

# Results from the 2018 LPSNRD AEM Survey

LPSNRD Board of Directors Meeting  
December 11, 2019

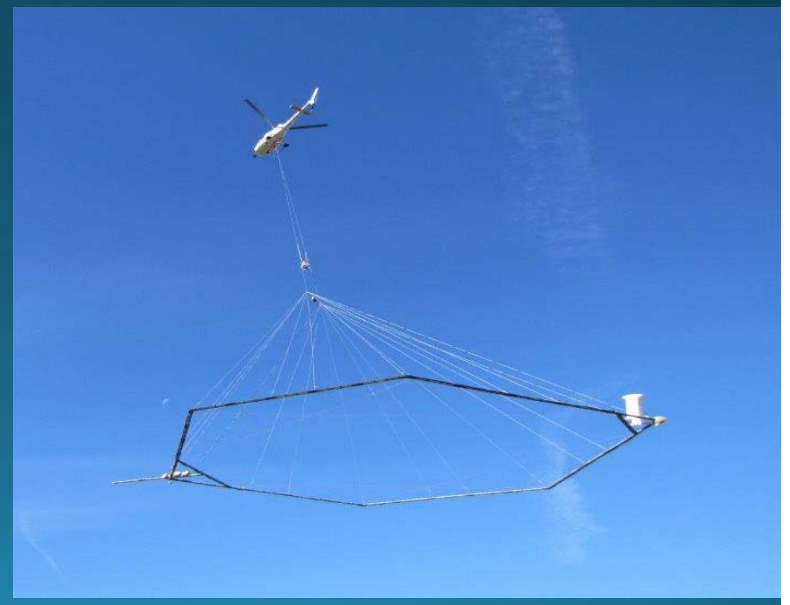
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James C. Cannia, Senior Geologist, PG  
Ted Asch, Research Geophysicist, PG  
Aqua Geo Frameworks, LLC  
Mitchell, NE

# Overview

- What were the objectives for this survey?
- LPSNRD AEM Survey Results
  - Reconnaissance lines
  - Ceresco, Davey Raymond, Denton, Dwight South, Emerald Pleasant Dale and Garland Malcolm Blocks
  - Key Findings
- Questions?

# LPSNRD AEM Survey Objectives



- Improve the Hydrogeologic framework of the LPSNRD
- Provide Reconnaissance Level Profiles and 3D representations of the hydrogeology
- Provide a detailed framework in the Ceresco, Davey Raymond, Denton, Dwight South, Emerald Pleasant Dale and Garland Malcolm Block flight areas
- Investigate extents of glacial aquifer deposits and boundary conditions within the subsurface
- Identify hydrologic connections between various groundwater aquifers and surface water
- Potential of groundwater recharge areas













**Block and Flight Line Locations**

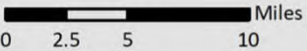
**Legend**

-  Report Boundary
-  Natural Resources District Boundary

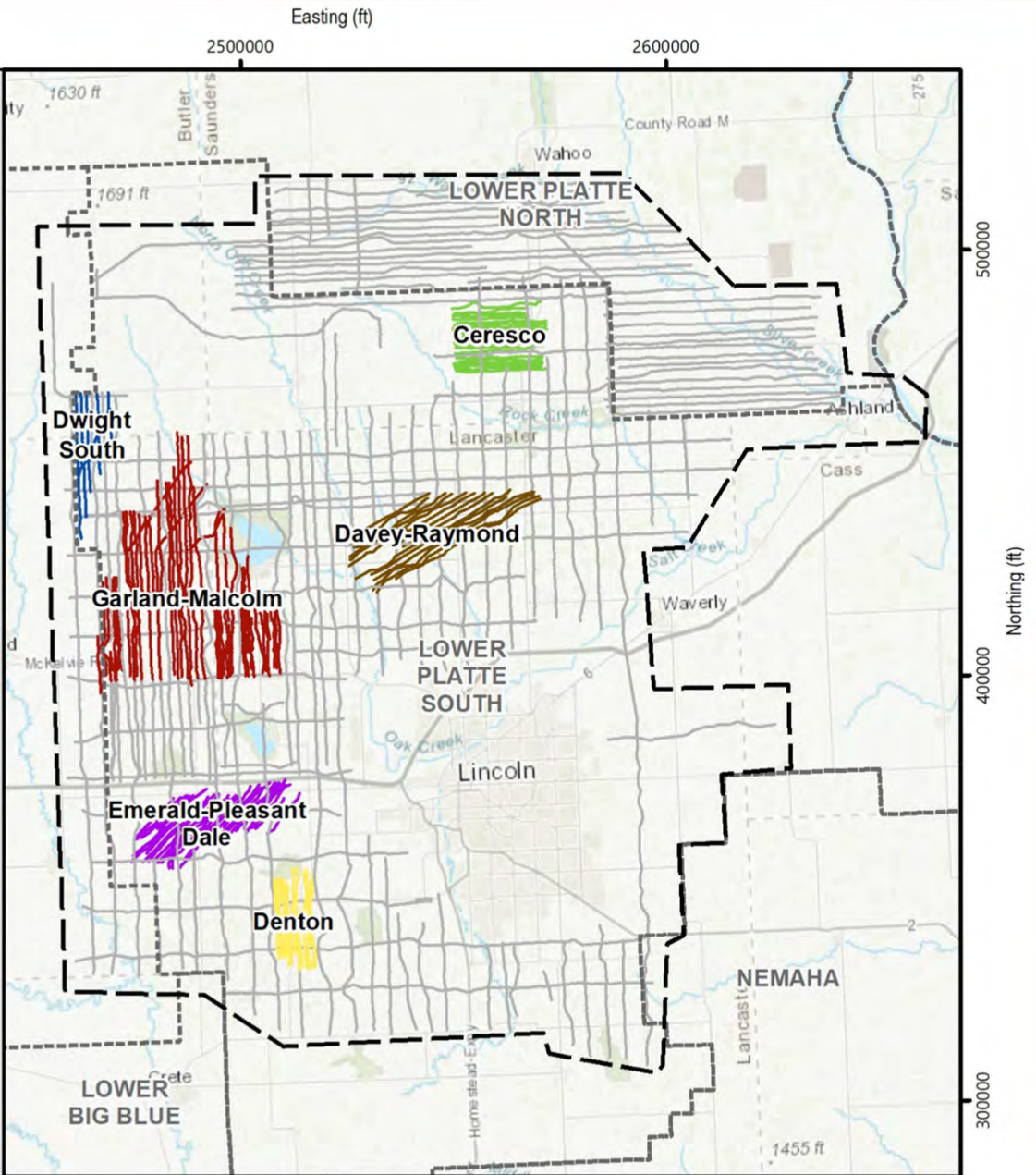
**Flight Lines**

-  2018 Flight Line
-  Ceresco Block
-  Davey-Raymond Block
-  Denton Block
-  Dwight South Block
-  Emerald-Pleasant Dale Block
-  Garland-Malcolm Block



 Miles  
0 2.5 5 10

Map Projection:  
NAD83/State Plane Nebraska, feet

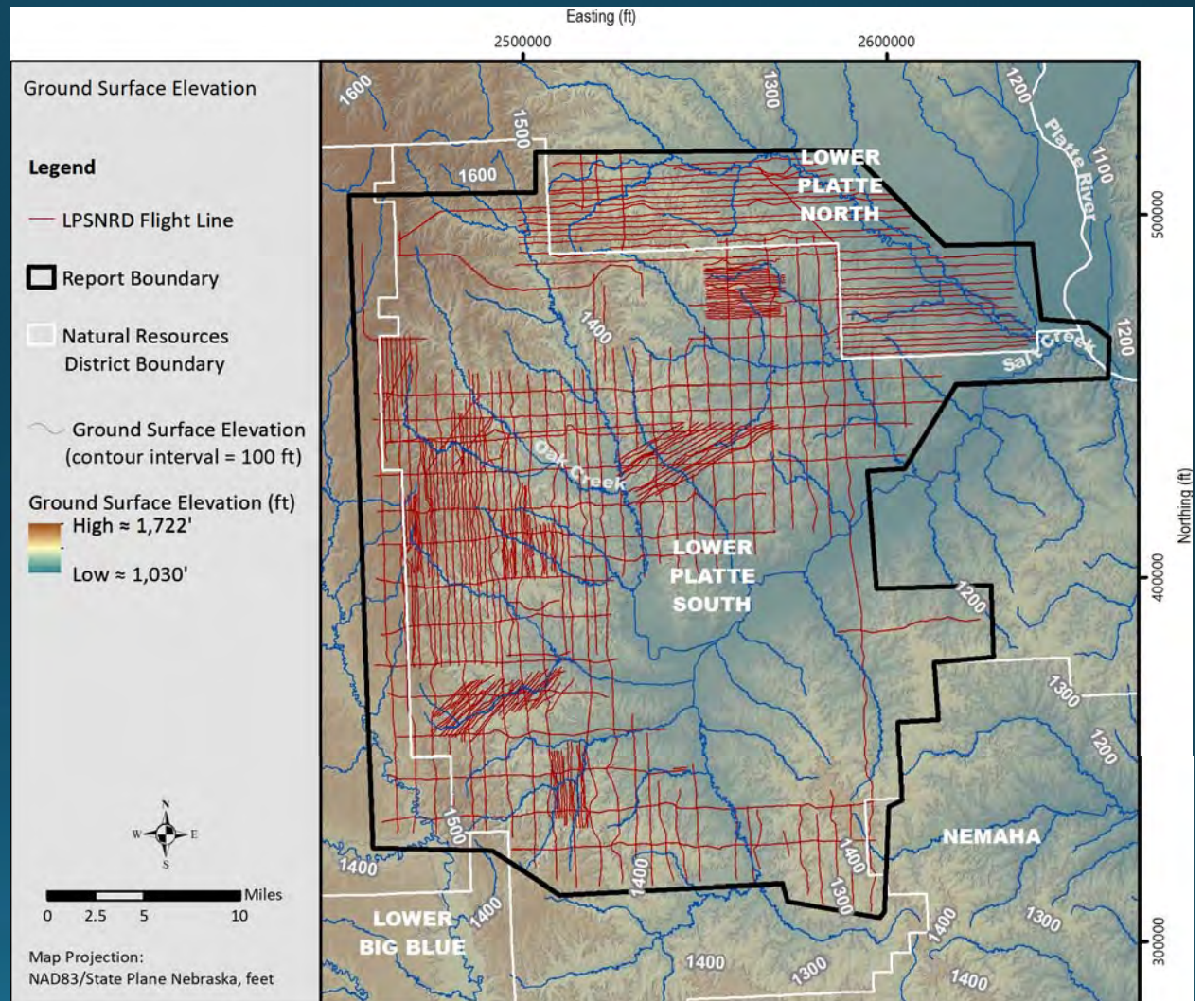






# LPSNRD AEM Survey Area 2018

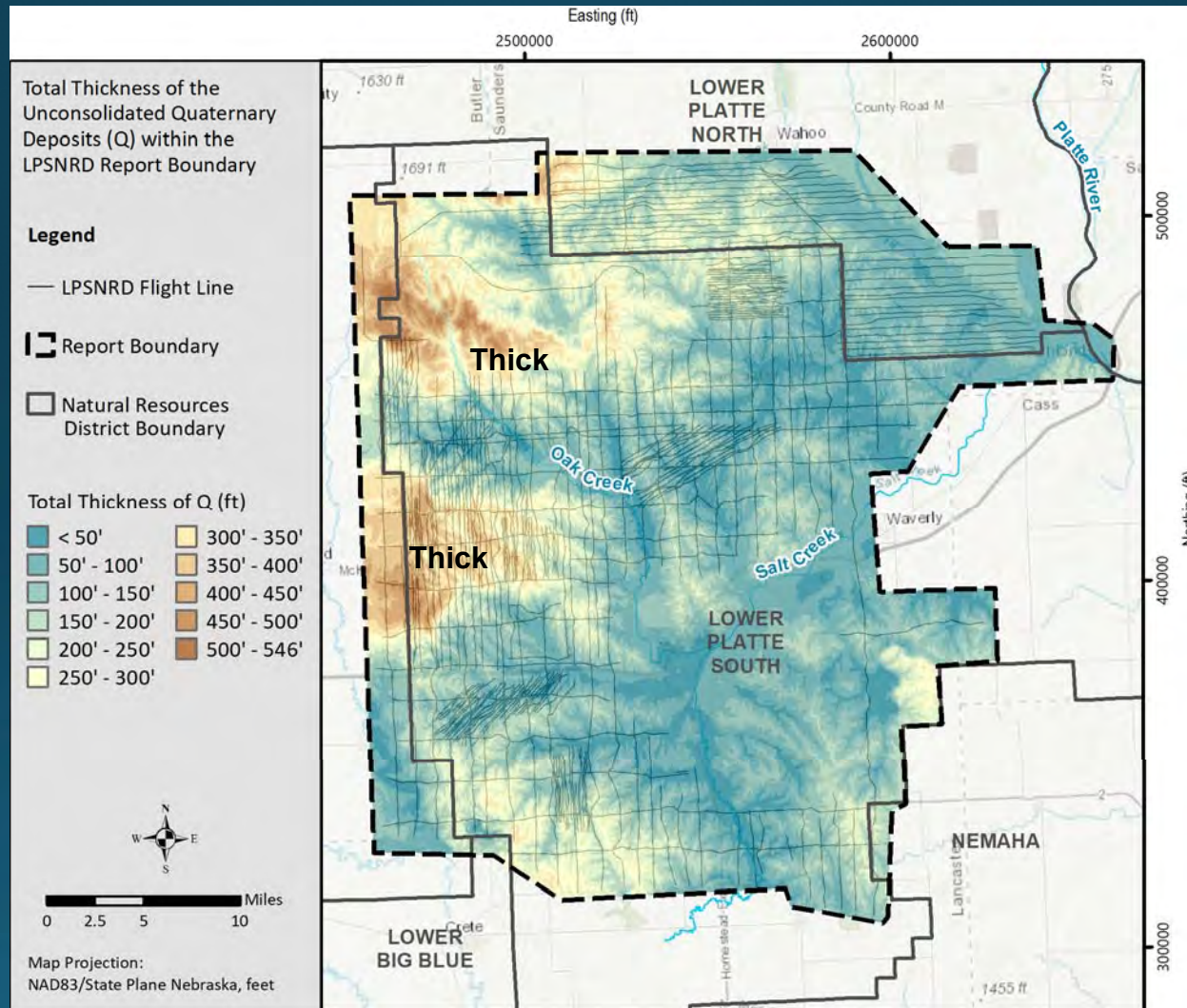
- ~1,990-line miles
- \$850,000 total cost
- 50% additional miles flown due to better price from vendor





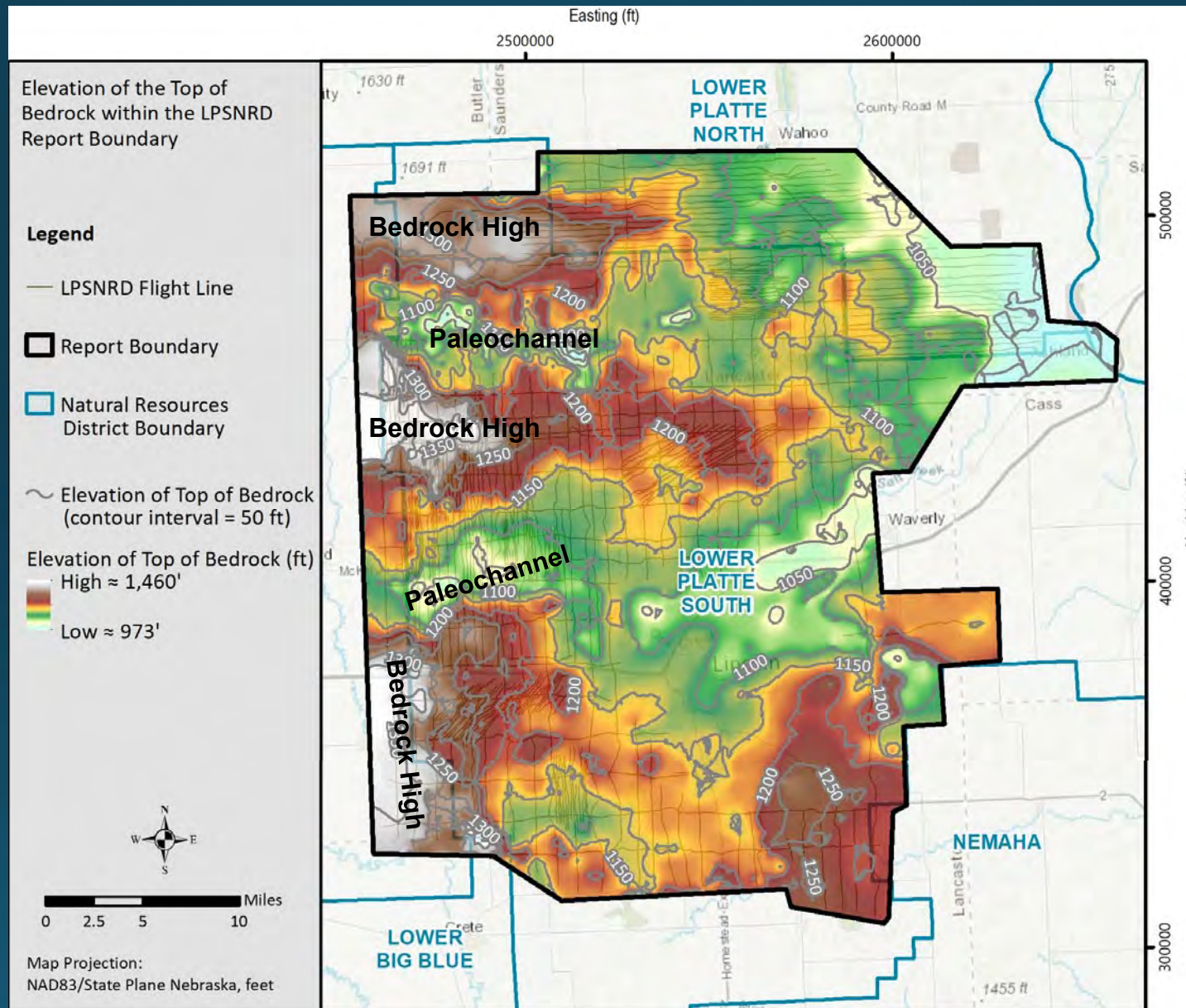


# Saturated Thickness of Quaternary Deposits -Reconnaissance Lines



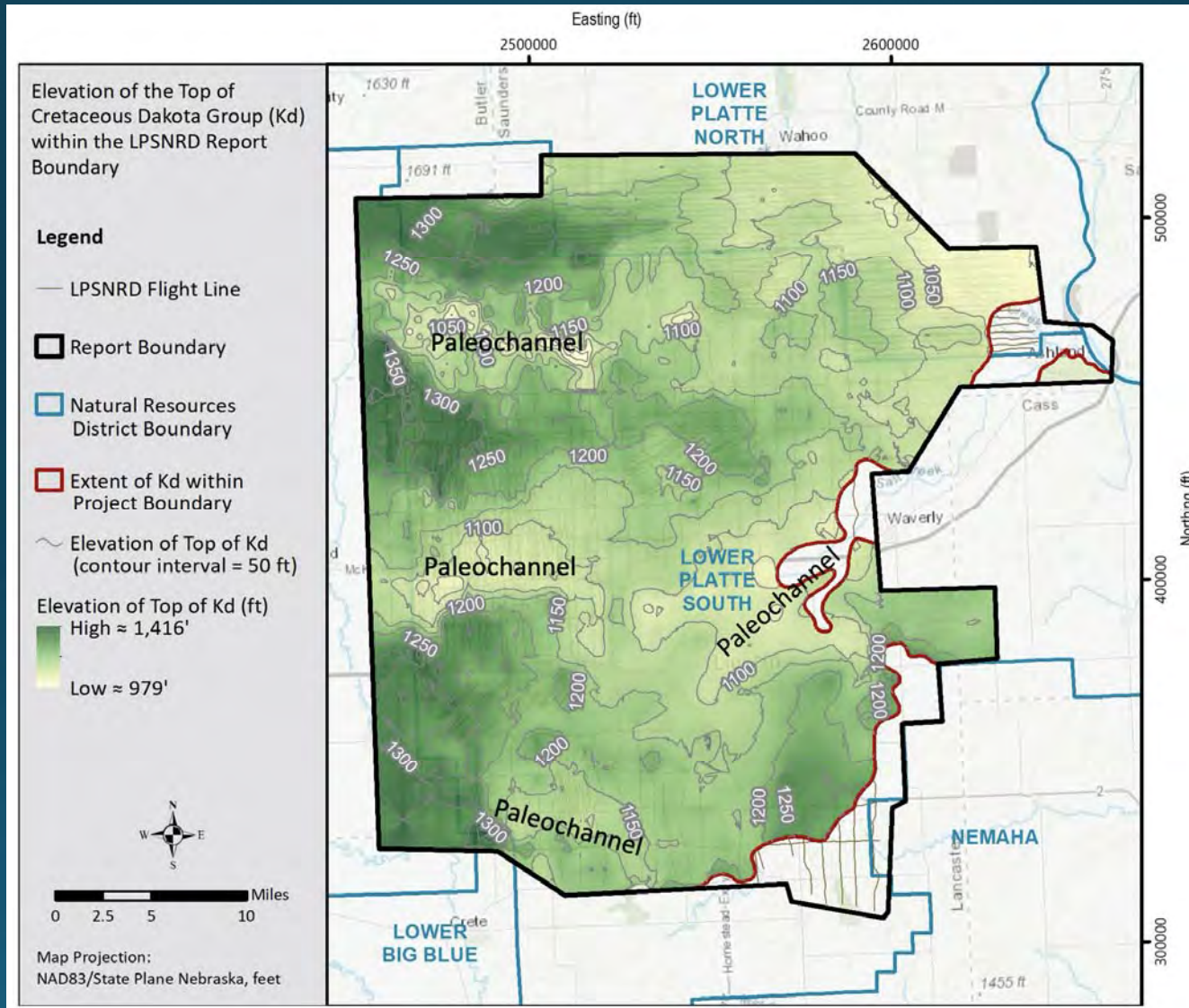


# Top of Bedrock Surface-Reconnaissance Lines



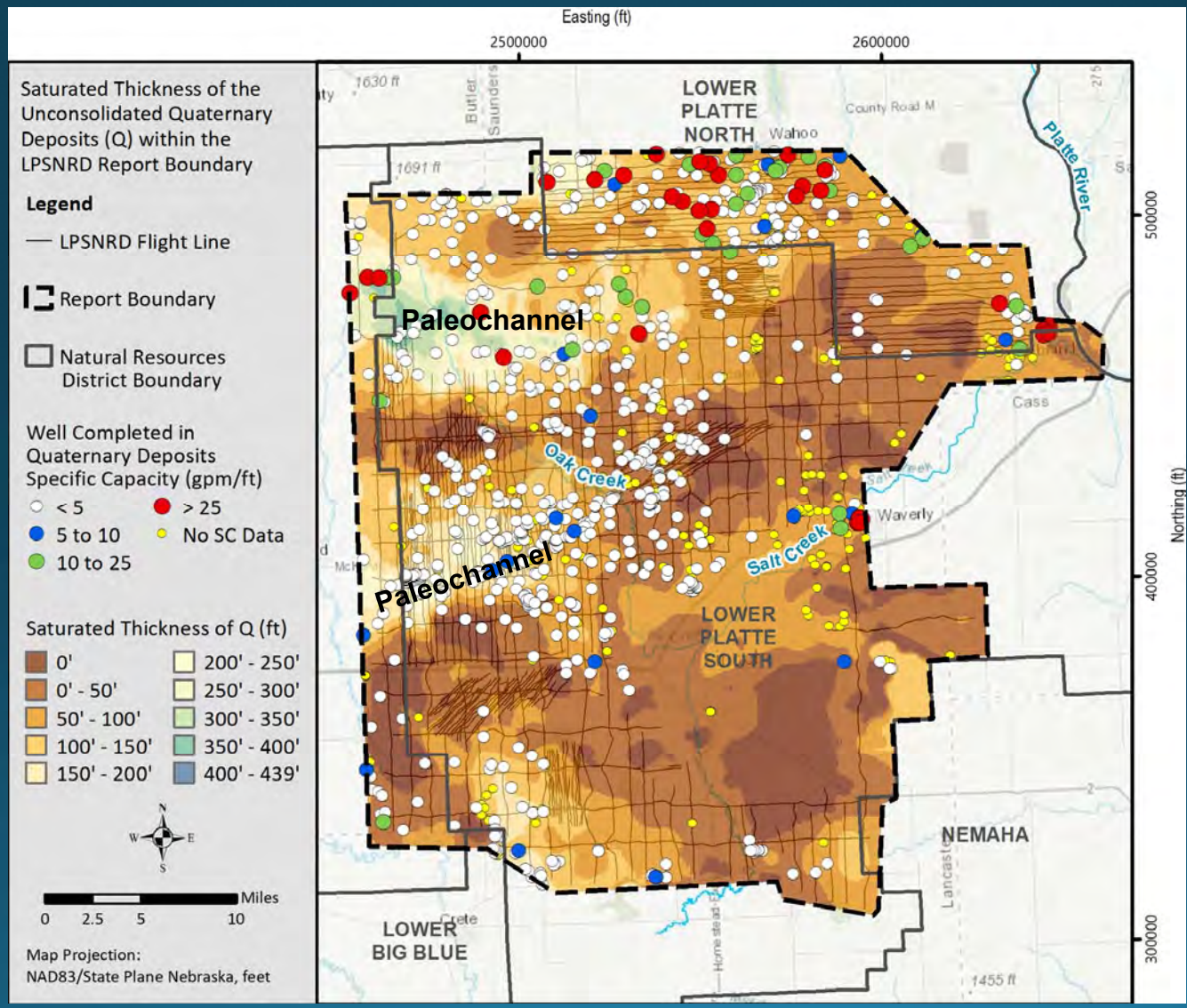


# Top of Cretaceous Dakota Surface- Reconnaissance Lines



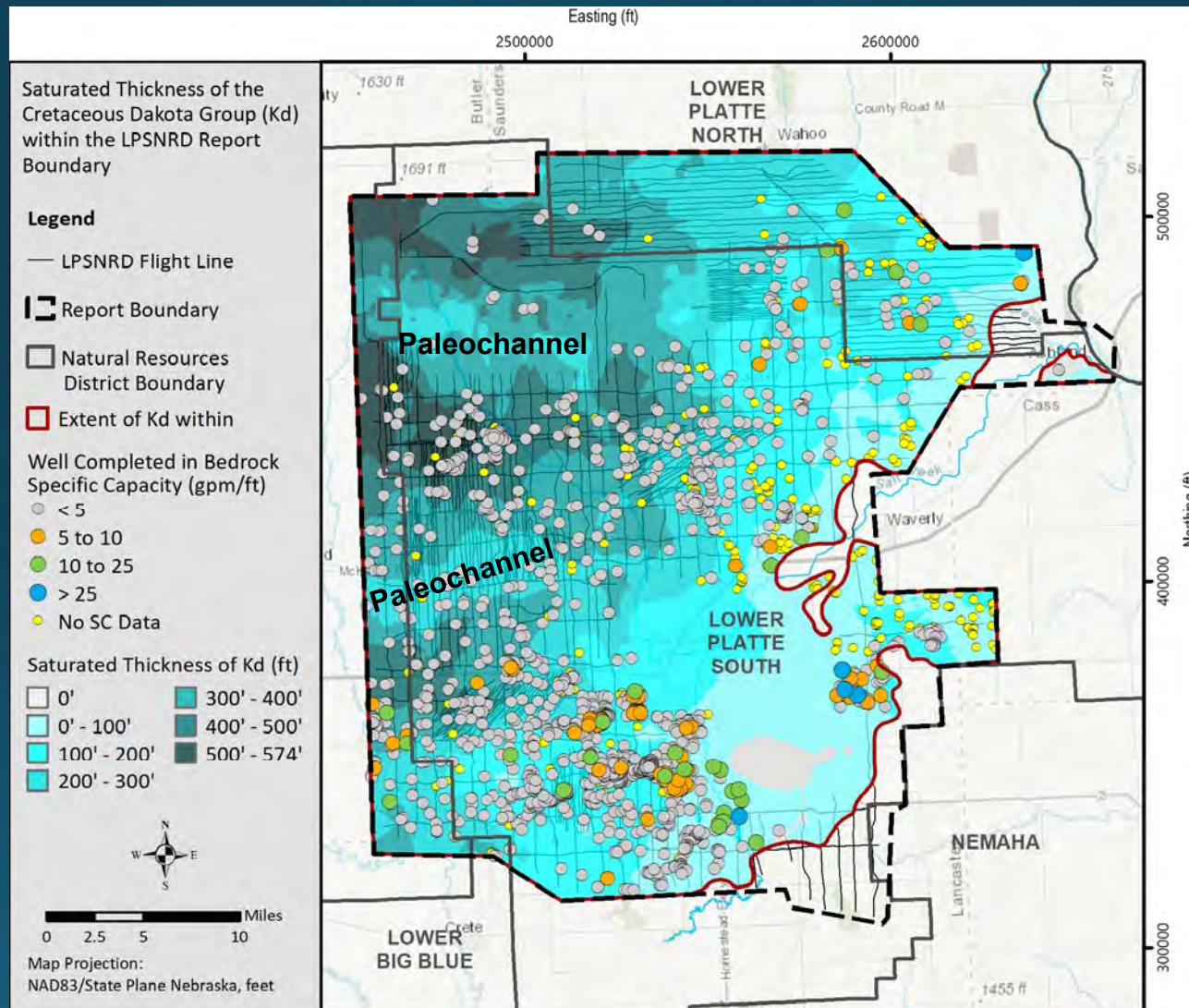


# Saturated Thickness of Quaternary Deposits and Specific Capacity of Wells



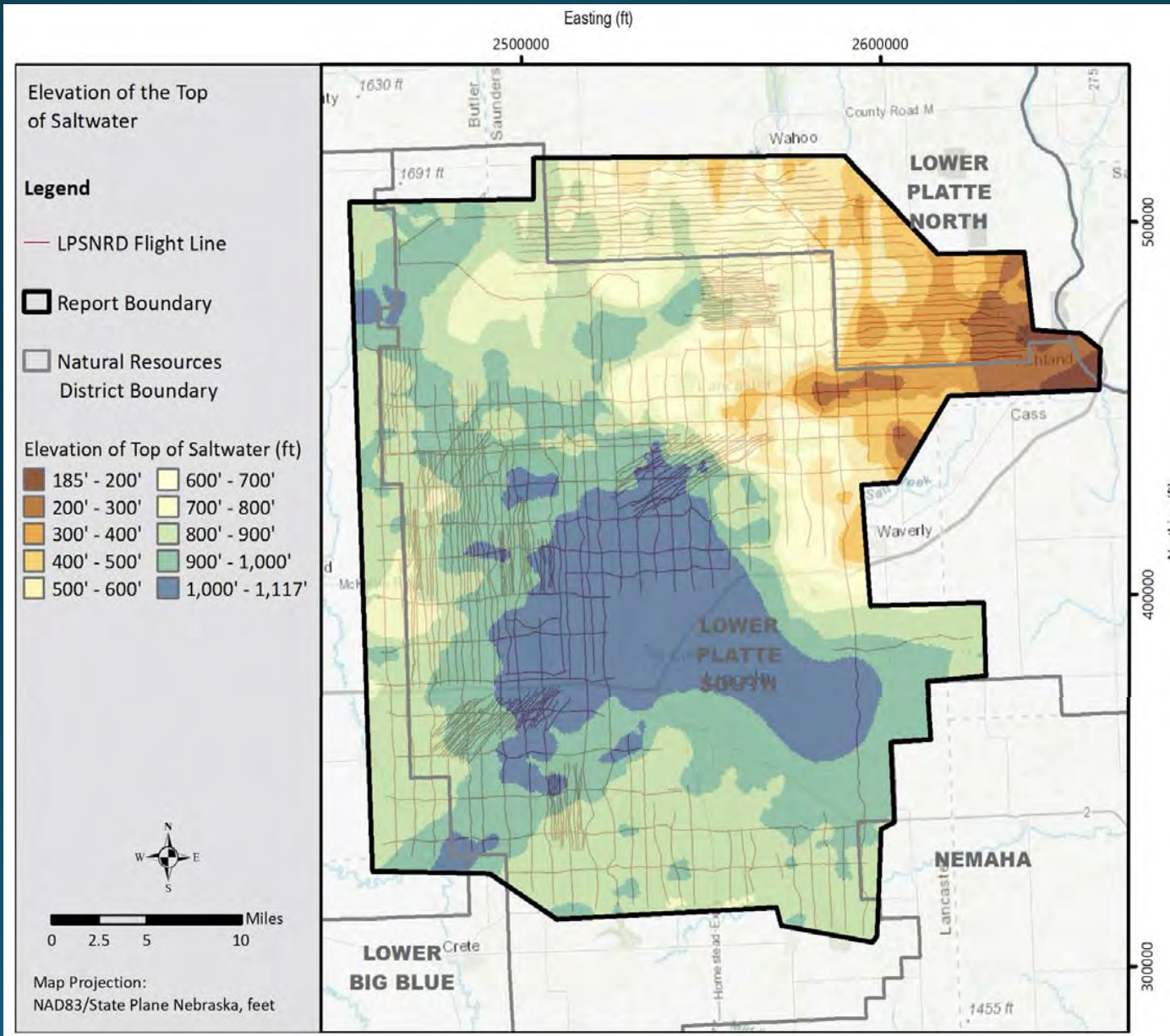


# Saturated Thickness of Cretaceous Dakota Deposits and Specific Capacity of Wells

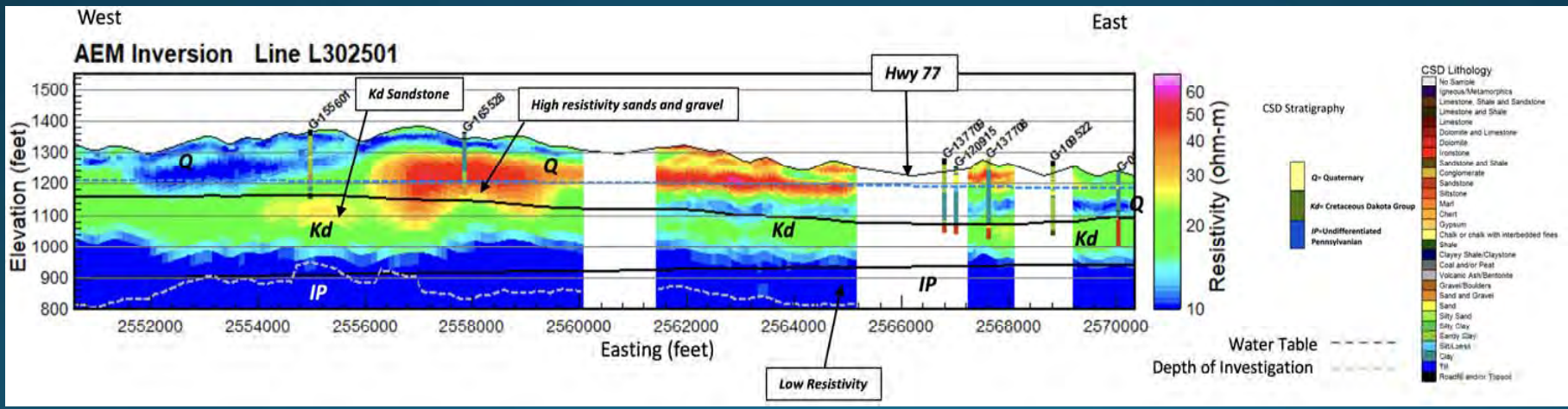
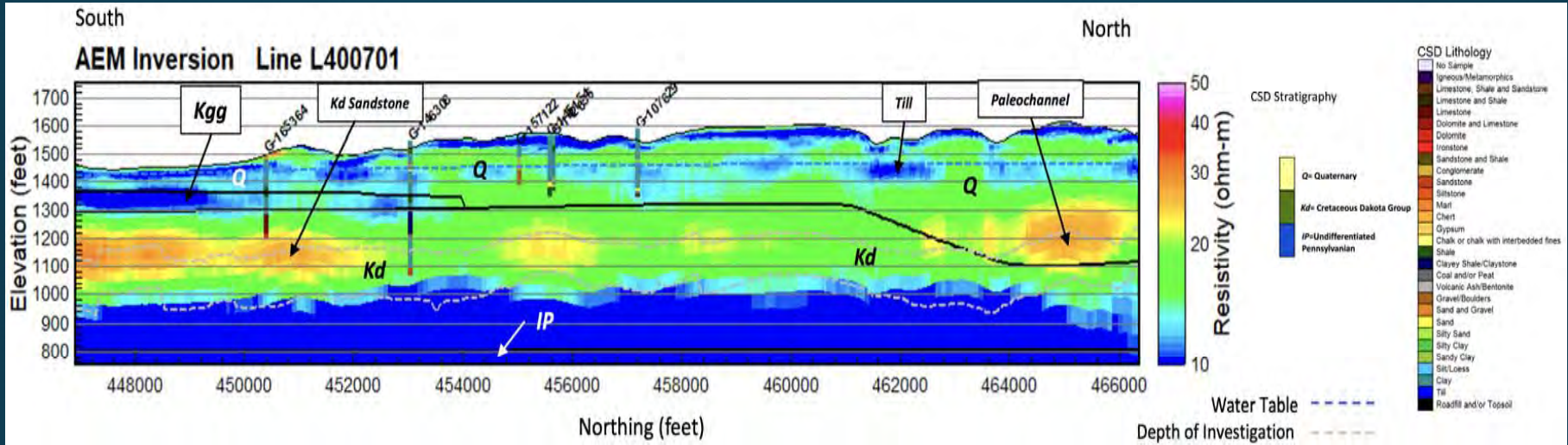




# Elevation of the Top of Saltwater

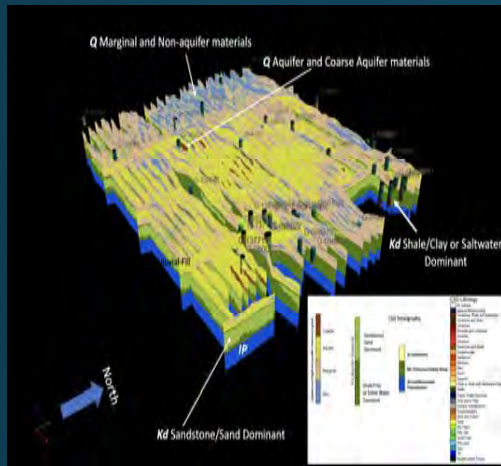


# LPSNRD Cross Sections

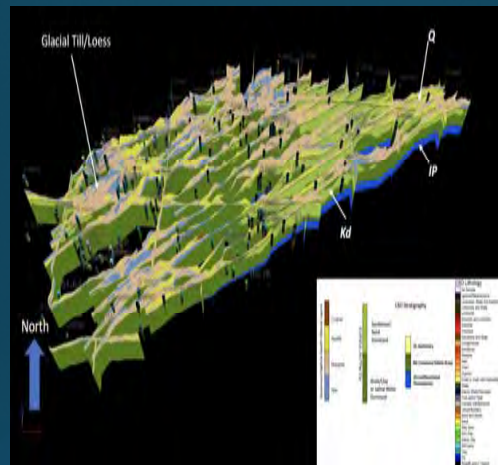




# 3D Fence Diagrams of Interpreted AEM Profiles - All Block Flight Areas



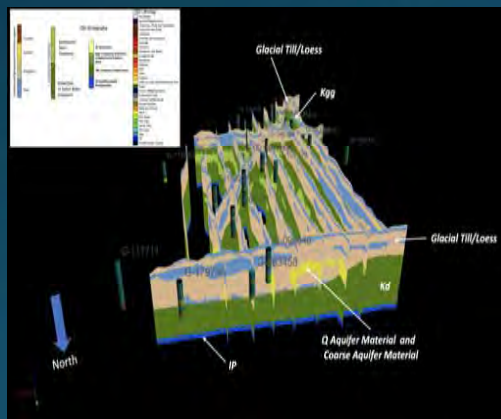
Ceresco



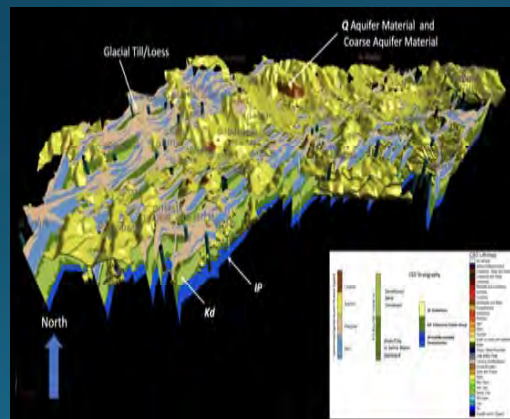
Davey Raymond



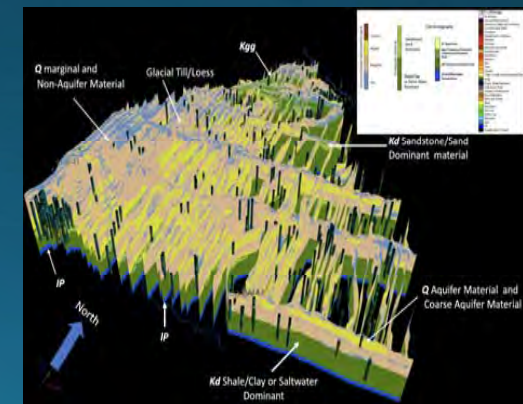
Denton



Dwight South

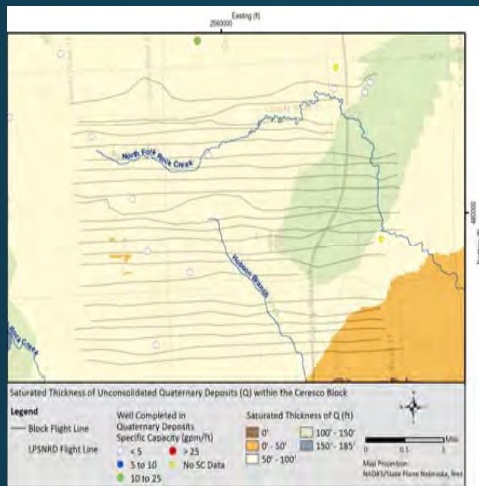


Emerald Pleasant Dale

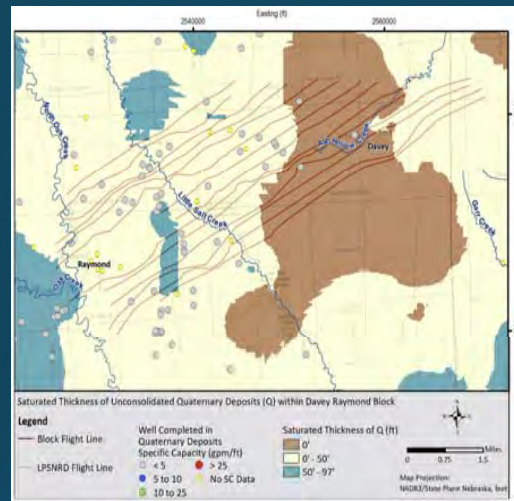


Garland Malcolm

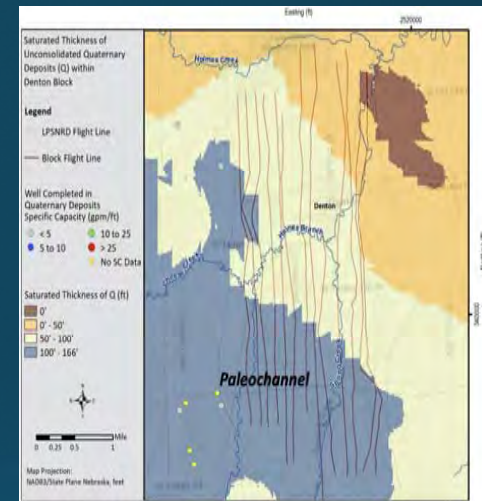
# Saturated Thickness of Quaternary Deposits and Specific Capacity of Wells All Blocks



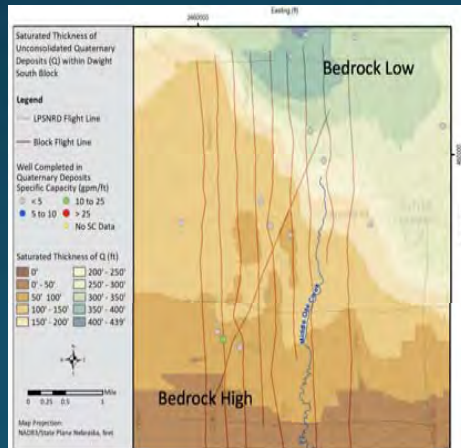
Ceresco



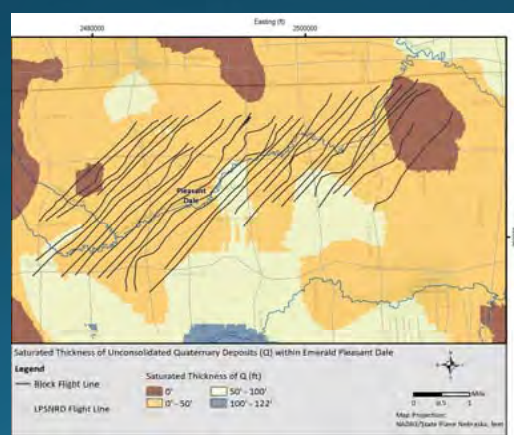
Davey Raymond



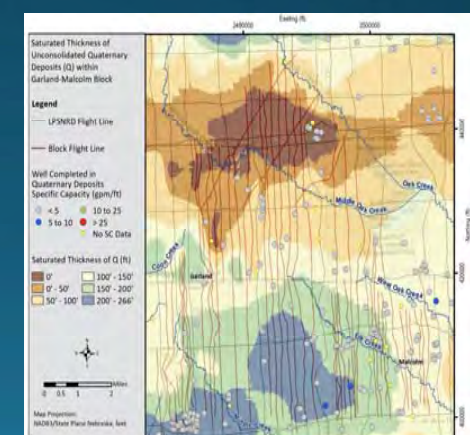
Denton



Dwight South



Emerald Pleasant Dale



Garland Malcolm



# Leshara Block Estimates of Groundwater in Storage

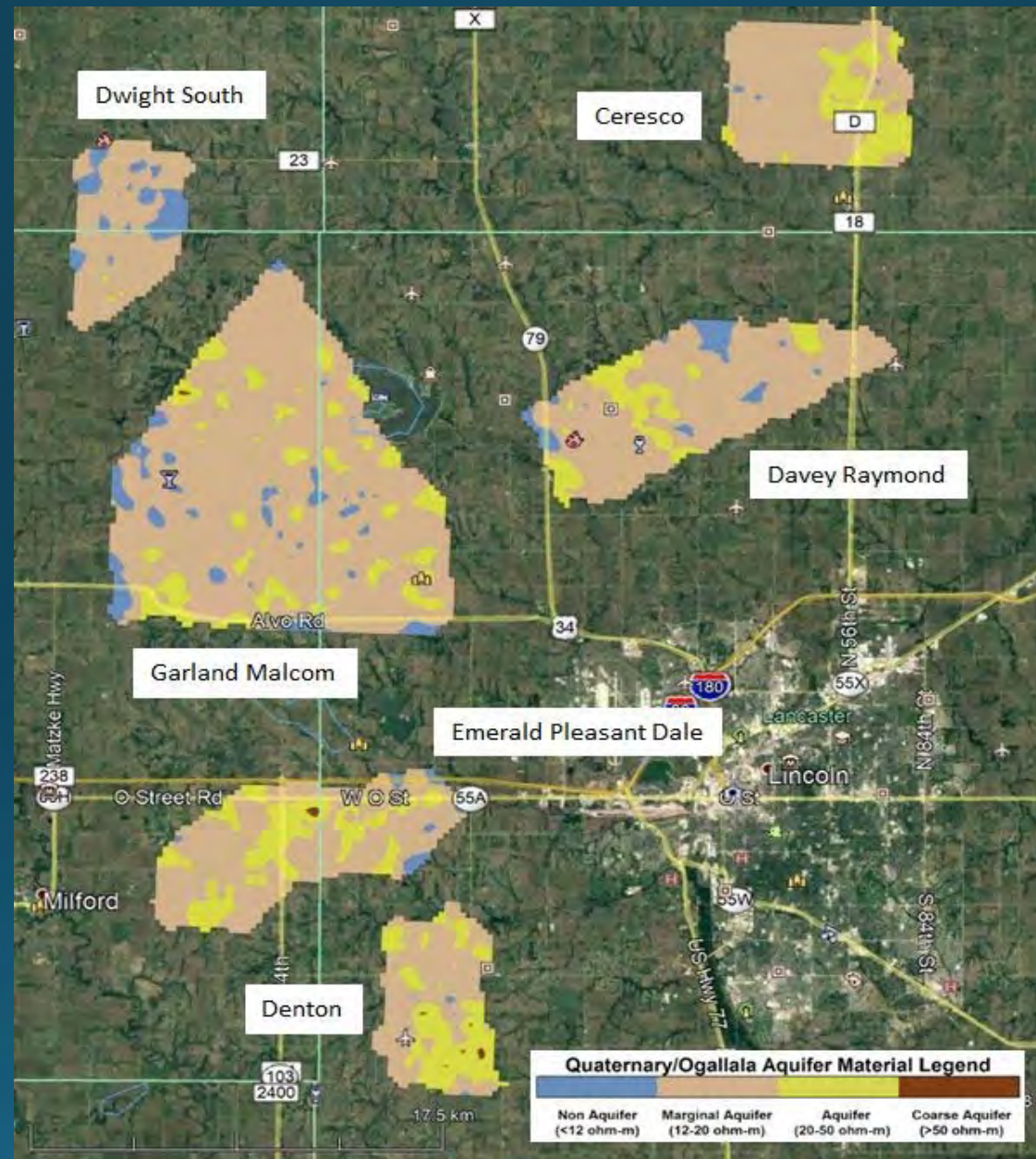
Table 3-1. Unsaturated Q aquifer materials underlying the Leshara AEM Block Area.

Aquifer Material Type	Aquifer Volume (ft <sup>3</sup> )	Aquifer Volume (acre-ft)	Average Porosity	Groundwater in Storage Volume (acre-ft)	Average Specific Yield	Extractable Water Volume (acre-ft)
Non-Aquifer	8,960,015,723	205,693	0.40	82,277	0.02	1,645
Marginal	49,031,915,420	1,125,619	0.35	393,966	0.05	19,698
Aquifer	97,805,136,845	2,245,300	0.20	449,060	0.10	44,906
Coarse Aquifer	80,296,461,490	1,843,355	0.25	460,838	0.15	69,125
<b>TOTAL</b>	<b>236,093,529,478</b>	<b>5,419,969</b>		<b>1,386,141</b>		<b>135,374</b>

Table 3-2. Saturated Q aquifer materials underlying the Leshara AEM Block Area.

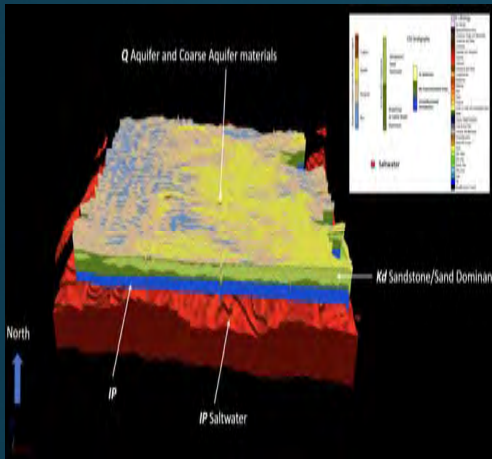
Aquifer Material Type	Aquifer Volume (ft <sup>3</sup> )	Aquifer Volume (acre-ft)	Average Porosity	Groundwater in Storage Volume (acre-ft)	Average Specific Yield	Extractable Water Volume (acre-ft)
Non-Aquifer	133,079,051,330	3,055,079	0.40	1,222,031	0.02	24,440
Marginal	200,526,101,528	4,603,452	0.35	1,611,208	0.05	80,560
Aquifer	112,381,180,318	2,579,920	0.20	515,984	0.10	51,598
Coarse	24,094,461,723	553,133	0.25	138,283	0.15	20,742
<b>TOTAL</b>	<b>470,080,794,898</b>	<b>10,791,586</b>		<b>3,487,506</b>		<b>177,340</b>

# Potential Recharge by Aquifer Material for all Blocks

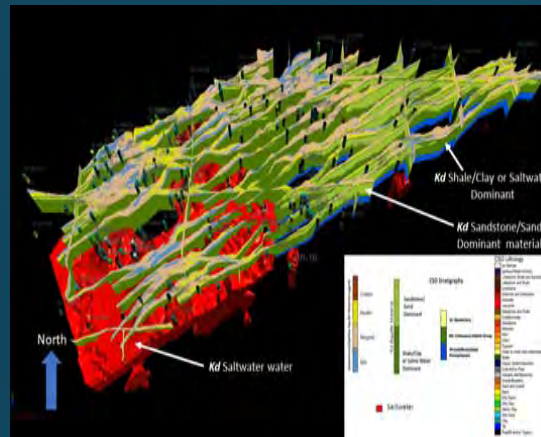




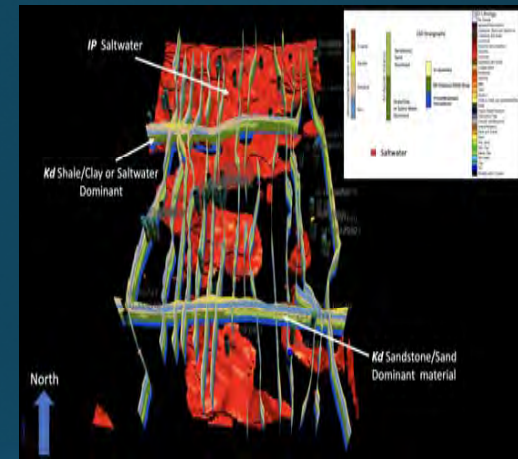
# Voxel Models Showing Saltwater Areas Within All Blocks



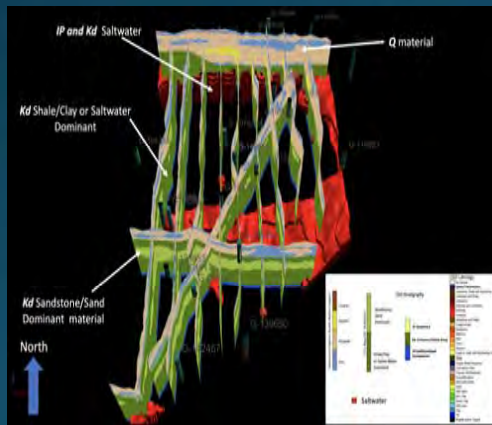
Ceresco



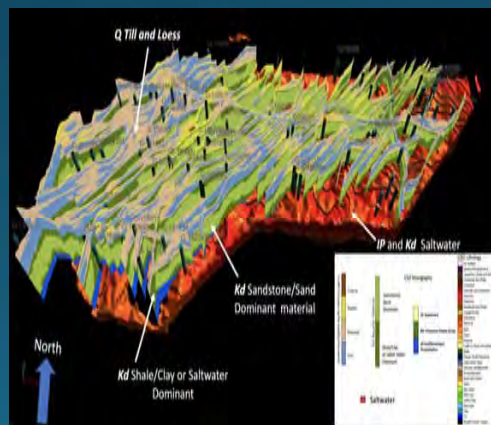
Davey Raymond



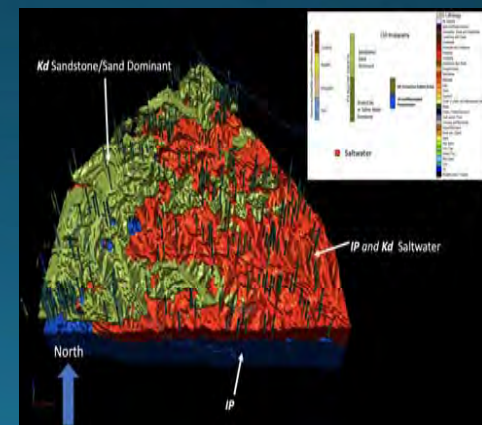
Denton



Dwight South



Emerald Pleasant Dale



Garland Malcolm

# Key Findings

- **Boreholes** - Information from boreholes was an important to analyze the AEM inversion results. However, dependence on just boreholes for geologic interpretation can sometimes have these limitations the boreholes are wrong, improperly located, have improper stratigraphic/lithology picks, and/or other errors.
- **Digitizing Interpreted Geological Contacts** - Characterization and interpretation of the subsurface was performed in cross-section and derived surface grid formats. Contacts between the geologic units were digitized in 2D including: Quaternary (*Q*), Cretaceous Greenhorn Limestone and Graneros Shale (*Kgg*), Cretaceous Dakota Group (*Kd*), and undifferentiated Pennsylvanian (*IP*). The interpretive process benefited from the use of CSD, , Nebraska Oil and Gas Conservation Commission (NEOGCC), and NE-DNR borehole logs.



# Key Findings

- **Resistivity/Lithology Relationship** -A numerically robust assessment of the resistivity thresholds was used to characterize non-aquifer (<12 ohm-m), marginal (12-20 ohm-m), and aquifer (20-50 ohm-m), including coarse sand-rich intervals (>50 ohm-m) was determined.
- **Hydrogeological Framework of the LPSNRD** - The 2018 LPSNRD AEM survey reveals variability in the Quaternary (**Q**) deposits across the LPSNRD AEM survey area. The **Q** make up the aquifer materials overlying the undifferentiated Cretaceous Dakota (**Kd**) and Pennsylvanian (**IP**) bedrock units.
- **Groundwater Aquifers**-The Cretaceous Dakota sandstone/sand dominant can be a primary or secondary aquifer in the LPSNRD.
- **Saltwater Zones**- within the block areas were identified on the 3d voxel models presented in the report.

# Key Findings

- **Potential Recharge Zones within the LPSNRD AEM Survey Area** - The use of block flights in Leshara area illustrates the preferred method to use AEM to identify areas where the potential for recharge to the aquifer can be high and low. Locations where the flight lines are closely spaced showing either aquifer or coarse aquifer material at the land surface should be considered as locations for higher likelihood for recharge. Recharge estimates along the Reconnaissance lines is less confident due to the spacing between the lines.



# Future Work using AEM Results

- Provide additional information for groundwater modeling/management efforts in LPSNRD
- Refine transmissivity and specific yield (storativity) maps district-wide.
- Improve water table data – add water level monitoring wells to network
- Determine wells for additional water quality testing based on their location and depth
- Inform landowners and well drillers of the new geology maps
- Perform aquifer tests in appropriate locations based on AEM results
- Select recharge and vadose zone study locations
- The list is long



Questions??



# Acknowledgments

- Dick Ehrman- LPSNRD
- Katie Cameron - ENWRA