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Deep Challenges for Foundation Performance at Savannah River Site

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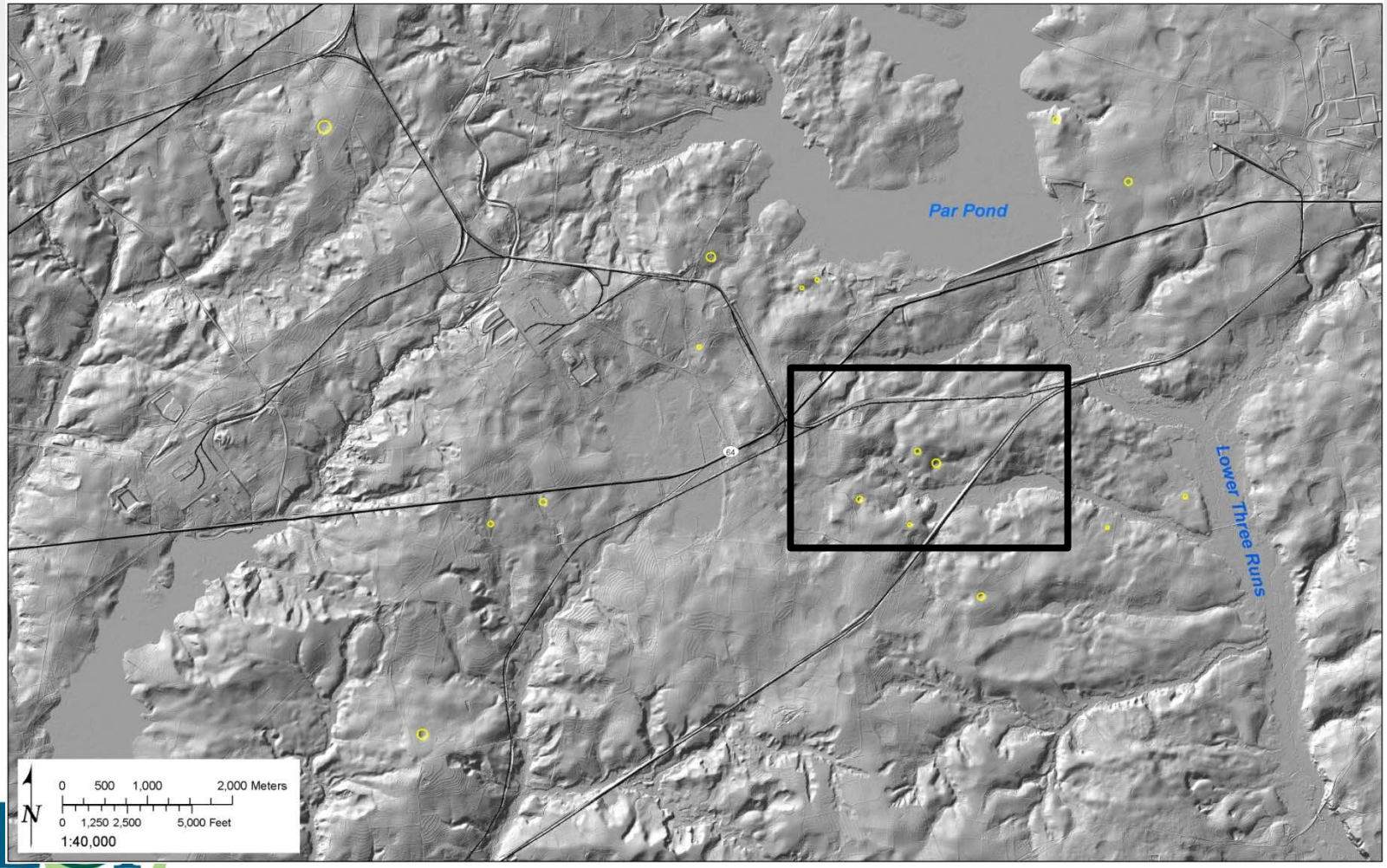
SRS Historical Perspective

- USCOE performed extensive geologic characterization of SRS prior to construction in early 1950's
- Subsurface strata (darn geologists always changing nomenclature) identified that presented potential foundation performance issues
- A grout injection program was performed for all critical facilities prior to construction (reactors, canyons, etc.)
- Later constructed facilities not grouted however static foundation performance acceptable
- "Santee" formation subject of numerous foundation investigations over the following decades
- *Utley known to exist at SRS however significance overlooked*

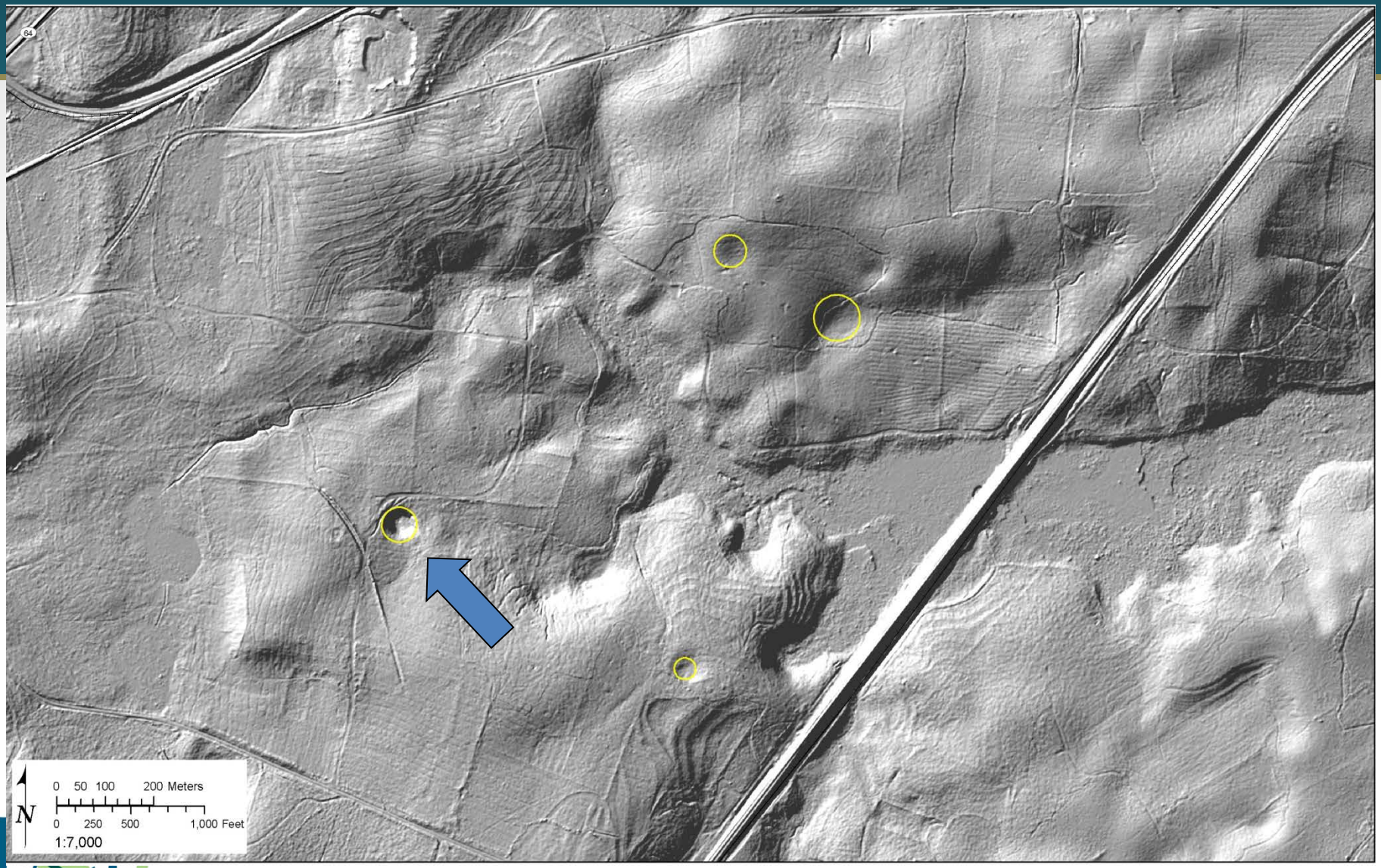
And Other Realizations

- Lark Hole – found at last!
- Hilda Hole – 1886 Charleston EQ related
- Surface depressions likely karst and modern

Candidate Depressions – Slope analysis of SRS LiDAR

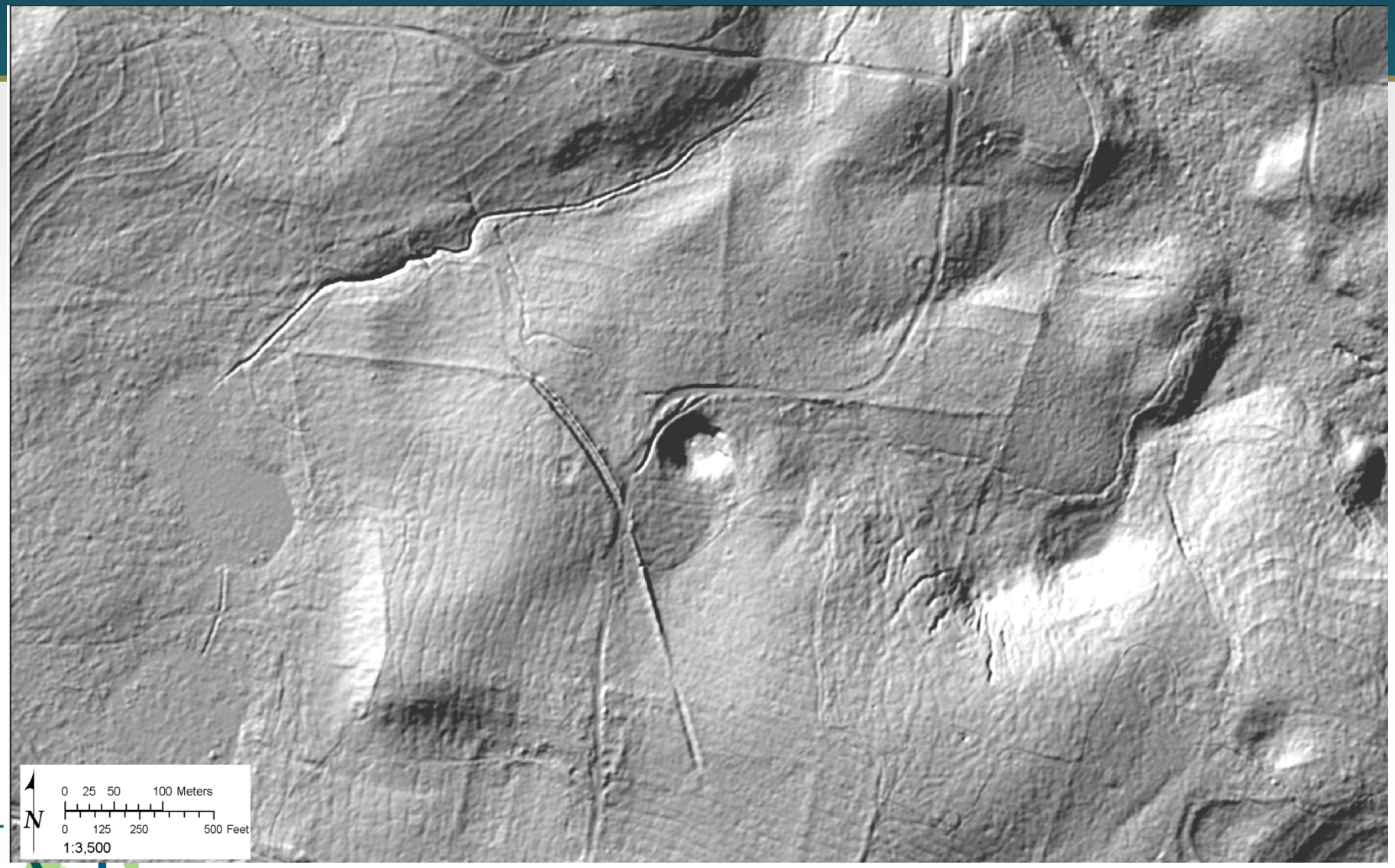


Closer View – Note one with sharp edges (shadow)

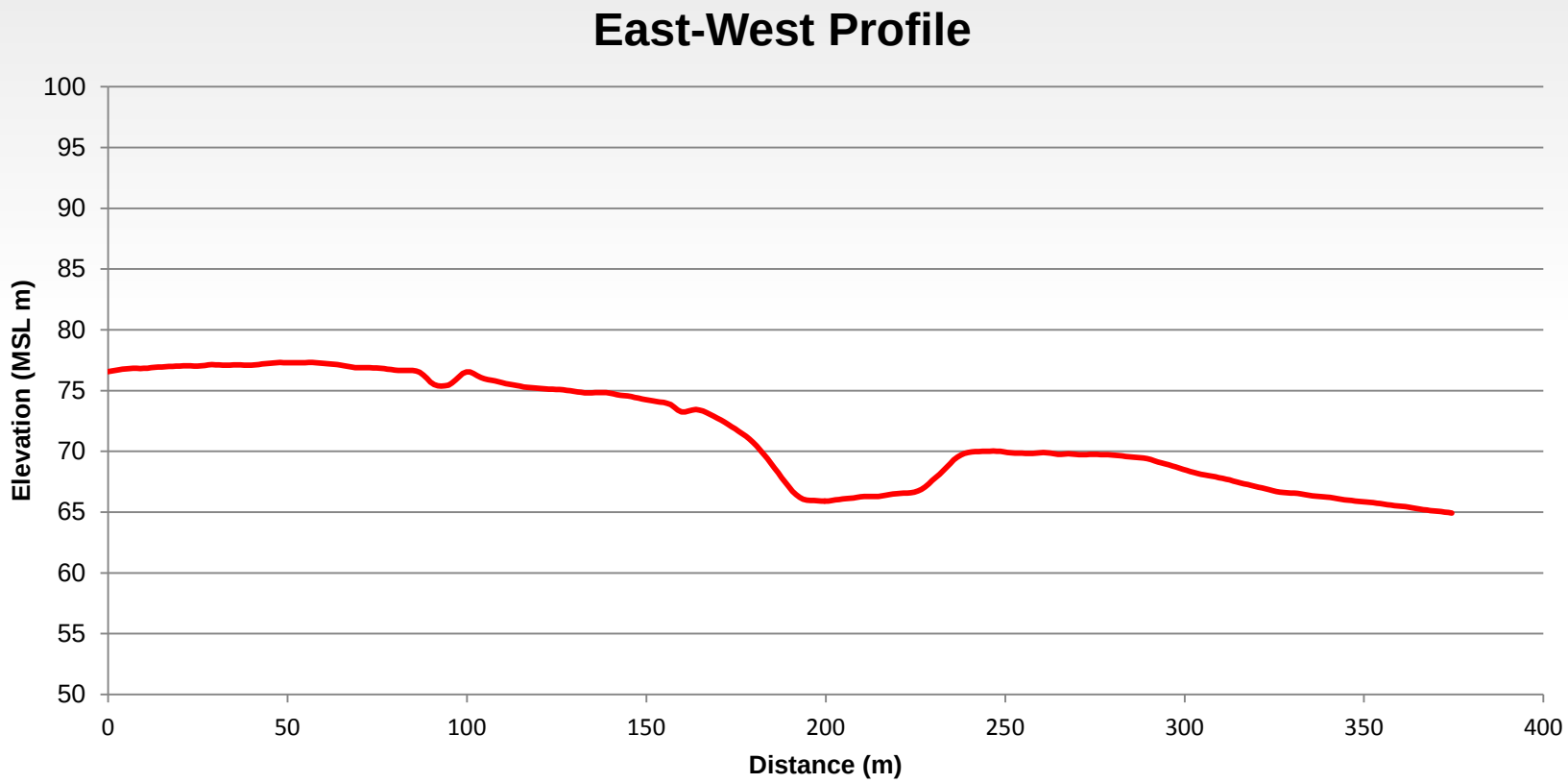


Depression obscured by Vegetation (lat 33.2096; long -81.5389)

Most Likely Candidate – about 150 ft wide and 16-26 ft deep



Profile Across Depression



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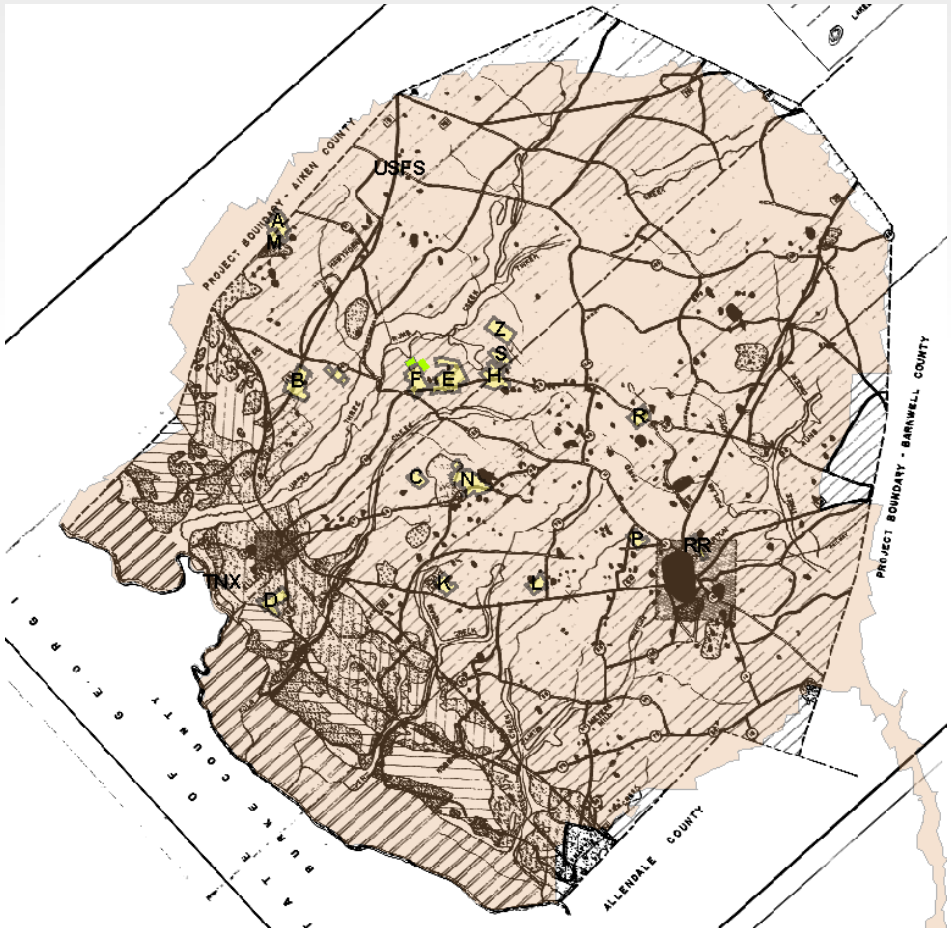
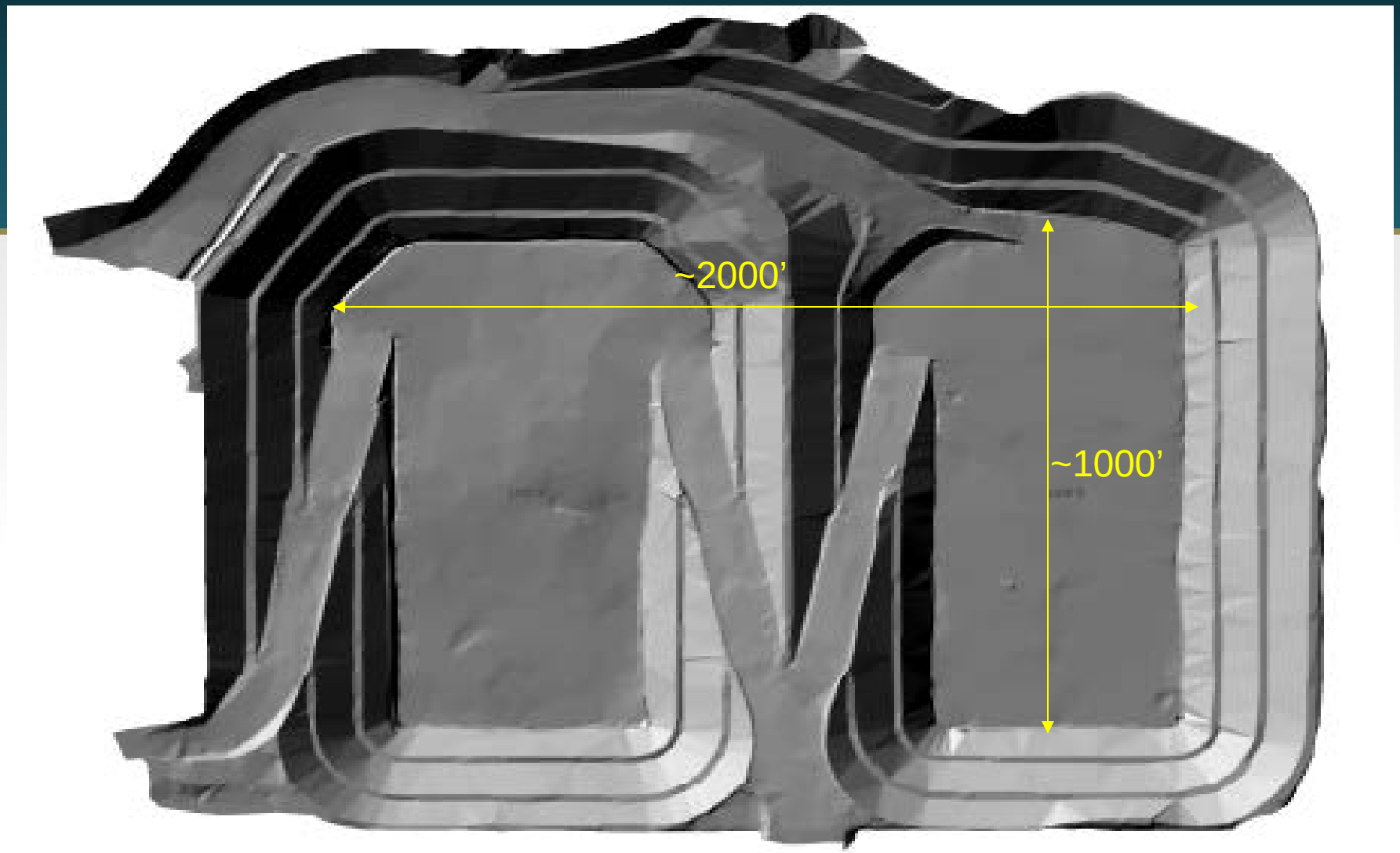
1950 SRS COE Sink/Depression Map

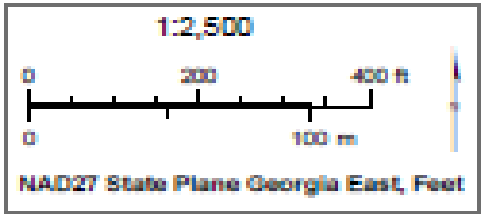


Expanded Knowledge

- Recent large excavations in Georgia (Big Dig) provided a window into sediments correlative to strata beneath the SRS
- DOE research conducted over a multi year program by Georgia Tech resulted in insight into these problematic strata
- Actual NPH related to these conditions identified – a shift in thinking

The Georgia Big Dig





Vogtle Excavation Dimensions – Field of View

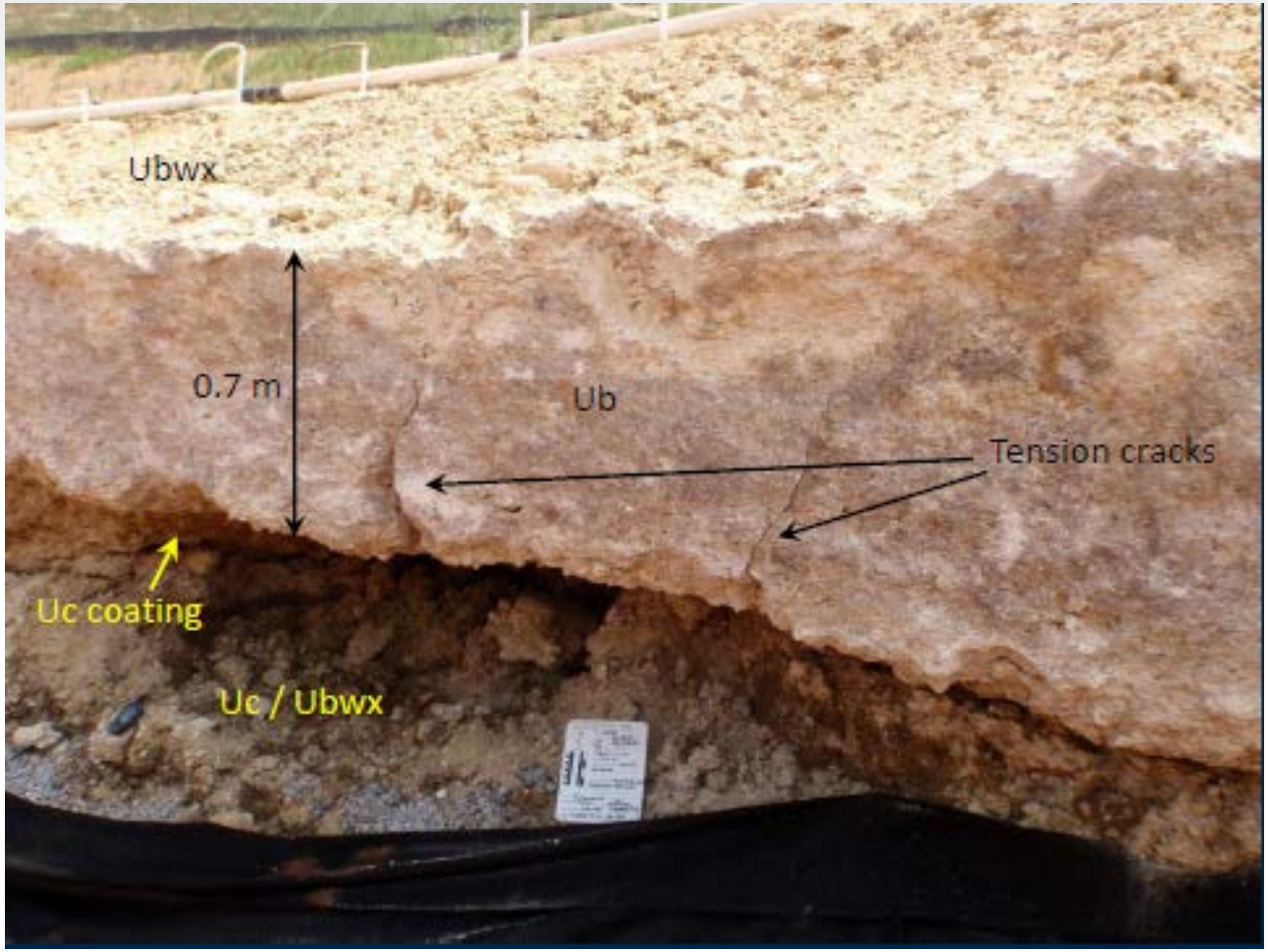
Voids

Slurry Filled Pockets

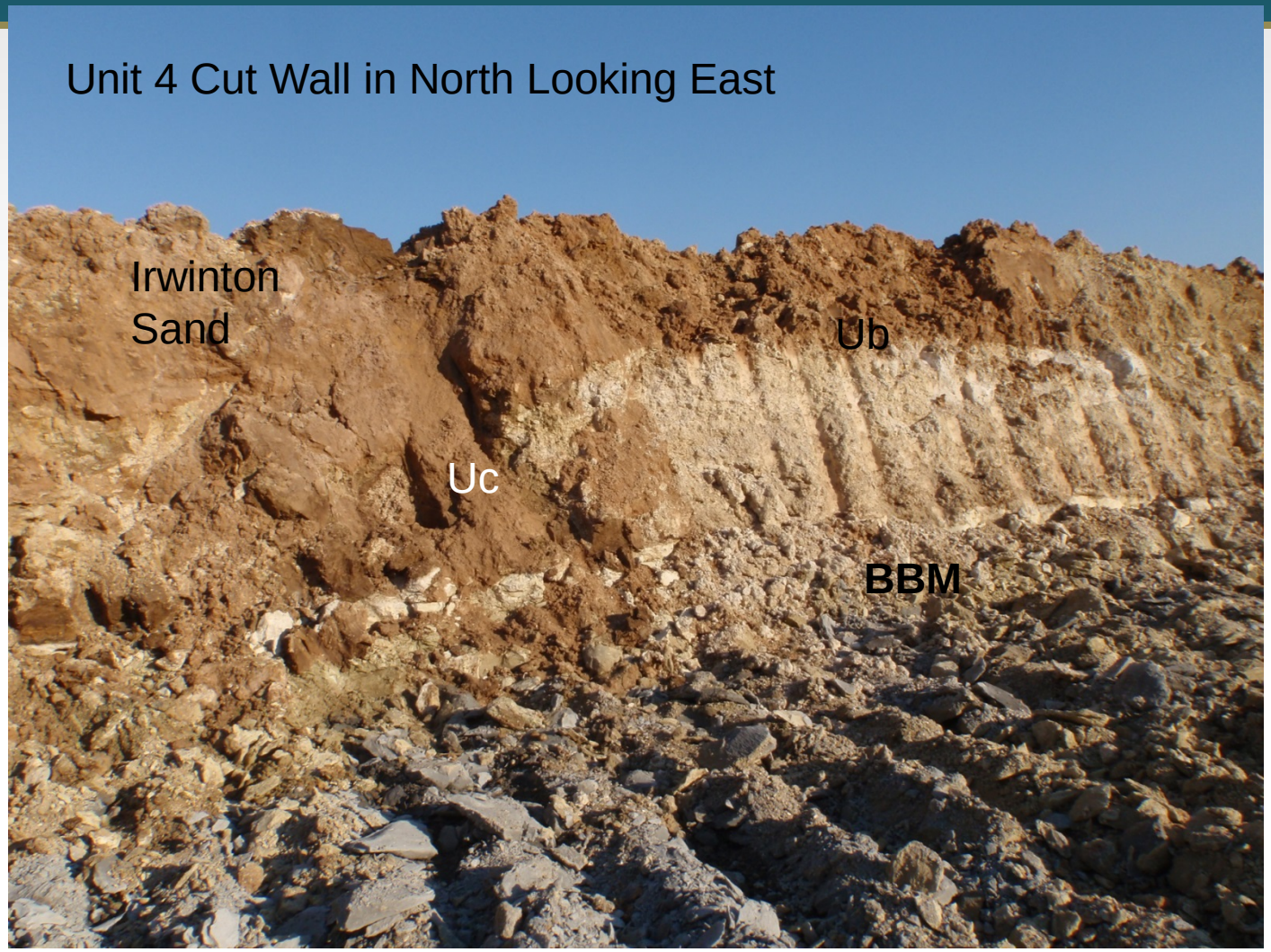
Caves

Let’s go Spelunking

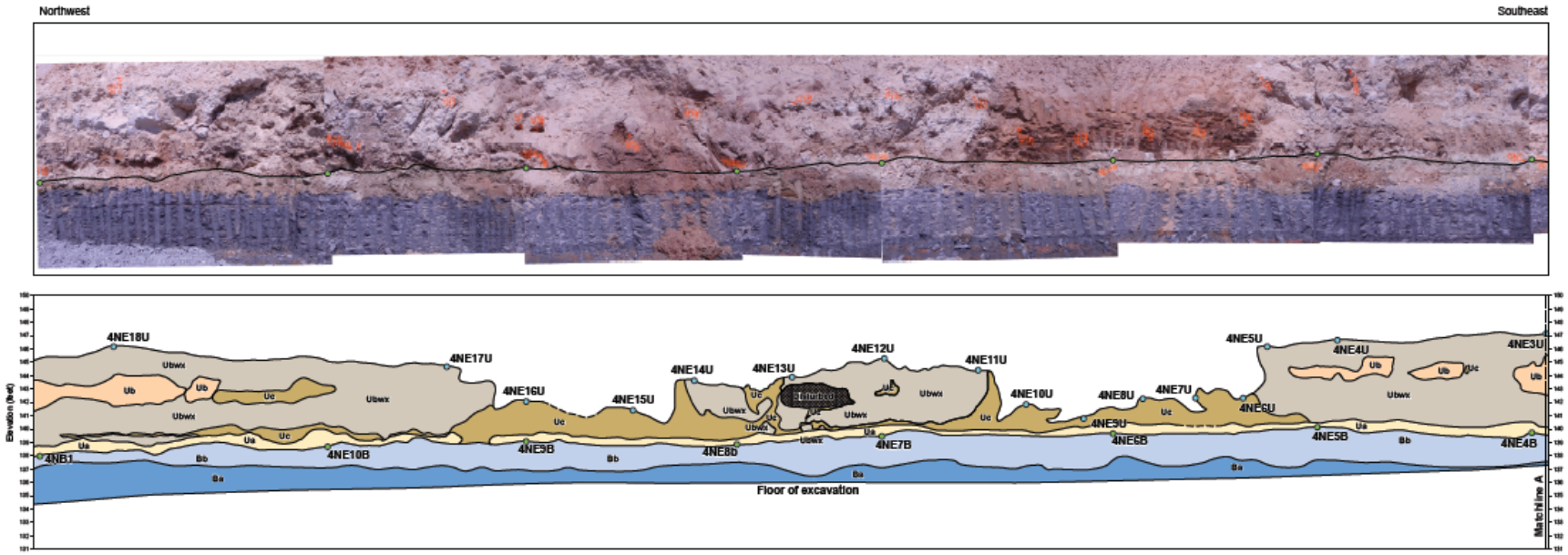
Slab Spanning Dissolution Zone

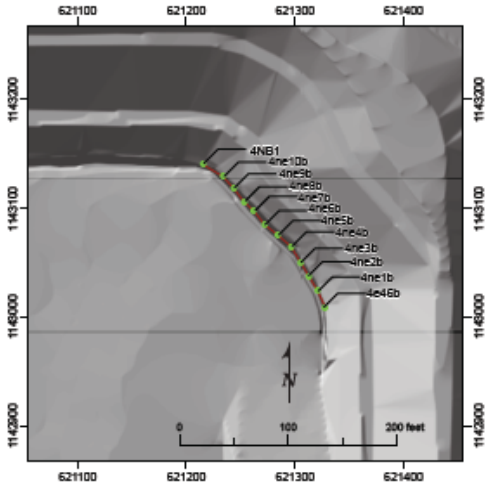


Collapse Structures



Example Mapping of Dissolution Zone





Site map showing section location and BBM stationing

Explanation

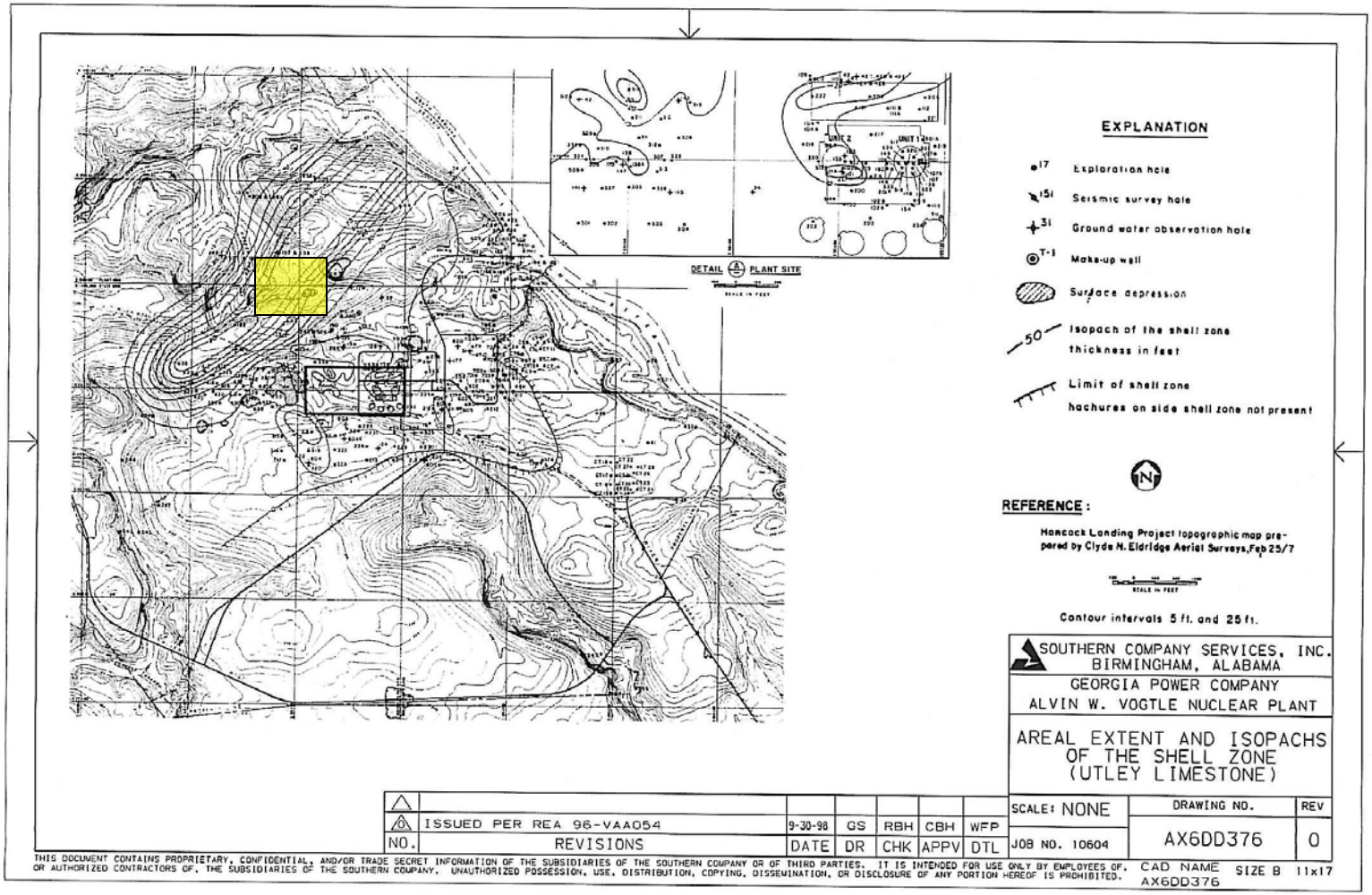
Top of Utley (see Table 1)

Uc, Ubwx, Ub, Ua — Utley limestone

nwb14 — Top of BBM (see Table 2)

Bc, Bb, Ba — Blue Bluff Marl (BBM)

Surface Depressions



Surface Depressions

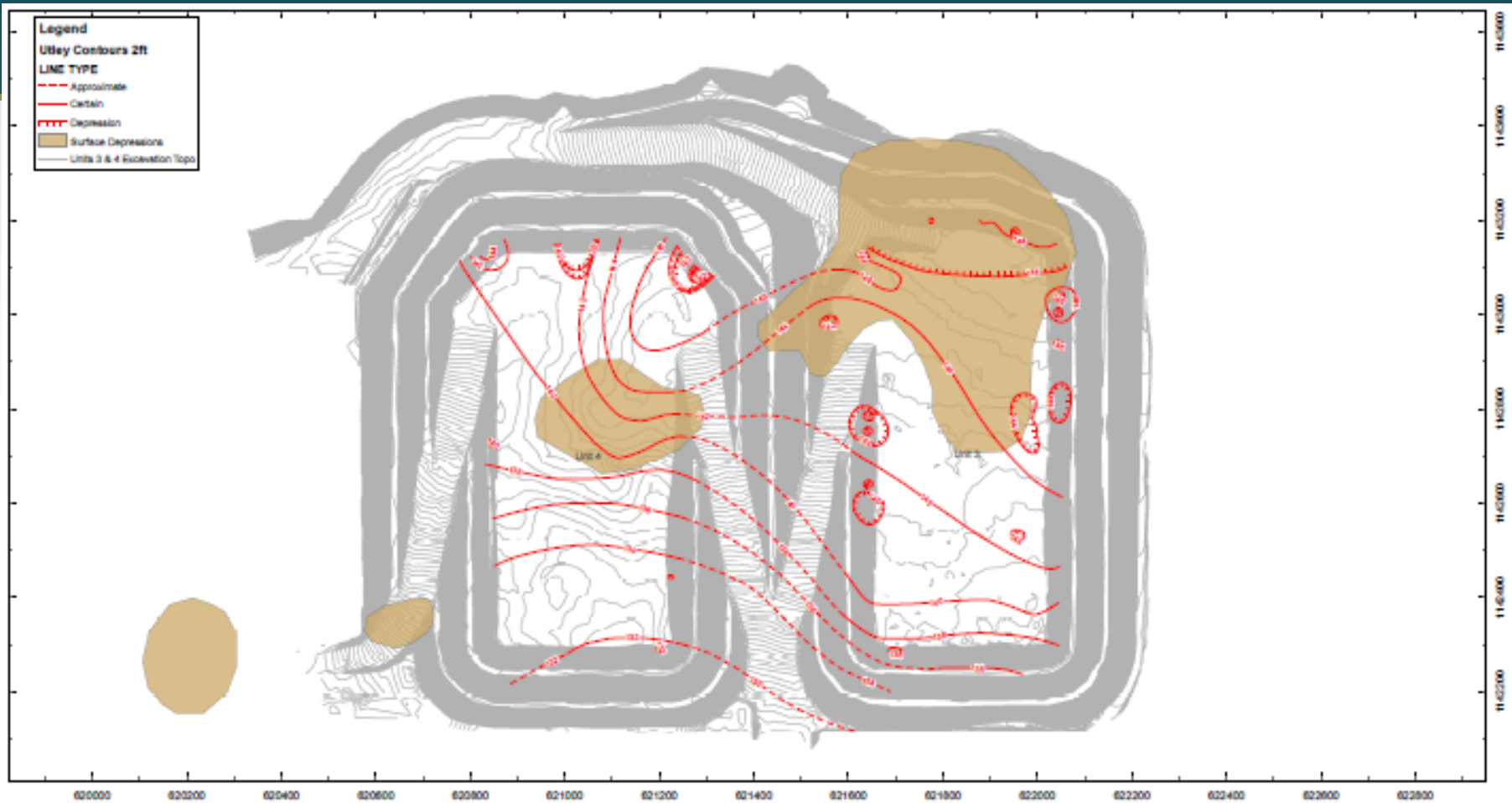
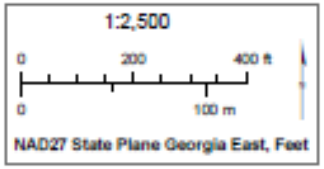


Figure X. Vogtle Units 3 and 4 Top of Utley (Contours = 2ft)



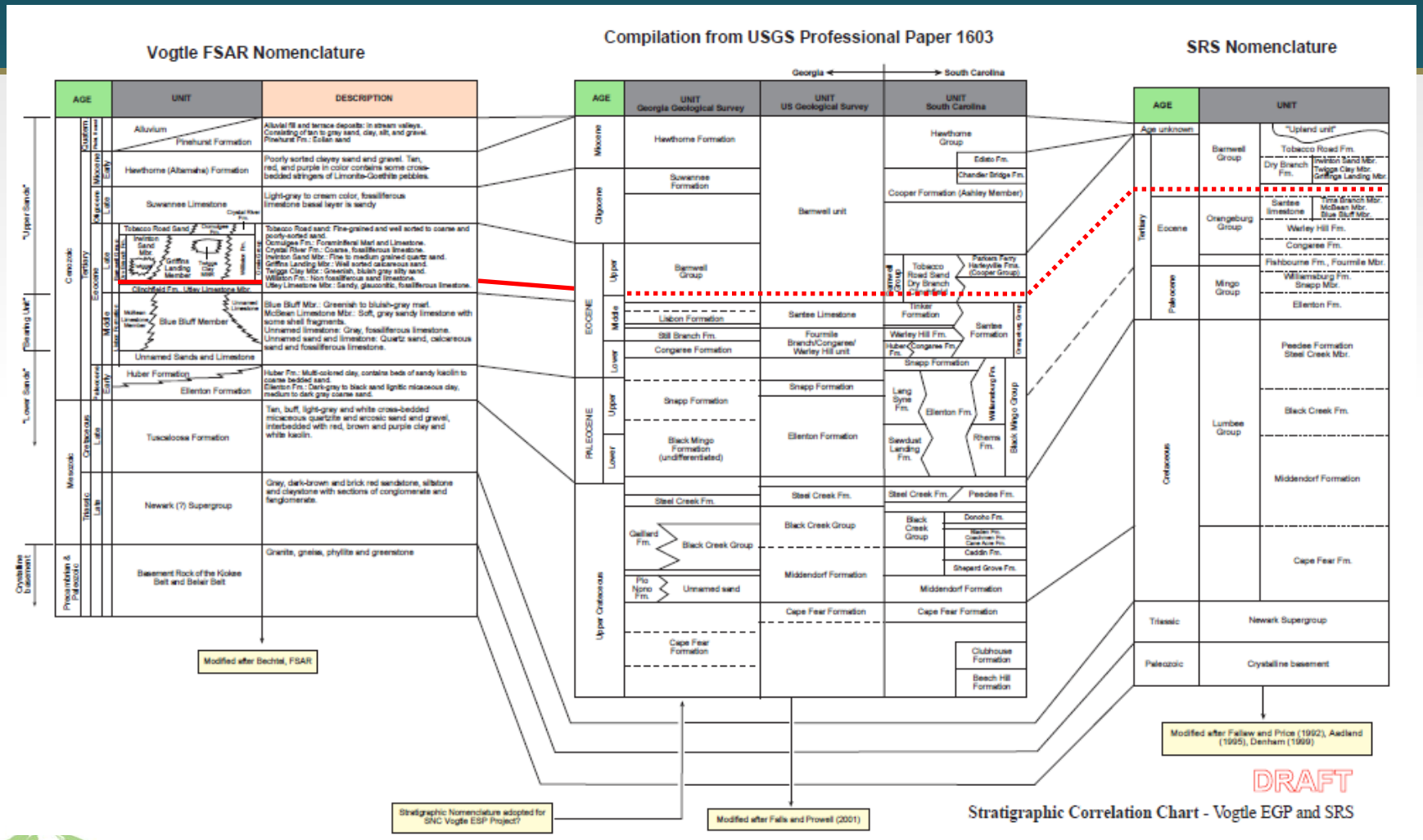
Georgia Big Dig Observations

- The Utley is a distinct lithostratigraphic unit with several facies
- Diagenesis of the Utley differs from both underlying and overlying carbonate units
- Large dissolution features do exist in the subsurface (Utley) with evidence of open voids
- Collapse features noted in the Utley section correspond to surface depressions i.e., karst
- Age dates of spaleothems ~40K to recent

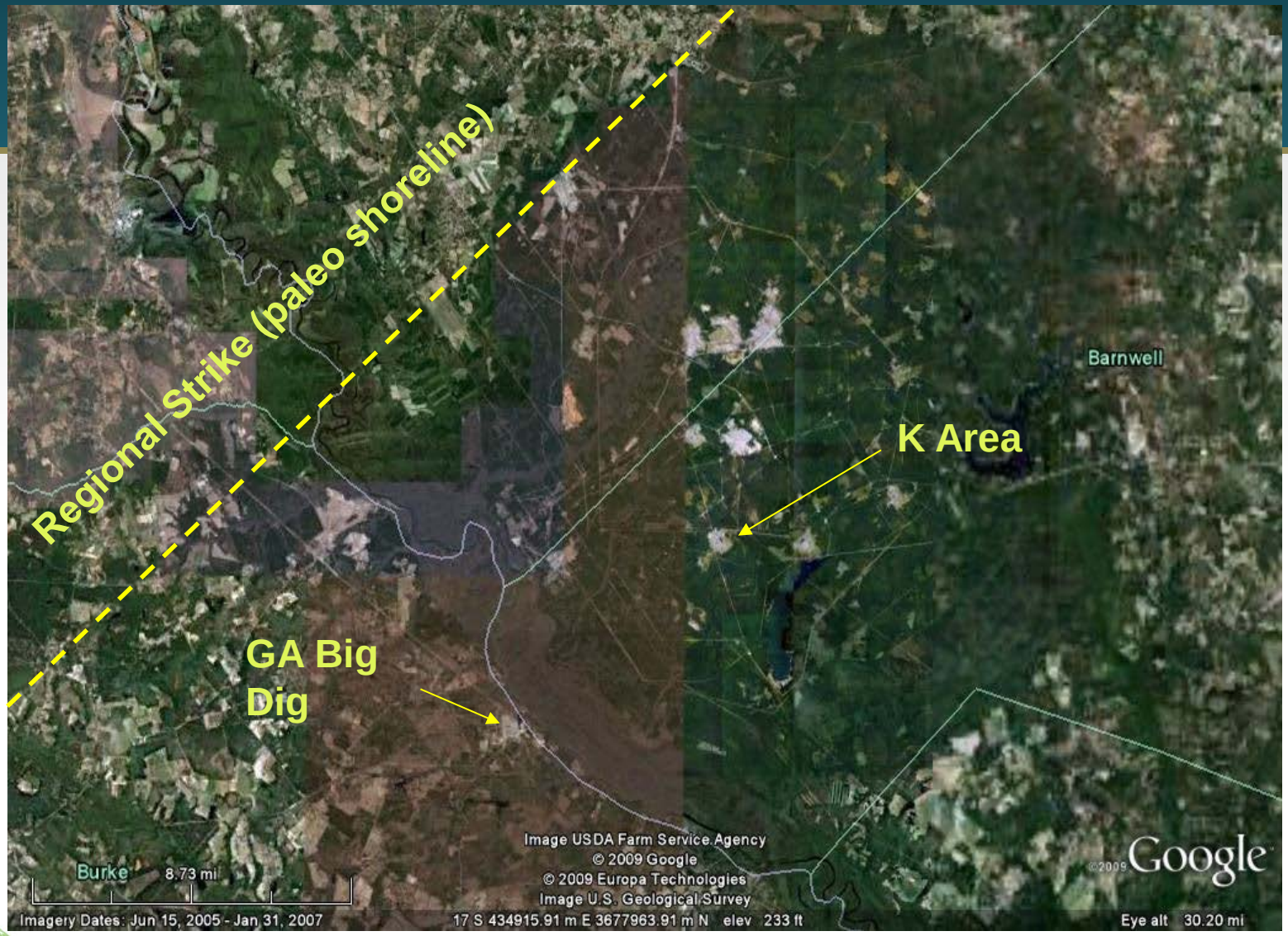
Case Study - K-Area

- K-Reactor USCOE grout program observations re-evaluated
  - Numerous “soft zones”, rod drops, etc.
  - Large grout takes and travel between grout holes
- Re-evaluation of core from K-Area indicated the presence of the same geologic strata as the GA Big Dig (pUtley)
- Grout travel paths indicate similar distribution to voids noted in GA Big Dig
- Core from early 1990’s KASS program re-analyzed and Utley was present.

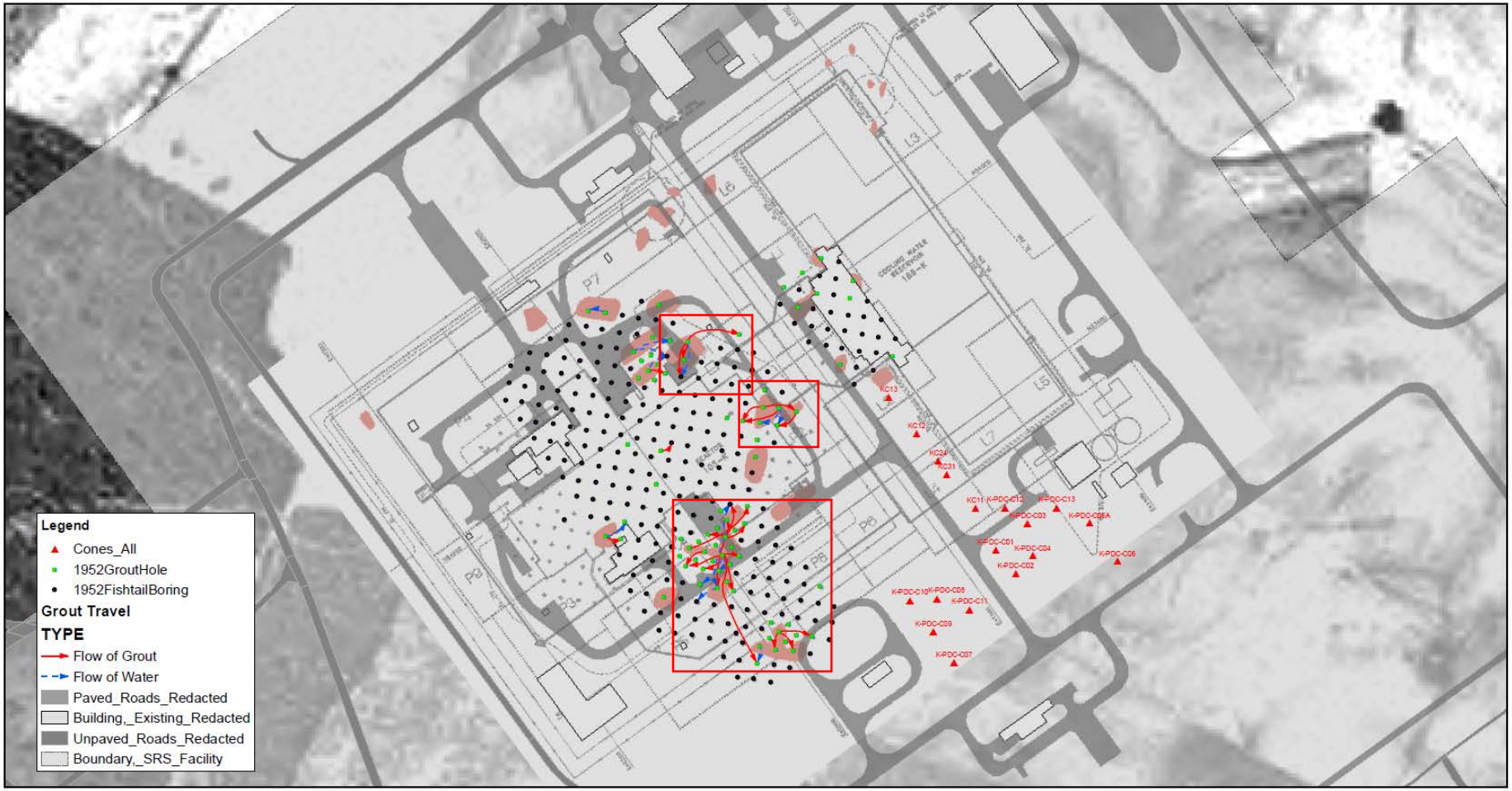
Stratigraphic Correlation



Top of Utley


Regional Strike (paleo shoreline)
K Area
GA Big Dig
Barnwell
Burke
8.73 mi
Image USDA Farm Service Agency
© 2009 Google
© 2009 Europa Technologies
Image U.S. Geological Survey
Imagery Dates: Jun 15, 2005 - Jan 31, 2007
17 S 434915.91 m E 3677963.91 m N elev 233 ft
Eye alt 30.20 mi
©2009 Google

K Area Grout Take Evaluation



1:2,500

0 300 ft

0 100 m

NAD27 UTM Zone 17N

Figure X. K-Area with Grout Take and Travel Figure

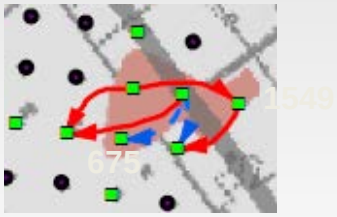
Sources: SRS provided layers
Georef. Grout Take Figure - SRS - Illustration B Redo.jpg

USCOE Grout Takes

10912 cu ft

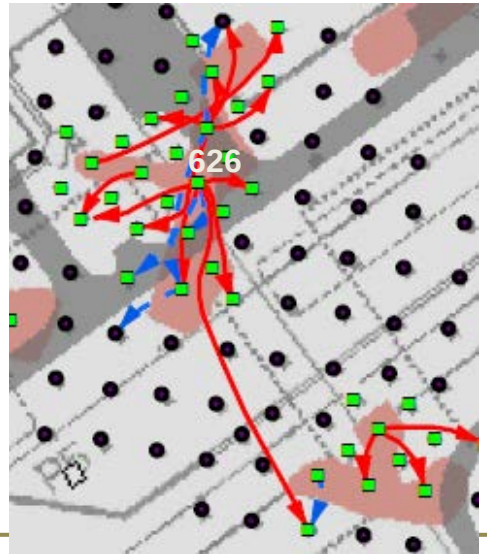
Travel ~200’
Unconstrained to East

Width Constrained
North, West and South



17039 cu ft

Travel ~50’
Unconstrained East and South



6886 cu ft

Travel ~200’

Width constrained
North, South, East and West

A Shift in Thinking- Time for Confessional

- Subsurface conditions similar to those noted in the Georgia Big Dig can exist at SRS
  - Soft Zones typically analyzed as material filled (OCR<1.0)
- Voids can exist in the subsurface at SRS and are likely stable under static conditions
- Surface depressions (excluding Carolina Bays) are indicative of surface manifestation of subsurface collapse

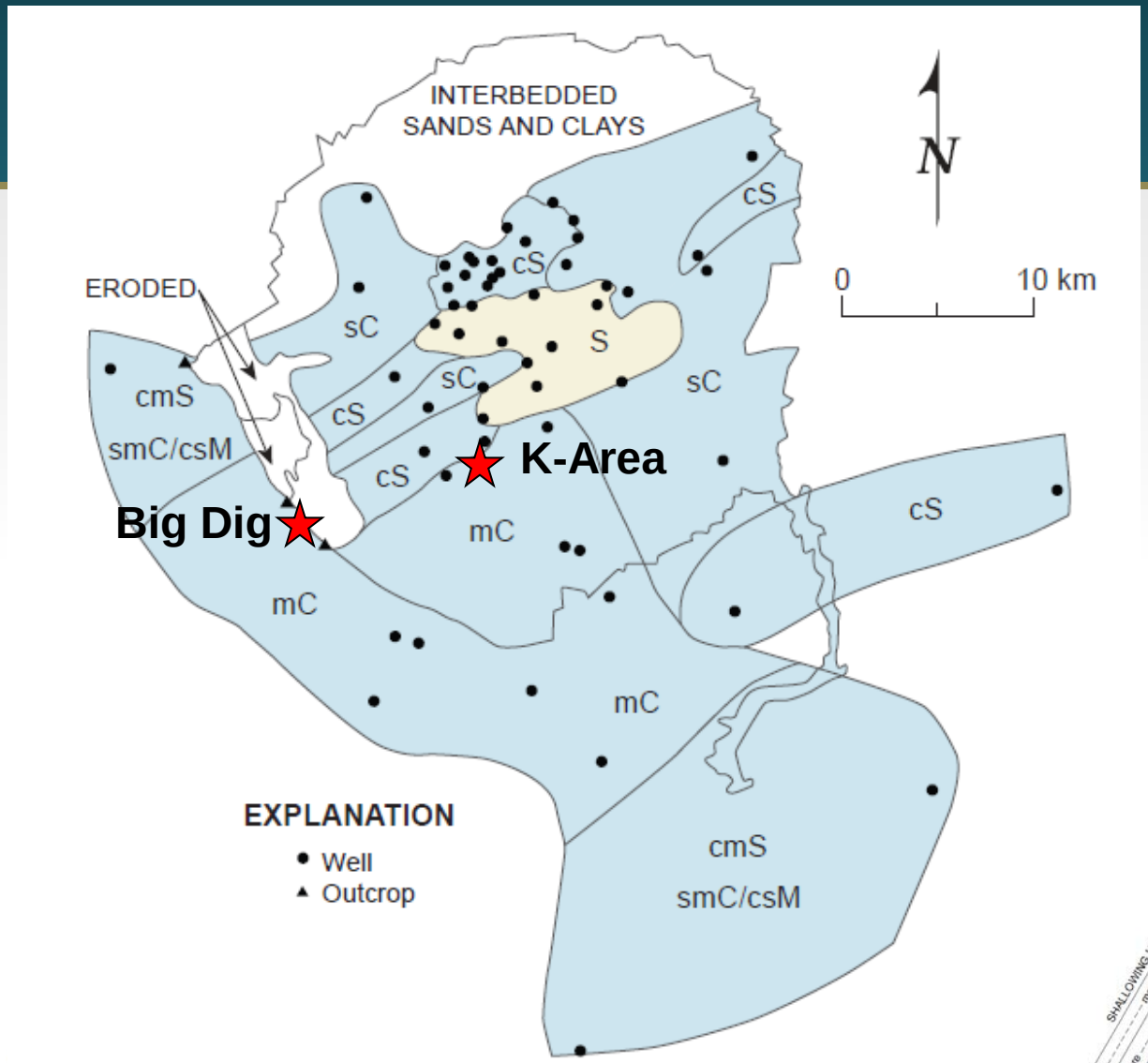
Implications

- I never get to work for DOE again!
- Are all critical structures at SRS safe under dynamic loading?
- What analytical techniques best approximate performance?

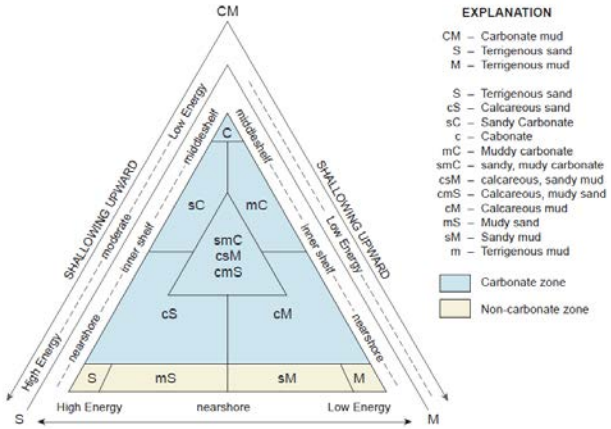
Path Forward (Brent you should have been here!)

- Detection of voids problematic with standard exploration techniques
  - Revised approach to exploration programs to focus on areas of early refusal by CPT to consider the “slab span” condition
  - Employ new surface geophysical techniques to map lateral extent of “slabs”
- Further studies
  - Correlation of sinks and carbonate distribution
  - Understand the diagenetic difference of the Utley vs. Santee
  - Evaluate existing CPT database for void signatures and boring data
  - Use measured surface depression expression to back check modeling
- Improved FEM techniques

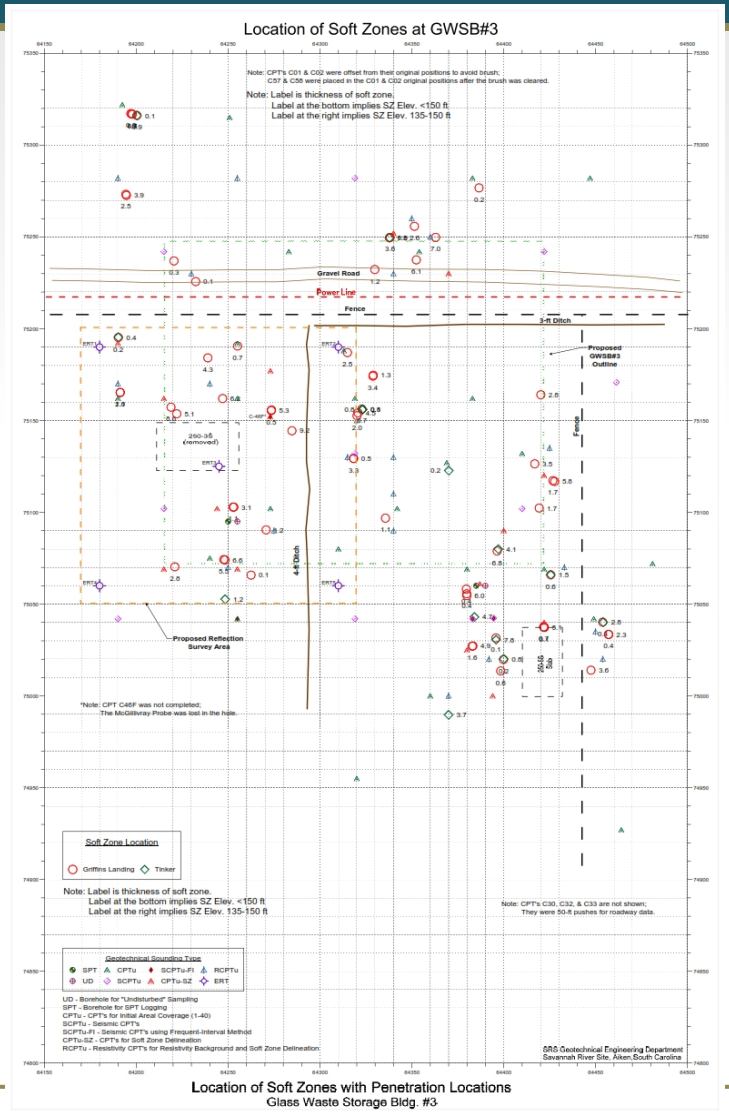
Eocene Carbonate Facies Map



Modified from Harris, et al., 1997



Case Study-Glass Waste



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Case Study- Sand Filter

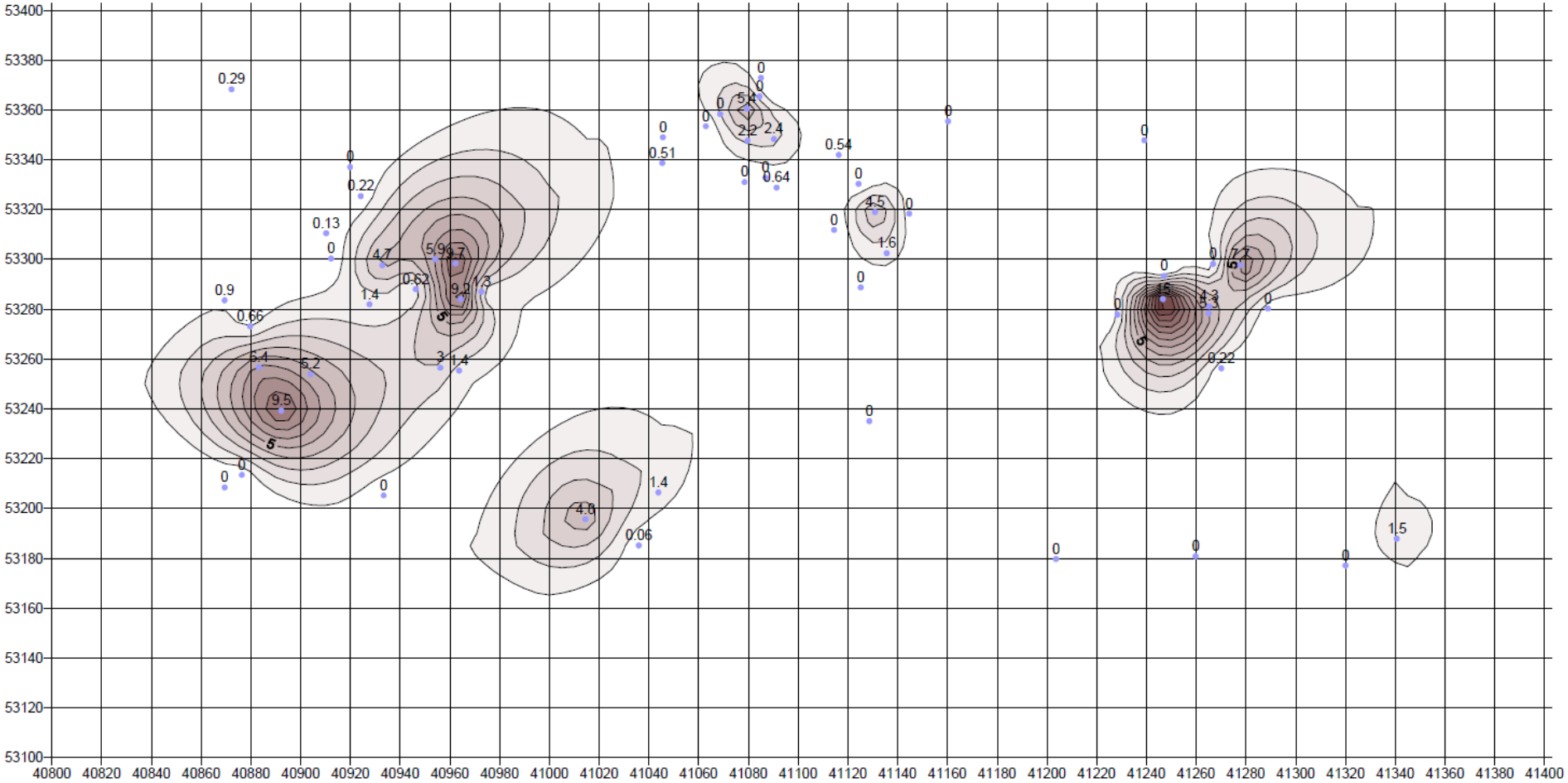

Figure 9: Contour Map of Soft Zone Thickness, 15 tsf criteria