

Ammonium Mystery at Hemlock Crossing

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Ottawa County Water Quality Forum
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Timeline

February 5, 2010
Received email from
Parks Dept. aquarium
fish dying

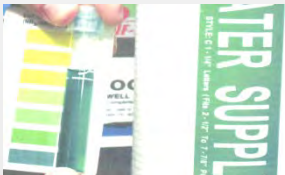
March 16, 2010
Samples sent to DEQ
(Ammonia 13 mg/L)

June 25, 2010
Tested homes
along Pigeon Creek
Dr. and noted
ammonia in water

Homes were tested during
this time period for
numerous parameters such
as VOC's, SOC's, Metals etc.

Waiting for further
clarification from DEQ
on next steps...

March 12, 2010
Purchased
aquarium test kit
from pet store and
tested water at
sample tap.



March 30, 2013
Advisory Issued
posted at
Hemlock
Crossing Nature
Center

June 30, 2010
Advisory Issued
Ottawa County
Department of
Public Health for
all homes on
Pigeon Creek Dr.

October 11, 2010
Tritium Test results
received from
University of Miami.
(older water)

January 7, 2011
Advisory Lifted
Determined that due
to all the information
available: Ammonia is
the only known source
of contamination,
likely naturally
occurring, and R.O.
systems seem to
eliminate its presence
in the water.



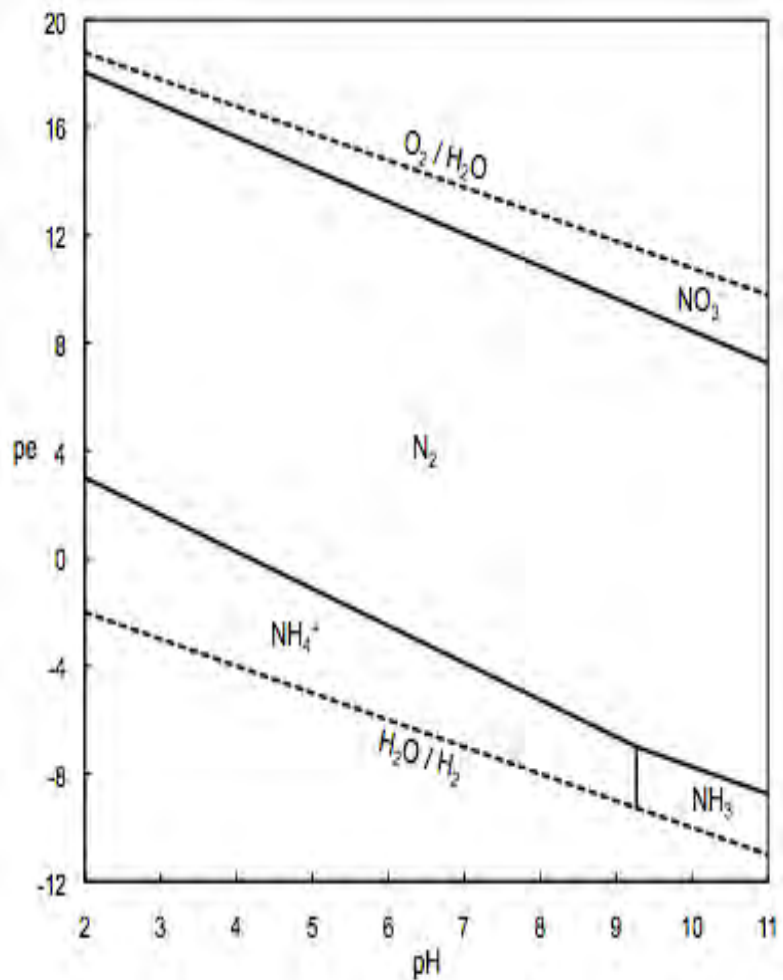
Contacted Western Michigan University to see if there was any interest in continuing this investigation. Ottawa County Environmental Health hoped that through further research, more evidence would be revealed that the contamination wasn't man made, and therefore other contaminants are less likely present.

Study Site



Potential NH_4^+ sources:
-Manure application
-Buried organic material

Background Info



Modified from Kehew, 2000



Modified from Rieck and Winters, 1988

$$\delta_{\text{sample}} = [(R_{\text{sample}} / R_{\text{standard}}) - 1] \times 1000$$

Rotosonic Drilling



Performed as a demo during the 2012
WMU Hydrogeology Field Camp

Sampling



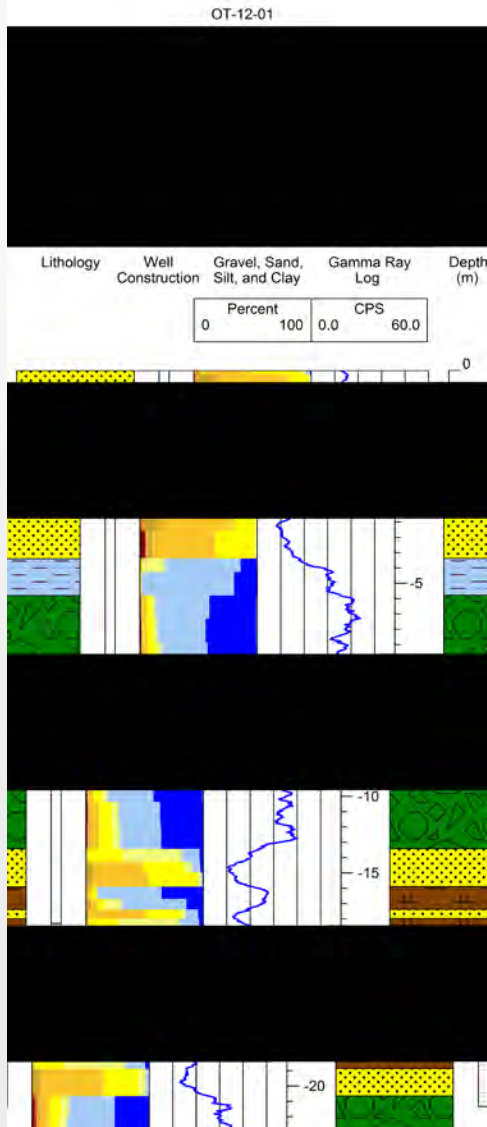
Parameters:

- Common ions
- DOC
- CH_4
- $\delta^{18}\text{O}/\delta^2\text{H}$
- ^3H
- $^{14}\text{C-DOC}$
- $\delta^{15}\text{N-NH}_4$
- $\delta^{15}\text{N-NO}_3$



Results and Discussion

Top: 14.9 m



Bottom: 21 m



Photo: Pat Colgan



Age of organic material:
41,920 to > 43,500 cal. yrs
B.P. (Colgan, 2013a and
unpublished data)

Water Wells with organic sand units

Red = Below Saugatuck Till

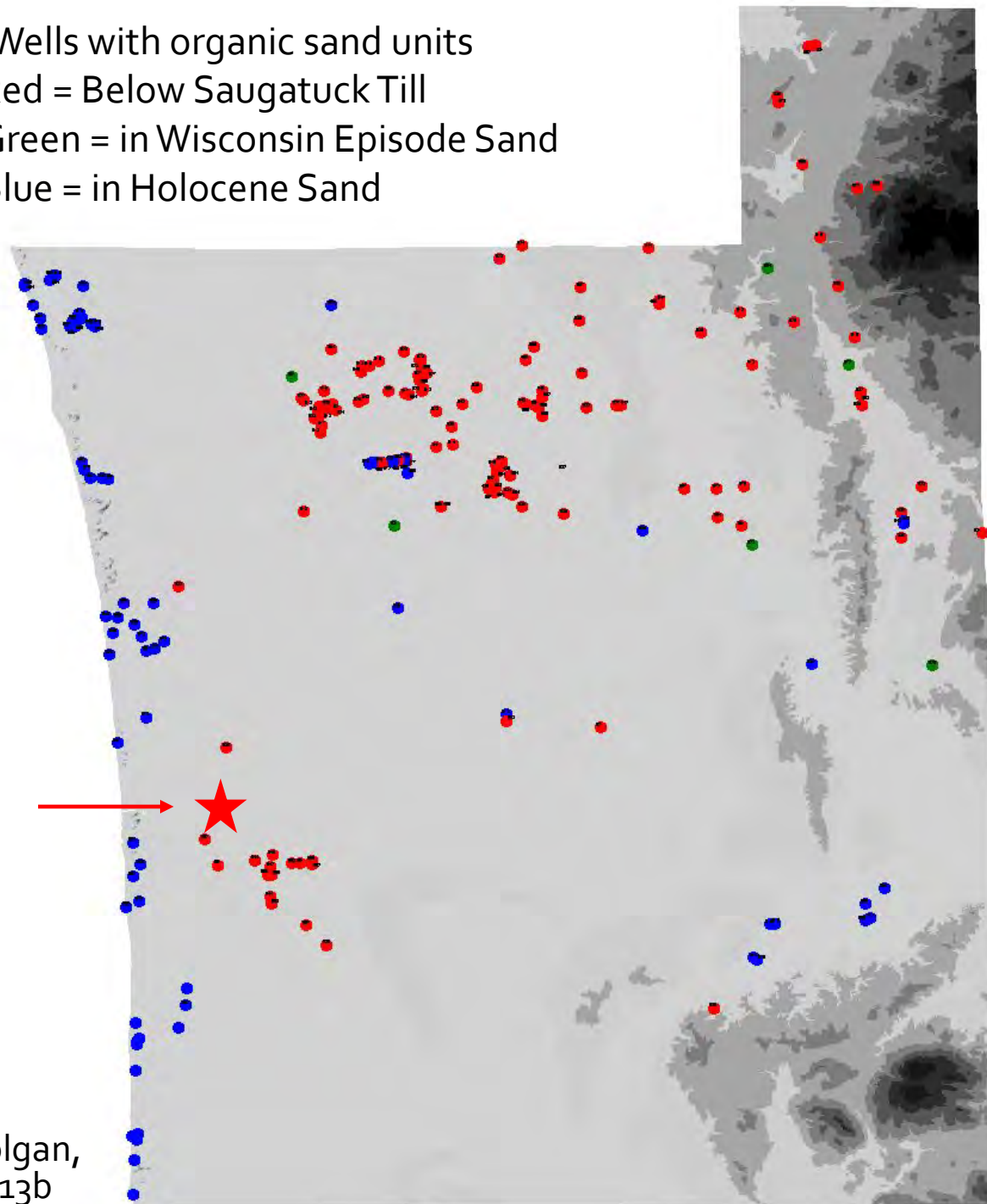
Green = in Wisconsin Episode Sand

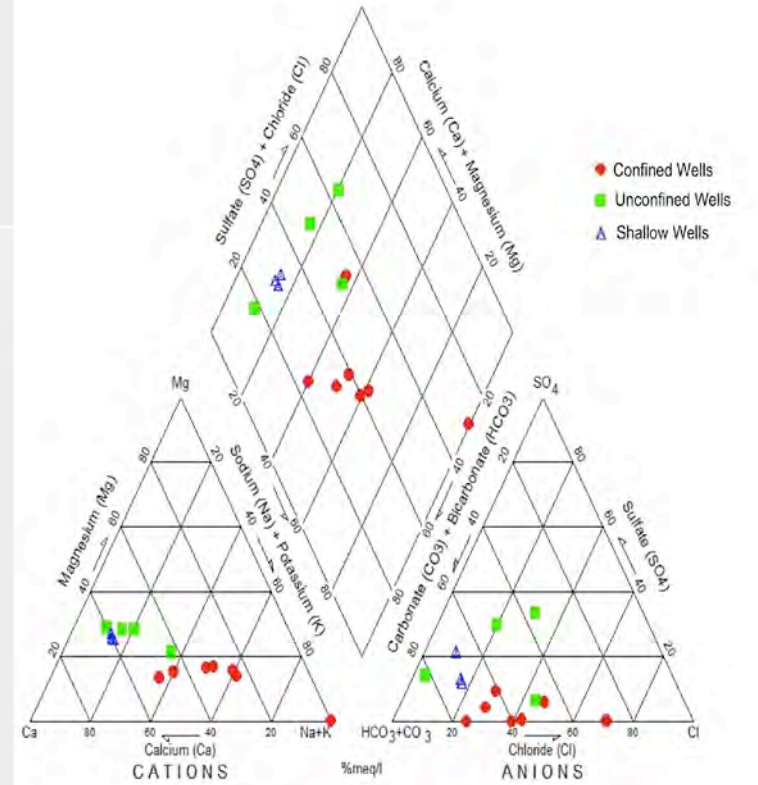
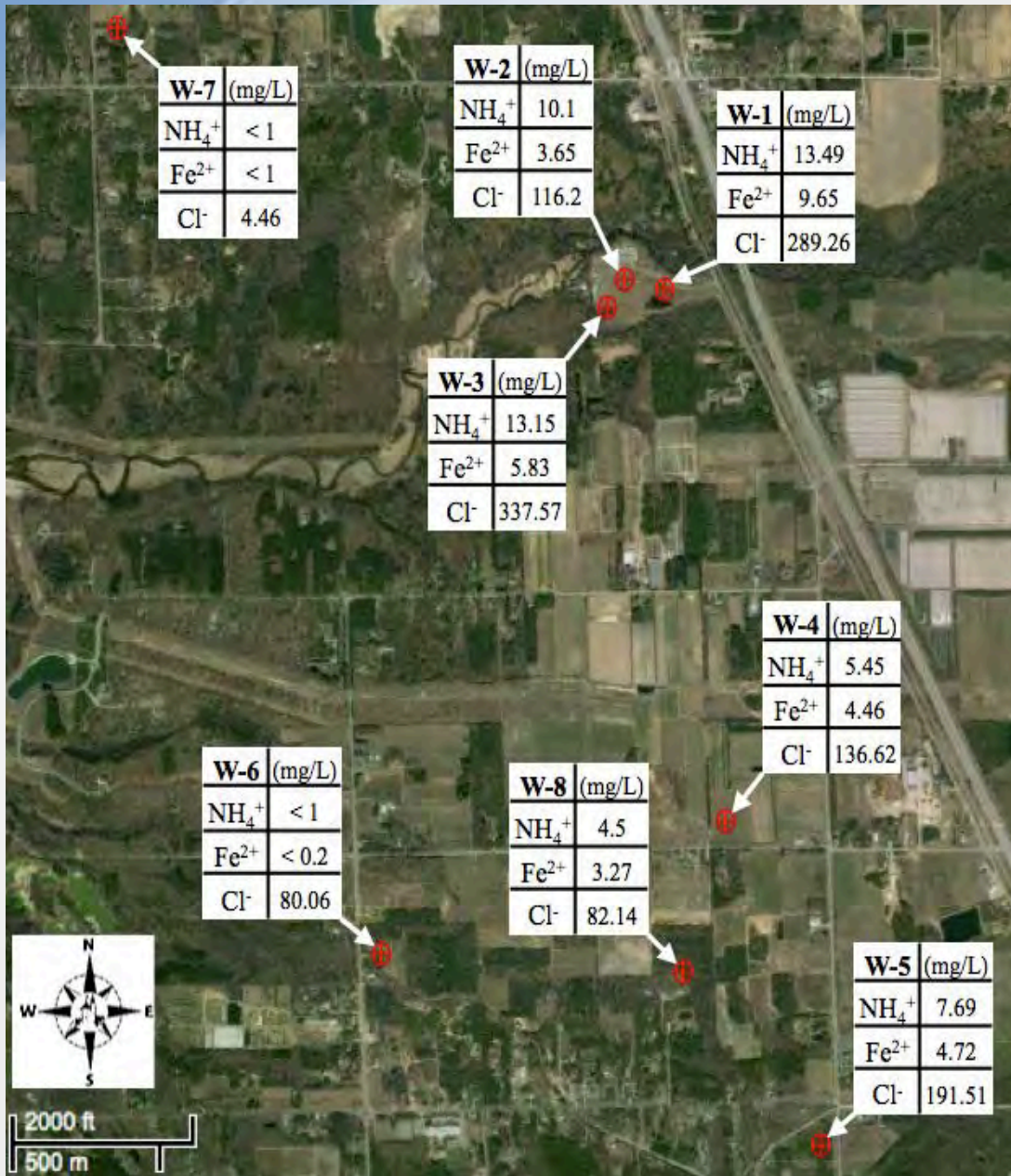
Blue = in Holocene Sand

Hemlock Crossing
Park Core
(OT-12-01)



Colgan,
2013b

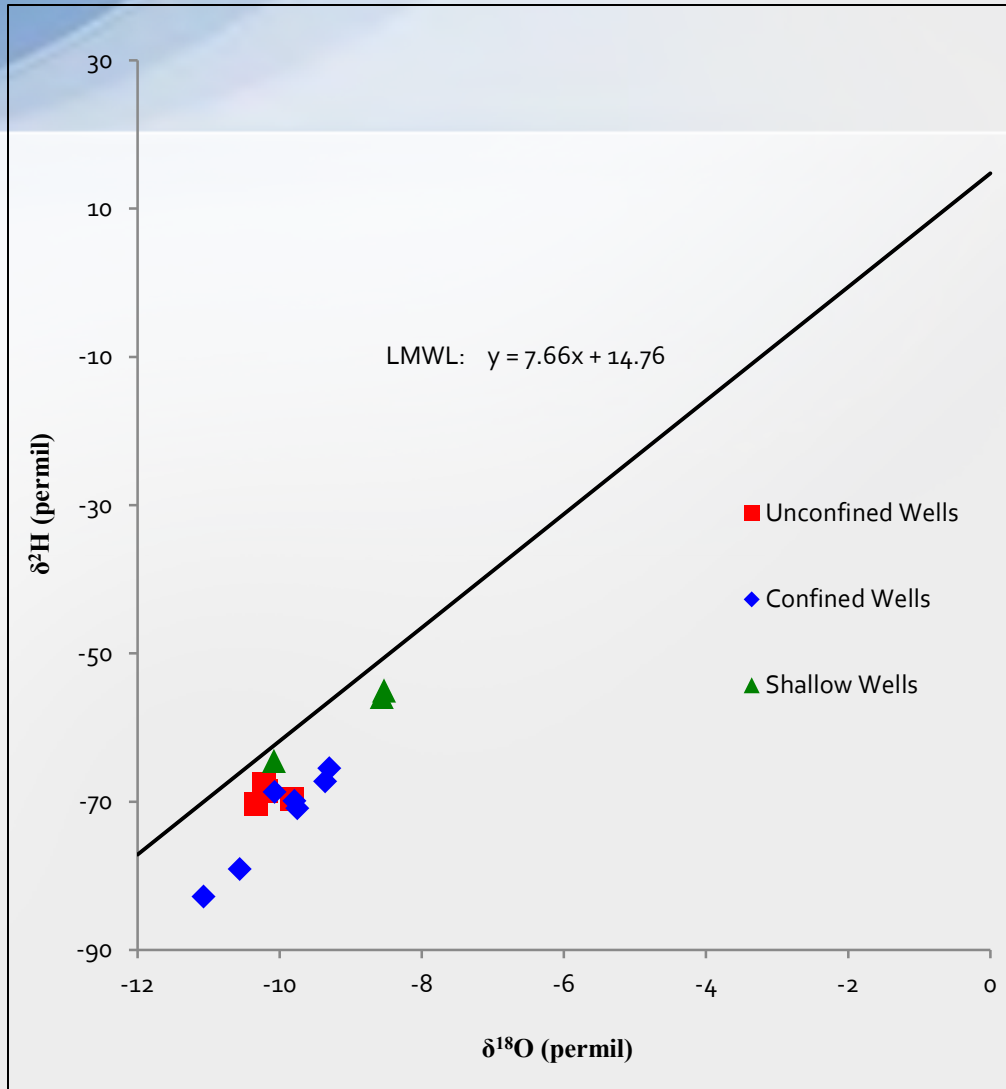




Well	CH ₄ (μg/L)
W-1	46,000
W-2	21,000
W-3	20,000
W-4	20,000

DEQ FESL: 520 (μg/L)

Tritium



LMWL from Machavaram and Krishnamurthy, 1994

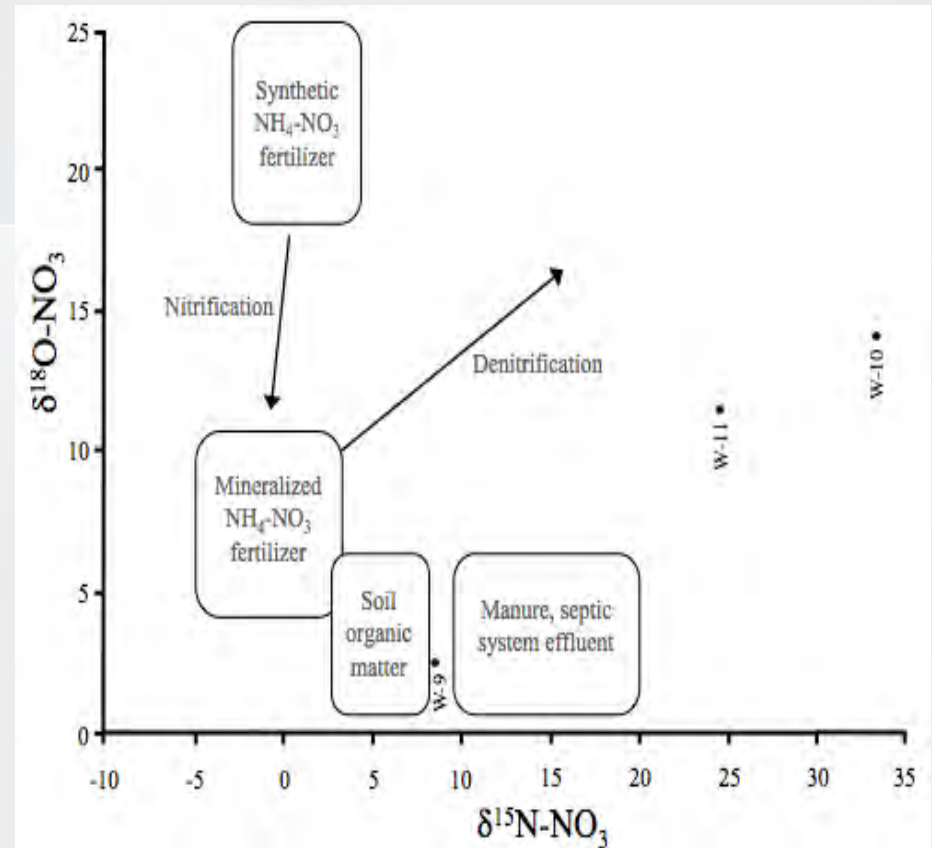
Well	TU (± 0.09)
W-1	0.17
W-2	0
W-3	0.1

Data for W-1 from OCHD (unpublished)

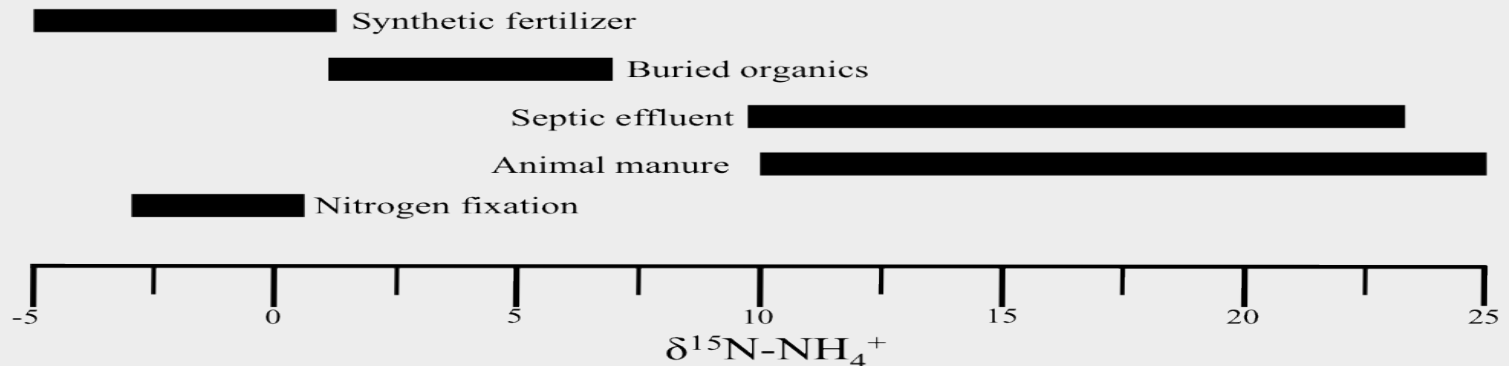
- δ¹⁸O values between 12 and -8.5‰ signifies post-glacial recharge (Ging et al., 1996)
- Recharge prior to 1952 will have insignificant ³H values (Clark and Fritz, 1997)

Nitrogen Isotopes

Well	$\delta^{15}\text{N-NH}_4$	$\delta^{15}\text{N-NO}_3$	$\delta^{18}\text{O-NO}_3$
W-1	+ 0.17	-	-
W-2	0	-	-
W-3	+ 0.1	-	-
W-4	+ 1.38	-	-
W-9	-	+ 7.81	+ 2.44
W-10	-	+33.54	+14.61
W-11	-	+24.06	+12.60



Modified from Clark and Fritz, 1997



Modified from Lindenbaum, 2012

Conclusion

- Confined aquifer system with elevated ammonium concentrations is in contact with buried organics
- No significant recent recharge
- The source of ammonium is likely from the decay of in-situ organic material
- Wells screened in the confined aquifer system should be vented if high methane concentrations are present

References

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Questions?