Levy Nuclear Plant
Geotechnical Review

07-28-08

Meeting Objectives

- Update Staff regarding previous presentation
  - Geotechnical Investigations and Site Characterization
  - Foundation Design Concept and Construction
- Present new information
  - Karst Investigation and Characterization
  - Liquefaction Evaluation and Results
  - Contingency Plans
- Review LWA scope

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SITE LOCATION

Site Location

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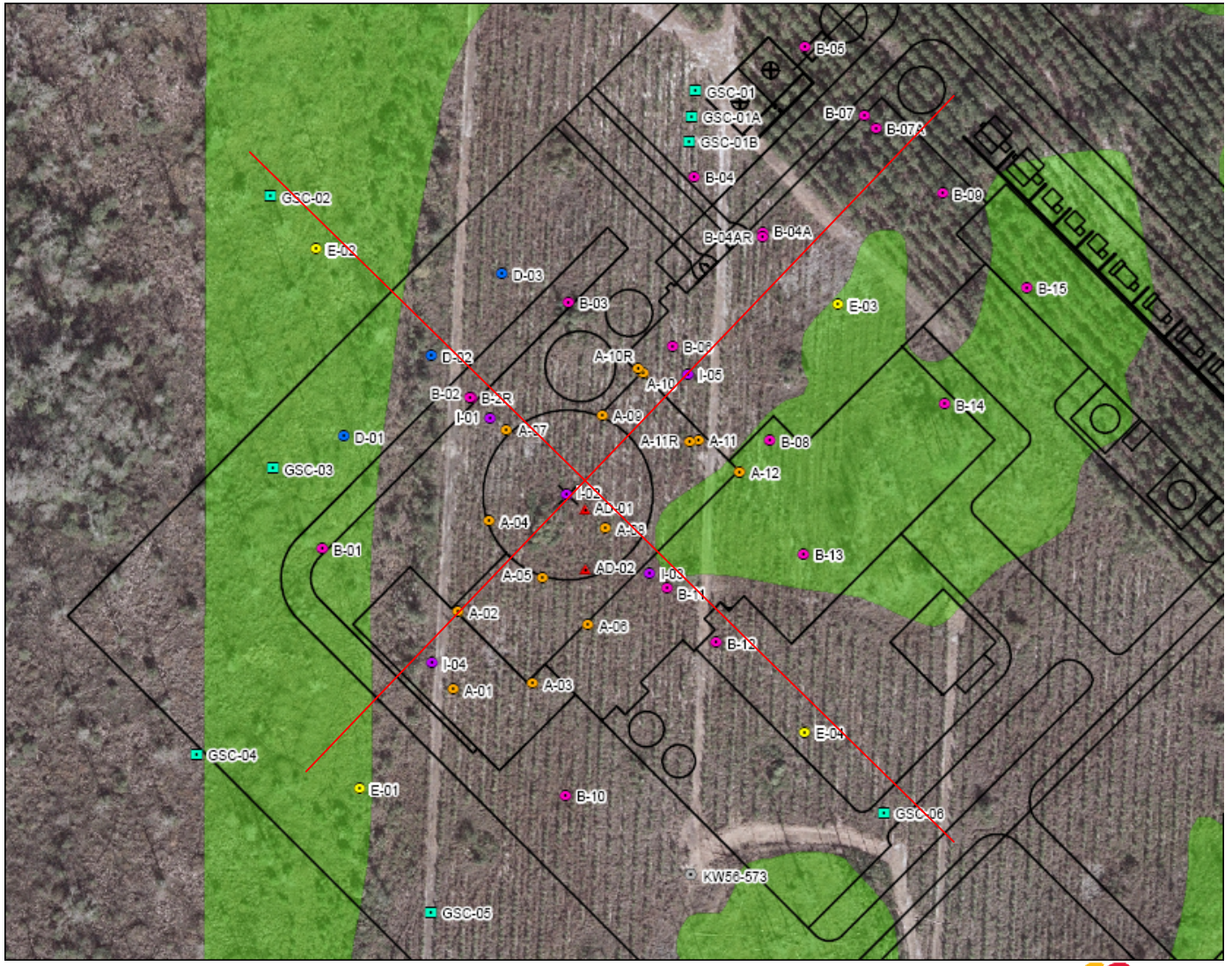
GEOTECHNICAL INVESTIGATION & SITE CHARACTERIZATION

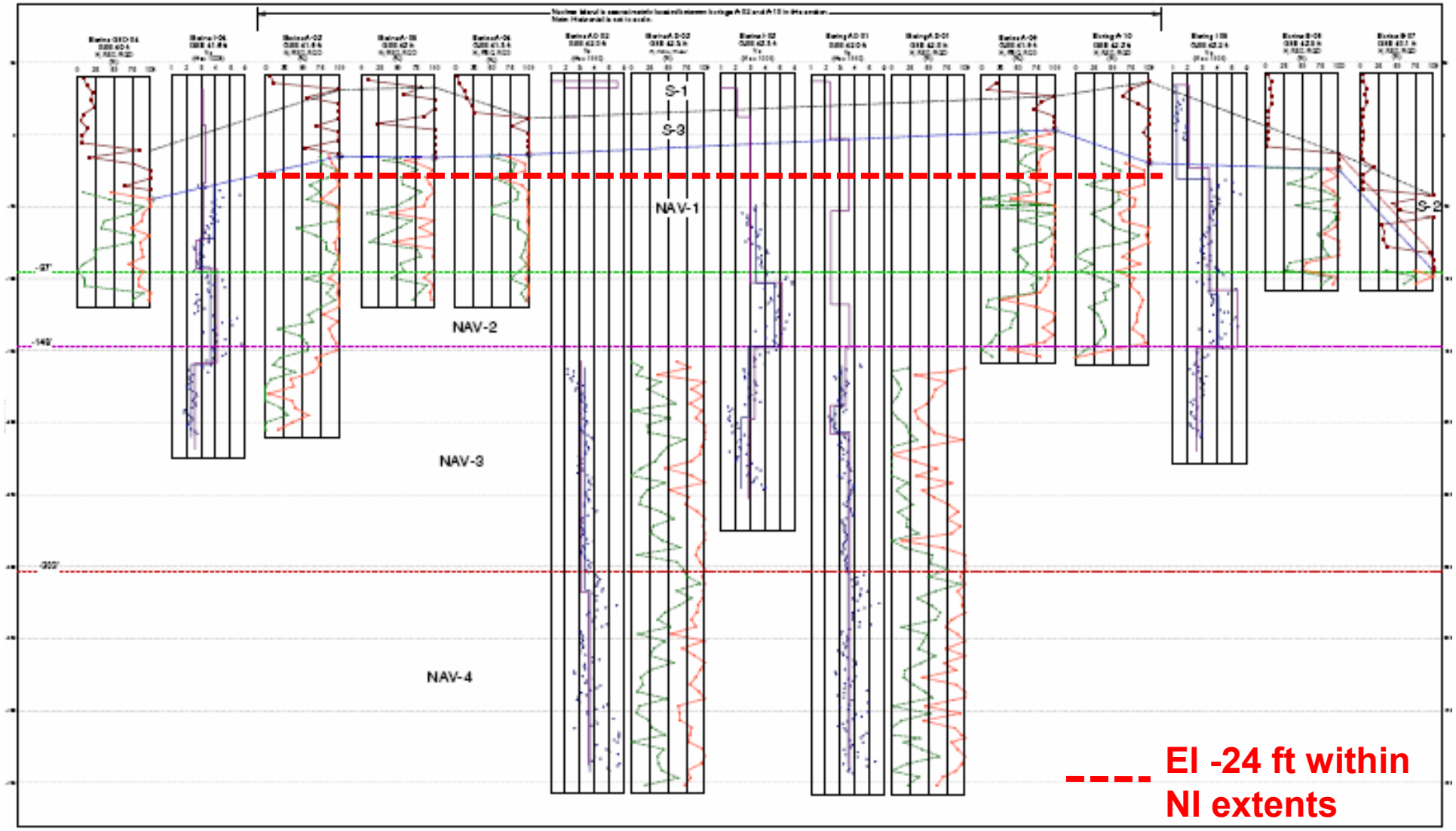
Summary of Field Investigations

- Boring Program (SPT & Coring)
  - 51 borings under Safety Related structures
  - 65 additional borings for site characterization/Non-Safety Related structures
  - Depths - 45 feet to 500 feet
- Seismic Geophysical Testing
  - Suspension P-S velocity logging in 9 borings at each proposed unit*
  - Downhole velocity logging in 7 borings at each proposed unit*
  - *Included two borings to 500 feet at each unit
- Acoustic Televiewer and Caliper Surveys
  - Performed in open mud-rotary holes where P-S logging was performed (4 borings at each site)
- Geophysical Logging
  - Natural gamma, gamma-gamma, neutron-neutron, and induction (7 borings at each site)
- Pressuremeter Testing
  - Various depths at one boring per site
- Karst Investigation
  - Field reconnaissance at Gulf Hammock Quarry, Waccasassa River

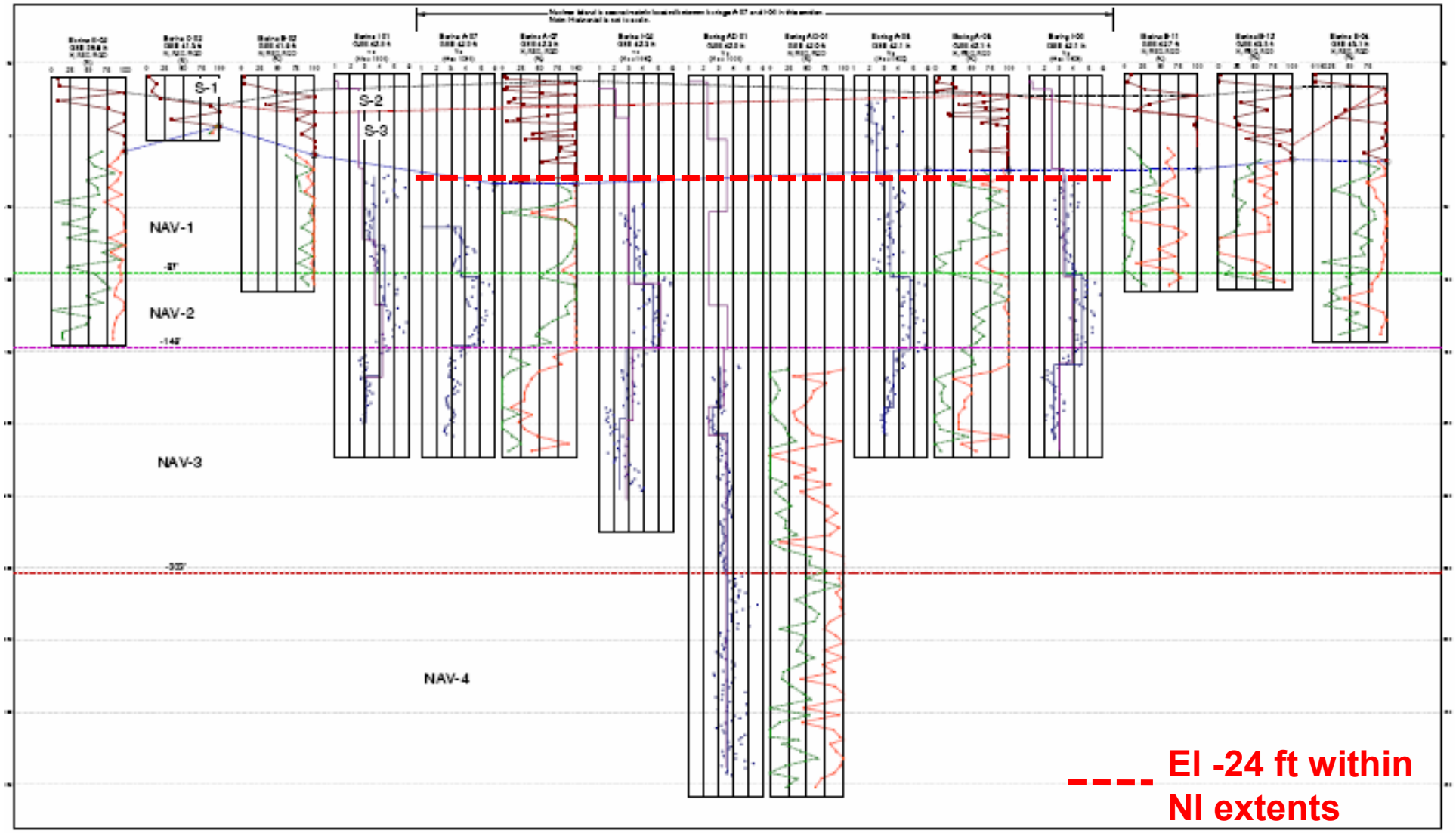
North Plant (LNP 2) Profile Locations



North Plant (LNP 2) North-South Profile

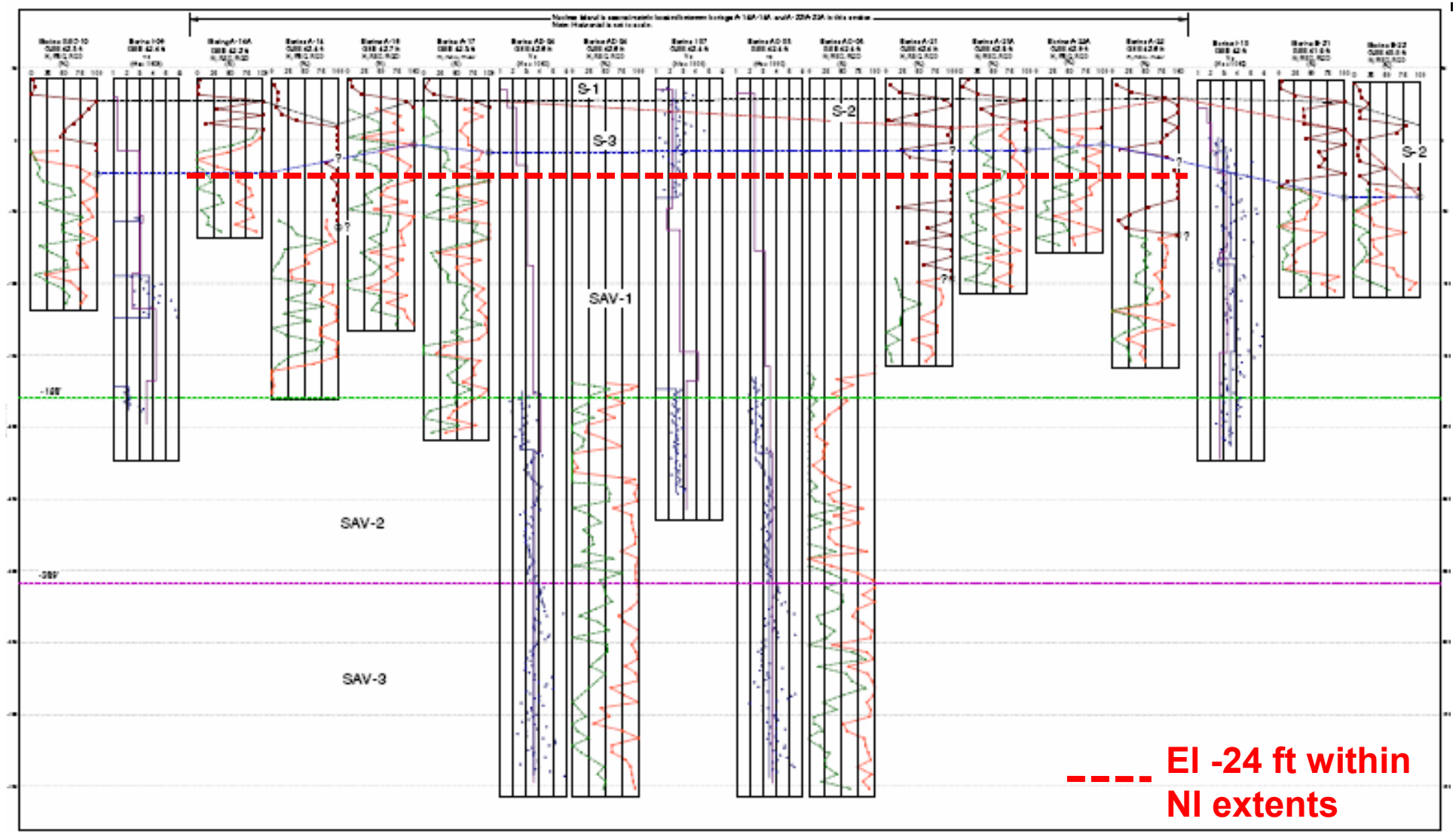


North Plant (LNP 2) East-West Profile

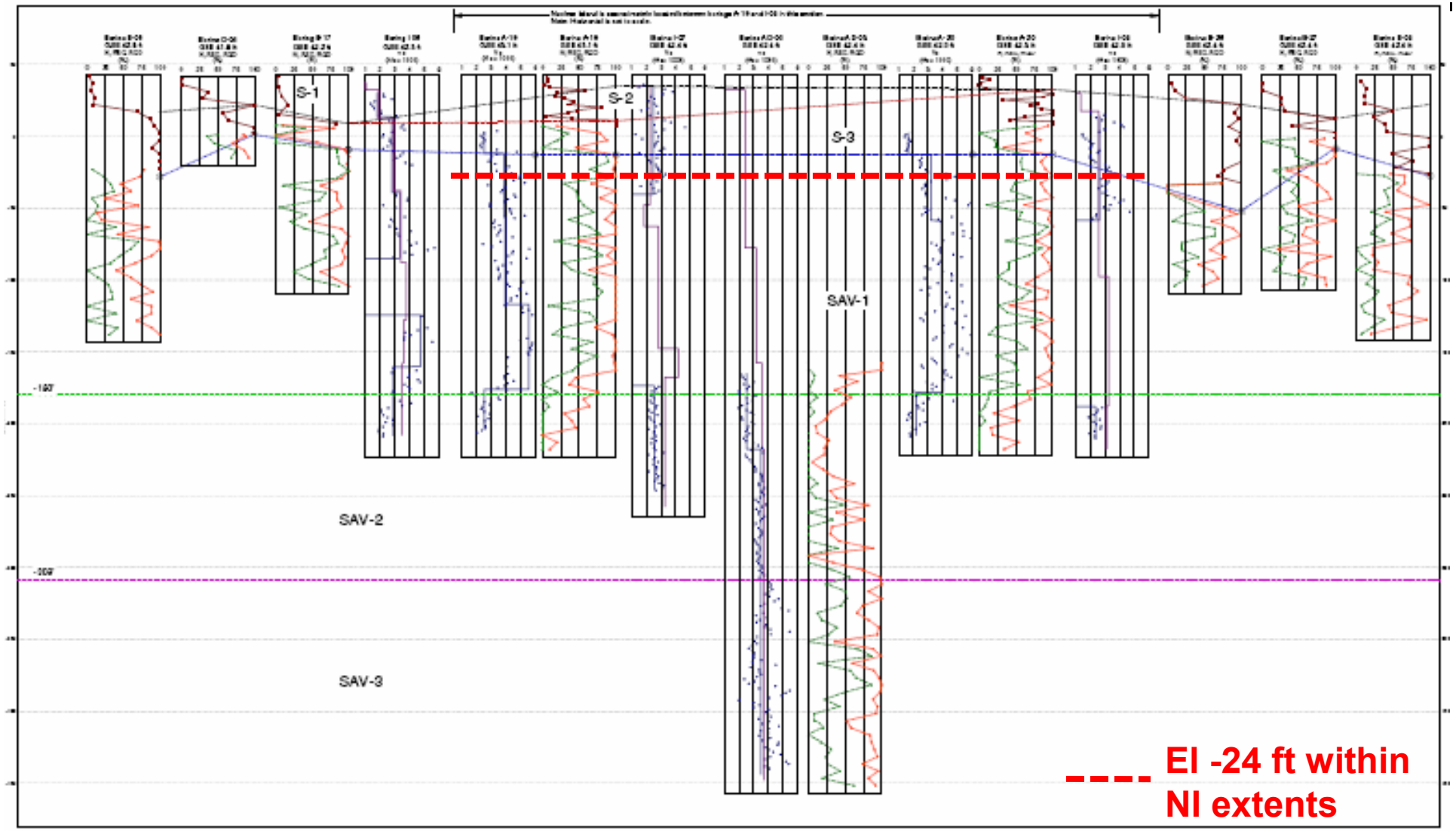


South Plant (LNP 1) Profile Locations

South Plant (LNP 1) North-South Profile



South Plant (LNP 1) East-West Profile



Summary of Soil and Rock Engineering Parameters

Soil/Rock Parameters of North Reactor LNP-2

Layer	Type	Average Unconfined Compressive Strength (psi)	Average or Typical Shear Wave Velocity (ft/sec)
S-1	Soil	-	2,000
S-2	Soil	-	2,200
S-3	Soil	-	3,000
NAV-1	Rock	2,414	3,660
NAV-2	Rock	2,938	4,614
NAV-3	Rock	711	3,097
NAV-4	Rock	2,526	3,963

Soil/Rock Parameters of South Reactor LNP-1

Layer	Type	Average Unconfined Compressive Strength (psi)	Average or Typical Shear Wave Velocity (ft/sec)
S-1	Soil	-	2,000
S-2	Soil	-	2,200
S-3	Soil	-	2,800
SAV-1	Rock	3,760	3,932
SAV-2	Rock	736	2,932
SAV-3	Rock	3,690	3,839

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KARST INVESTIGATION & CHARACTERIZATION

Karst Characterization

- Methods used to evaluate karst feature dimensions
  - Literature review
  - Site-specific data review
    - Rod drops, drill fluid losses
    - Core recovery, RQD's
    - Acoustic televiewer and caliper surveys
  - Step Out borings
  - Field geologic reconnaissance of Avon Park outcrops
    - Gulf Hammock Quarry
    - Waccasassa River
  - Analysis of grout take from Site Characterization

Karst Characterization

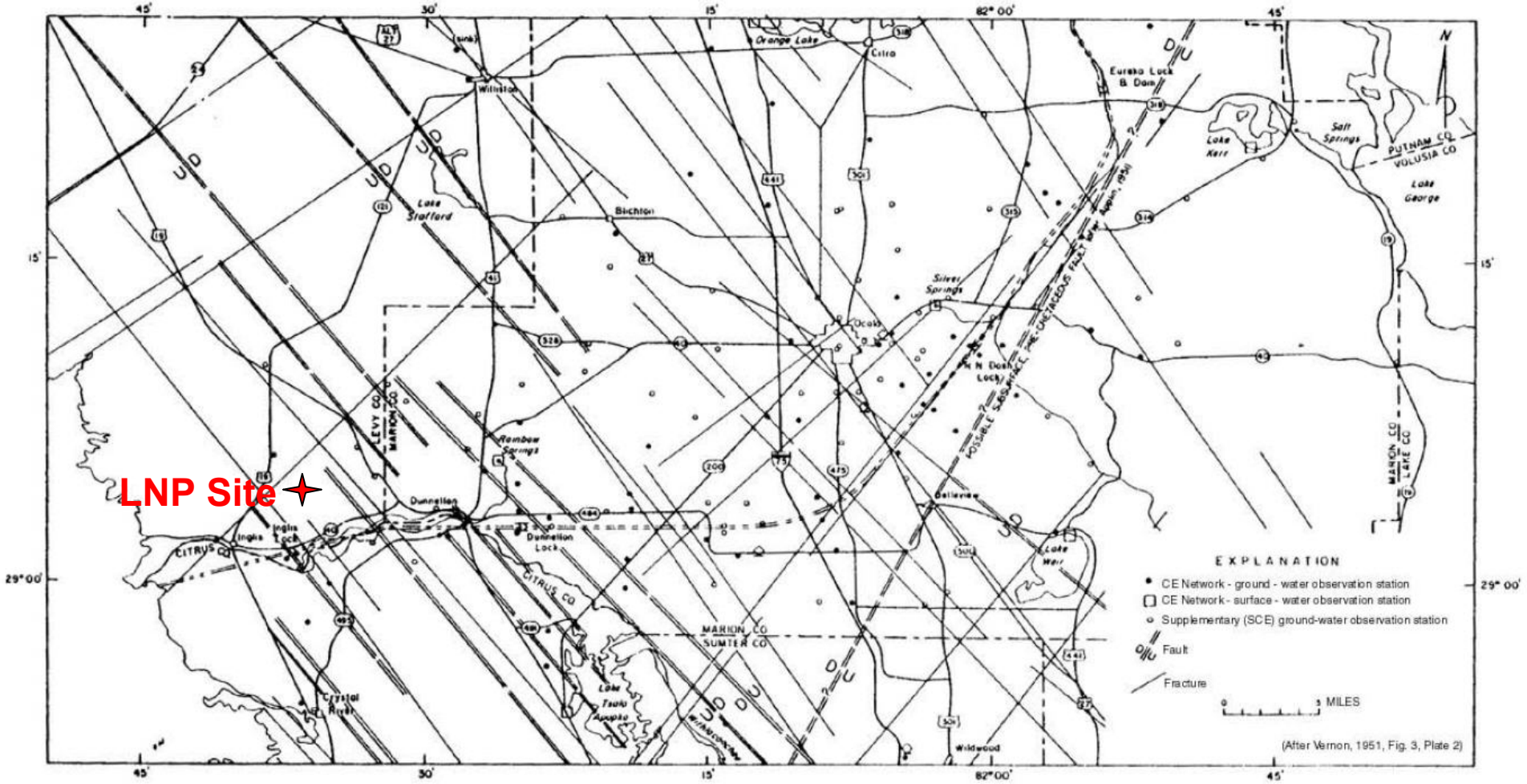


Figure 17. Fractures and faults mostly as interpreted from surface lineations and alignments observed on aerial photographs, Cross-Florida Barge Canal area.

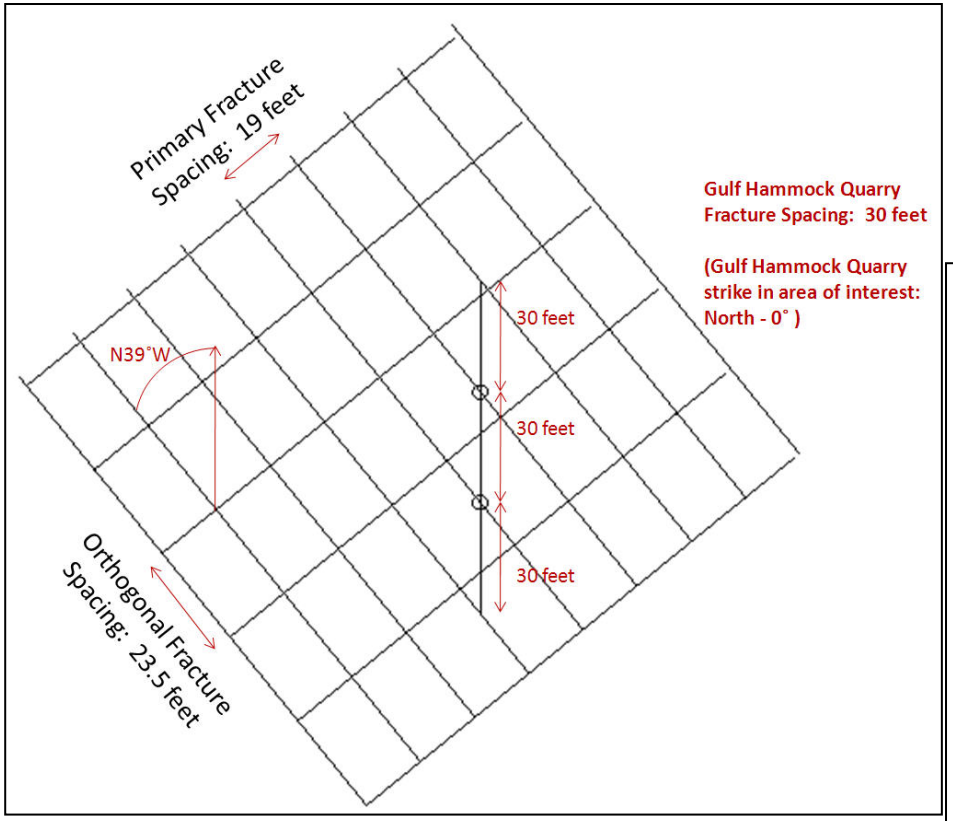
Karst Characterization – Gulf Hammock Quarry

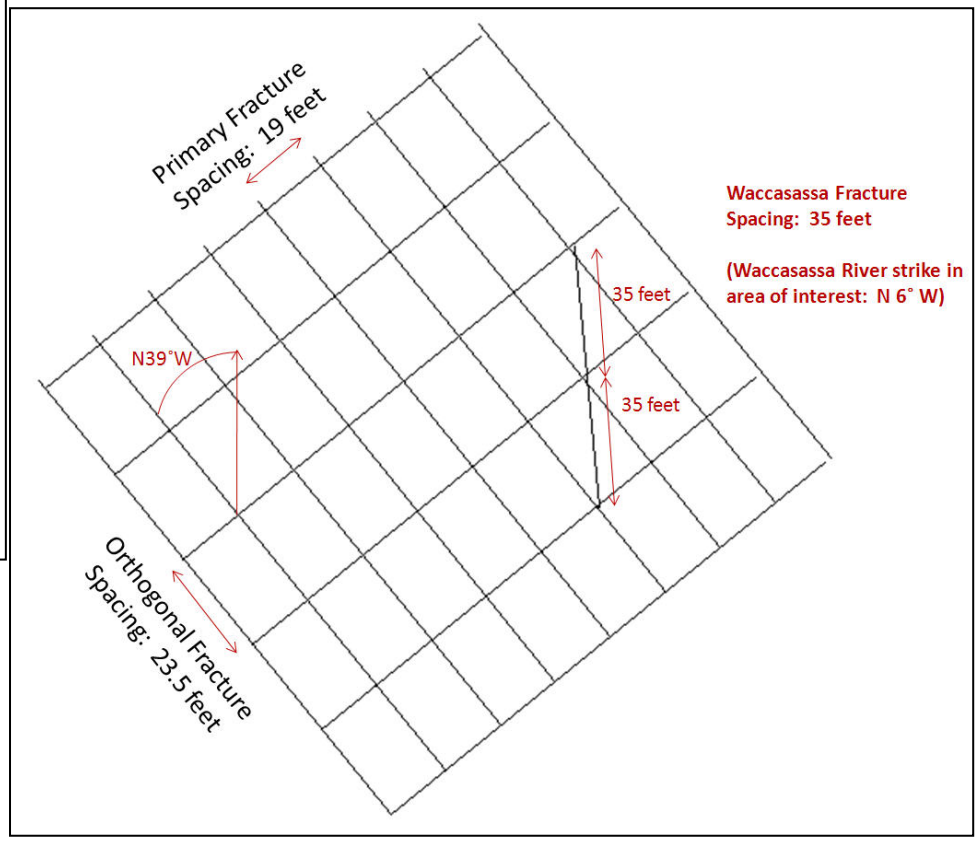
Outcrop face observed

Karst Characterization – Waccasassa River

Outcrop face observed

Karst Characterization

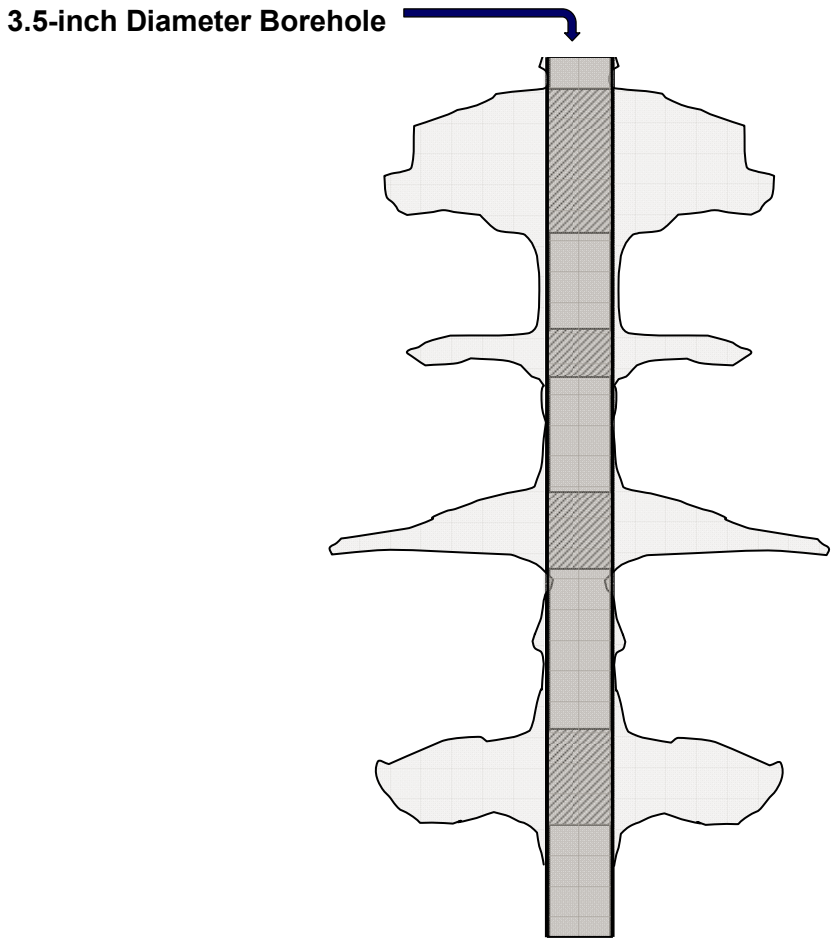




Karst Characterization

- Low-density features are associated with vertical/near-vertical fracturing, and horizontal bedding planes
- Used excess grout data to estimate dimensions of low-density features
- Use three layers of conservatism, as described on the following slides
  - Determine conservative excess grout
  - Establish conservative vertical thickness
  - Calculate conservative cylinder volume

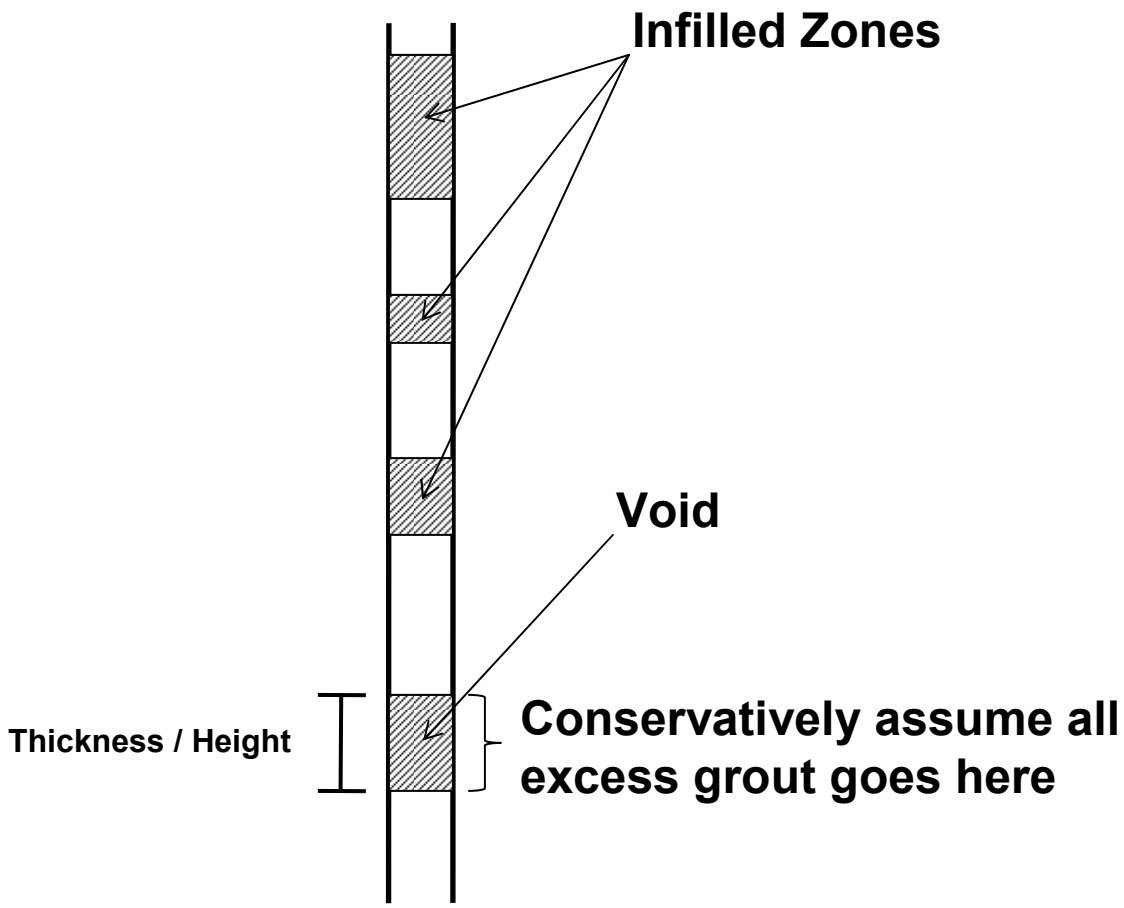
Karst Conservatism #1 – Excess Grout



Conservatively Estimate Excess Grout Volume as:

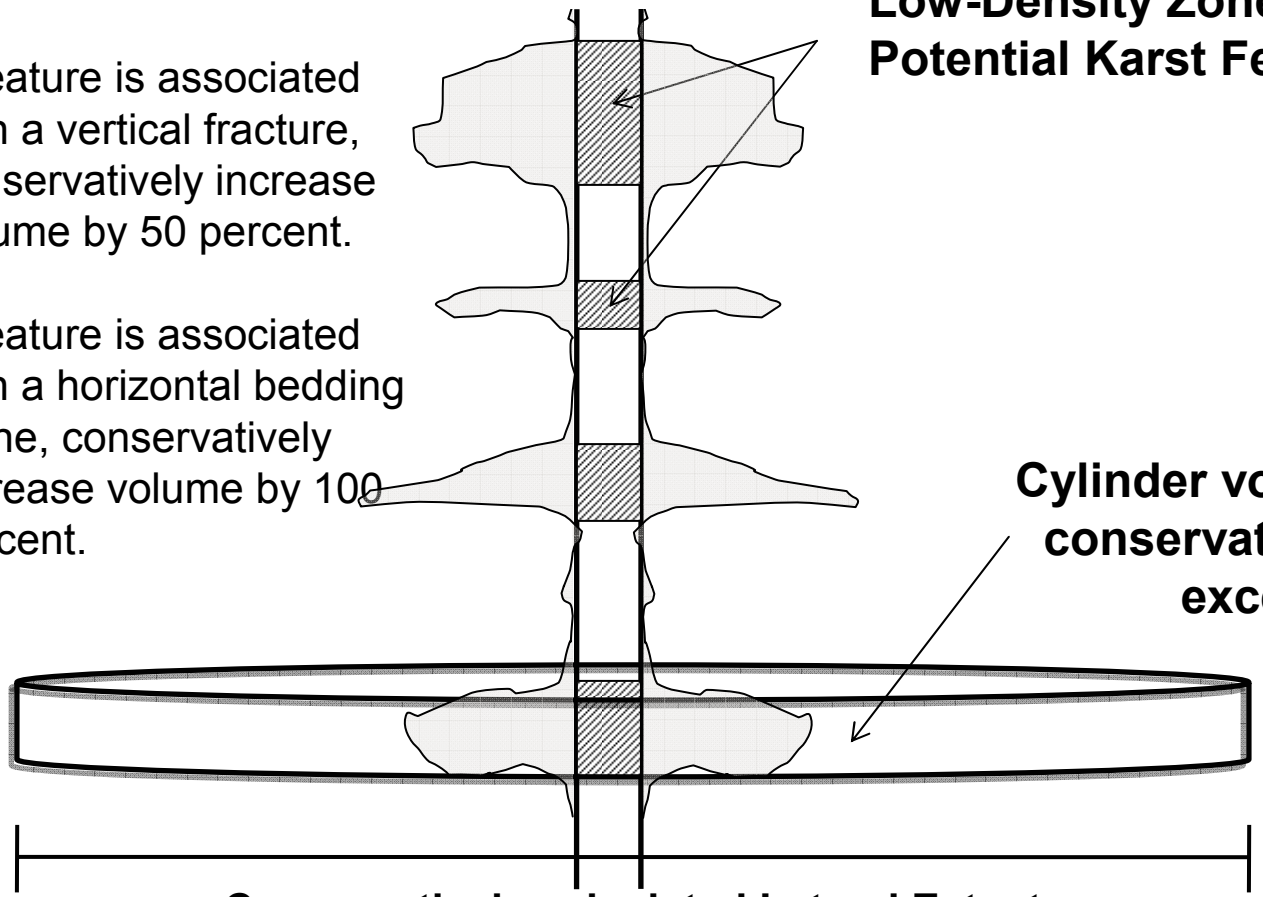
(Total Grout Used)
- (3.5” Cylinder)
EXCESS GROUT VOLUME

Karst Conservatism #2 – Vertical Thickness



Karst Conservatism #3 – Cylinder Volume

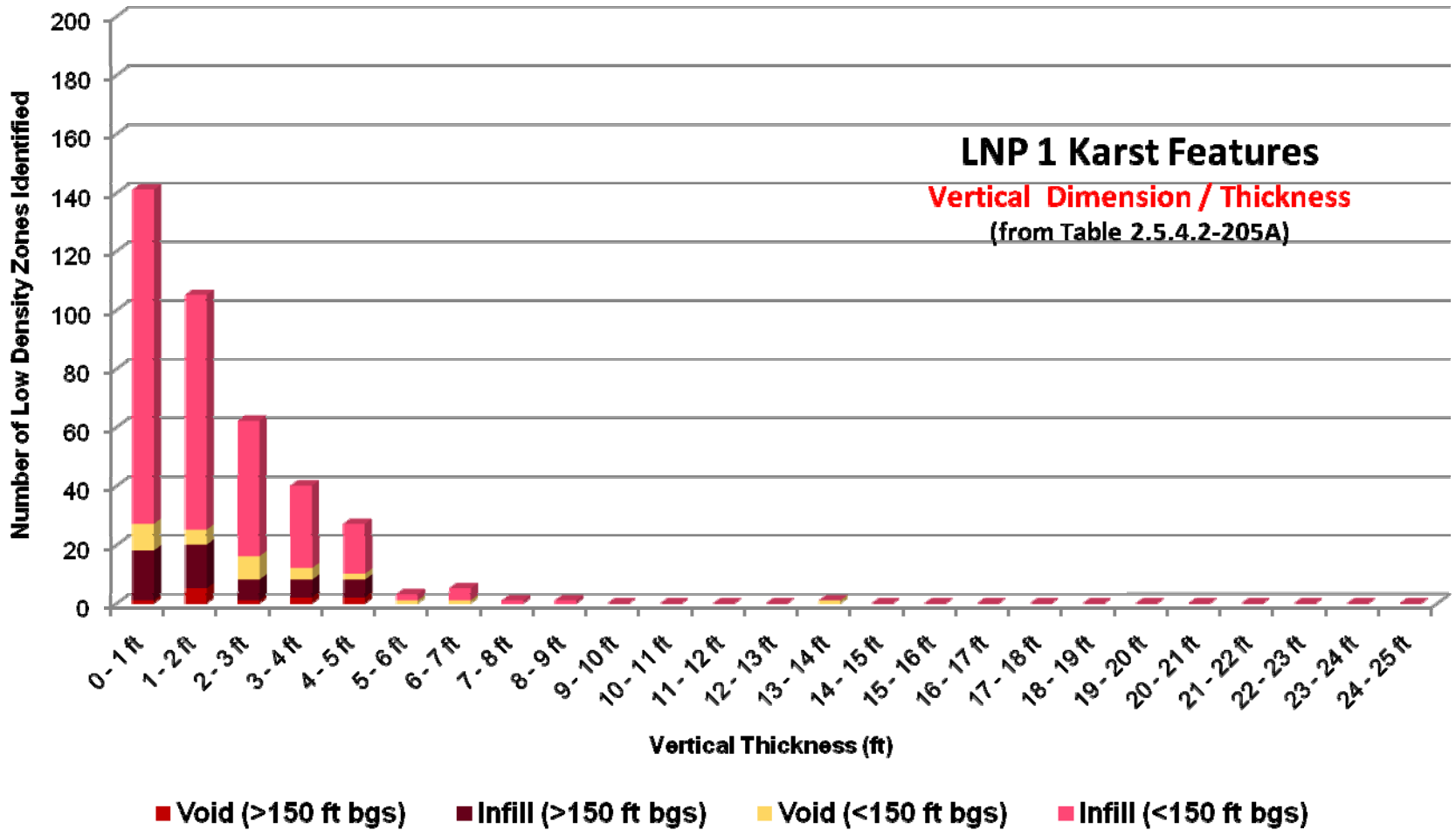
- If feature is associated with a vertical fracture, conservatively increase volume by 50 percent.
- If feature is associated with a horizontal bedding plane, conservatively increase volume by 100 percent.



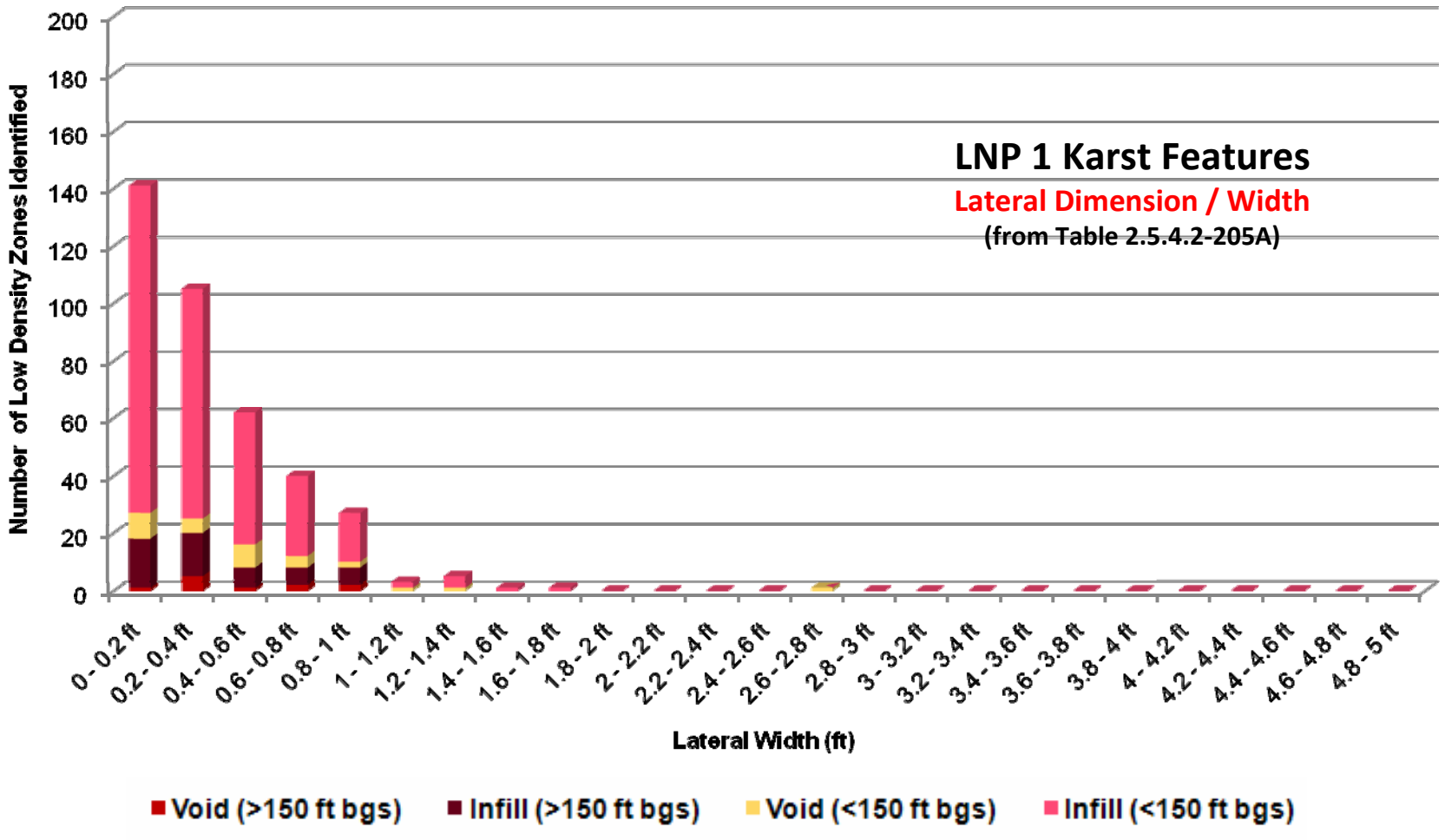
Karst Characterization

- Statistically analyzed low-density zones in 60 borings, using three layers of conservatism.
- For features associated with vertical fractures, the maximum lateral extent postulated is 6.1 feet (3.1 feet average).
  - Average width to height ratio is 0.2:1, so lateral extent is typically 1/5 the height of the feature.
- For features associated with bedding planes, the maximum lateral extent postulated is 9.9 feet (6.5 feet average).
  - Average height to width ratio is 0.3:1
- Foundation concept designed to span 10-foot lateral void beneath nuclear island
  - At any location, in multiple locations, in continuous strip beneath nuclear island, etc

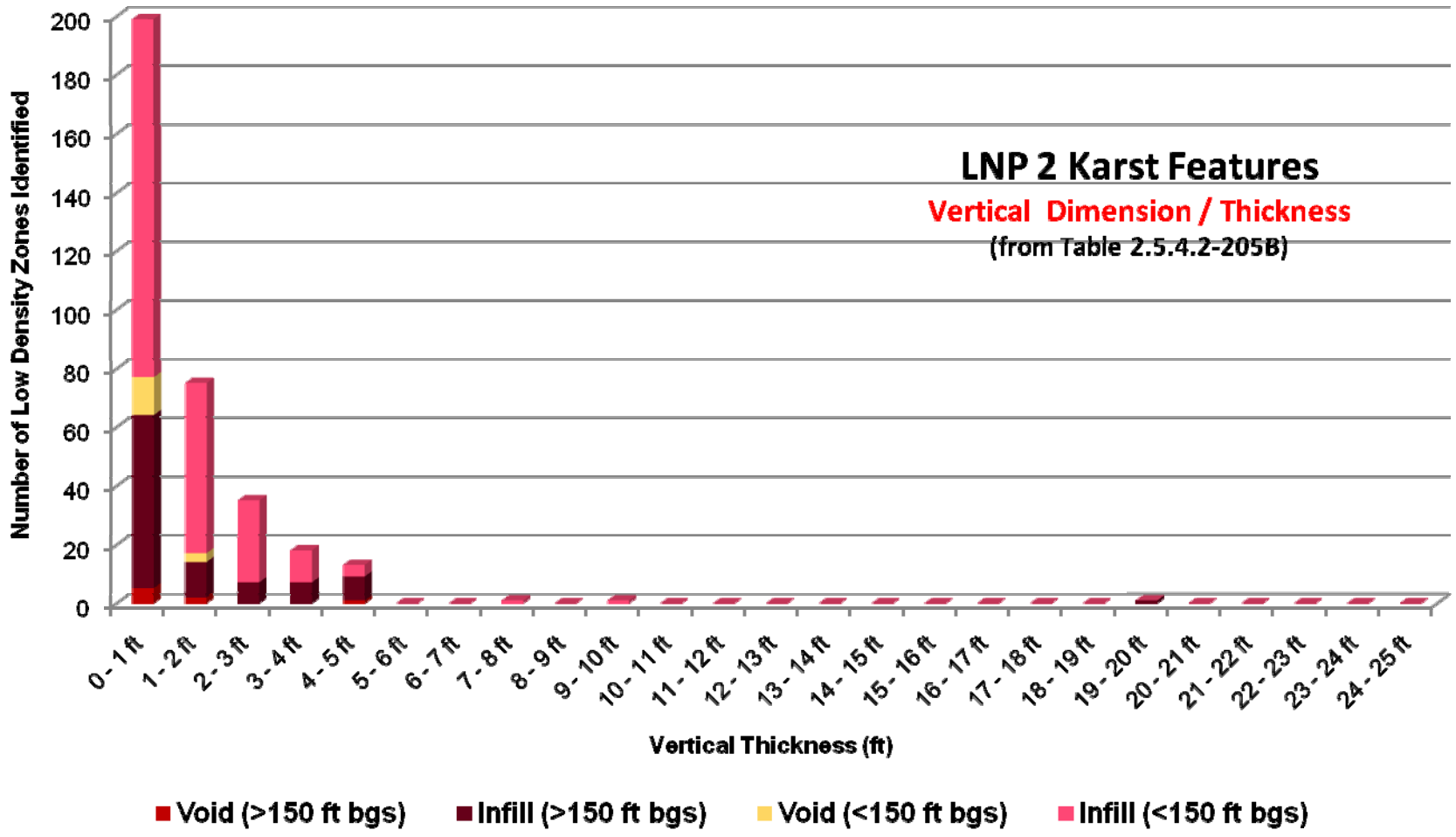
Karst Characterization – LNP 1 Vertical Dimension



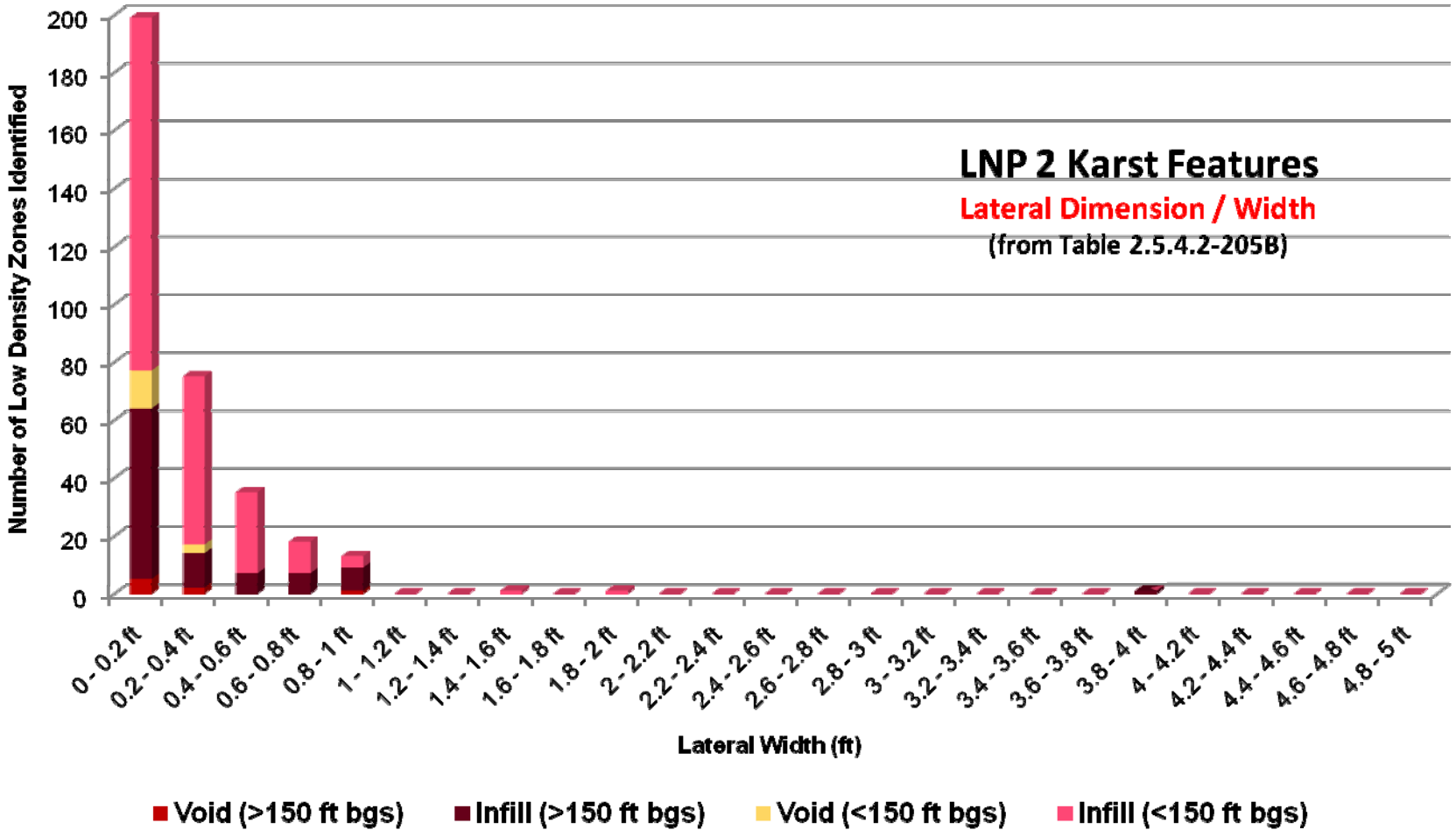
Karst Characterization – LNP 1 Lateral Dimension
(use image for legend)



Karst Characterization – LNP 2 Vertical Dimension



Karst Characterization – LNP 2 Lateral Dimension



Karst Characterization

- Conclusions
  - Position that features are identified either with vertical fractures or with horizontal bedding planes has been validated by research, data review, and field observations.
  - Conservative analyses have been used to calculate worst-case lateral extent of features on site.
  - For design, we postulate a feature with 10-foot lateral dimensions that is open void (air filled, not infilled with soil). Data show that a void would not be open, but infilled.
  - Approach has been critiqued by independent expert.

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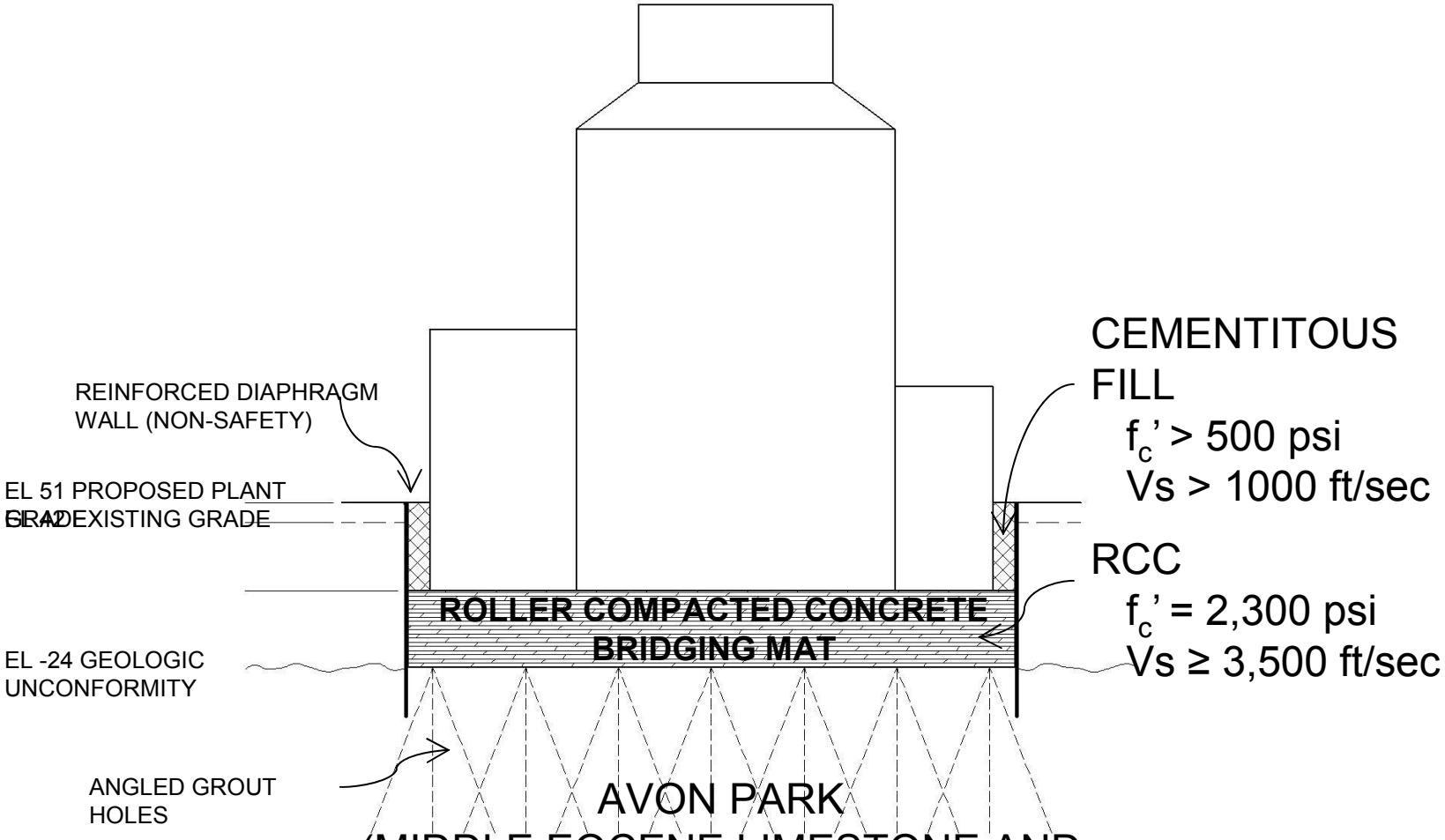
FOUNDATION DESIGN CONCEPT / CONSTRUCTION

LNP Foundation Concept



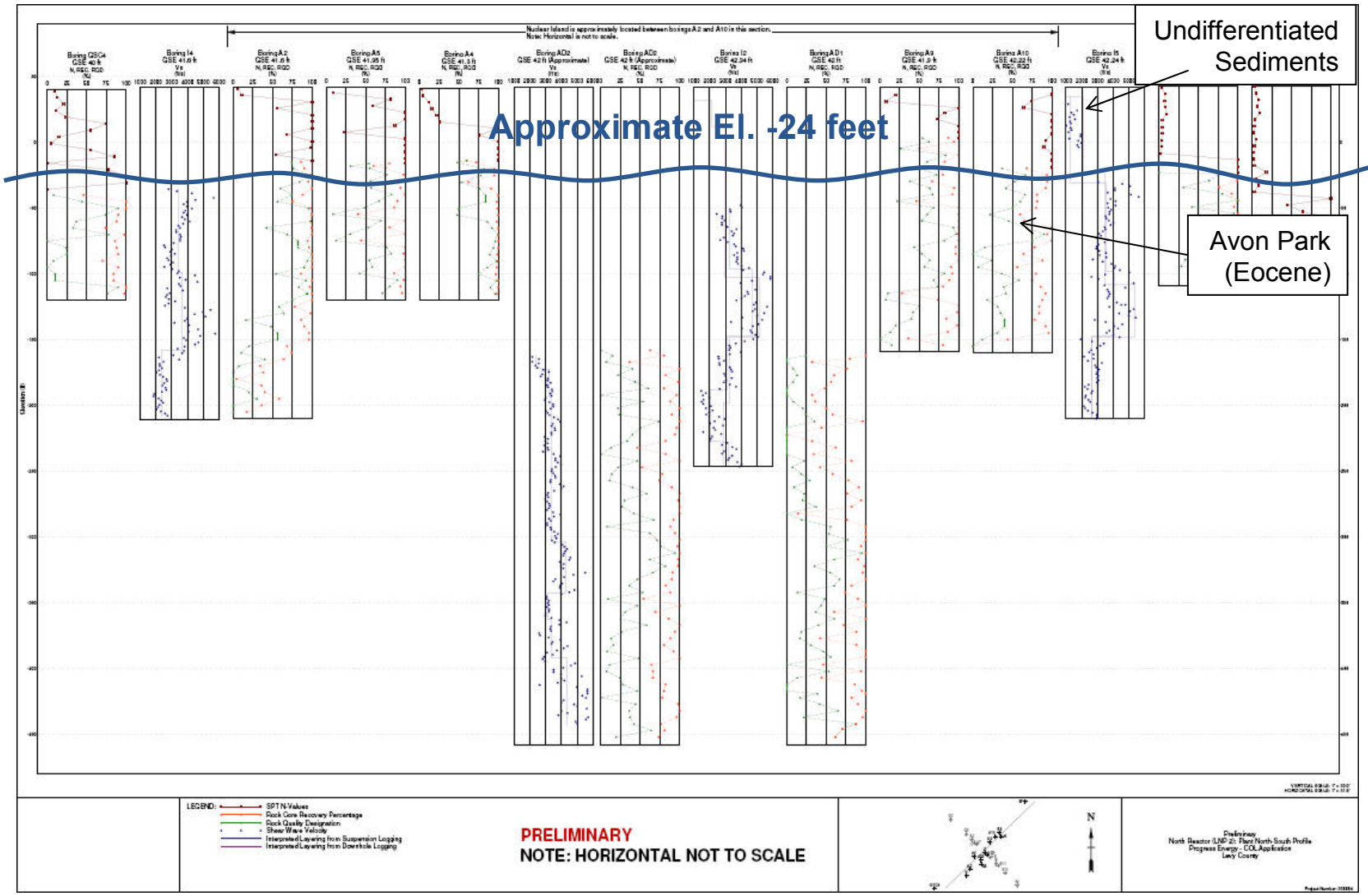
LNP Foundation Concept

- RCC Bridging Mat: ~35-ft thick RCC Mat
  - Basic Function
    - Bridge over postulated solution-induced irregularities in the Avon Park that may develop in the future
    - Provide a “bedrock” foundation for the AP1000 Basemat
    - A Safety Related feature
  - Basic Properties
    - f_c' > 2,300 psi
    - V_s > 3,500 fps

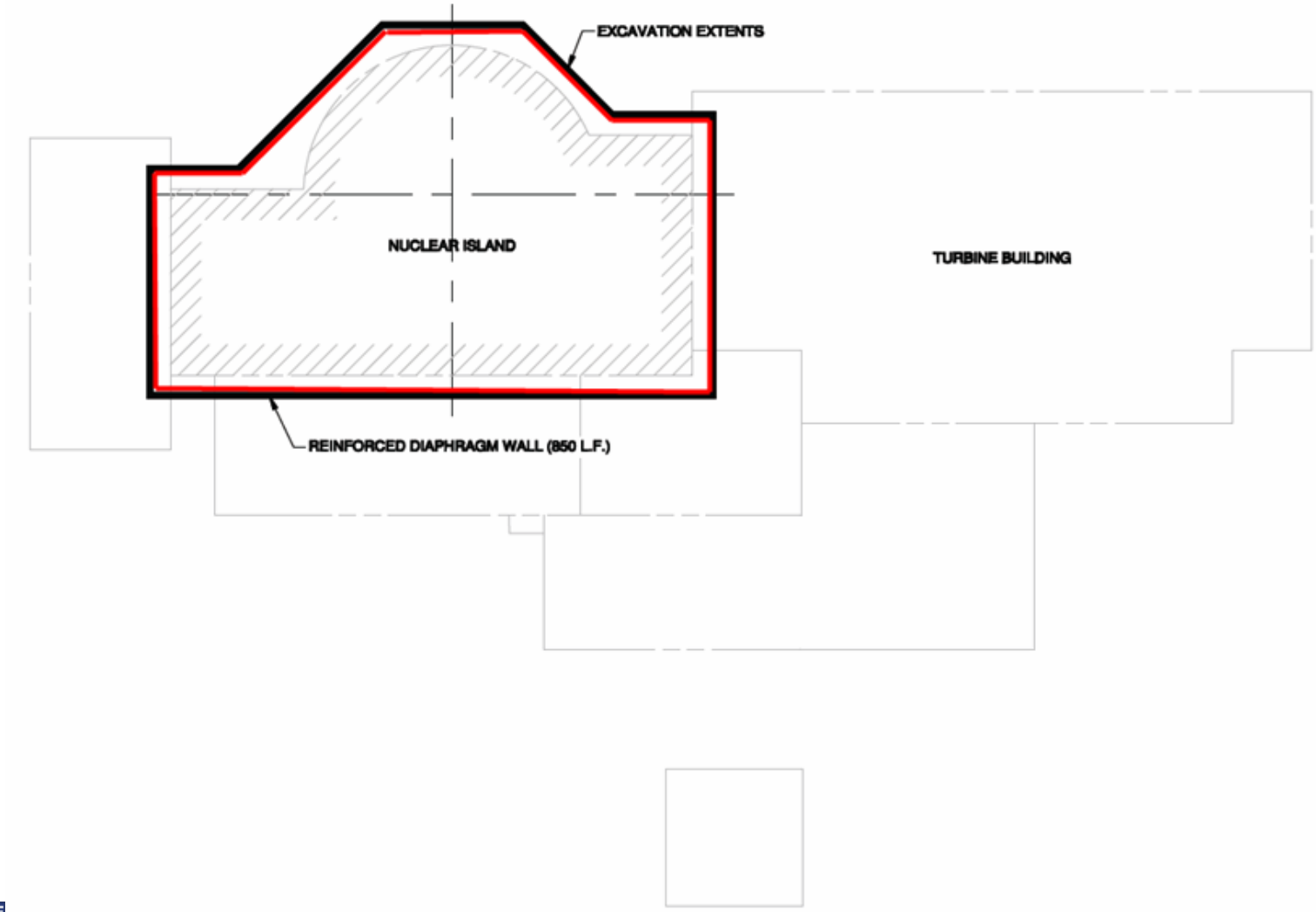
LNP Foundation Concept

- Approximately 75-foot thick Grouted Zone (upper Avon Park)
  - Primary Functions
    - Provide a “bottom for the bathtub” as part of excavation
    - Not a Safety Related feature
  - Secondary Benefits
    - Prevents future solution activity by inhibiting the flow of water through porous zones and fractures
    - Fills potential voids located within the zone
    - While credit was not taken for improving the foundation, the grouted zone adds conservatism to the design in terms of strength, stiffness, and potential settlement.
  - Basic Properties
    - UCS ≈ 2,500 psi
    - V_s ≈ 3,000-4,500 ft/sec

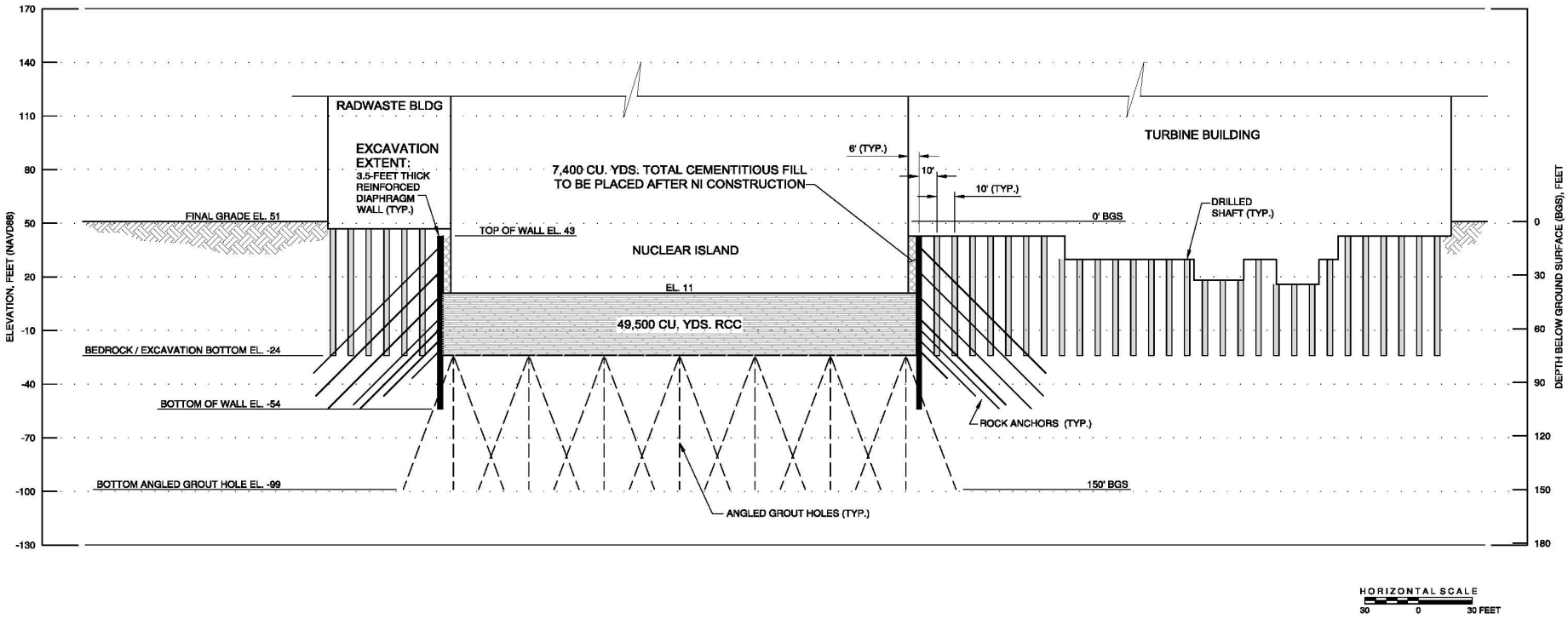
Planned Excavation Bottom



Foundation Concept – Plan View



Foundation Concept – Section



LNP Foundation Excavation Sequence

- Construct groundwater cutoff for the “walls of the bathtub”
- Conduct Grouting Program to form the “bottom of the bathtub”
  - Low Mobility Grout
  - High Mobility Grout
- Install the shallow wells to “drain the bathtub”
- Excavate the soil in the “bathtub” down to the Avon Park
  - Remove soil pockets and soil-filled fractures

Grouting Program

- Drill & Grout with Low Mobility Grout (LMG)
  - Depth 75 ft (approximate)
  - Spacing 8 ft (subject to confirmation during 2008 Grout Test Program)
  - Concentric pattern starting on perimeter and working inward toward center
  - Computerized monitoring of pressures and takes (systems to be tested during 2008 Grout Test Program)
- Drill & Grout with High Mobility Grout (HMG)
  - Depth 75 ft (approximate)
  - Split spacing with LMG holes
  - Computerized monitoring of pressures and takes (systems to be tested during 2008 Grout Test Program)

LNP Foundation Construction Sequence

- Prepare the top of the Avon Park
  - Use dental concrete (and possibly grout) to prepare surface to receive RCC
- Construct the RCC Bridging Mat
- Install the waterproofing on the RCC Bridging Mat
- Place the mud mat to protect the membrane
- Construct the AP1000 Basemat
- Place Cementitious Fill

Ongoing Activities

- RCC Test Pad
  - RCC placement and properties
  - Material sampling and mix designs currently underway
  - Test Pad construction anticipated to occur in November 2008.
- Grout Test Program
  - Grouting methods and rock properties
  - Specification issued, contractor being selected
  - Grout Test Program anticipated to occur in November 2008.

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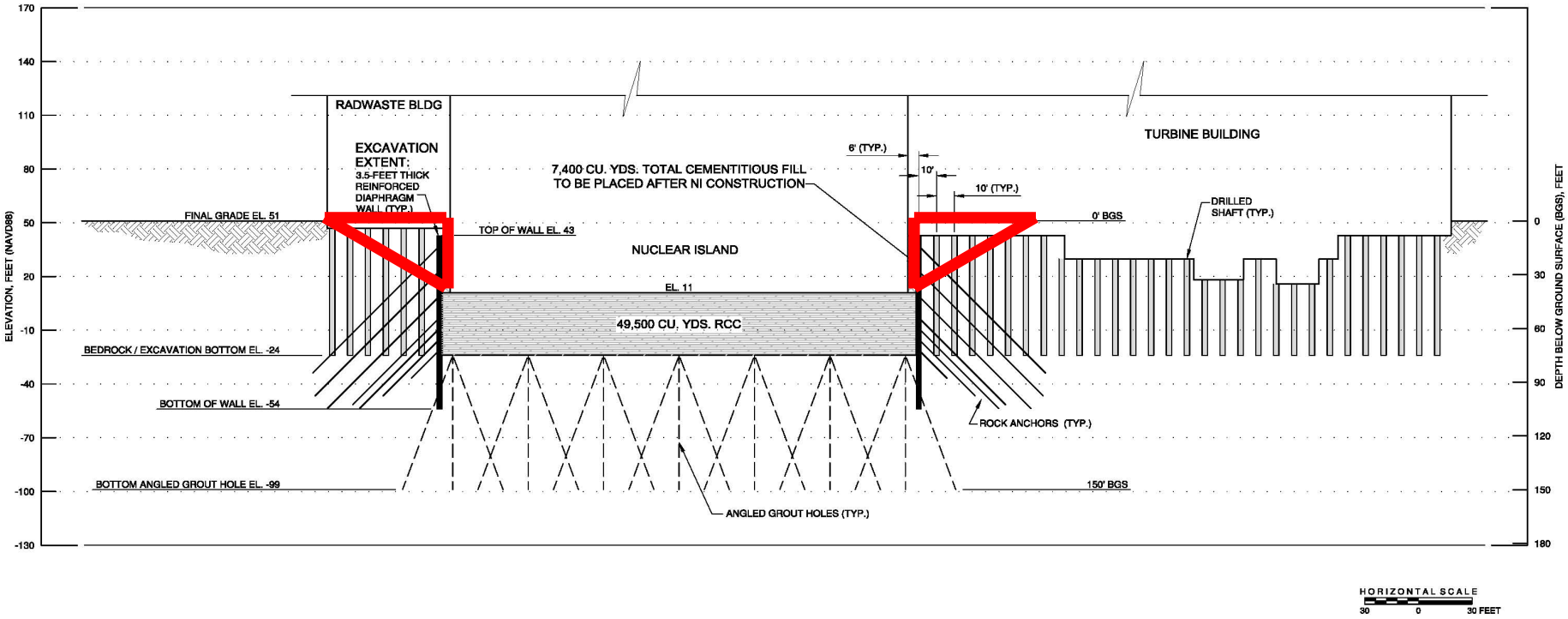
LIQUEFACTION EVALUATION & RESULTS

Liquefaction Evaluation

- Liquefaction is regarded as having a low potential of occurrence, given the seismic environment (0.07g) of the Site.
- Some potentially liquefiable material was encountered during Site Characterization.
- Beneath nuclear islands, all soil being removed as part of foundation concept
- During foundation construction for adjacent structures (drilled shafts), potentially liquefiable zones will be remediated as appropriate.
  - Adequate support at socket ensured during drilled shaft installation
  - Adequate lateral support ensured after drilled shaft installation
- Potentially liquefiable soils in the passive wedge will be remediated as required. An evaluation is planned to determine whether the passive wedge is required for sliding resistance at the LNP site.

Passive Wedge Extent



Liquefaction Evaluation – Adjacent Structures

- A pilot hole will be drilled at each drilled shaft to allow for design of rock socket depth.
- Drilled shafts will be initially sized through pseudo-static analysis which considers the shafts and pile cap to act as a moment frame with no lateral soil support.
  - If this yields a reasonable diameter for the drilled shafts, then no further remediation is necessary.
  - If this yields an unreasonable number or diameter of drilled shafts, then we will use pilot hole data to determine if required lateral support is available without remediation.
    - If yes, then no remediation is required.
    - If no, a remediation program will be developed, likely involving grouting.

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CONTINGENCY PLANS

Contingency Plans

- Issue #1: During nuclear island excavation, the Avon Park Limestone is not consistently encountered at the anticipated elevation (El -24 ft)
  - Since the top of the Avon Park Limestone is expected to be undulatory, localized pockets of unconsolidated sediments are anticipated.
  - Although unlikely, an infilled vertical fracture could also be discovered beneath the nuclear island.

- Contingency Plan
  - Excavation will advance until the Avon Park Limestone is reached, and the surface will be cleaned using typical rock excavation methods.
  - Dental concrete will be used where practical to create a level surface at El -24 ft.
  - If an infilled vertical fracture or deeper pocket of unconsolidated materials is encountered, a grouting program will be undertaken to prepare the excavation bottom.

Contingency Plans

- Issue #2: The designed dewatering system is inadequate to handle unanticipated water flow into the excavation

- Contingency Plan
  - The dewatering system developed during the Site Characterization has many conservatisms designed into the pumping arrangement.
  - In the event that these pumps are insufficient, higher capacity pumps can be quickly installed.

Contingency Plans

- Issue #3: Karst features are discovered at the base of a drilled shaft

- Contingency Plan
  - Since a pilot hole will be drilled prior to the construction of each drilled shaft, the presence of any low density zones will be identified at that time, and remediated.

Contingency Plans

- Issue #4: Liquefiable materials under adjacent structures are encountered during construction

- Contingency Plan
  - If liquefiable material is identified beneath the adjacent structures, and if the drilled shafts are not able to be practically designed with no lateral soil support, then remediation will occur on a case-by-case basis, likely in the form of grouting.

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LIMITED WORK AUTHORIZATION SCOPE

Pre-Construction Work

- Construct barge slip
- Conduct site grading and clearing
- Install construction access and heavy haul roads
- Excavation for nuclear island – 5 steps
  - Install diaphragm wall for dewatering
  - Install dewatering wells
  - Conduct grouting program for dewatering
  - Dewater
  - Excavate

LWA Scope

- Prepare nuclear island foundation surface
- Place roller compacted concrete
- Install waterproofing membrane
- Install mud mat
- Install forms & rebar in the nuclear island foundation
- Install drilled shafts
  - Turbine, Annex and Radwaste Building foundation
- Install circulating water piping*
- Install raw water intake structure*

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Geotechnical Review

Questions?