Detection of Structural Components and Seepage Zones at the Eagle Mountain Facility Using Geophysics

ASDSO 2010
Seattle, WA

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PB 125 Years

Site Location

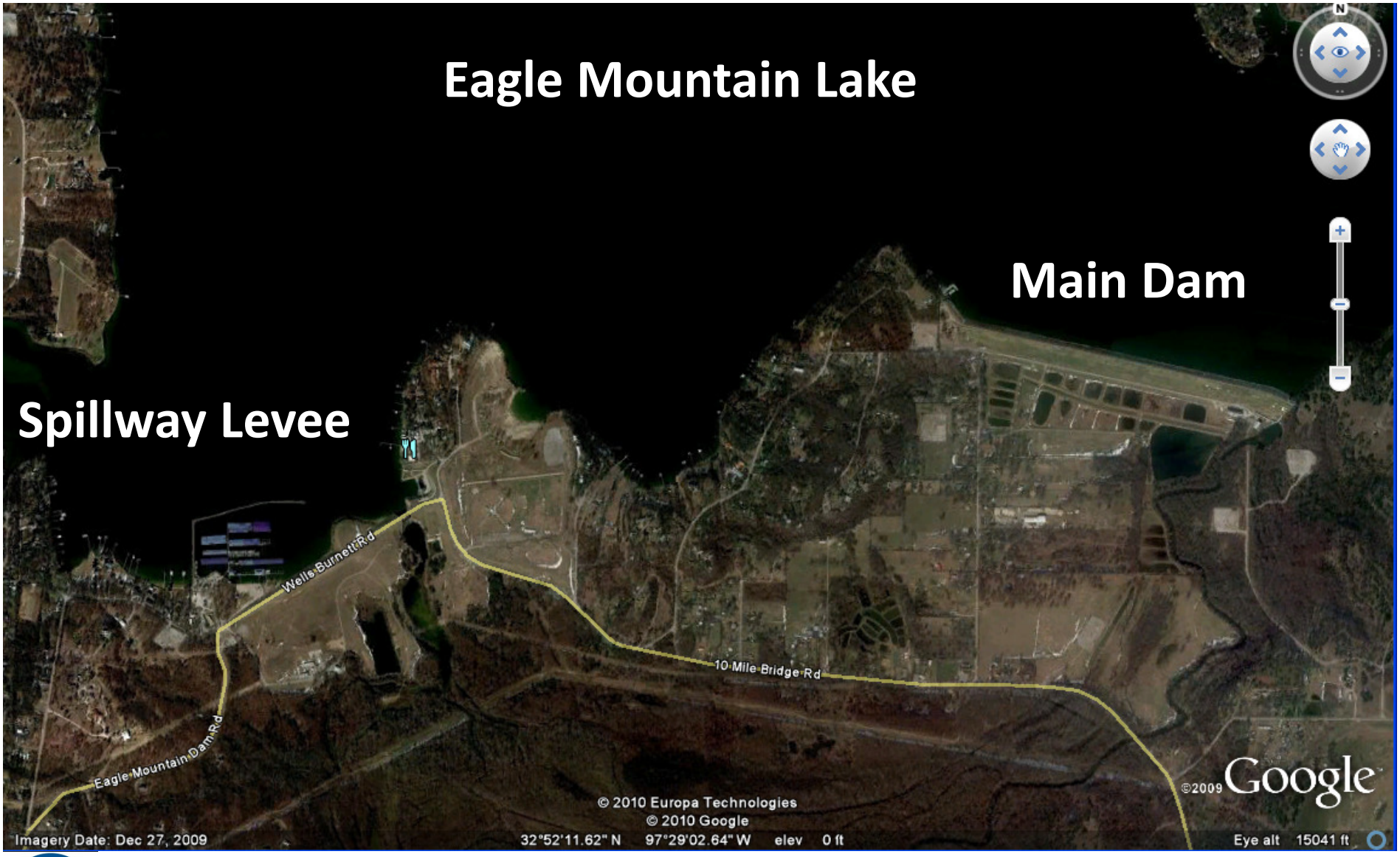
Eagle Mt. Dam & Lake

Introduction

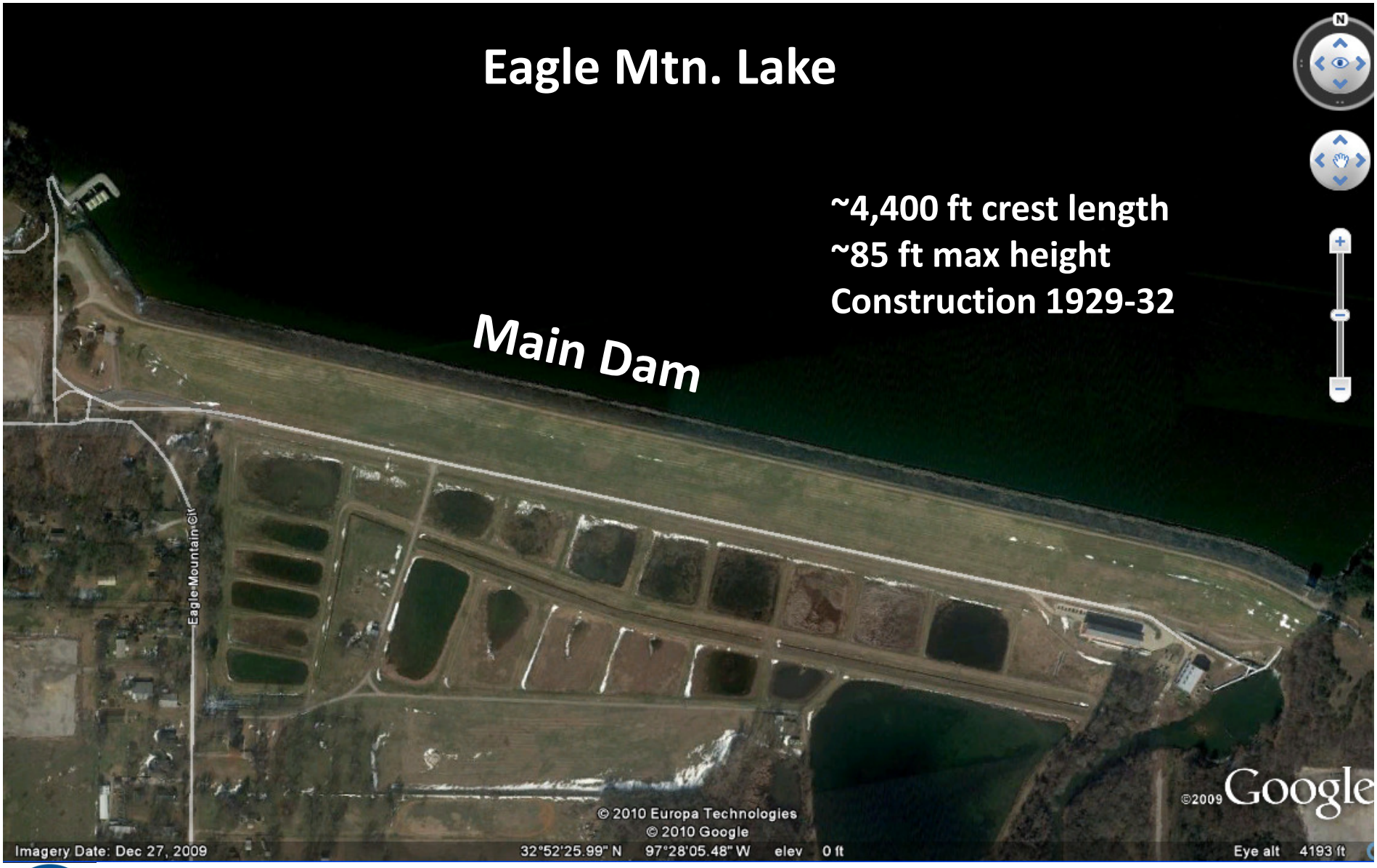
- Eagle Mountain Dam and Spillway Levee are two separate structures north of Lake Worth, TX and are maintained by the **Tarrant Regional Water District.**

- Each structure is a earthen dam with a **sluice-filled clay-core** and **vertical sheet-piling** at the base of a cut-off trench which is intended to tie the core into the sandstone/conglomerate bedrock, shell materials, upstream rip-rap, concrete spillways, utilities and roadways.

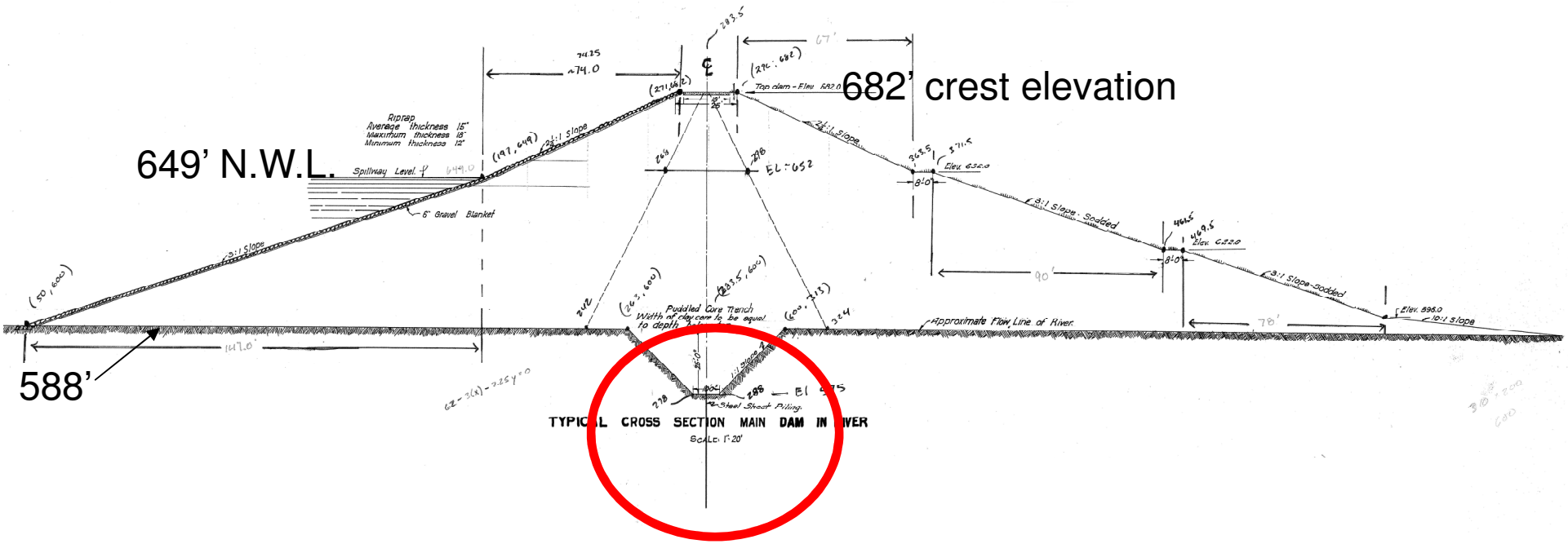
Site Location – TWO STRUCTURES!



Site Location



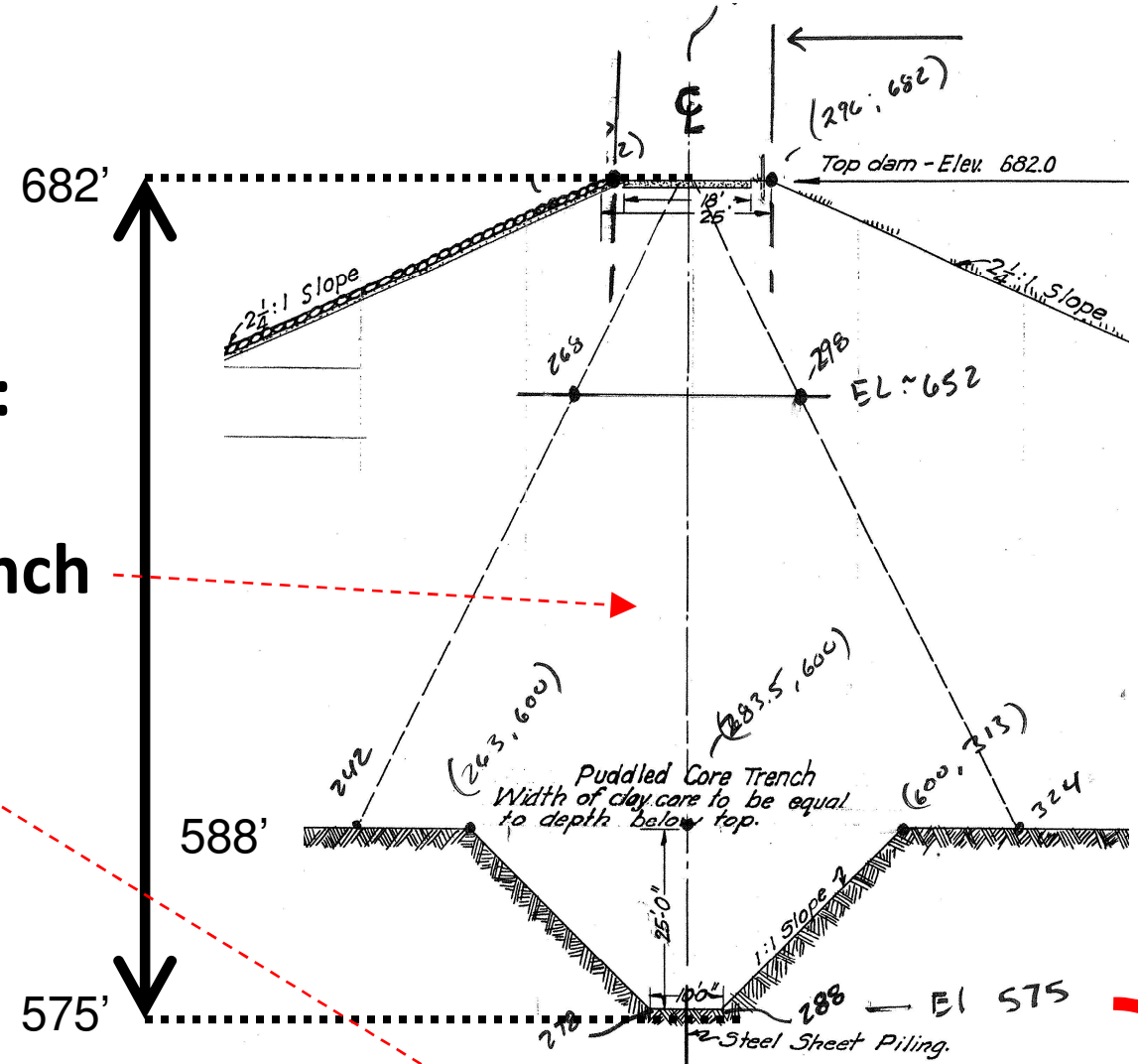
Structure Details – Main Dam



Main Dam section:

-Puddled Core Trench

-Steel sheet piling



Undifferentiated "overburden"
(silts, clays, with some sands)

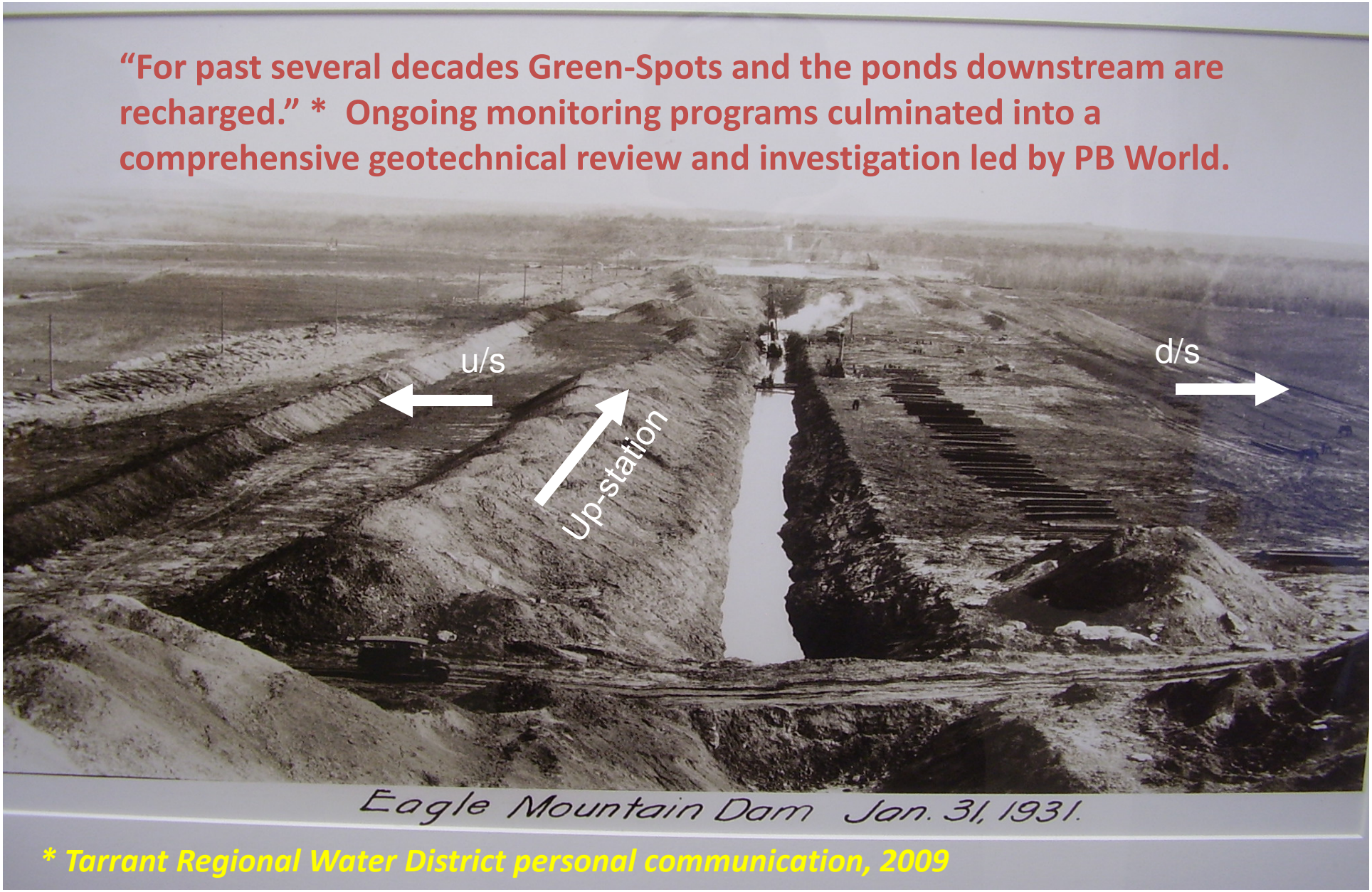
?

Sandstone/Conglomerate Bedrock (Paluxy Fm.)

Historical Record – Main Dam

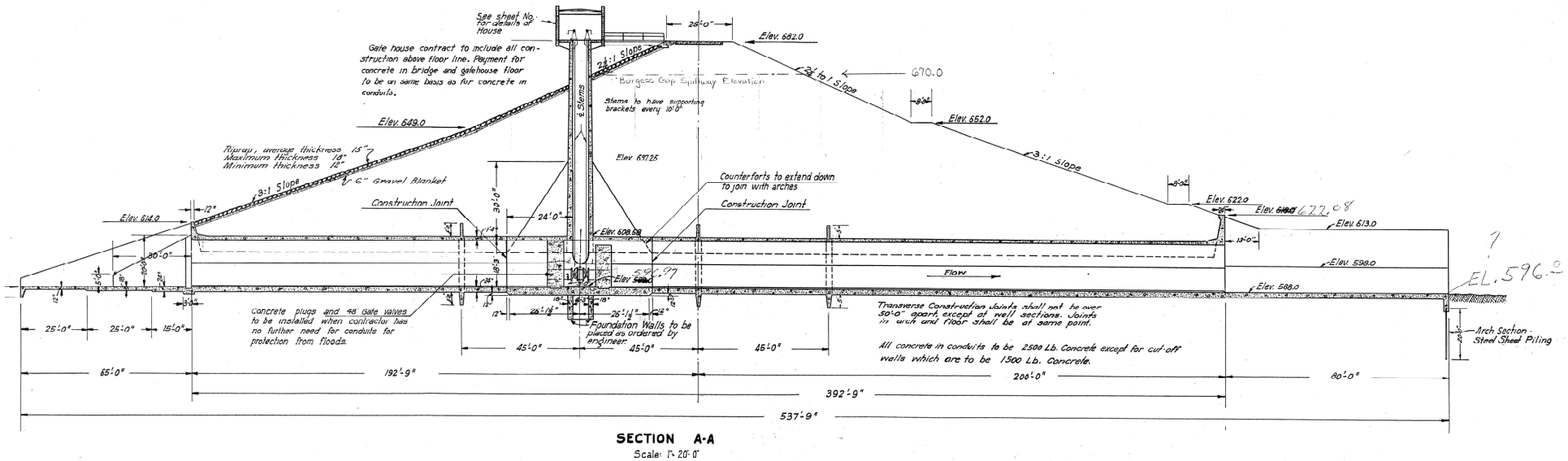
Historical Record – Main Dam

"For past several decades Green-Spots and the ponds downstream are recharged." * Ongoing monitoring programs culminated into a comprehensive geotechnical review and investigation led by PB World.



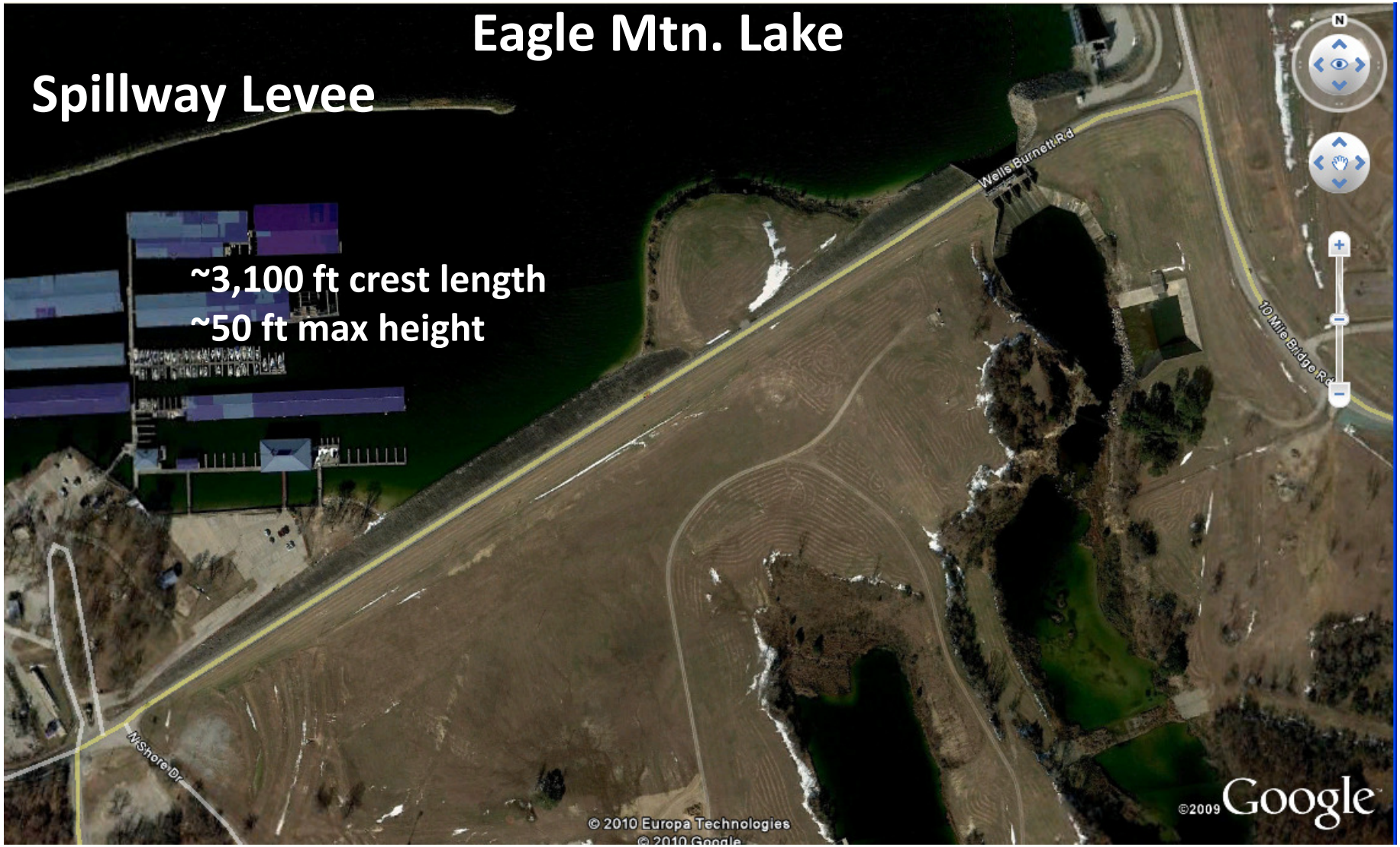
** Tarrant Regional Water District personal communication, 2009*

Structure Details – Main Dam

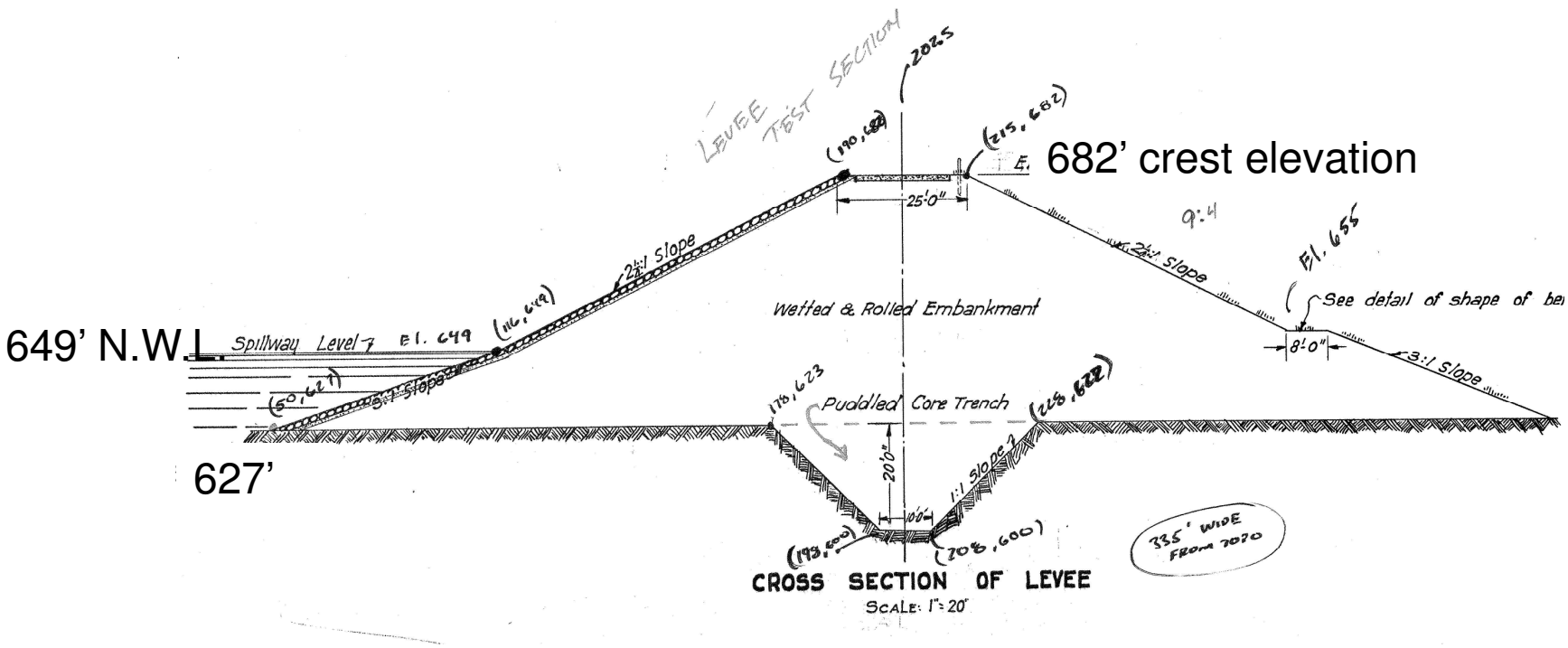


1929 Design Drawings (small outlet works left abutment)

Site Location



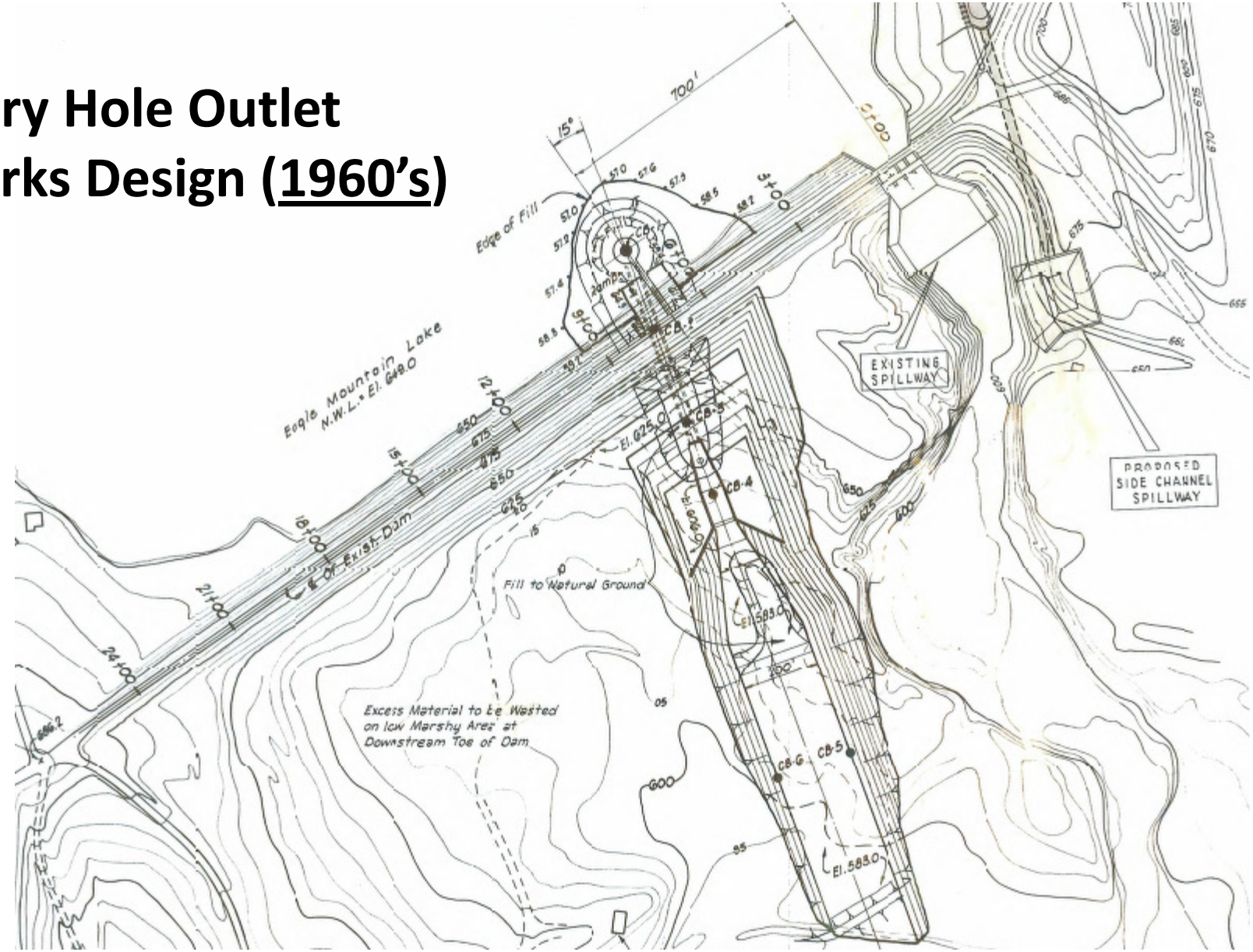
Background – Spillway Levee



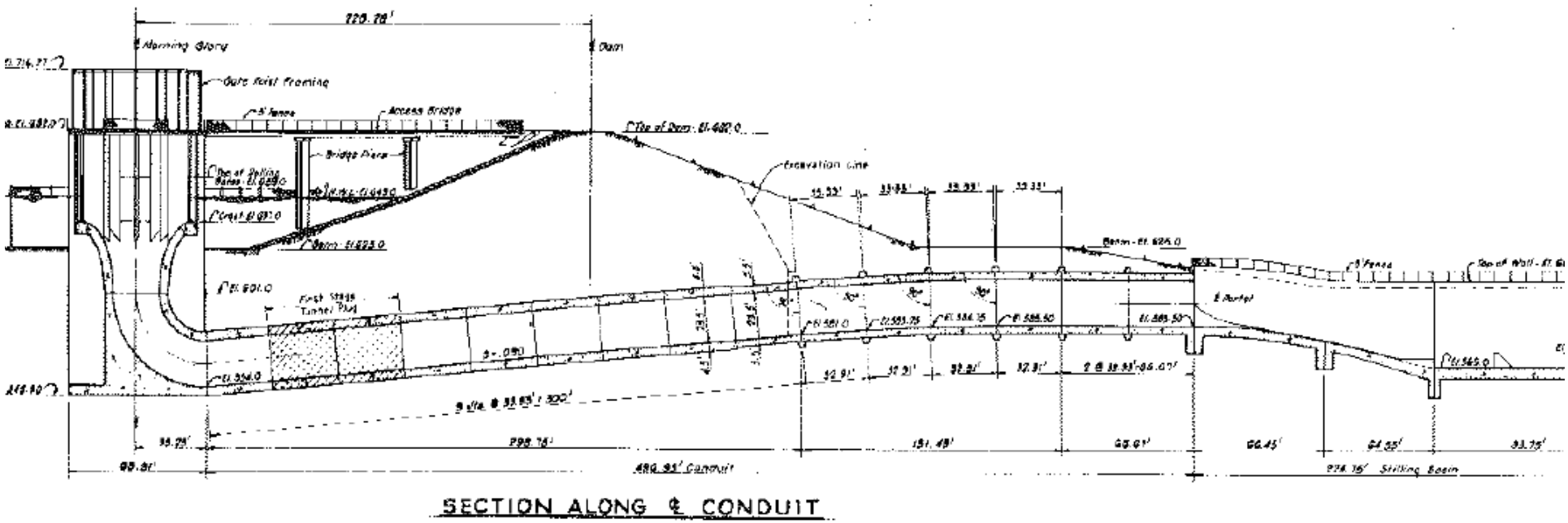
Typical Levee Section…
1929 Design Drawing

Structure Details – Spillway Levee

Glory Hole Outlet Works Design (<u>1960's</u>)



Structure Details – Glory Hole



1960's Design Dwgs.

Background:

"The morning glory spillway's inlet shaft was nearly completely built (u/s). But they encountered difficulties the deeper they extended the shaft. Seepage was the main issue, *grouting* ***and*** *freezing* was largely unsuccessful.

Simultaneously, the downstream portion of the channel was excavated into the levee embankment. The cut into the levee produced uncontrollable flow from at least one cavity at the levee's toe."

Structure Details

Tasks and Approach

Choosing the right geophysical tools from the tool box…
And… use a "*Phased Approach*"

PHASE 1:

- Verify presence & location of sheet-piling "installed" along both structures and the abandoned morning glory structure at the levee → MAGNETICS (MAG)

- Confirm presence & location of cultural features and utilities
  → MAGNETICS

- Detect possible seepage paths, and type of seepage flow
  → SELF POTENTIAL (SP)

Tasks and Approach

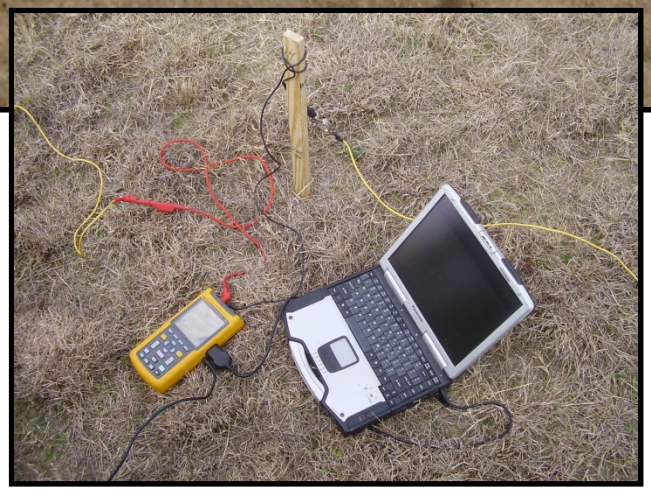
Choosing the right geophysical tools from the tool box…
And… use a "*Phased Approach*"

PHASE 2:

- Perform 2D 'follow-up' 2D profiling across SP anomalies (if present) → Electrical Resistivity Imaging (ERI)

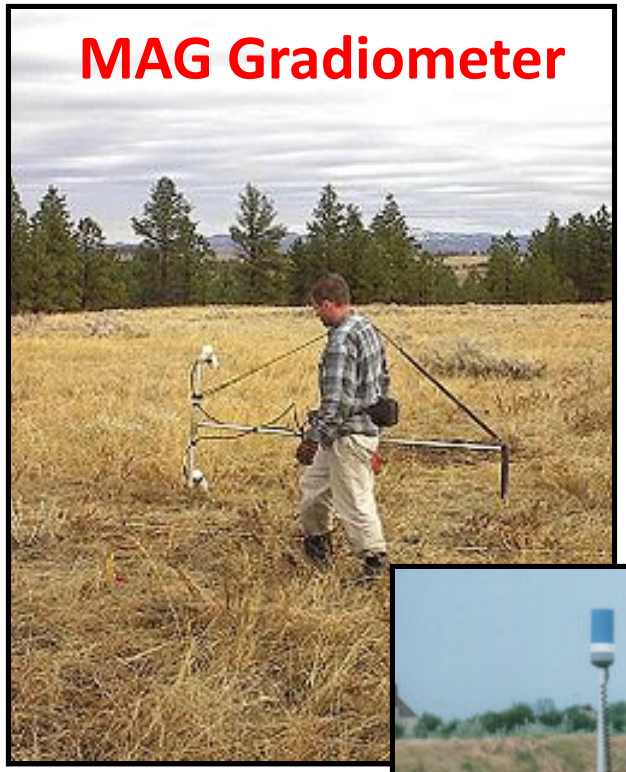
- If possible, perform low-pool SP for 'differential' assessment of seepage conditions

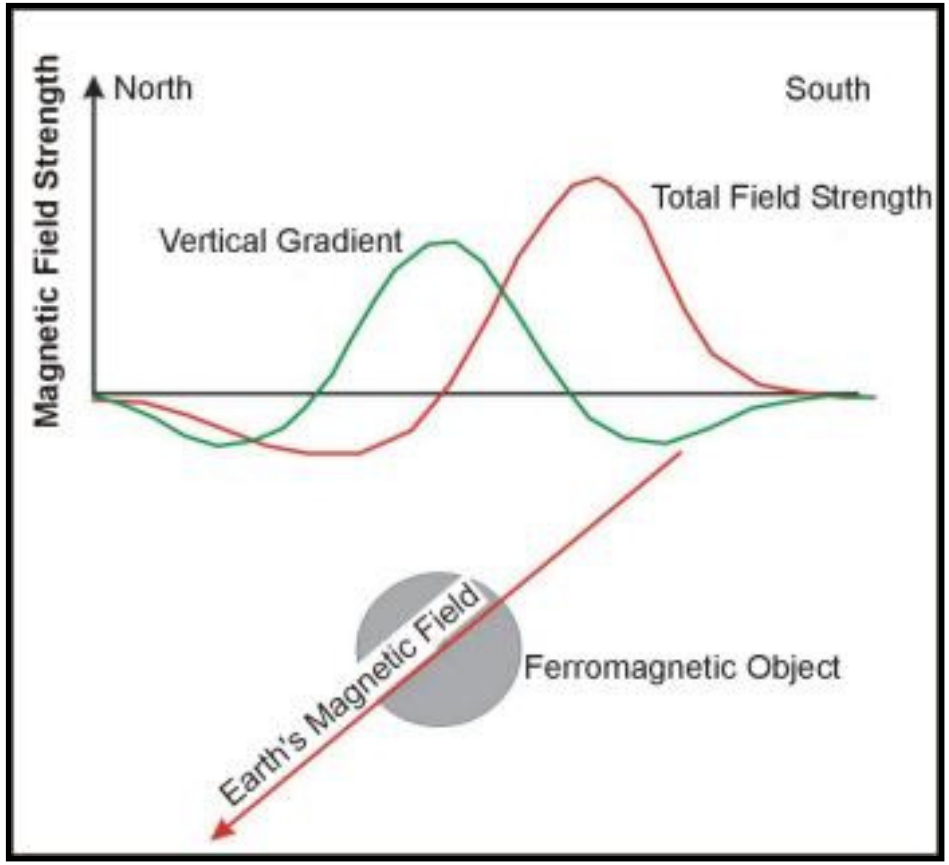
Methods / Data Acquisition



Full-time Telluric Monitoring

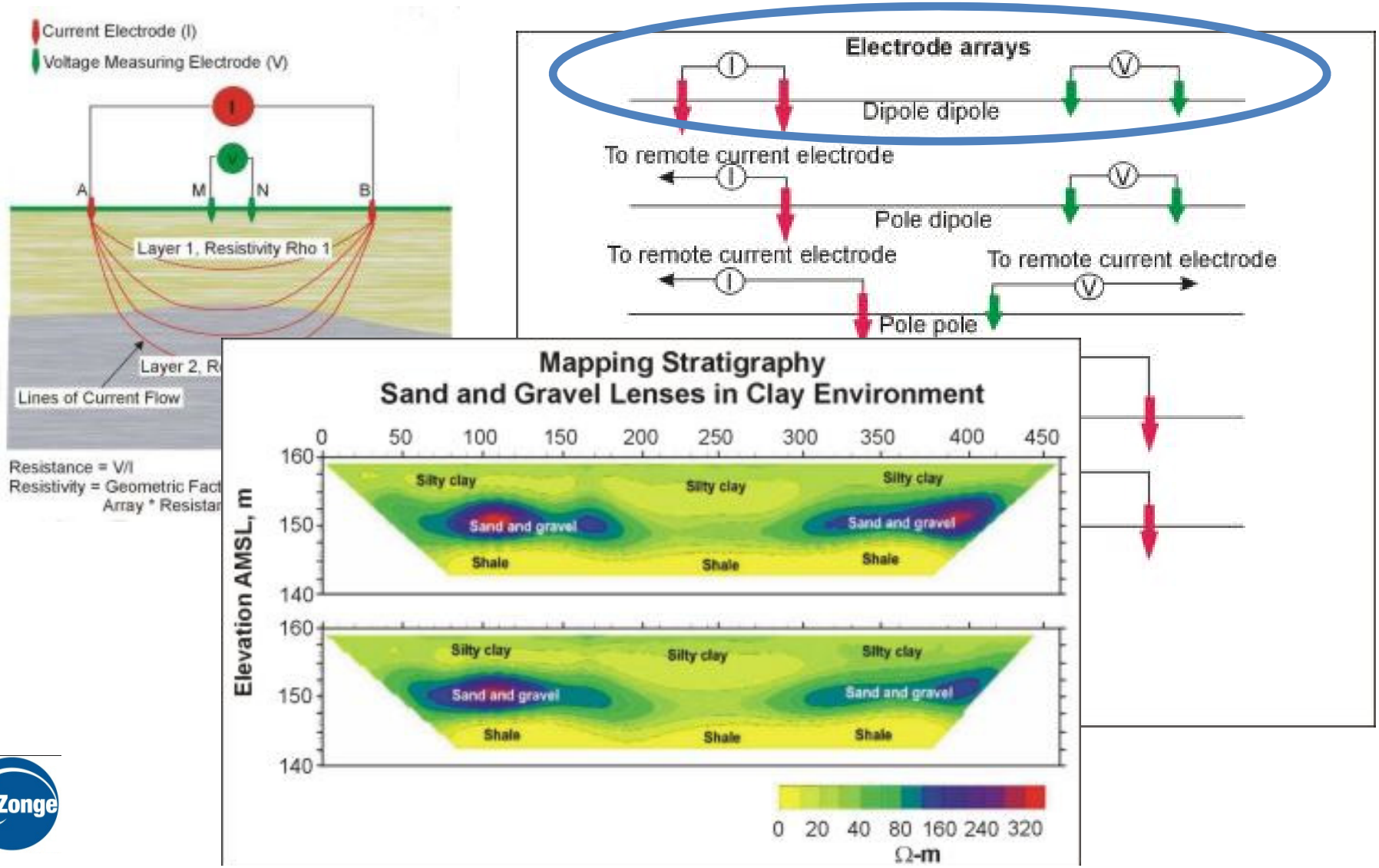
Methods / Data Acquisition



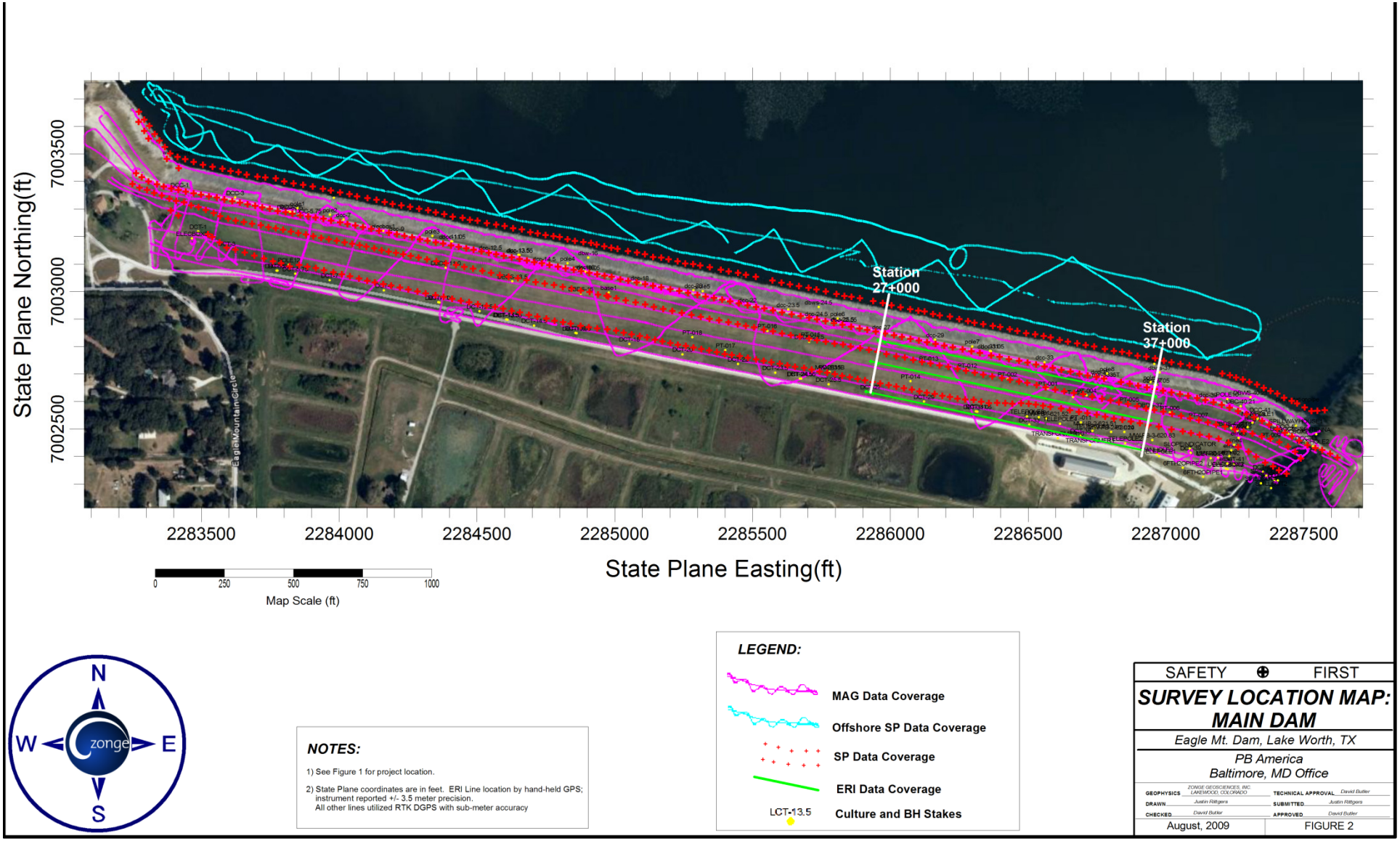


Methods / Data Acquisition

Electrical Resistivity Tomography (Imaging) - ZETA

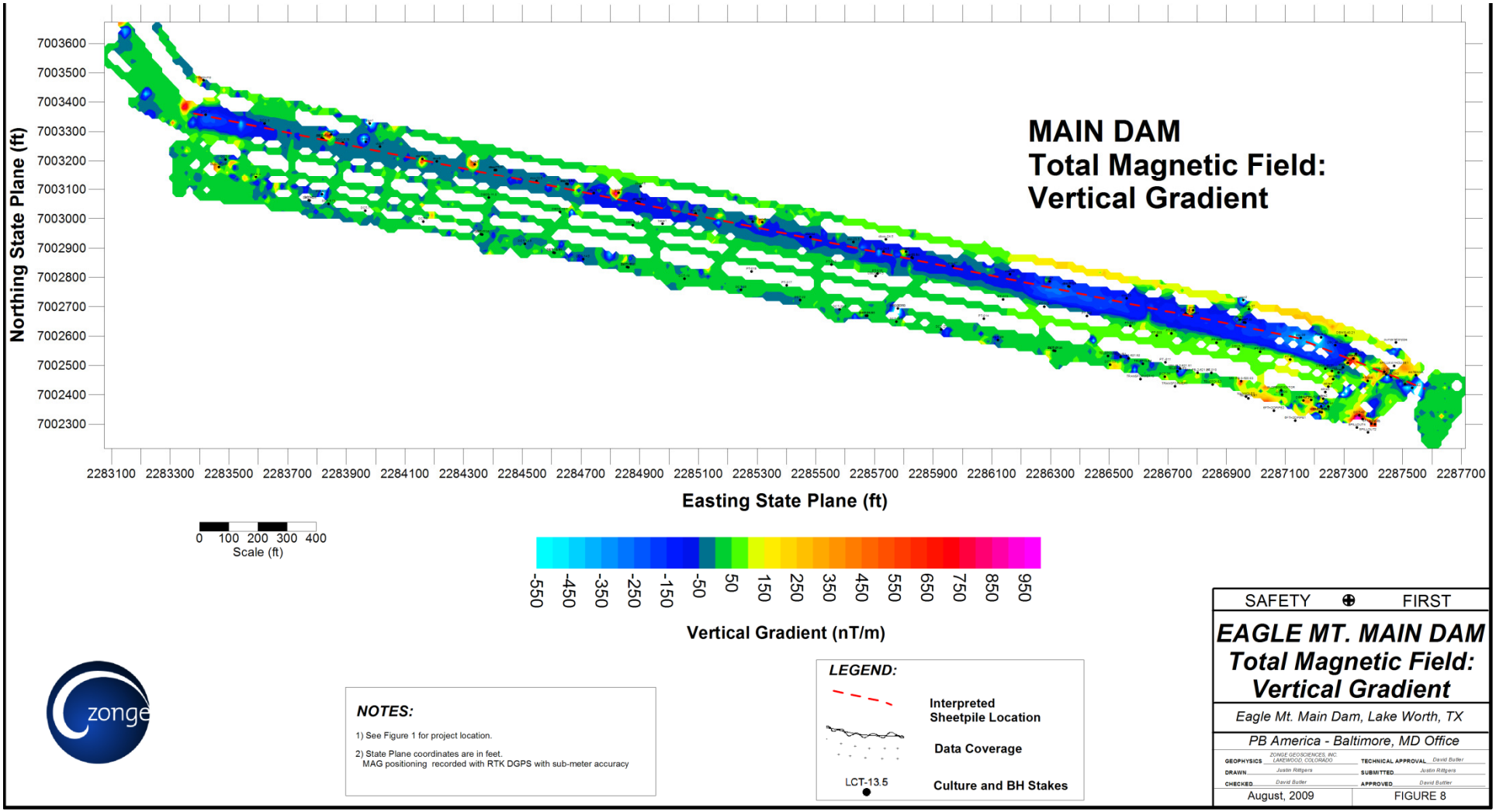


Main Dam – Data Coverage

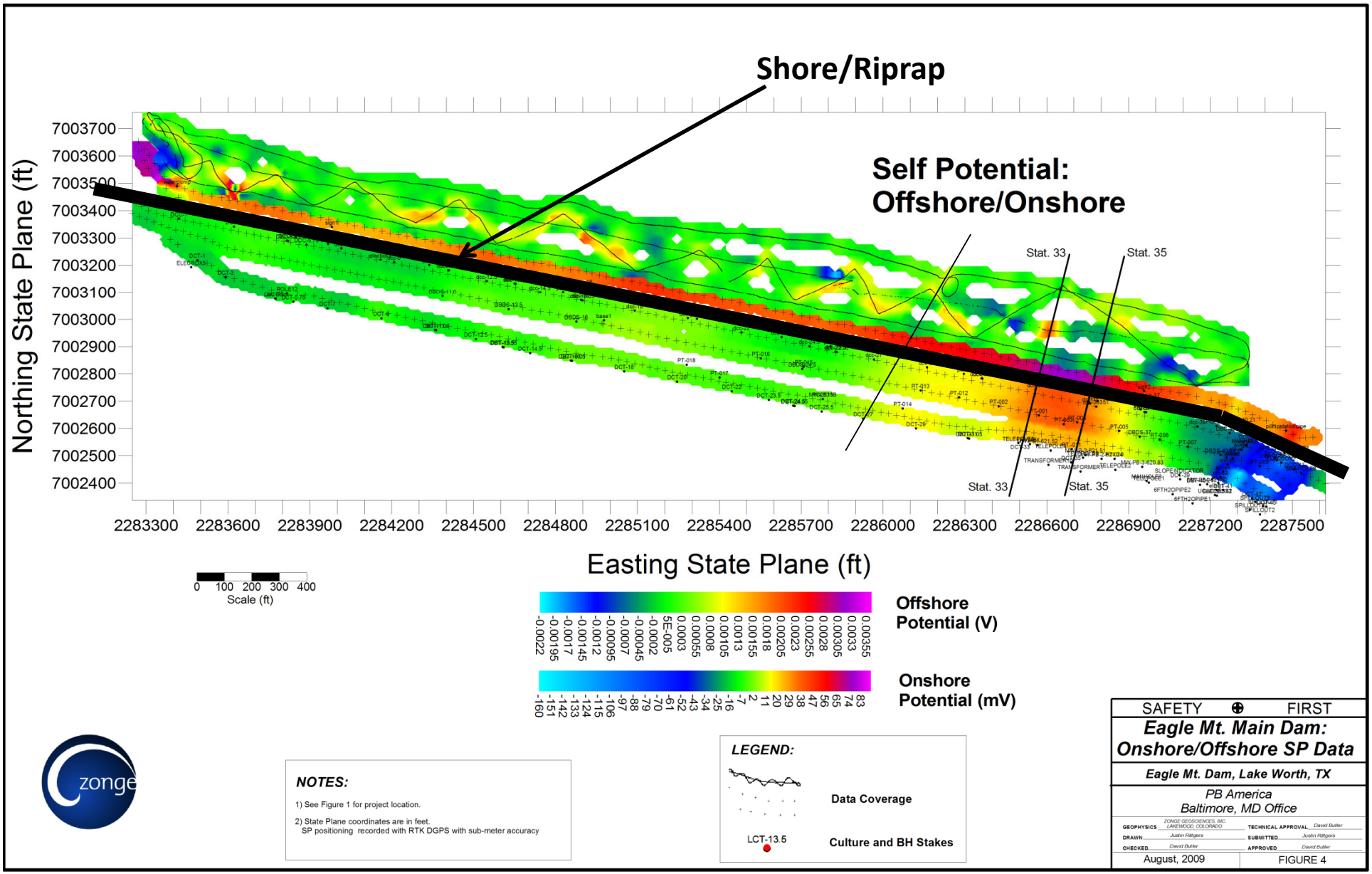


Vertical MAG Gradient- Main Dam

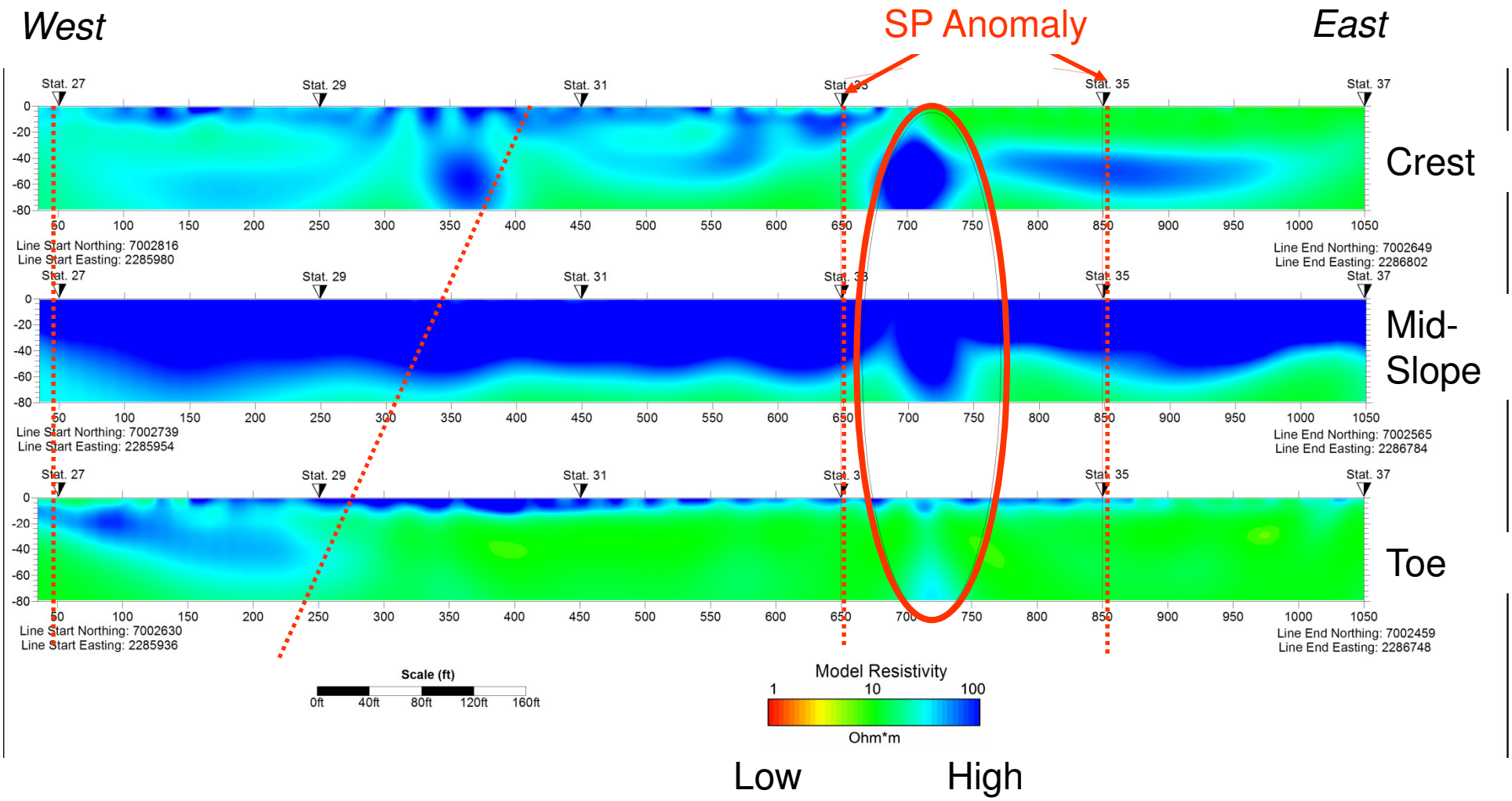
Final Results



Self Potential - Main Dam



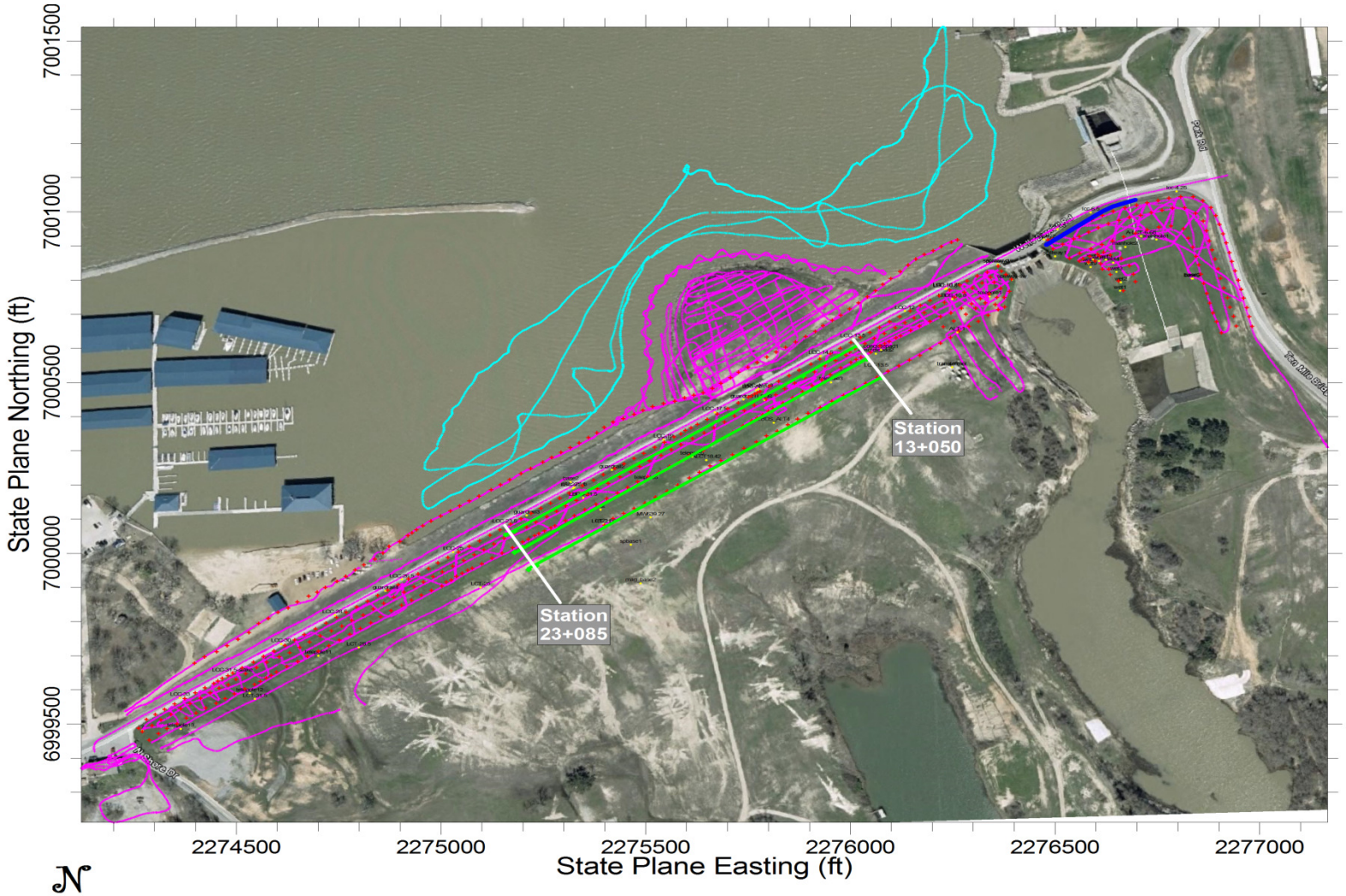
Electrical Resistivity- Main Dam

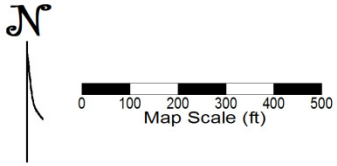


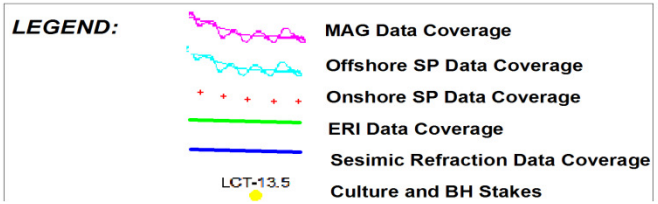
Results – Main Dam

- Magnetics:
  - Mapped the position and lateral extent of sheet-piling – full length of structure - as well as some cultural features that helped place the ERI lines.
- SP:
  - Mapped one broad anomaly perpendicular to the main dam, and has good correlation with ERI results; and one lesser anomaly near the right abutment
- ERI:
  - Mapped u/s-d/s “linear” anomalies coincident with the SP anomaly location.

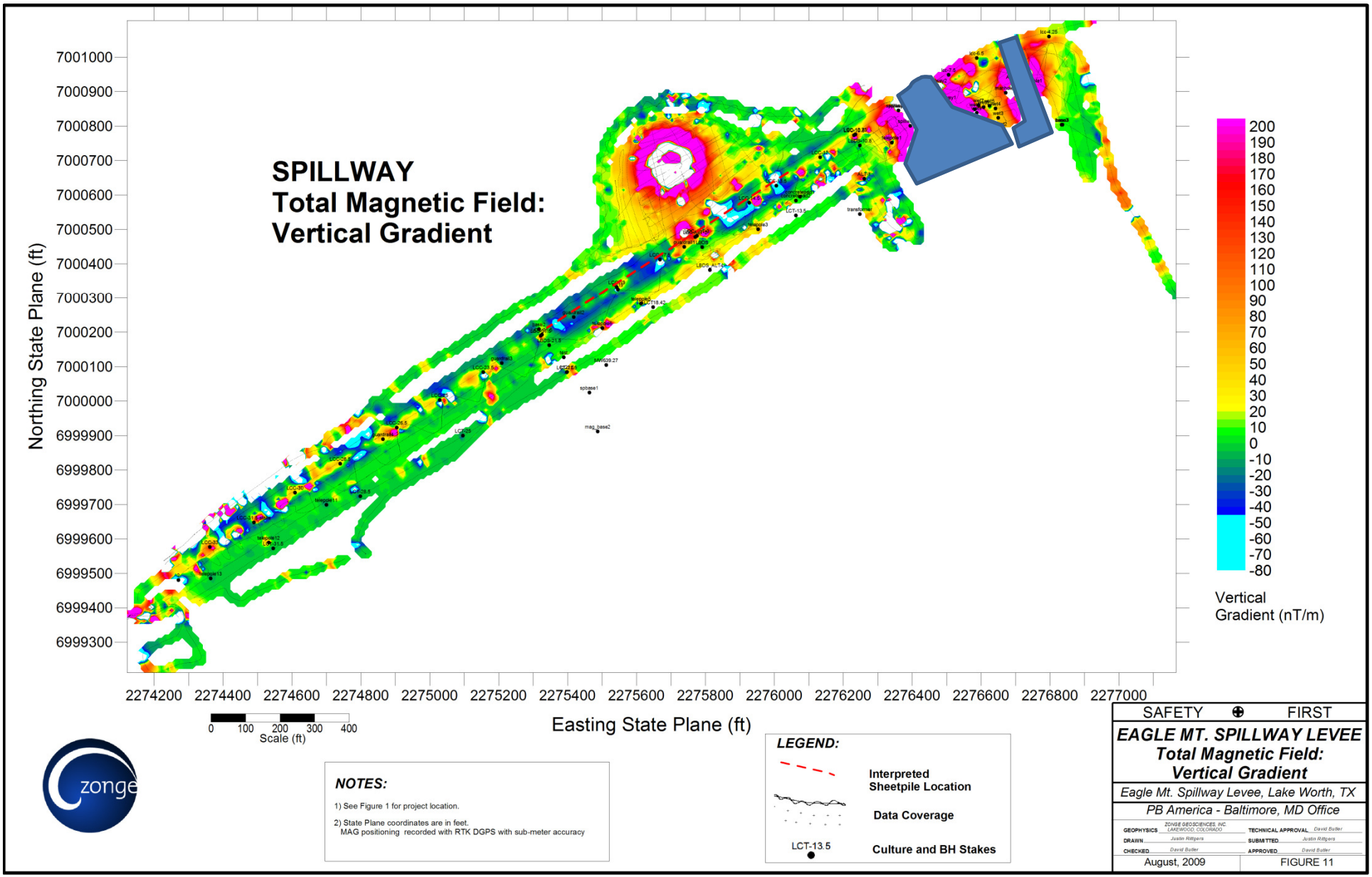
Levee and Spillway



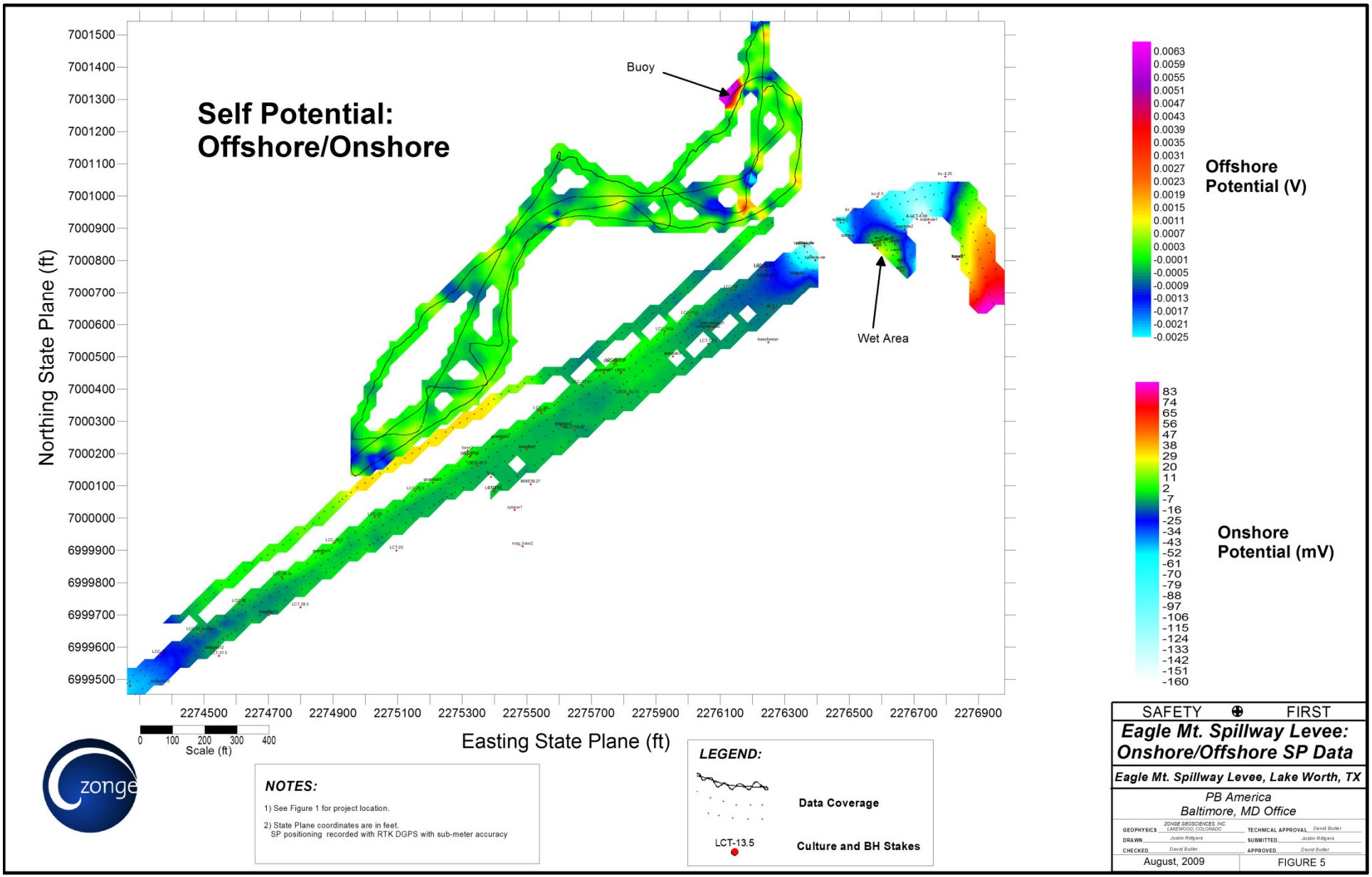




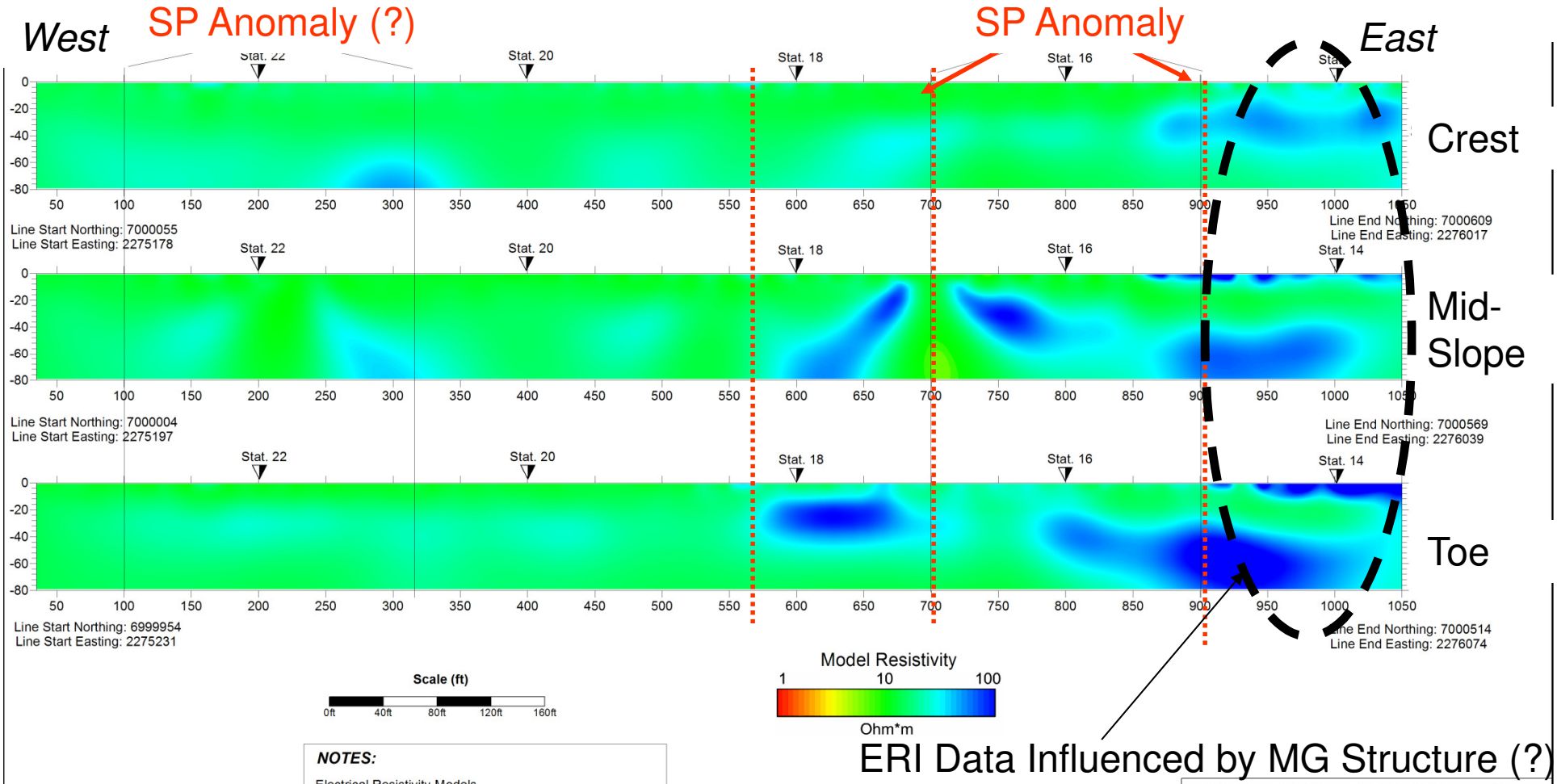
Vertical MAG Gradient- Spillway Levee



Self Potential- Spillway Levee



Electrical Resistivity- Spillway Levee



NOTES:

-Electrical Resistivity Models for Eagle Mountain Main Dam

-No Vertical Exageration

-Lines located Approximately between stations 13+050 and 23+060

-GPS positioning reported in NAD83 Texas N.C. State Plane

-Hand-held GPS has +/- 10ft accuracy Per Manufacturer

Survey Parameters:

25-foot A-spacing

0.125 hertz repetition rate

Inversion control parameters:
ResSmth=1, dpW=1, dxW=1, dzW=1

Shallow 2D Smooth-Model Inversion Dipole-Dipole Resistivity Data

Eagle Mt. Spillway Levee, Lake Worth, TX Stations 13+050 to 23+060

PB America- Baltimore, MD Office

AUTHOR	DRAWN	DATE	SCALE	REPORT
Justin Rittgers	Zonge	August, 2009	1:1000	Job 0968
REFL1normal.ipm				FIGURE 15

2D MAG Modeling

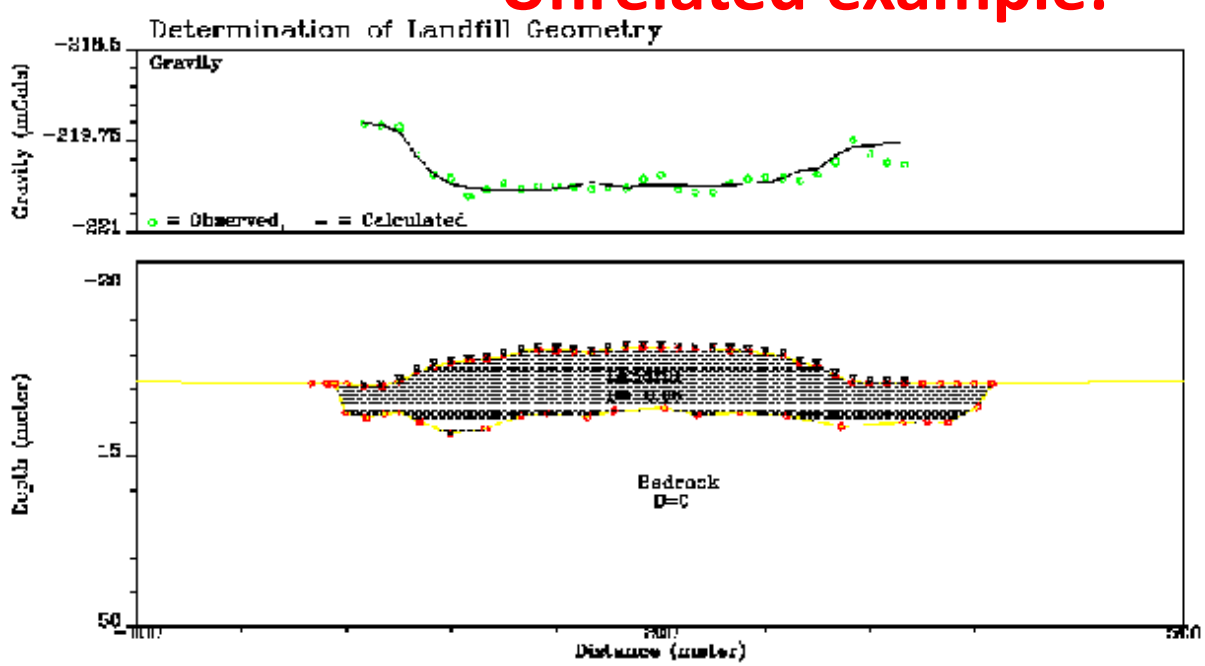
1- Selected data for a line oriented perpendicular to the main dam.
2- Built a 2D cross-sectional model of the dam using realistic dimensions and values of magnet susceptibility for sand/clay/steel sheet-piling.
3- Input earth's local magnetic field (magnitude, declination, inclination)
4- Adjusted sheet-piling position and depth in model till calculated measurements best fit the selected data.

OBTAINED AN EXCELLENT FIT THAT:

- Confirmed estimated 80-foot depth below dam crest

- Refined actual position of sheet-piling wall just north (upstream) of crest roadway based on model, helping guide drilling activities.

Unrelated example:



Results

- Magnetics:
  - Mapped position and lateral extent of sheet-piling beneath the levee structure – **NOT ENTIRE LENGTH**! Also, helped identify buried cultural features that helped with placement of ERI lines.

  - Confirmed the presence and location of an abandoned morning glory structure very well.

- SP:
  - Mapped one small / broad anomaly perpendicular to the levee west of the morning glory area and end of the sheet piling wall

- ERI:
  - Mapped linear anomalies coincident with the main dam's SP anomaly location, and at other suspect portions of the spillway structure

Conclusions

- Gradient MAG:
  - Mapped position and lateral extent of sheet-piling beneath both structures, as well as culture that helped with placement of ERI survey lines.
  - Confirmed the presence and location of an abandoned morning glory spillway at the side-channel spillway levee.

- SP:
  - Mapped one broad anomaly perpendicular to the main dam, and a couple small (amplitude) anomalies at the Spillway Levee; correlated well with ERI results.

- ERI:
  - Mapped linear “resistive” anomalies (sand lenses?) coincident with the main dam’s SP anomaly location, and at other suspect portions of the morning glory structure.