

# IMPACT OF AIRBORNE ELECTROMAGNETIC (AEM) SURVEYS IN GROUNDWATER MANAGEMENT IN THE LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT, NEBRASKA, USA

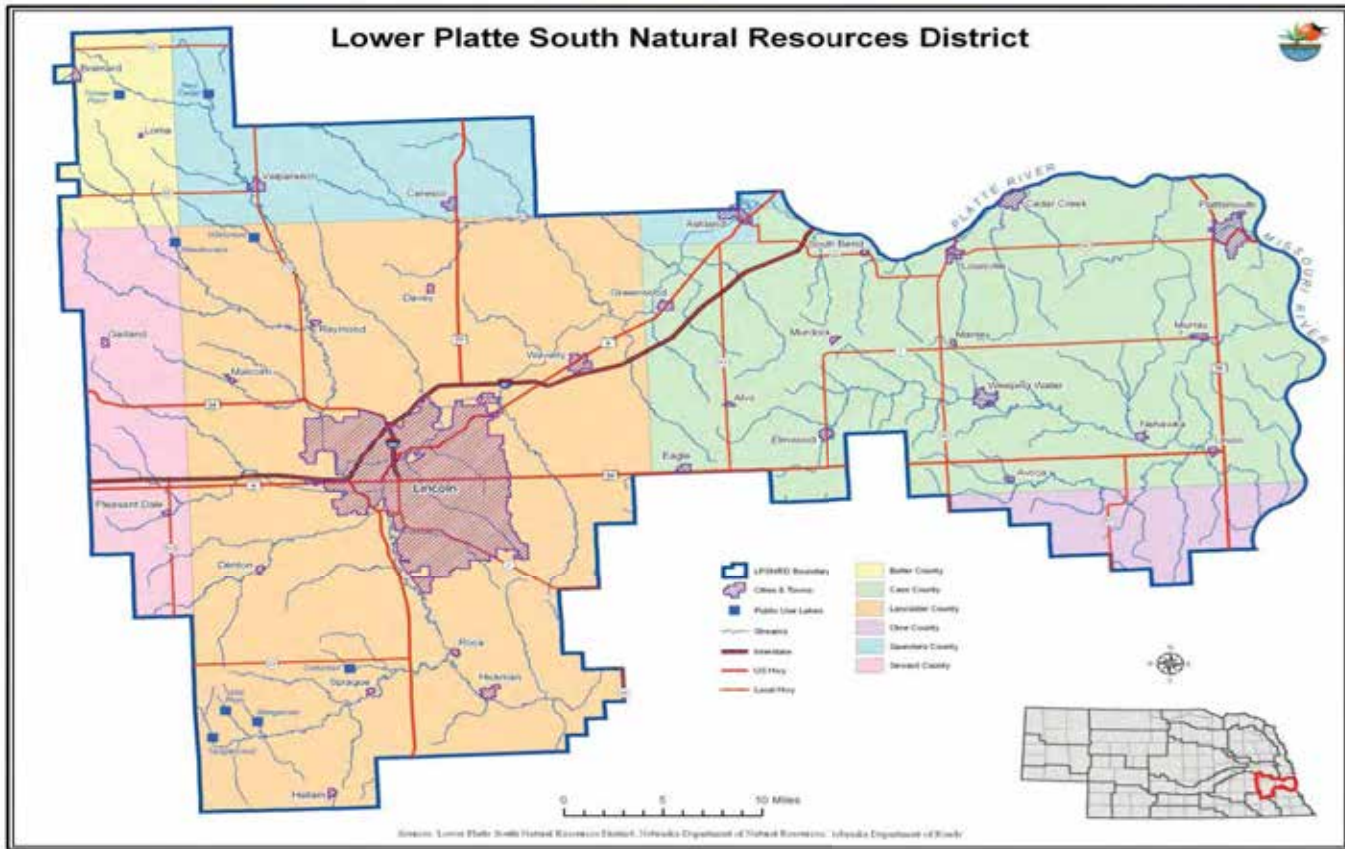
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# Lower Platte South Natural Resources District

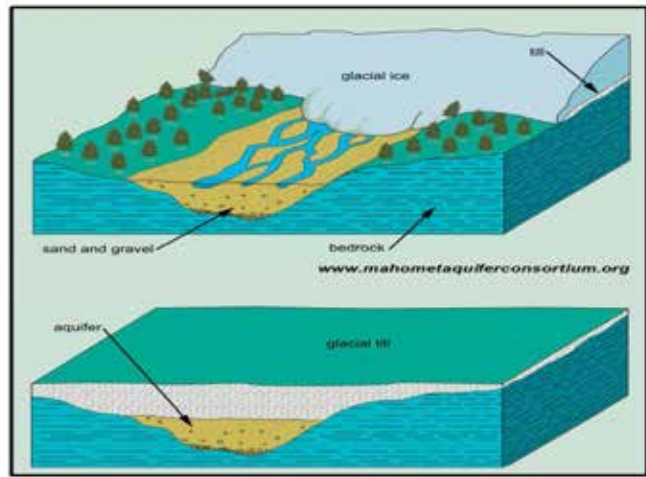
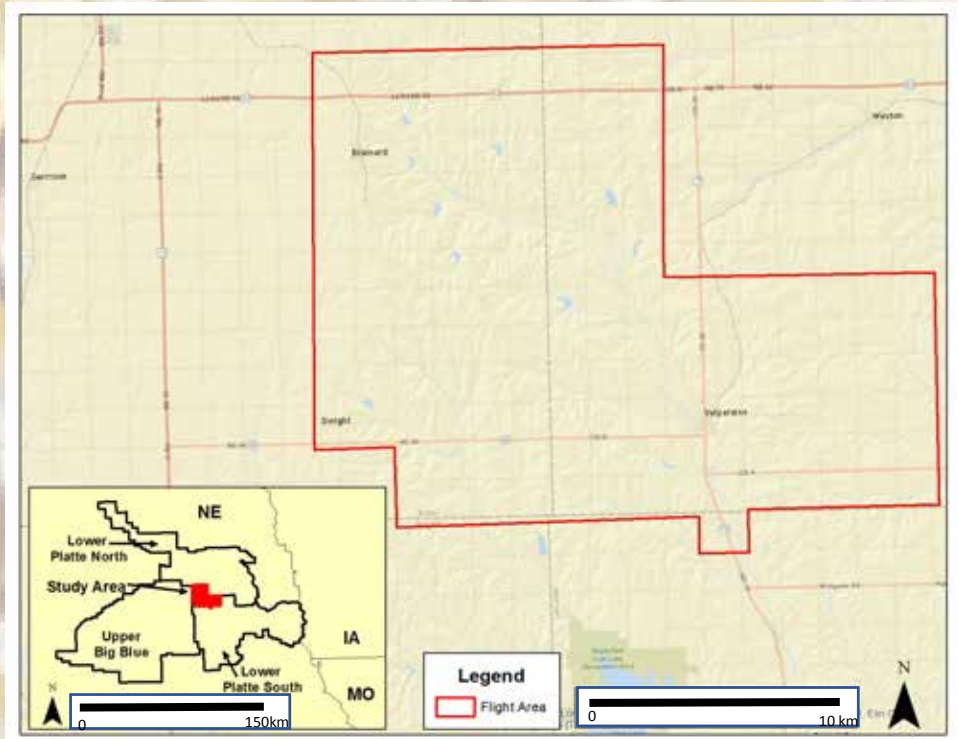


The Lower Platte South NRD (LPSNRD) has been a leader in supporting AEM surveys on its own and as part of the Eastern Nebraska Water Resources Assessment group (ENWRA). As one of 23 NRDs in Nebraska they are responsible for management of the groundwater quality, quantity and groundwater-surface water interaction.



# Dwight-Valparaiso-Brainard Special Management Area (DVB SMA)

- Geologic setting: Quaternary glacial till, glacial outwash, alluvium filled paleo-channels and Cretaceous bedrock.
- Most of the groundwater in the area is produced from the glacial outwash and the alluvial paleo-channels.
- These groundwater sources have sufficient capacity to provide irrigation for agriculture, municipal supply, and domestic wells



# Why AEM?



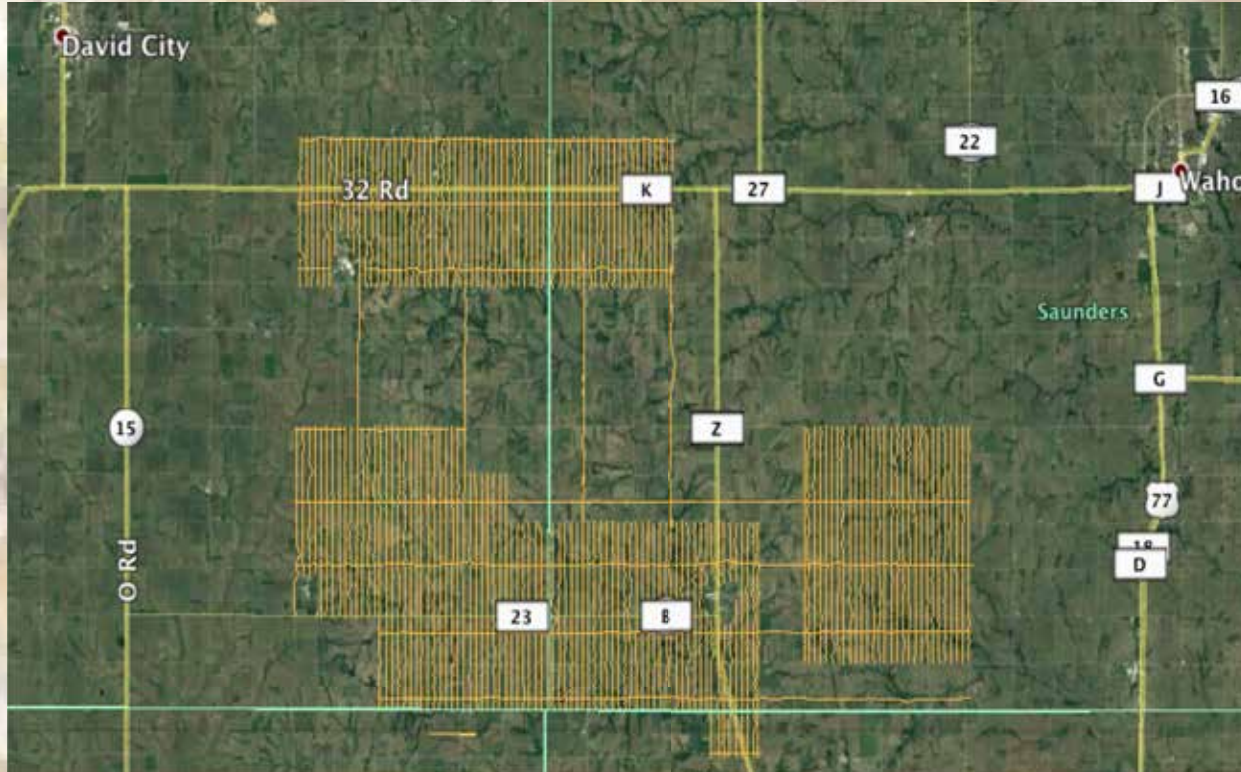
- The nature of the hydrogeology of the area is such that sustainable supply concerns prompted the LPSNRD to initially restrict groundwater development in the DVB SMA based on water level changes and complaints from the public on groundwater use interference and declining well performance.
- The confined aquifer units in the DVB SMA, while not showing signs of long-term water level declines, respond rapidly to irrigation well pumping in the summer months. In cases of dry weather and high irrigation demand, ground water levels can decrease on the order of 30 m in a matter of several days, leading to decreased well yield especially in older, shallower wells.
- The aquifers are not mappable from the surface and well control is not adequate



# Pre-AEM Management Controls

- **The confined aquifer units in the DVB SMA, while not showing signs of long-term water level declines, respond rapidly to irrigation well pumping in the summer months. In cases of dry weather and high irrigation demand, ground water levels can decrease on the order of 30 m in a matter of several days, leading to decreased well yield especially in older, shallower wells.**
- **The LPSNRD imposed regulations consisting of the following directives:**
  - **A prohibition on new irrigated land development, an allocation of groundwater irrigation application of 76 cm over 3 years with a maximum of 30 cm in any one year**
  - **Irrigators must complete a management certification class, the LPSNRD has established cost share for improved irrigation management**
  - **Deeper wells for domestic uses are required to avoid seasonal draw-down effects**
  - **Requirement that all new wells be approved by the LPSNRD Board of Directors**

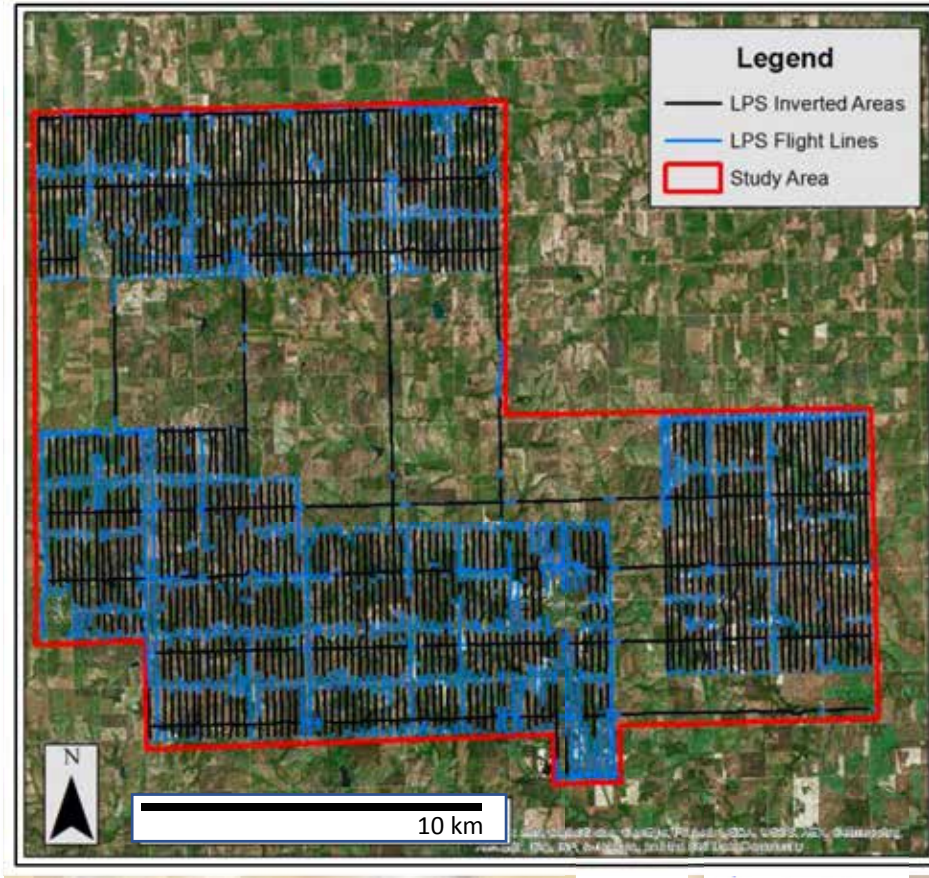
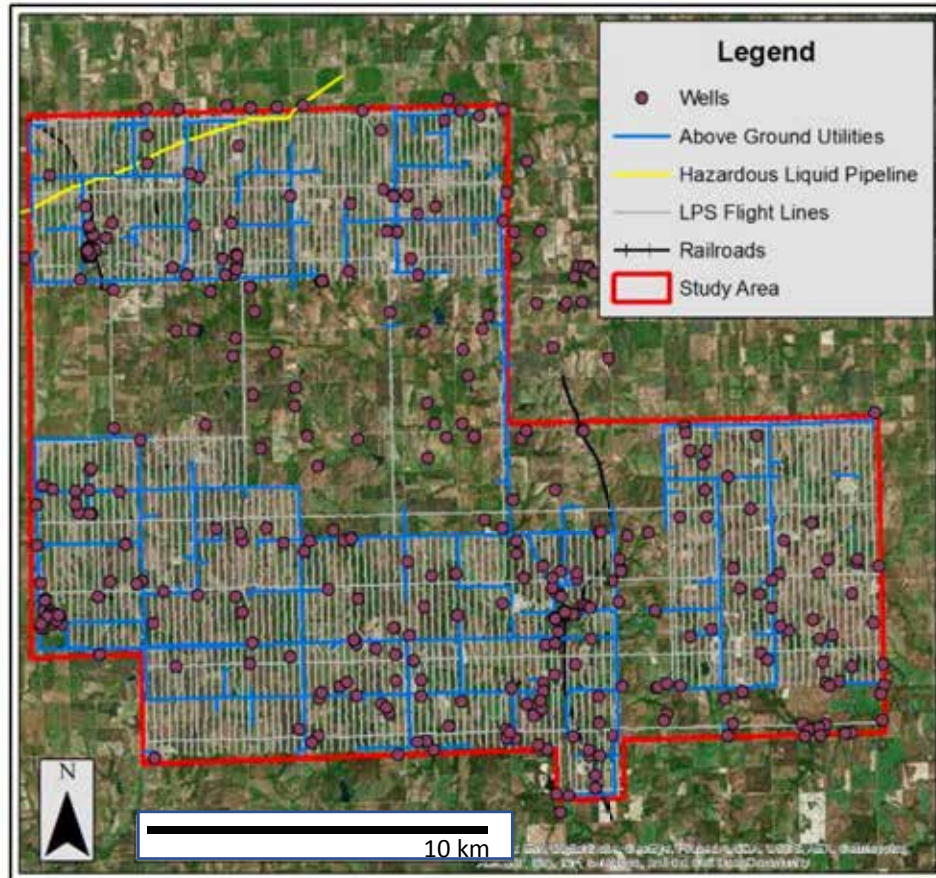
# AEM SURVEY



- Approximately 1,331 line-km were flown within the three project area blocks in August of 2013
- Utilized the SkyTEM304
- The AEM survey was flown with a line separation of approximately 300 metres in a north-south direction and approximately 1500 metre spacing in the east-west direction.
- Aarhus Workbench was used for a Spatially-Constrained inversion



# Wells and infrastructure/decoupling



# East-West Profile Northern Block

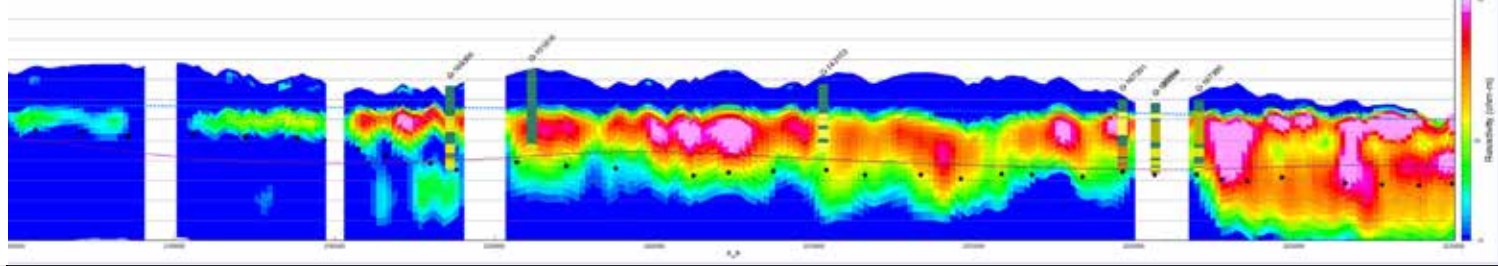
Subsurface Resistive Materials

Surface Resistive Materials

West

East

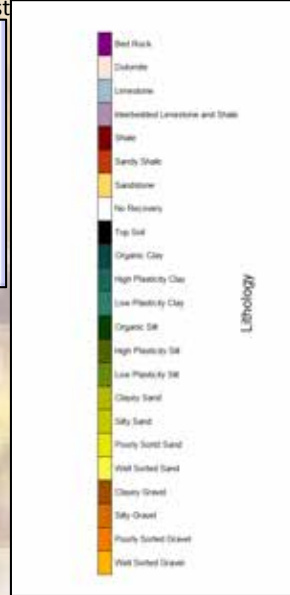
Elevation (metre)



240 m

6 km

Color scale 10 to 30 ohm-m





# East-West Profile Southern Block

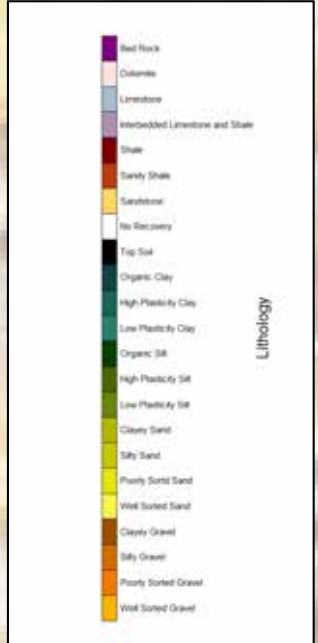
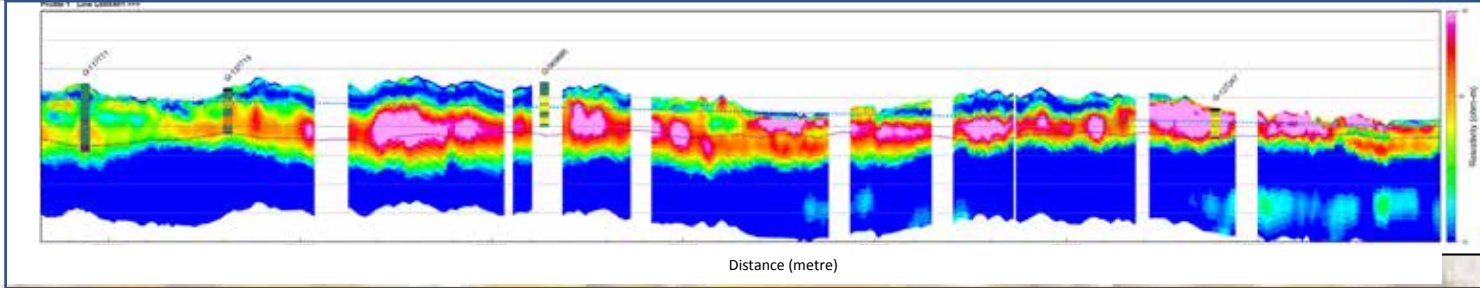
Subsurface Resistive Materials

Surface Resistive Materials

West

East

Elevation (metre)



Color scale 10 to 30 ohm-m

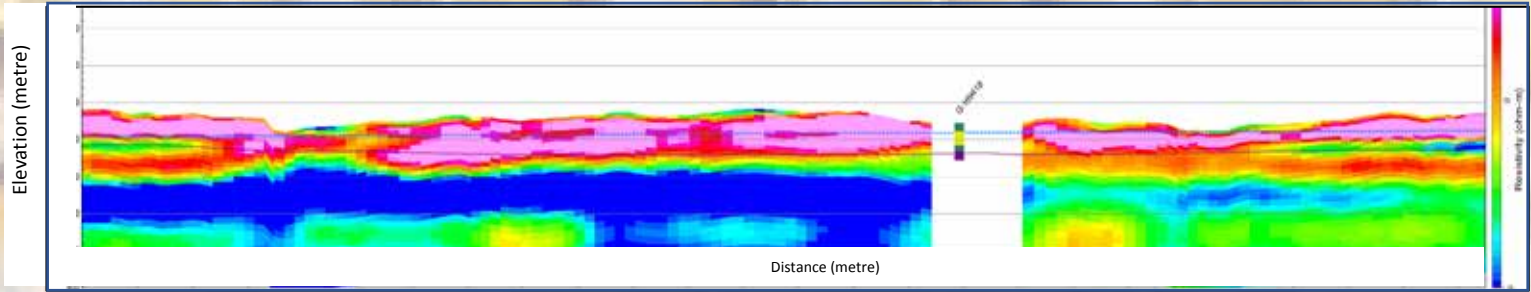
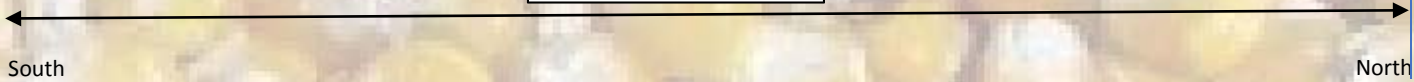
6 km

240 m



# North-South Profile Eastern Block

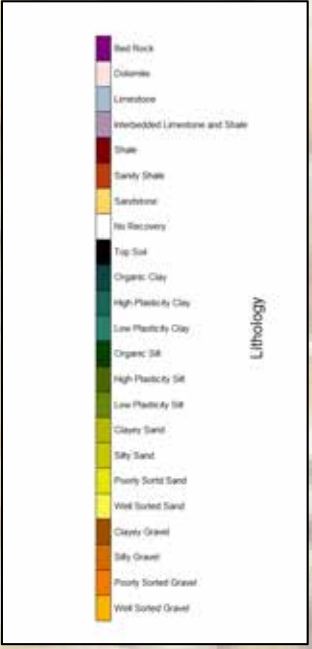
Surface Resistive Materials



8 km

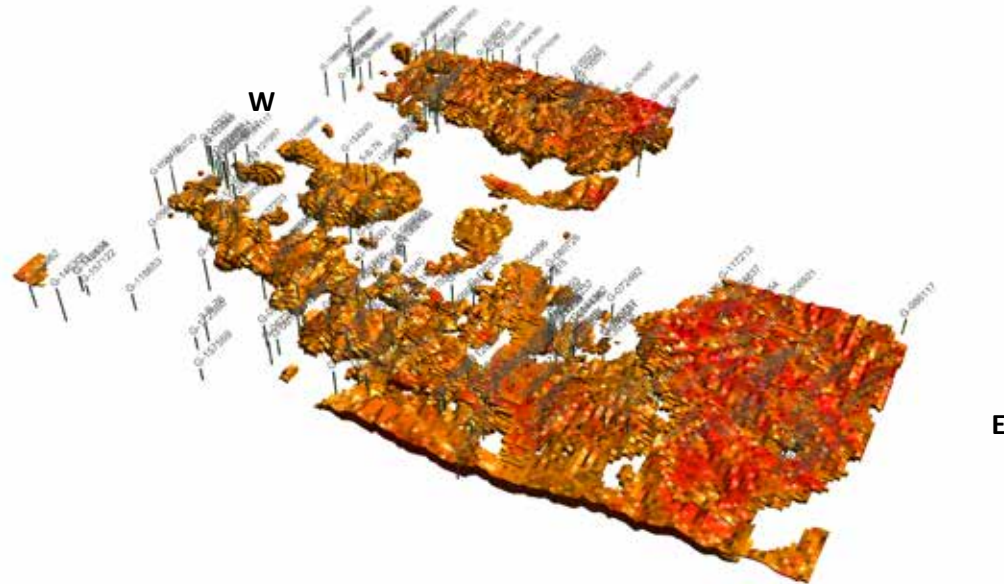
Color scale 10 to 30 ohm-m

240 m



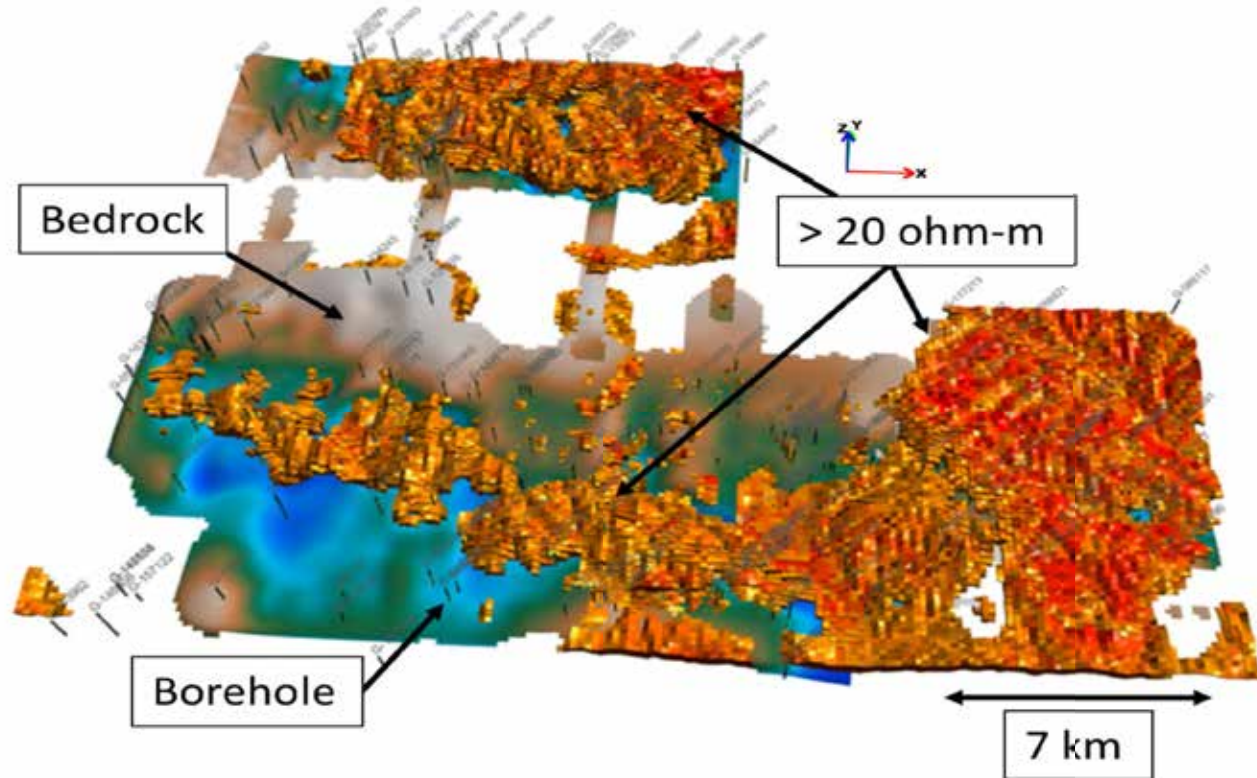


# Aquifer Material above Cretaceous Bedrock



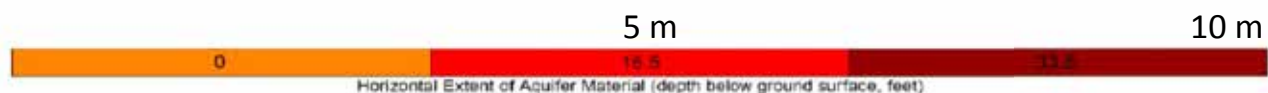
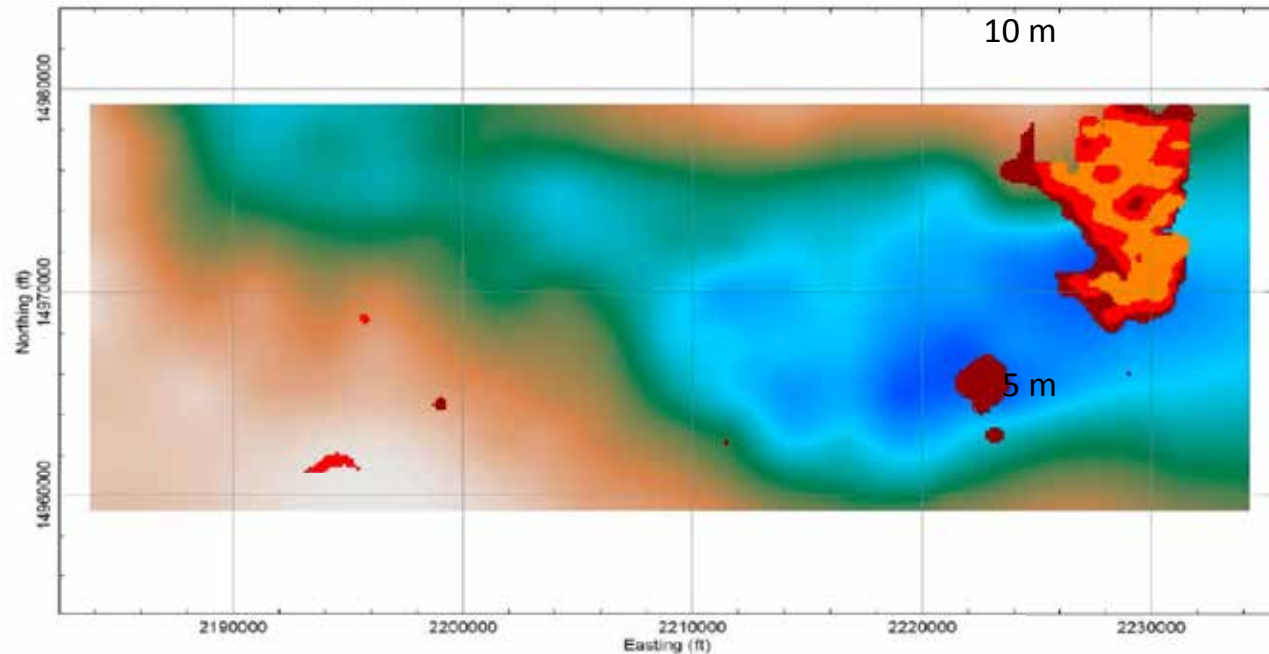
VOXELS OF RESISTORS  $\geq 20$  OHM-M

# Aquifer Material showing Bedrock





# Recharge Area North Block



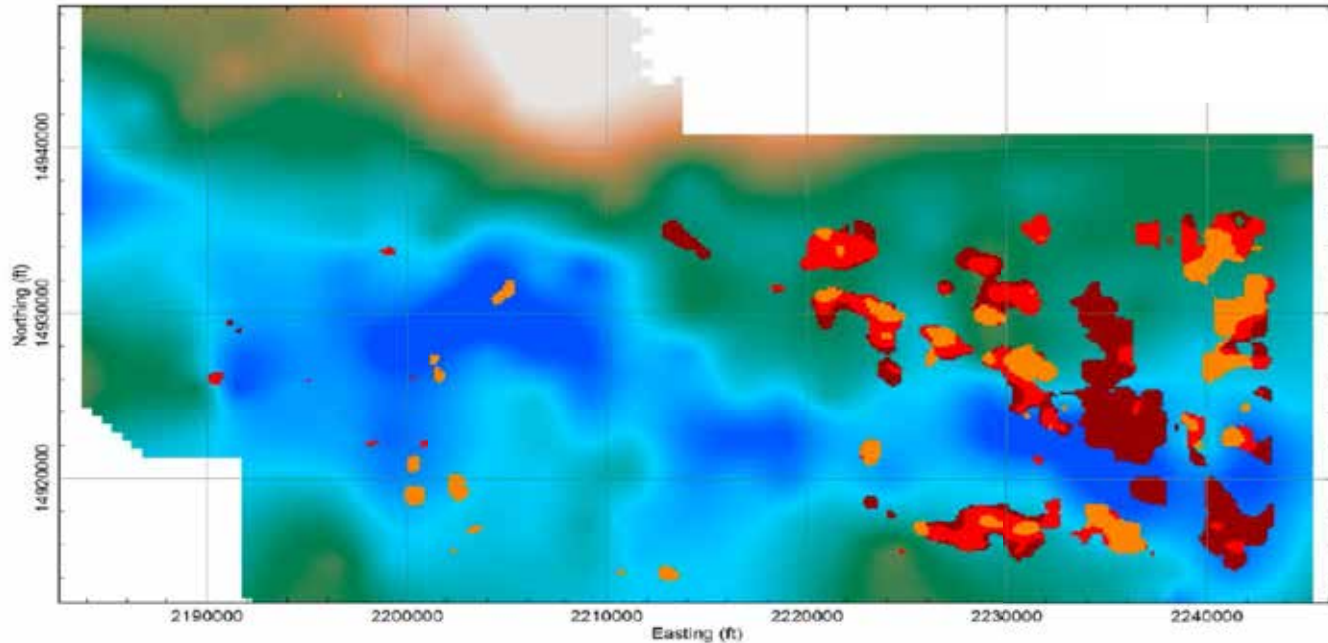
320 m

365 m

411 m

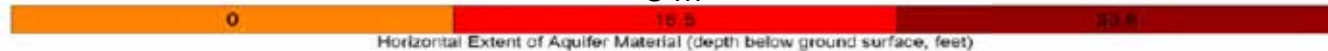


# Recharge Area South Block



5 m

10 m



Horizontal Extent of Aquifer Material (depth below ground surface, feet)

320 m

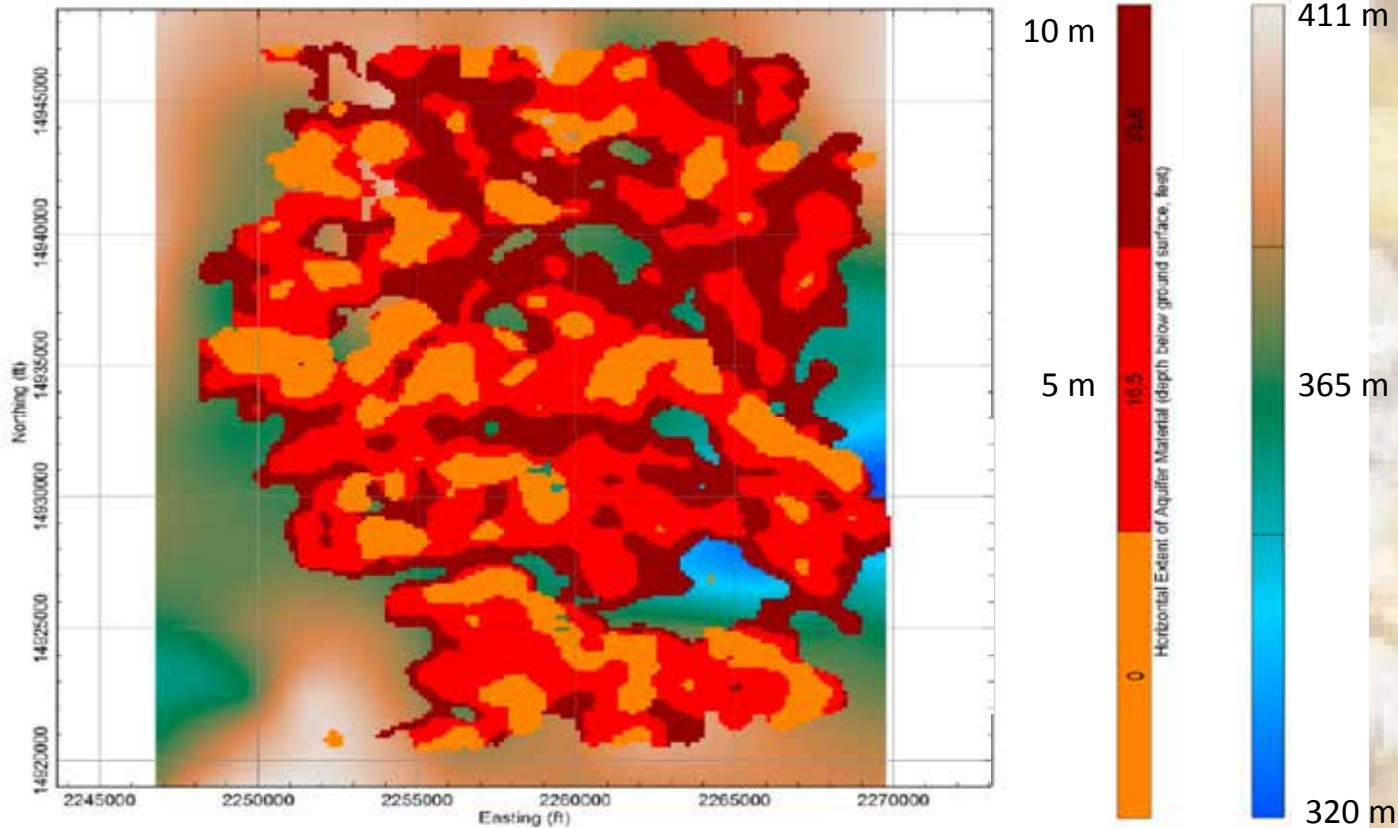
365 m

411 m





# Recharge area East Block



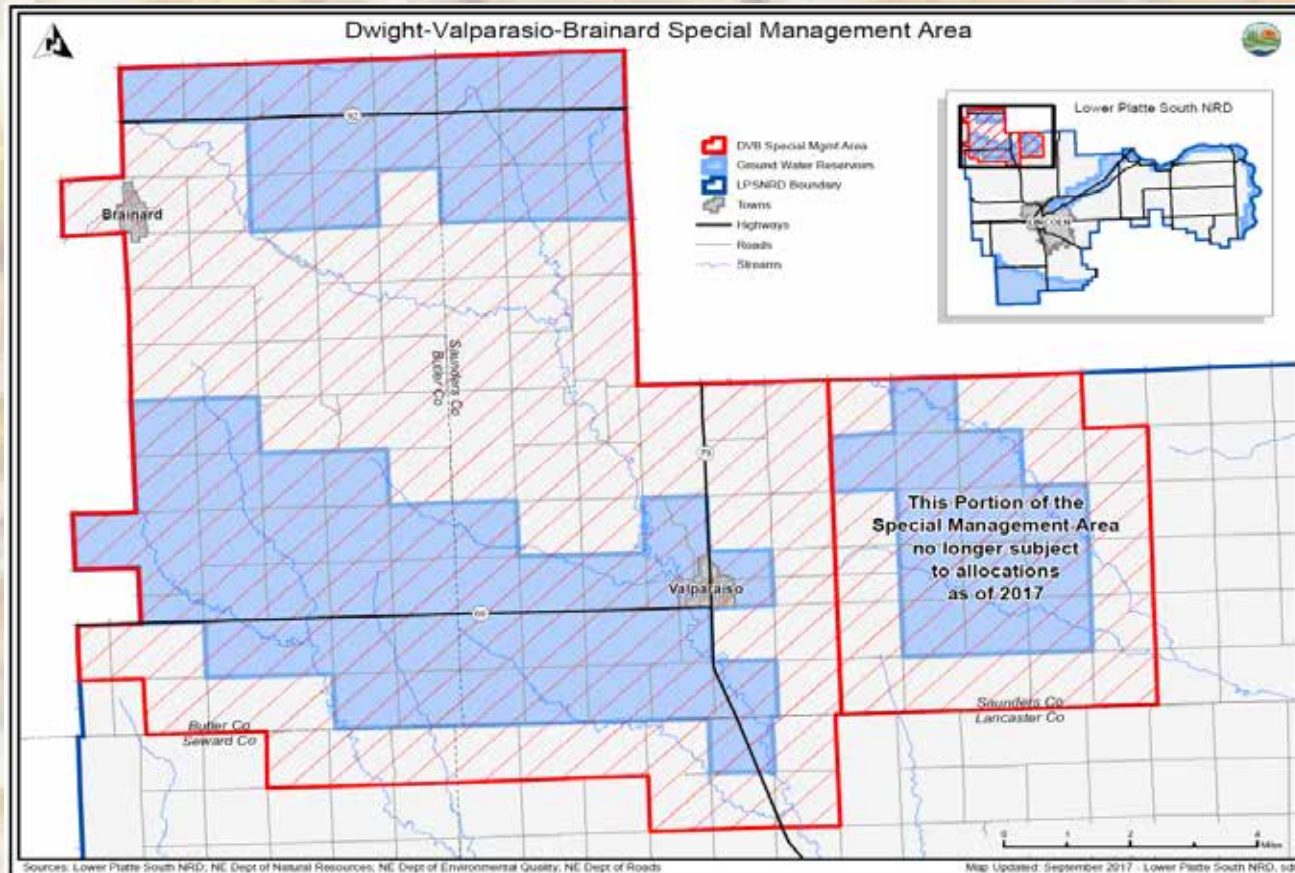
# Recharge Area East Block



# Results of AEM

- **Results of the inversion show two distinct areas within the survey area.**
  - **An area to the west that shows subsurface resistors that indicated coarse materials within the Quaternary section**
  - **An area to the east that indicates that the resistive materials within the Quaternary section are at the surface . The resistive materials at the surface is a recharge area that is connected to an unconfined aquifer system directly below. This aquifer system is continuous as it dips to the west and becomes a confined groundwater system when it is covered by glacial till.**

# Management Changes



Removing the allocation requirement in the easternmost management area in 2017. This area was proven to be a recharge area with an unconfined aquifer



# Impacts to LPSNRD

- **The AEM data has been instrumental in this management in three primary ways:**
  - **First, detailed information on the extent and occurrence of confining units, aquifer materials, and potential recharge areas has guided the District's installation of new monitoring wells, allowing those wells to be sited to maximize the value of ground water data collected.**
  - **Second, this data has yielded important insight into the geometry, volume, and degree of confinement of the various aquifer units in the area. This information was used to justify removing the allocation requirement in the eastern part of the SMA, as it was possible to demonstrate that the aquifer units there were essentially unconfined, and thus extensive in-season water declines are not a concern.**
  - **Finally, the AEM data have played an important role in raising public knowledge of the ground water issues facing the DVB SMA.**

# References

- Carney, C. P., Pierce, K.S., Abraham, J.D., Steele, G.V., Genco, A.G., and Cannia, J.C., 2014, Hydrogeologic Assessment and Framework Development of the Aquifers beneath the Brainard-Valparaiso Area of the Lower Platte South Natural Resources District in Eastern Nebraska, Prepared for the Lower Platte South Natural Resources District by Exploration Resources International Geophysics LLC, Vicksburg, MS. <http://www.lpsnrd.org/Programs/gwaem.htm>
- Public Broadcasting Company Quest Series. <http://www.pbs.org/video/quest-skytem-aquifer/>
- Lower Platte South Natural Resources District. <https://www.lpsnrd.org>



# Acknowledgements

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