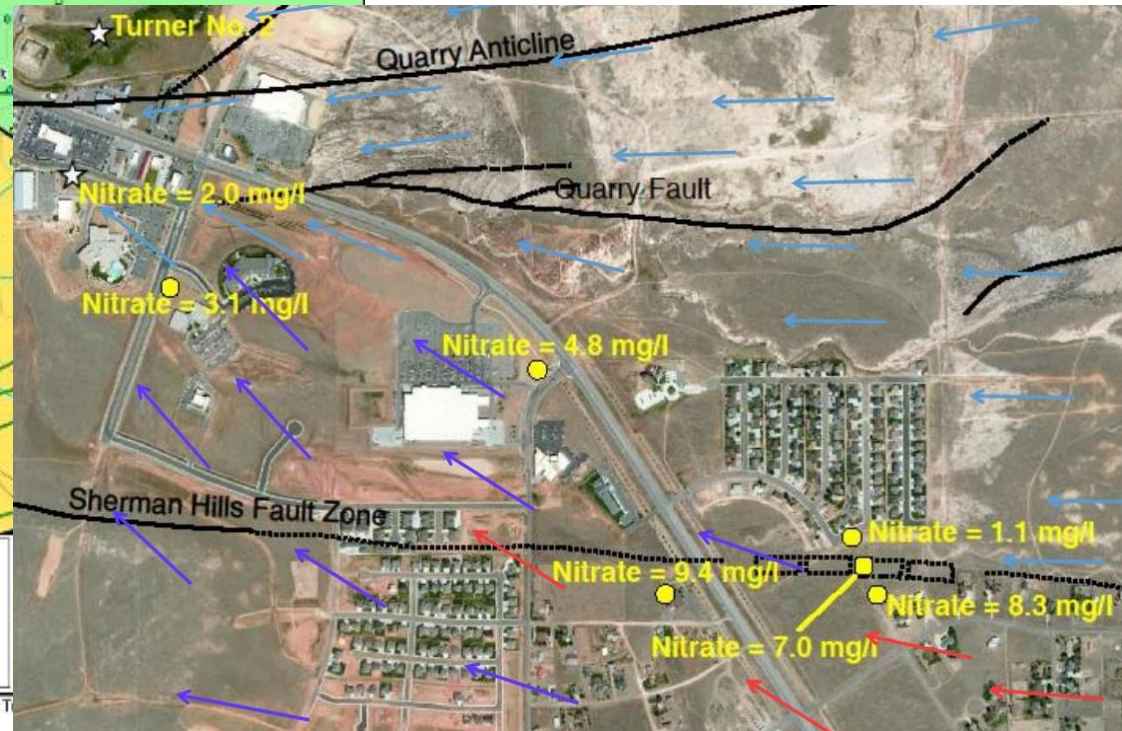


Figure 4-2c. Potential contaminant sources, wells, and septic systems near T



Septic System Impact Analysis, Albany County, Wyoming

STUDY PURPOSE

The goal of this study was to answer the following questions related to soil nutrient removal capacity in the CAPA:

- Will soils within the unsaturated (vadose) zone remove nitrogen prior to reaching groundwater?
- What nitrate concentrations will exist after treatment by the septic system?
- What is the long term capacity of soils to attenuate nitrogen within the area?

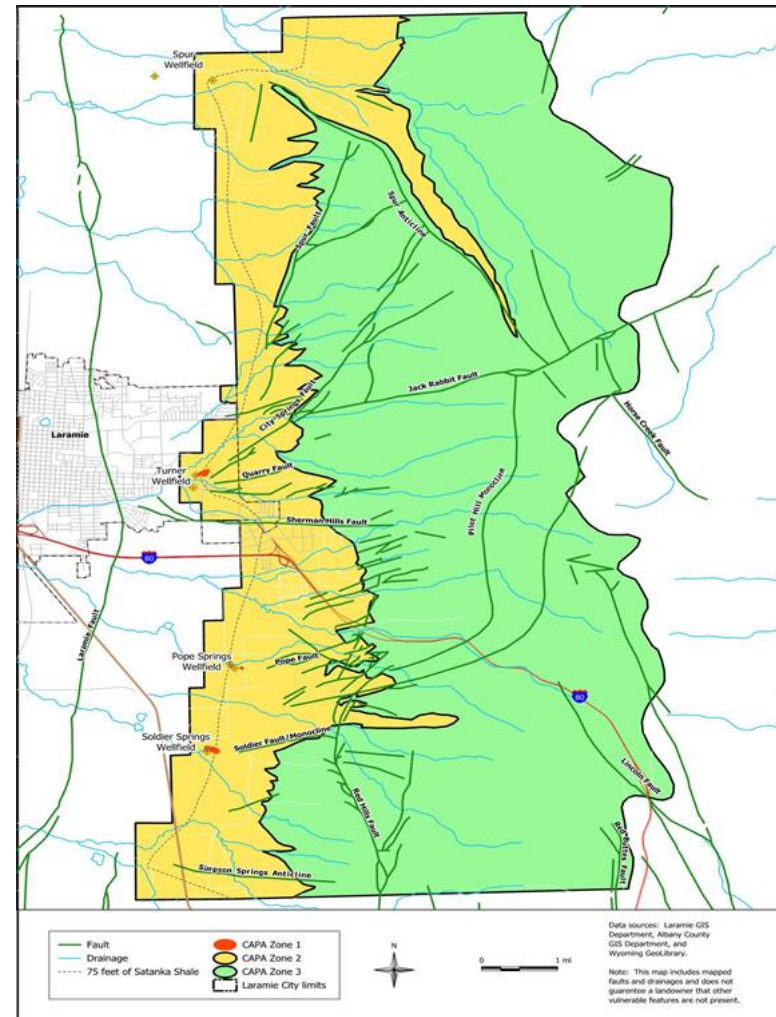
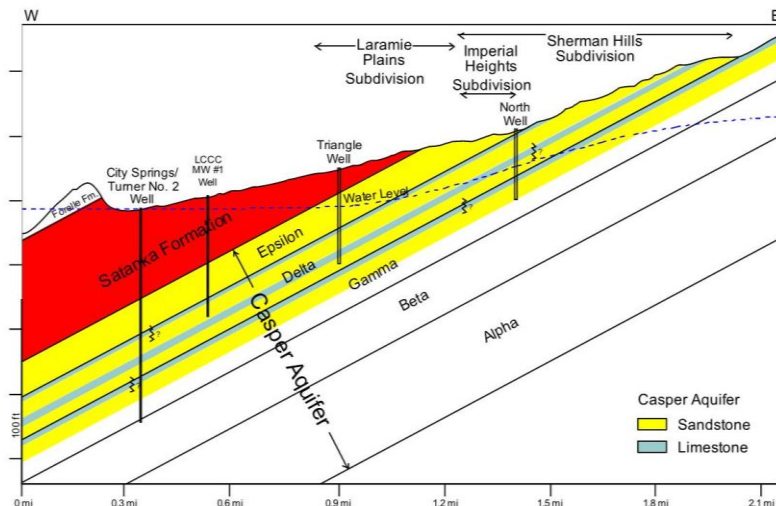


Figure 3-5. Mapped faults and drainages within the Casper Aquifer Protection Area.

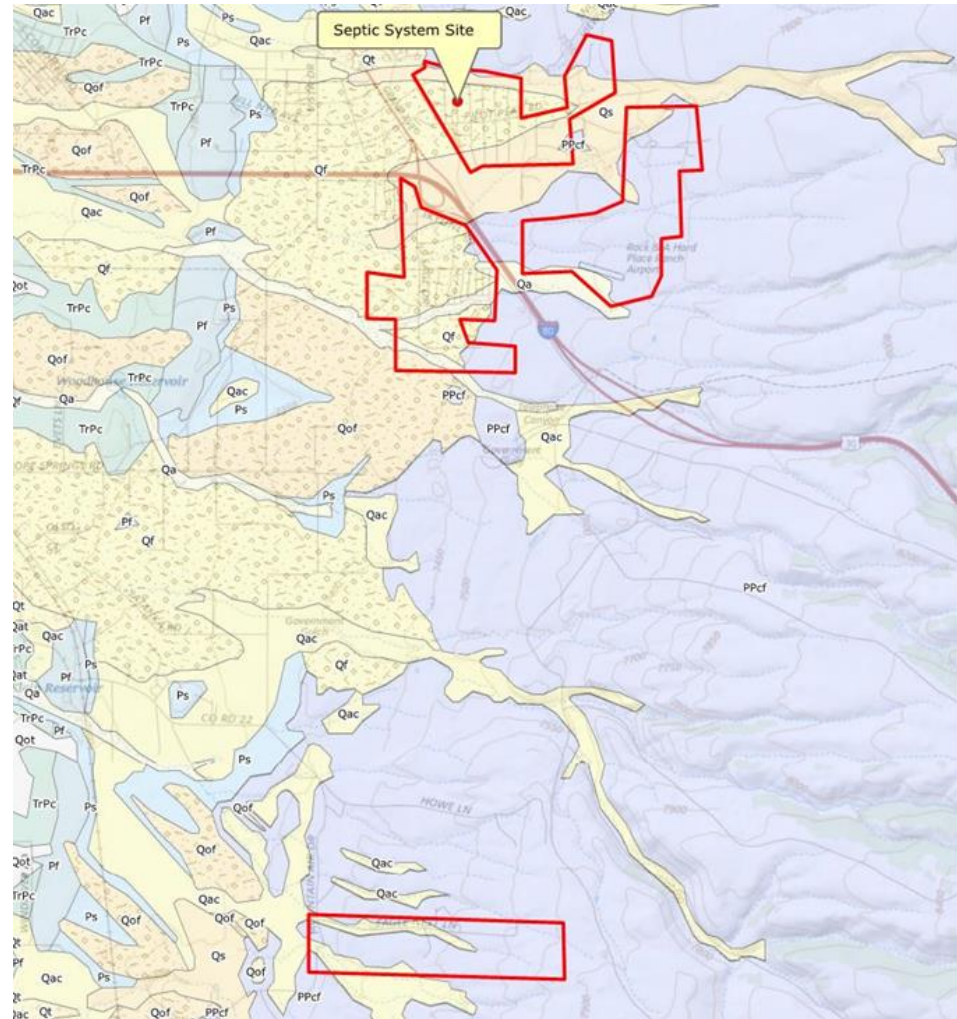
UNSATURATED ZONE MONITORING PROPOSAL: LYSIMETER INSTALLATION

The goal of the emplacement of a lysimeters was to assess the soils capacity to attenuate nutrient concentrations throughout the vadose zone.

- Lysimeters are porous ceramic cups which are placed in the unsaturated zone and will collect water due to a difference in osmotic pressures (soil to cup)
- After a period of time, the cup fills with water collected from the unsaturated zone and the sampler removes it by installing a negative pressure and allowing the sample to flow from the cup to sample bottle for analysis
- For this study, Wenck installed these cups diagonally below the infiltration pipes of the leach field at various depths. This allowed us to sample at depth intervals to identify the ability of the underlying soils to treat effluent

MONITORING NETWORK SITING

- Located over Casper outcrop east of Satanka
- Septic system built within last 10 years with detailed records
- 10+ feet of soil overlying Casper Formation
- We considered 19 systems (3 different types) and short listed to 7 systems.
- After both internal and Albany County discussions and finding a willing landowner, we settled on the current system.



RANGE VIEW LANE SITE



TEST HOLE DRILLING



TEST HOLE DRILLING - CASPER



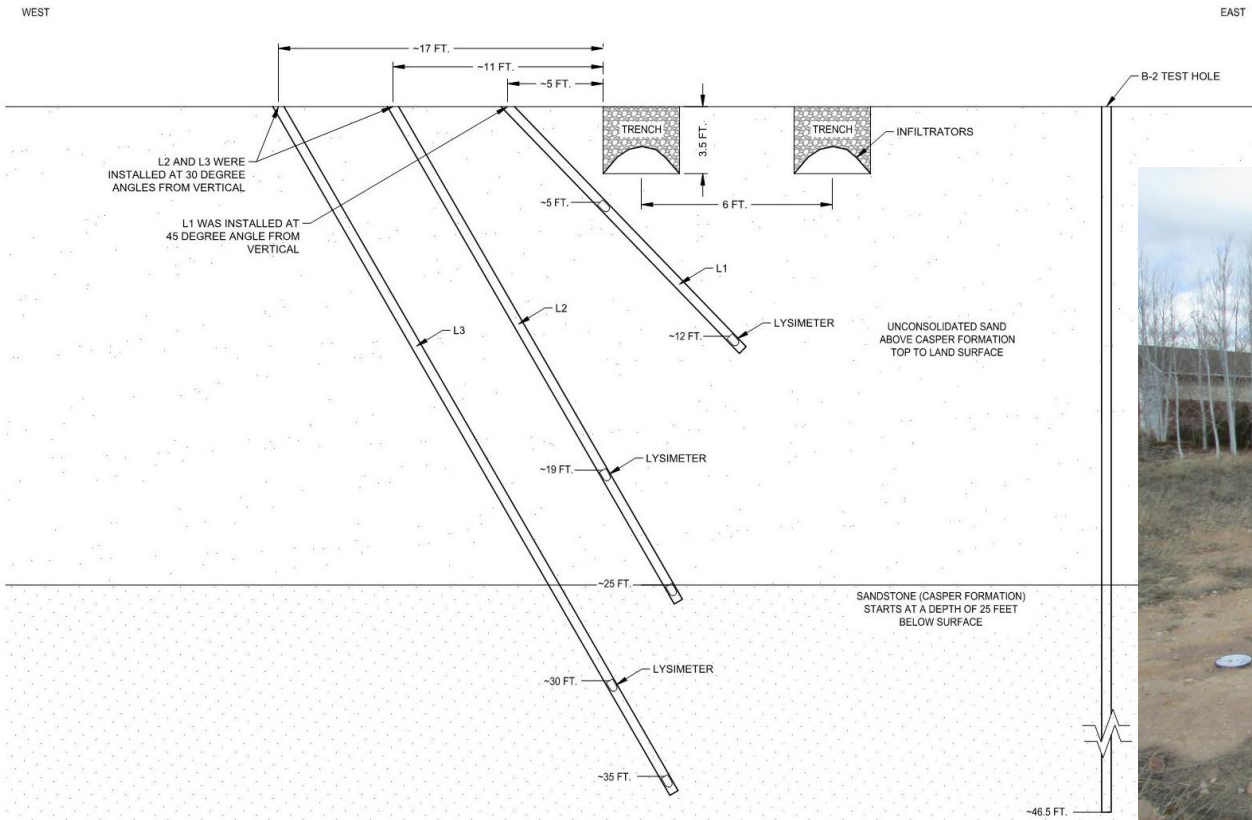
LYSIMETER DRILLING BELOW THE LEACH FIELD



LYSIMETER INSTALLATION



MONITORING NETWORK SETUP



SEPTIC TANK WATER QUALITY

Septic Tank Water Quality vs. Local Casper Aquifer Water Quality						
Analyte		Wyoming DEQ, Chapter 8 Domestic Water Quality Standards	Septic Tank Results (mg/L)		USGS Well 1 (mg/L)	USGS Well 2 (mg/L)
Sample Date			2/26/2018	12/4/2018	9/11/2012	9/13/2016
General Parameters	Total Dissolved Solids (180)	500.0	440	460	227	276
	Alkalinity, Total (as CaCO3)	--	586	530	204	186
	Nitrogen, Ammonia (as N)	0.5	94.4	70.9	ND	ND
	Nitrogen, Total Kjeldahl	--	89	80	NM	NM
Anions	Alkalinity, Bicarbonate as HCO3	--	714	646	252	199
	Alkalinity, Carbonate as CO3	--	ND	ND	ND	ND
	Chloride	250.0	41	30	0.7	31
	Flouride	4.0	0.1	0.1	ND	ND
	Nitrogen, Nitrate-Nitrite (as N)	10.0	ND	ND	ND	6.29
	Sulfate	250.0	12	2	7.1	26
Cations	Calcium	--	57	57	60	67
	Magnesium	--	17	18	15	17
	Potassium	--	24	23	ND	1.1
	Sodium	--	37	40	1.7	12
Dissolved Metals	Aluminum	--	ND	ND	ND	ND
	Arsenic	0.05	ND	ND	ND	0.002
	Barium	2.0	0.2	0.2	0.19	0.26
	Boron	0.75	ND	ND	ND	ND
	Cadmium	0.005	ND	ND	ND	ND
	Chromium	0.1	ND	ND	ND	ND
	Copper	1.0	0.01	0.01	ND	ND
	Iron	0.3	ND	0.06	ND	ND
	Lead	0.015	ND	ND	ND	ND
	Mercury	0.002	ND	ND	NM	NM
	Molybdenum	--	ND	ND	ND	ND
	Nickel	--	ND	ND	ND	ND
	Selenium	0.05	0.003	ND	ND	0.0017
	Zinc	5.0	ND	ND	ND	ND
Total Metals	Iron	0.3	0.18	1.82	ND	ND
	Manganese	0.05	ND	0.07	ND	ND
	Phosphorus	--	5.2	11.0	NM	NM

Footnotes: ND = Not Detected; NM = Not Measured; -- = No Standard; **Bold** = Exceeds Standard

USGS Well 1

ID: USGS 411727105305901 15-072-07bba01
 Latitude: 41°17'27.2"
 Longitude: 105°30'59.3"
 Well Depth: 300 ft.
 Source: <https://nwis.waterdata.usgs.gov/nwis/qwdata?>

USGS Well 2

ID: USGS 411754105314601 15-073-01caa01
 Latitude: 41°17'54.0"
 Longitude: 105°31'46.1"
 Well Depth: 163 ft.
 Source: <https://nwis.waterdata.usgs.gov/nwis/qwdata?>

SOIL ANALYSIS RESULTS

Figure 5: Soil Sampling Laboratory Results for the Lysimeter Holes

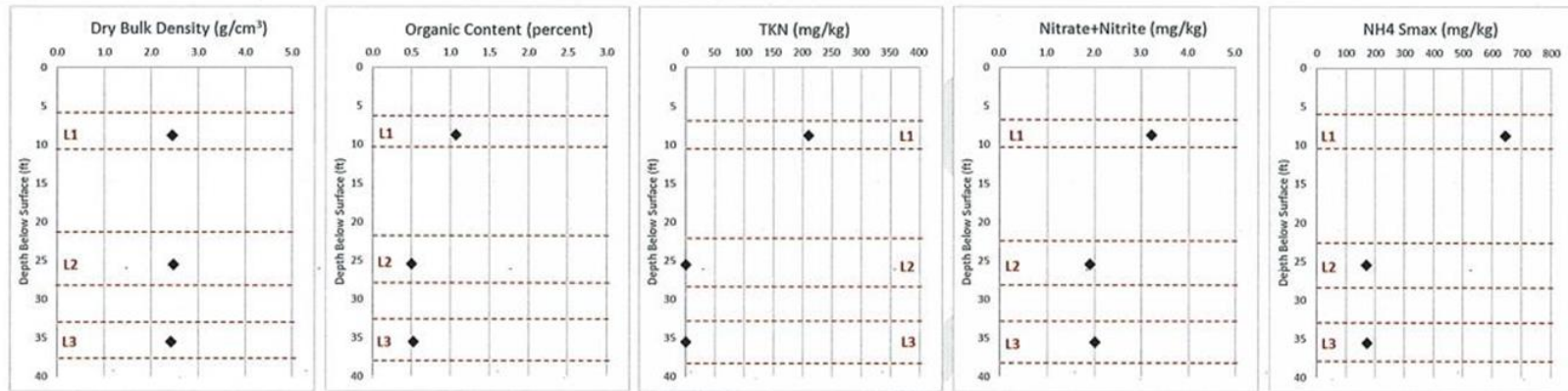
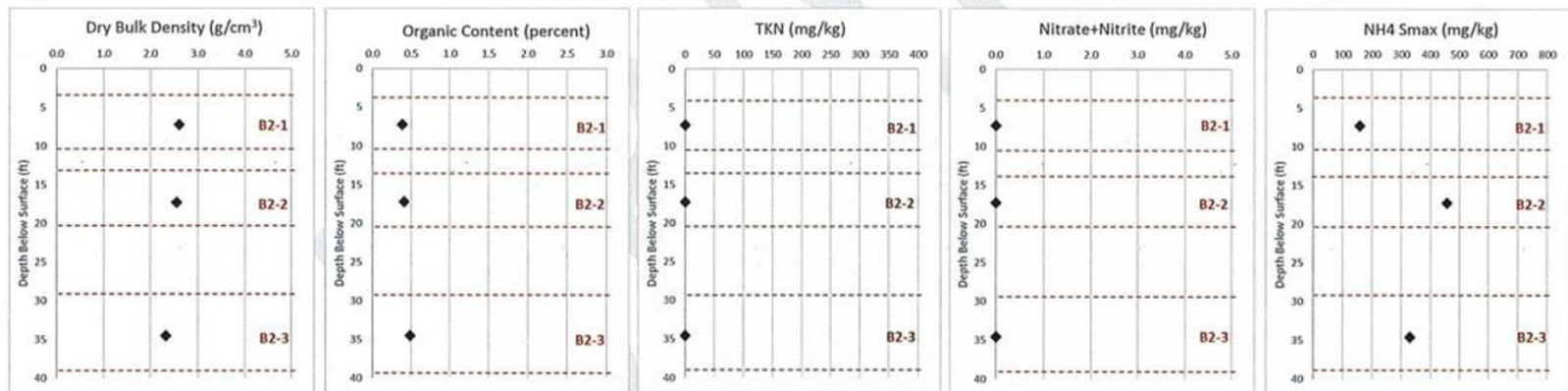


Figure 6: Soil Sampling Results for Test Hole B-2 East of the Infiltrators (non-septic impacted area)



SOIL MOISTURE RESULTS

Water Quality Data Summary for Lysimeters						
Lysimeter Depth (ft)	Date Collected	Nitrogen, Nitrate (as N) (mg/L)	Nitrogen, Nitrite (as N) (mg/L)	Nitrogen, Total Kjeldahl (TKN) (mg/L)	Chloride (mg/L)	Phosphorus (mg/L)
Wyoming DEQ, Chapter 8 Domestic Water Quality Standards		10.0	1.0	--	250.0	--
L-1 5'	2/27/2018	2.74	0.85	56	61	6.9
	4/4/2018	0.11	0.1	61	NM	NM
	5/15/2019	6.92	0.2	53	26	8.4
	6/25/2018	49.2	6.44	30	227	5.9
	9/5/2018	26.3	5.18	20	27	4.5
L-1 12'	6/25/2018	91.8	ND	NM	52	NM
	9/5/2018	69.0	ND	6	75	1.9
	12/4/2018	69.7	0.06	7	121	NM
L-2 19'	5/15/2018	75.9	ND	5	366	0.9
	6/25/2018	69.3	ND	6	366	1
	9/5/2018	65.9	ND	1	224	1.5
L-2 25'	2/27/2018	66	0.08	3	101	1.1
	4/4/2018	72.5	0.08	2	NM	NM
	5/15/2018	74.7	0.17	2	202	1.4
	6/25/2018	72.3	1.41	3	210	1.2
	9/5/2018	70.6	ND	ND	187	1.3
L-3 30'	2/27/2018	63	ND	4	2540	1
	6/25/2018	55.5	ND	10	489	2
	9/5/2018	54.7	ND	7	321	2.3
	12/4/2018	55.4	0.16	4	291	NM
L-3 35'	2/27/2018	51.2	0.09	ND	142	1.4
	4/4/2018	51	0.09	1	NM	NM
	5/15/2018	53.1	ND	1	238	1.3
	6/25/2018	54.1	ND	2	239	1.2
	9/5/2018	55.9	ND	ND	211	1.3

Footnotes

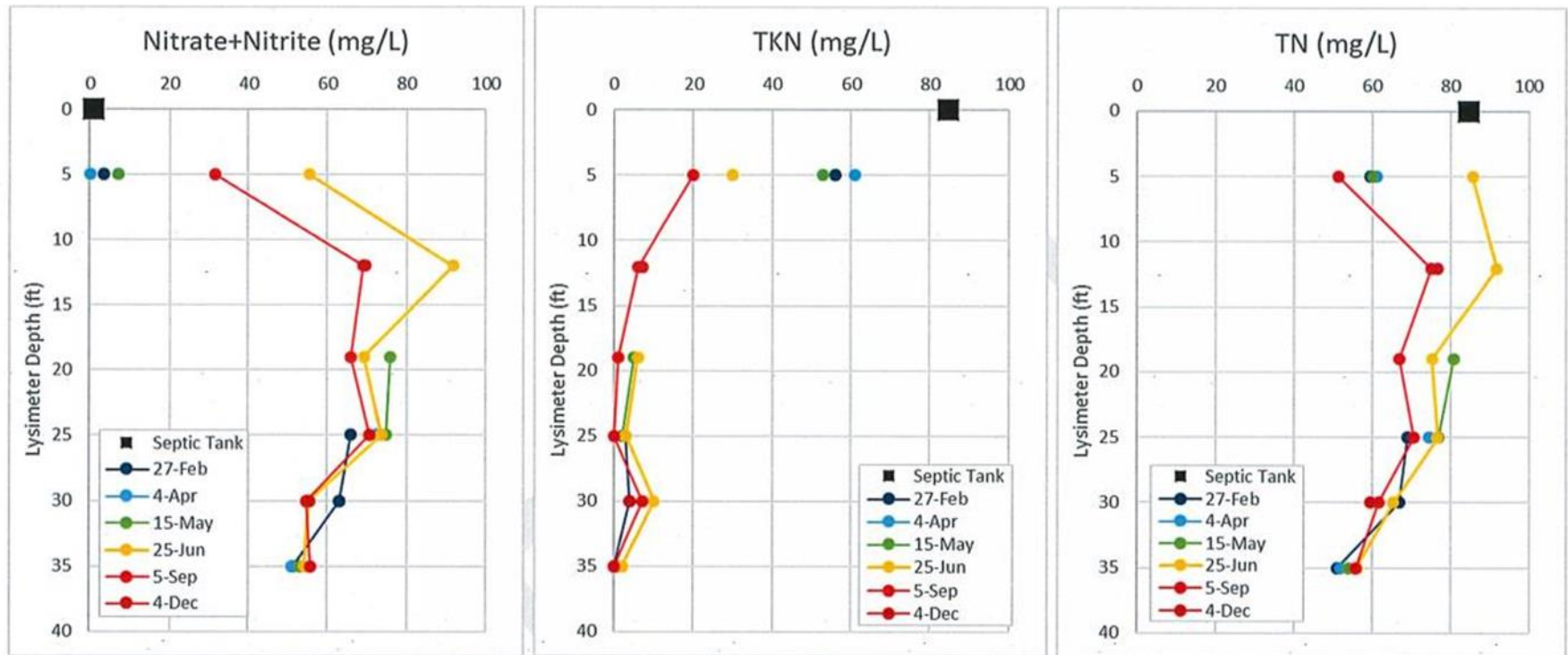
ND = Not Detected

NM = Not Measured

Bold = Exceeds WY DEQ Domestic Water Quality Standard

-- = No standard

SOIL MOISTURE QUALITY PROFILE



CONCLUSIONS

- The unsaturated zone at this site is approximately 39% efficient in removing nitrogen (all forms) from the septic tank to a depth of 35 feet through a combination of adsorption, denitrification, and dilution
- Soil moisture with nitrate concentrations in excess of EPA and DEQ Class I standards (51-63 mg/L) is percolating through the unconsolidated sand alluvial fan deposits into the unsaturated Casper Formation
- The unsaturated zone at this site does not remove sufficient nitrogen to protect the Casper Formation and by inference the Casper Aquifer from nitrate contamination

RECOMMENDATIONS

- Continue monitoring the unsaturated zone sampling network at this site with landowner consent
- Install several similar monitoring networks at different properties with different soil types or septic systems
- Preferably test an “enhanced treatment septic system”
- Use these data to evaluate septic system design requirements in the CAPA
- Consider extending city wastewater service to these areas or regional collection and treatment systems
- Estimate nitrate loading to the CAPA assuming similar operating conditions
- Make recommendations as data set grows

PROCESS – WHAT WORKED

- Coordination with County for site selection
- Lysimeter installation approach using new augers and dry materials
- Finding a site with adequate soil cover above the Casper Formation

PROCESS – WHAT DID NOT WORK

- Relying on septic system layout maps
- Lysimeter sampling in cold weather

PROCESS – IMPROVEMENTS

- Excavate to locate system margin before drilling
- Allow more time to initially find sites and landowners willing to partner
- Increase funding to cover professional services
- System installation in the spring or fall
- Concentrate sampling during spring through fall months
- Install a downgradient monitoring well

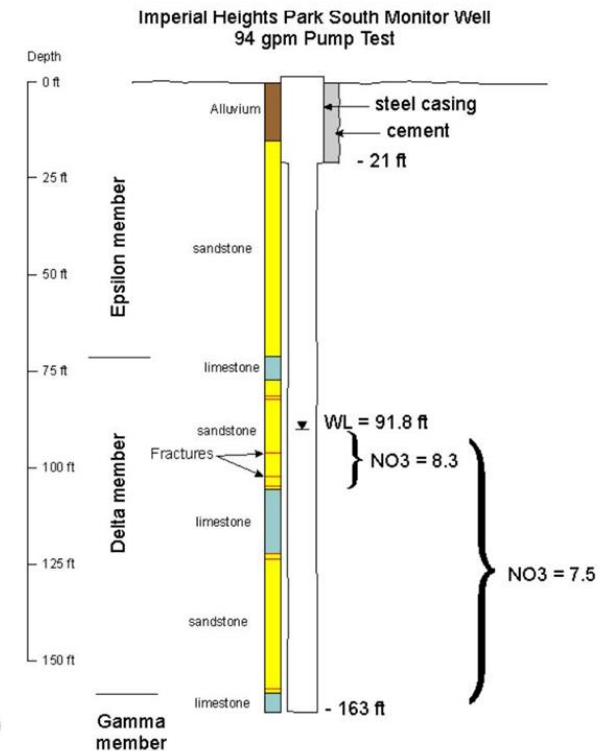
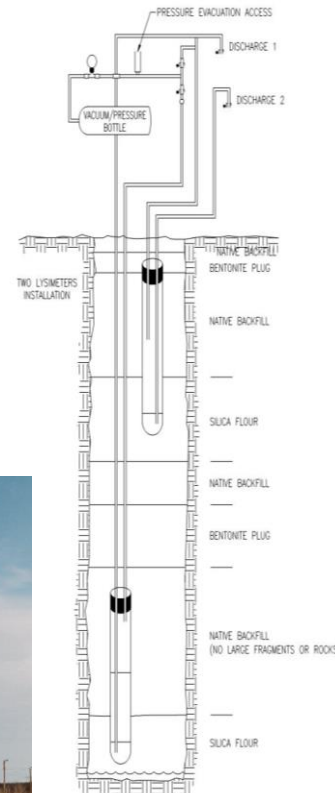


WENCK

Responsive partner.
Exceptional outcomes.

FIELD SCALE APPROACH

1. Project area site selection
 1. Field scale approach
 2. 3- 45 degree holes (0-15ft)
2. Lysimeter installation
3. Strat hole defining field lithologies
4. Monthly sampling
5. Data analysis



SEPTIC SYSTEMS AND DRAINFIELDS

Septic System Nutrient Attenuation is Governed by:

- System Maintenance and Owner's Actions
- Quality of Effluent Leaving Septic Tank
- Daily Flow Rate
- System Design and Drainfield Sizing
- Soil Texture and Structure
- Soil Moisture
- Soil Geochemical Characteristics
- Soil Organic Matter Abundance

