



Effects of Liquid Manure Seepage on Groundwater – Geophysical Testing Results



LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Till E. Angermann

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Presumption

Must be leaking like a sieve

CVDRMP Lagoon Investigations

Objective: *Generate a knowledge base to aid in evidence-informed decisions regarding the fate of earthen dairy lagoons*

Questions we answered

1. At what rates does lagoon liquor percolate and how does this compare to NRCS design seepage rates?
2. Are there significant seepage differences between lagoons (e.g., between sandy vs. clay-rich soils)?
3. How do lagoon loading rates to the subsurface compare to crop land loading rates?
4. How do loading rates compare to groundwater quality?
5. What is the extent of local impacts to groundwater quality?

Methods

Site/Lagoon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Water Balance Test			✓			✓			✓	✓	✓	✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Lagoon Perimeter Soil Borings		✓	✓		✓	·	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓											
Monitoring Wells	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Geophysical Survey	✓	✓	✓	✓	✓				✓	✓	✓			✓	✓	✓	✓											

Lagoon and Site Characteristics

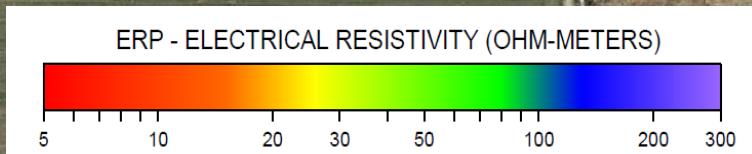
- Minimal or no lagoon construction records
- Lagoon ages: <10 to ~50 years
- Lagoon depths: 8-30 feet
- Native materials: sand, loamy sand, sandy loam, loam, clay loam, silty clay

Electrical Resistivity Profiling of Earthen Materials

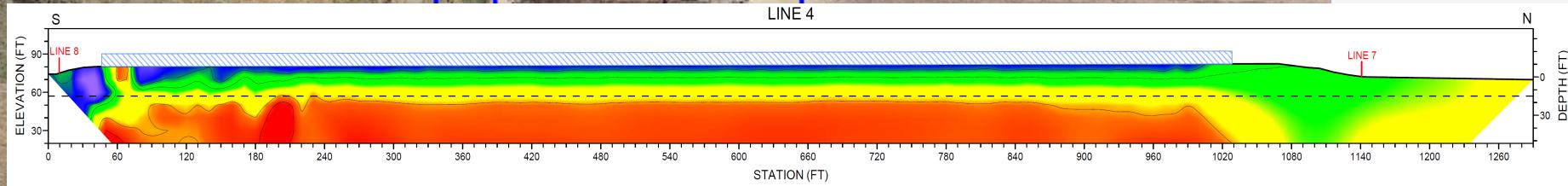
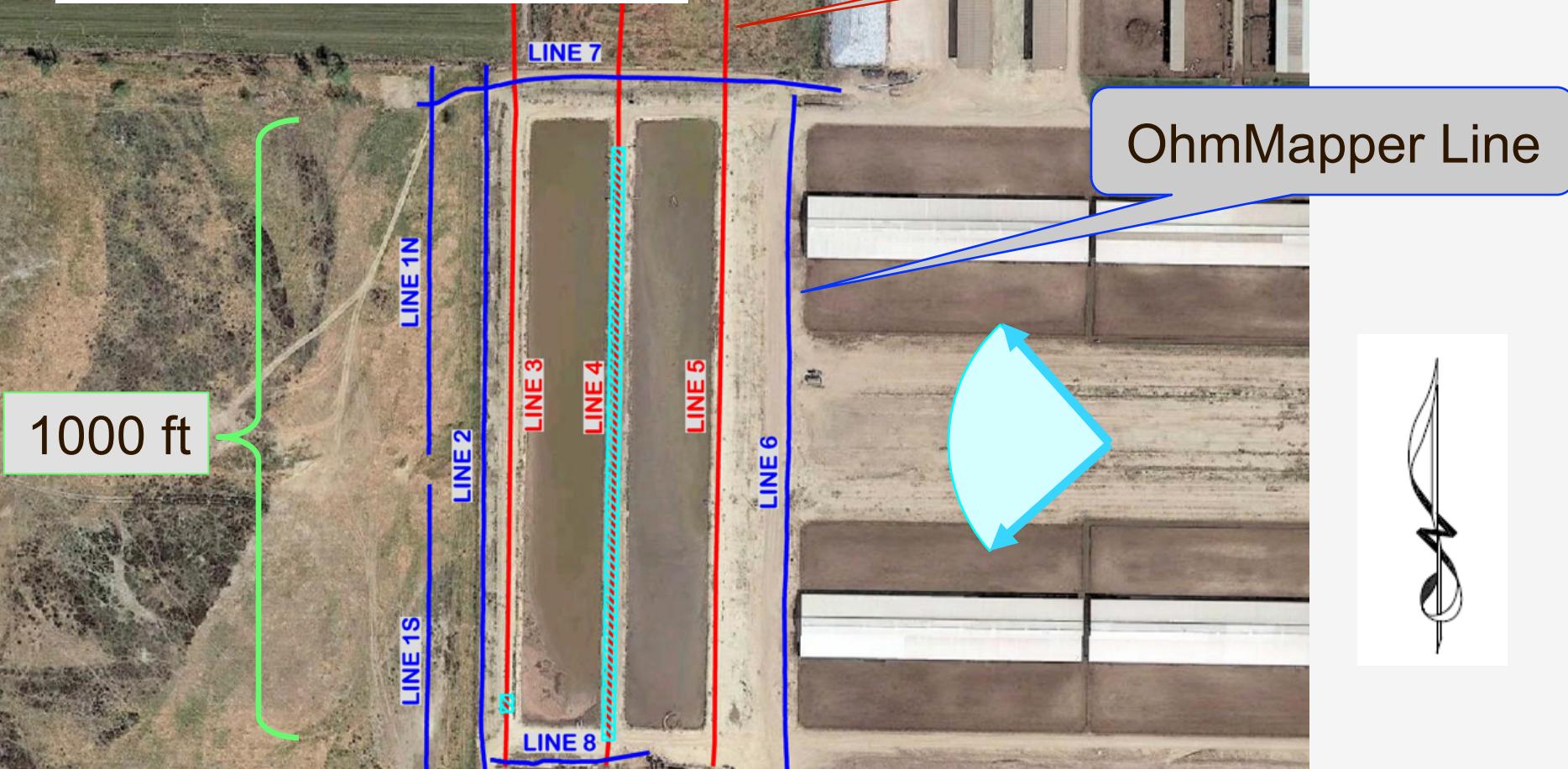
- Measure of the resistance of a volume of material to the flow of electrical current
- Variables affecting ER: mineralogy, porosity, permeability, water content, salinity of pore water
- Gravel/sand more resistive than silt/clay
- ER of saturated materials GREATLY affected by free ions in solution
- Earth materials invaded by highly conductive fluids (e.g., lagoon nutrient water) exhibit **anomalously low ER**
- Electromagnetic (EM) survey quantifies ground conductivity

Electrical Resistivity Profiling – Interpretation and Color Scheme

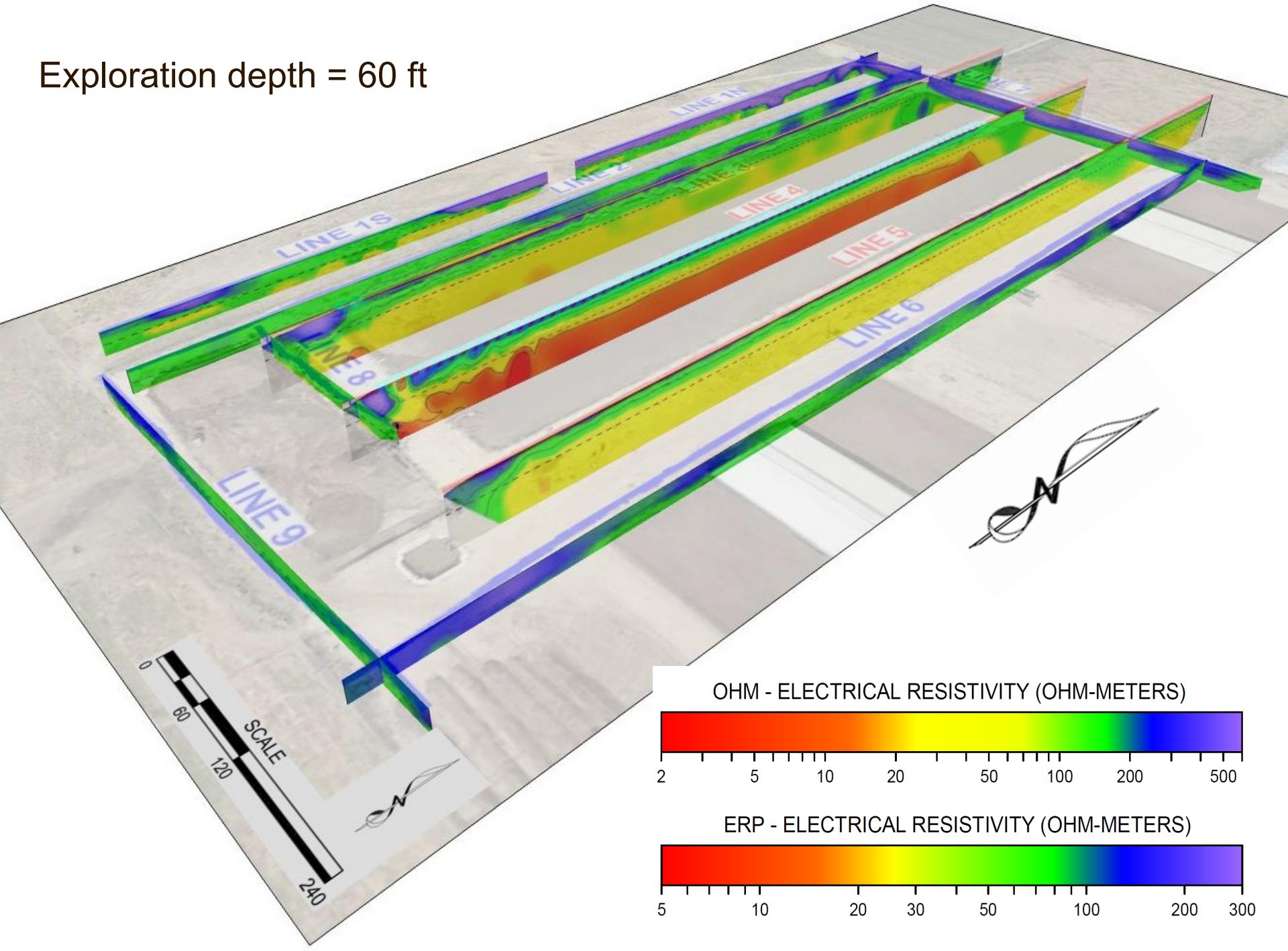
- ER values are relative to a starting model based on all measurements in a given survey (unique for every survey)
- Cannot compare results from one survey to another
- Changes of ER are more important than absolute values
- Hot colors (orange and red) delineate **anomalously low** ERs; interpreted as areas invaded by highly conductive water
 - Hot colors may represent different ERs between surveys
- Same applies to EM

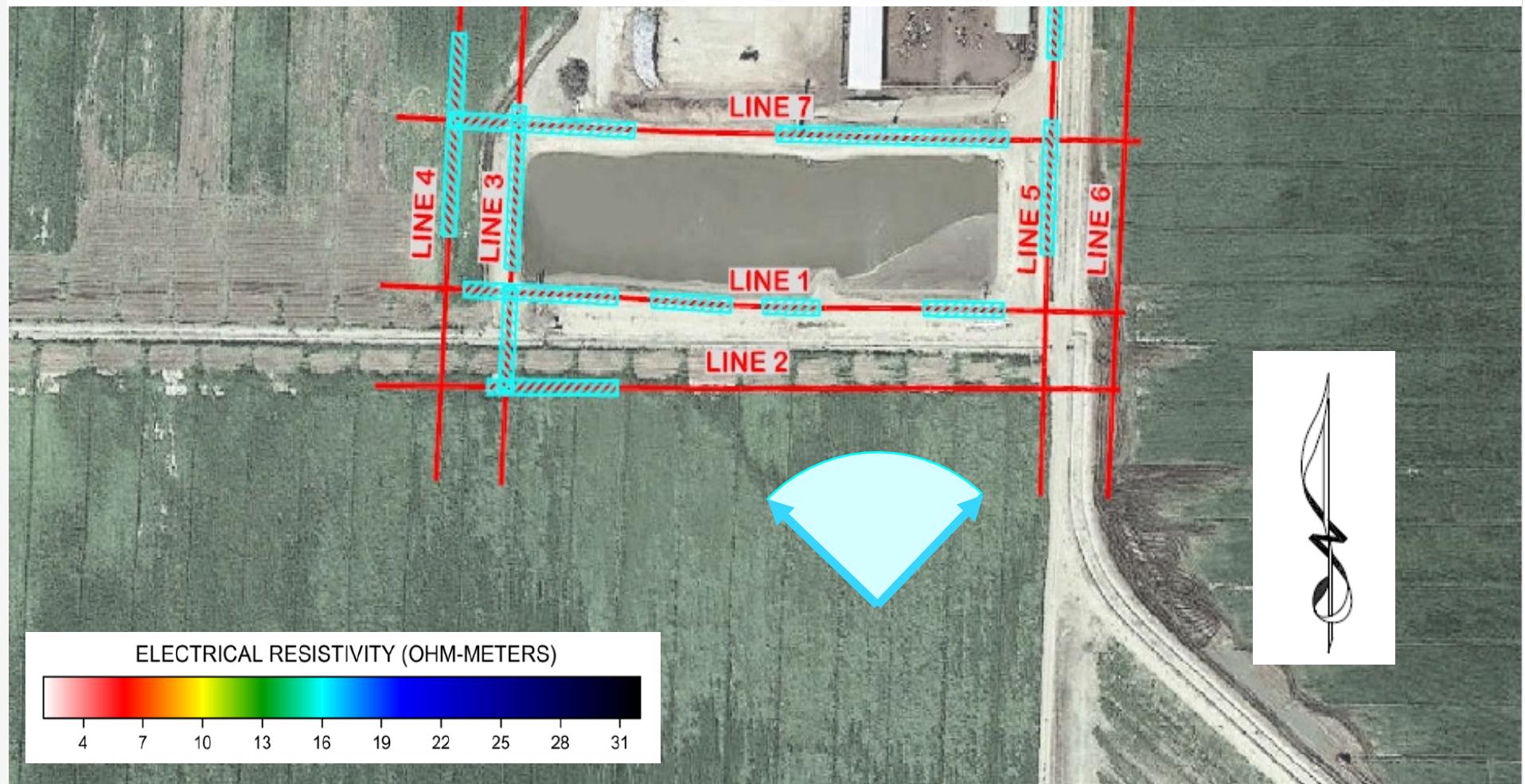
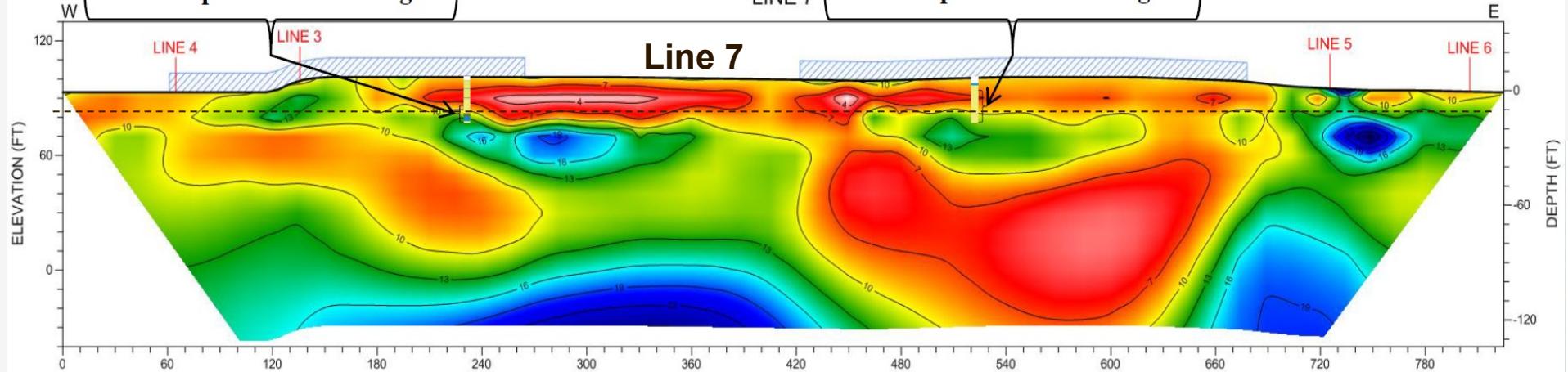


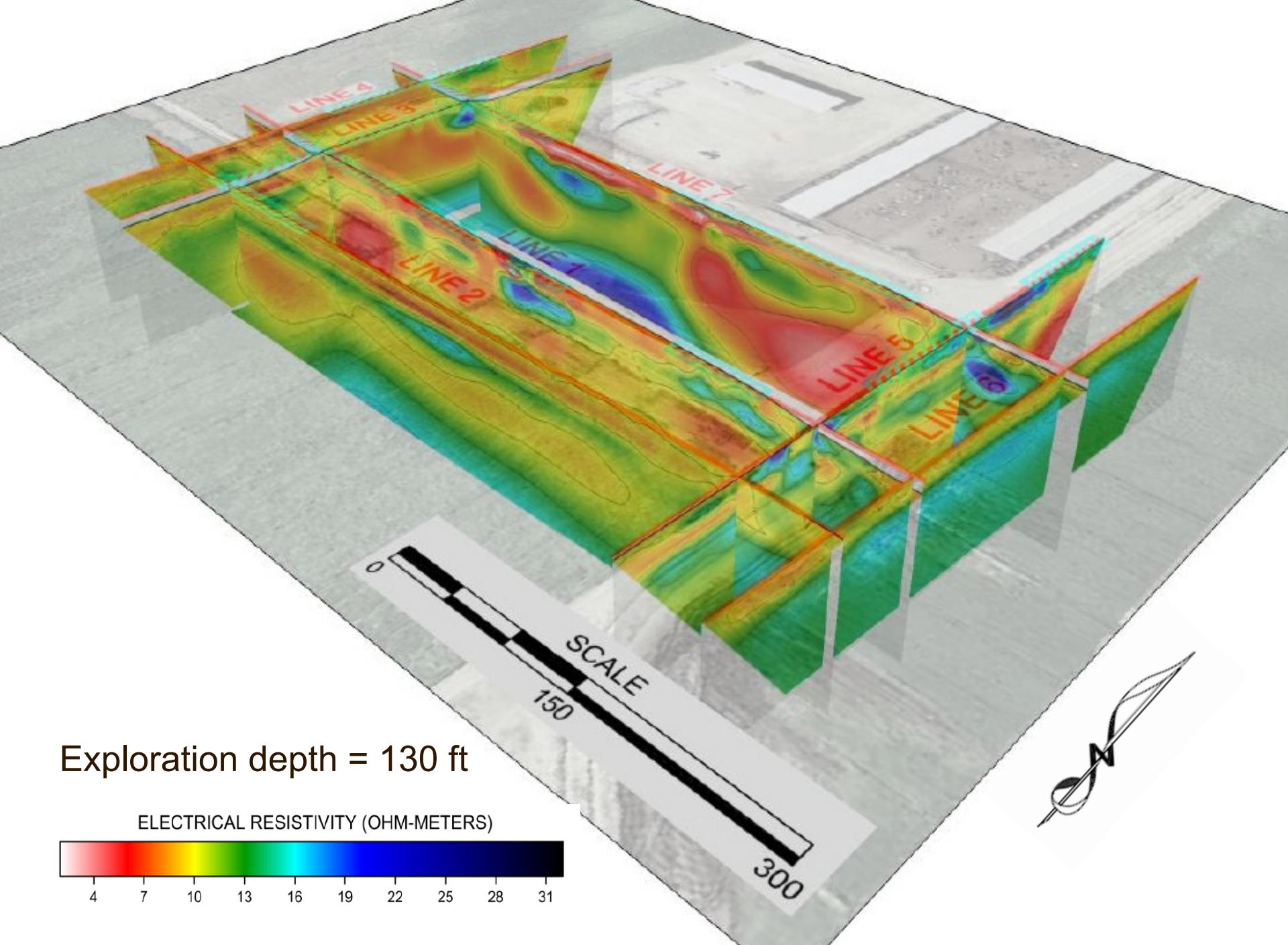
ERP Line

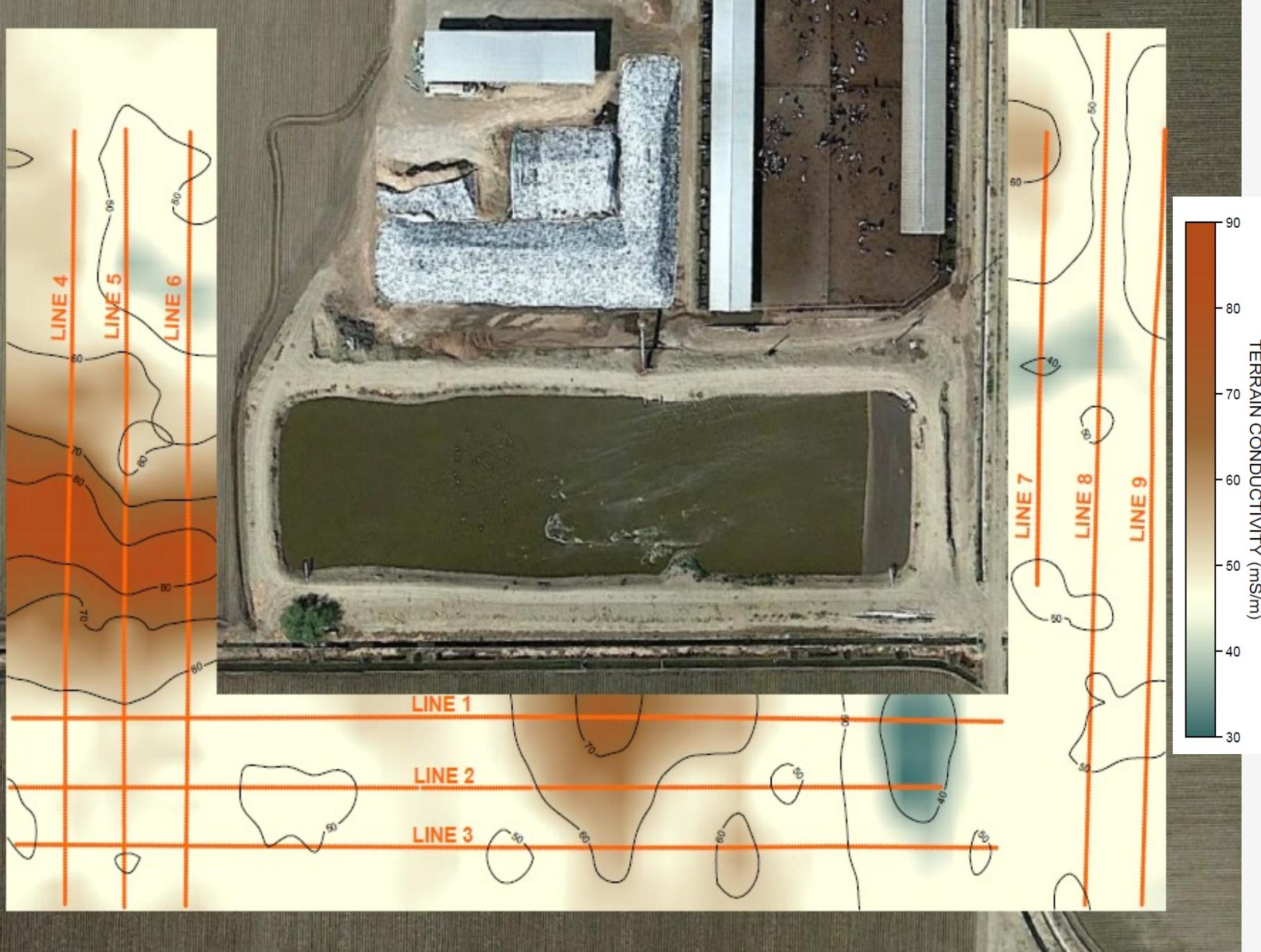


Exploration depth = 60 ft









Endnotes

- Traditional ERT produced the most useful results
 - Lateral salinity impacts appear relatively small
 - Vertical salinity impacts sometimes exceeded exploration depth of 60 ft
- OhmMapper & EM did not provide sufficient exploration depth
- Some challenges:
 - conductive structures (e.g., fences, power lines)
 - land ownership
 - other salinity sources (e.g., corrals, manure drying & composting areas, leachate from silage, manured forage fields)

A photograph of a sunset over a calm body of water, likely a lake or reservoir. The sky is a gradient of warm colors from orange to blue. In the foreground, dark silhouettes of bare bushes and branches frame the scene. The water reflects the sky's colors.

Thank You