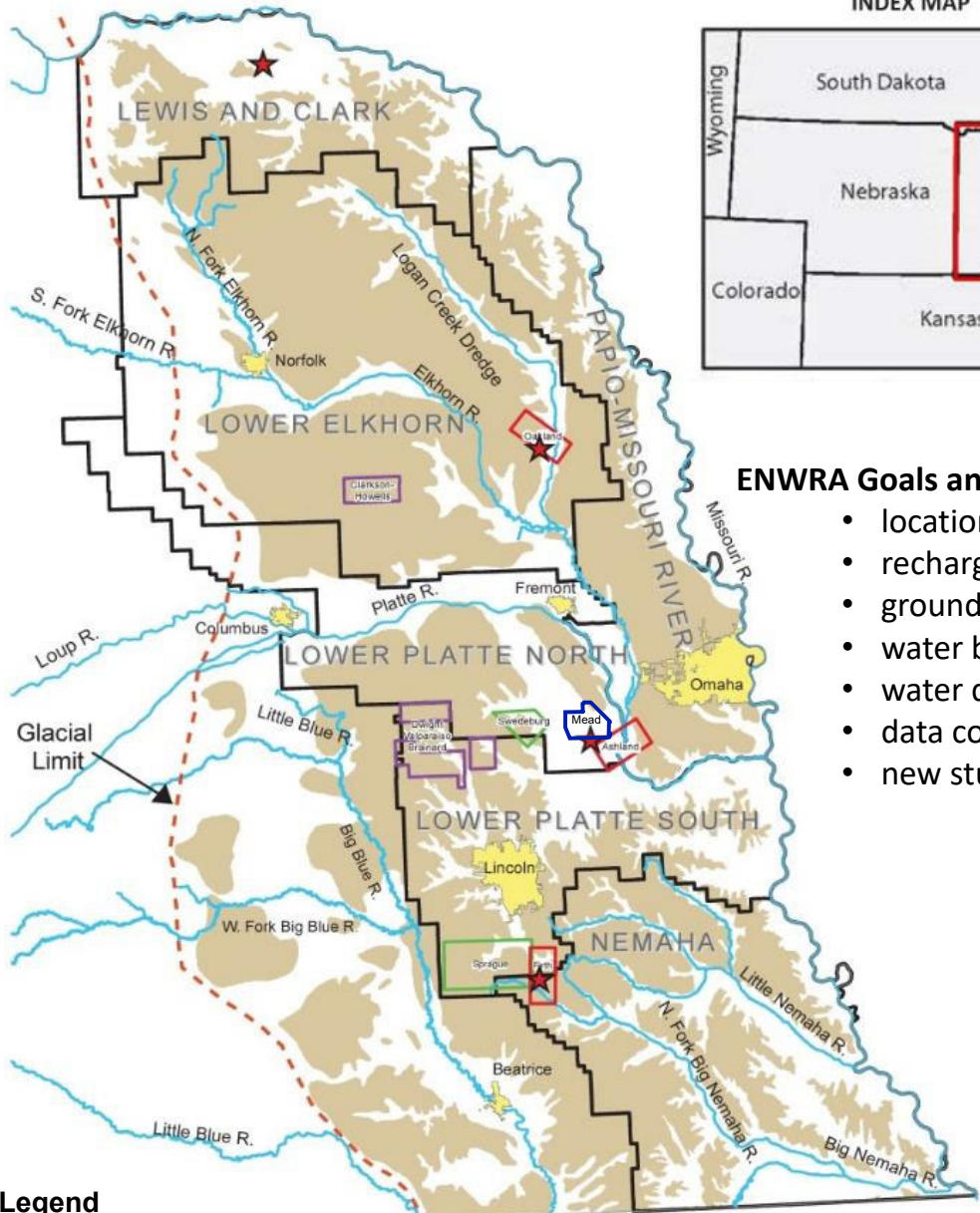


ENWRA STUDY SITES

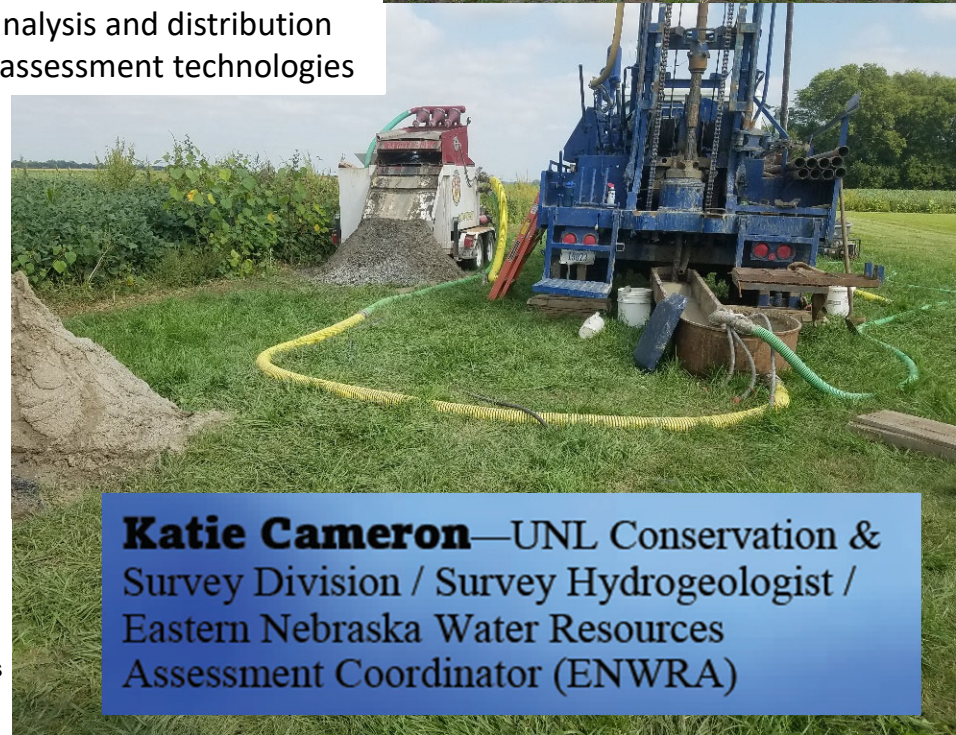


INDEX MAP



ENWRA Goals and Objectives:

- location and volume of aquifers
- recharge areas and rates
- groundwater surface water interactions
- water budgets
- water quality concerns
- data collection, analysis and distribution
- new studies and assessment technologies



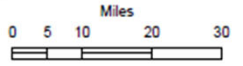
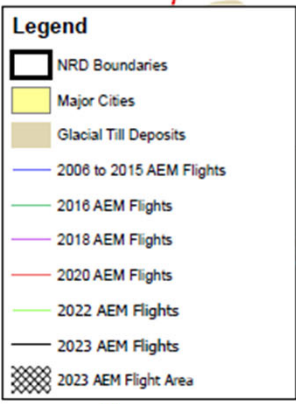
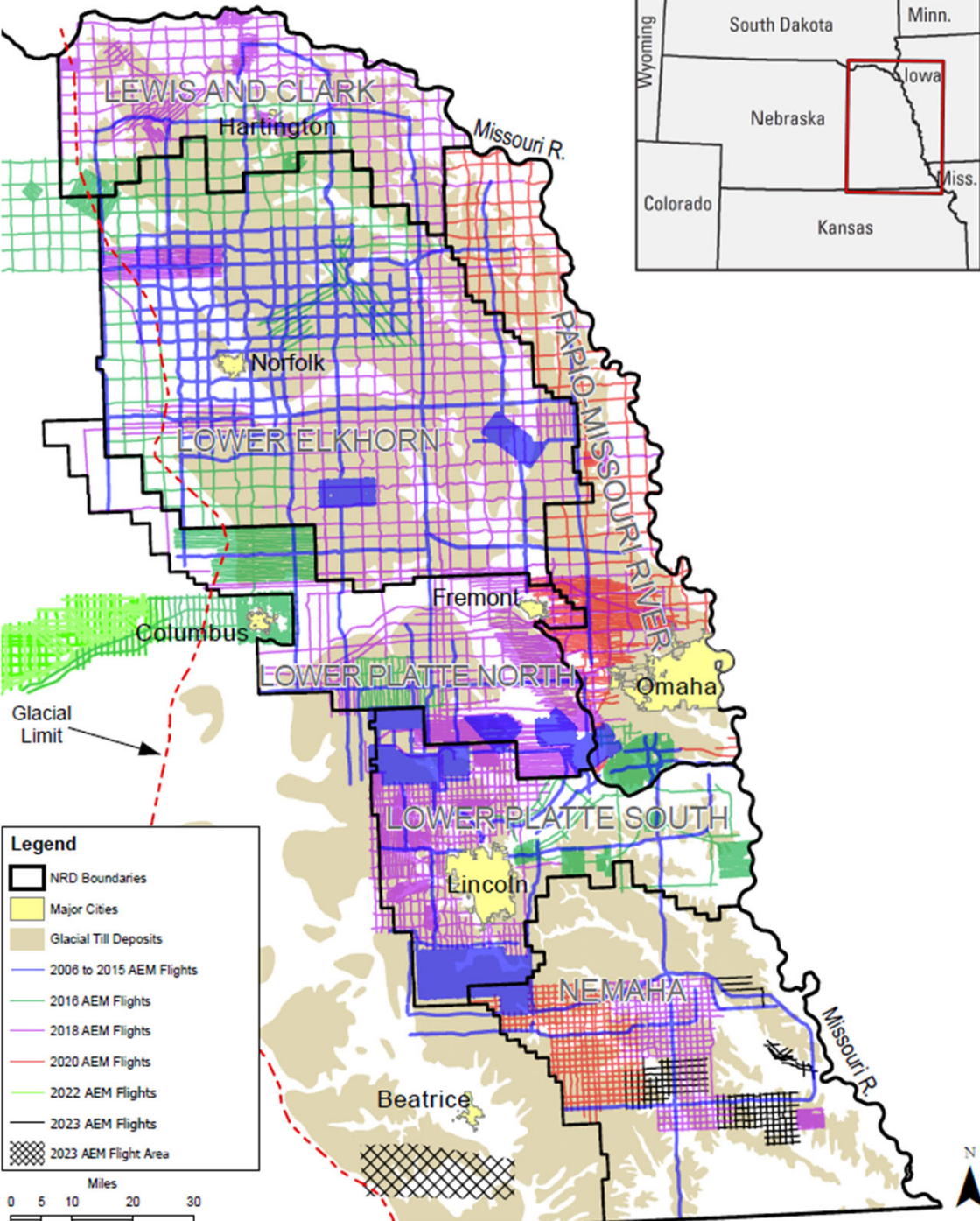
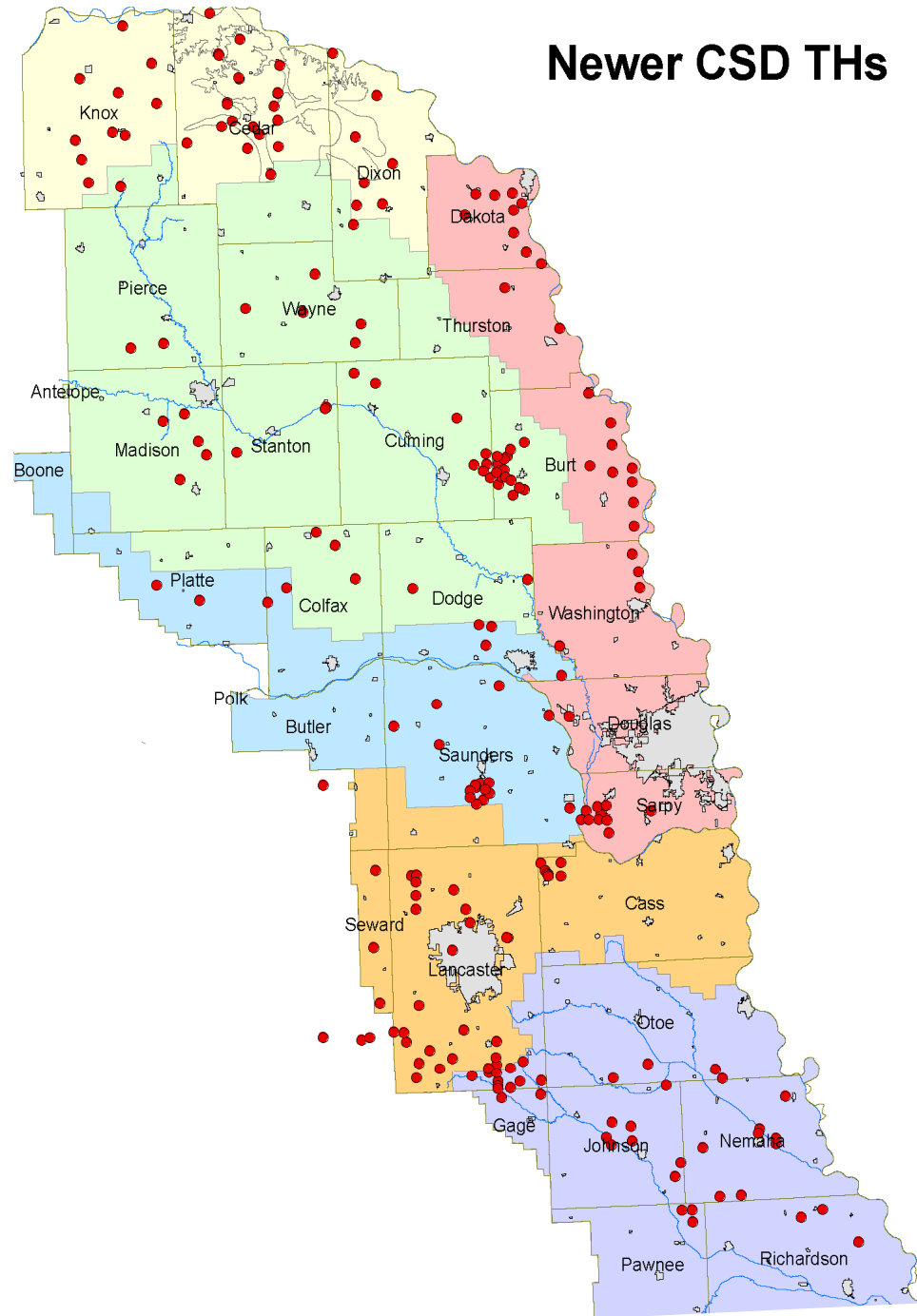
Legend

- | | |
|-----------------------|--|
| ENWRA NRD Boundaries | 2007 Ashland, Oakland, and Firth Pilot Study Sites |
| Major Cities | 2009 Sprague and Swedeburg Flights |
| Major Rivers | 2012 USACE Flights at Mead |
| Glacial Till Deposits | 2013 Clarkson-Howells and Dwight-Valparaiso-Brainard Flights |
| Recharge Stations | |

Katie Cameron—UNL Conservation & Survey Division / Survey Hydrogeologist / Eastern Nebraska Water Resources Assessment Coordinator (ENWRA)

ENWRA STUDY AREA

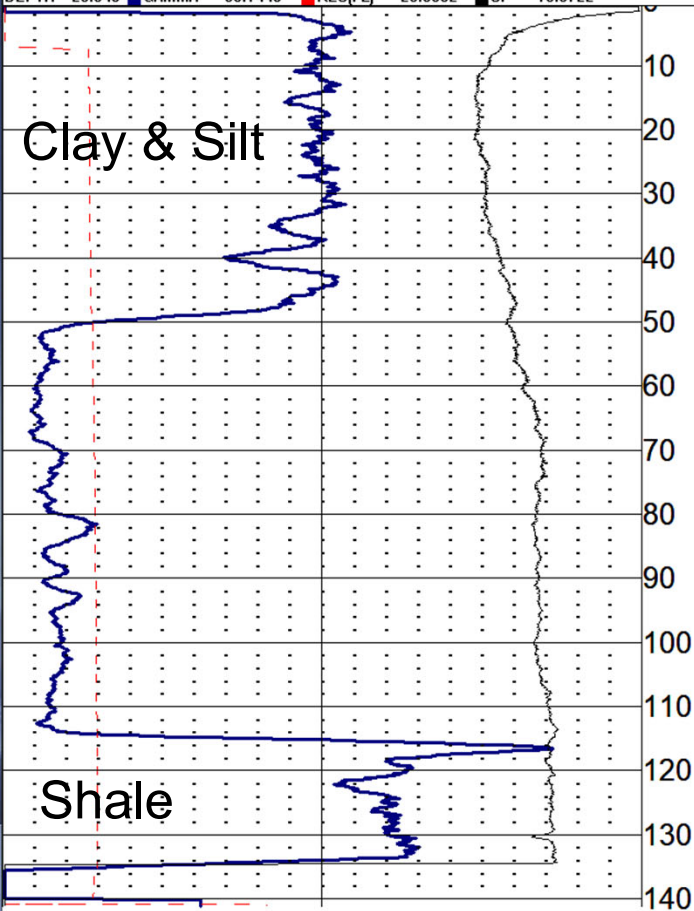
Newer CSD THs





Downhole Geophysical Logs

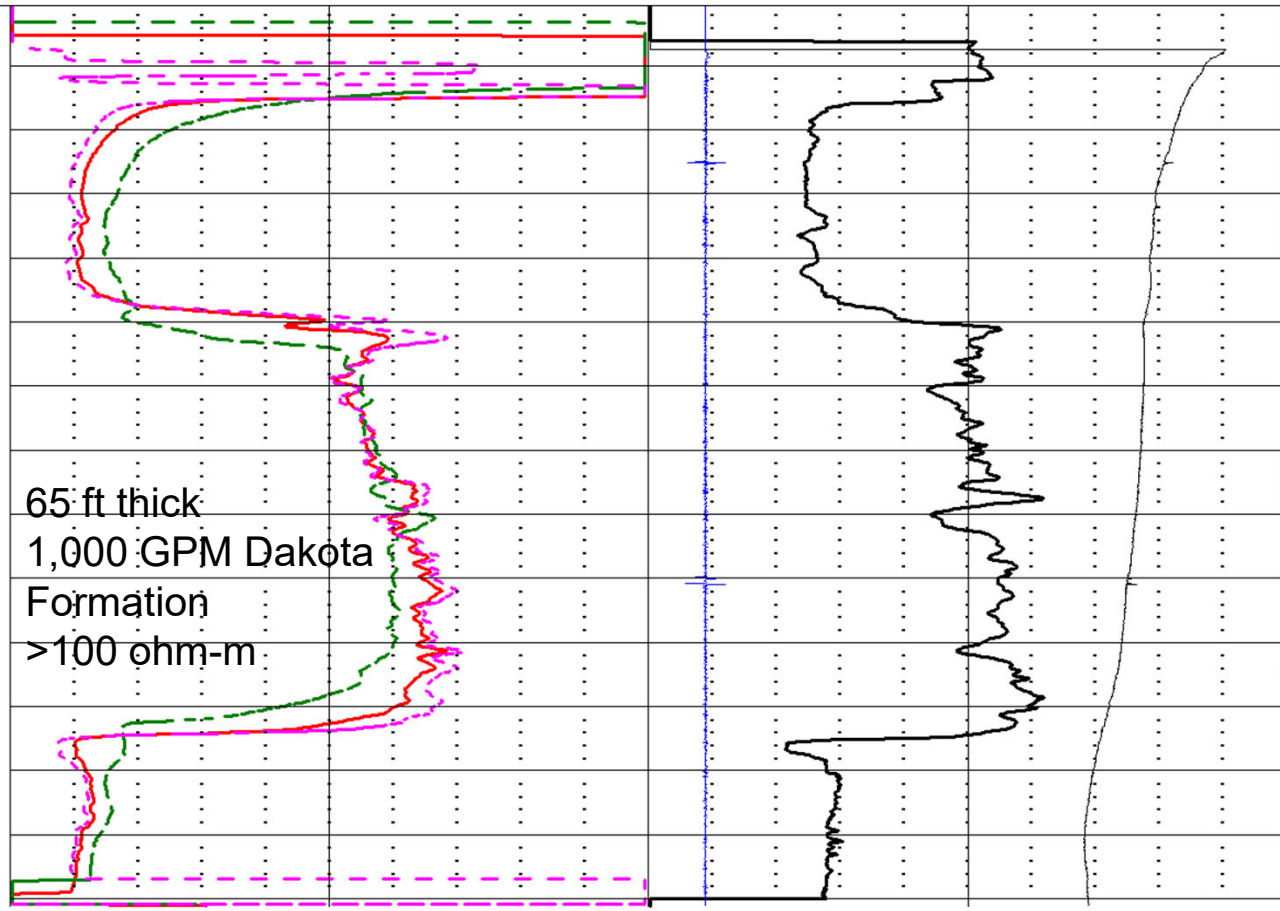
Log File: 01-SP-22_09-28-22_12-51_8143A_10_070_141.20_ORIG.log Id=8143A Top=0.7 Bot=141.2 SI=0.1 DIR=U
 File View Options Print Edit Interpret Processing Log Help VERSION 3.64KT
 DEPTH 25.043 GAMMA = 38.1443 RES[FL] = 28.6082 SP = 19.0722



Gamma and SP

0	API-GR	200
0	GAMMA	
0	MV	100
0	SP	
0	OHM-M	150
0	RES[FL]	

FEET



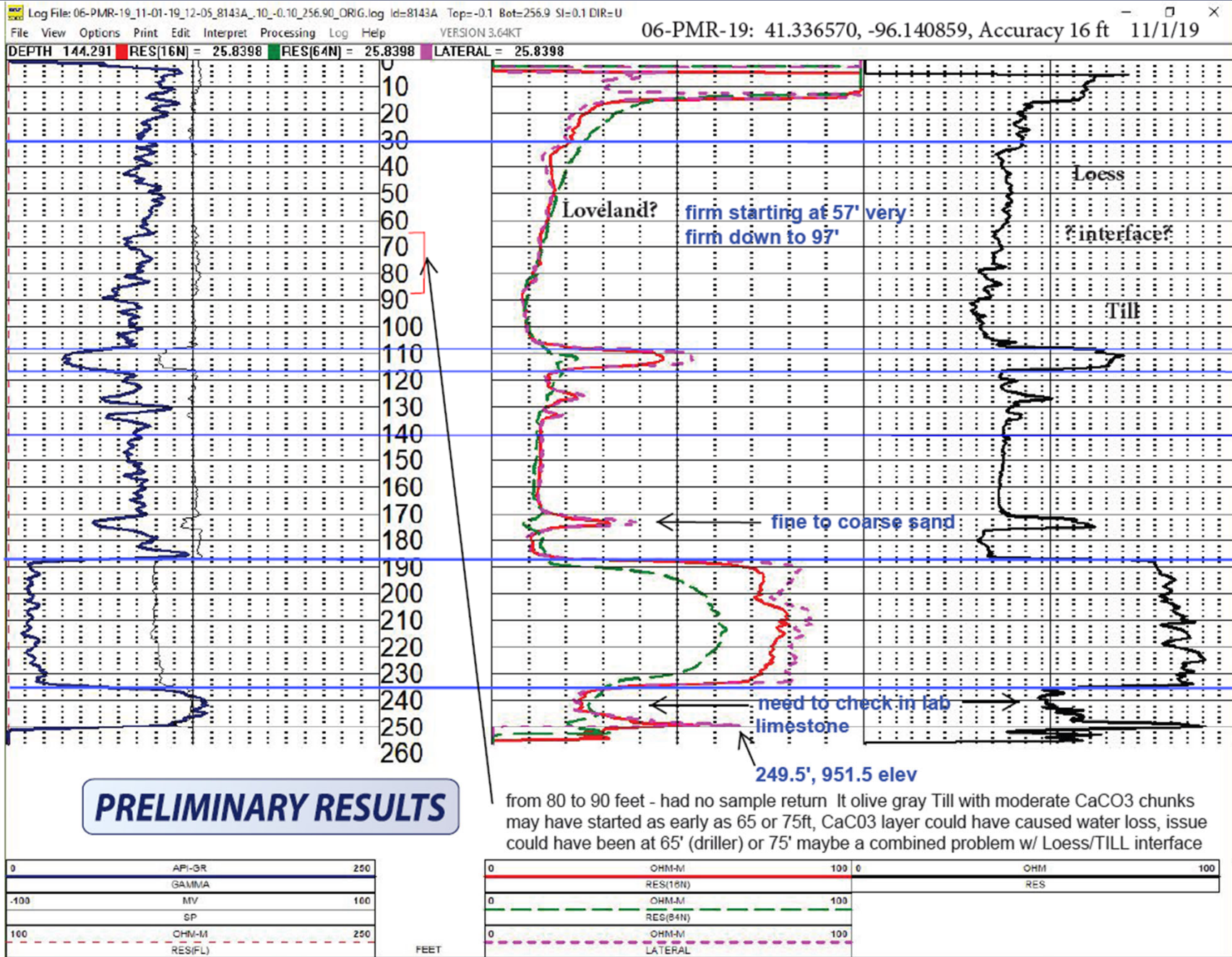
Resistivity values

0	OHM-M	200	0
0	RES(16N)		
0	OHM-M	200	55
0	RES(84N)		
0	OHM-M	200	-0.4
0	LATERAL		

Resistivity & temp. F

0	OHM	200
0	RES	
0	DEG_F	65
0	TEMP	
0	DEG_F	4
0	DEL_TEMP	

Downhole Geophysical Logs



1201 FT Gnd. ELEV

silt, variable clay content
sl. wt CaCO₃ 20-30ft
1,171 elev

Loess

clay, silty - need to check in lab for slight sand & gravel in matrix
?interface?

Till

1,092 elev
sand, fine to medium

clay, in and out of interbedded sand lenses
1,061 elev

calcareous silt and clay, very sandy, sand is VF-F

1,014 elev Dakota Top ?
(but drill change reported at 191')

fine sandstone, thin siltstone interbeds

966 elev
gray mudstone to very dark gray shale, moderate thin limestone layers (all limestone 249.5-260'? minus slower drill at 258' are drill action notes at the bottom)

from 80 to 90 feet - had no sample return It olive gray Till with moderate CaCO₃ chunks may have started as early as 65 or 75ft, CaCO₃ layer could have caused water loss, issue could have been at 65' (driller) or 75' maybe a combined problem w/ Loess/TILL interface

249.5', 951.5 elev

fine to coarse sand

need to check in lab limestone

Loveland?
firm starting at 57' very firm down to 97'

Test Holes – for CSD online



Log Materials:

clay	sand & gravel
gravel	sand & clay
sand	clay & sand
Till	silt & clay
shale	sandstone

Screen at 860-880' in Dakota fine sand near Tarnov, NE

ENWRA

EASTERN NEBRASKA WATER RESOURCES ASSESSMENT



3125 Portia St
PO Box 83581
Lincoln, NE 68501
402.476.2729

kcameron_enwra@lpsnrd.org

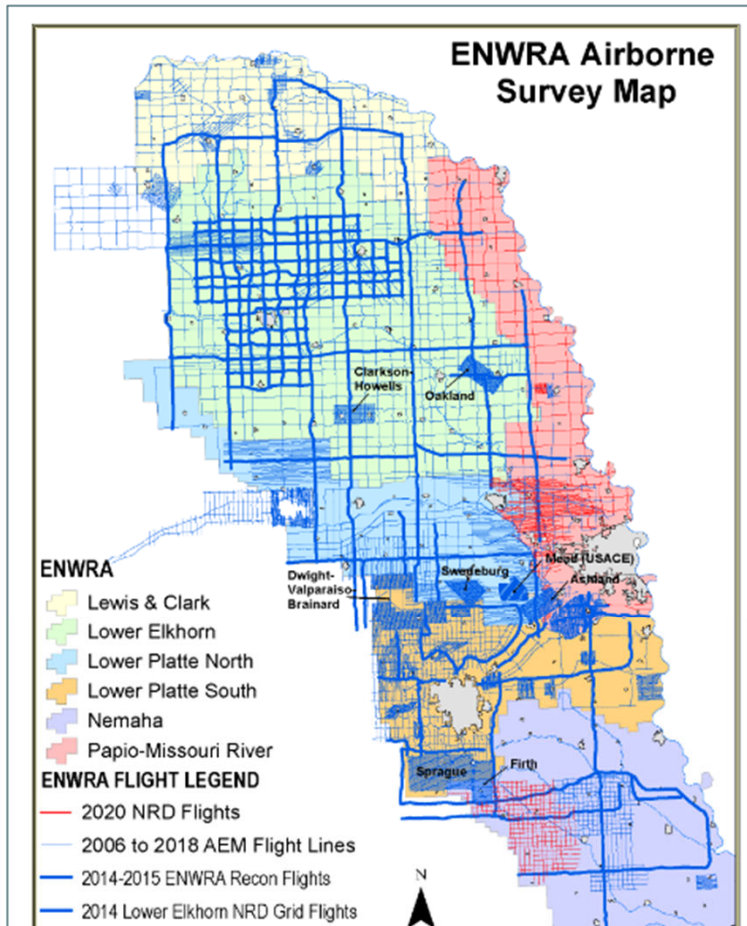
[About](#) [Projects](#) [Media/Downloads](#) [2023 AEM](#) [2020 AEM](#)

[2018 AEM](#) [2016 AEM](#) [2015 AEM](#) [2014 LENRD AEM](#)

[AEM Partner Projects](#) [Contact](#) [Home](#)

NRDS: [Papio-Missouri River NRD](#) [Nemaha NRD](#)

2020 Airborne Electromagnetic Survey (AEM)

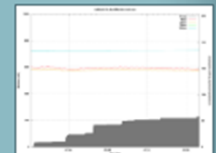


News

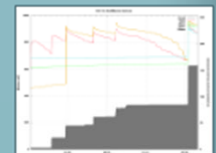
ENWRA Groundwater Recharge Mapping and Focus Area Assessments (Water Sustainability Fund [WSF] #5312) was awarded in December 2021. The USGS-UNL CSD project team concluded Phase 1 regional activities in 2022 and Phase 2 work with the Focus Areas is underway in 2023 with the ENWRA NRDs. Annual status report available here: [WSF 2023 Annual Report # 5312](#)

Moisture at Weather Stations:

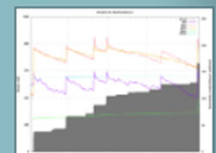
Oakland



Firth



Ashland

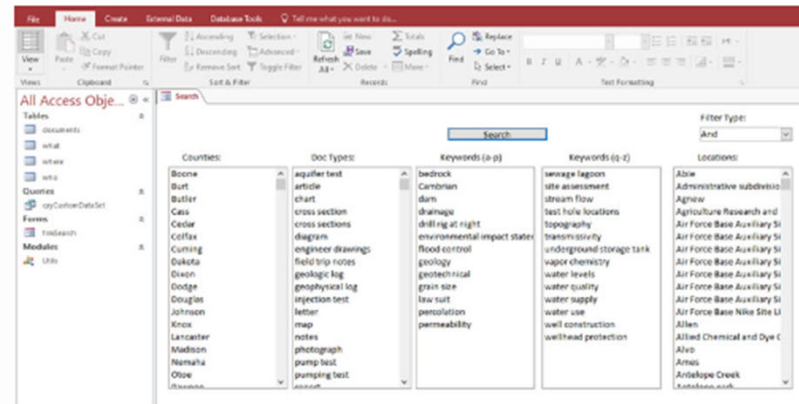


Fordyce

folders. Dropbox is free for users but when downloading data, please save to your computer hard drive (choose direct download) so as to not fill up space on your personal dropbox account (300 MB).

ENWRA Archive

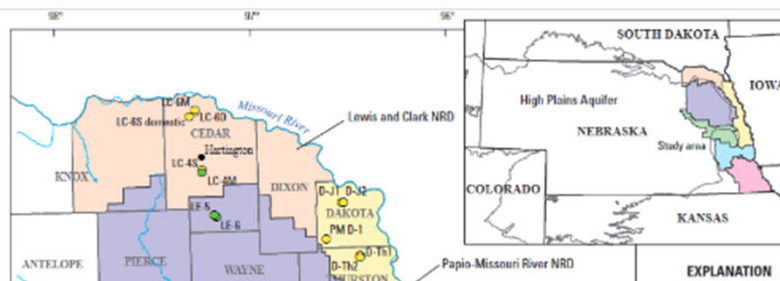
Click [here](#) to access ENWRA's Archive data folders prepared by Dana Divine of the Conservation and Survey Division (CSD) of the School of Natural Resources at University of Nebraska-Lincoln in 2011 (includes some additional archived sources gathered to-date). Dropbox is free for users but when downloading data, please save to your computer hard drive (choose direct download) so as to not fill up space on your personal dropbox account (**Warning files total 5.7 GB**). It is recommended you download the access database and then return to the Dropbox for copies of the PDF files associated with your search. You can select "no thanks" to the sign-up for a Dropbox account and still download the files (Dropbox no longer works in Internet Explorer browser).



Secondary Bedrock Aquifer Sampling and Age-Dating Project (Water Sustainability Fund #4125)

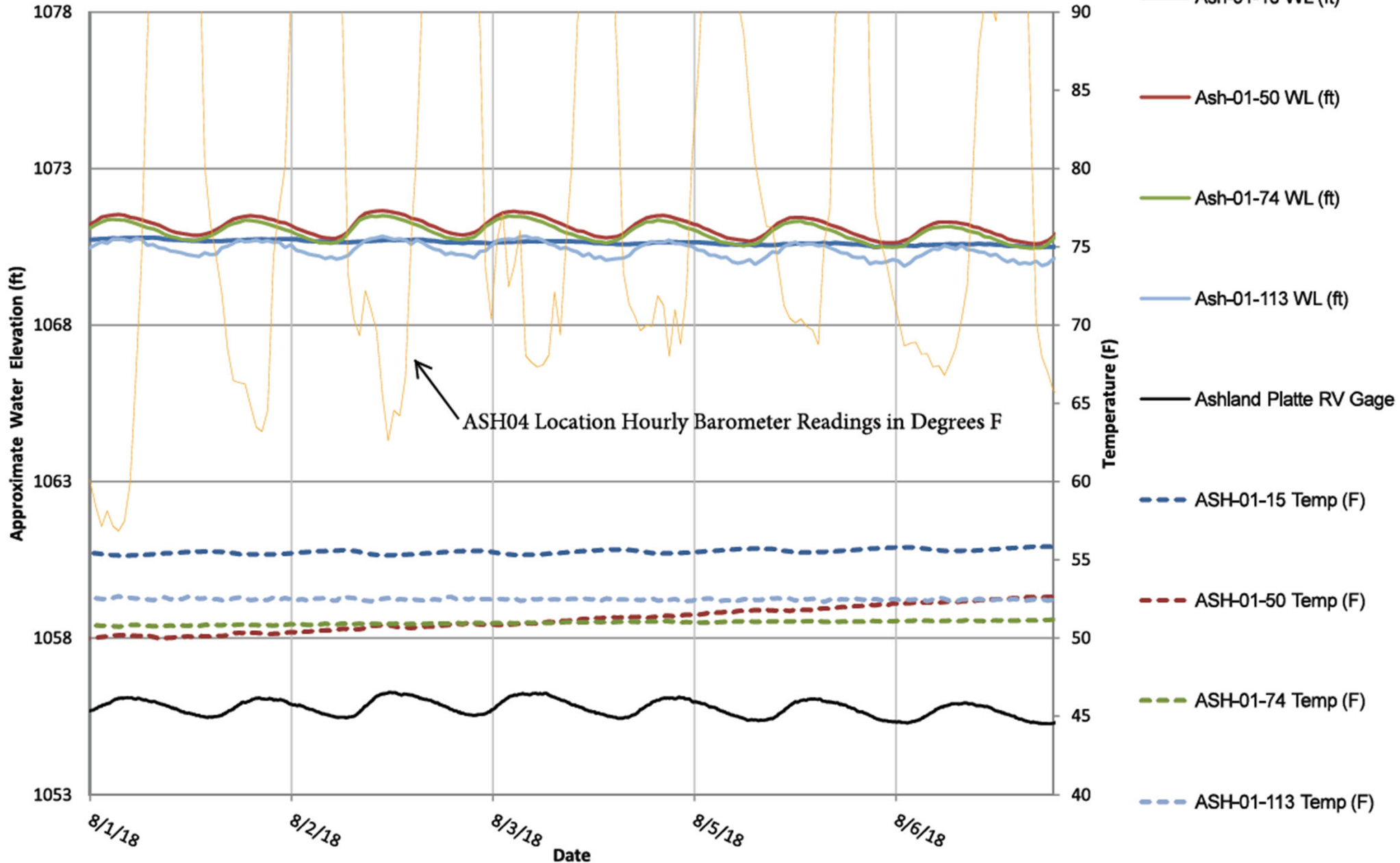
The following USGS online publication was approved for release and has been made available to the public: [USGS Scientific Investigations Report 2021-5055](#)
Suggested citation: Hobza, C.M., and Flynn, A.T., 2021, Groundwater quality and age of secondary bedrock aquifers in the glaciated portion of eastern Nebraska, 2016-18: U.S. Geological Survey Scientific Investigations Report 2021-5055, 42 p. This publication is available online only (<https://doi.org/10.3133/sir20215055>).

Click [here](#) for a link to a presentation of the results from December 9, 2020. An additional talk was presented at the March 2, 2021 NRD Water Programs conference.



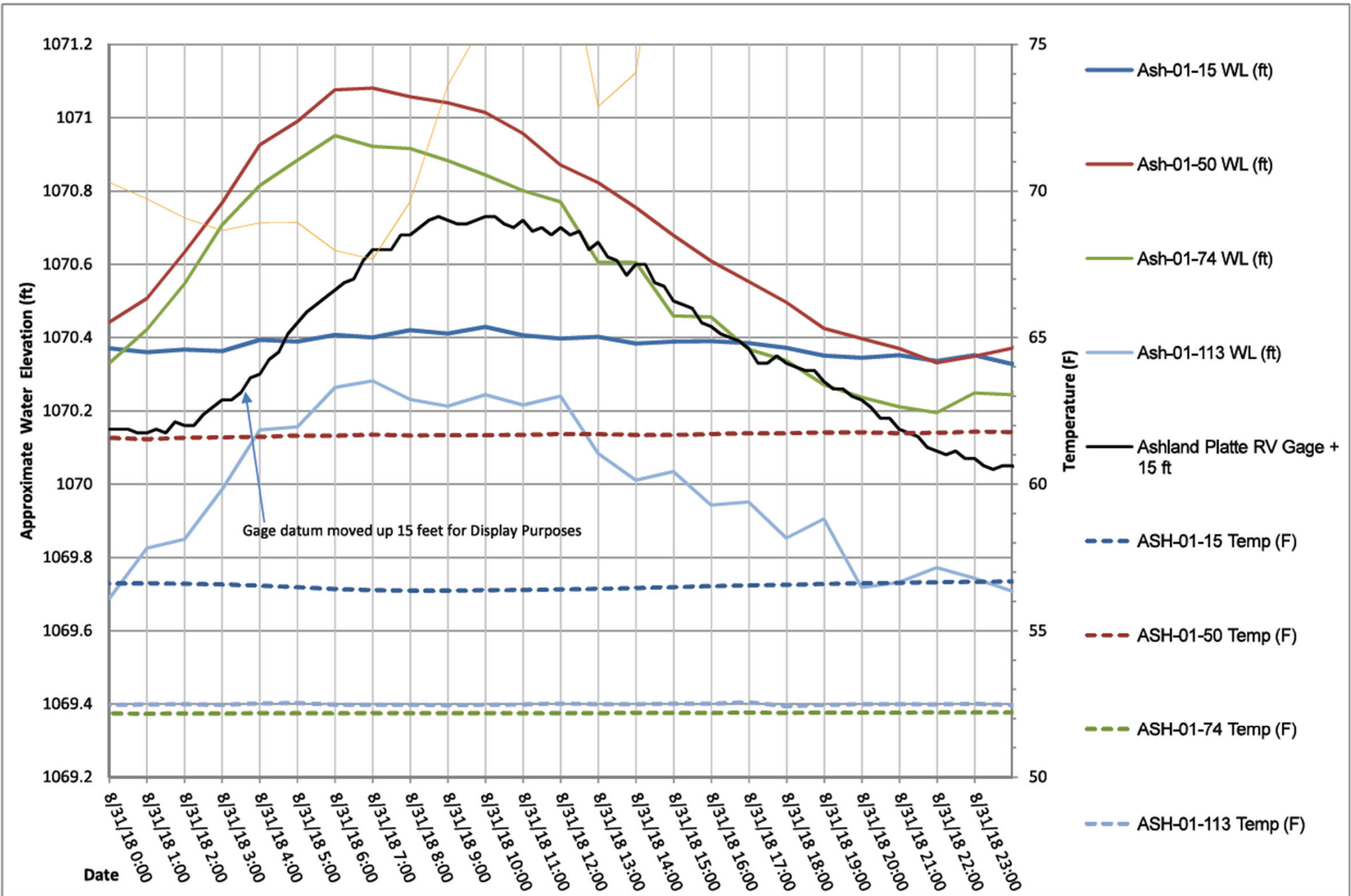
Water Level and Temp. ASH-01 Well Site - One Week of Hourly Data

Note: Platte River Gage readings are from USGS <https://waterdata.usgs.gov/nwis> - some data is provisional



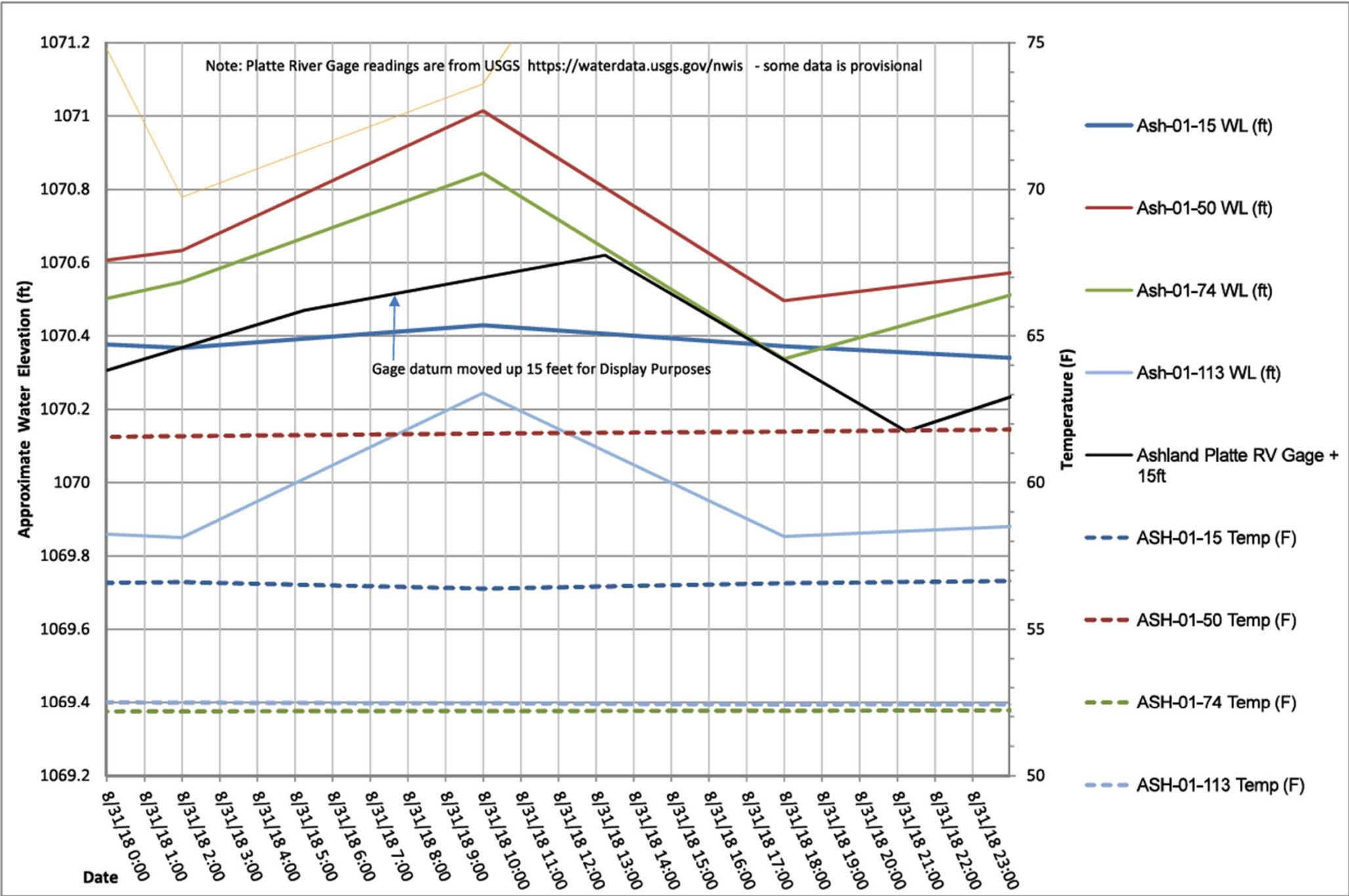
Note: 15 Minute Readings are Displayed for the Platte River Gage at Ashland

Water Level & Temp. ASH-01 Well Site - Summer Day of Hourly Data

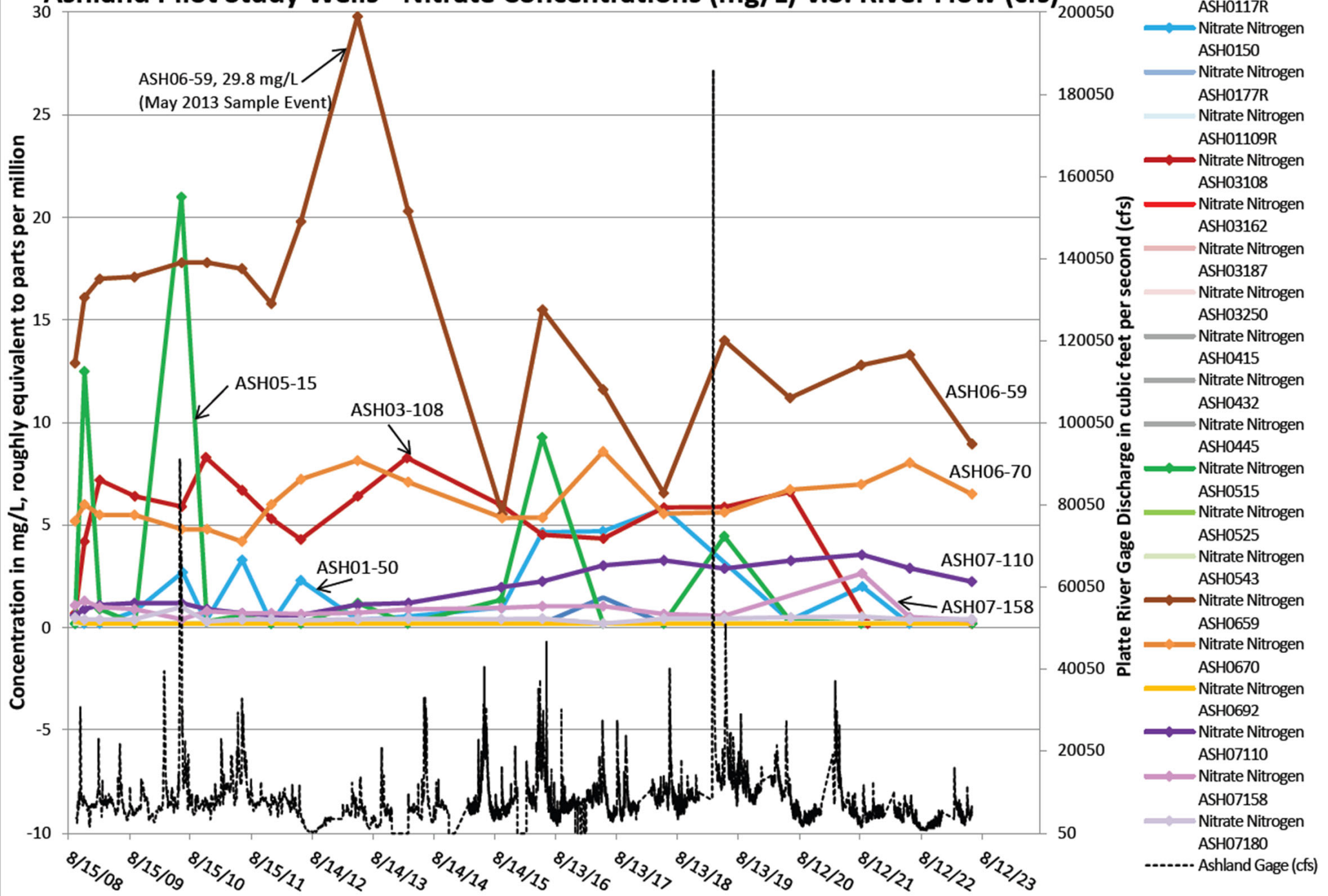


Note: Platte River Gage readings are from USGS <https://waterdata.usgs.gov/nwis> - some data is provisional

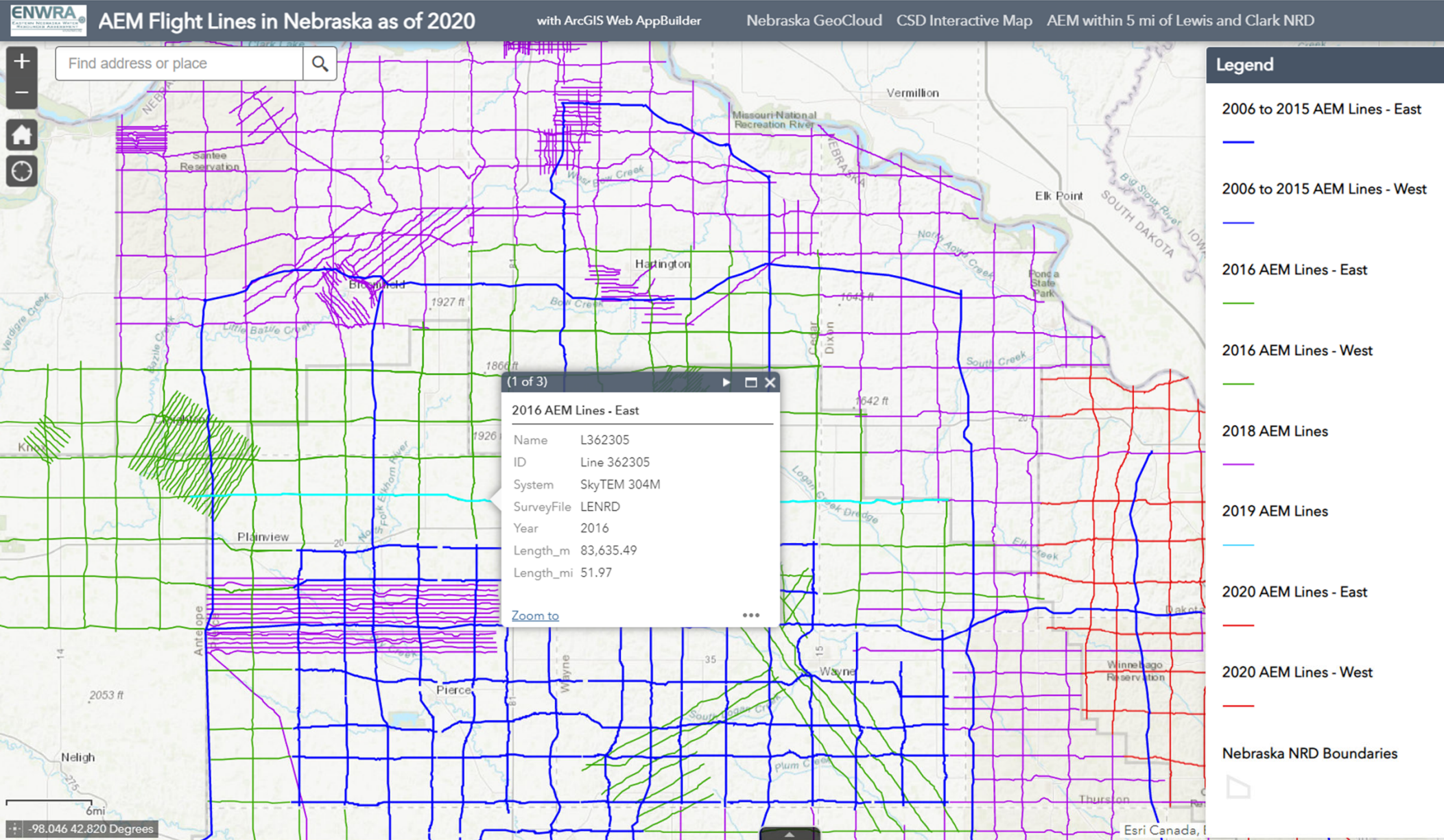
Water Level and Temp. ASH-01 Well Site - Summer Day of 8Hour Data 2018



Ashland Pilot Study Wells - Nitrate Concentrations (mg/L) V.S. River Flow (cfs)



Website: enwra.org



CSD Website: your State Geological Survey

CSD Ground Water and Geology Data Portal

CSD Website Nebraska GeoCloud NDEE GW Quality Clearinghouse

Layer List

Layers

- Test Holes
- Active Water Levels
- Real-Time Observation Wells
- DNR-Registered Wells
- Bedrock Geology
- Basement Rock Type
- Navigation Layers (Click Here for Options)
- Aquifer Boundaries (Click Here for Options)
- 2021 Water Level Changes (Click Here for Options)
- 2021 Precipitation (Click Here for Options)
- AEM_Flight_Lines

Great Plains

Nebraska National Forest

Sand Hills

Nebraska

North Platte

South Platte

Republican

Sioux Falls

Missouri National Recreation River

Sioux City

Norfolk

Omaha

Lincoln

Hastings

Grand Island

Kearney

60mi

-104.165 42.121 Degrees

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https://youtu.be/_4nJiafhH9g

Click [here](#) to watch an educational video produced by [QUEST NEBRASKA](#)



regarding AEM survey and Nebraska's groundwater. Please click [here](#) for a 2017 presentation of ENWRA AEM data by Aqua Geo



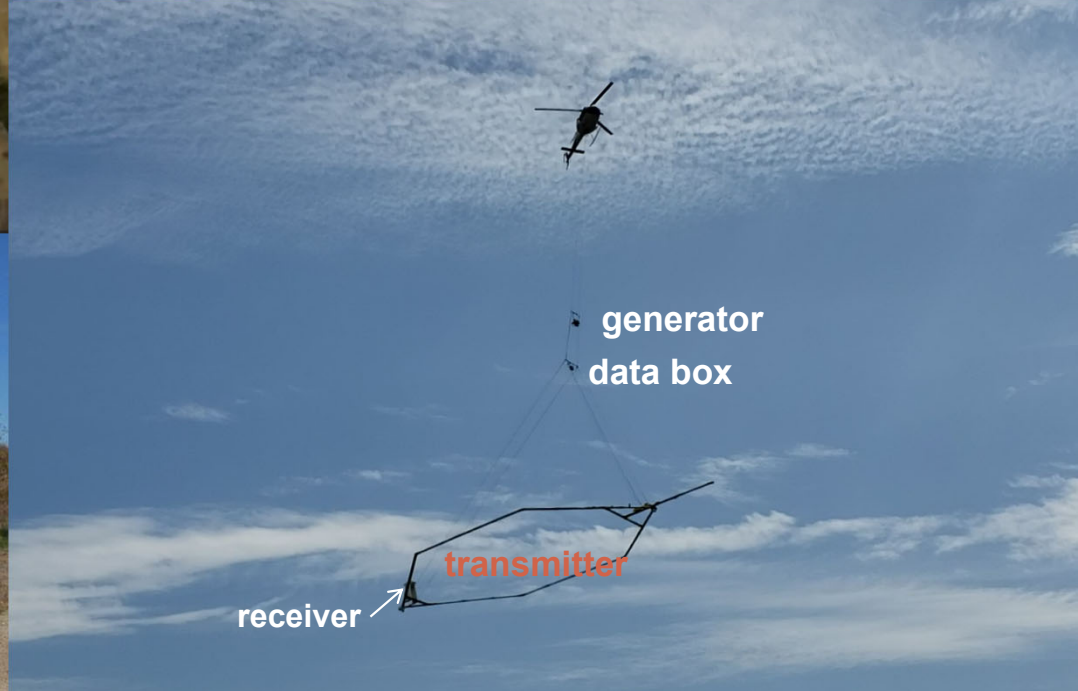
Frameworks, LLC

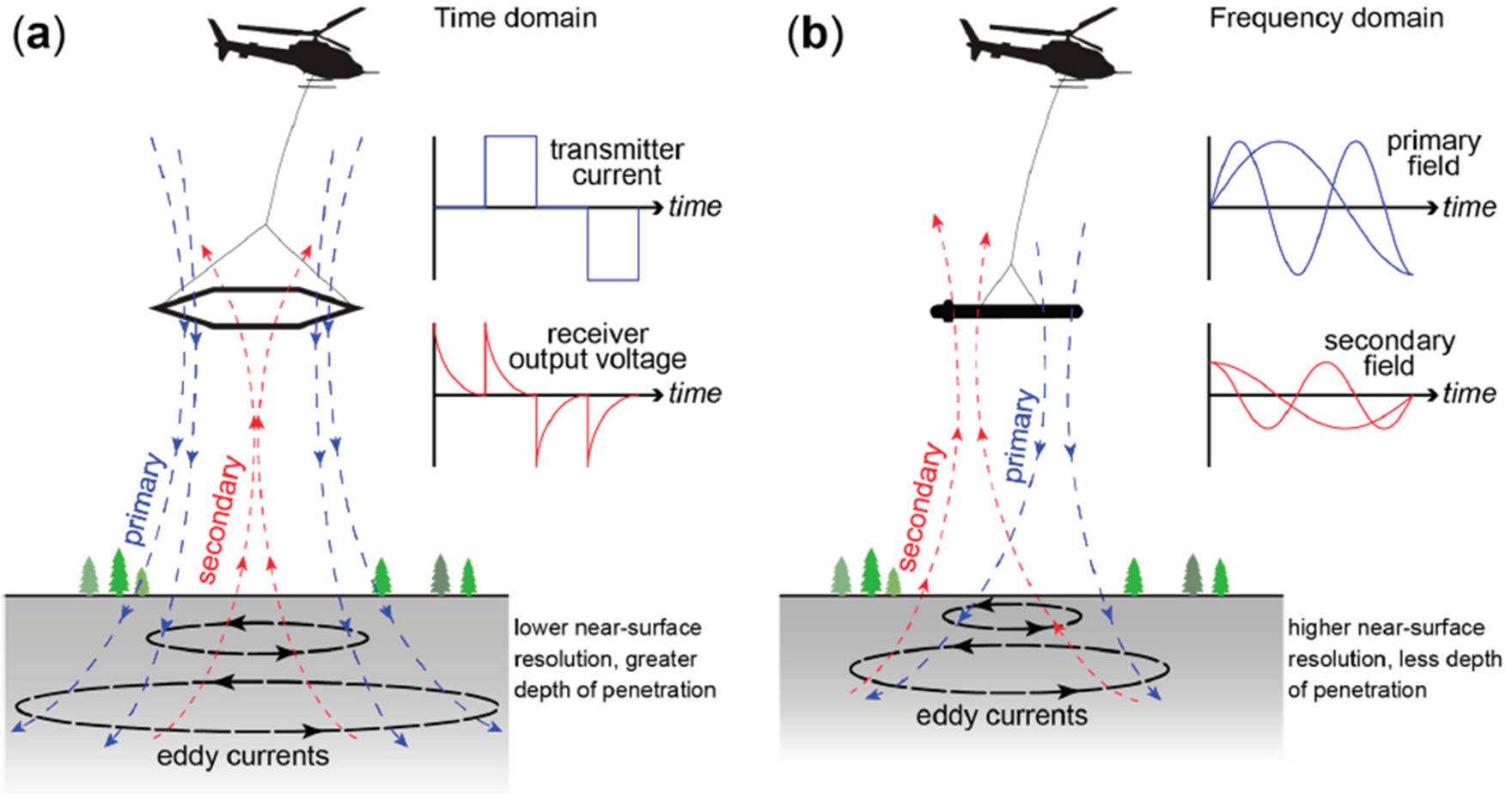


QUEST



**SkyTEM
Aquifer Mapping**





Korus, Jesse T., "Combining Hydraulic Head Analysis with Airborne Electromagnetics to Detect and Map Impermeable Aquifer Boundaries" (2018). <http://digitalcommons.unl.edu/conservationsurvey/659>

Figure 2. Comparison of airborne electromagnetic systems: (a) Time domain system; (b) frequency domain system.

AEM Fundamentals *Resistivity applied to sediments*

Finer-grained
sediment

Decrease in resistivity



Increase in resistivity

Coarser-grained
sediment



Non Aquifer
(<12 ohm-m)

Marginal Aquifer
($12-20$ ohm-m)

Aquifer
($20-50$ ohm-m)

Coarse Aquifer
(>50 ohm-m)

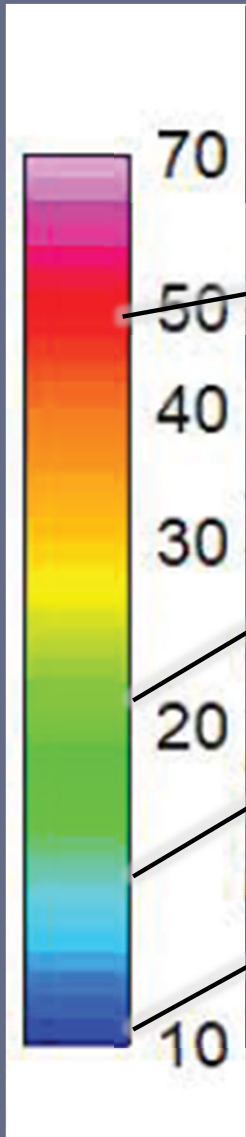
Cretaceous Dakota Group (Kd)



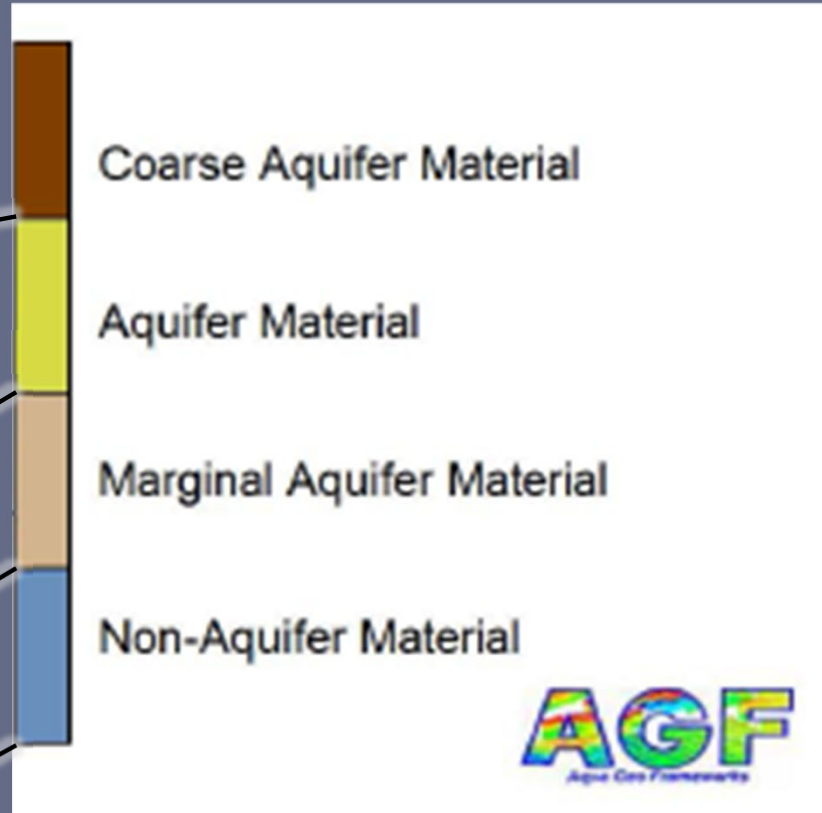
**Shale/Clay or Saline Water
Dominant**

Sandstone/Sand Dominant

Resistivity (ohm-m):



Aquifer Material Interpretation:



Brown = sand-rich, coarse intervals of the aquifer

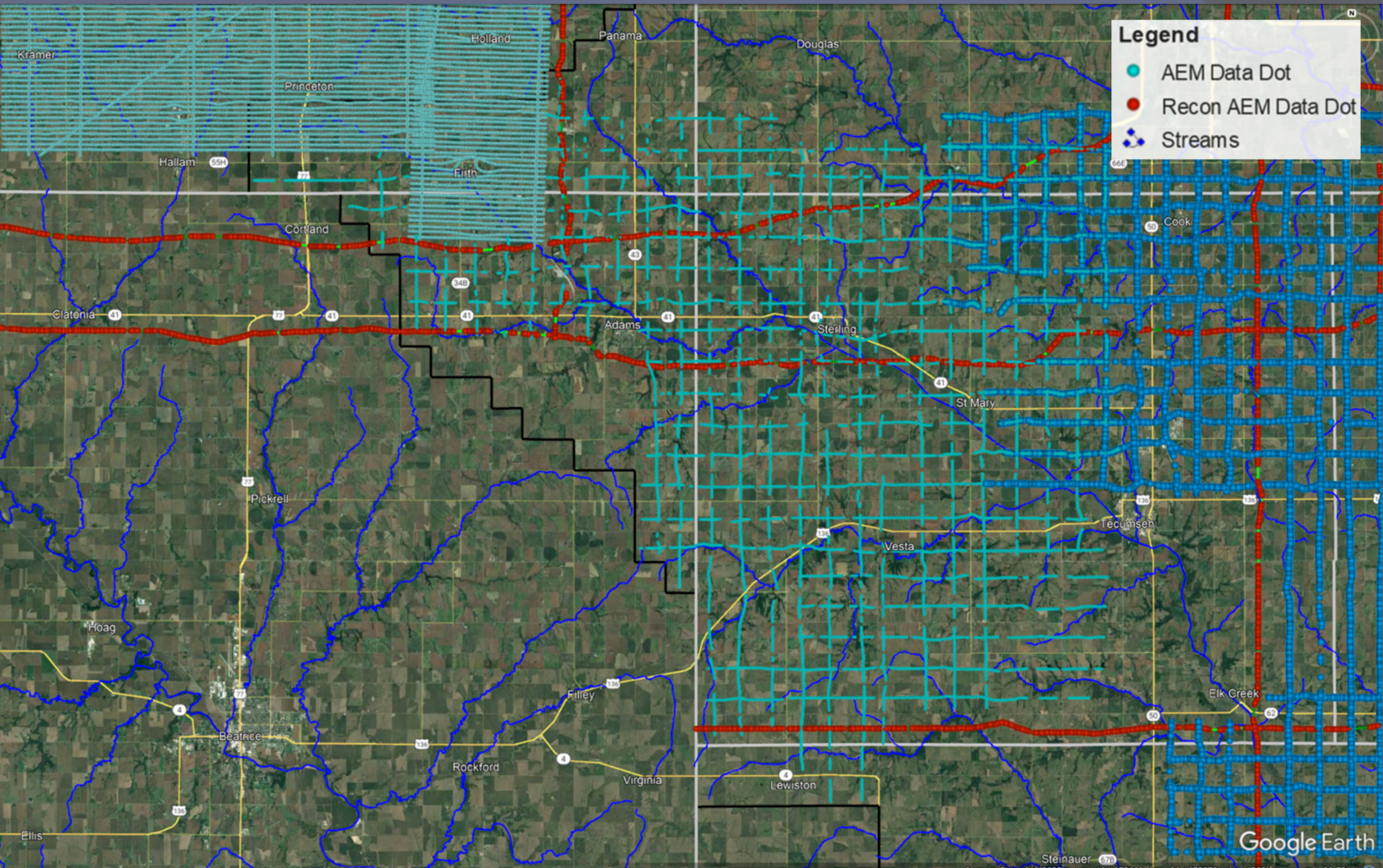
Yellow = aquifer

Tan = marginal aquifer

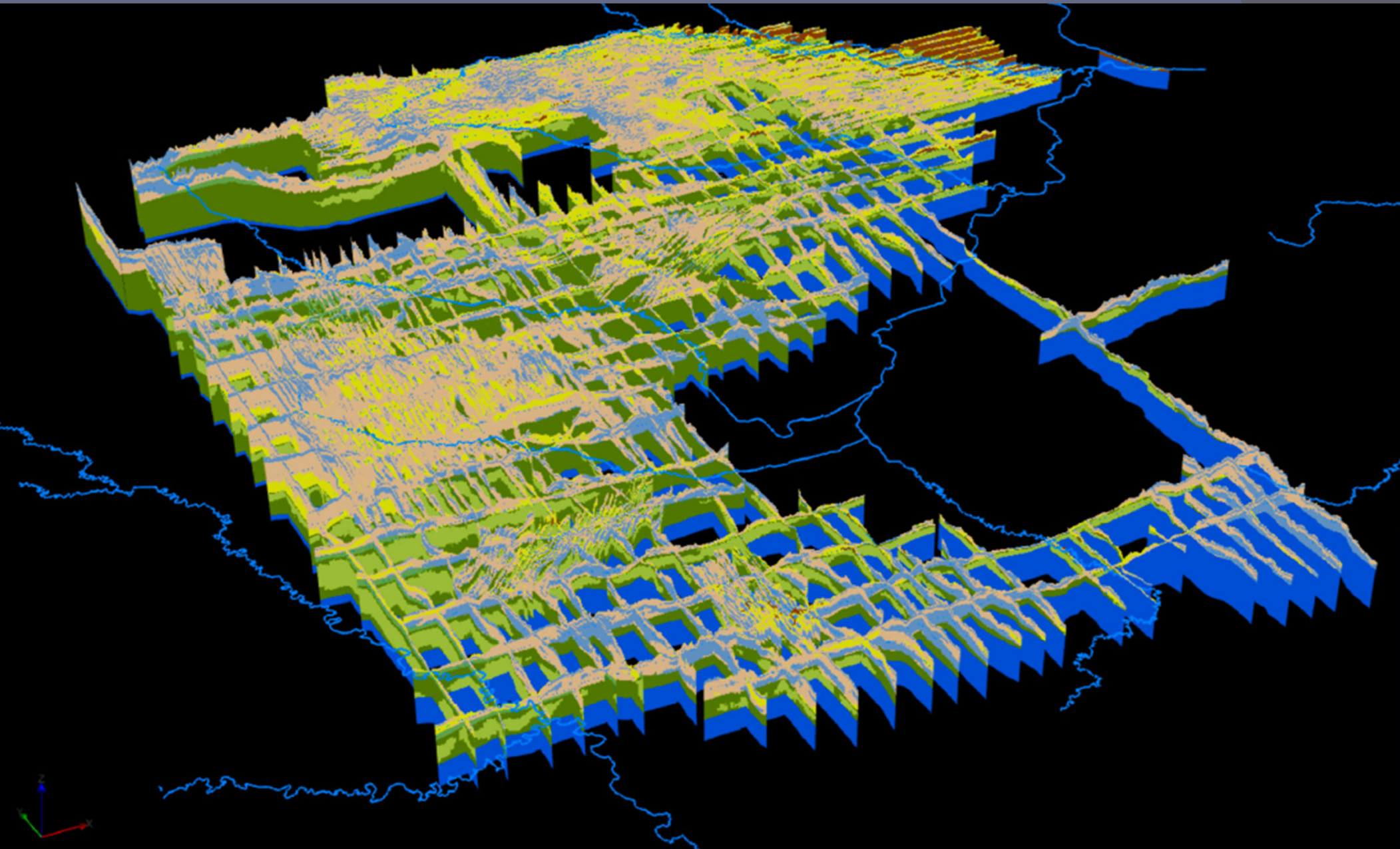
Blue = non-aquifer material

Resistivity thresholds based on 58+ ground truth borehole and geophysical logs assessed from across the ENWRA area

Google Earth datasets on enwra.org



Example 3D Fence Results



Example Block Flight Results

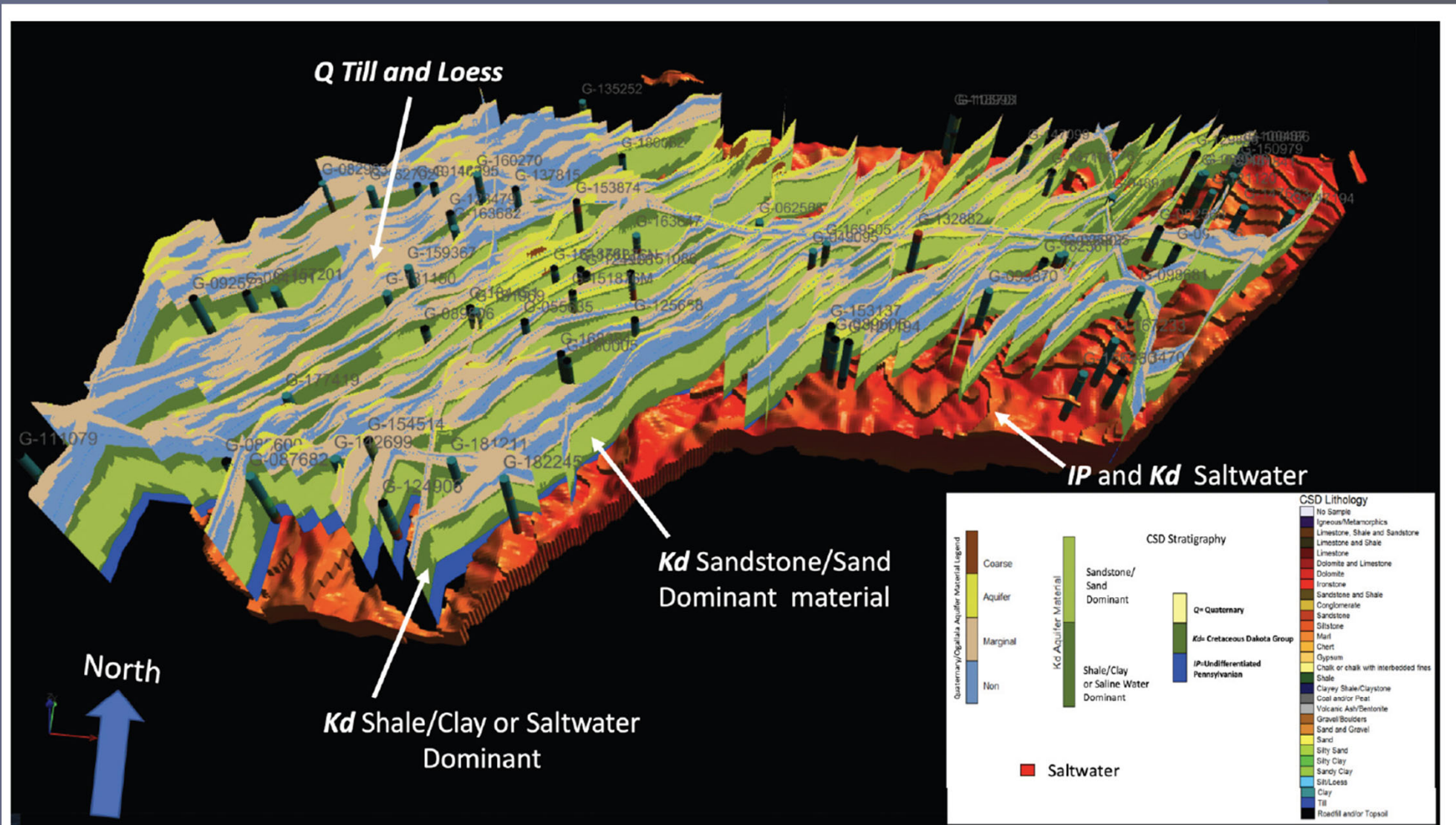


Figure 3-237. 3D voxel model looking north showing the saltwater areas (red) in the Emerald Pleasant Dale Block. A fence diagram of all Q,

Salt water in Dakota

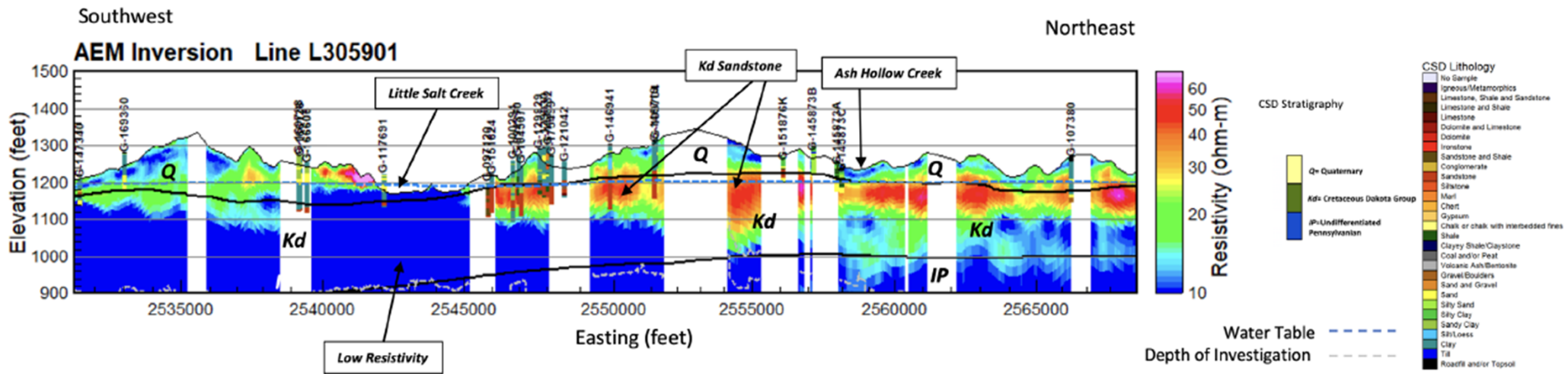
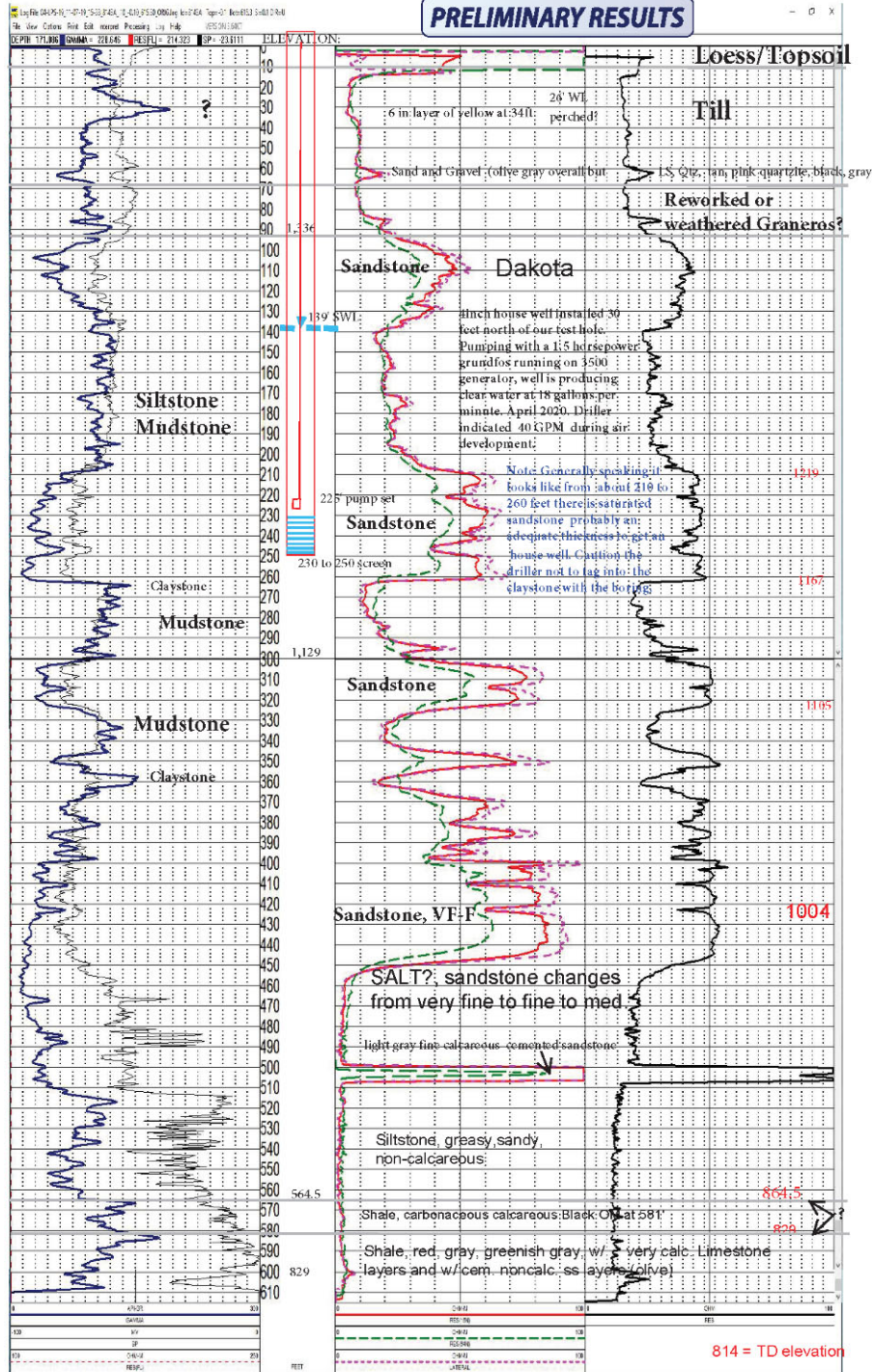


Figure 3-11. 8-mile-long southwest-northeast line, L305901. Nebraska DNR borehole lithology logs are indicated on the AEM inverted earth models if they are within ¼ mile of the flight line. Interpretations of the top geologic units are indicated by the black lines. Gaps indicate areas removed due to coupling. Projection is North American Datum of 1983 (NAD 83) State Plane Nebraska (feet) and the elevation values are referenced to the North American Vertical Datum of 1988 (NAVD 88).

04-LPS-19 (40.837372, -96.963116) 1429 ELEV 615' TD

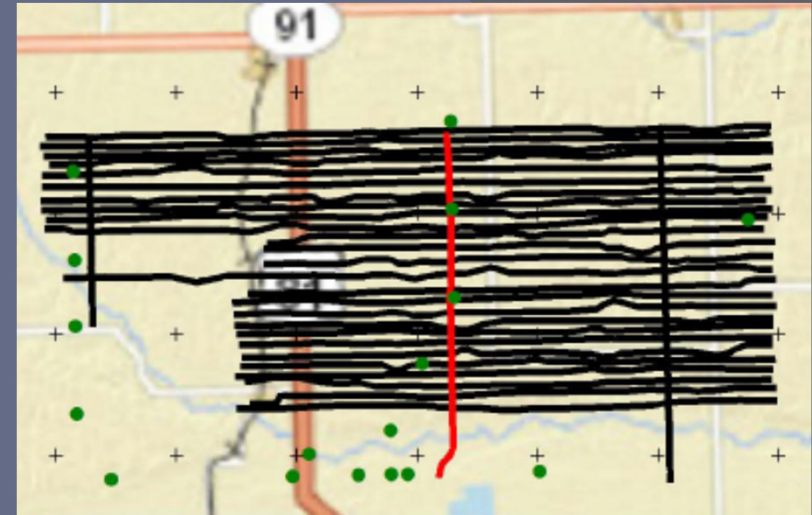
PRELIMINARY RESULTS



- Cautioned the driller not to tag into the claystone with the boring advancement
- April 2020: 4-inch house well installed 30 feet north of our test hole. Pumping with a 1.5 horsepower grundfos running on 3500 generator, well is producing clear water at 18 gallons per minute. Driller indicated 40 GPM during air development.

Groundwater Quantity

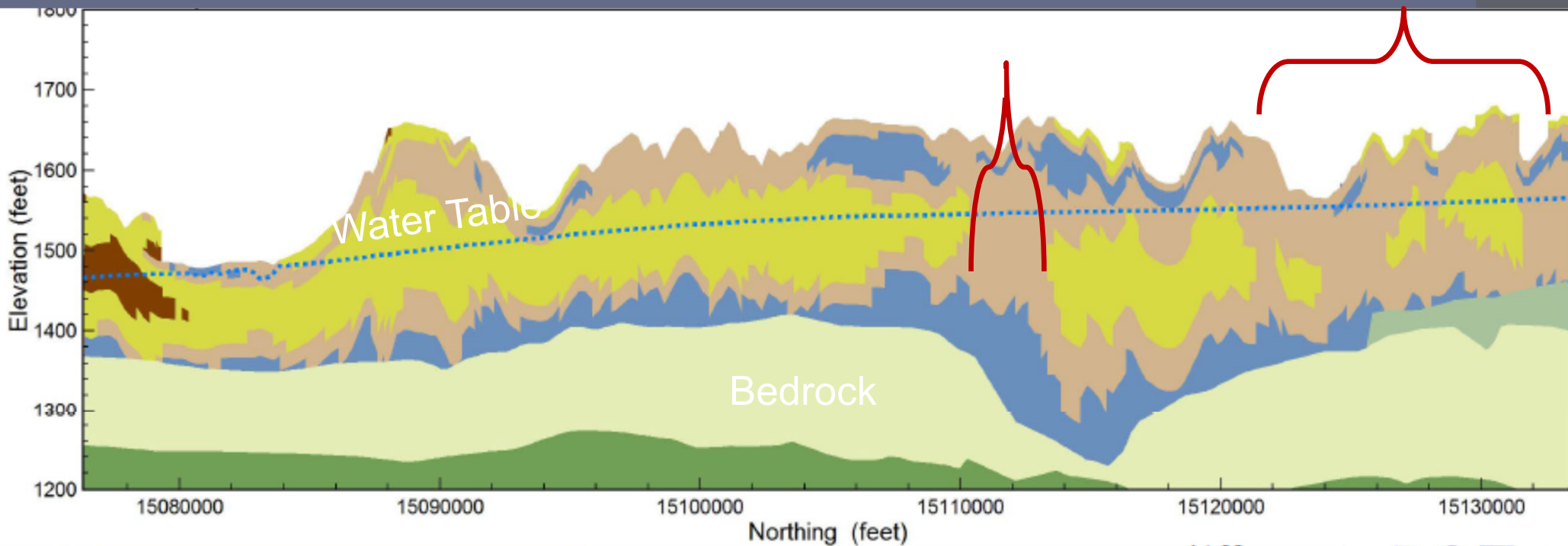
Where are the most likely areas for well interference to occur?



Isolated areas
of aquifer
material

SOUTH

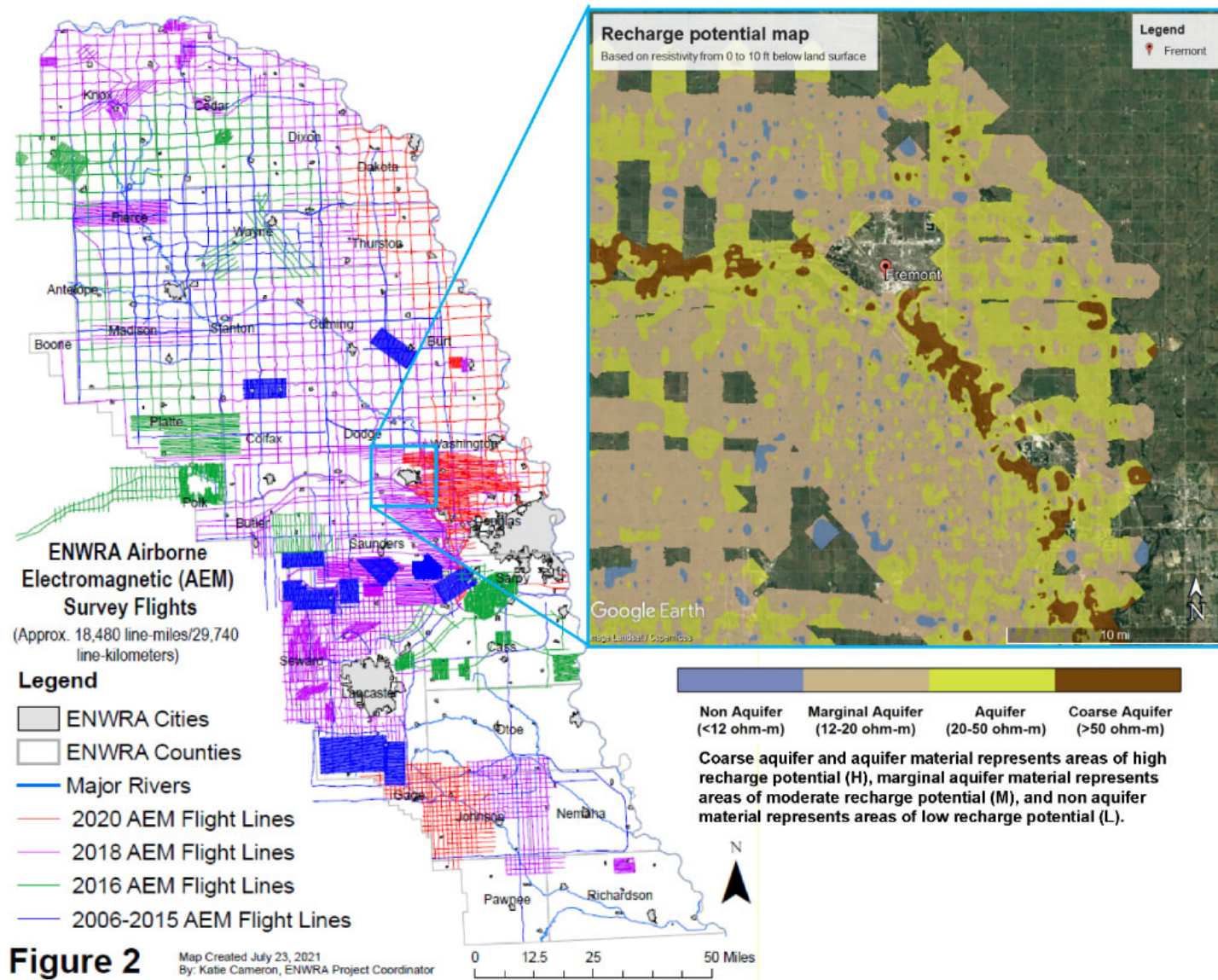
NORTH



WSF #5312

- ENWRA Recharge and Focus Areas
- 3 Phase collaborative effort with the ENWRA NRDs, UNL-CSD and the U.S. Geological Survey
- Phase 1 will focus on the entire ENWRA region and AEM with NWIS
- Phase 2 - Focus Area Work - better than 1995 Water Contours
- Phase 3 - Regional Recharge Map Refinements, Report and Recommendations

ENWRA \$240,000 project with the USGS and CSD: \$144k WSF award, \$74k USGS Cooperative Dollars, \$96k ENWRA local funds



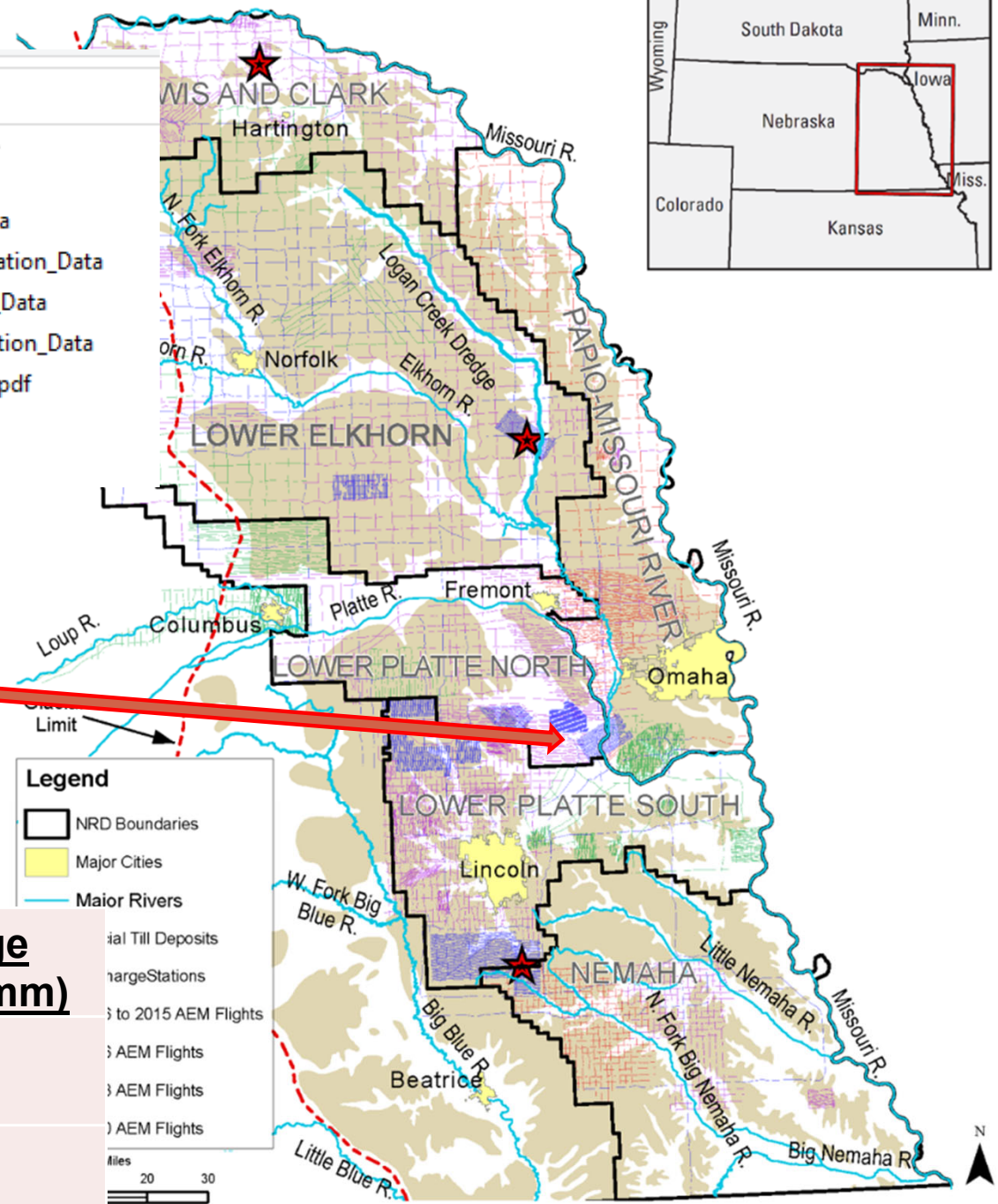
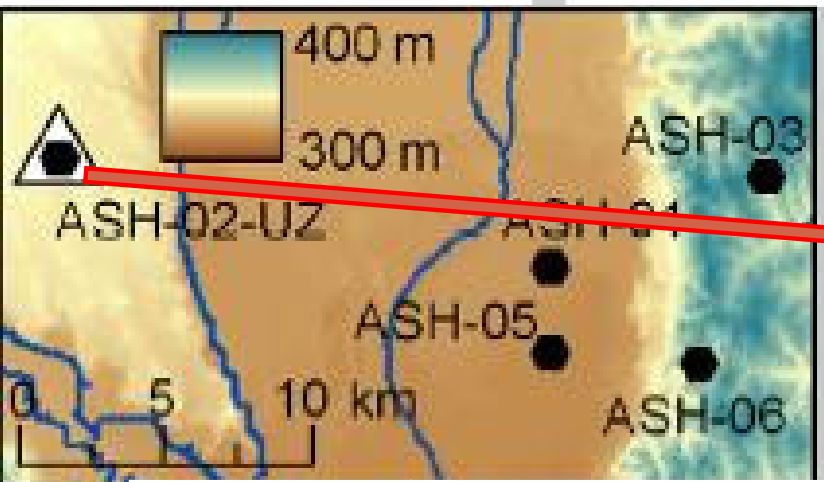
Recharge

ENWRA STUDY AREA



Dropbox > ENWRA_WaterLevelandSamplingData

- ENWRA_Quality_Data
- ENWRA_RechargeStation_Data
- ENWRA_Transducer_Data
- ENWRA_WeatherStation_Data
- ENWRA_Well_Maps.pdf



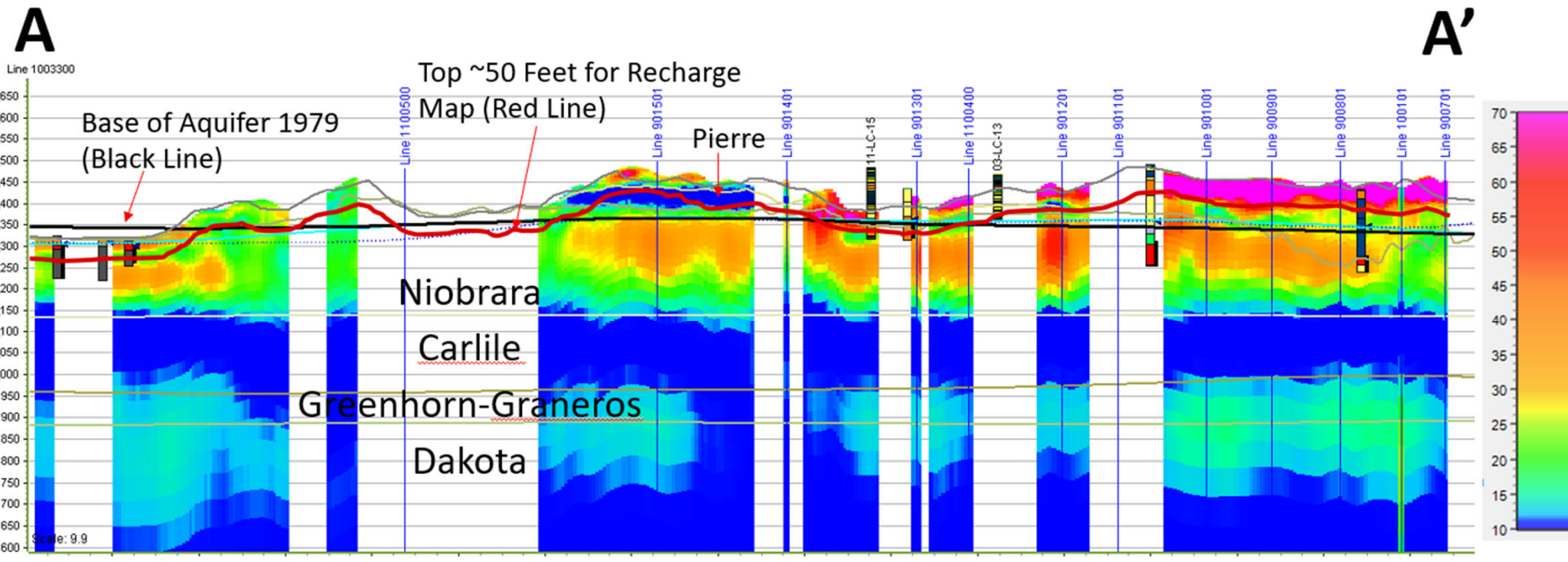
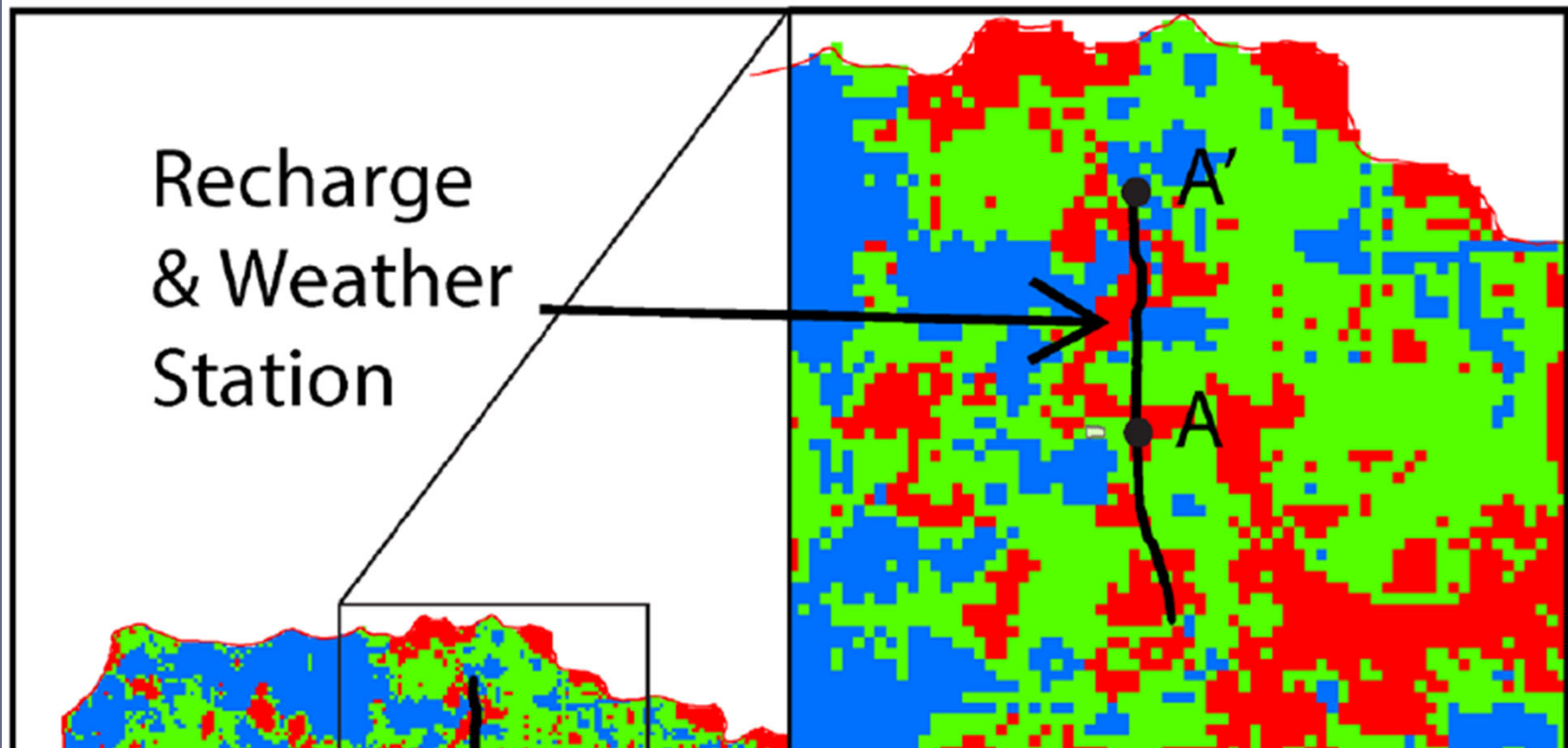
Legend

- NRD Boundaries
- Major Cities
- Major Rivers

Special Till Deposits
 Recharge Stations
 2015 to 2015 AEM Flights
 2016 AEM Flights
 2017 AEM Flights
 2018 AEM Flights

Scale: 0, 20, 30 Miles

Well	Time Period	Recharge Amount (mm)
USGS MUD-95	6/16-3/17	233
USGS Valley	6/16-3/17	404



Nebraska GeoCloud Access & Standards

UNIVERSITY of NEBRASKA-LINCOLN

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N School of Natural Resources
CONSERVATION AND SURVEY DIVISION



About CSD

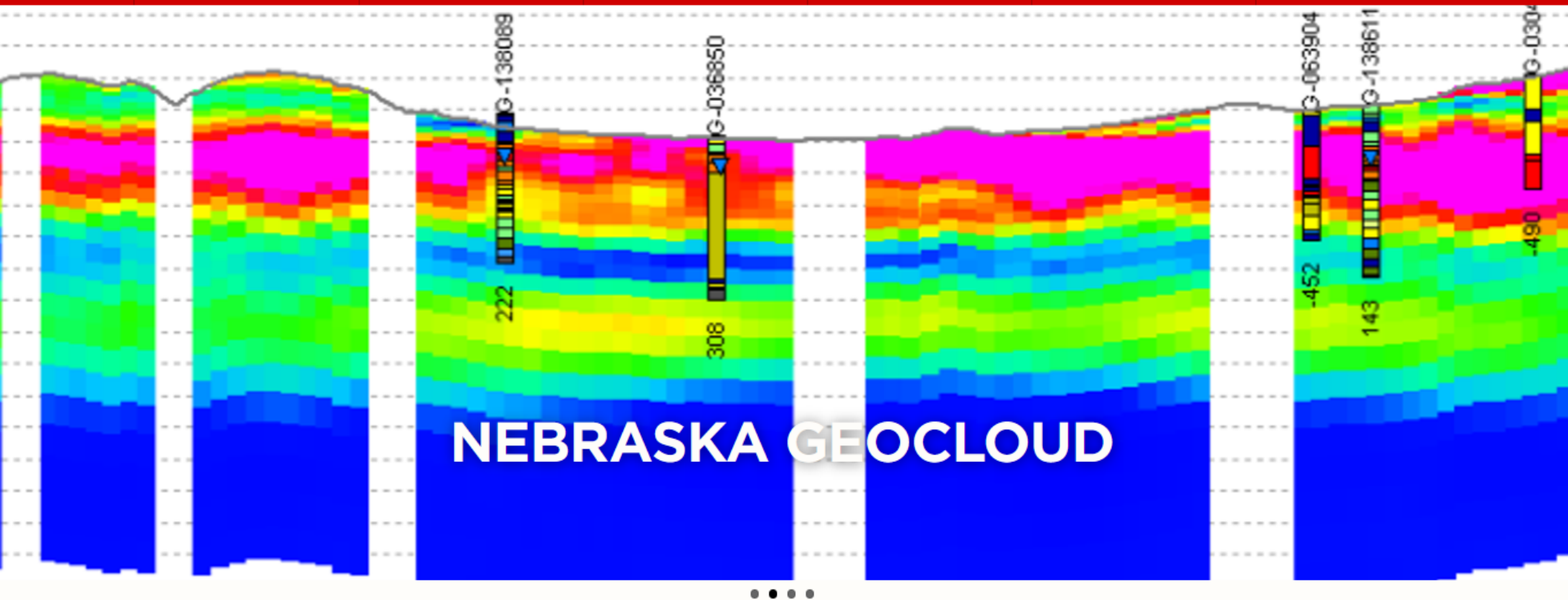
Geology

Water

Soils & Landscapes

GIS

Interactive Data Map



The Nebraska GeoCloud (NGC) is a web-based digital platform for geophysical, geological, and groundwater data and models. The purpose of the NGC is to archive Nebraska's vast volume of data and make it accessible to both model builders and model users. The NGC consists of databases, web servers, and web interfaces designed for data storage, sharing, and distribution. It contains one interface for [Projects](#) and another interface for [Data](#). [Projects](#) may include software files, reports, and other information related to a project. It can be used to store and share project files, or it can be used as the final repository for completed projects. The [Data](#) interface is built upon structured databases that support the upload and download of data and models used in typical hydrogeological studies. Users can access the data contained in this part of the NGC via the GeoScene3D data portal. These data can also be viewed on an interactive web map and they are accessible via a web map service (WMS) in GIS programs (e.g. ArcGIS, QGIS). To request a user account to the NGC, please contact Jesse Korus at jkorus3@unl.edu.

Request User Access

Nebraska Geocloud Projects

Nebraska Geocloud Data

Nebraska GeoCloud Data Map & Upload

<https://youtu.be/Fs4OsWJQhe8>

GeoCloud - Nebraska

Maps Administration Help kcameron_enwra@lpsnrd.org

Get WMS For Data

Data Type: 2D Models

Service Type: OWS (WMS & WFS)

Copy Link

Toggle All

Only Data in Extent

Groups Data Order

Search

Surveys	37
2D Grids	180
3D Grids	2
Boreholes	33
Points	3
Logs	1
Shapefiles	18
WMS Data	0
WMS Temporary	+

GeoCloud - Nebraska

Maps Administration Help kcameron_enwra@lpsnrd.org

Home

Home

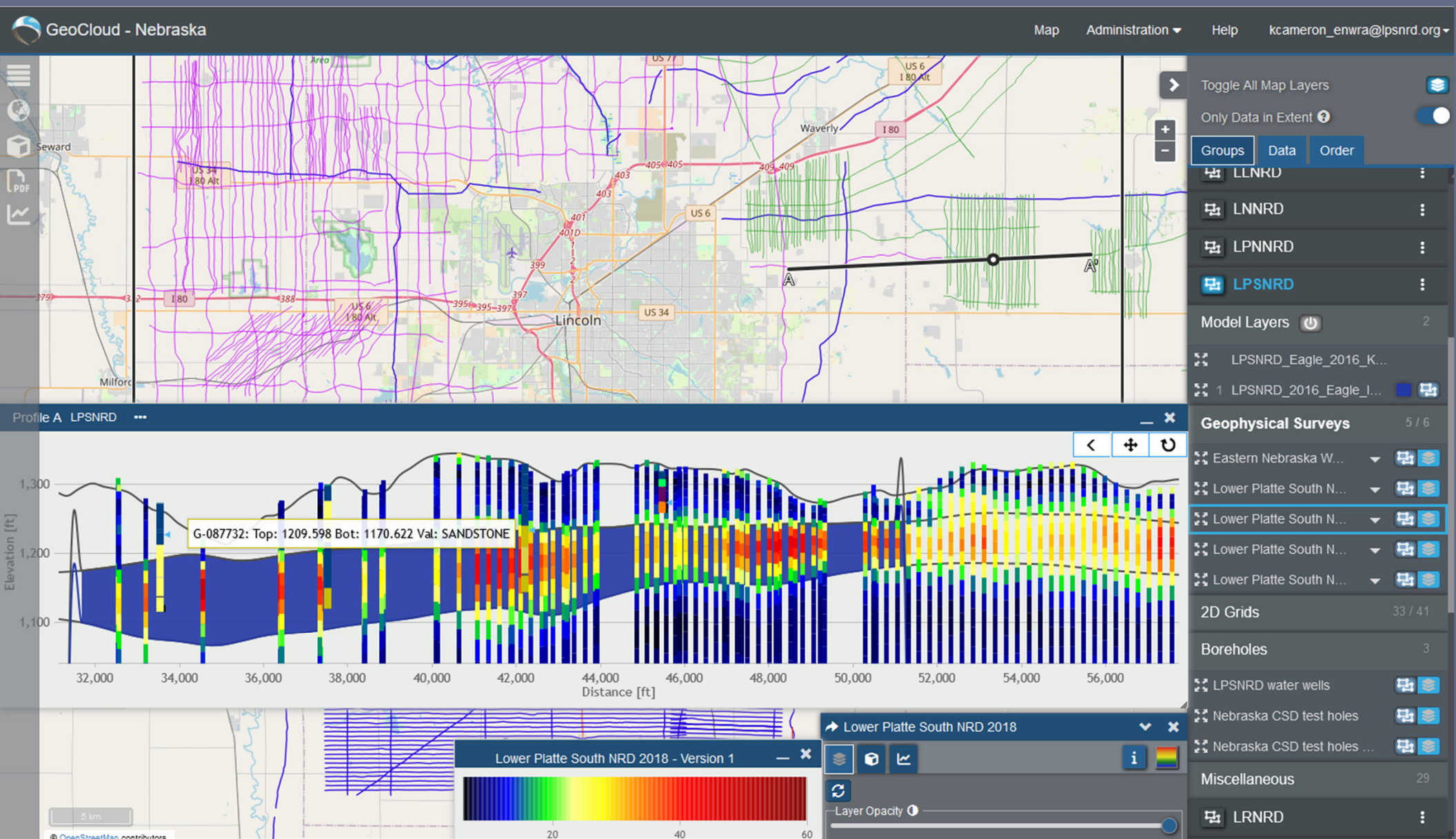
Data

File Upload

Materials

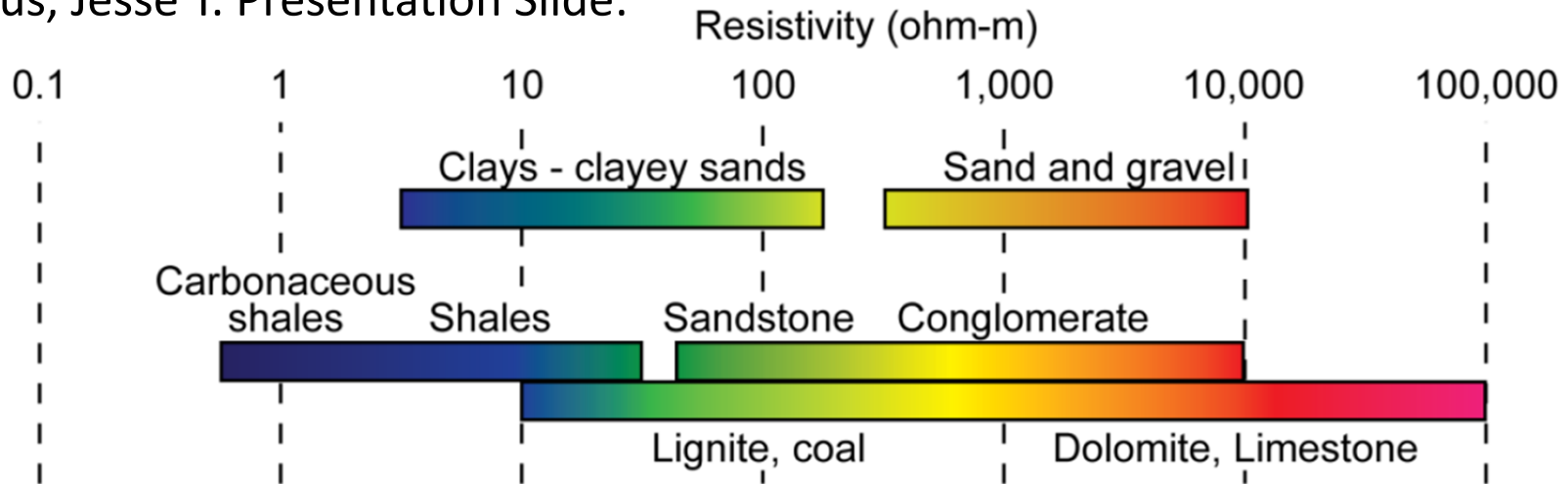
Nebraska GeoCloud

<https://news.unl.edu/newsrooms/today/article/california-turns-to-nebraska-know-how-on-aquifer-analysis-groundwater/>



Resistivity ranges of rocks & sediments

Korus, Jesse T. Presentation Slide:

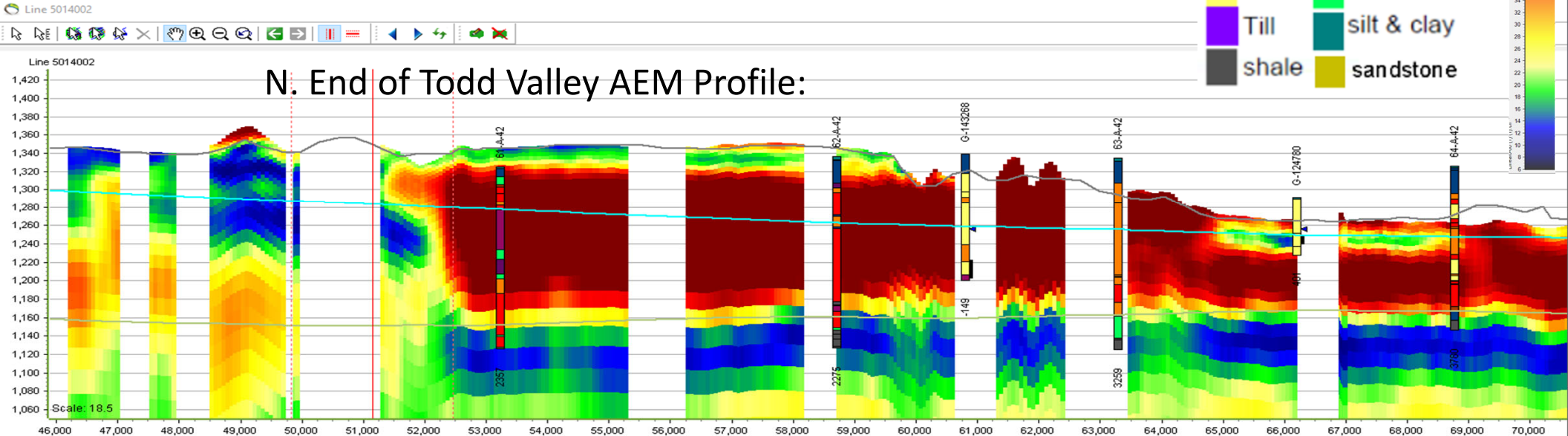


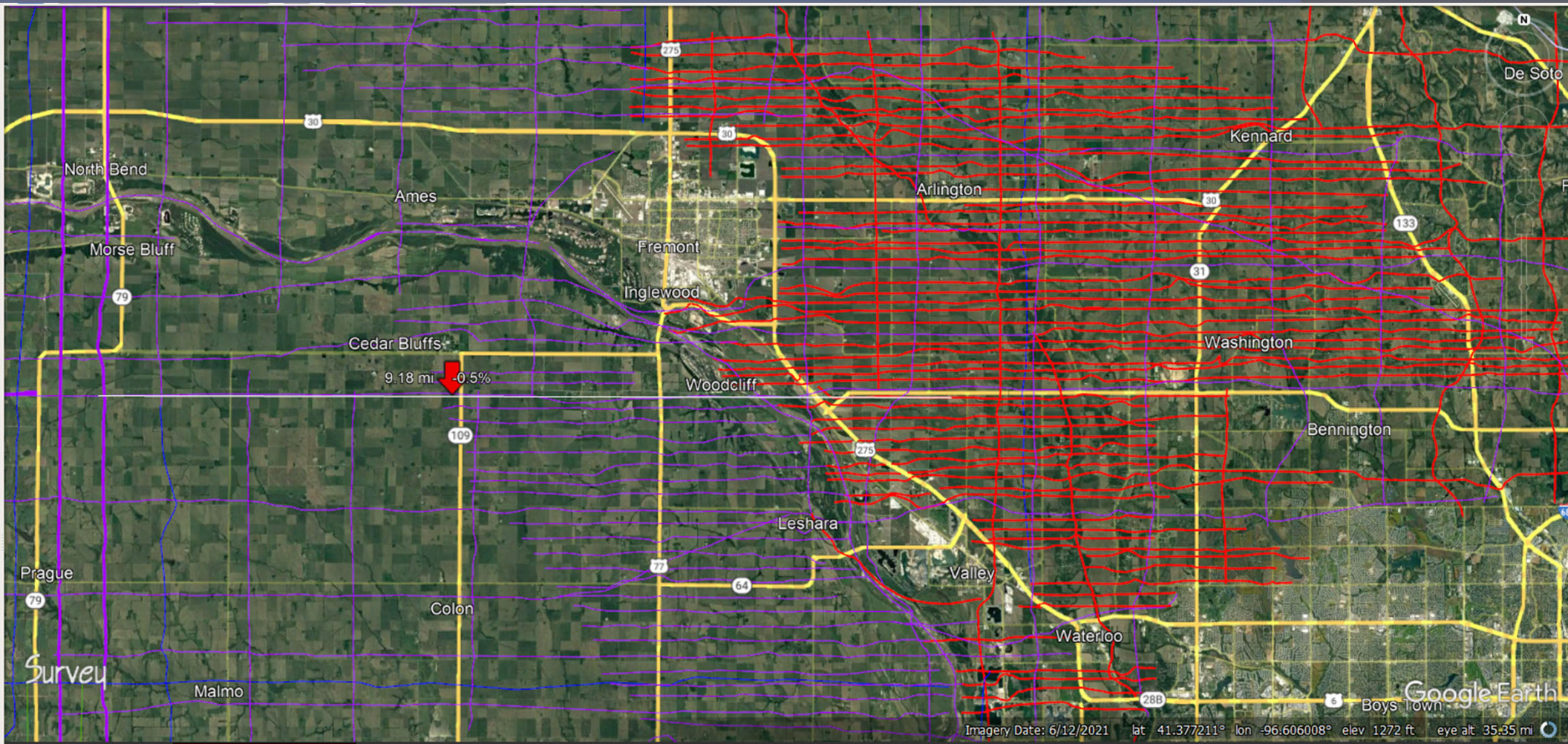
Common resistivity ranges of sediments and sedimentary rocks (after Palacky, 1988)



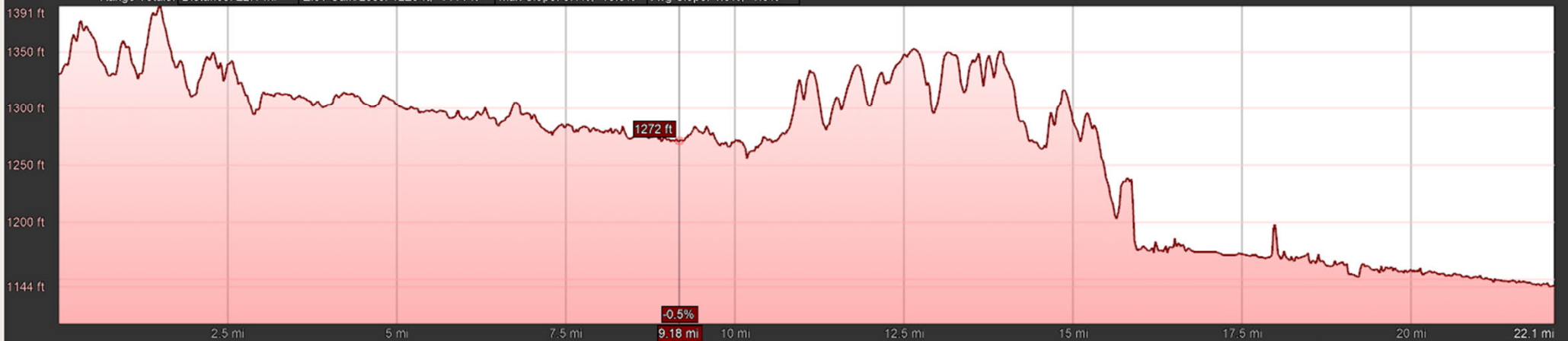
Log Materials:

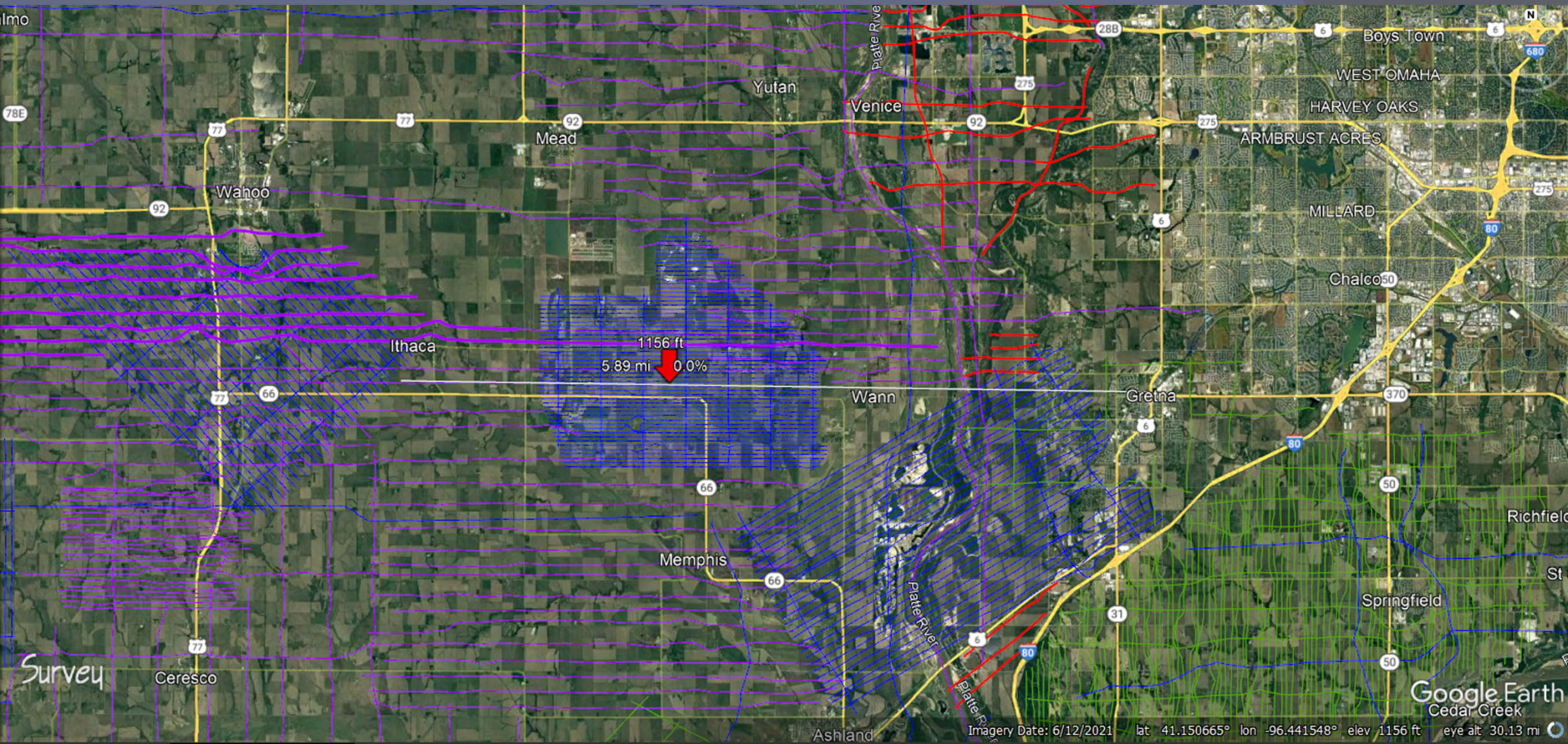
- clay
- sand & gravel
- gravel
- sand & clay
- sand
- clay & sand
- Till
- silt & clay
- shale
- sandstone



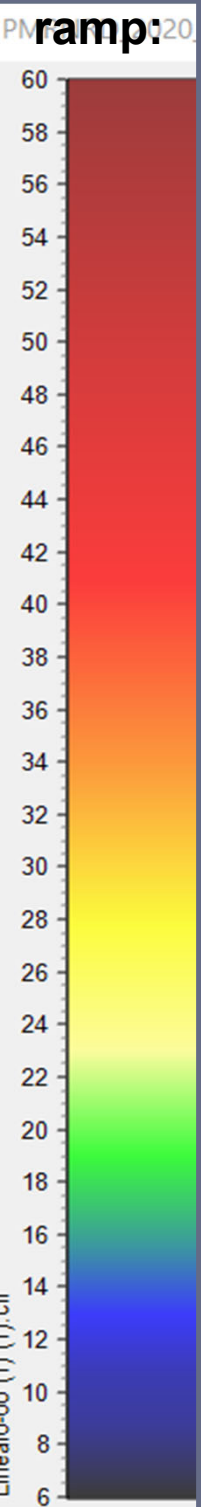


Graph: Min, Avg, Max Elevation: 1144, 1265, 1391 ft
 Range Totals: Distance: 22.1 mi Elev Gain/Loss: 1225 ft, -1411 ft Max Slope: 8.1%, -13.3% Avg Slope: 1.5%, -1.5%





AEM color ramp:20



- fill
- fill and soil
- fill and clay
- fill and silt
- fill and sand
- fill and gravel
- soil and fill
- soil
- soil and clay
- soil and silt
- soil and sand
- soil and gravel
- peat
- peat and clay
- peat and gravel
- clay and fill
- clay and soil
- clay and peat
- clay
- clay and till
- clay and silt
- clay and sand
- clay and gravel
- till and clay
- till
- silt and fill
- silt and soil
- silt and clay
- silt
- silt and sand
- silt and gravel
- sand and fill
- sand and soil
- sand and clay
- sand and silt
- sand
- sand and gravel
- gravel and fill
- gravel and soil
- gravel and clay
- gravel and till

- gravel and silt
- gravel and sand
- gravel
- coal and sand
- coal and ash
- clay and claystone
- claystone and clay
- claystone
- claystone and sand
- shale and coal
- clay and shale
- shale and clay
- shale
- sand and shale
- shale and sand
- shale and sandstone
- gravel and shale
- shale and gravel
- shale and limestone
- shale and chert
- clay and siltstone
- siltstone and clay
- siltstone and claystone
- silt and siltstone
- siltstone
- sand and siltstone
- siltstone and sand
- siltstone and sandstone
- gravel and siltstone
- siltstone and gravel

- sandstone and soil
- clay and sandstone
- sandstone and clay
- sandstone and shale
- silt and sandstone
- sandstone and silt
- sandstone and siltstone
- sand and sandstone
- sandstone and sand
- sandstone
- sandstone and gravel
- gravel and sandstone
- sandstone and limestone
- sandstone and chert
- conglomerate and gravel
- clay and limestone
- limestone and clay
- limestone and shale
- silt and limestone
- sand and limestone
- limestone and sand
- limestone and sandstone
- gravel and limestone
- limestone and gravel
- limestone
- limestone and ash
- limestone and chert
- clay and ash
- ash
- clay and chert
- chert and clay
- chert and shale
- chert
- no result

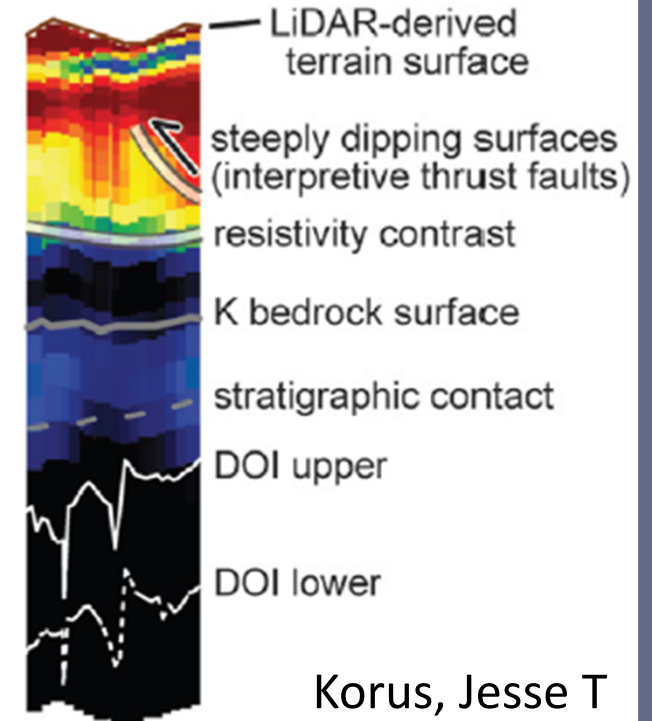
GeoCloud

Logged Materials Legend:

Well Log Legend:

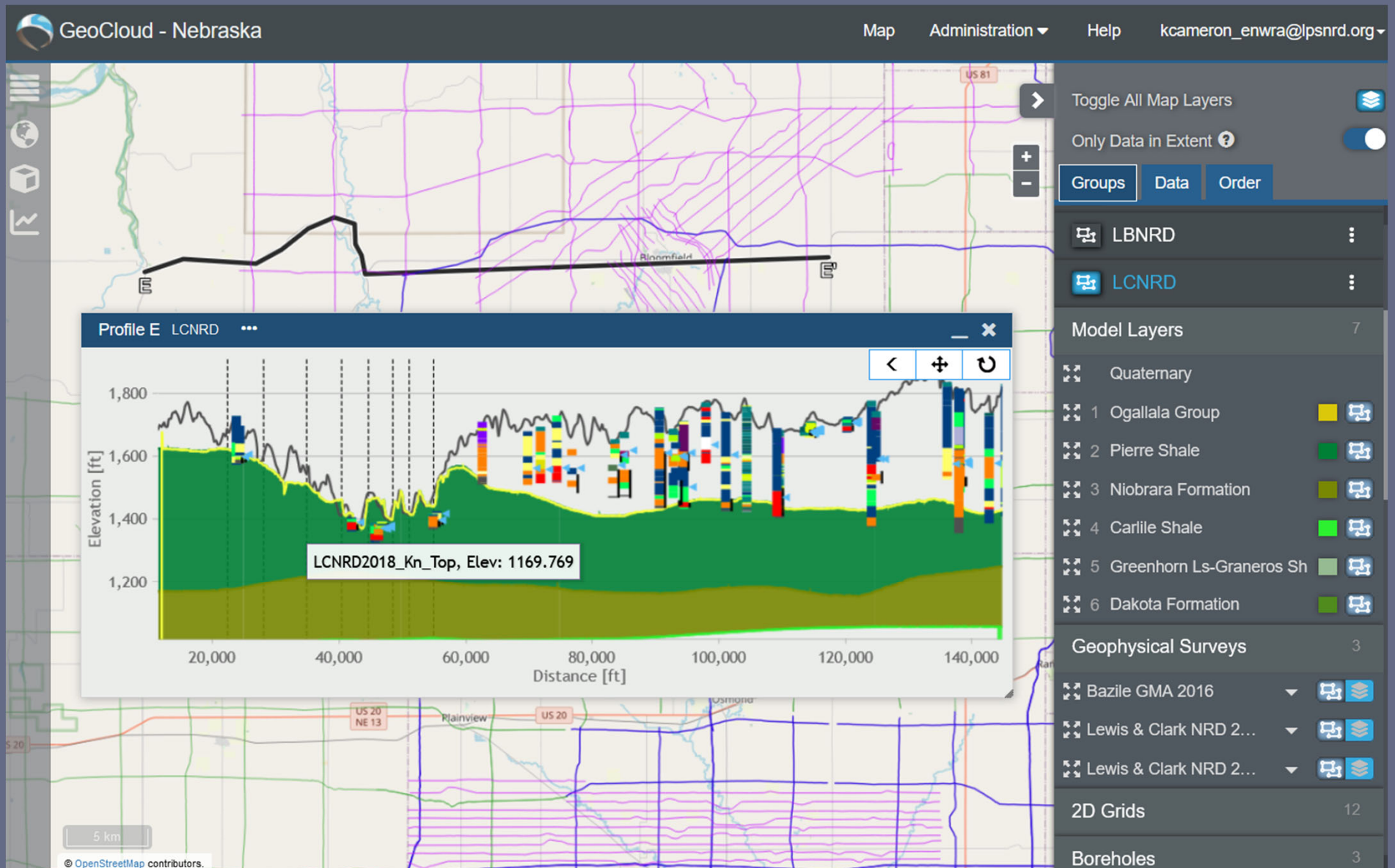
- SILT_silt
- CLAY_
- SAND AND CLAY_
- SAND_sand
- SAND AND GRAVEL_
- GRAVEL_
- SANDSTONE_
- CLAY AND SHALE_

profile overlays



Korus, Jesse T

Nebraska GeoCloud



Nebraska GeoCloud Enhancements

GeoCloud - Nebraska

Maps Help jesse.korus@gmail.com

LLNRD

Tools Measure Navigation Fly speed: 1287.7 Point budget: 6.0M Vertical Scale: 5

Adjust the size and position of the cut

Toggle All

Only Data in Extent

Groups Data Order

LLNRD

Surveys 1

1: Lower Loup NRD 20

2D Grids 7

LLNRD2019_Kp_Top

LLNRD2019_Q_Aquif_...

LLNRD2019_Q_Aquif_...

LLNRD2019_Q_Non_M...

LLNRD2019_Q_Non_M...

LLNRD2019_To_Non_...

Nebraska 90 m DEM

3D Grids 0

Boreholes 3

LLNRD water wells

Nebraska CSD test holes

Nebraska CSD test hole...

Points 0

Logs

Lower Loup NRD 2019

Toggle Point Cloud

2:00 / 2:30

1:00 / 2:30

Scroll for details

Scroll for details

Nebraska GeoCloud Nebraska Viewer

<https://geoscene3d.com/Download>

The screenshot displays the GeoScene3D Builder interface with the following components:

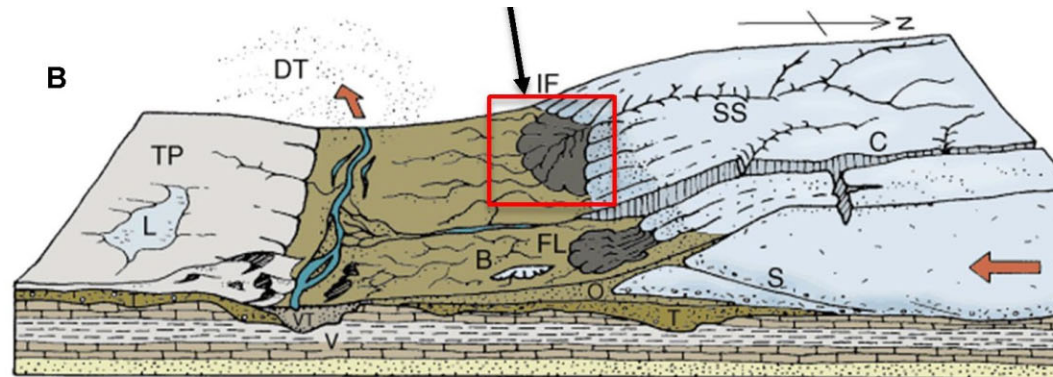
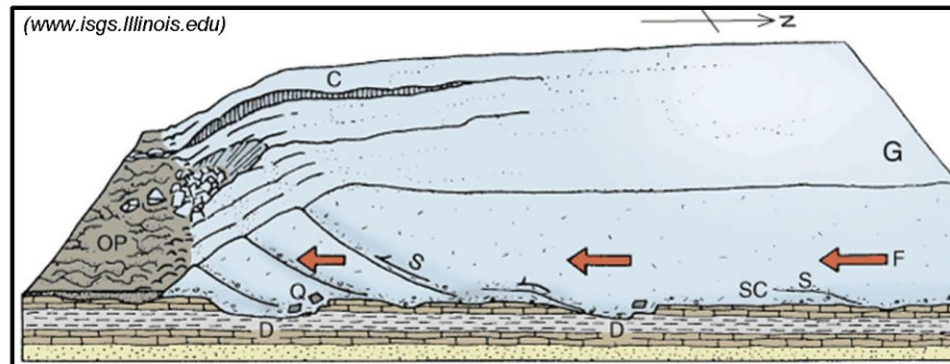
- File Manager:** Shows the project path: C:\Users\kcameron_enwra\Dropbox\2020_AEM_Flights\Papio_Missouri_River_NRD\GeoScene3D_NebraskaGeoCloud_DWLDs\GeoCloudTEST_PMRNRDv2.asmod.(K).
- Object List:** A tree view on the left containing various data layers such as PMRNRD_2020_Profiles, Recon_2015_Profiles, and AEM_Data.
- Legend:** A central legend titled "CSD_Testholes" listing geological units with corresponding color swatches, including: FILL_fill, SOIL_soil, PEAT_peat, CLAY_clay, CLAY AND SILT_clay and silt, CLAY AND SAND_clay and sand, CLAY AND GRAVEL_clay and gravel, TILL_till, SILT AND CLAY_silt and clay, SILT_silt, SILT AND SAND_silt and sand, SILT AND GRAVEL_silt and gravel, SAND AND CLAY_sand and clay, SAND AND SILT_sand and silt, SAND_sand, SAND AND GRAVEL_sand and gravel, GRAVEL AND CLAY_gravel and clay, GRAVEL AND SILT_gravel and silt, GRAVEL AND SAND_gravel and sand, GRAVEL_gravel, CLAYSTONE_claystone, CLAY AND SHALE_clay and shale, SHALE AND CLAY_shale and clay, SHALE_shale, SAND AND SHALE_sand and shale, SHALE AND SAND_shale and sand, SHALE AND SANDSTONE_shale and sandstone, SILTSTONE_siltstone, CLAY AND SANDSTONE_clay and sandstone, SANDSTONE AND CLAY_sandstone and clay, SANDSTONE AND SHALE_sandstone and shale, SILT AND SANDSTONE_silt and sandstone, SANDSTONE AND SILT_sandstone and silt, SAND AND SANDSTONE_sand and sandstone, SANDSTONE AND SAND_sandstone and sand, SANDSTONE_sandstone, SANDSTONE AND GRAVEL_sandstone and gravel, GRAVEL AND SANDSTONE_gravel and sandstone, LIMESTONE_limestone, ASH_ash, and CHERT_chert.
- Line 901100 Cross-section:** A geological profile showing depth (0 to 500) versus distance (0 to 12,000). It features a color-coded stratigraphic column with labels for various geological units and borehole identifiers like G-079765 and G-041847.
- Line 1000801 Cross-section:** A larger geological profile showing depth (0 to 500) versus distance (0 to 55,000). It includes a detailed stratigraphic column and numerous borehole labels such as G-051287, G-041847, G-051908, G-051909, G-051910, G-051911, G-051912, G-051913, G-051914, G-051915, G-051916, G-051917, G-051918, G-051919, G-051920, G-051921, G-051922, G-051923, G-051924, G-051925, G-051926, G-051927, G-051928, G-051929, G-051930, G-051931, G-051932, G-051933, G-051934, G-051935, G-051936, G-051937, G-051938, G-051939, G-051940, G-051941, G-051942, G-051943, G-051944, G-051945, G-051946, G-051947, G-051948, G-051949, G-051950, G-051951, G-051952, G-051953, G-051954, G-051955, G-051956, G-051957, G-051958, G-051959, G-051960, G-051961, G-051962, G-051963, G-051964, G-051965, G-051966, G-051967, G-051968, G-051969, G-051970, G-051971, G-051972, G-051973, G-051974, G-051975, G-051976, G-051977, G-051978, G-051979, G-051980, G-051981, G-051982, G-051983, G-051984, G-051985, G-051986, G-051987, G-051988, G-051989, G-051990, G-051991, G-051992, G-051993, G-051994, G-051995, G-051996, G-051997, 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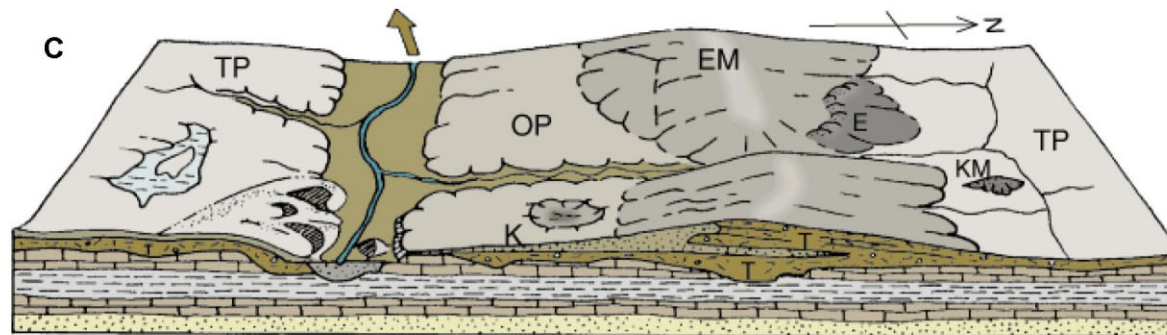
Thank You

Glacial Processes

Figure 3-6 – Schematic diagram showing the “plucking” process of bedrock material within the ice sheet that becomes part of the till deposits in the end and ground moraines.



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Figure 4-13 – Example of possible outwash fan feature in the east block (A) with the glacial margin environment from which these deposits possibly originated (B), and the remnant post-glacial landscape indicating an outwash plain (OP) to the left of the moraine structure (EM). Note that the AEM profile in 23a is facing westward.

Transmissivity of the Aquifers

The Groundwater Atlas of Nebraska



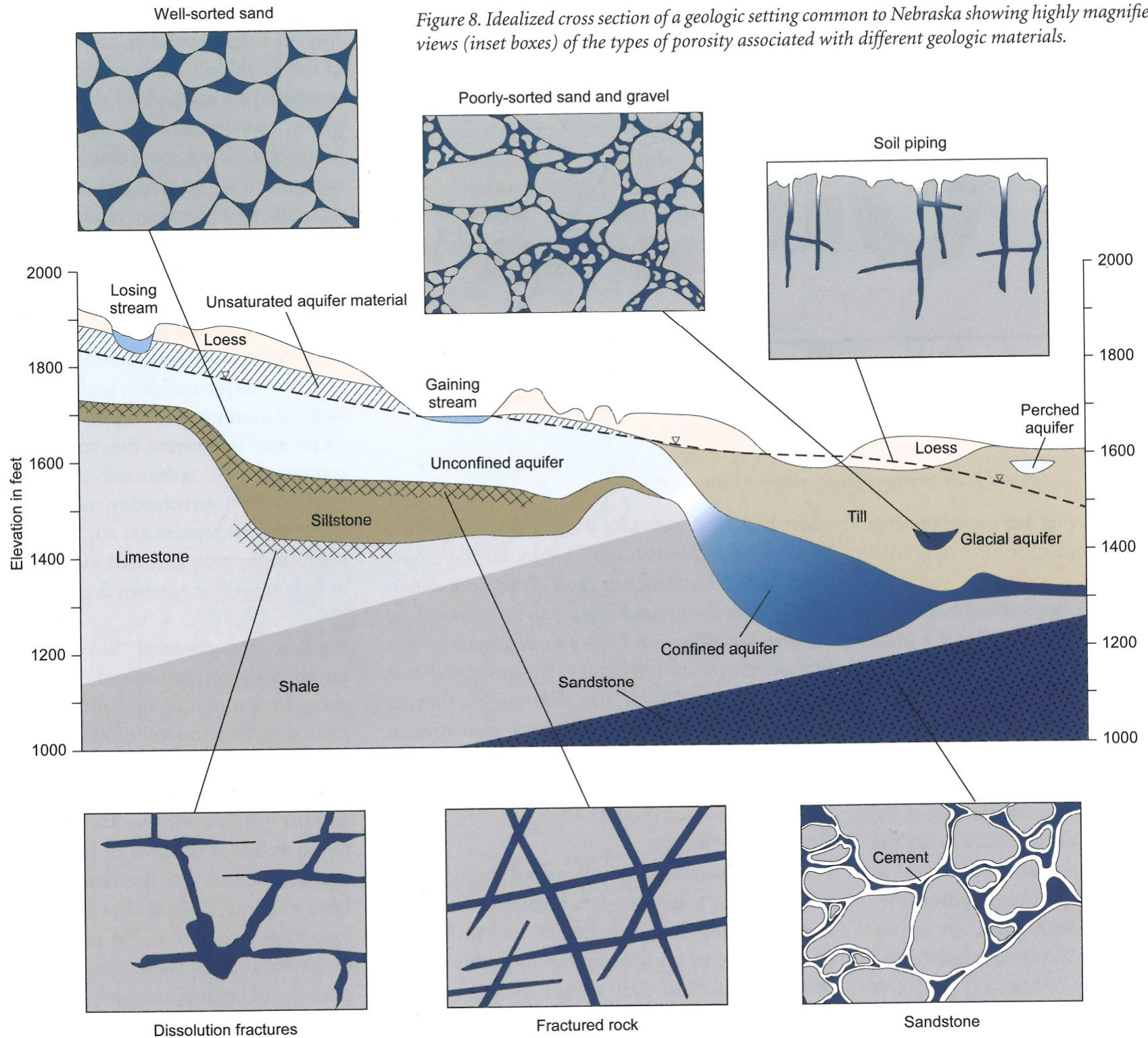
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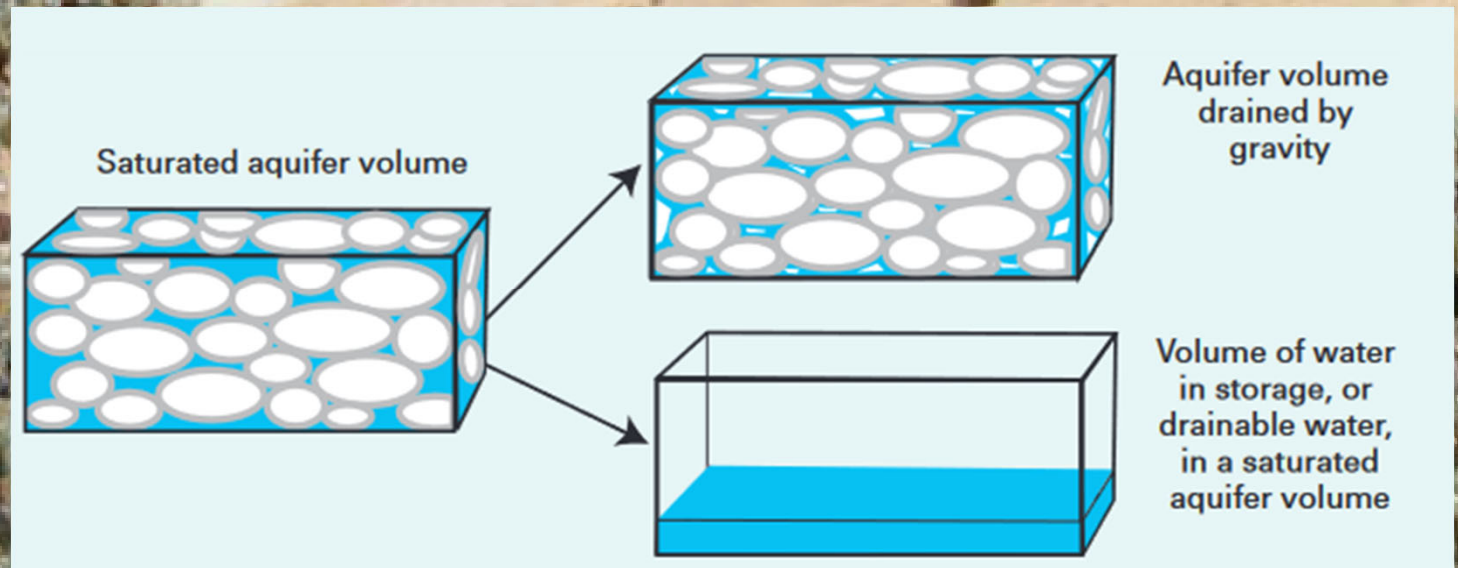


Conservation and Survey Division
School of Natural Resources
Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln

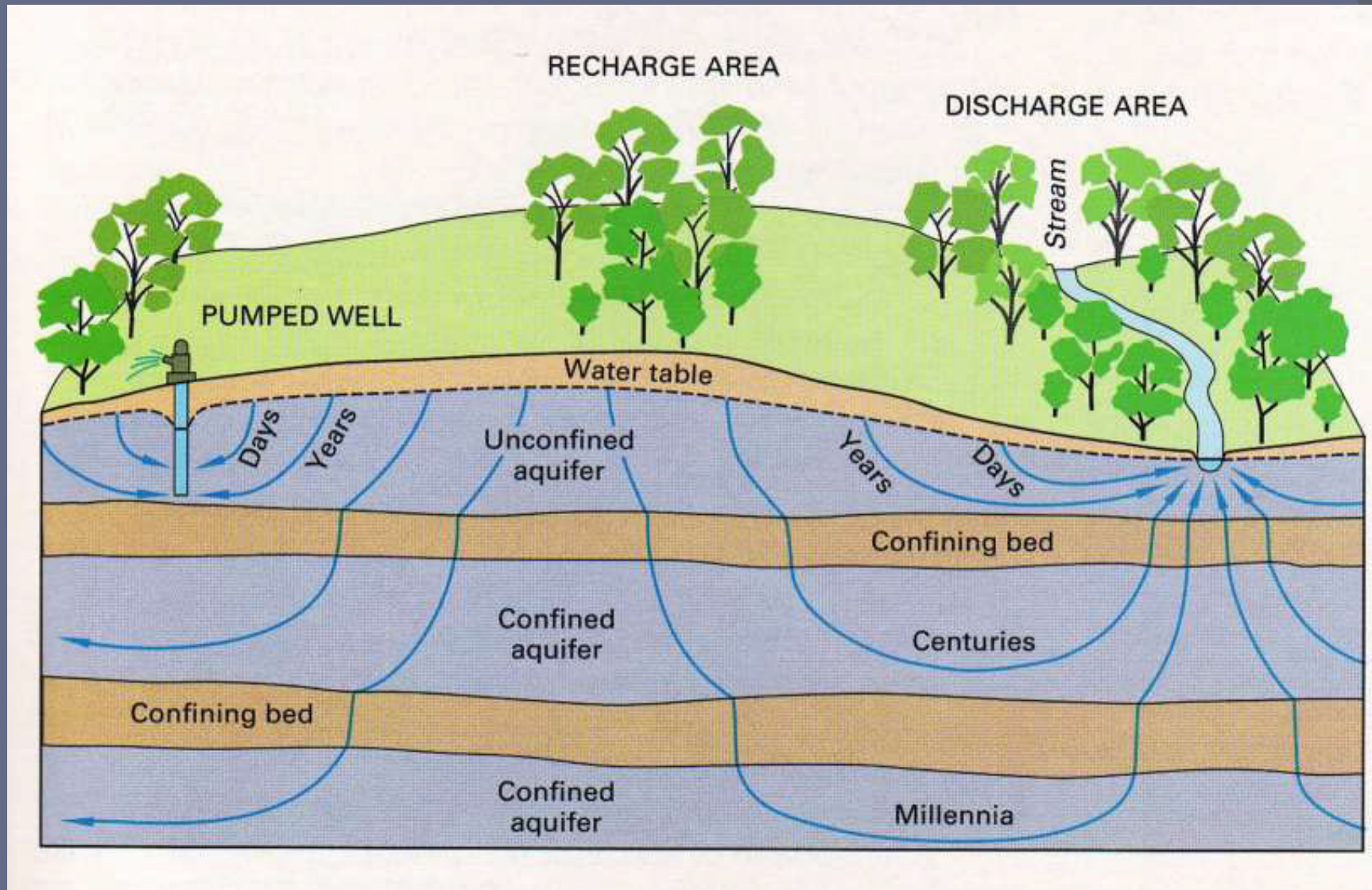




Like a sponge



Aquifer Complexity



New understandings with AEM

