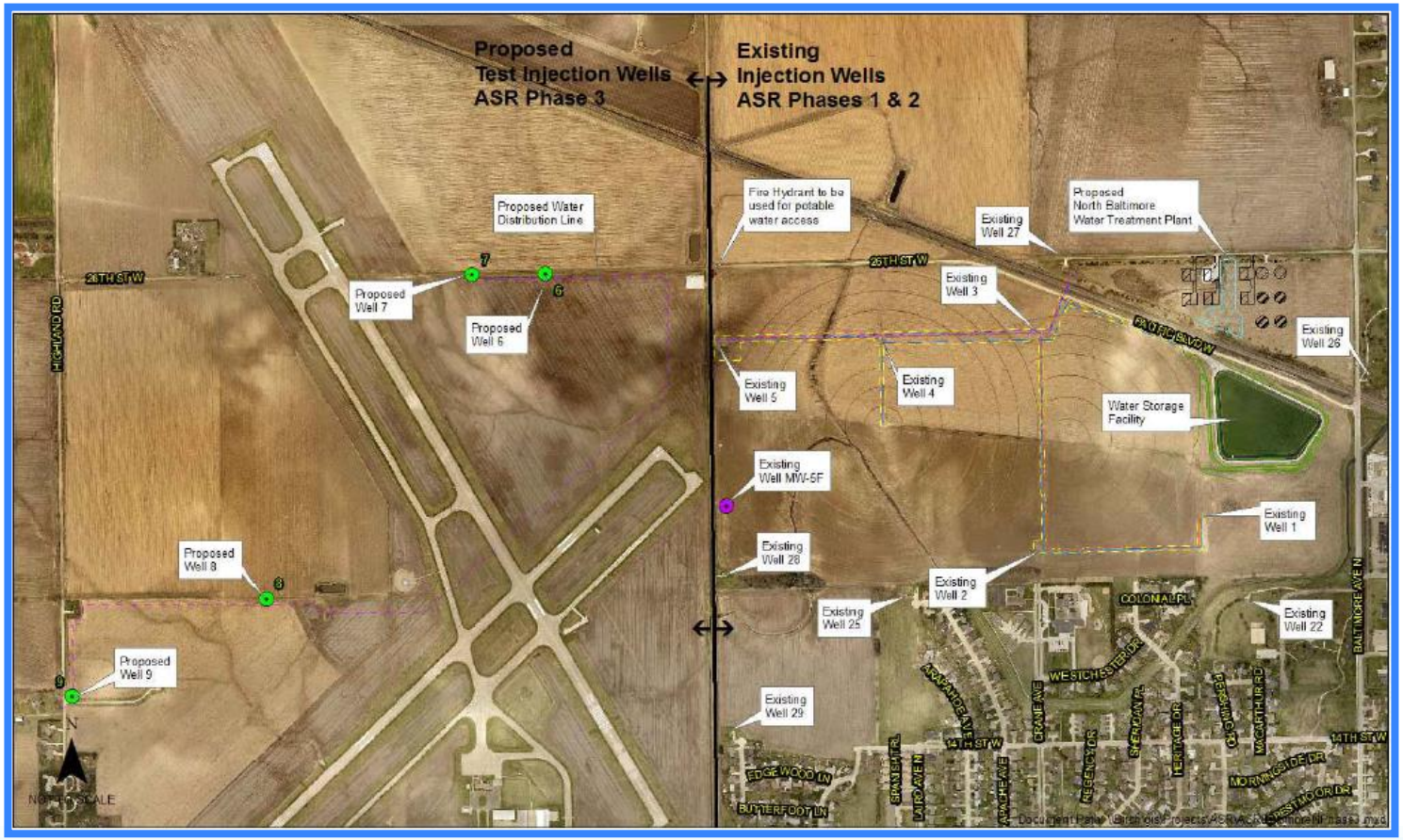
HASTINGS UTILITIES WATER SYSTEM WELL FIELD DEVELOPMENT AND MANAGEMENT ASR PROGRAM

Aquifer Storage and Restoration (ASR) - 5 Prong Solution

- Dual Pumping – Reduction in treated water
- Focused water treatment – RO with low nitrate water mixing to stabilize injection water
- Aquifer storage to reduce need for above ground storage and standby power - restoration of aquifer
- Irrigation Management – wastewater disposal
- Blending and Surface Storage – not yet needed

ASR Site Development

ASR estimated $45 Million - $15 Million spent



Finding the tools to get the problems solved

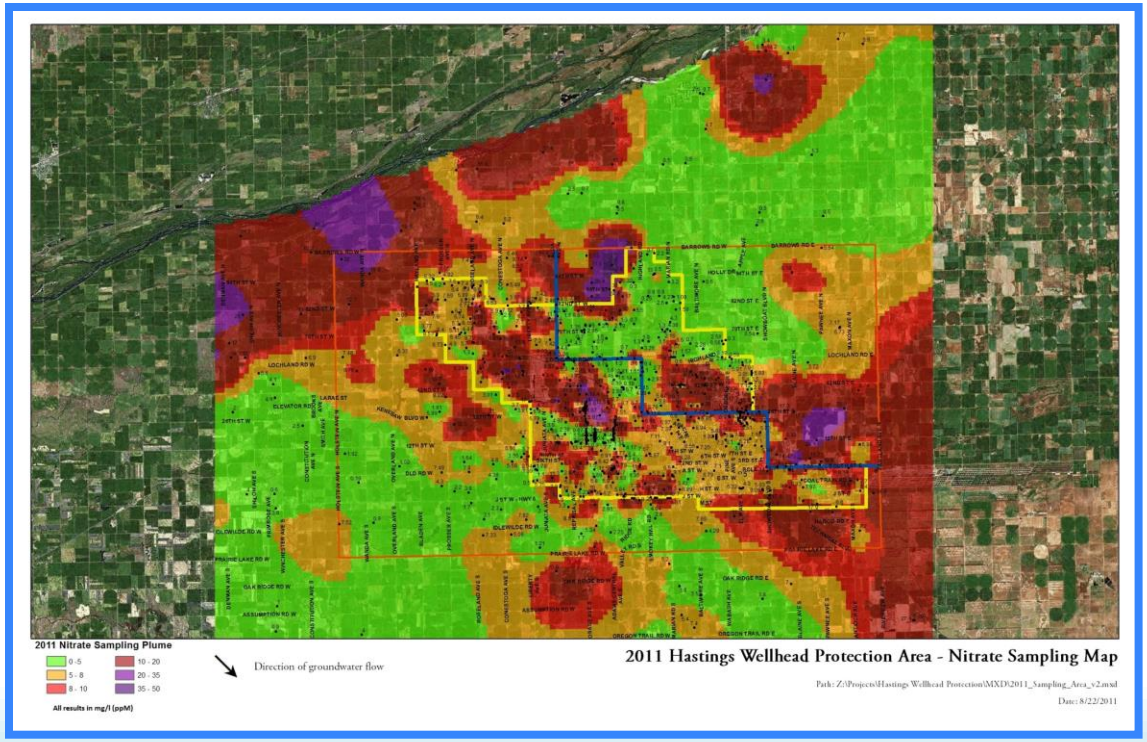
The next slides are a summary of some of the “tools” we developed to get the ASR project operational

Assistance came from many agencies and institutions

Tools used to develop ASR (1)

Only an urban issue: Collected 800+ water samples in 200 square mile area to define the nitrate problem - WHPA of 76 Sq. Miles had 87.5% if all wells tested

Involved staff from City, County, NDEE, LBNRD, UBBNRD, and homeowners.



Tools used to develop ASR (2)

Groundwater does not flow east from Platte River: Groundwater modeling showed 50% of groundwater recharge coming from Platte River - Remaining 50% enters through root zone

Platte River is recharging the Little Blue River Basin – Allocation of Basin Resources

Tools used to develop ASR (3)

Nitrates from feed lots and septic tanks: Water samples tested using UNL Nitrate and Oxygen Isotope testing confirmed source of Nitrogen – Ammonia nitrogen the main source of nitrates

Producers did not want to believe Nitrates from NH3 use

Nitrate Isotope Testing 08/01/2008

Well #	NO3-N mg/l	N15N-NO3 %	Comments
33	8.5	8.42	Indicates Commercial Fertilizer
28	3.1	5.69	Indicates Commercial Fertilizer
26	5.2	4.7	Indicates Commercial Fertilizer
16	7.0	5.88	Indicates Commercial Fertilizer

15N-NO3 Results of -5 to +5 indicate commercial fertilizer (NH4)
15N-NO3 Results of +10 to +30 indicate animal wastes

Tools used to develop ASR (4)

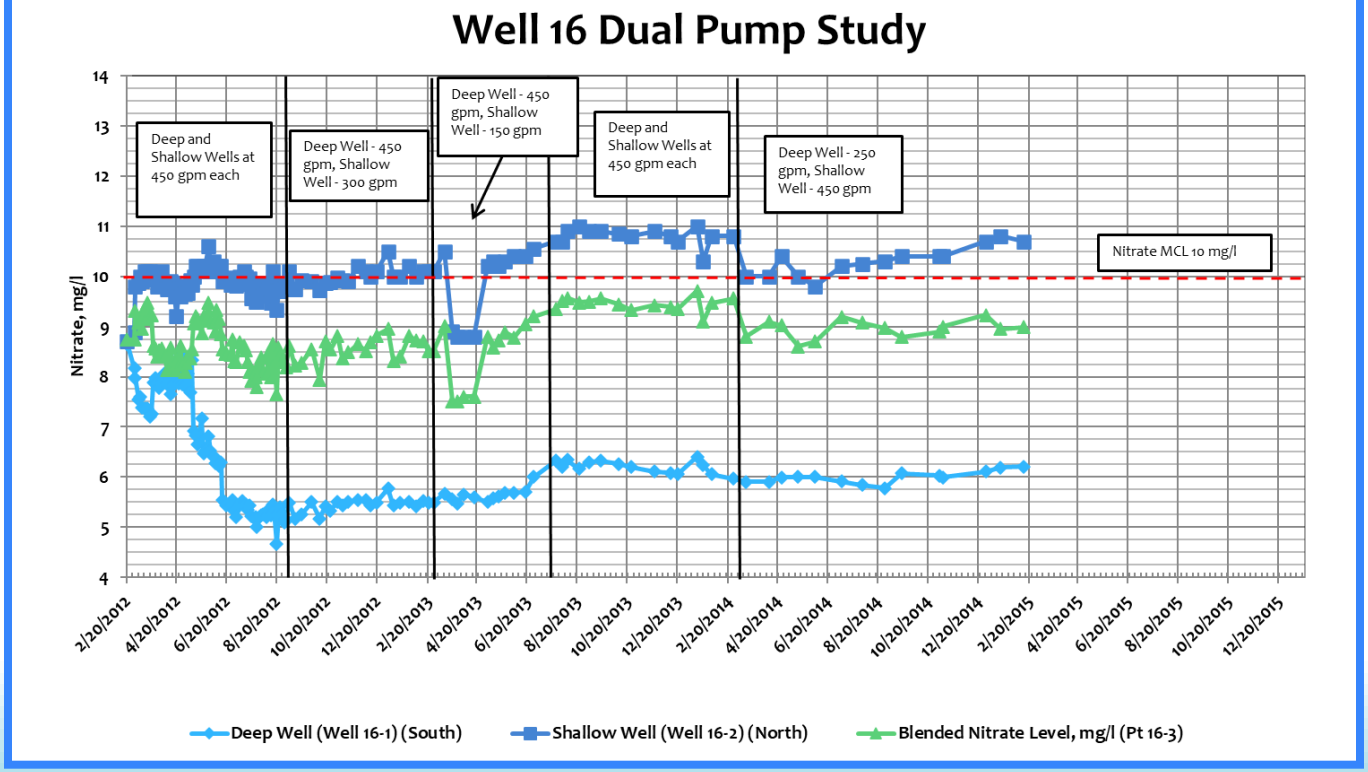
Nitrates are not escaping the root zone: Vadose Zone studies showed significant amounts of nitrates in the vadose zone

2011 Vadose Sampling indicates 500 to 2000 lbs of Nitrogen per acre located below Root Zone – 2011 to 2016 30% increase in Vadose

Tools used to develop ASR (5)

Why are some wells low in nitrates: Nitrates float - Dual Pumping and Tri-plex pumping showed good response to separating waters within a well

3 months to stabilize



Tools used to develop ASR (6)

Groundwater travel times to slow be beneficial to restoration: Tested groundwater flowrate and exceeded consultant's model but matched staff prediction – We had knowledge of our aquifer

Provided opportunity for staff education and project support

Tools used to develop ASR (7)

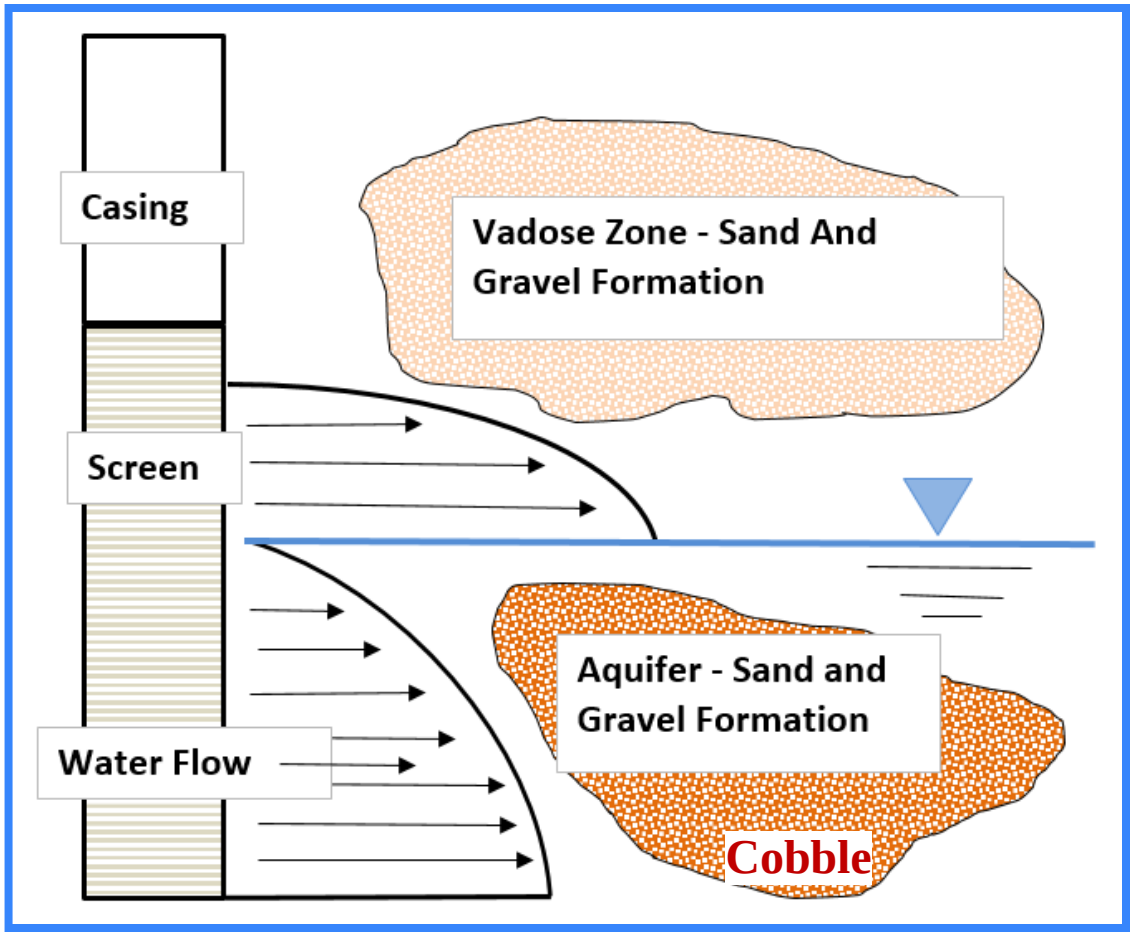
Injection of water difficult: We had experienced several injection well projects by EPA / Consultants - We saw they were not controlling biofilm growth and had poor screen design

Our design provided a Specific Injectivity equal to Specific Capacity – “New Recipe”

Discovered Injection Well 1 – Mushroom Effect

Tools used to develop ASR (7)

Injection well screened above water table allowing clean water to impact the highest nitrates - flows faster to the production well



Tools used to develop ASR (8)

Lack of aquifer knowledge: Agricultural producers did not and some still have not understood their practices are a major part the problem - Feed lots and urban areas are not a major source of contamination

We actively provide presentation and assist NRDs with training – **Public Organizations, Schools, Soil Health Initiatives and Operator Training**

Regulatory Tools (1)

Overwatering by irrigation is the transport mechanism for nitrates moving into the aquifer.

Groundwater declining down gradient.

Implemented **mandatory metering** of water withdrawn for irrigation.

Water use 24 to 36 inches per year has dropped to 12 to 18 inches per year and 6 to 9 inches per year.

Regulatory Tools (2)

Required soil sampling of at least one field of each producer in WHPA.

Soil pH has dropped to 5.0, soil uranium levels are increasing and impacting plant growth, depletion of soil carbon levels.

HU provides incentives for soil testing and water conservation tools – minimal use, not worth the farmer's time. **$1,000 not worth their time!!!**

Regulatory Tools (3)

Urban water use in Hastings is typical – Range of irrigation use is 1 to 8 inches per year

The more affluent the homeowner the less likely they are willing to discuss water conservation

Regulatory Tools (3)

Correlation of higher water use with greater nitrate application

Lawn and garden test plots preformed well but mostly viewed by persons already practicing water and nitrate conservation

ASR Concept – Combined Technologies

We have been successful so far because we

- Let the data lead us to the solutions
- We checked the data against field observations
- We asked for help from trusted experts
- We fostered input from staff – No bad ideas

Not trying is Failure

- Willing to do the hard work and being patient knowing it takes time to complete the work
- Consist focus on finding a solution - No bad ideas if the idea is to accomplish the goals

I believe all of you can make an impact on the challenges we face – **Don’t let fear be your failure**

Questions

Goal: Is to provide potable water at a fair and equitable cost