SAGEEP2021

14-19 MARCH 2021 | ONLINE

# Lessons Learned in a Consulting Career Using Near-Surface Geophysics

*John A. Mundell, P.E., L.P.G, P.G., President/Senior Consultant, Mundell & Associates, Inc.*

33rd Symposium on the Application of Geophysics to Engineering and Environmental Problems

1st Munitions Response Meeting

WWW.SAGEEP.ORG

# *SAGEEP 2021*
# *March 16, 2021*

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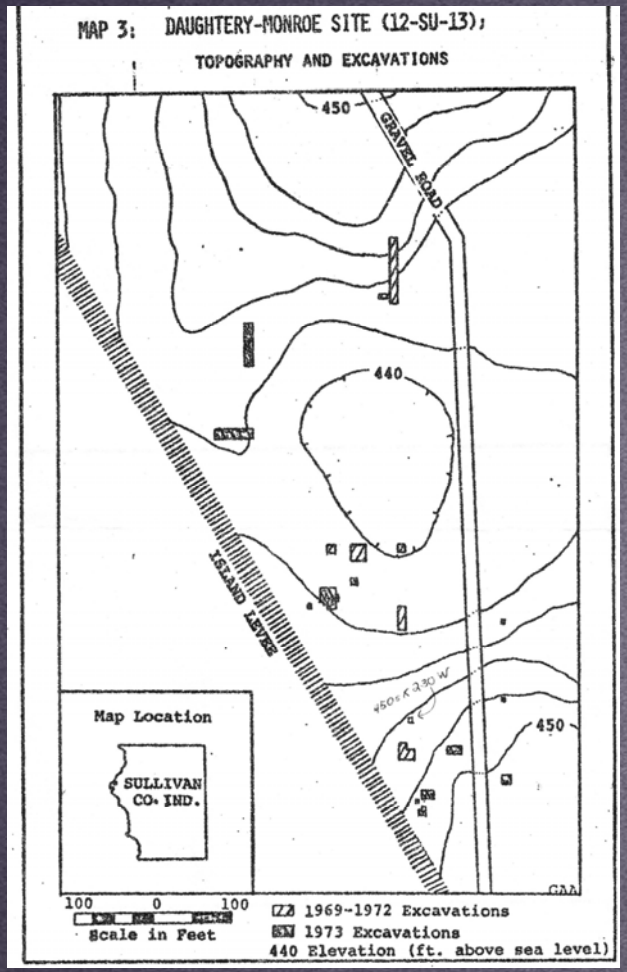
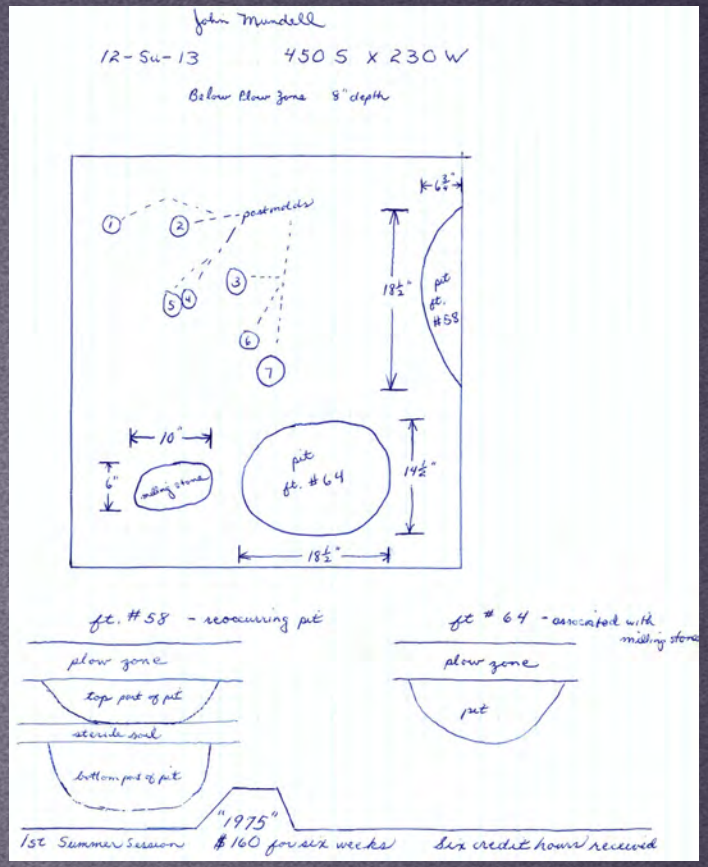
Mundell & Associates, Inc.

**Cortez, Colorado 2001**






# ARCHAEOLOGY
# Part 1

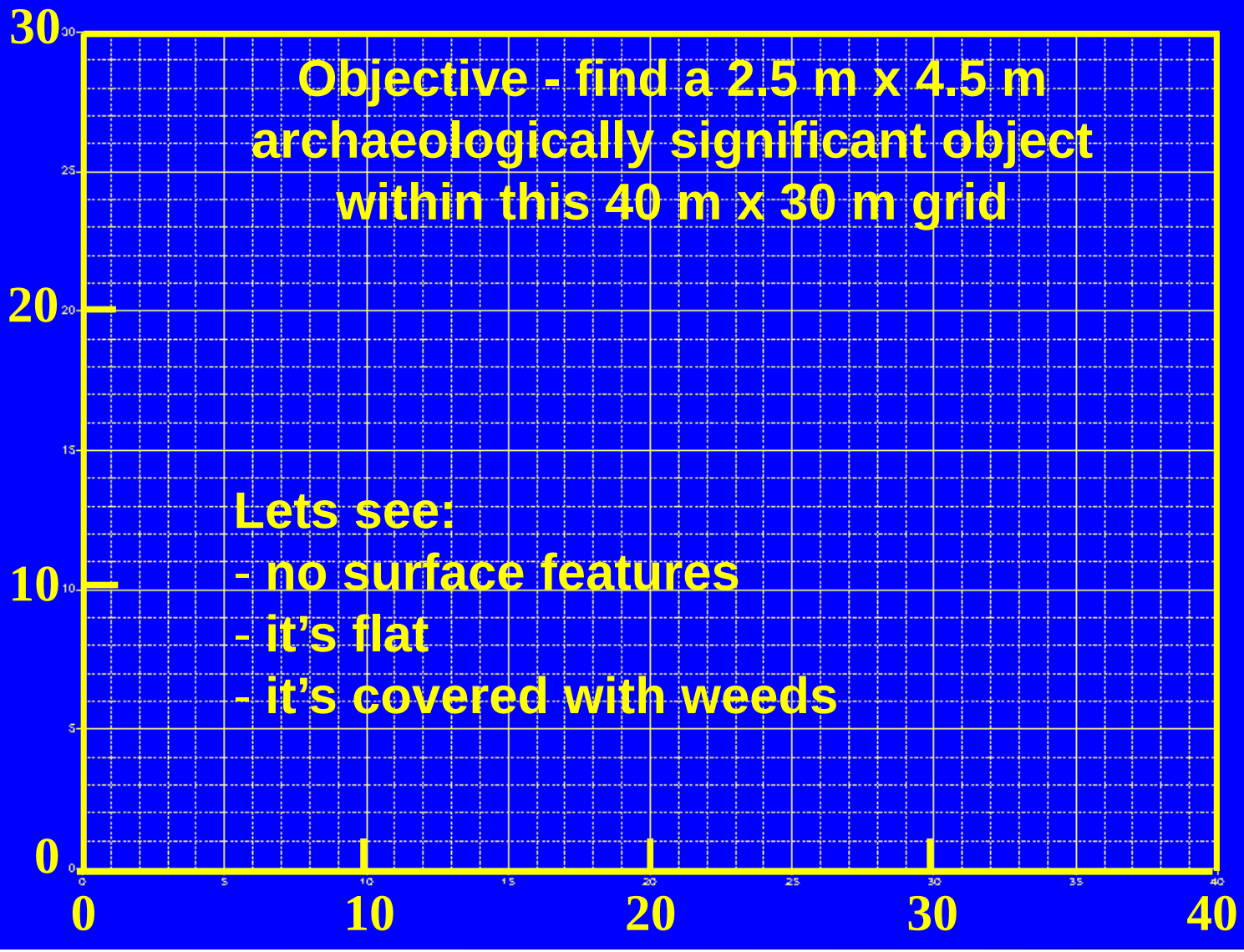
## SUMMER 1974

## PLANTING THE SEEDS

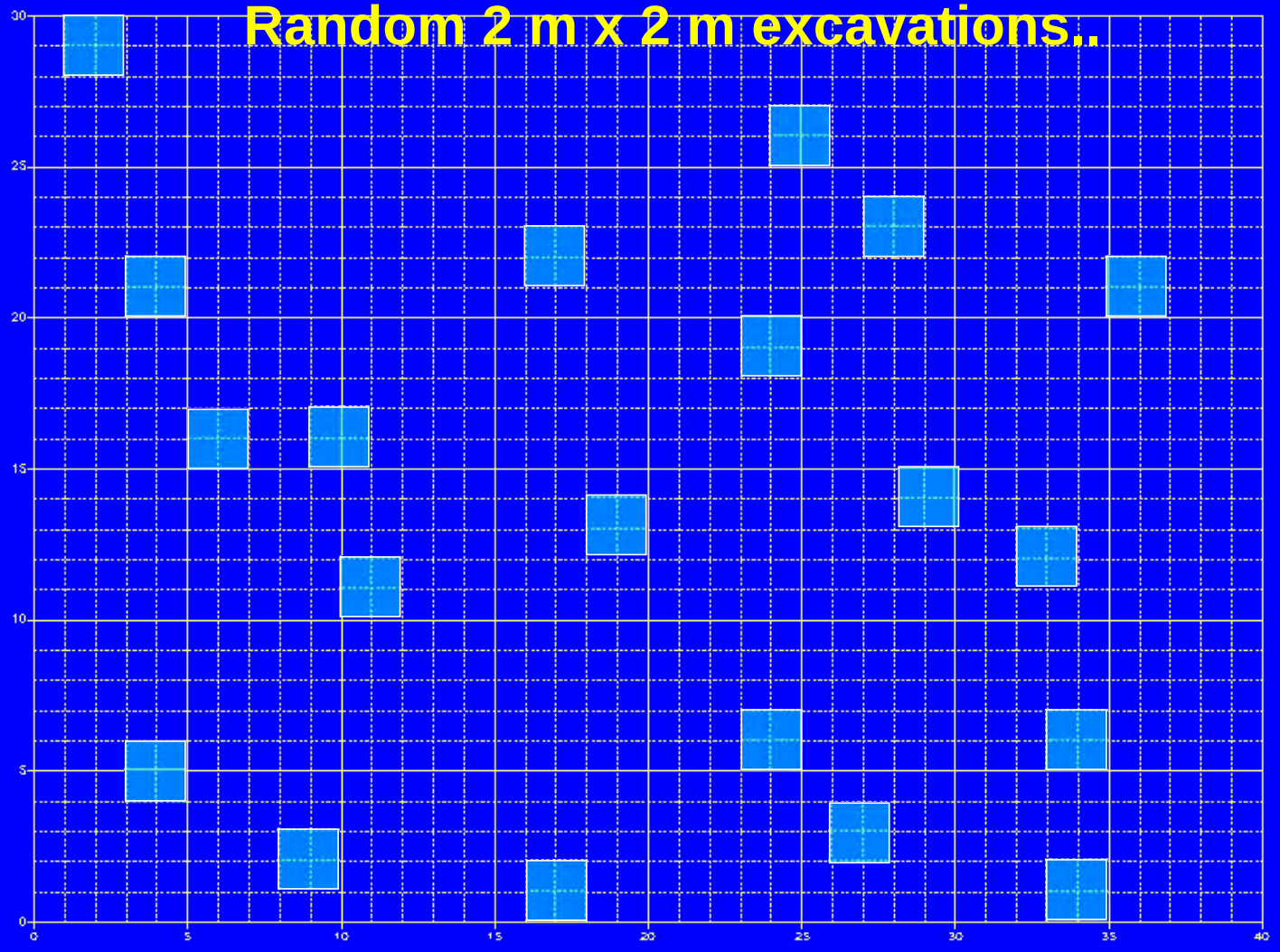
# Lesson Learned No. 1

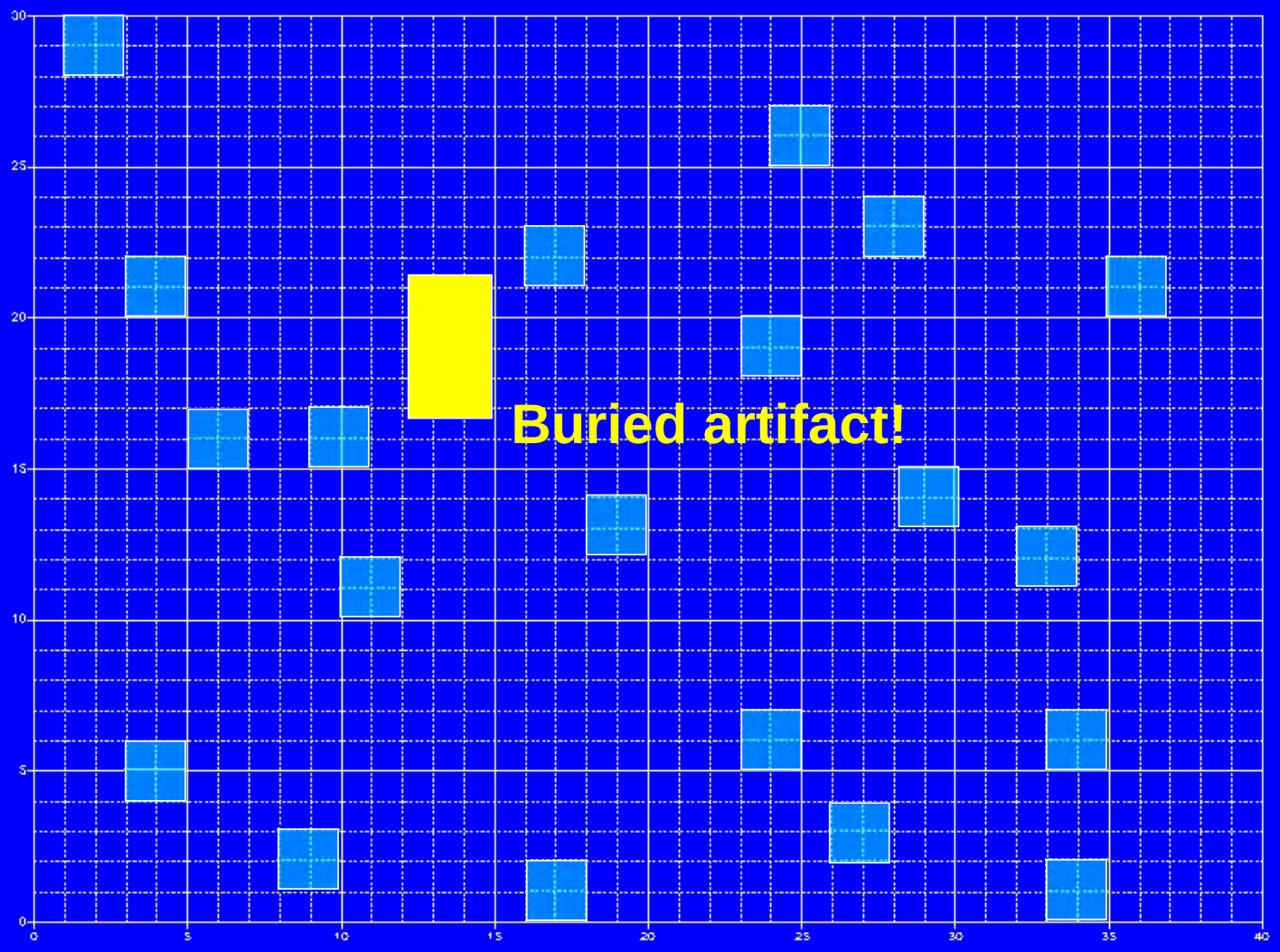
Subsurface exploration is exciting and fun….when you find something of value!

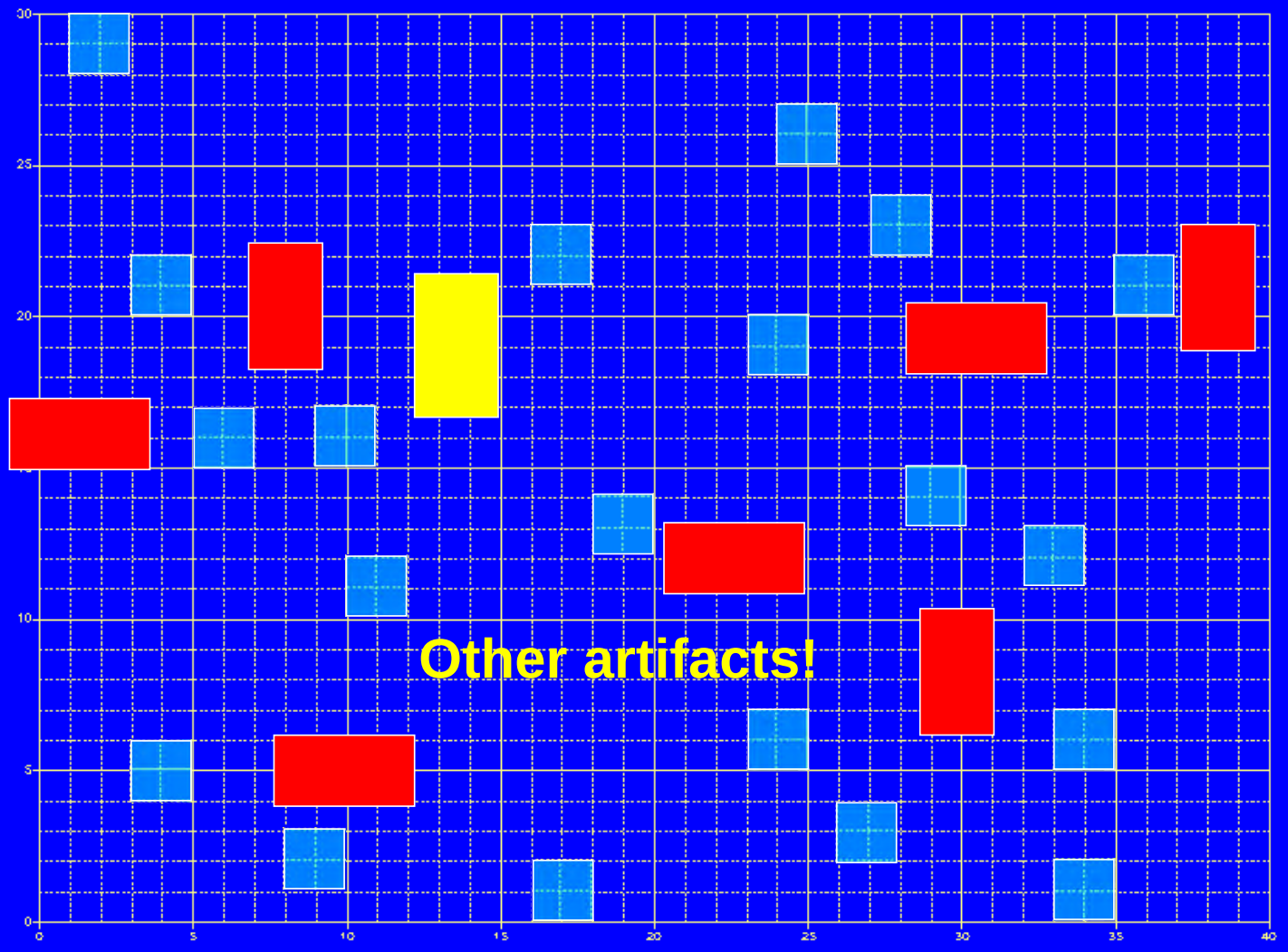
When you don’t (and miss it)….it sucks!

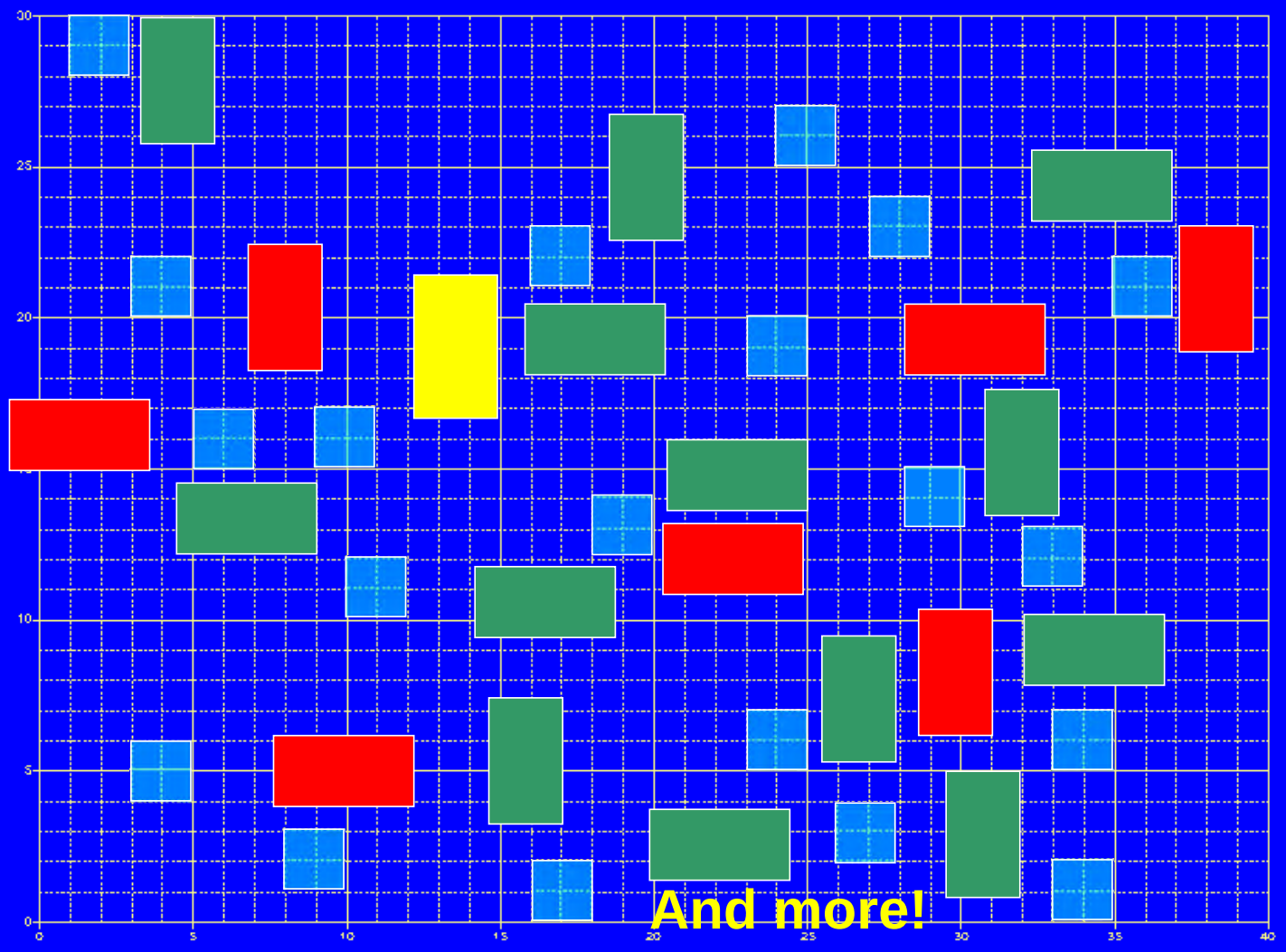

Objective - find a 2.5 m x 4.5 m archaeologically significant object within this 40 m x 30 m grid
Lets see:
- no surface features
- it's flat
- it's covered with weeds
30
20
10
0
0
10
20
30
40

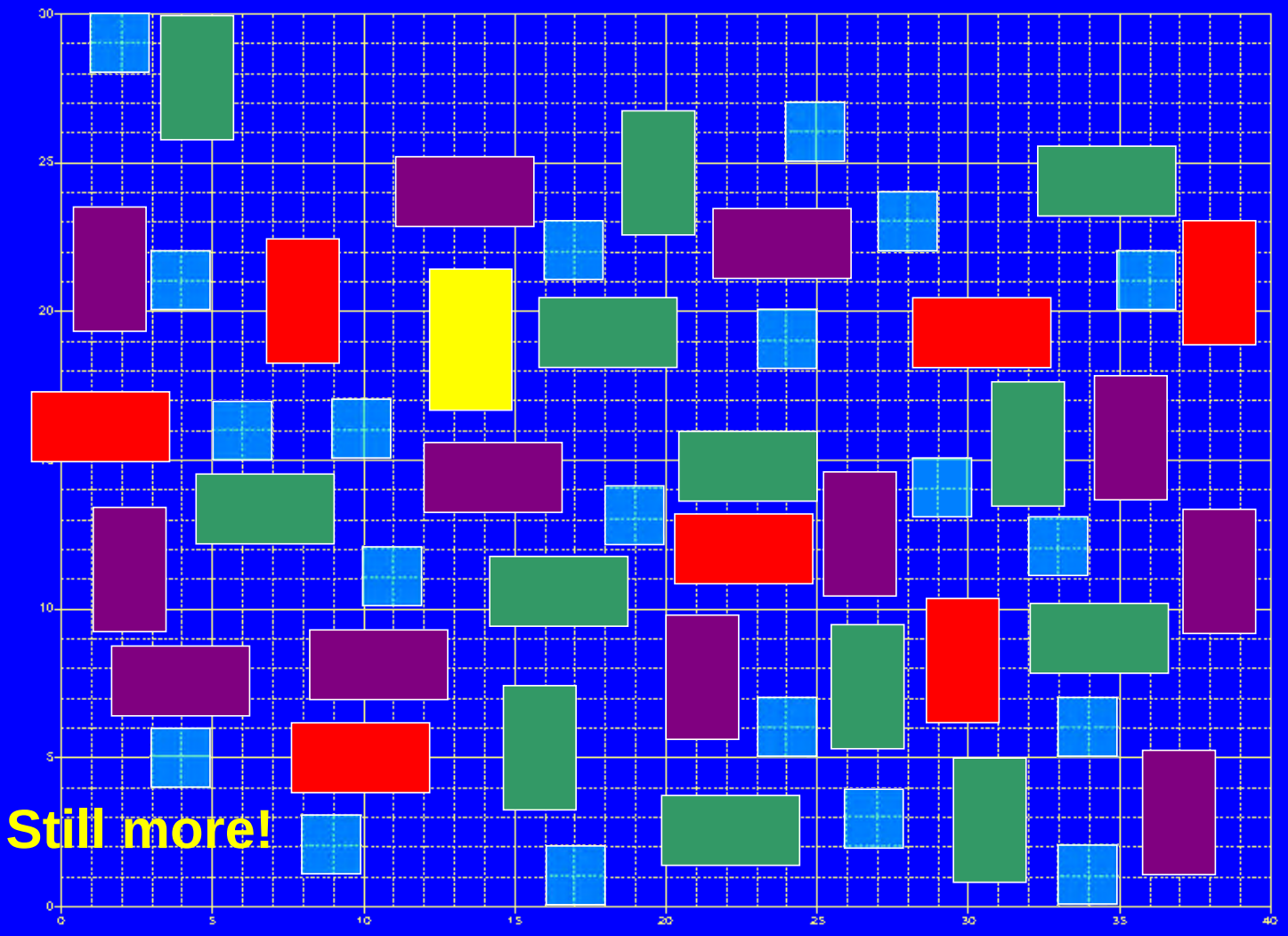
# Random 2 m x 2 m excavations..




Buried artifact!
30
25
20
15
10
5
0
0
5
10
15
20
25
30
35
40


30
25
20
10
5
0
0
5
10
15
20
25
30
35
40
Other artifacts!


30
25
20
10
5
0
0
5
10
15
20
25
30
35
40
And more!




Still more!

# Lesson Learned No. 2

The odds of finding buried features is low when the sampling locations are widely spaced, and the targets are small compared to the sample separation distances.

It’s simply about probability!

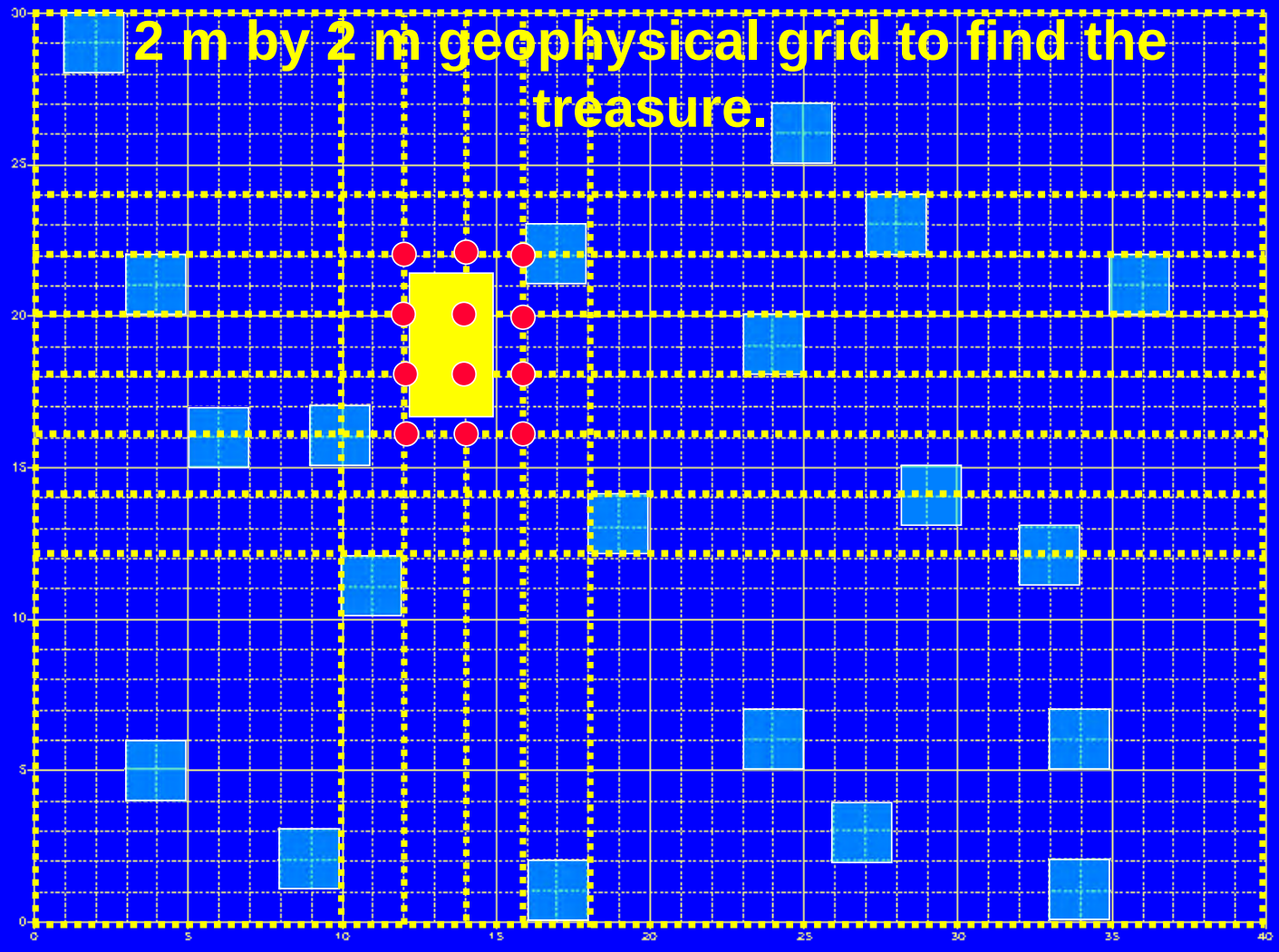
# Lesson Learned No. 2

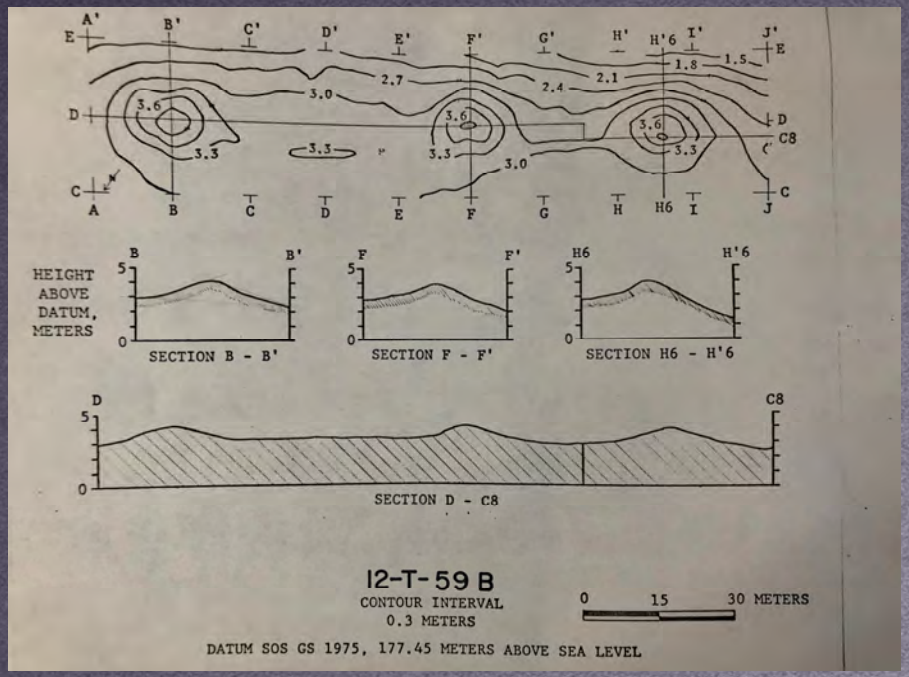
The odds of finding buried features is low when the sampling locations are widely spaced, and the targets are small compared to the sample separation distances.

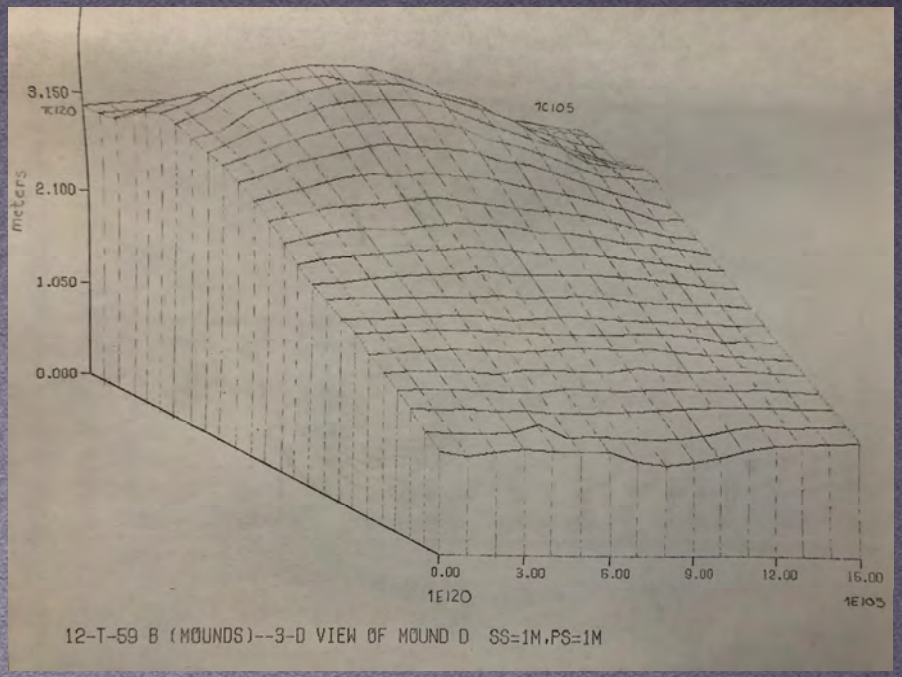
It's simply about probability!

Question  Is there a way to improve the odds?

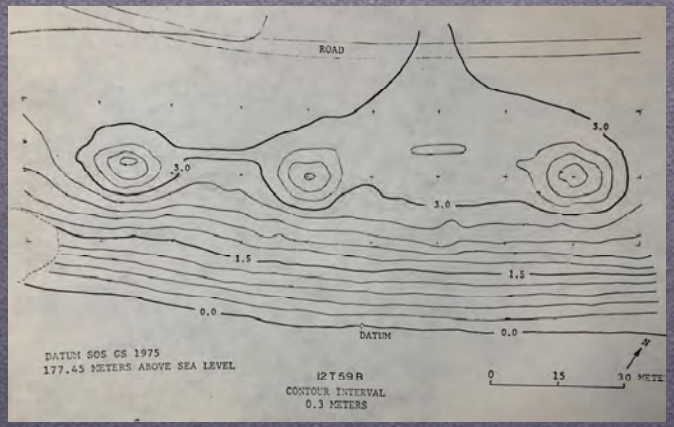
It would have taken a 2 m by 2 m geophysical grid to find the treasure.





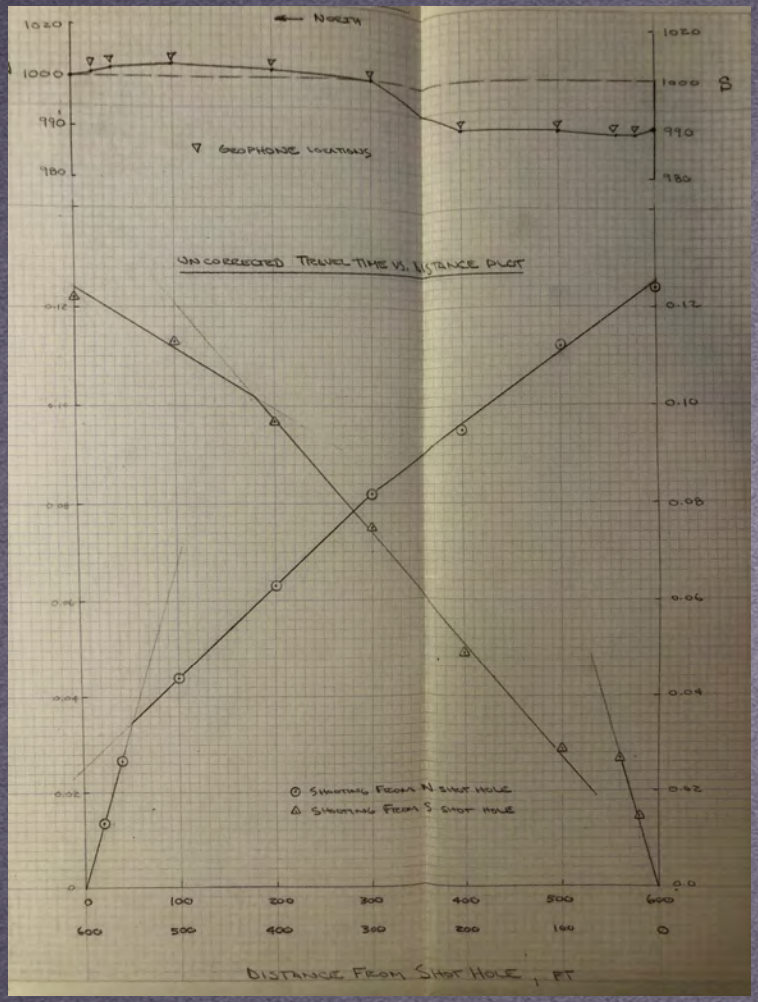

# TOPOGRAPHY

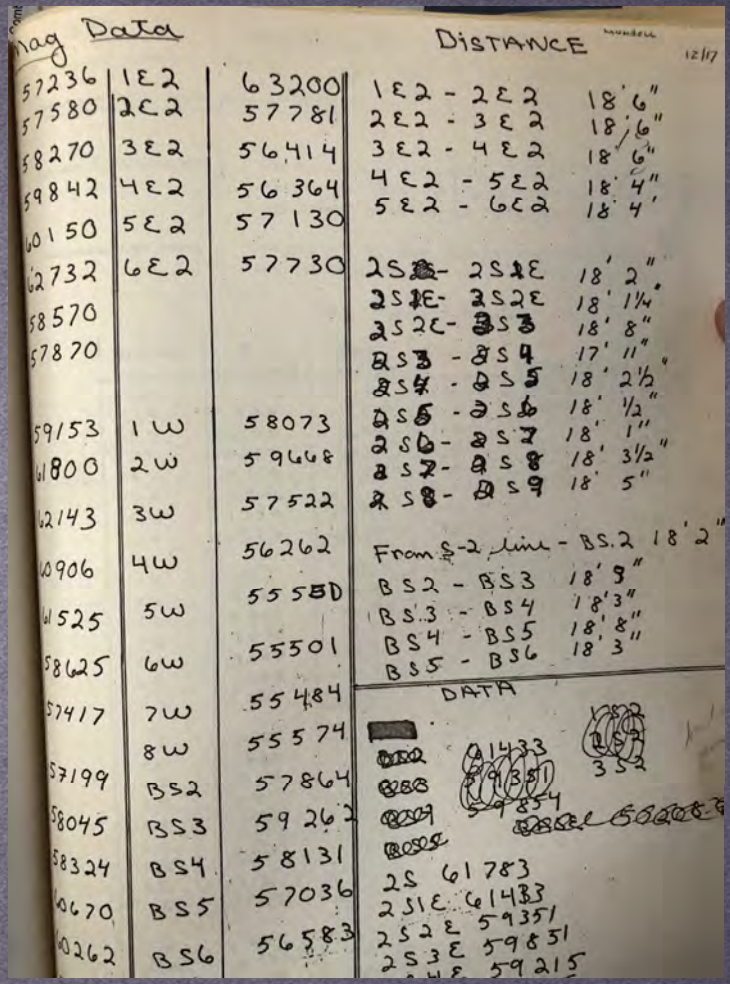



# ARCHAEOLOGY
# Part 2

## SUMMER 1976

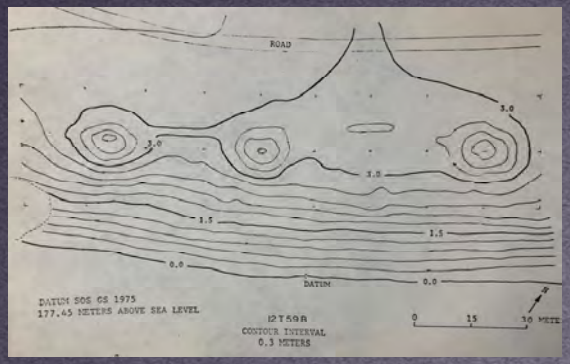
## WATERING THE SEEDS



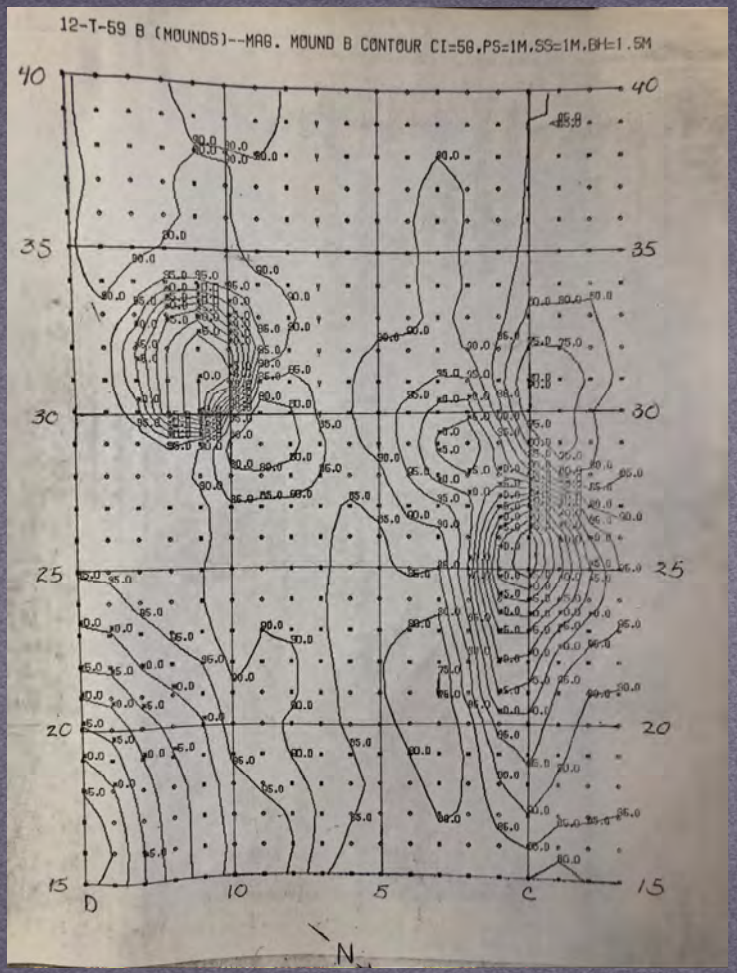




**SUMMER 1976**

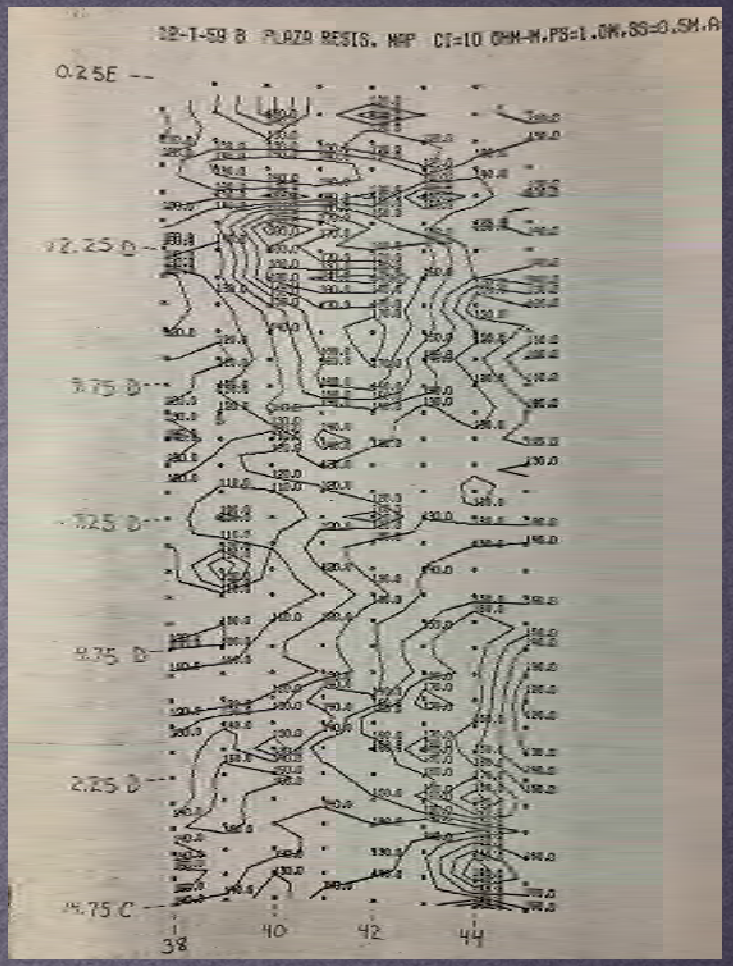
**FIELD DATA COLLECTION**




TOPOGRAPHY

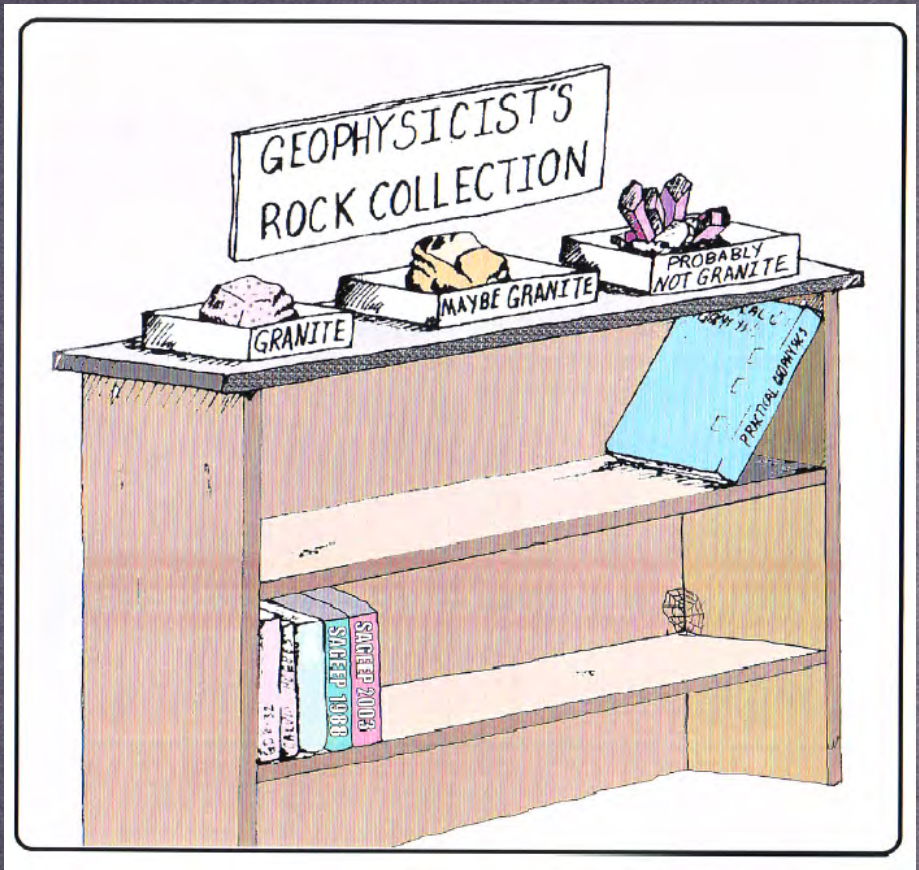


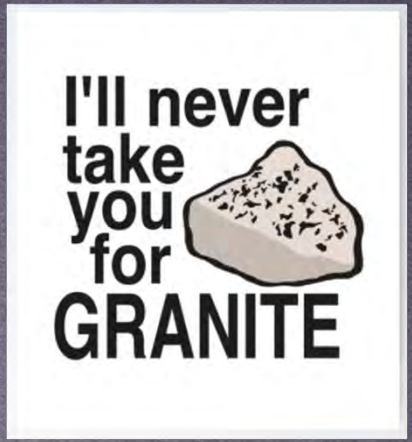

MAGNETICS

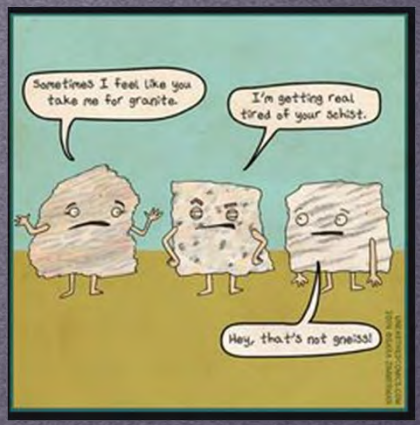



RESISTIVITY

SUMMER 1976




## UNCERTAINTY

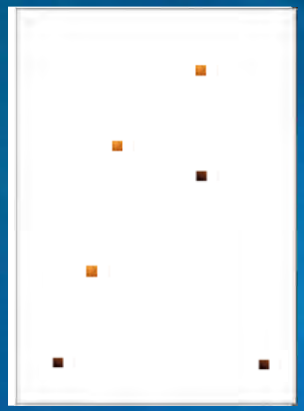
# Lesson Learned No. 3

Even when you've collected good data from the field and have done everything right, if you are unable to communicate that data in a way that is convincing, people will not believe what you did has value.

You have to make your results look believable!

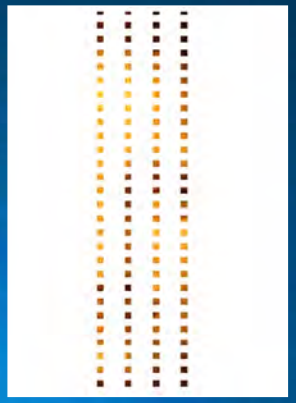
Question: How have we done that?

# DATA ACQUISITION DENSITY AND ITS RELATIONSHIP TO MEETING CHARACTERIZATION OBJECTIVES



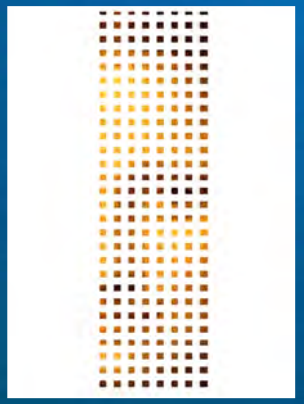
Random

Single row, Perimeter

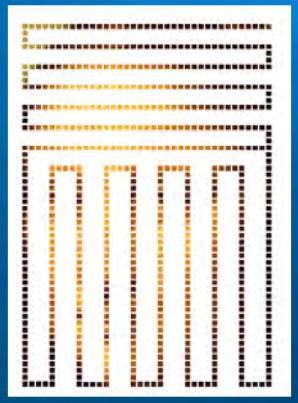


Low Density, Center

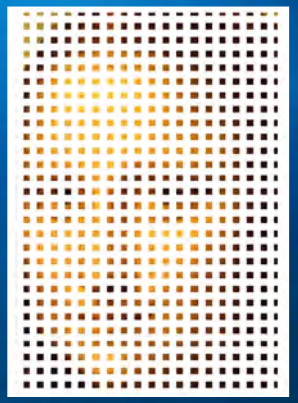
Single Row Cross



Medium density, Center



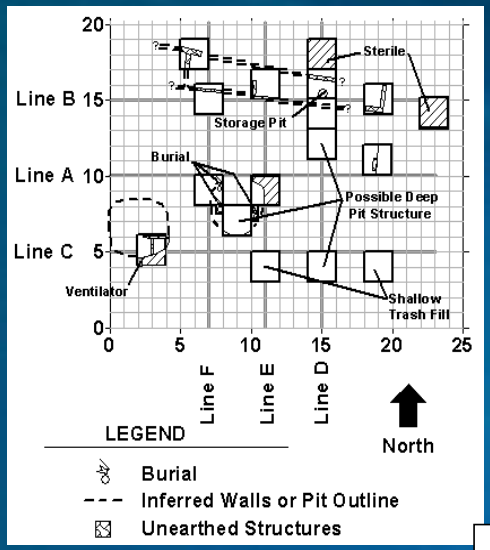
Low density, Meandering

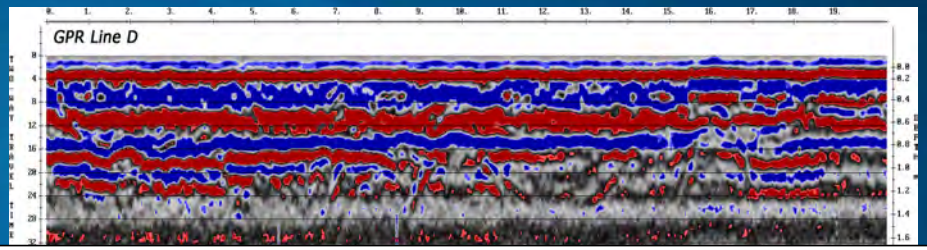


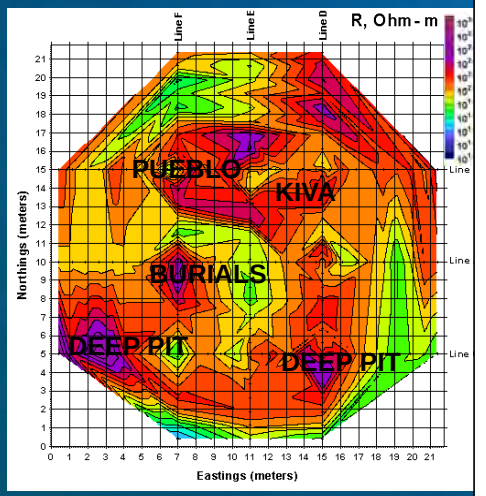
Medium density, target

High density, target

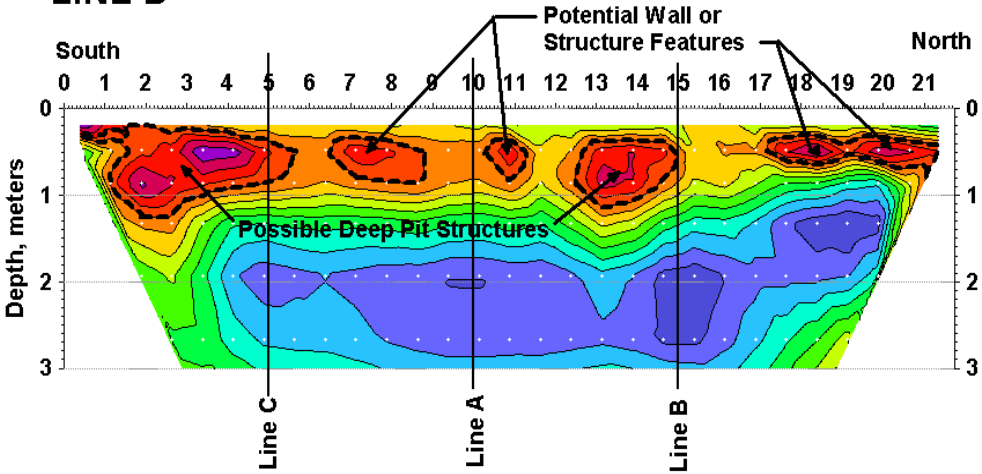
**REPORT FIGURE QUALITY**



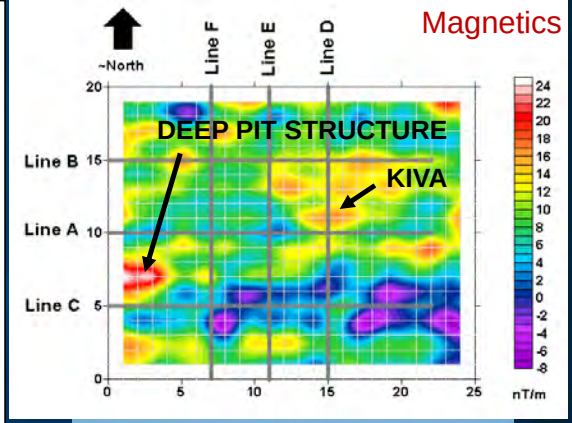



Electrical Resistivity "slice"




2D-Electrical Resistivity



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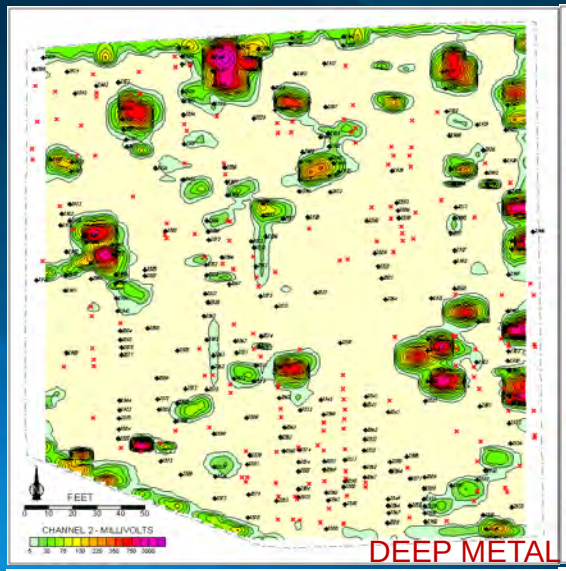
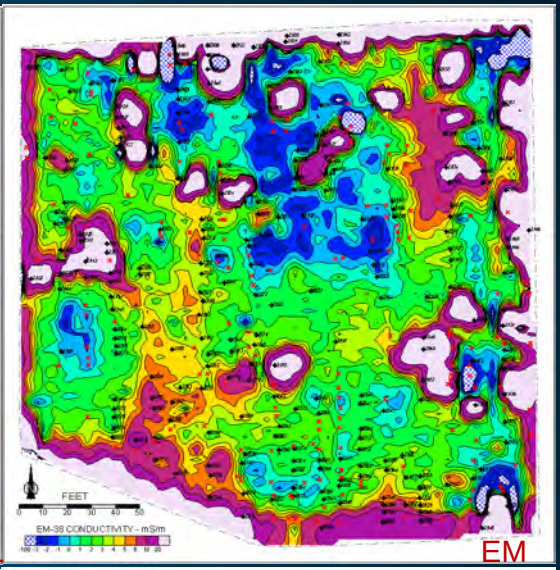
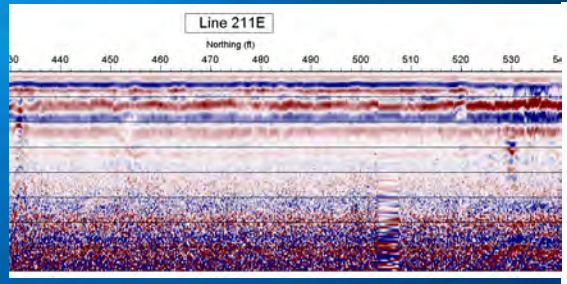
# HISTORIC CEMETERY

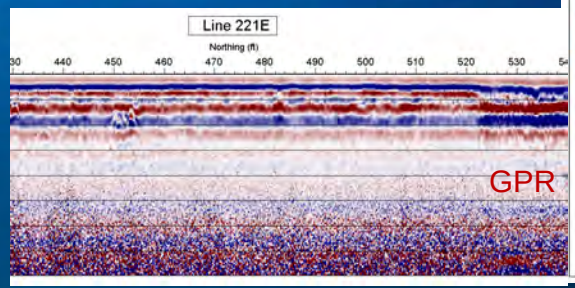



DEEP METAL

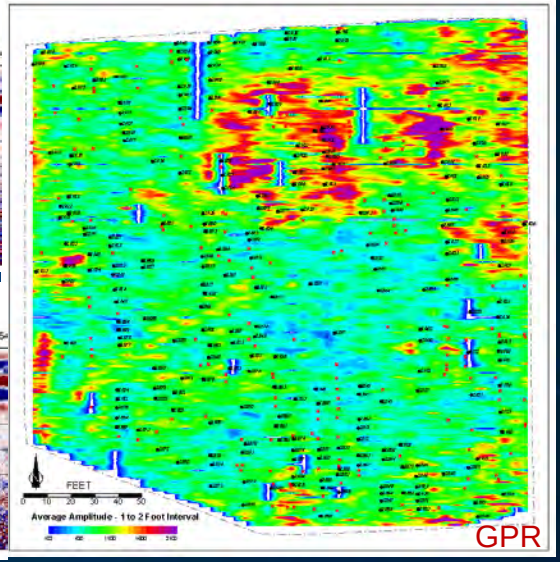



EM




GPR

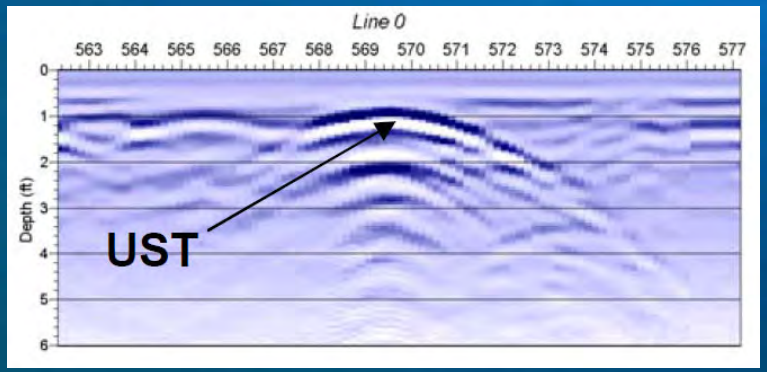


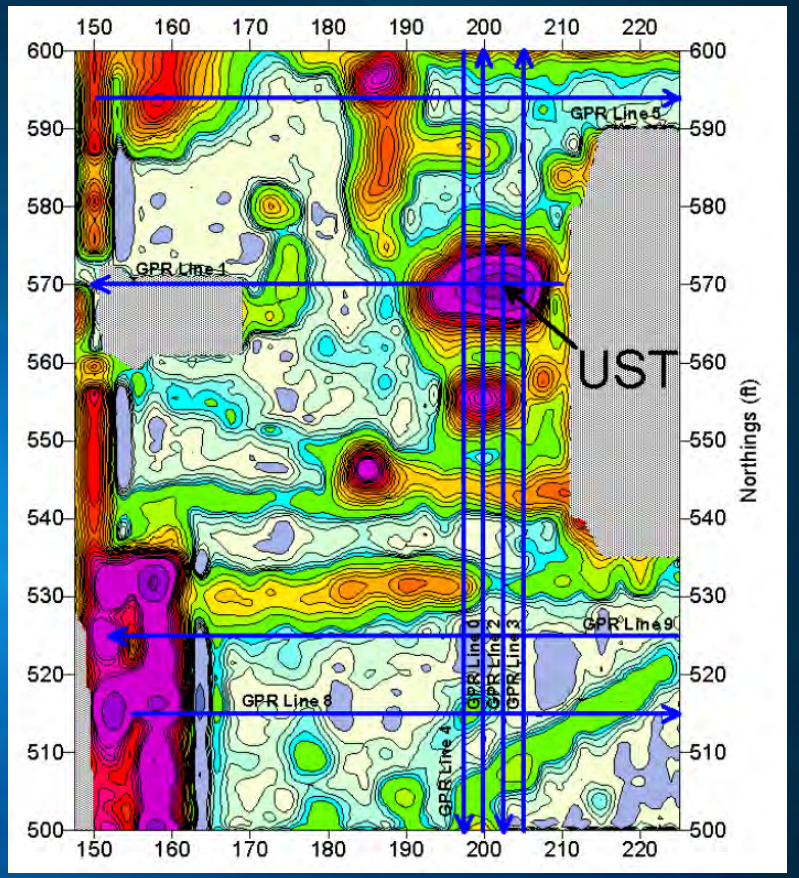

GPR

SAGEEP 2003

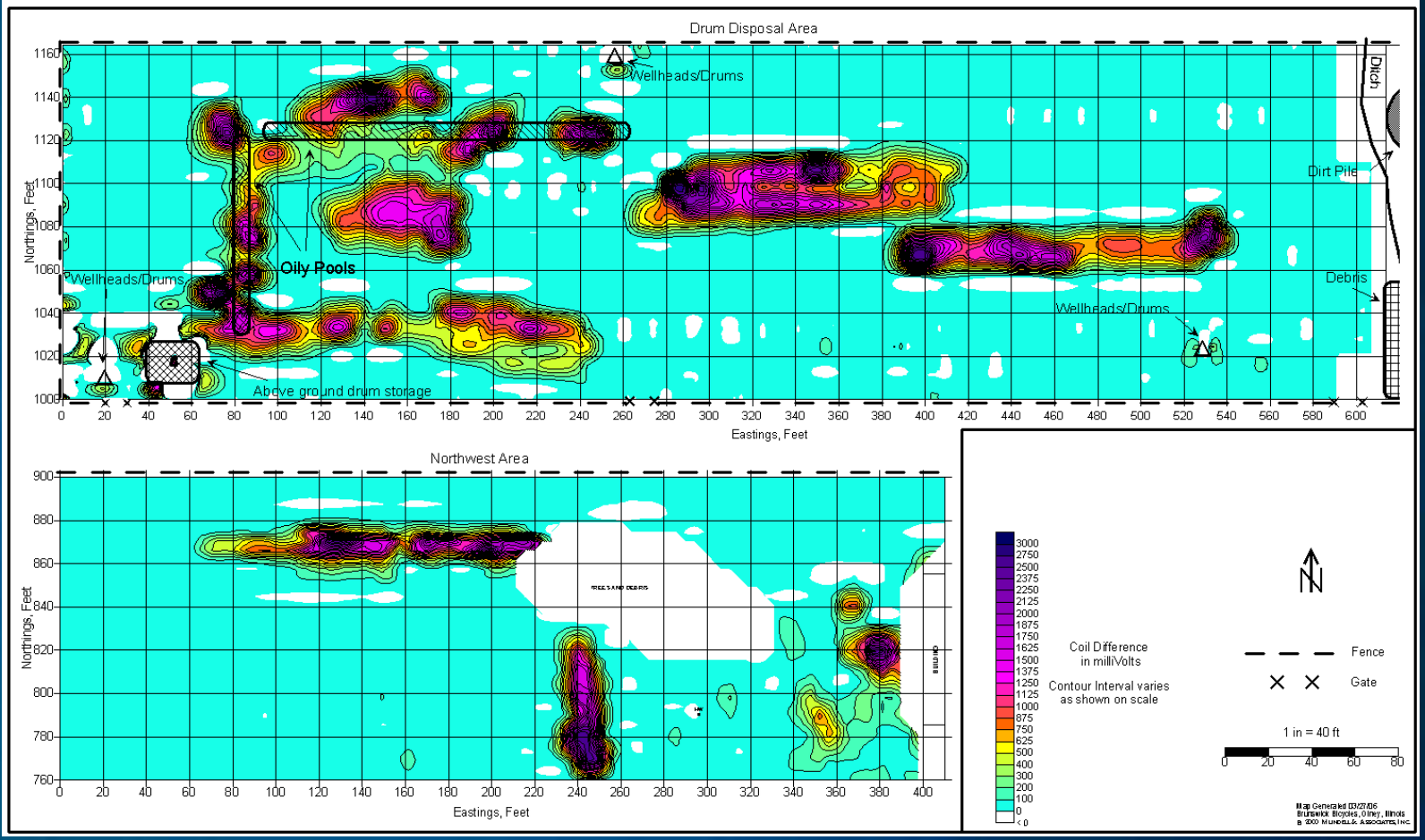
# Underground Storage Tank Search

Deep Metal Detection
Ground-penetrating Radar



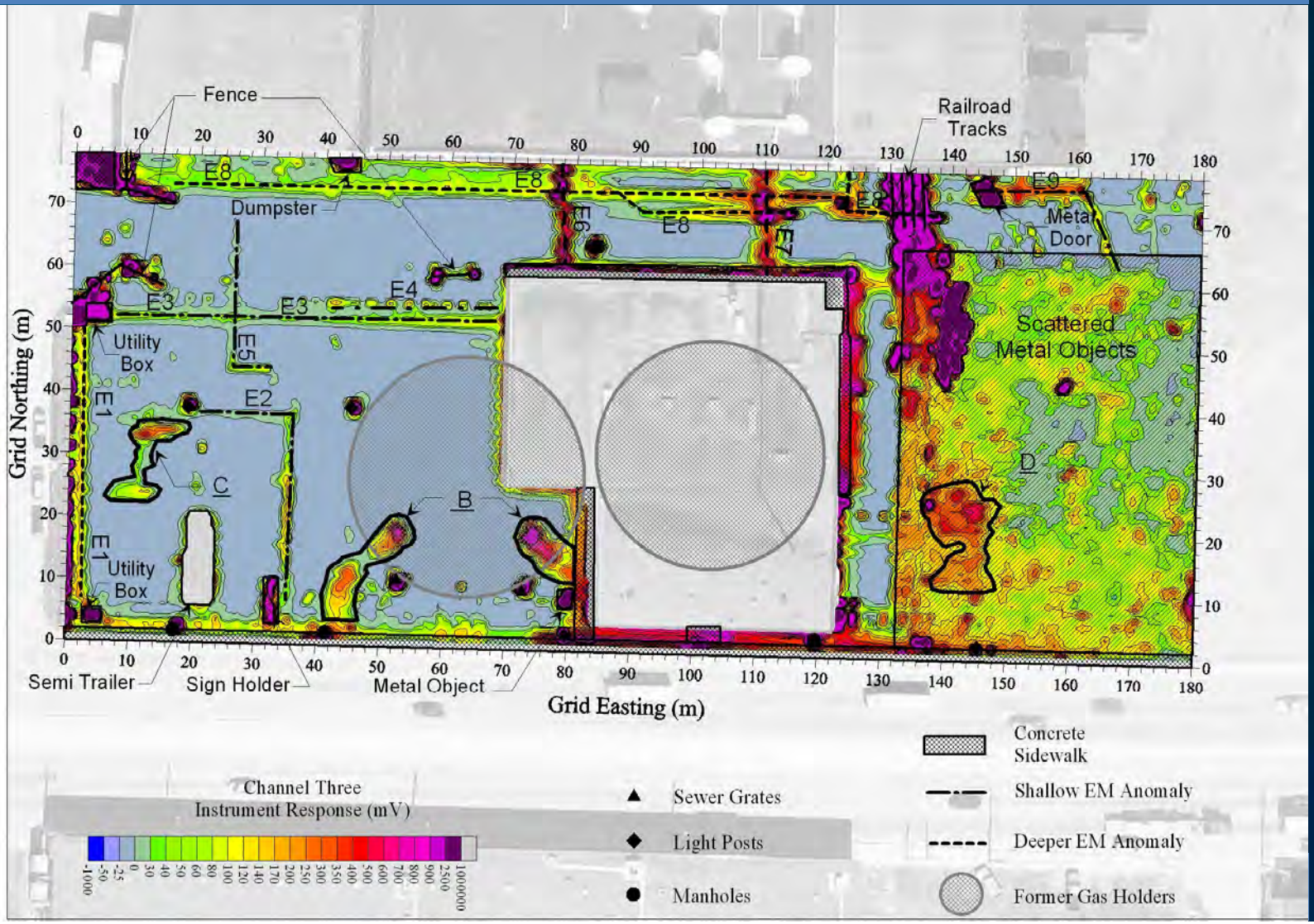



# Drum Search with EM-61

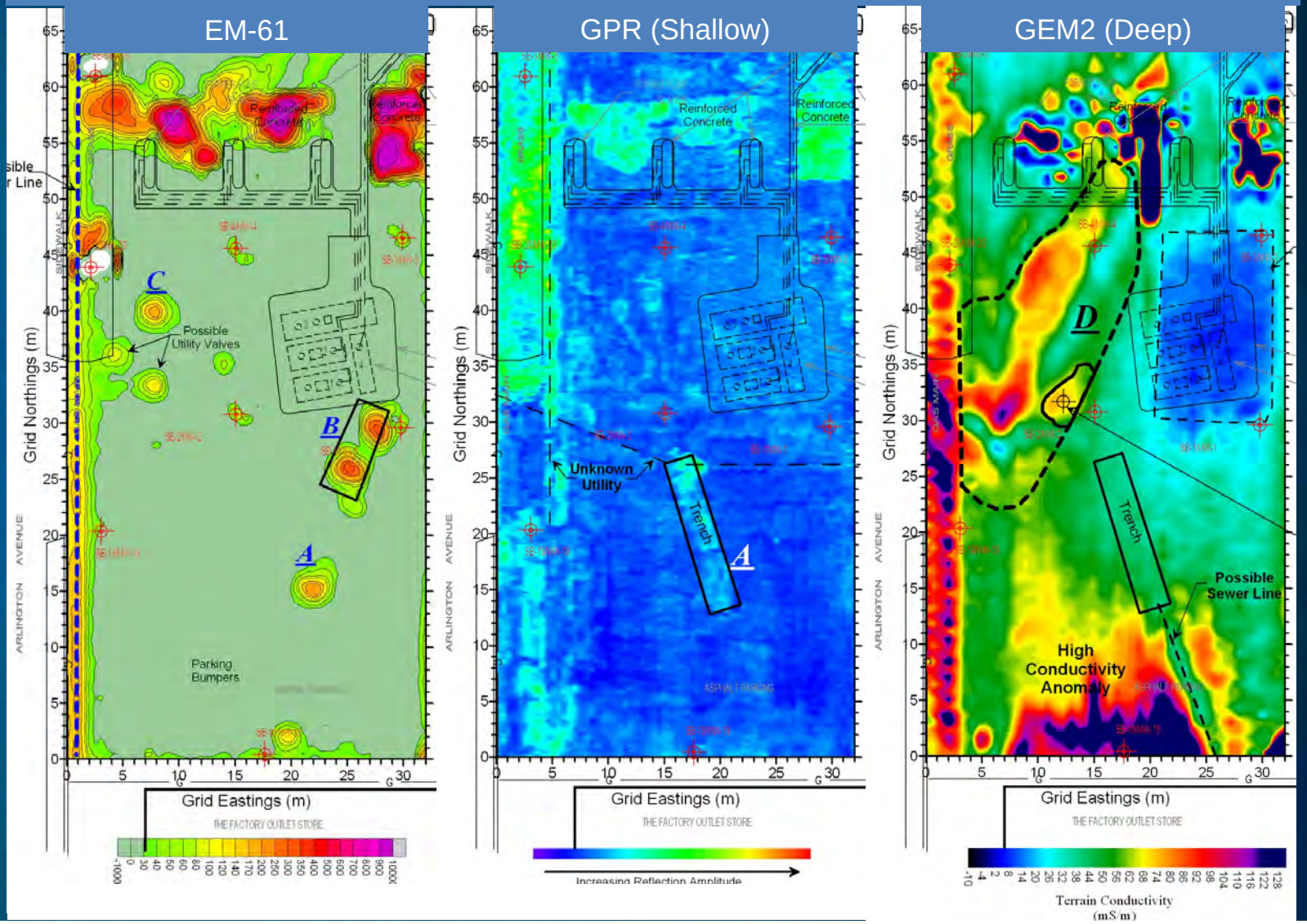


# In The End, 4,000 Drums Were Discovered!

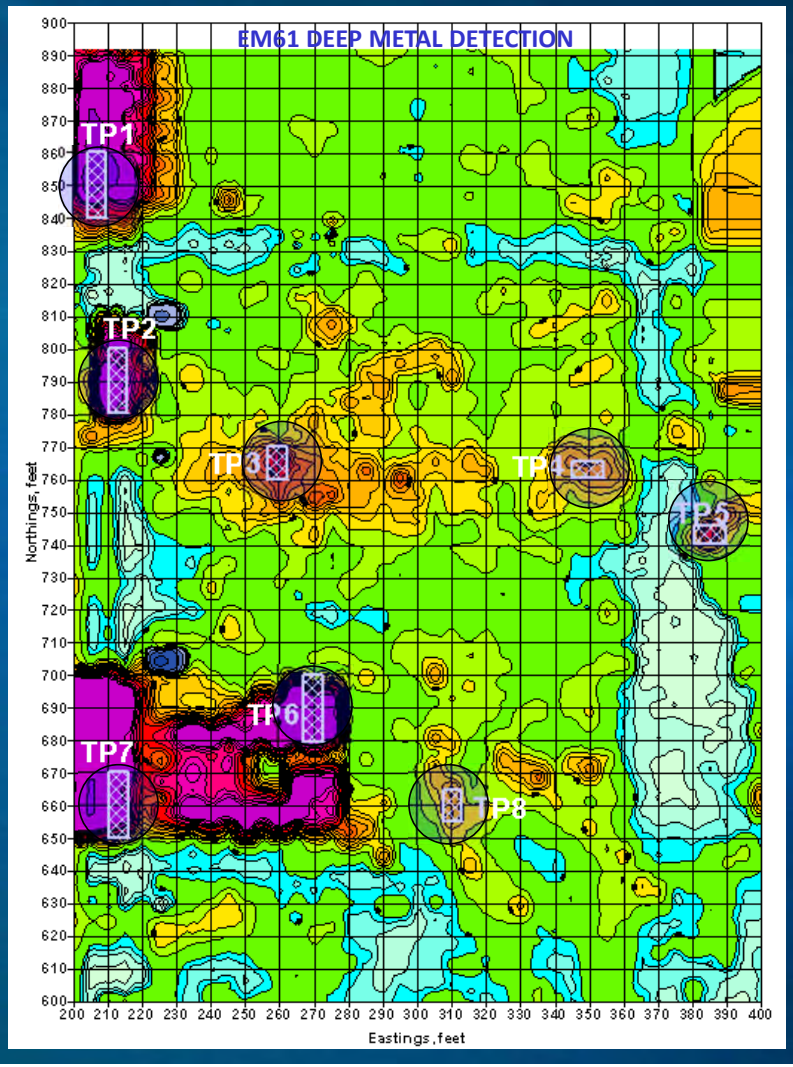
# Site Mapping a Former MGP Site with EM-61

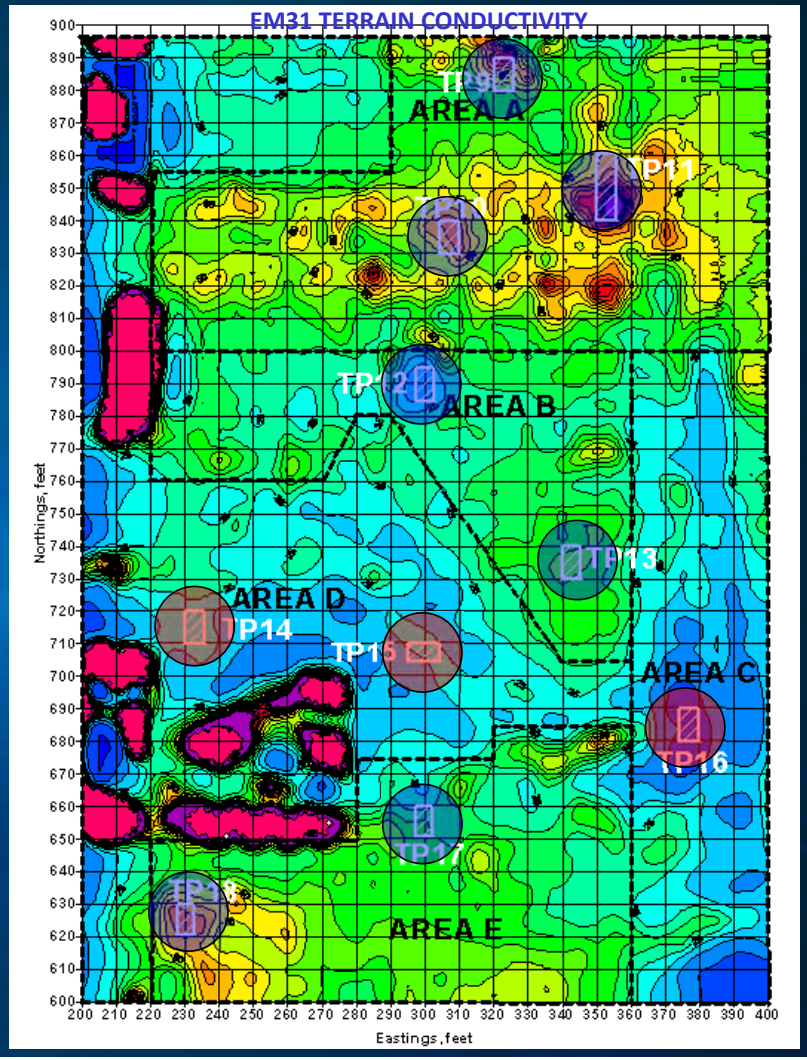


# Site Mapping with Multiple Techniques



# GRAVEL-COVERED PARKING LOT

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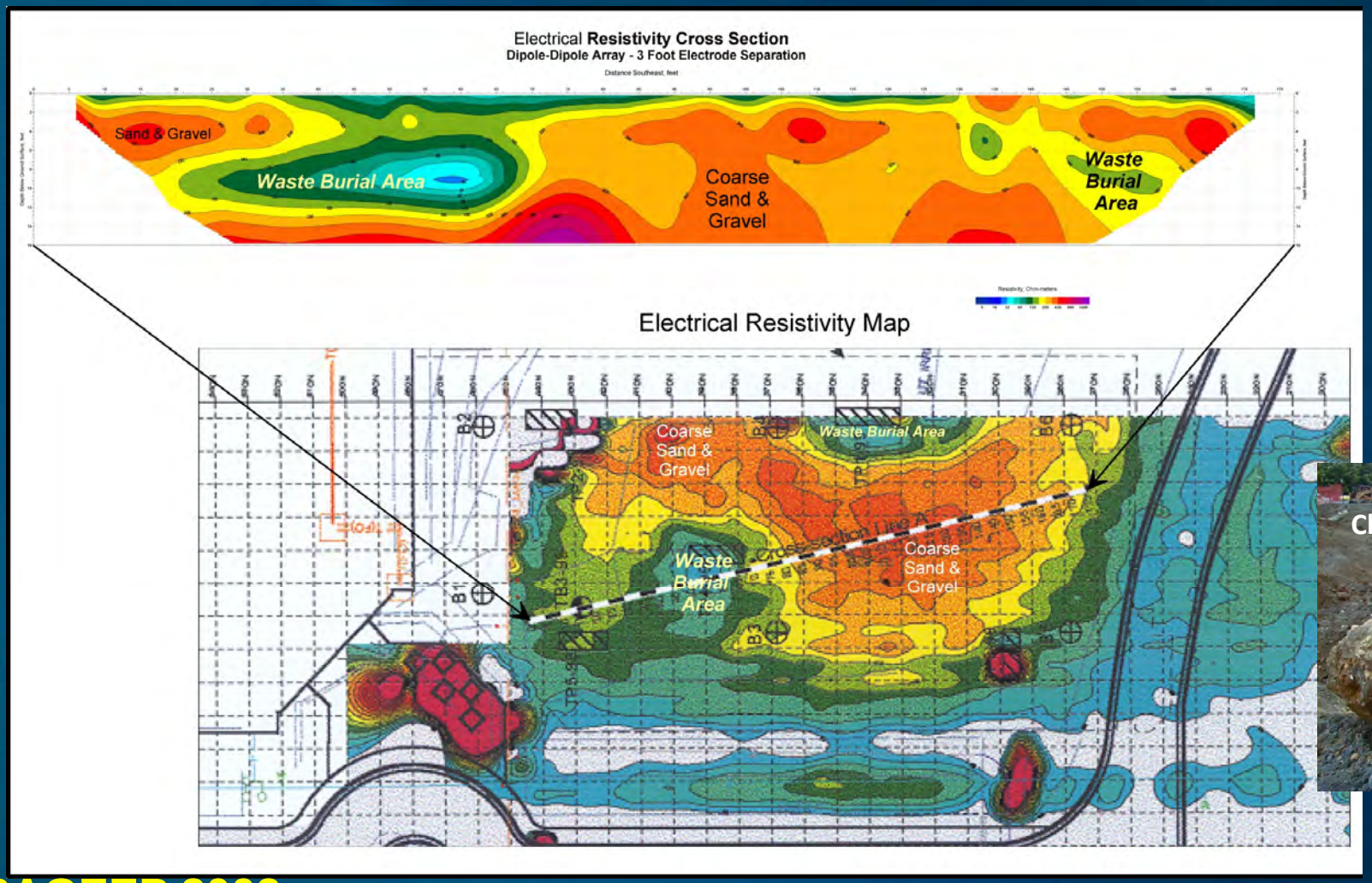
# Delineating Fill Materials with EM Methods



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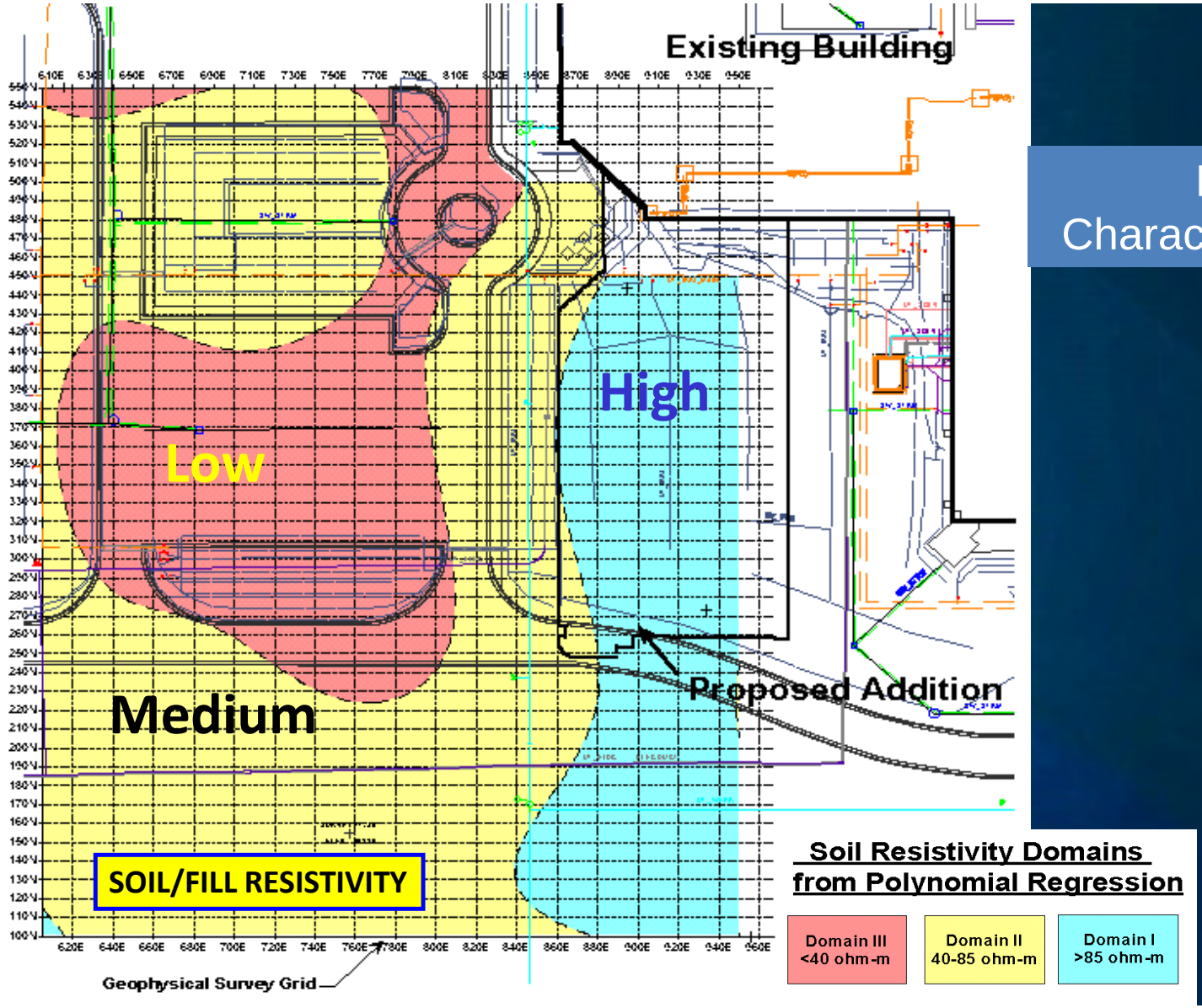
# Fill Characterization

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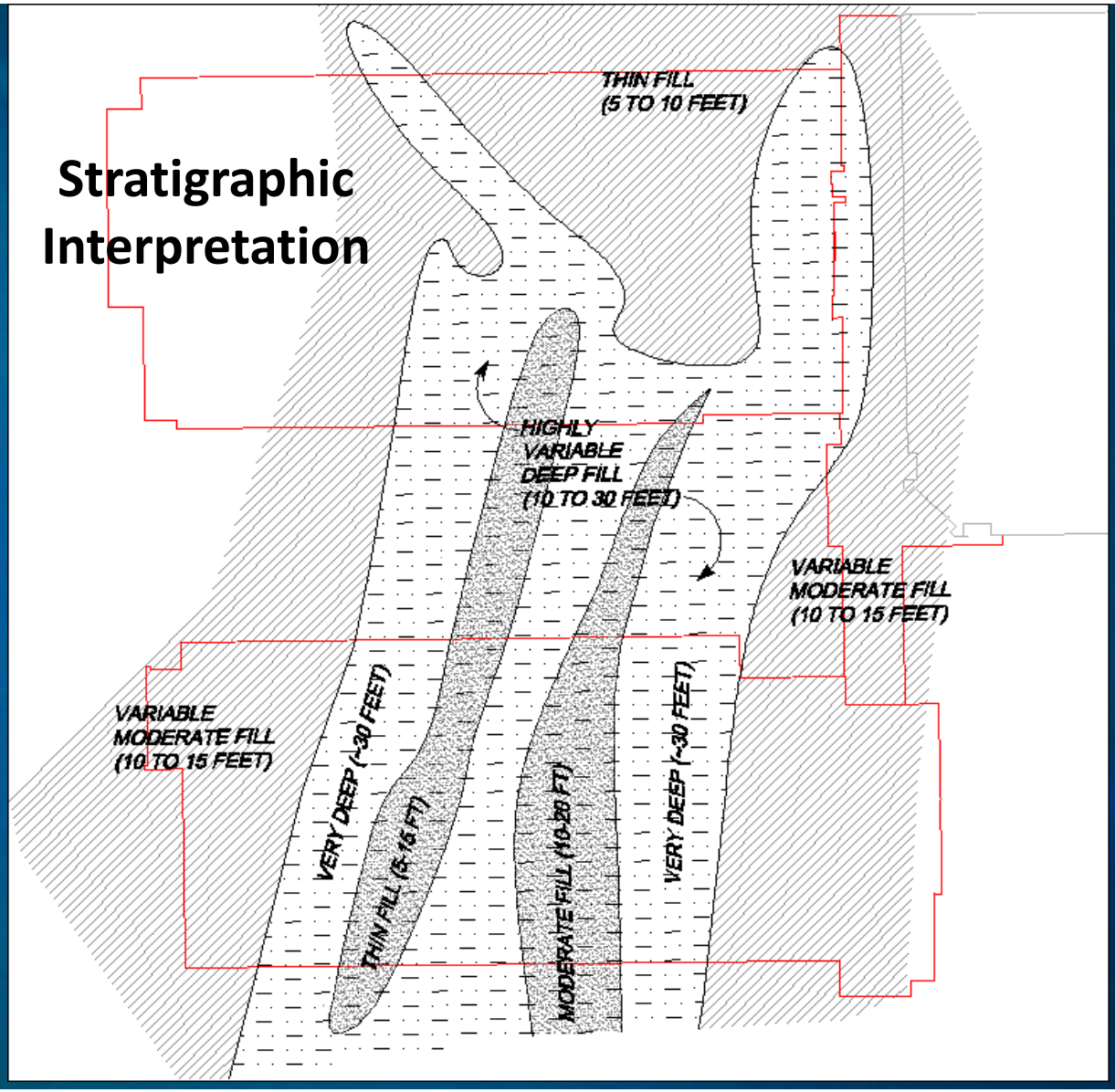
# Stratigraphic Interpretation




Fill Characterization

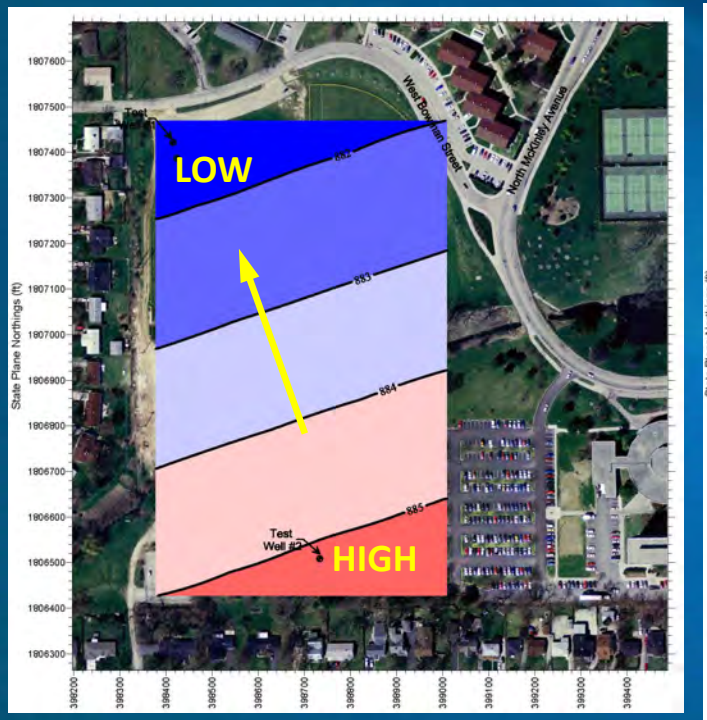
# Lesson Learned No. 4

Believable results come in many forms:

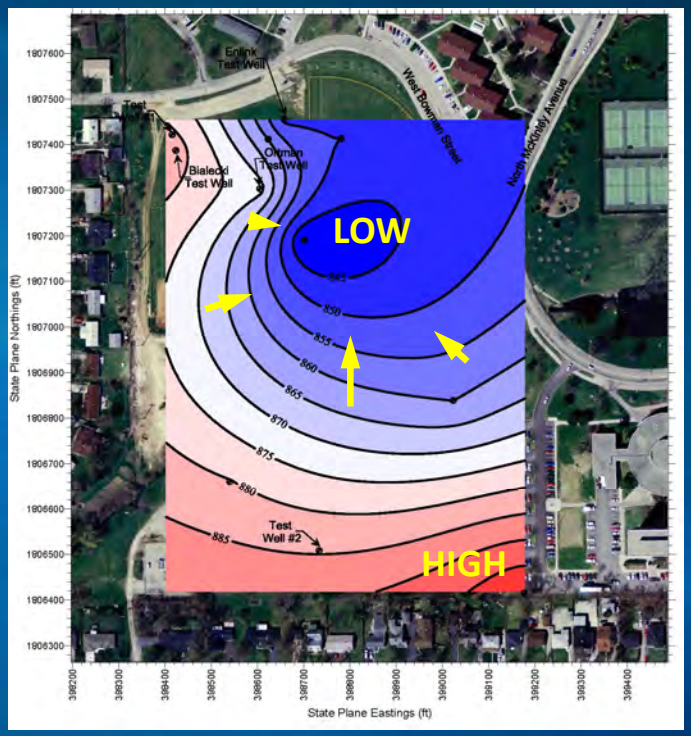
- Accurate data
- High density data
- Selection of color schemes/contour intervals
- Annotations and labeling
- Various viewpoints and orientations
- Removal of extraneous information

Question: How does a non-geophysicist see the world?

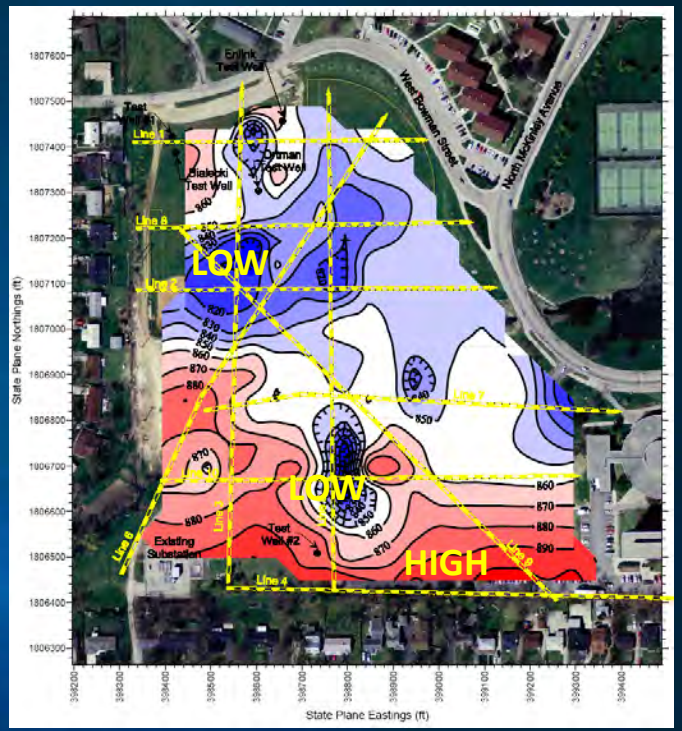
# GEOTHERMAL WELL FIELD




TOP OF BEDROCK SURFACE
2-point Constant Sloping Model

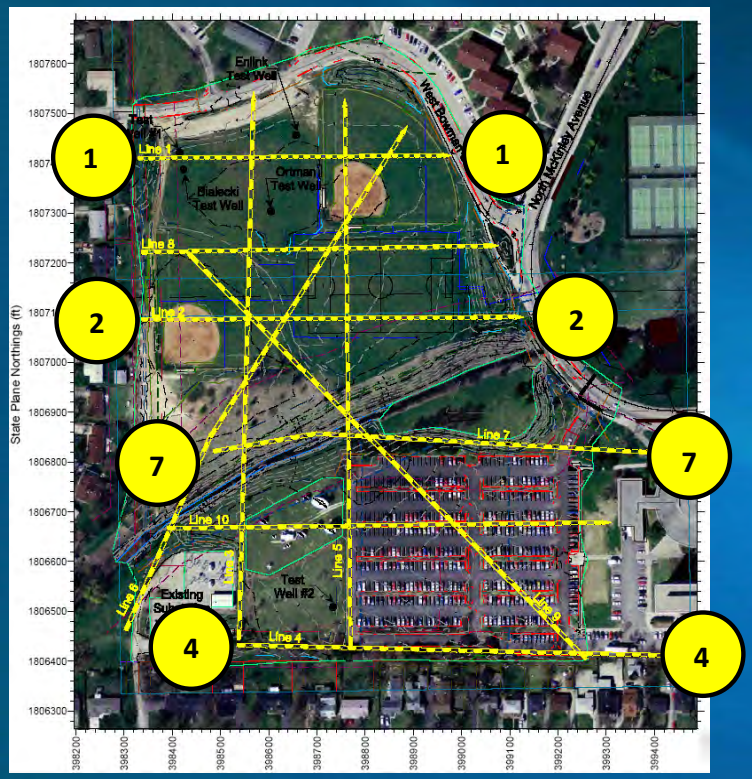


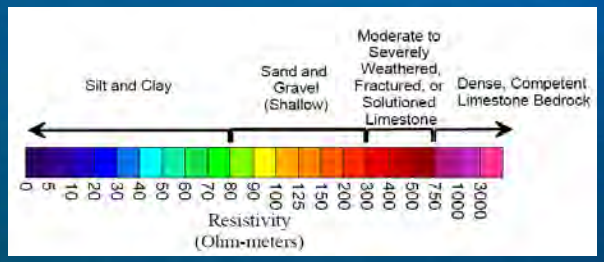

TOP OF BEDROCK SURFACE
11-point Boring Model

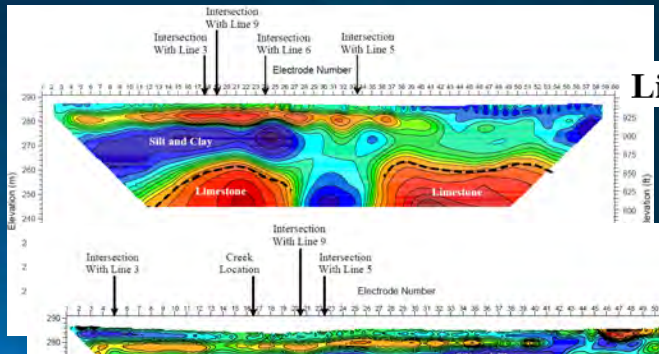


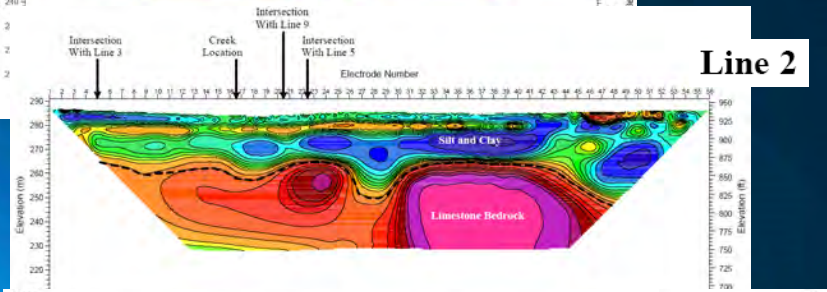

TOP OF BEDROCK SURFACE
700-point Geophysical Model

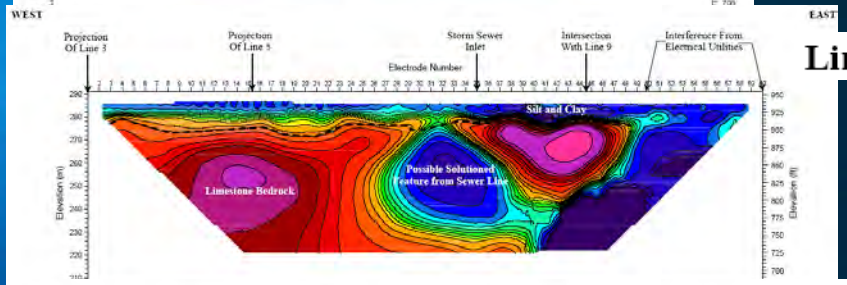
# GEOTHERMAL WELL FIELD

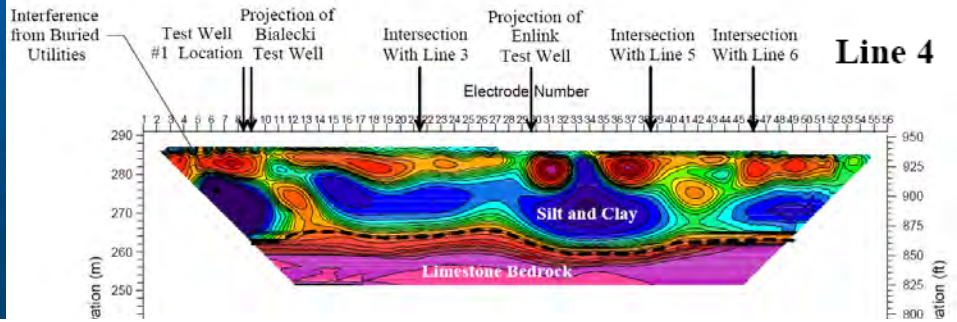


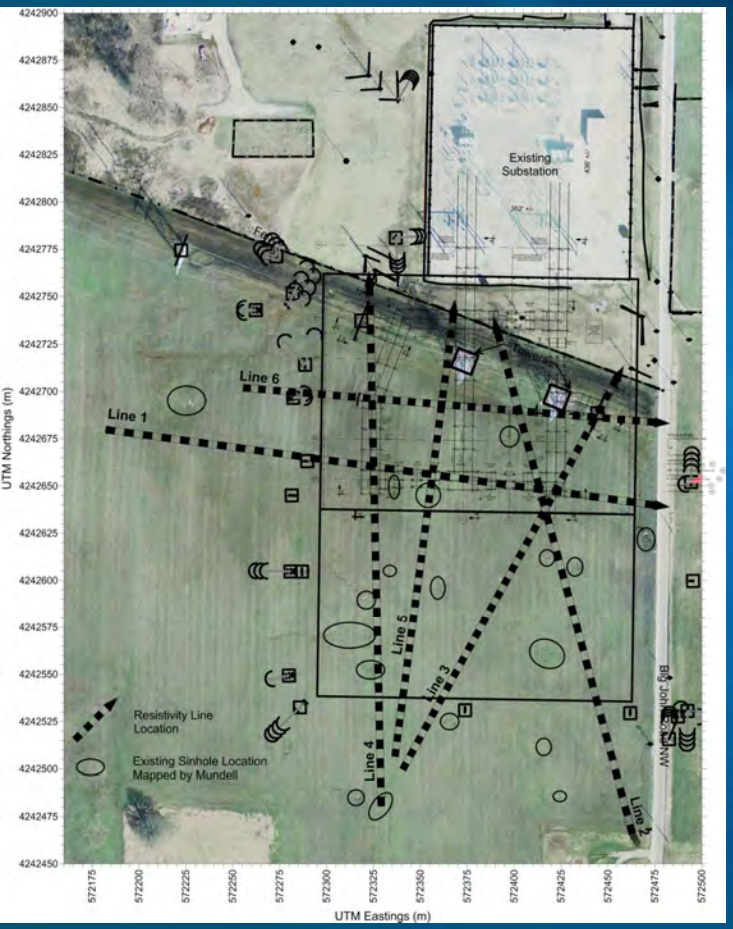



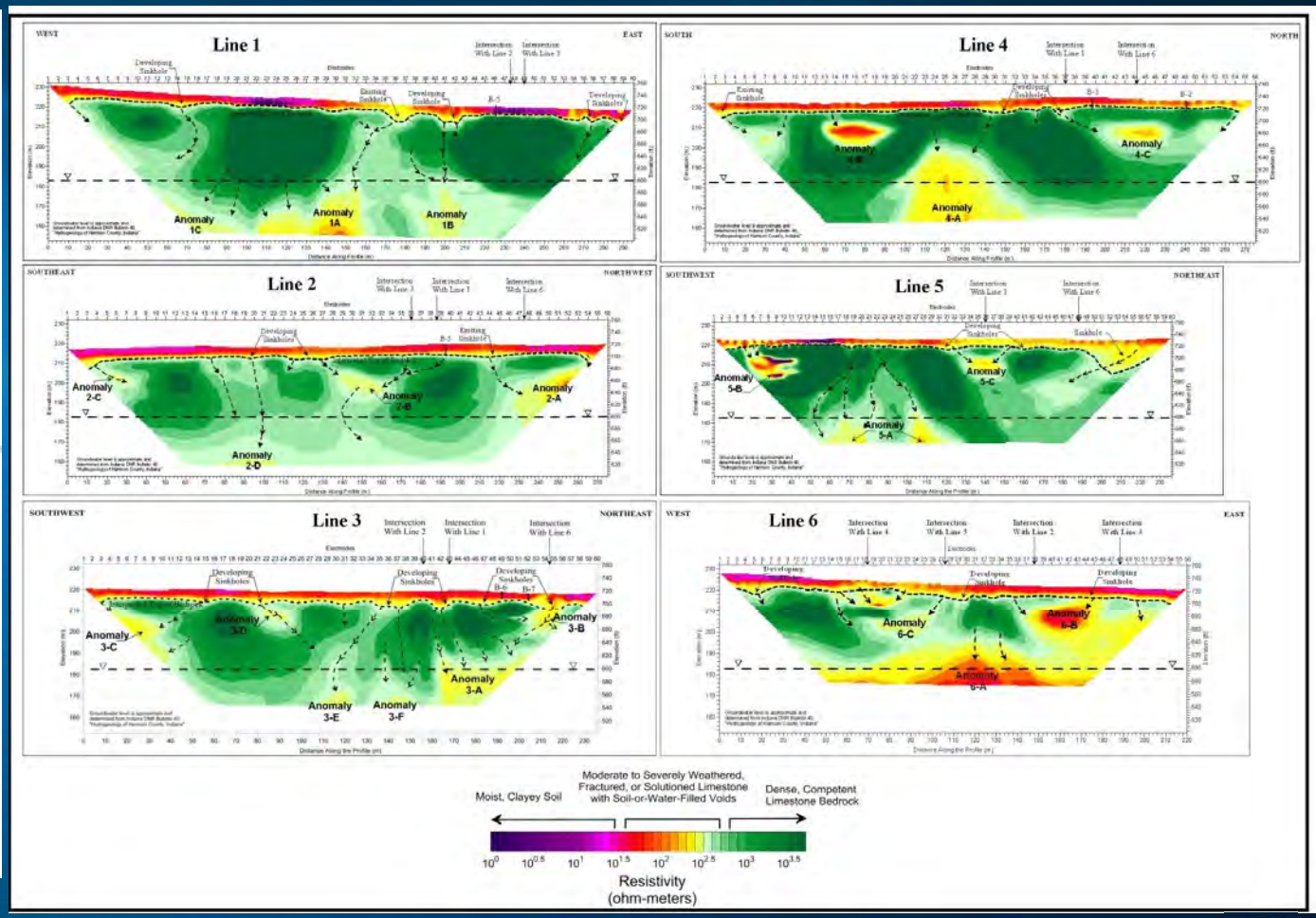




SAGEEP 2010

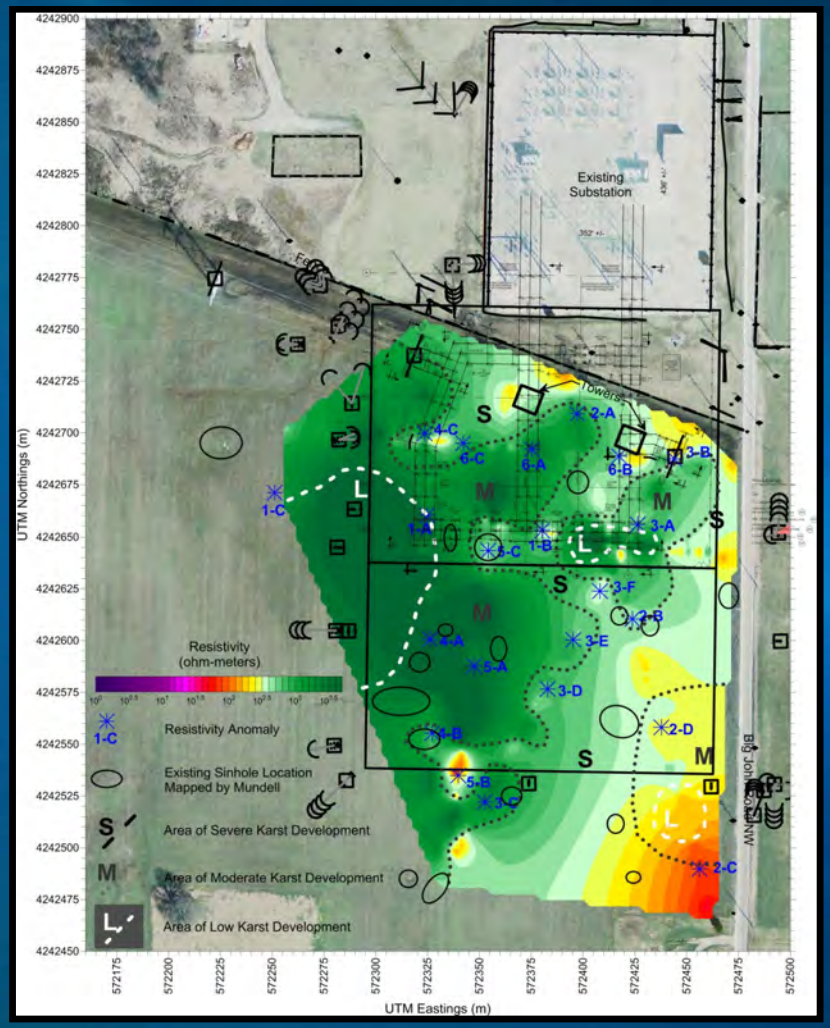
# FOUNDATIONS FOR A POWER STATION

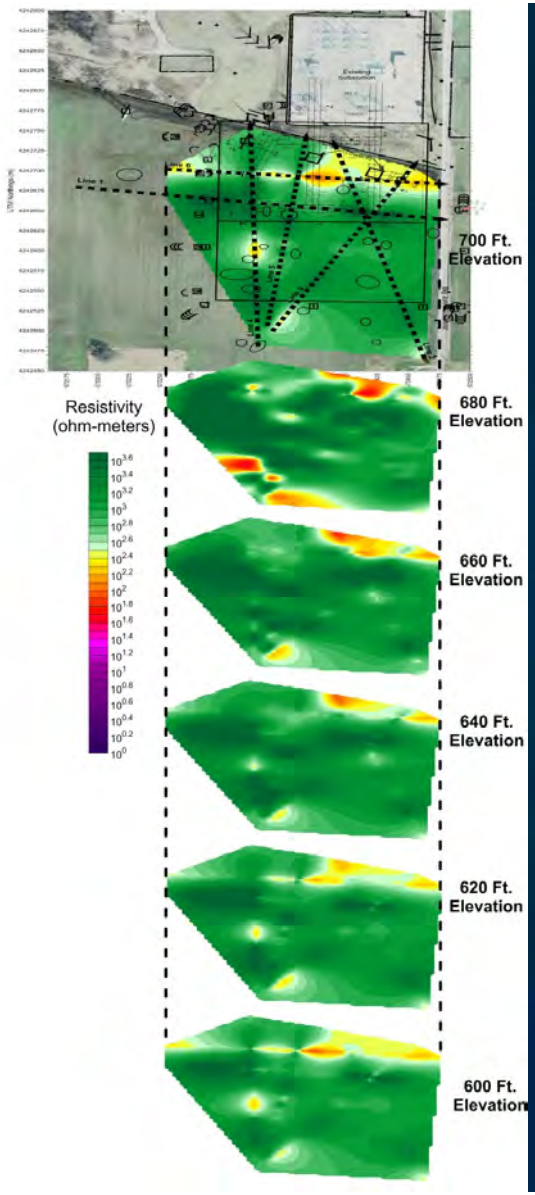



SAGEEP 2007

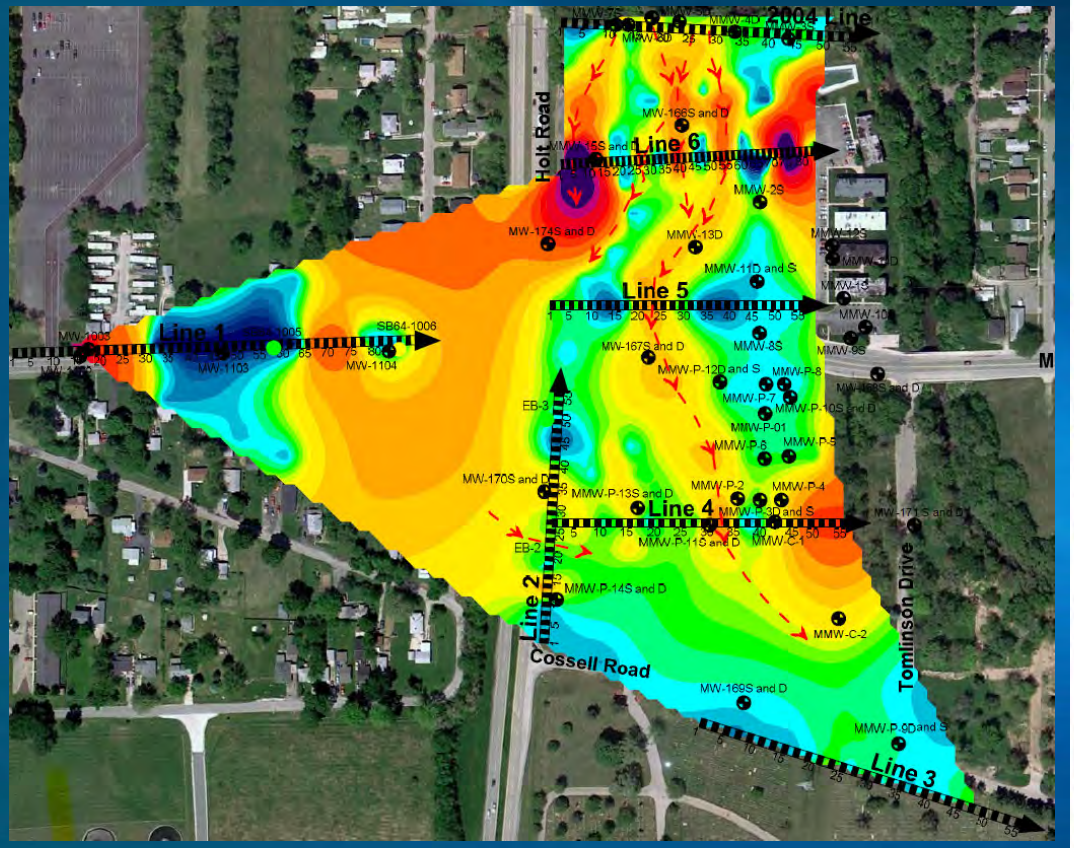
# FOUNDATIONS FOR A POWER STATION



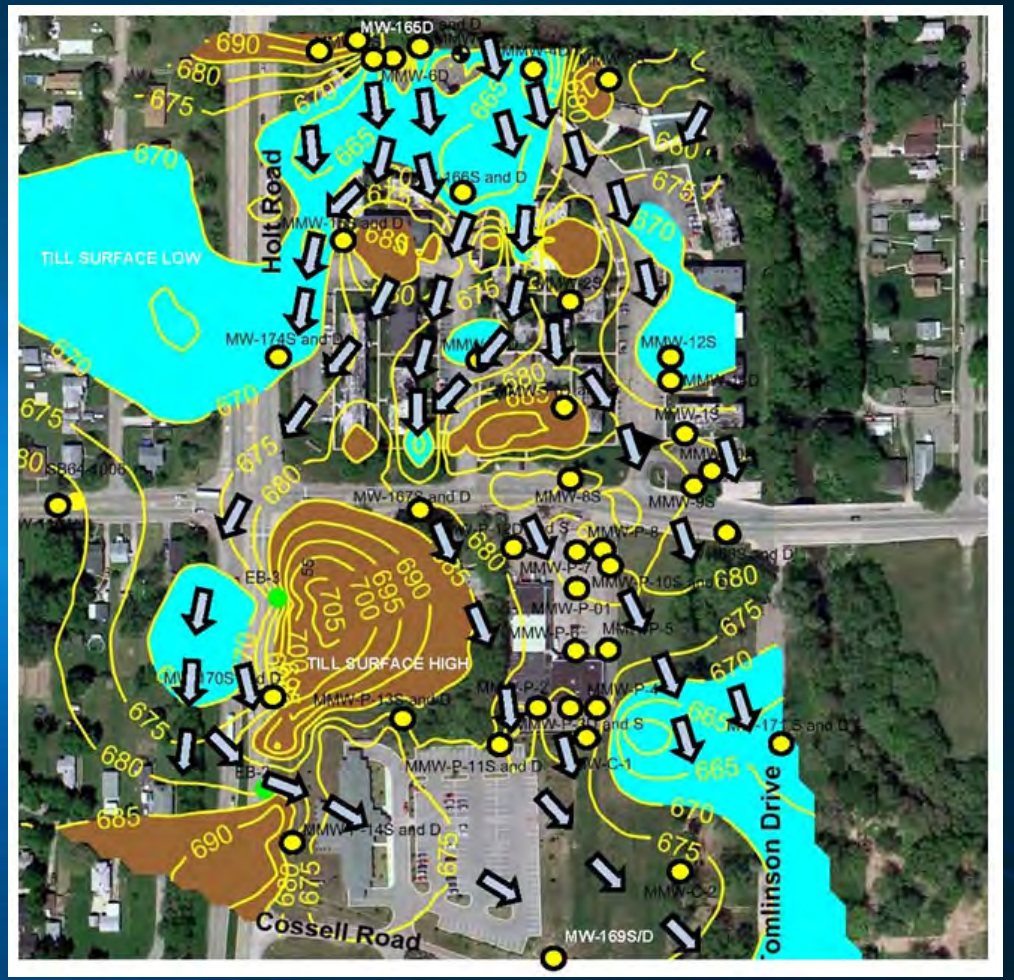




SAGEEP 2007

# CONTAMINANT MIGRATION PATHWAYS



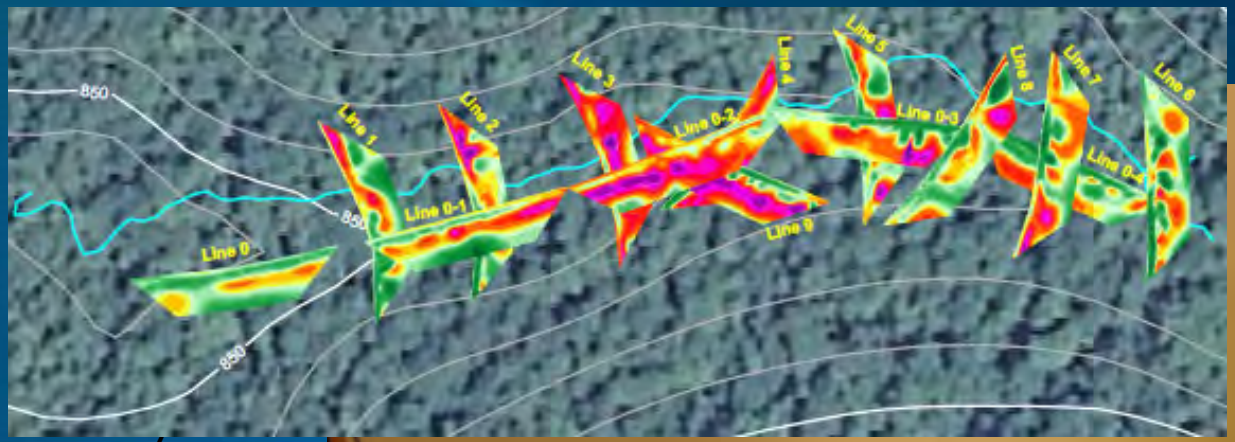

Resistivity Slice Map – Deep Aquifer

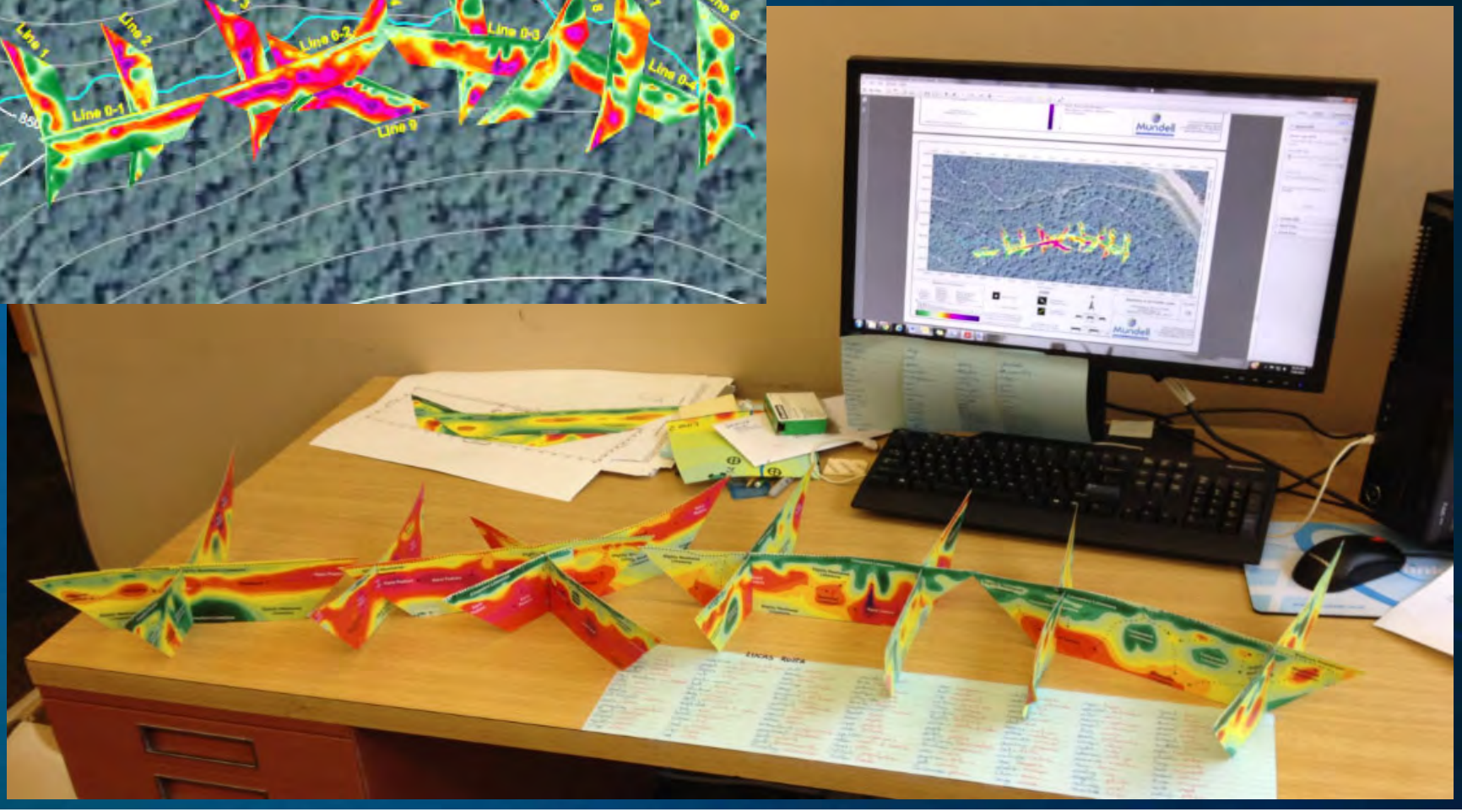



Conceptual Hydrogeologic Model

SAGEEP 2013

# REMEDIATION IN KARST



4

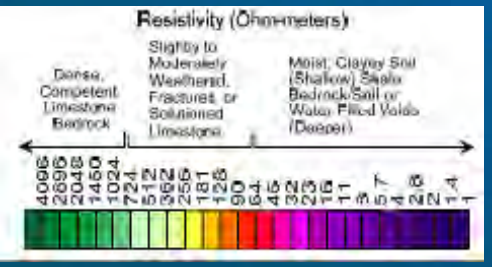
# REMEDIATION IN KARST

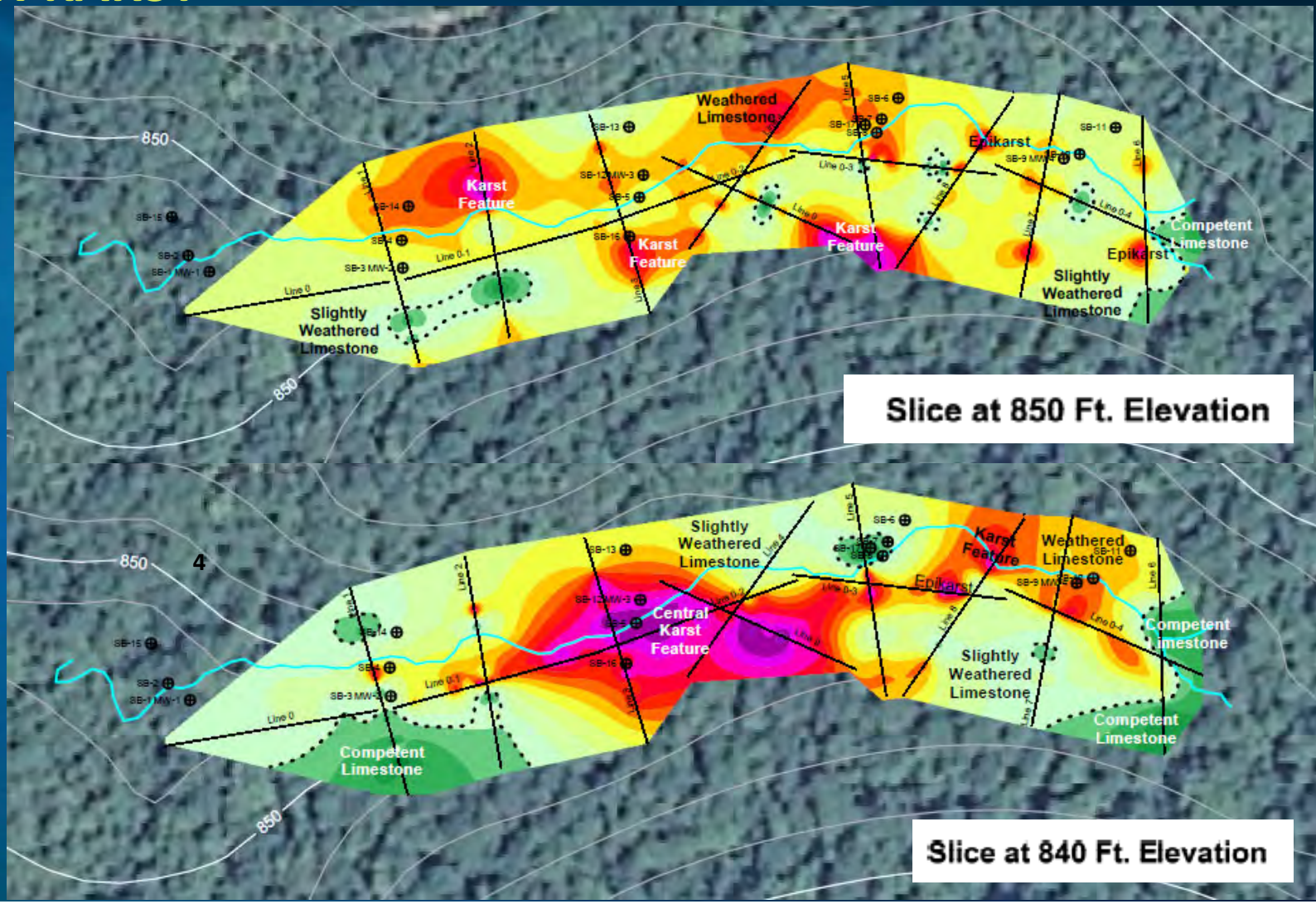
1

2

7

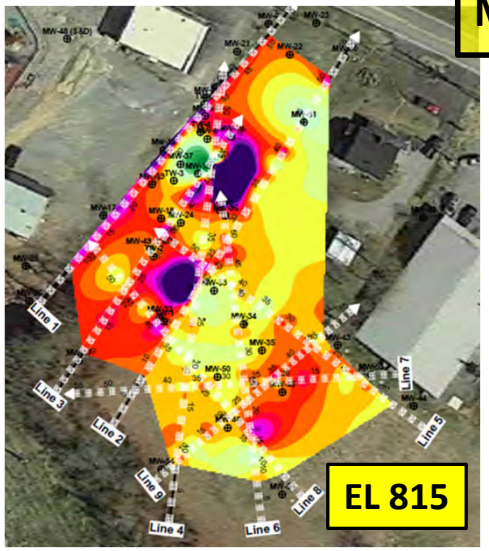
4

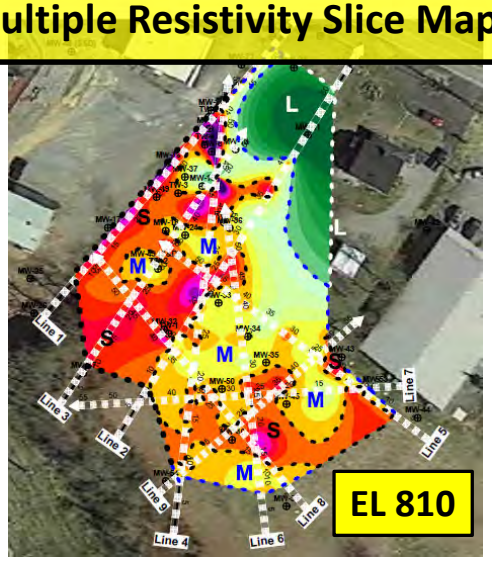


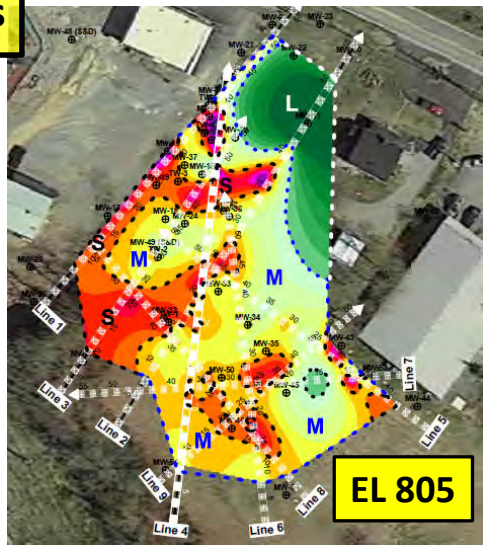



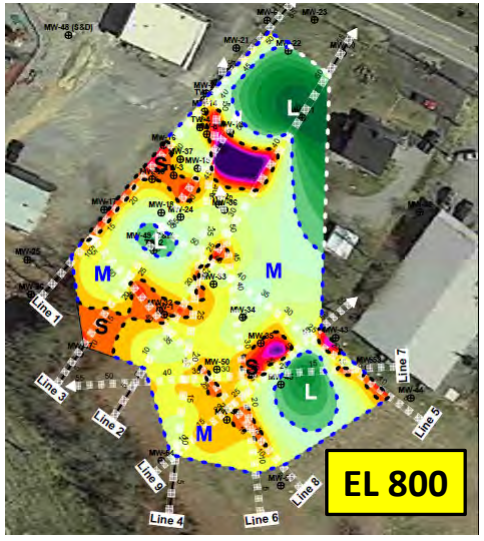

SAGEEP 2015

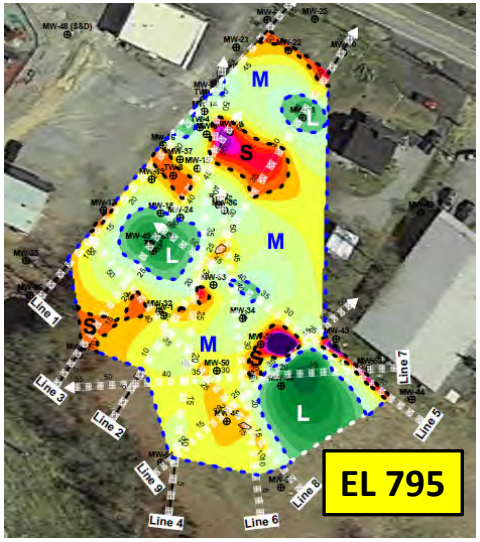
# Multiple Resistivity Slice Maps

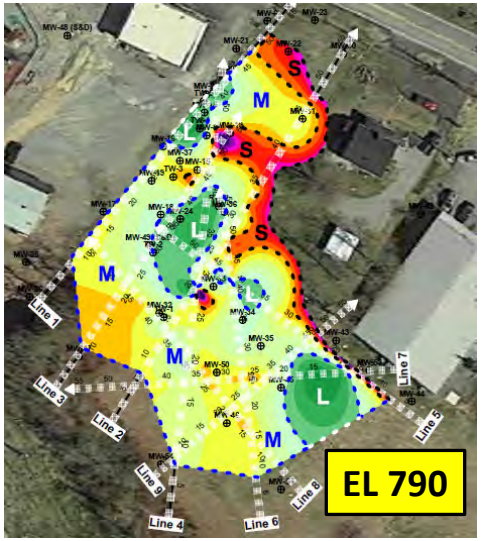


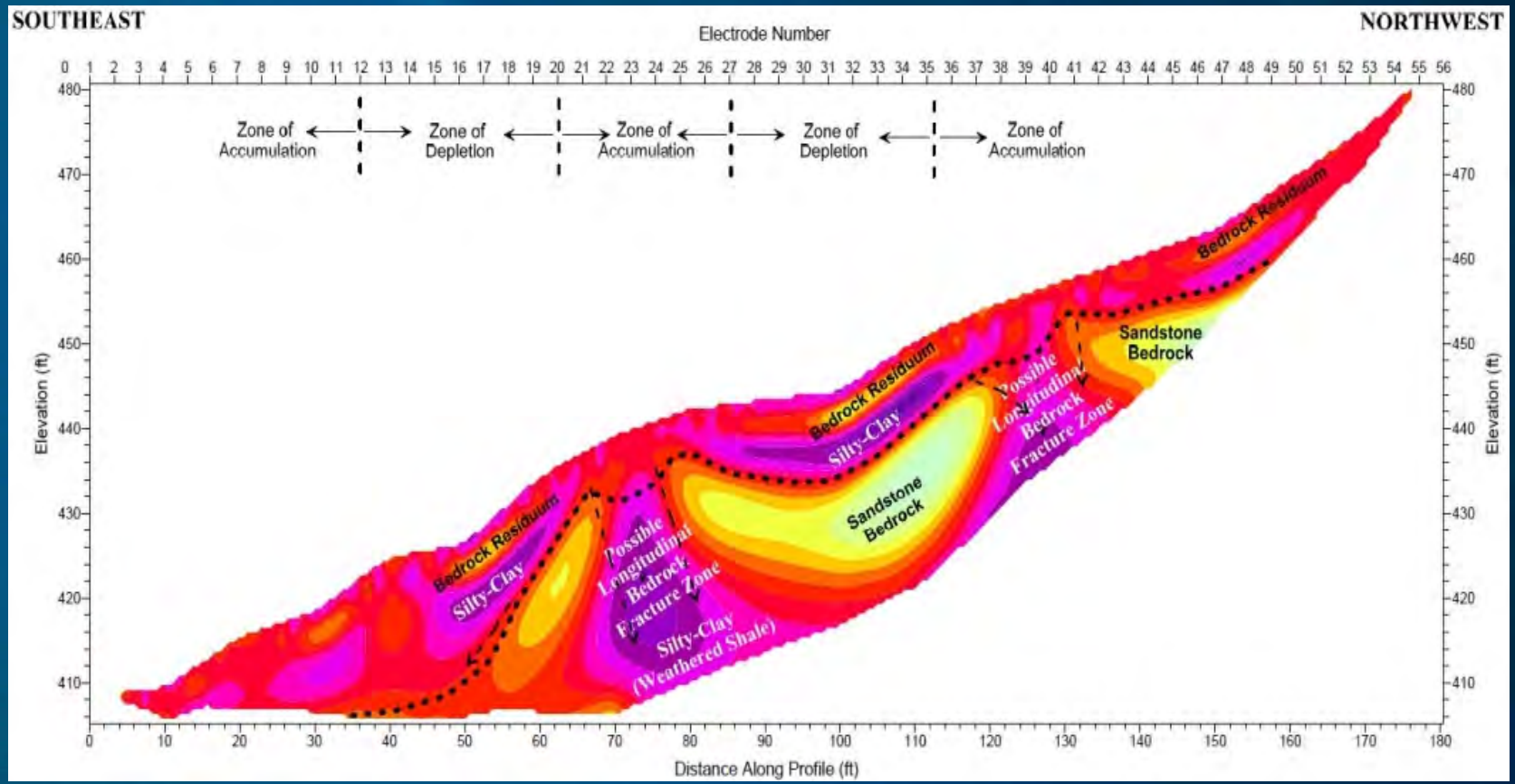



# TRANSPORTATION SLOPE STABILITY




SAGEEP 2016

# Lesson Learned No. 5

When properly performed and displayed, geophysical results provide an unparalleled enhancement to conceptual site models that allow for improvided understanding and better decision-making.

# Closing Remarks

- Subsurface characterization is an exciting adventure!
- Data density is paramount to develop accurate site conceptual models.
- Visual communication of the results is more important than the average geophysicist thinks!
- Have confidence that when properly used, geophysics can be applied with great success in the engineering and environmental fields.
- Future advances in more rapid field data collection, enhanced processing and analysis, and advances in equipment design will allowed even more success.

# THANKS GEOPHYSICAL COLLEAGUES OVER THE YEARS!

# Questions?

Mundell

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for the Earth and the Environment

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