

# Airborne Electromagnetic Surveys for for Groundwater Exploration and Management

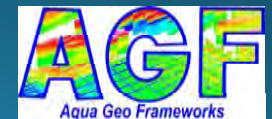
Aqua Geo Frameworks LLC

April 17, 2019

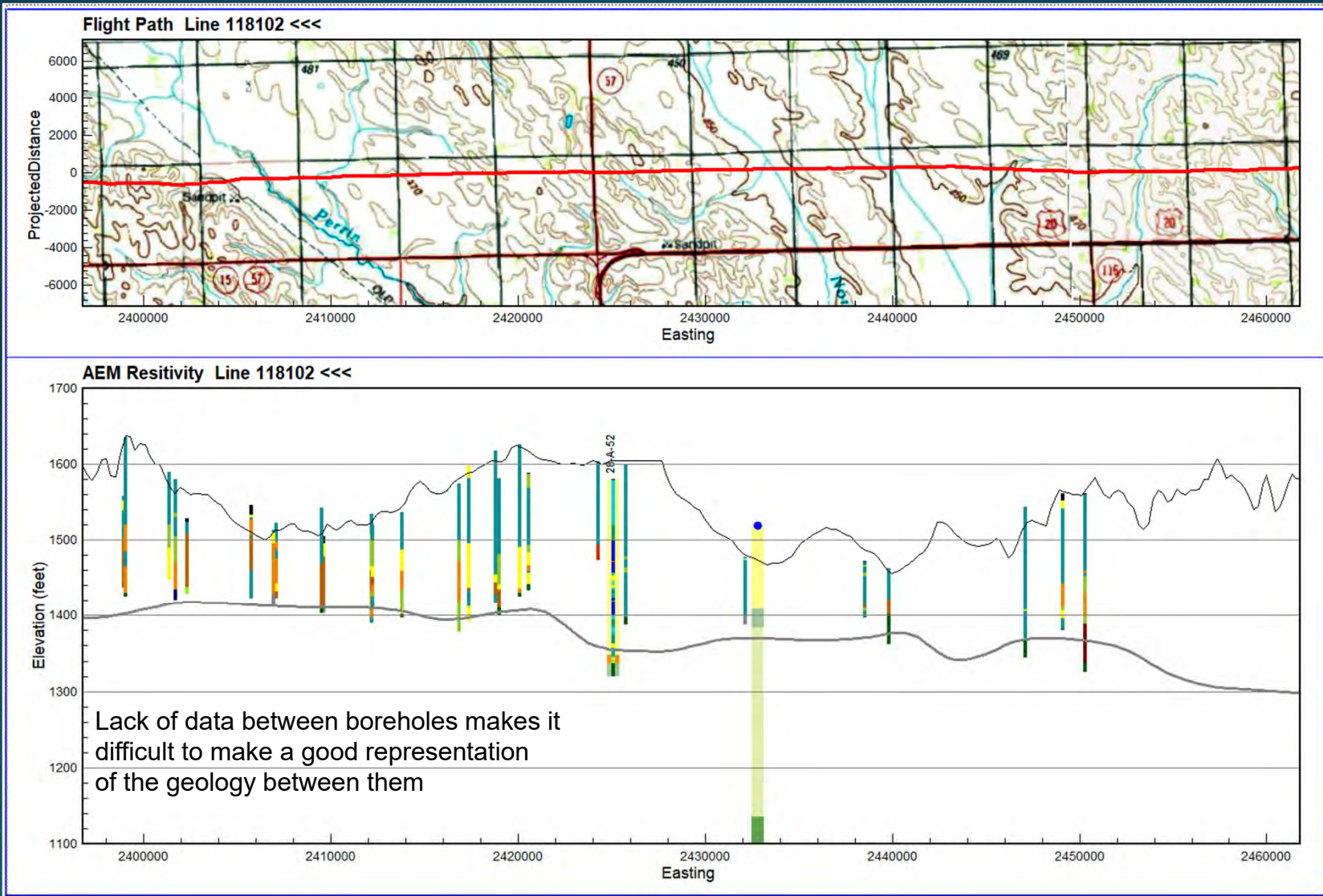
Jared D. Abraham, Research Geophysicist, PG

James C. Cannia, Senior Geologist, PG

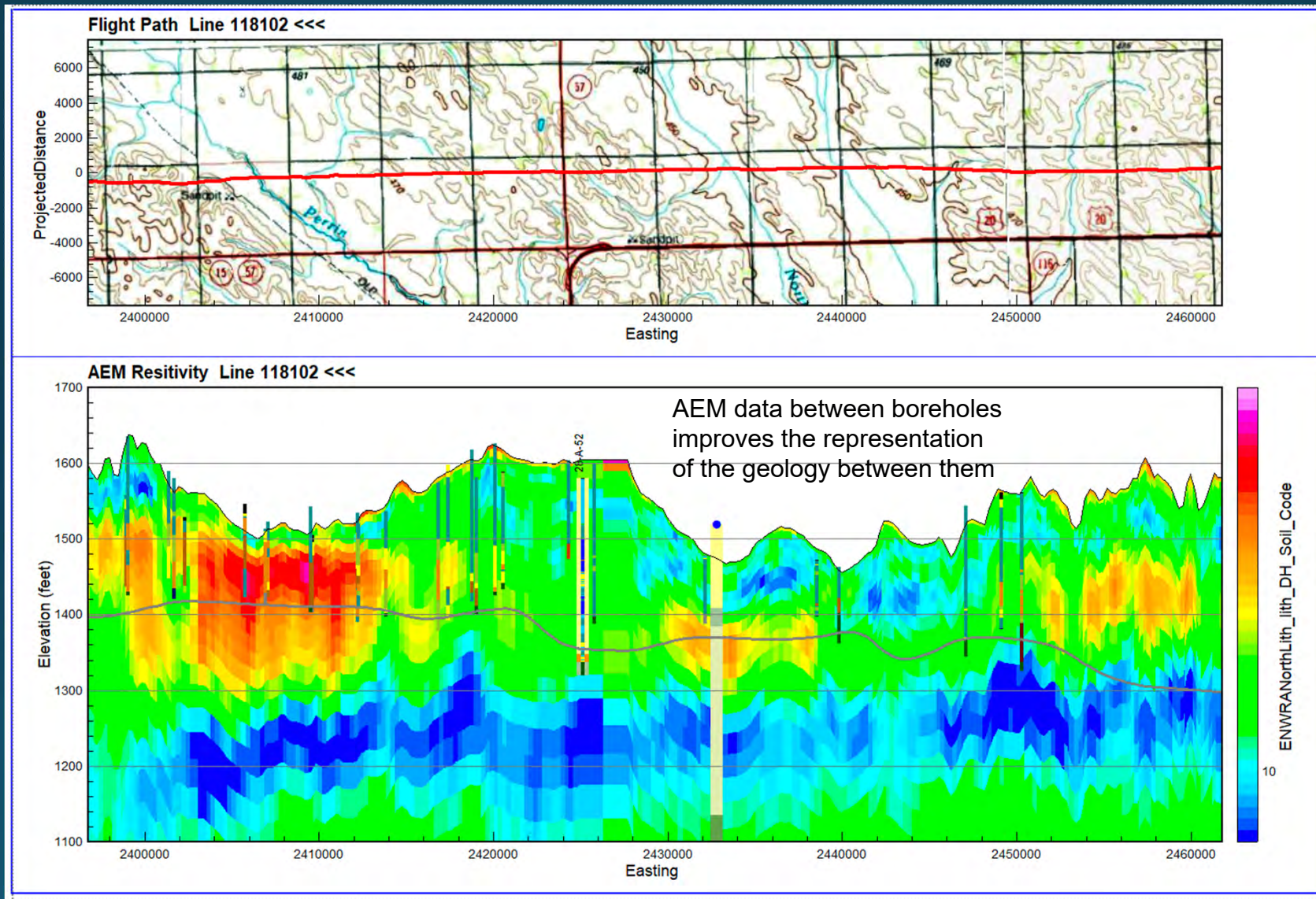
Ted Asch, Research Geophysicist, PG



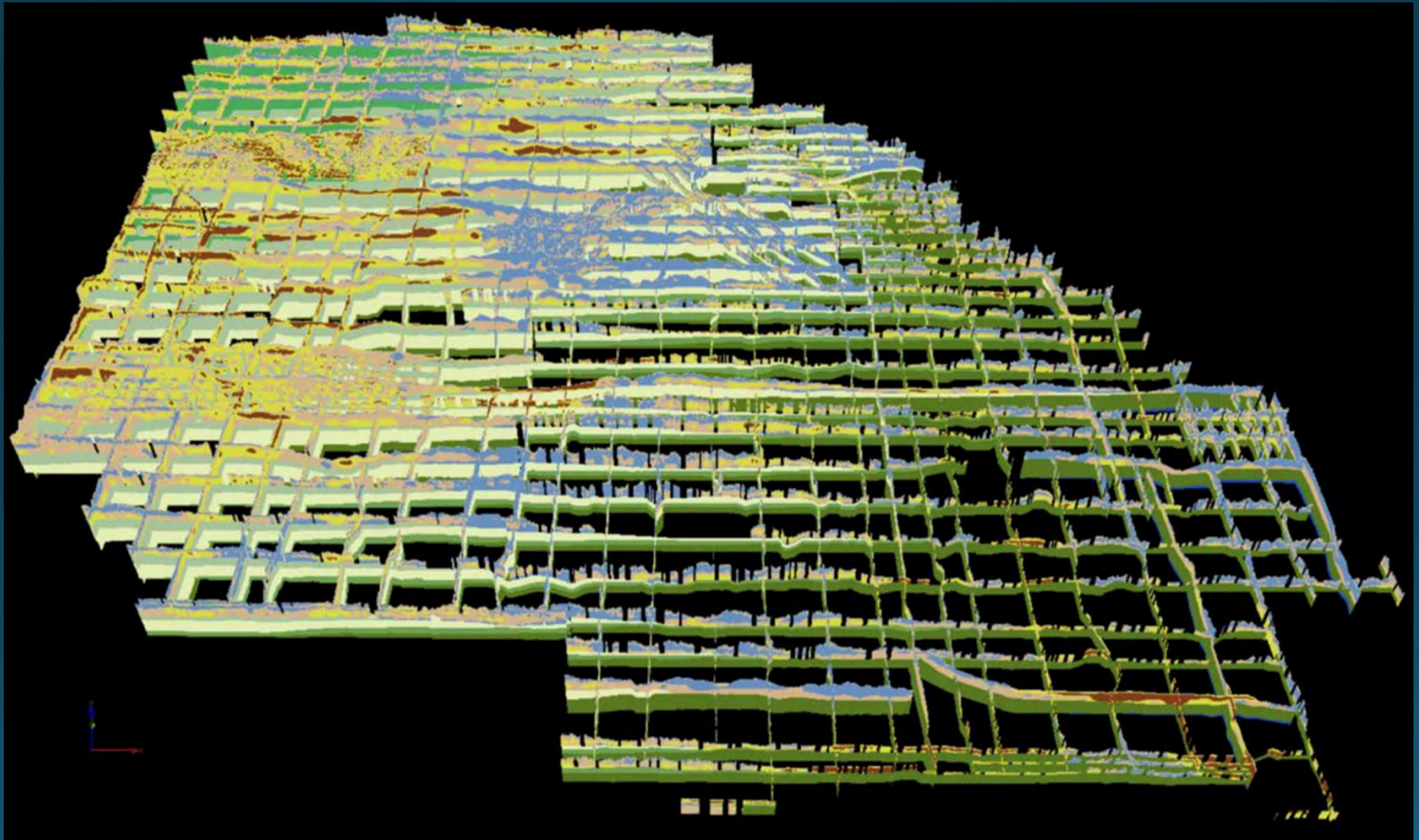
# Hydrogeologic Framework Without AEM Using Boreholes Only



# Framework With AEM

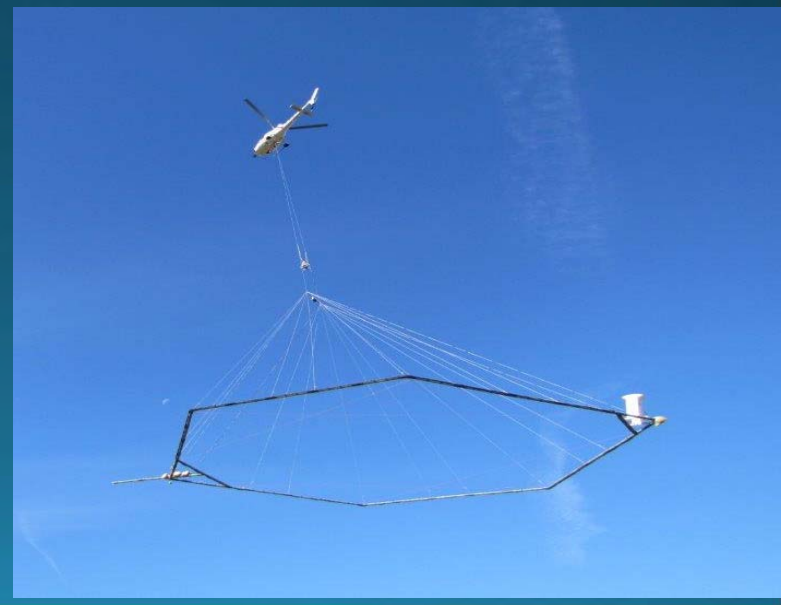


# Lower Elkhorn AEM Survey Area 2007-2018



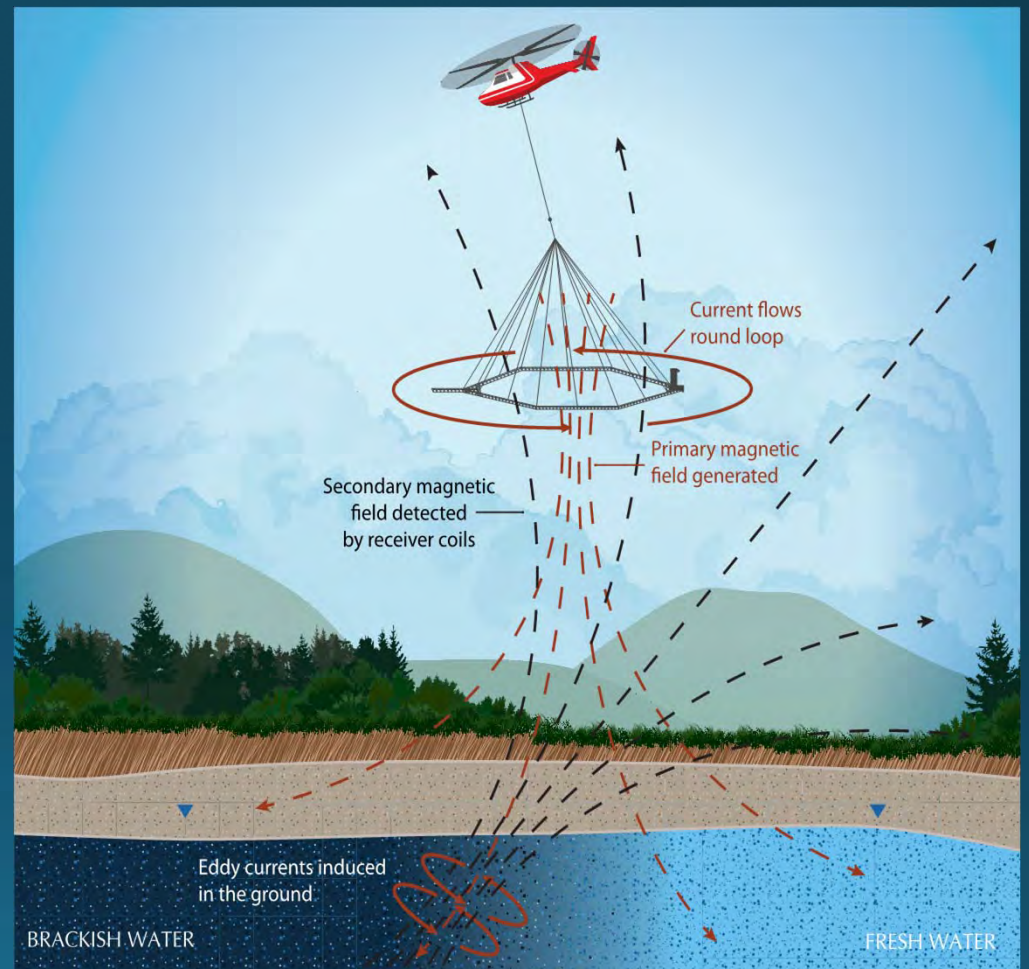
# Lower Elkhorn NRD AEM Survey Objectives

- Improve the Hydrogeologic framework of the LENRD
- Provide Reconnaissance Level Profiles and 3D representations of the hydrogeology
- Provide a detailed framework in the Pierce Block flight area
- Provide information on boundary conditions within the subsurface
- What is the hydrologic connections between groundwater and surface water in the survey areas.
- Potential of groundwater recharge areas



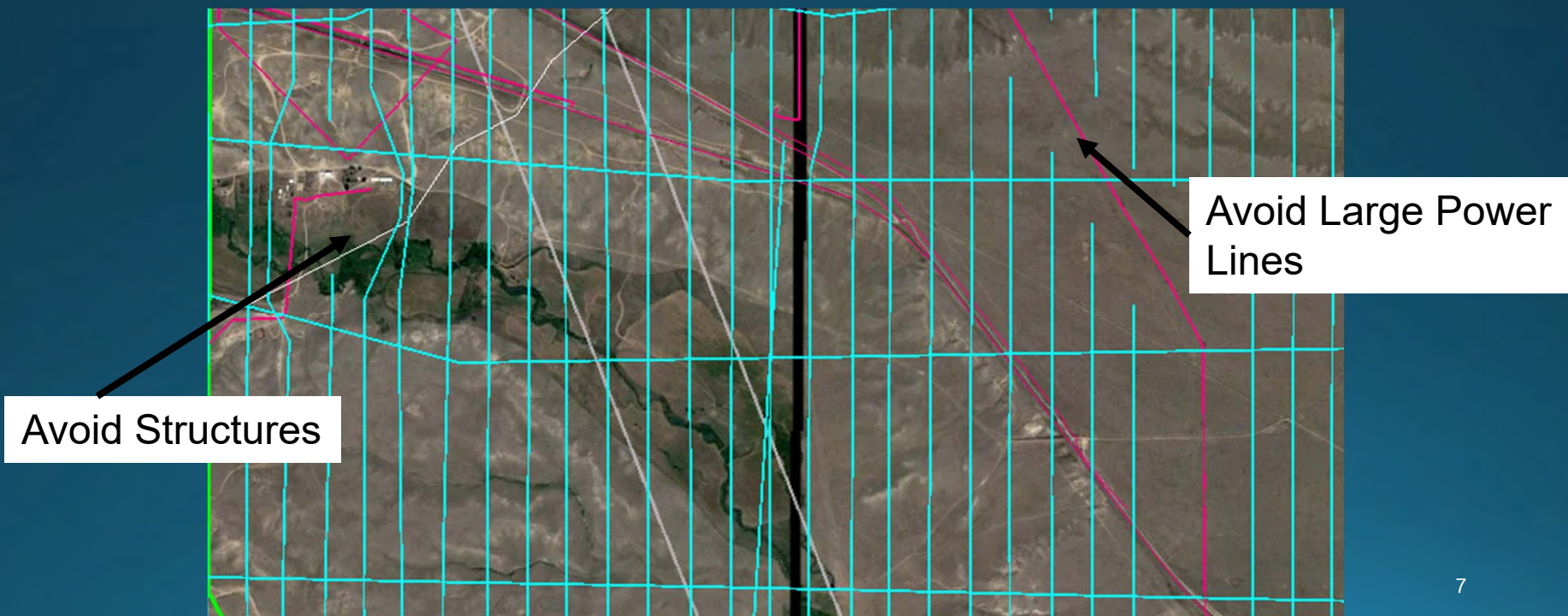
# AEM Fundamentals

- Airborne Geophysical Techniques
  - Electromagnetic – Time Domain (TDEM) or Frequency Domain (FDEM)
  - Gravity Gradient (Tensor)
  - Total-Field Intensity Magnetics
  - Radiometrics
- Surveys typically use multiple techniques to create contrast in physical properties



# Flight Line Planning for Each Project

- Maps of electrical lines along AEM flight lines
- Maps of pipelines and other infrastructure along the AEM flight lines
- Inspection of Google Earth coverages along each flight line for dwelling, CAFOs , and other no fly objects
- Provide detailed flight lines for navigation
- Build a detailed borehole database

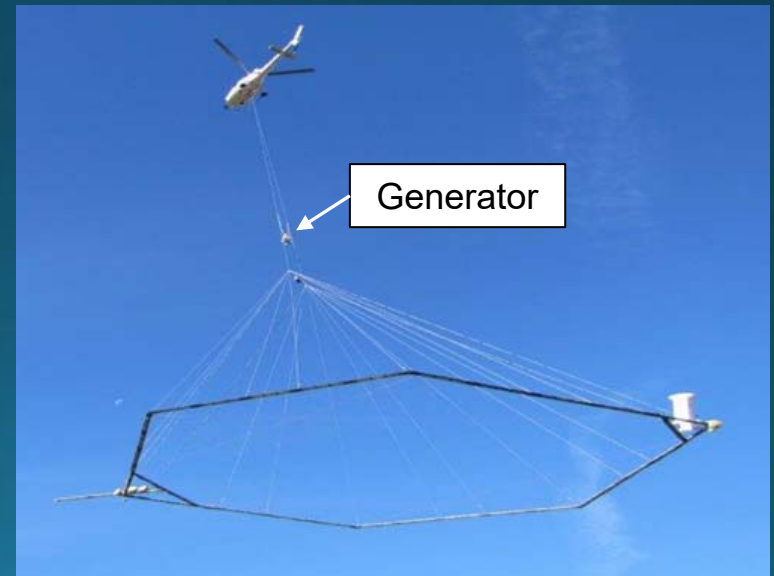


# Helicopter AEM Operation



*Usually 2-3 Flights/day  
Totaling about 180-250 line-miles/day  
Approx. 100' – 150' above ground*

*Along-Line Data Density,  
Post Processing,  
Approximately Every ~ 100 ft*





# QA/QC and Initial Preliminary Inversions

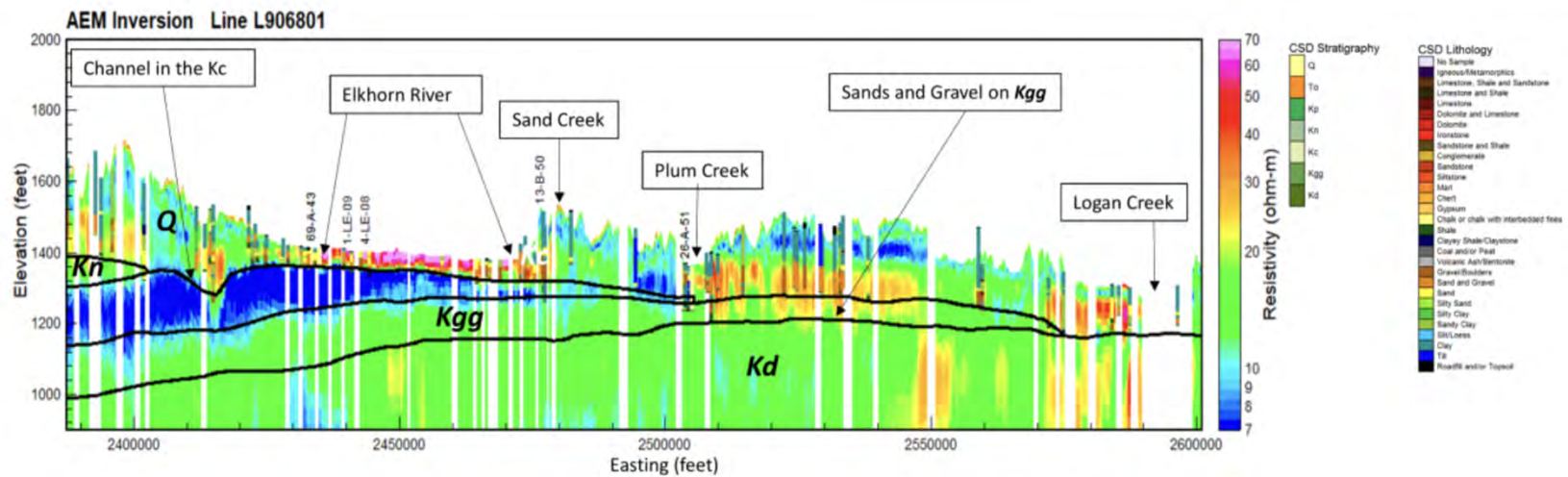
- QA/QC of collected data continued throughout the data collection process on every day's collected data
- Unacceptable data was recollected
- Initial preliminary inversions began immediately upon data availability

# Existing Geologic Data

- Use CSD test-hole database
- Use CSD historical cross sections
- Use selected DNR well logs
- Use selected oil and gas well logs
- Use any other pertinent information
- Water table elevations

Utilize as much existing and accurate geologic test-hole data as possible!

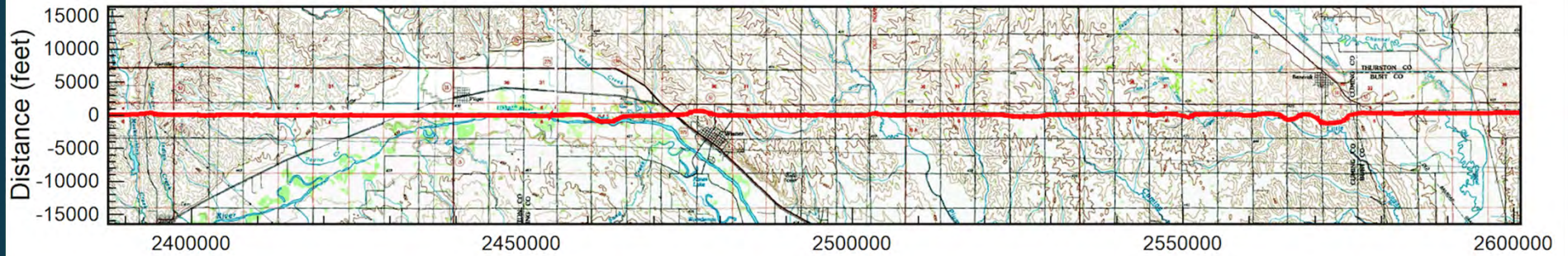
# Interpreting Resistivity



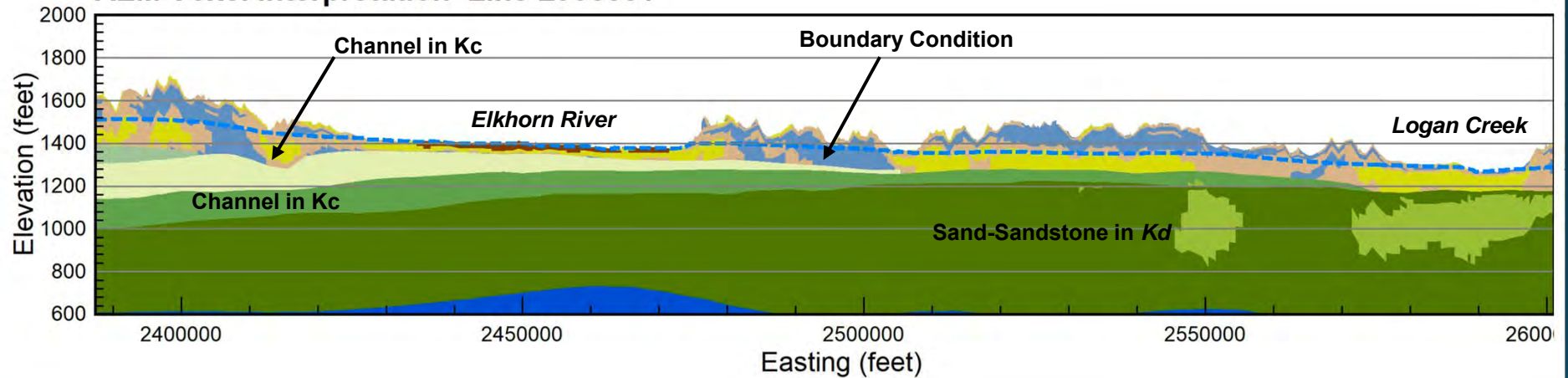
(Q) = Quaternary  
 (Kn) = Cretaceous Niobrara Formation  
 (Kc) = Cretaceous Carlile Shale  
 (Kgg) = Cretaceous Greenhorn Limestone and Graneros Shale  
 (Kd) = Cretaceous Dakota Group

# Interpreted Section

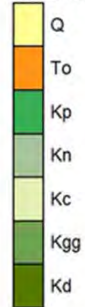
Flightline Position Line L906801 >>>



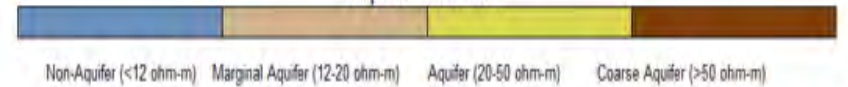
AEM Voxel Interpretation Line L906801



CSD Stratigraphy



Aquifer Materials



# Lower Elkhorn NRD 3D Map of Aquifer Materials Showing changes in Lithology That Act as Boundary Conditions to Groundwater Flow.

