

Contractor Panel on Constructability of Designs



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FDOT State Construction Pavement Engineer

Constructability

- ◆ What is Constructability?
 - ✓ Ability to Construct Something

- ◆ System-wide - Designs are very good
 - ✓ Most designs are constructible
 - ✓ However, there are cases where we can improve constructability
 - Discuss a few constructability challenges today

Intent of Discussion

- ◆ How to Improve Constructability
 - ✓ Review Constructability Challenges
 - ✓ Discuss Contractor Recommendations
 - ✓ Won't discuss all potential design constraints
 - Know there can be other design considerations
 - Hopefully the contractor's perspective will be considered, when possible

Why Improve Constructability?

- ◆ Typically, as constructability increases...
 - ✓ Construction Time Decreases
 - ✓ Construction Labor Decreases
 - ✓ Project Costs Decrease
 - ✓ Delays, Claims, & Conflicts Decrease
 - ✓ Construction Quality & Profits Increase

Why Improve Constructability?

- ◆ Your Designs:
 - ✓ Are easier to construct
 - ✓ Have fewer problems during construction

- ◆ Your Company:
 - ✓ More likely to be selected for projects
 - Design-Bid-Build: FDOT
 - Design-Build: Contractor

Maximizing Constructability

◆ Best Design:

- ✓ Provides an easily constructed project
- ✓ Meets design intent
- ✓ Achieves desired Quality
- ✓ Maximizes use of resources
 - Equipment
 - Labor
 - Materials
 - Time
 - Money

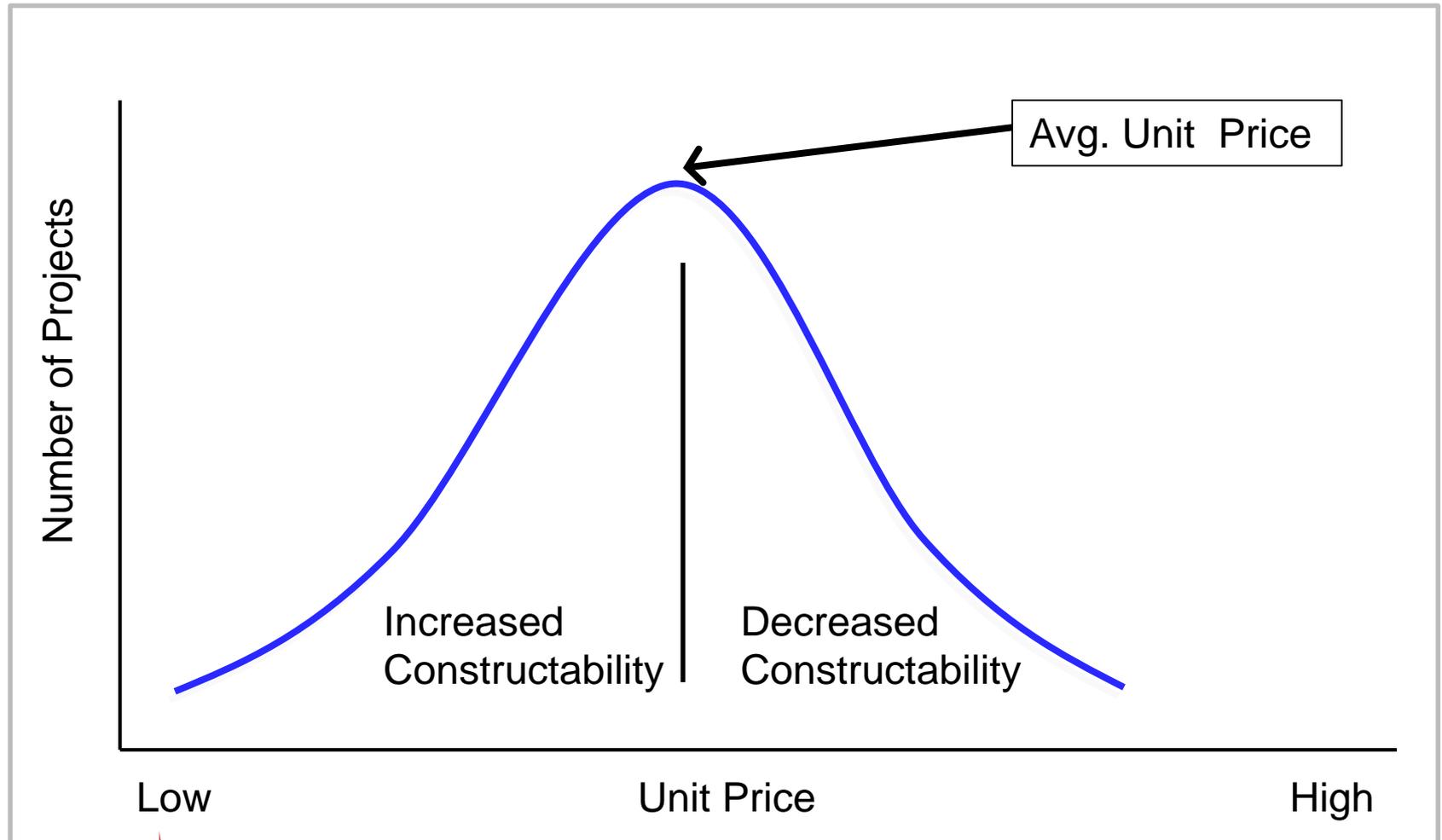
Design/Estimating Challenge

- ◆ Sometimes a more constructible design appears more expensive
- ◆ Likely it isn't more expensive, if it is easier to construct

Design/Estimating Challenge

- ◆ If, Project Cost = Average cost * Quantity
- ◆ You'd assume Lower Quantity = Lower Project Cost
 - ✓ Not always true
- ◆ Average cost based on data with a range of constructability (and range of unit prices)
- ◆ Projects with Constructability challenges
 - ✓ Cost is typically higher than:
 - Average Cost
 - Cost of a more Constructible Design

Constructability vs. Cost



Constructability

- ◆ Try to Improve Constructability
- ◆ Balance True Project Cost & Constructability Improvements

How do we Improve Constructability?

- ◆ Increase Communication between Construction & Design
 - ✓ Standard Construction Practices
 - Equipment capabilities
 - Additional work required to construct the design
 - Formwork, false-work, spacing for equipment & labor
 - ✓ Project Challenges as they are encountered
 - ✓ Project Challenges solved in field

Increasing Constructability Knowledge

- ◆ Visit Projects
 - ✓ Observe Construction Operations
 - ✓ Speak to Contractors about design issues
- ◆ Various Trade Organization websites have some construction training
- ◆ Milling & Paving videos online
- ◆ Talk to Rich Hewitt about providing training

Today's Constructability Discussion

- ◆ Discuss the Constructability Challenge
- ◆ Review Plan Details and/or Relevant Photos
- ◆ Discuss Contractor's Suggested Changes to Improve Constructability
- ◆ Feel Free to Question or Comment

Thanks

- ◆ Contractor Panel
 - ✓ Felipe Jaramillo – AJAX Paving
 - ✓ Kevin Price - D.A.B. Constructors
 - ✓ Keith Waugh – Leware Construction Company
 - ✓ Ed Mackiewicz – EJM Consulting
- ◆ Bob Burleson
 - ✓ Florida Transportation Builders Association
- ◆ Jim Warren
 - ✓ Asphalt Contractors Association of Florida

Contractor Panel - Introductions

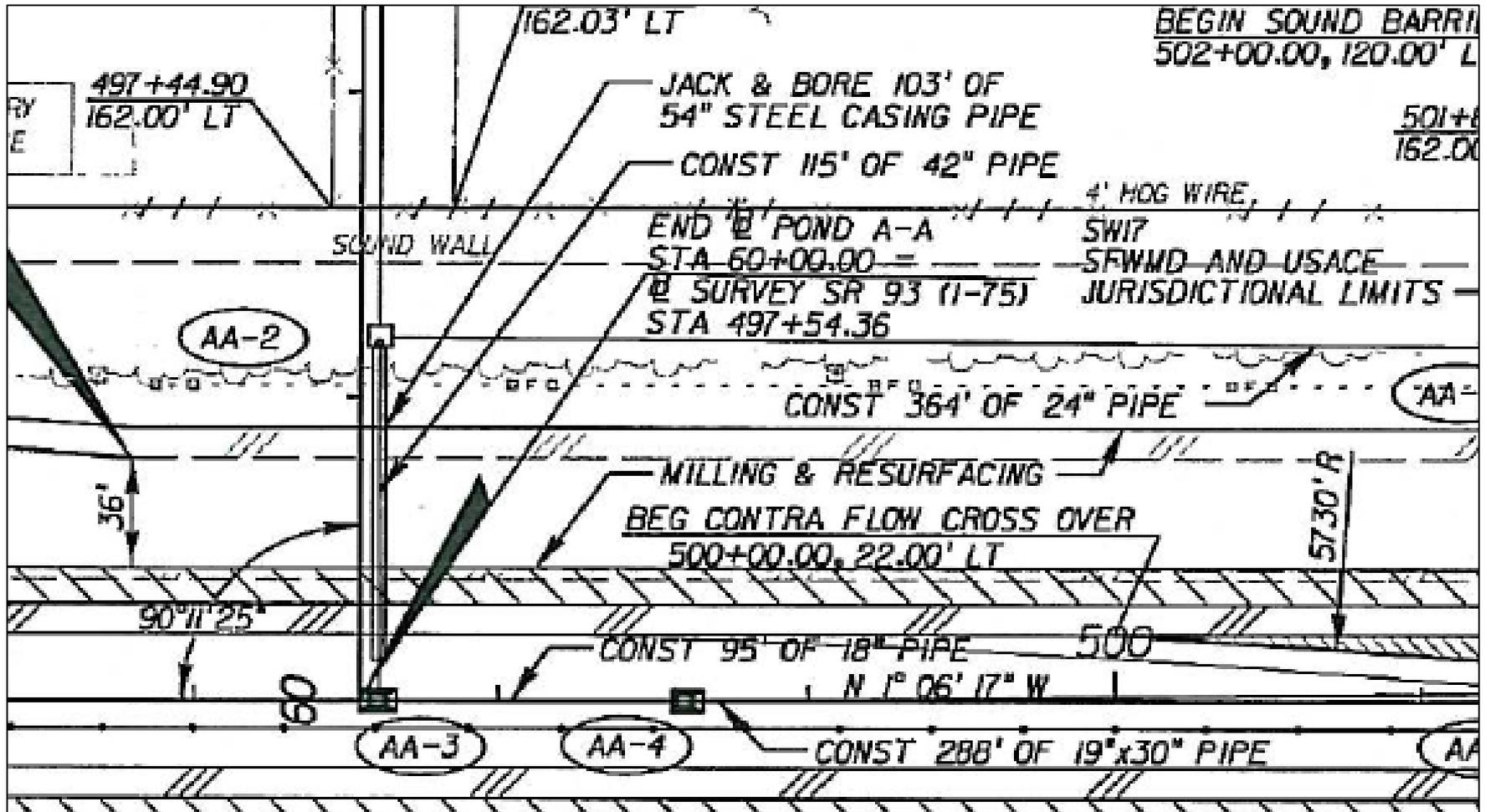
- ◆ Felipe Jaramillo – AJAX Paving
- ◆ Kevin Price - D.A.B. Constructors
- ◆ Keith Waugh – Leware Construction Company
- ◆ Ed Mackiewicz – EJM Consulting

Constructability Issues

AJAX Paving – Issue #1

- ◆ Construction Access not fully accounted for on a Jack & Bore project
 - ✓ Depth of excavation & Side Slope Safety Requirements
 - Can dramatically increase footprint needed to perform work
 - May require access agreements
 - May impact existing utilities
 - ✓ Water Table
 - May require significant dewatering efforts OR
 - Prevent work from being done during certain times of year
 - Potential Claims

AJAX Paving – Issue #1



AJAX Paving – Issue #1



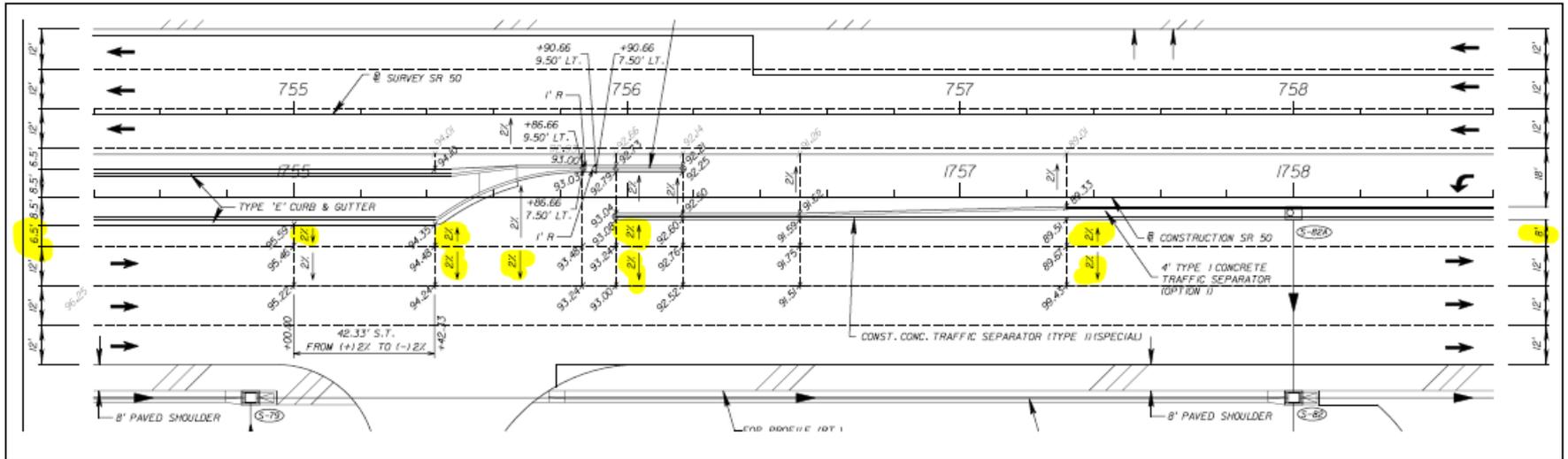
AJAX Paving – Issue #1 - Recommendations

- ◆ Account for true foot print of work area:
 - ✓ Jacking Pit & Receiving Pit
 - Bore Machine
 - Pipe being jacked
 - Work room behind Machine and Pipe
 - Depth of excavation & Side Slope Safety Requirements
 - Water Table
 - Actual Dewatering Needed
 - Area needed for water storage & treatment

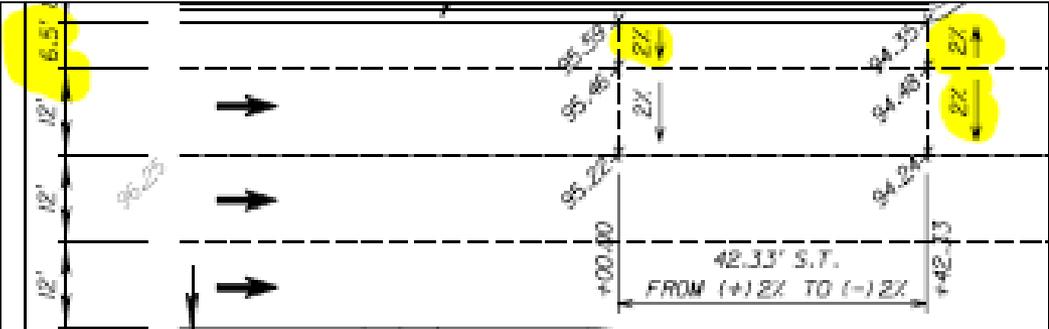
D.A.B. Constructors - Issue #1

- ◆ Varying shoulder widths & varying widening creates constructability challenges
 - ✓ Widths inconsistent with paving equipment capabilities
 - ✓ Shoulders greater than 5ft require an additional paving operation
 - ✓ Shoulders 5ft and less can be paved with the adjacent travel lane
- ◆ More paving operations = decreased efficiency & increased costs

D.A.B. Constructors - Issue #1



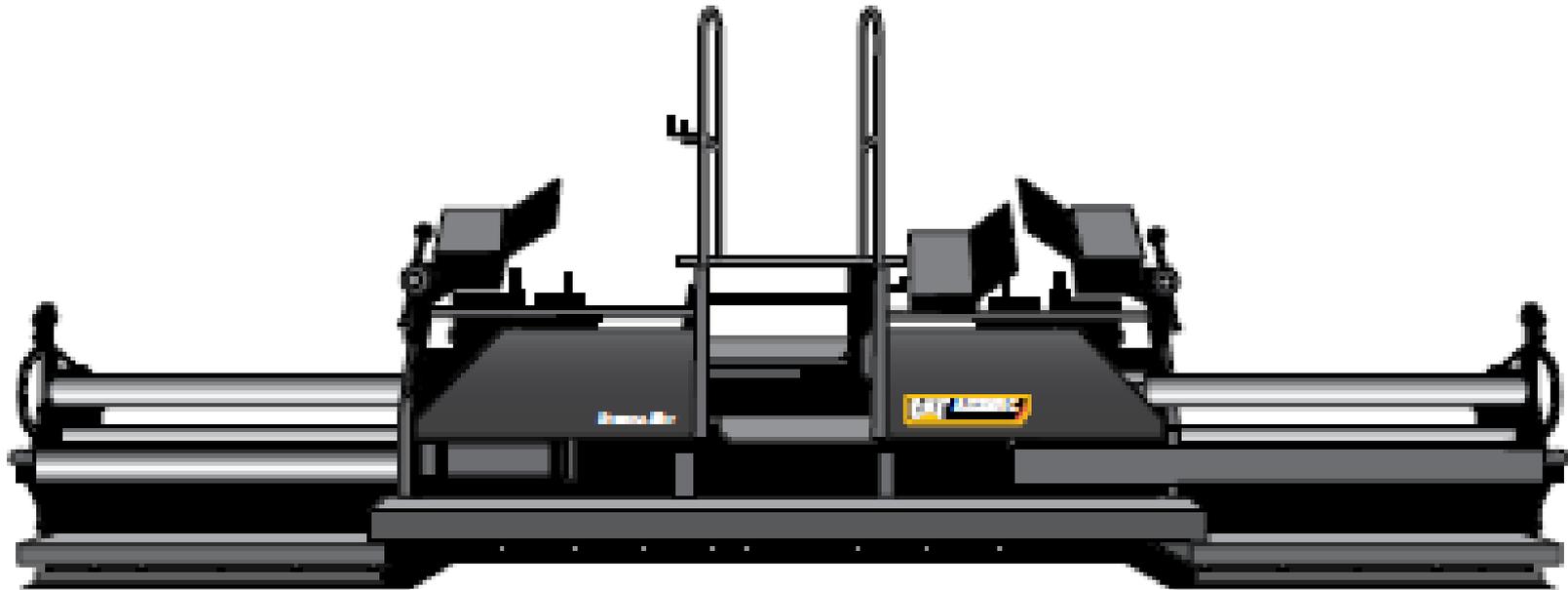
D.A.B. Constructors - Issue #1



D.A.B. Constructors - Issue #1



D.A.B. Constructors - Issue #1



5' Max

10' Standard

5' Max

20' Extended

D.A.B. - Issue #1 - Recommendations

- ◆ Consider Paver Dimensions when specifying lane & shoulder widths, as well as, mainline widening widths
- ◆ Design shoulder width either:
 - ✓ 5 ft or less
 - Shoulder can be paved with travel lane
 - Screed extension (up to 5ft)
 - ✓ 8 ft or more
 - Shoulder can be paved separately
 - Main screed = 8ft or 10ft
 - Most pavers are 10ft

Leware - Issue #1

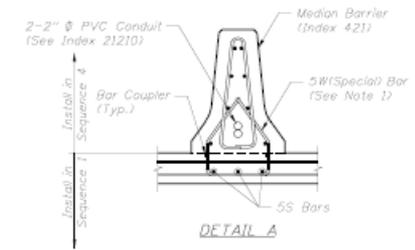
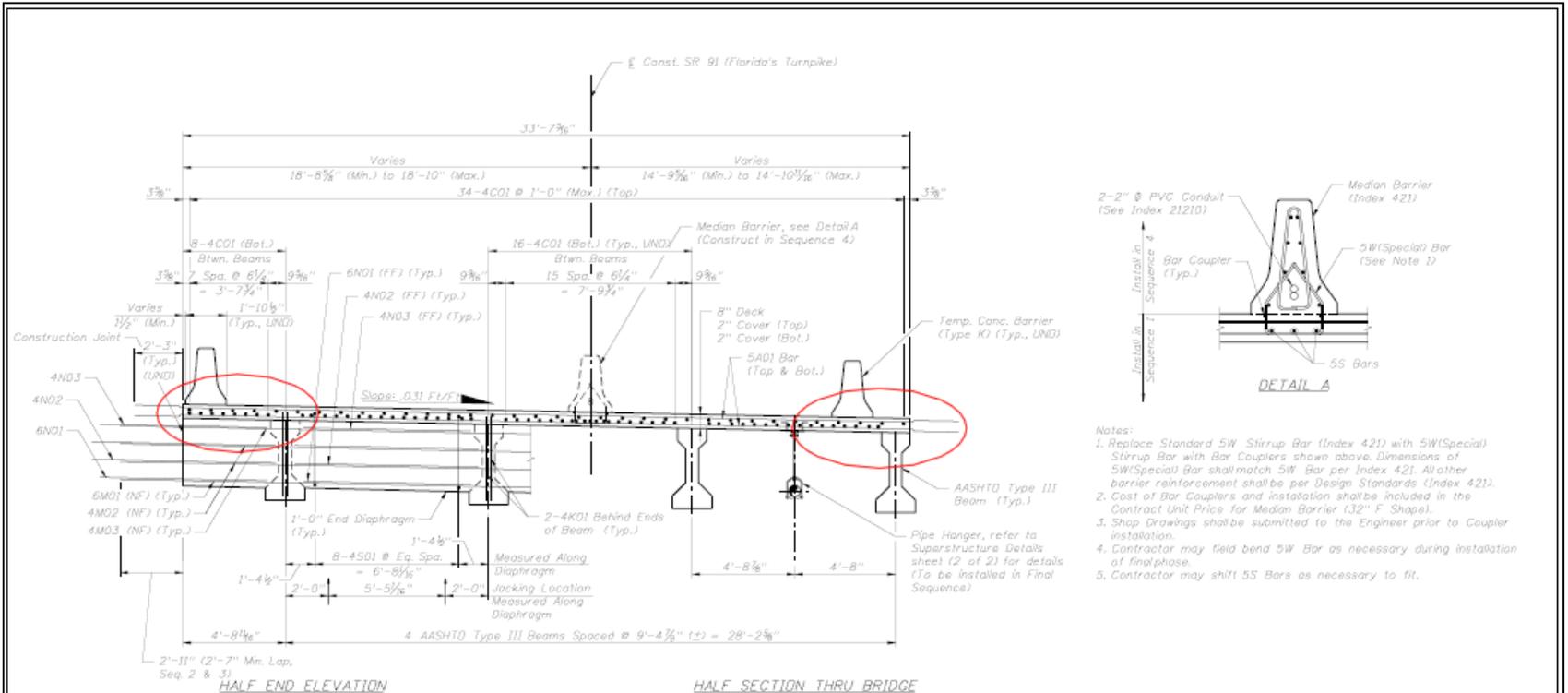
◆ Issue:

- ✓ Insufficient beam deflection data provided for phased bridge deck construction
- ✓ Issues arise during subsequent phase deck pours regarding clearances and thickness

◆ Impacts:

- ✓ RFI required during construction
- ✓ Lost time during resolution by CEI and EOR

Leware - Issue #1



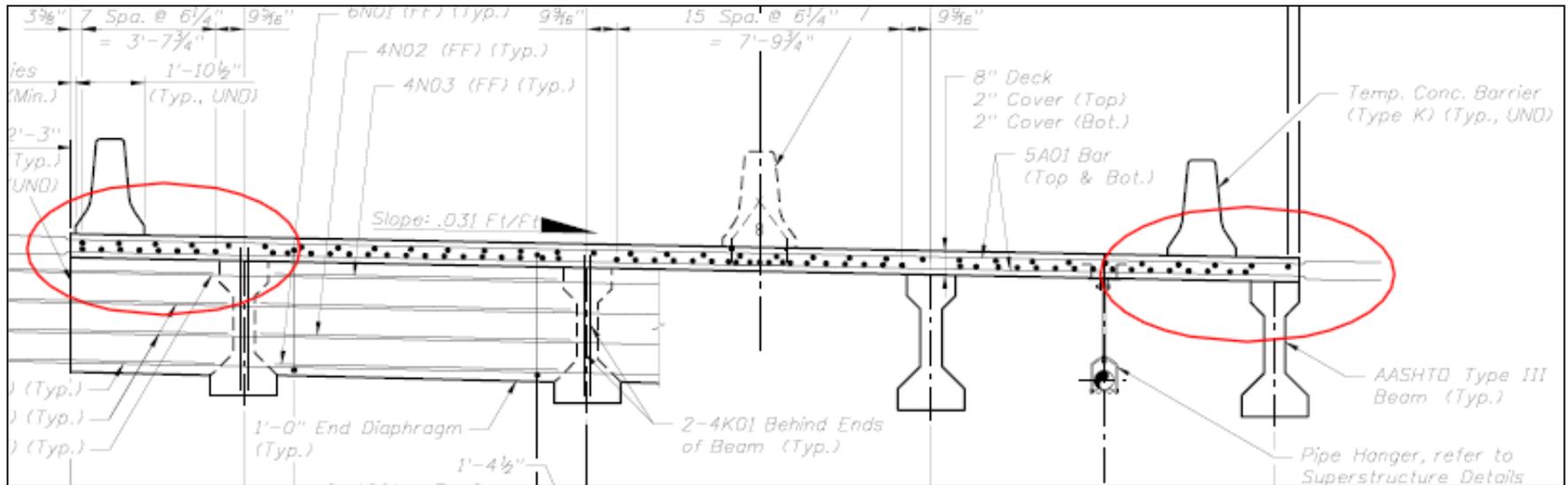
- Notes:
1. Replace Standard SW Stirrup Bar (Index 421) with 5W(Special) Stirrup Bar with Bar Couplers shown above. Dimensions of 5W(Special) Bar shall match SW Bar per Index 421. All other barrier reinforcement shall be per Design Standards (Index 421).
 2. Cost of Bar Couplers and installation shall be included in the Contract Unit Price for Median Barrier (32" F. Shape).
 3. Shop Drawings shall be submitted to the Engineer prior to Coupler installation.
 4. Contractor may field bend SW Bar as necessary during installation of final phase.
 5. Contractor may shift 5S Bars as necessary to fit.

- JACKING NOTES:**
1. Jacking Loads are for each Jack. Thirty (30) Jacks are required at Ends.
 2. To Replace Any One Bearing Device, all Beams at that Bent Must be Jacked Simultaneously and Must Displace Equally During Jacking Process.
 3. See Superstructure Section on this Sheet for Jacking Locations.
 4. Jacks Shall be Equipped with a Locking Ring which will Prevent Movement in the event that Hydraulic Pressure is Lost.
 5. Jacks Shall be Centered Beneath Diaphragms.
 6. Jacks are Required for Future Bearing Replacement and Not Part of this Contract.

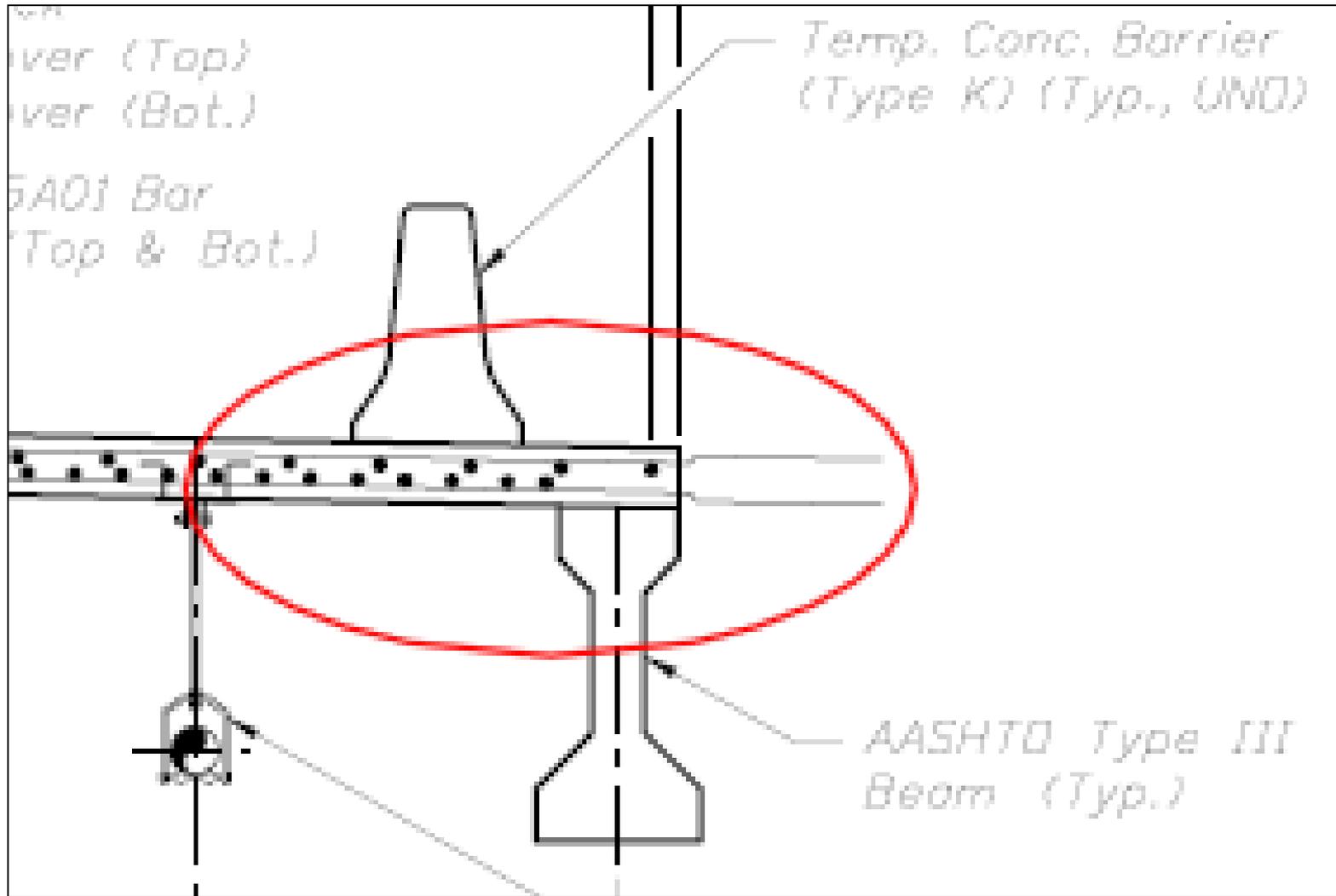
- GENERAL NOTES:**
1. All Transverse Dimensions Shown are Measured Radial to Const. SR 91 (Florida's Turnpike).
 2. For Details of Traffic Railing Barriers and Type K Barriers, Including Additional Reinforcing Originating in the Deck Slab, See Standard Details No. 420, 421 & 414.
 3. Refer to Indices No. 20110, 20130 and 20199 for Beam Details.
 4. NF Denotes Near Face, FF Denotes Far Face, & EF Denotes Each Face.
 5. For Diaphragm Sections, See Superstructure Details Sheet (1 of 2).
 6. Refer to Superstructure Plan for Spacing of Transverse Bars.

| JACKING LOADS (KIPS) (SERVICE LOAD) | | |
|--|--------------------|-------|
| Dead Load | Live Load & Impact | Total |
| 44.0 | 19.0 | 63.0 |

Leware - Issue #1



Leware - Issue #1



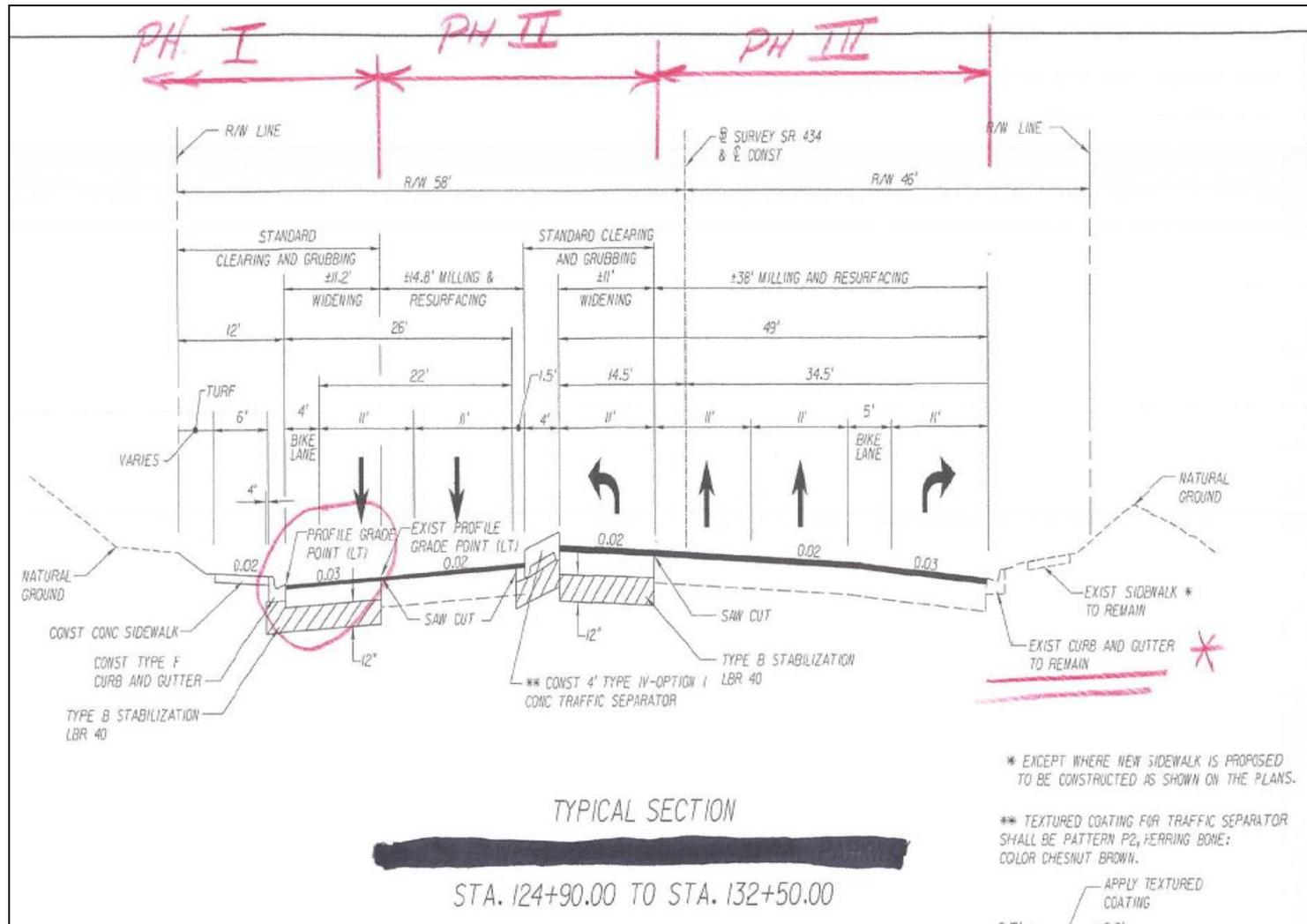
Leware - Issue - #1 - Recommendation

- ◆ EOR should provide Build-Up & Deflection Data Table that reflects phased loading of beams

EJM – Issue #1

- ◆ Road Reconstruction vs. Mill/Resurface
 - ✓ Coordinate TCP Phases with CP & Existing Features
 - i.e. curb
 - ✓ Caution when one side retains existing curb, but opposite side is newly constructed
 - ✓ Start at existing curb if cross slope is changing
 - ✓ Consider cross slope % \pm

Issue #1 - Example

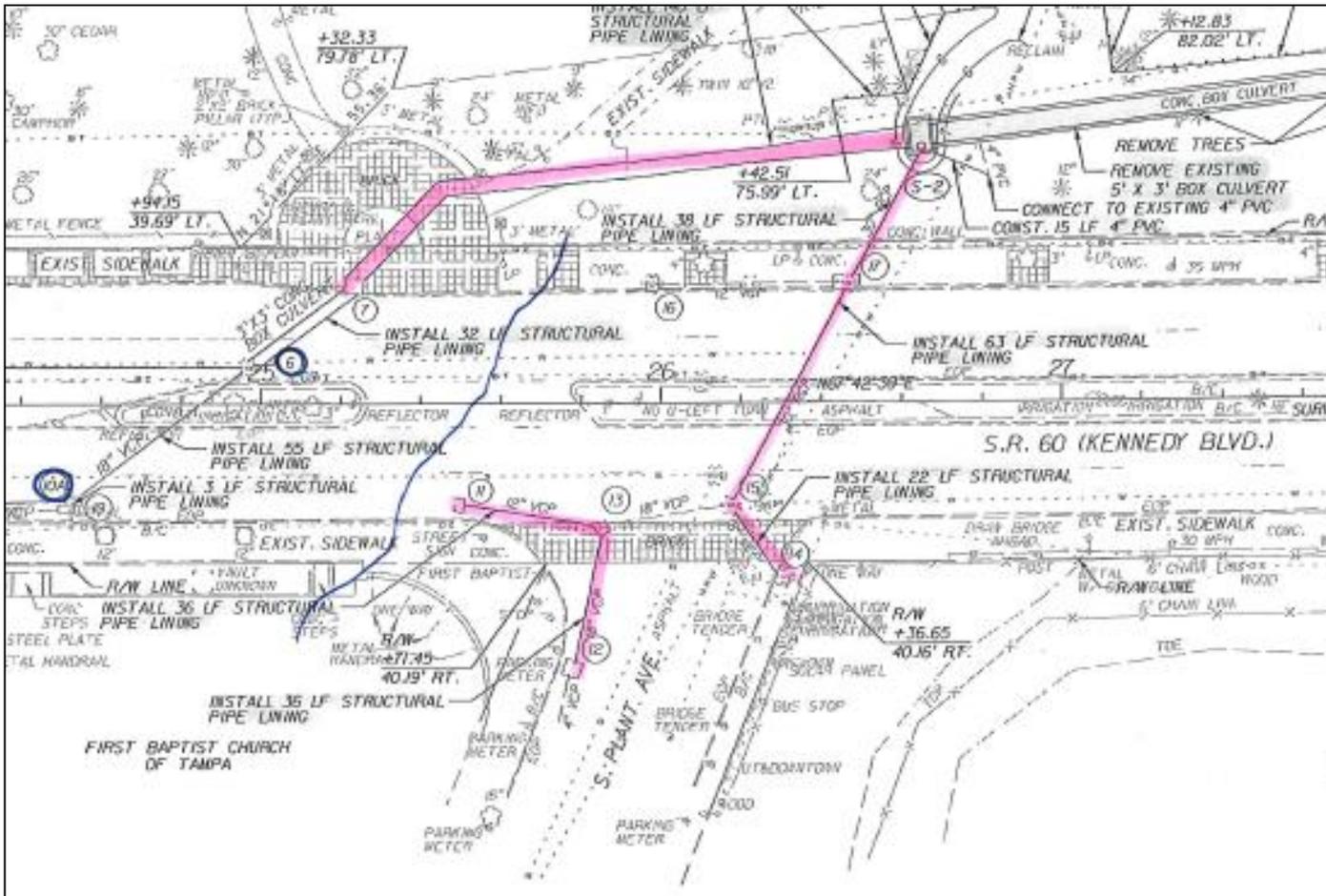


AJAX Paving – Issue #2

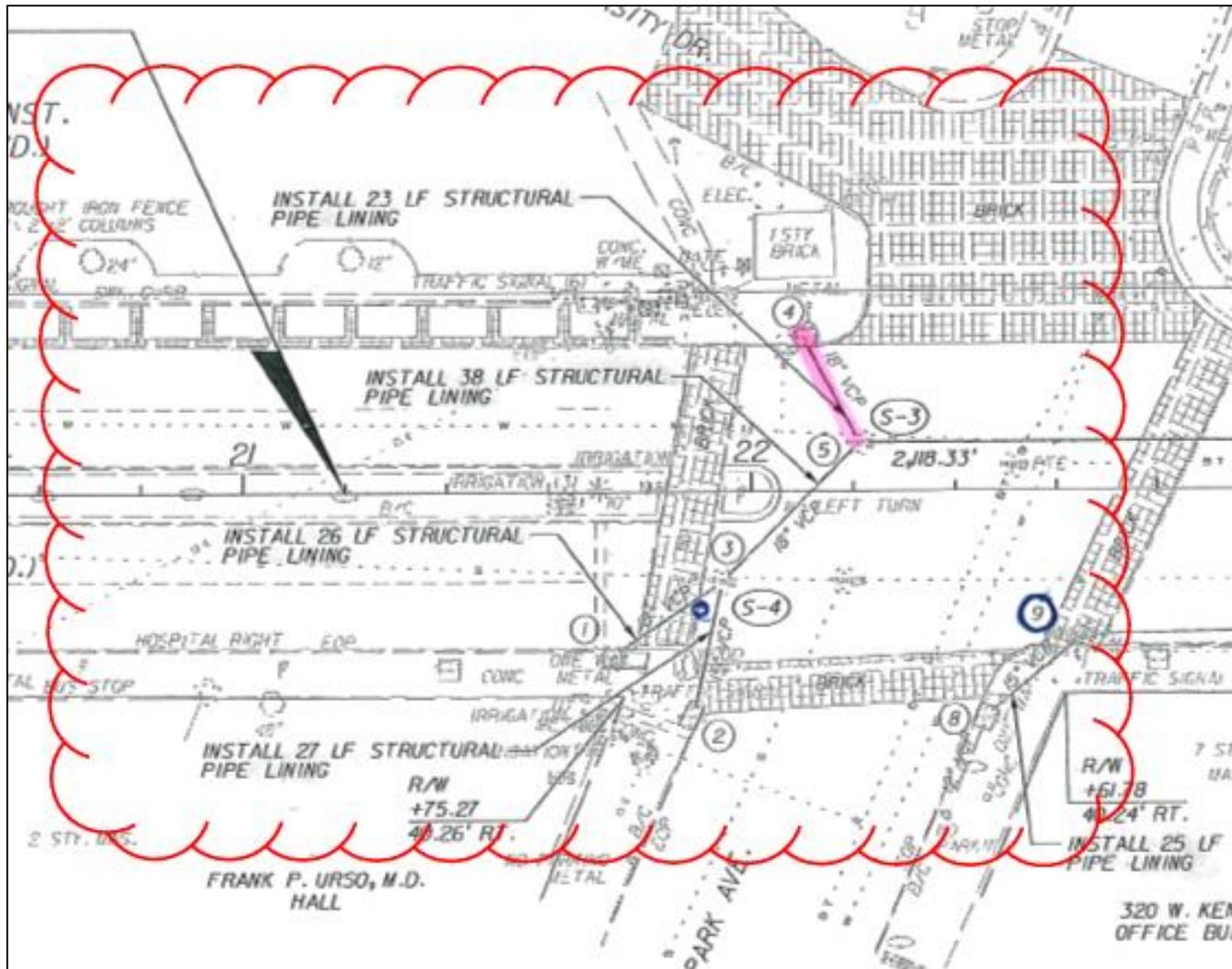
◆ Pipe Liner Work

- ✓ Construction access not fully accounted for
- ✓ Lane closure time not long enough
 - Time to excavate, install and cure time of pipe liner was longer than lane closure
 - Lane Closure Allowed 9pm to 5am

AJAX Paving – Issue #2



AJAX Paving – Issue #2



AJAX Paving – Issue #2



S-4 , STEEL PLATE SITTING ON TOP OF PIPES, 18" FROM ROAD SURFACE TO TOP OF STEEL PLATE

AJAX Paving – Issue #2 - Recommendations

Pipe Liner Work

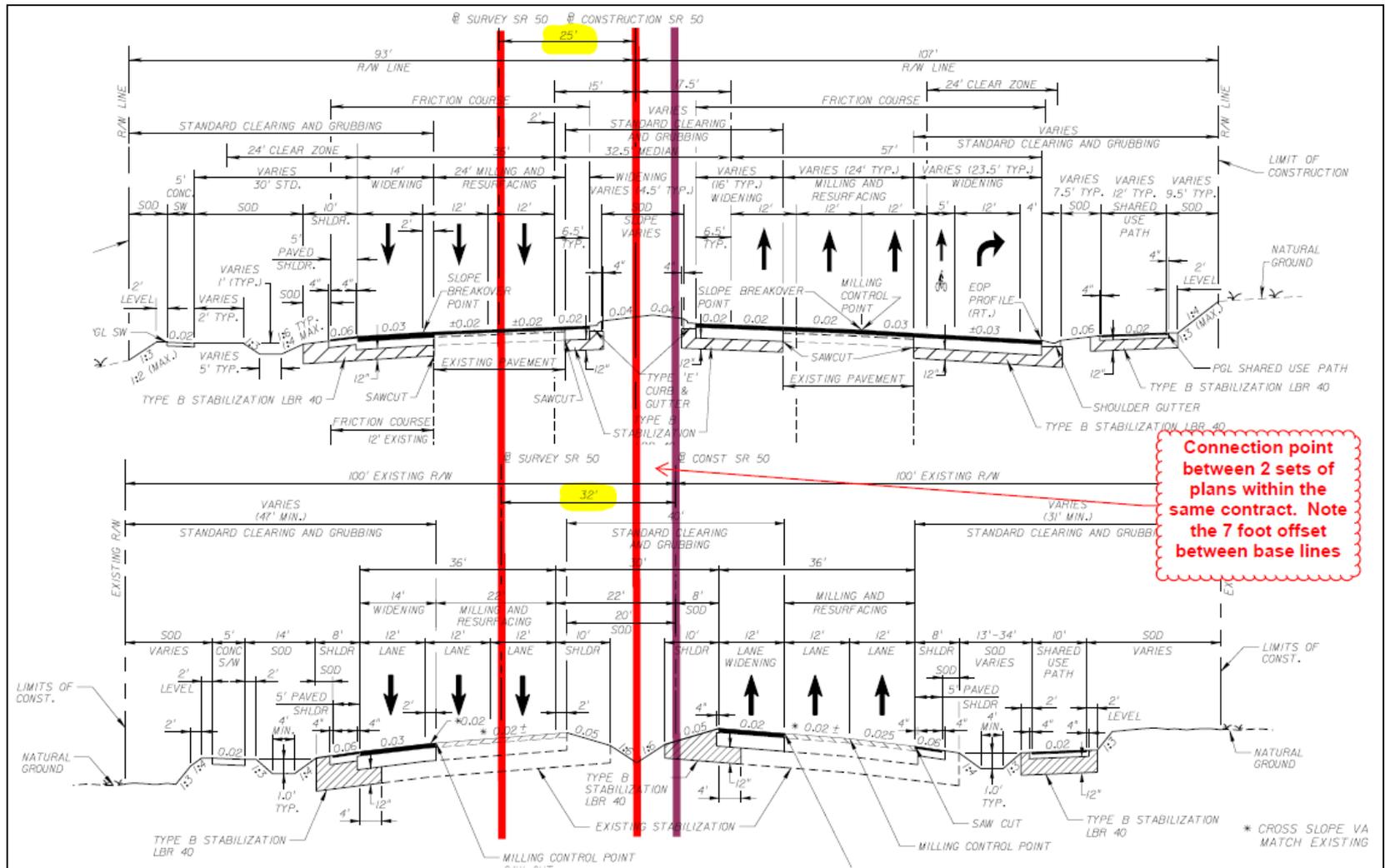
- ◆ Account for true area needed to perform work
- ◆ Lane closure time must exceed excavation, installation, and pipe liner cure time by at least 2 hours
 - ✓ Resin Cure Time = 2 hours
 - ✓ Critical on projects where “Inverting” (a.k.a. Cure-in-Place pipe lining) is the only option & slip lining (sections of pipe) cannot be installed

D.A.B. Issue #2 - Baselines

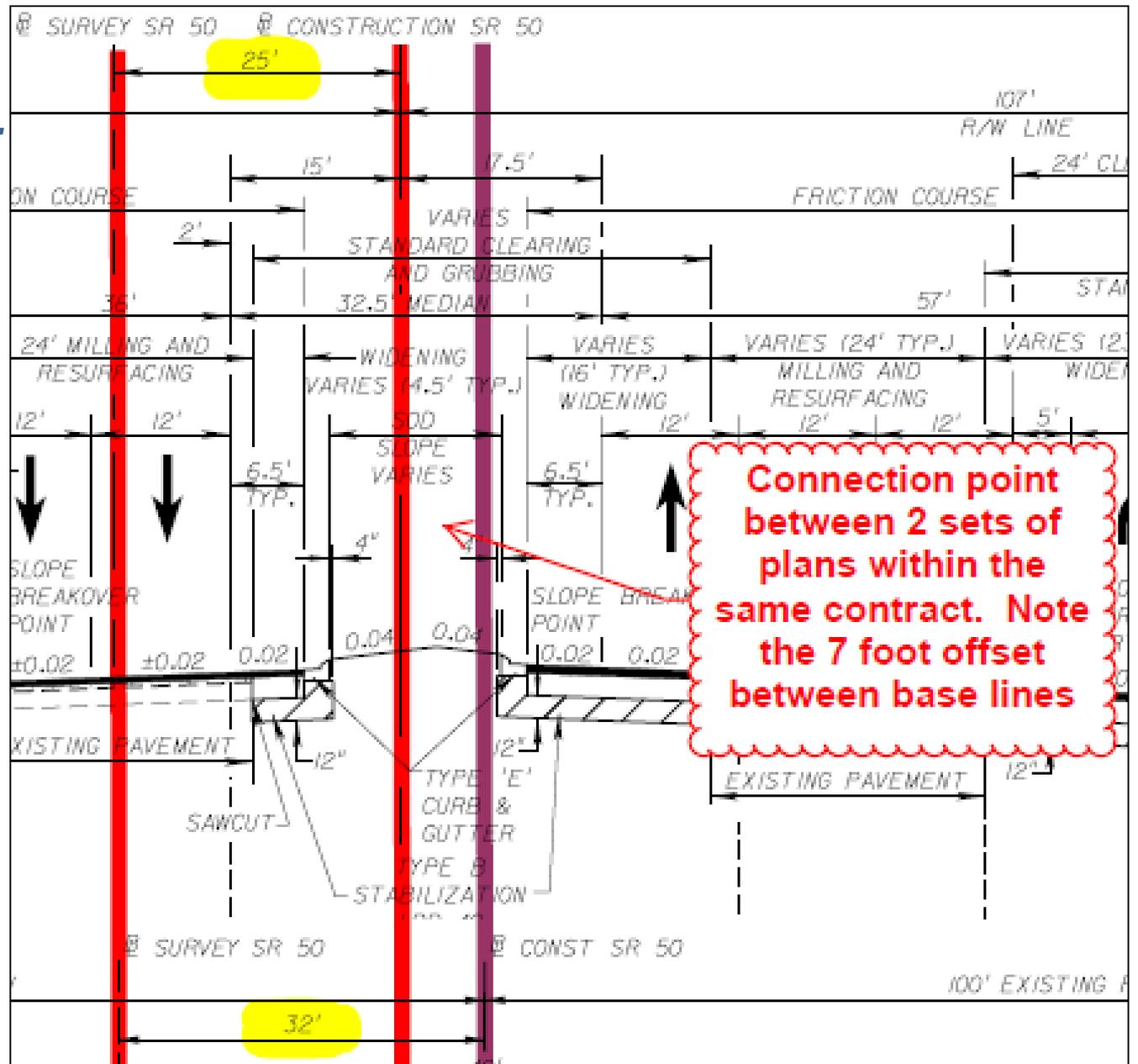
Problem:

- ◆ Contract with two projects (2 FIN's), had different location for base lines
- ◆ Causes issues with layout in the field, can lead to mistakes in locating lane lines and work areas due to different offsets from each baseline

D.A.B. Issue #2 - Baselines



D.A.B. Issue #2 - Baselines



D.A.B. Issue #2 - Recommendation

- ◆ Use one baseline for the entire project
- ◆ Resolve among FDOT & designers of the two projects

Leware - Issue #2

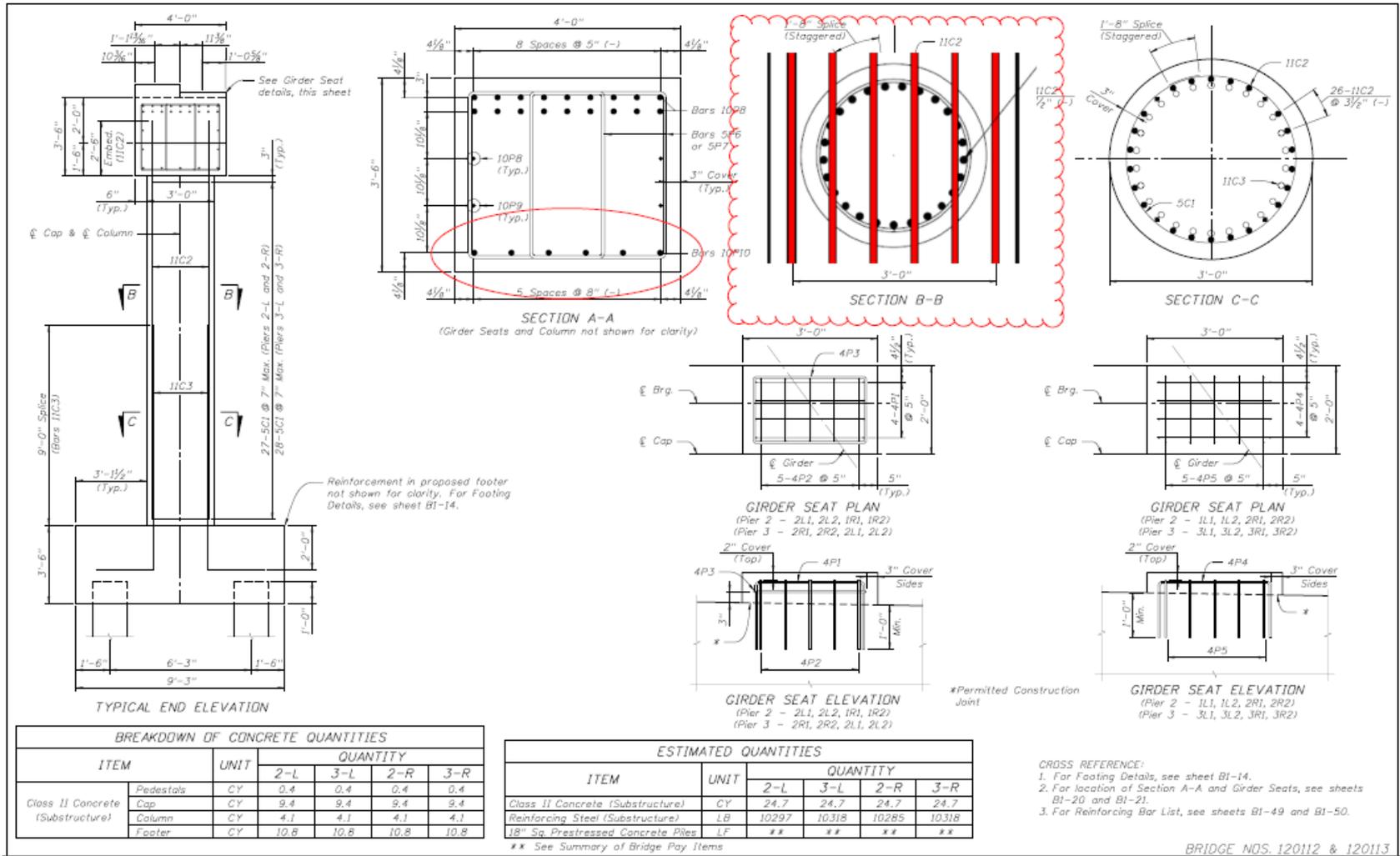
◆ Problem:

- ✓ Bottom of pier cap reinforcing not spaced to avoid interference with column vertical steel / 90° bends or 180° hooks on column verticals compound the problem
- ✓ Reinforcing steel for pier cap cannot be pre-tied and placed as shown

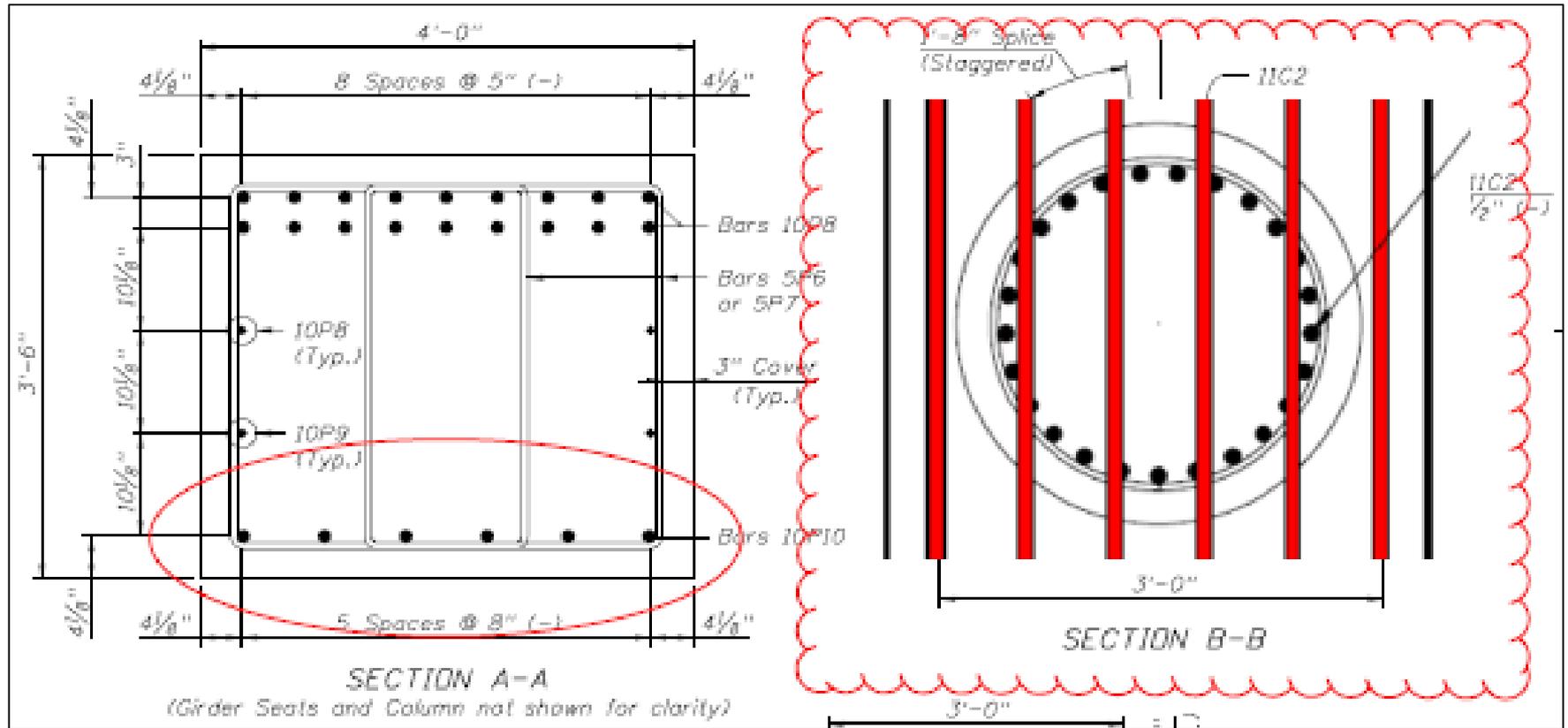
◆ Impacts

- ✓ RFI required to move cap reinforcement
- ✓ Lost time during resolution by CEI & EOR

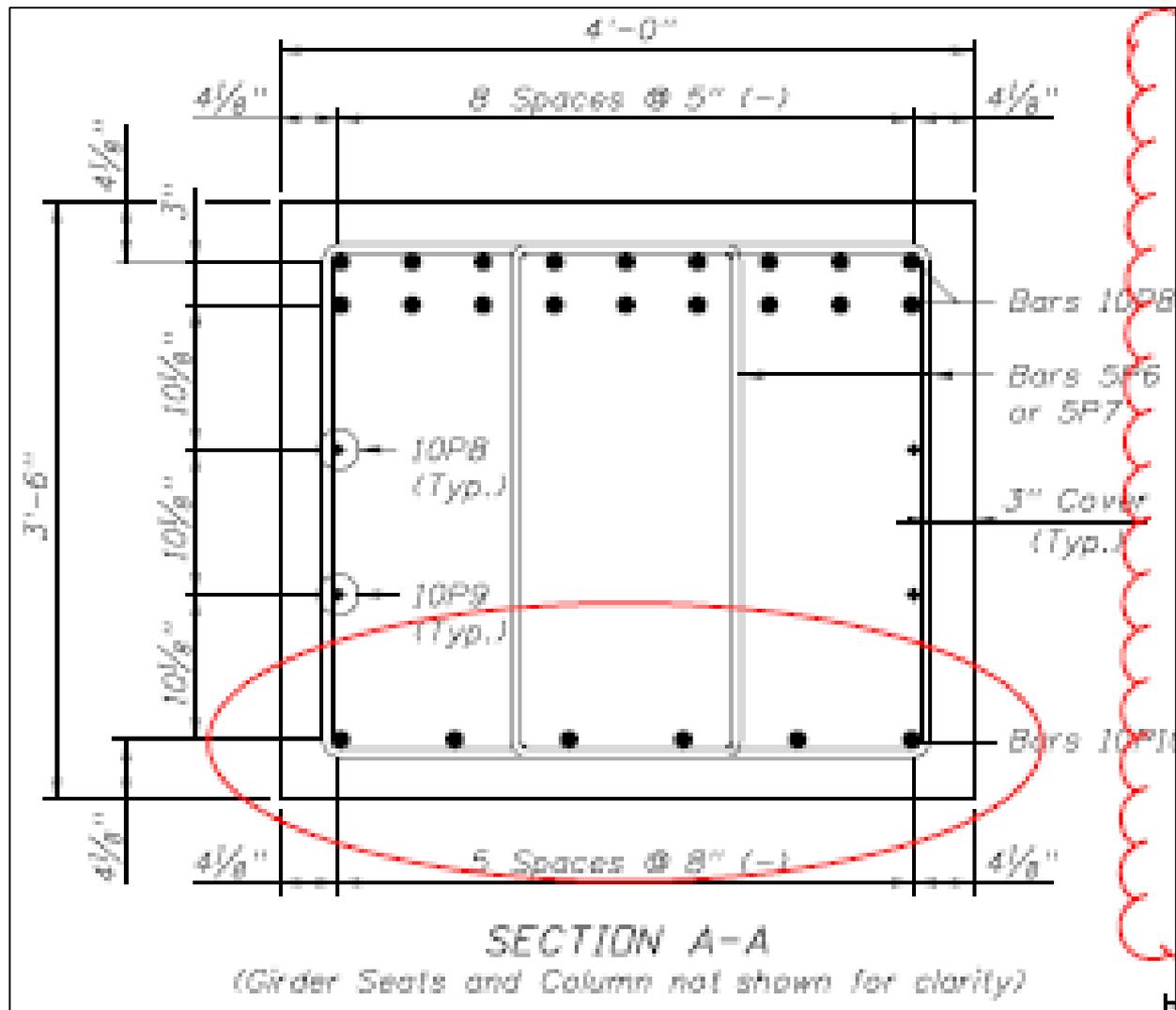
Leware - Issue #2



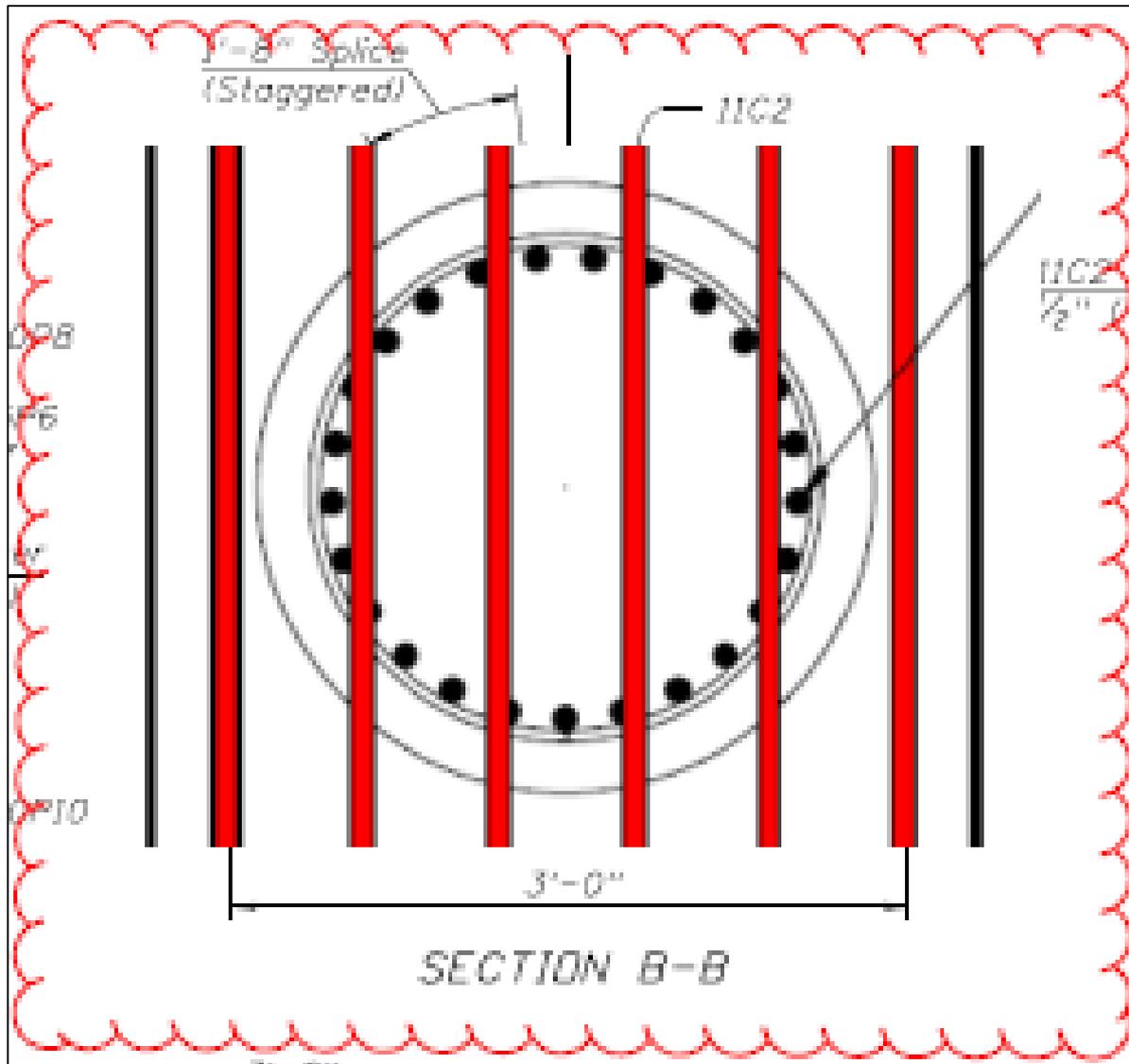
Leware - Issue #2



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Leware - Issue #2



Leware - Issue #2 - Recommendations

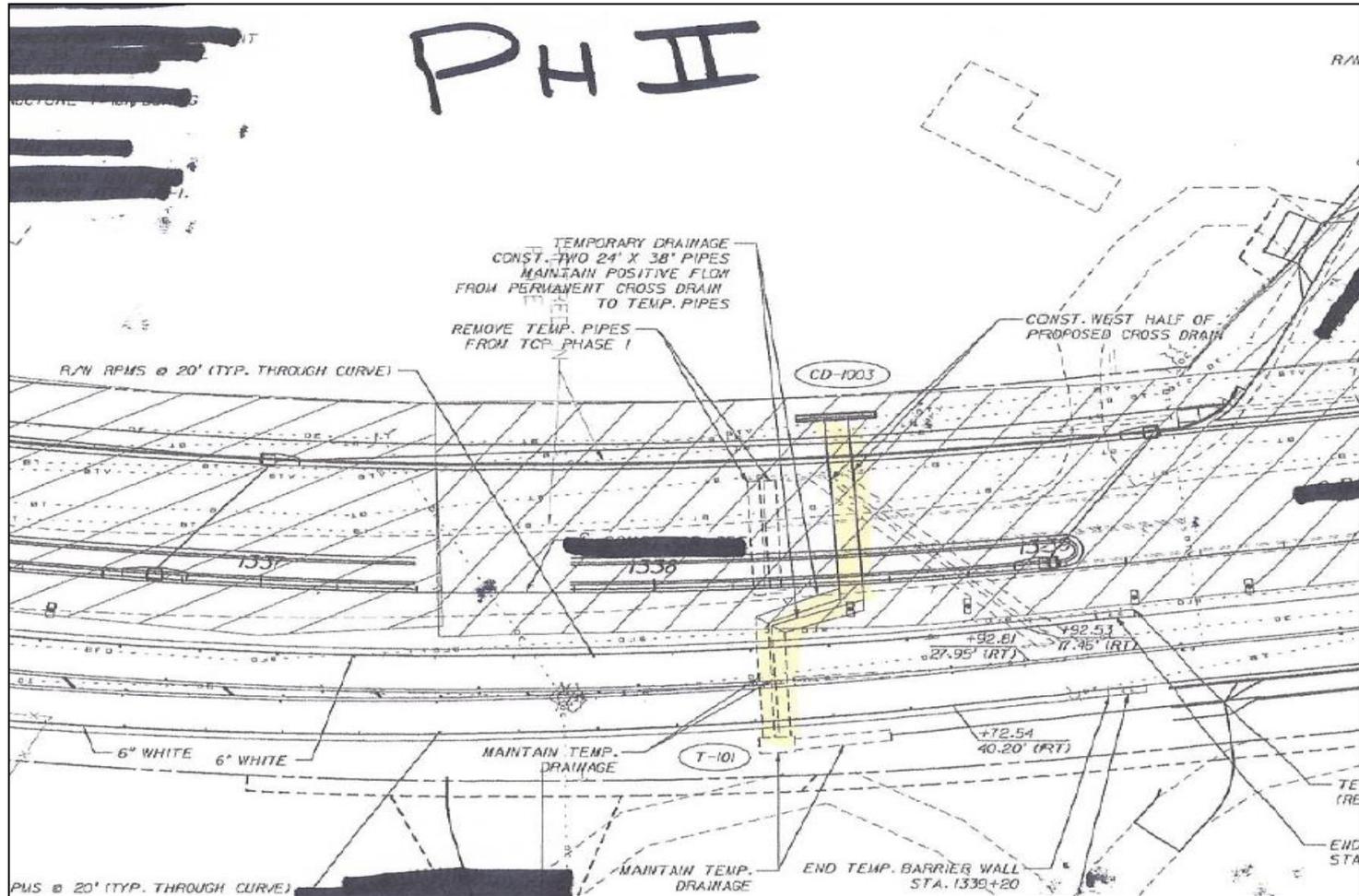
- ◆ EOR should plot the bottom longitudinal cap steel on the column section to verify that both column & cap reinforcement can be placed as shown.
- ◆ Hooks & bends to column verticals should be avoided

EJM – Issue #2

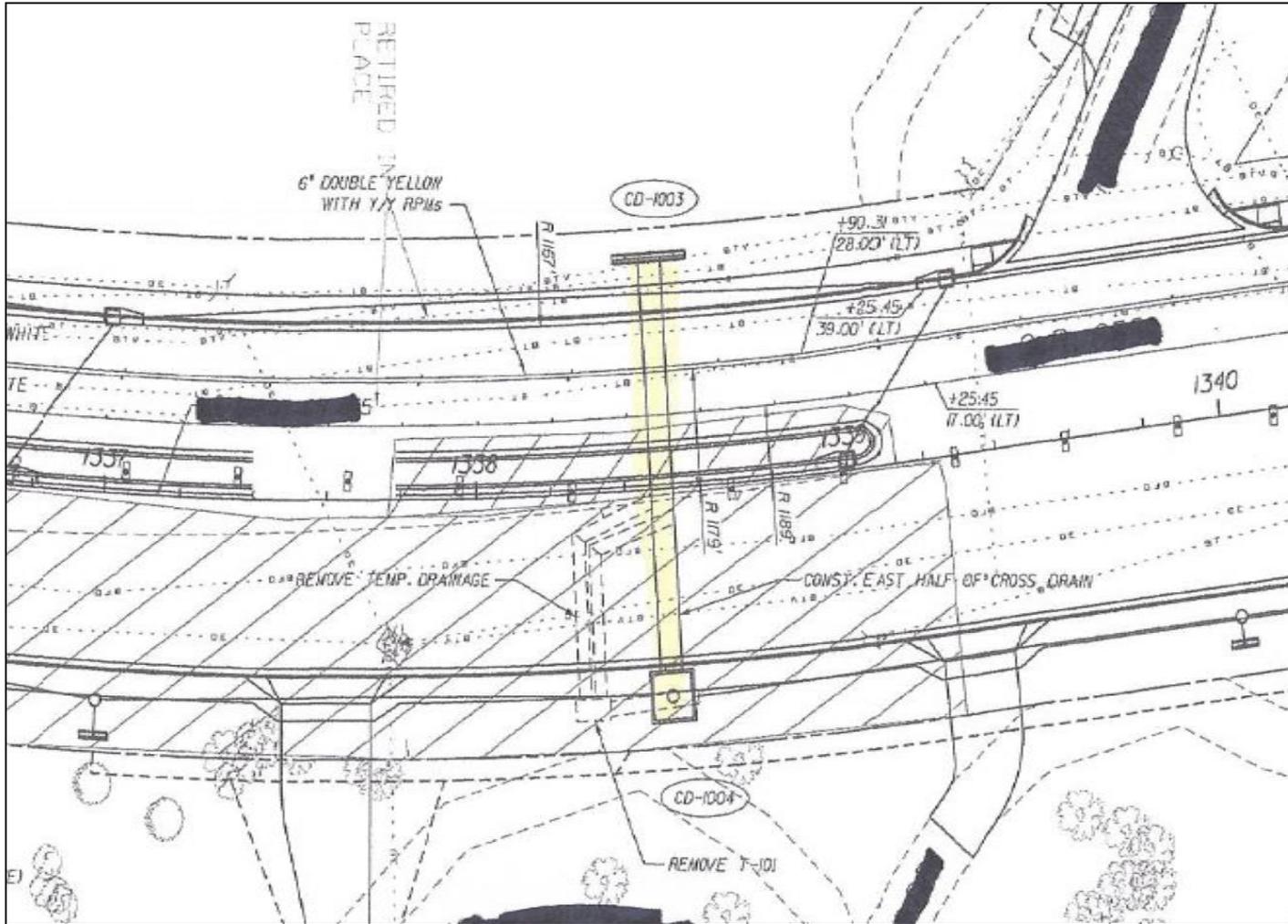
◆ Temporary Features

- ✓ Beneficial when design includes temporary features
- ✓ But, make sure they are truly warranted
- ✓ E.g. temp drainage as its own phase
- ✓ Look to see if permanent can be installed early to avoid the need

Issue #2 - Example



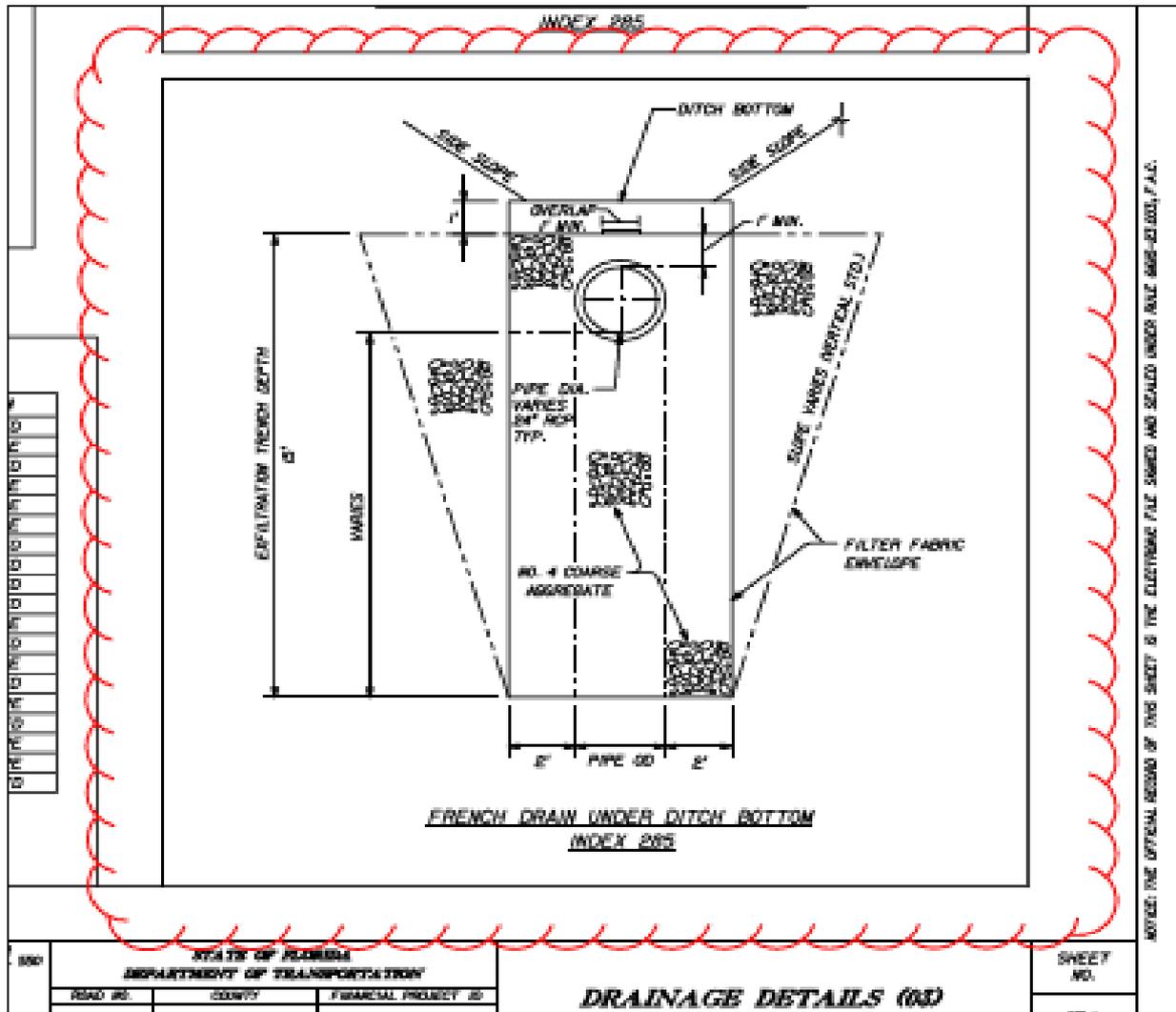
Issue #2 - Example



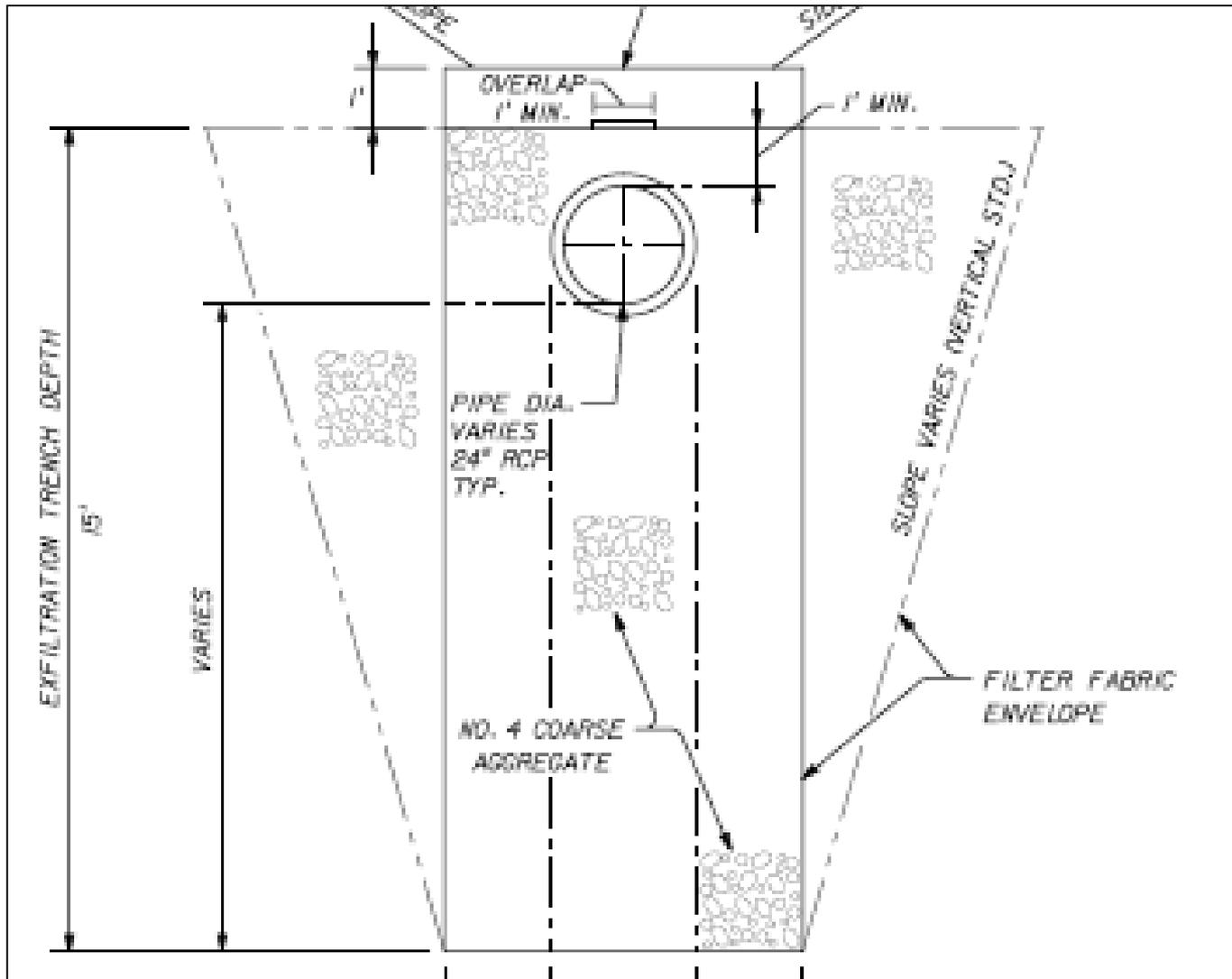
AJAX Paving – Issue #3

- ◆ French Drain - Constructability & Site Condition Issues
 - ✓ Rock layer
 - ✓ Water Table
 - Dewatering storage & treatment

AJAX Paving – Issue #3



AJAX Paving – Issue #3



AJAX Paving – Issue #3 - Recommendations

- ◆ Investigate underground conditions to adequately evaluate constructability
 - ✓ Water table
 - ✓ Rock layers
 - ✓ Existing Utilities
 - ✓ Permeability of surrounding materials

D.A.B. - Issue #3

Issue:

- ◆ Structural course thickness reduced by 0.5” in overbuild areas
- ◆ Had to taper structural course from 1.5” to 2” and back to 1.5” in numerous areas

D.A.B. - Issue #3

LIMITS OF MILLING AND RESURFACING WITHOUT OVERBUILD (SEE PAVEMENT DESIGN BELOW)

STA. 575+90.00 TO STA. 600+10.00
STA. 613+00.00 TO STA. 628+10.00
STA. 640+00.00 TO STA. 674+50.00
STA. 698+95.00 TO STA. 702+20.00
STA. 722+00.00 TO STA. 724+85.00
STA. 737+50.00 TO STA. 740+80.00
STA. 752+00.00 TO STA. 780+60.00
STA. 786+20.00 TO STA. 789+80.00

MAINLINE, TURN LANES, & MEDIAN CROSSOVERS MILLING

MILL EXISTING ASPHALT PAVEMENT (3.25" AVG. DEPTH)

MAINLINE, TURN LANES, & MEDIAN CROSSOVERS RESURFACING

ASPHALT RUBBER MEMBRANE INTERLAYER (0.5")
TYPE SP STRUCTURAL COURSE (TRAFFIC D) (2.0") (PG 76-22)
AND FRICTION COURSE FC-5 (0.75") (PG 76-22)

LIMITS OF MILLING AND RESURFACING WITH OVERBUILD (SEE PAVEMENT DESIGN BELOW)

STA. 600+10.00 TO STA. 613+00.00
STA. 628+10.00 TO STA. 640+00.00
STA. 674+50.00 TO STA. 698+95.00
STA. 702+20.00 TO STA. 722+00.00
STA. 724+85.00 TO STA. 737+50.00
STA. 740+80.00 TO STA. 752+00.00
STA. 780+60.00 TO STA. 786+20.00

MAINLINE, TURN LANES, & MEDIAN CROSSOVERS MILLING

MILL EXISTING ASPHALT PAVEMENT (3.25" AVG. DEPTH)

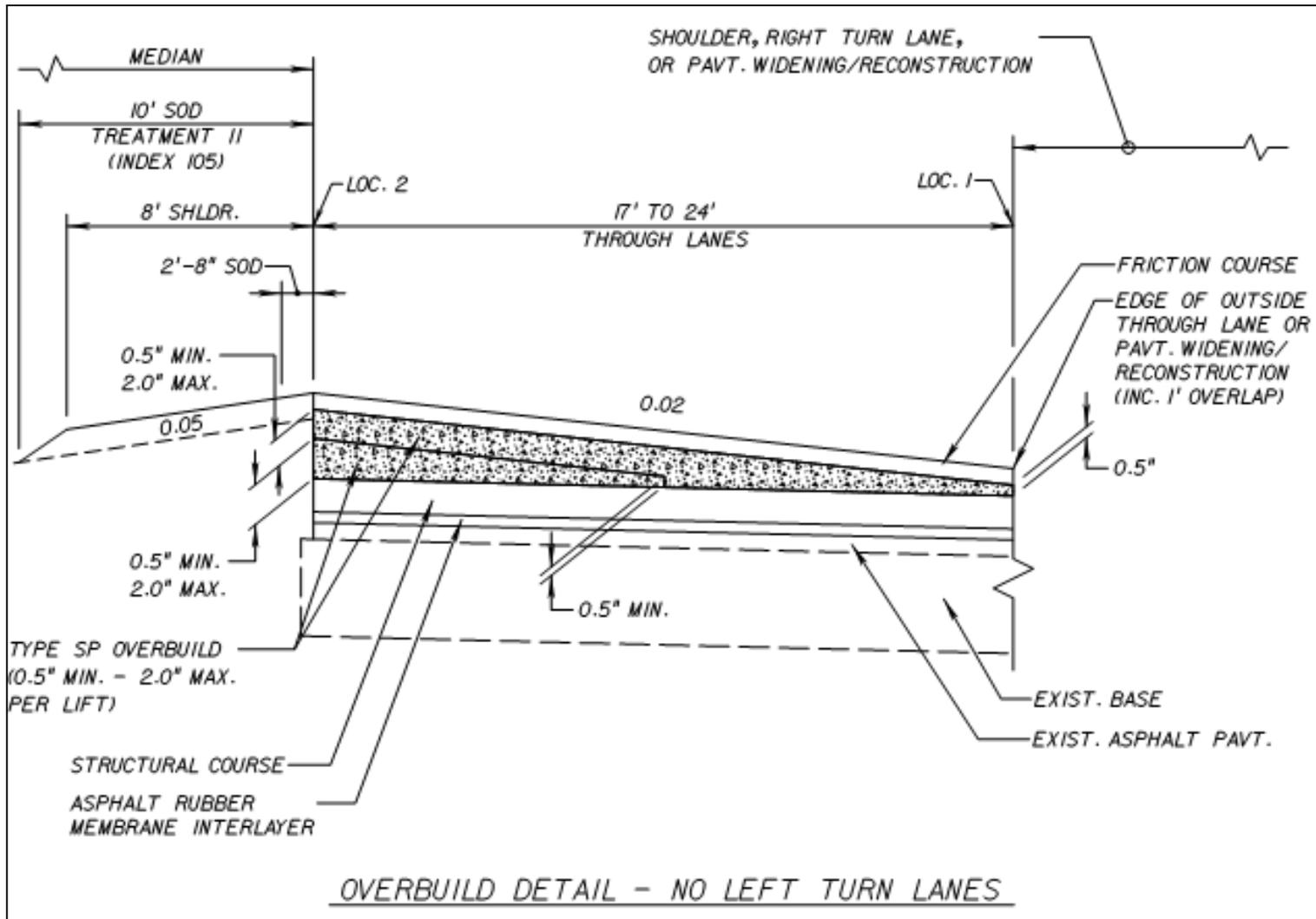
MAINLINE, TURN LANES, & MEDIAN CROSSOVERS RESURFACING

ASPHALT RUBBER MEMBRANE INTERLAYER (0.5")
TYPE SP STRUCTURAL COURSE (TRAFFIC D) (1.5") (PG 76-22)
AND FRICTION COURSE FC-5 (0.75") (PG 76-22)

MAINLINE, TURN LANES, & MEDIAN CROSSOVERS OVERBUILD

TYPE SP OVERBUILD (TRAFFIC D) THICKNESS VARIES (0.5" TO 4.0") (PG 76-22)

D.A.B. - Issue #3



D.A.B. - Issue #3 - Recommendations

- ◆ Keep Structural Course thickness consistent
- ◆ Only have to taper Overbuild
 - ✓ It is tapered longitudinally anyway
- ◆ Place the Overbuild First – low in the pavement structure
- ◆ Place Structural course on top of the Overbuild

Leware - Issue #3

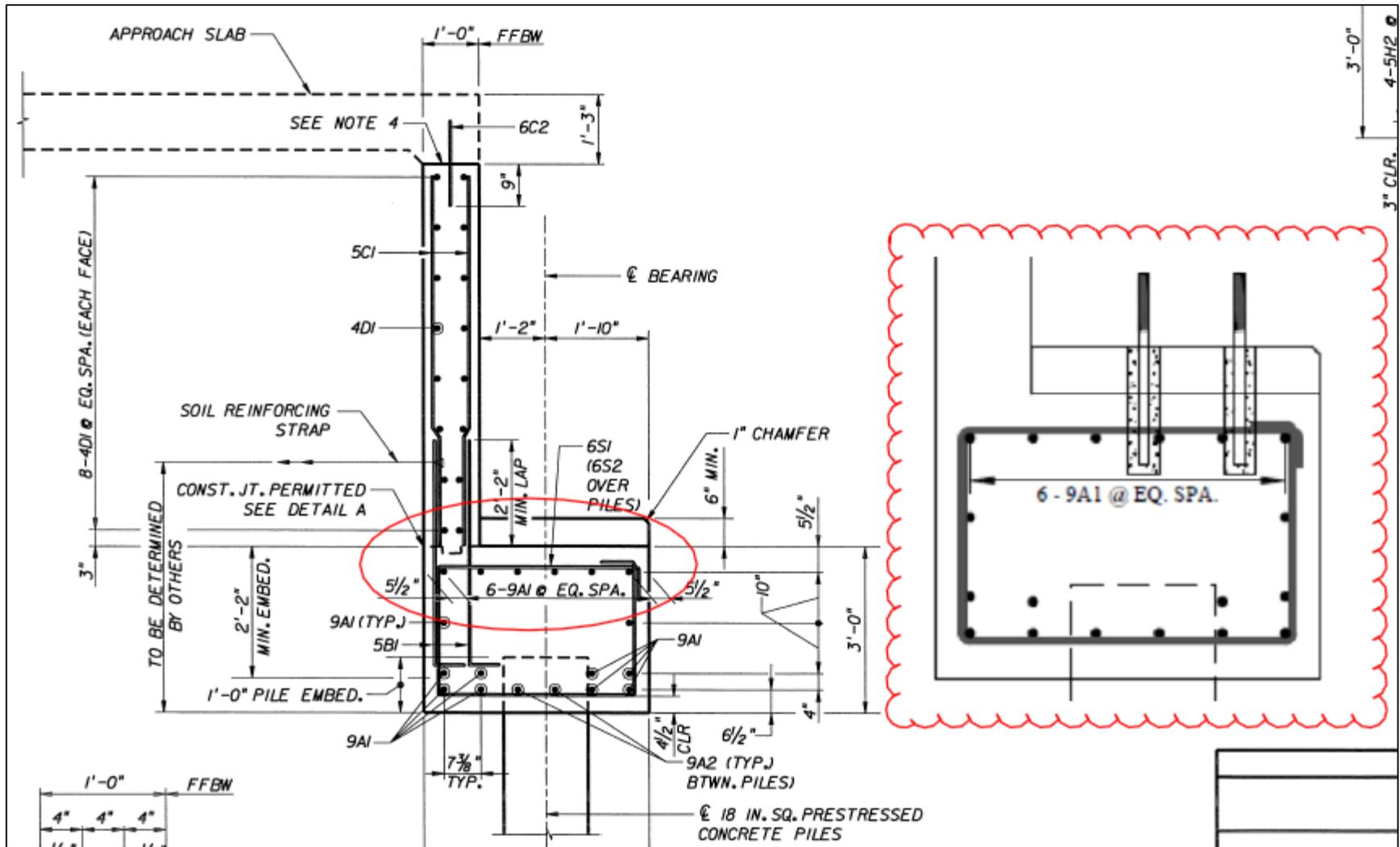
◆ Issue

- ✓ Insufficient room to install structural steel anchor bolts or anchor bolt sleeves in cap
- ✓ Reinforcing steel for cap cannot be placed as shown

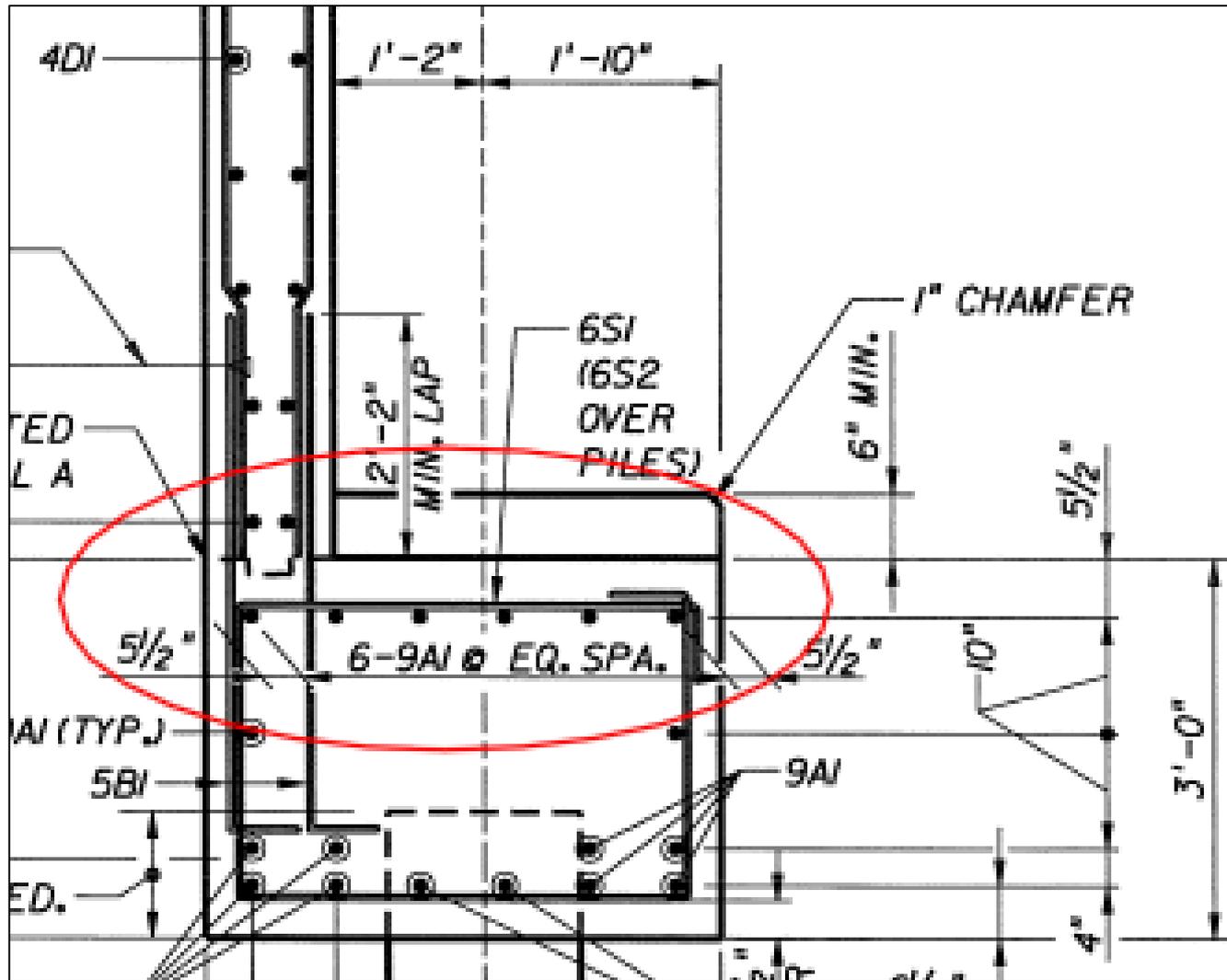
◆ Impact

- ✓ RFI required to move cap reinforcement
- ✓ Lost time during resolution by CEI & EOR

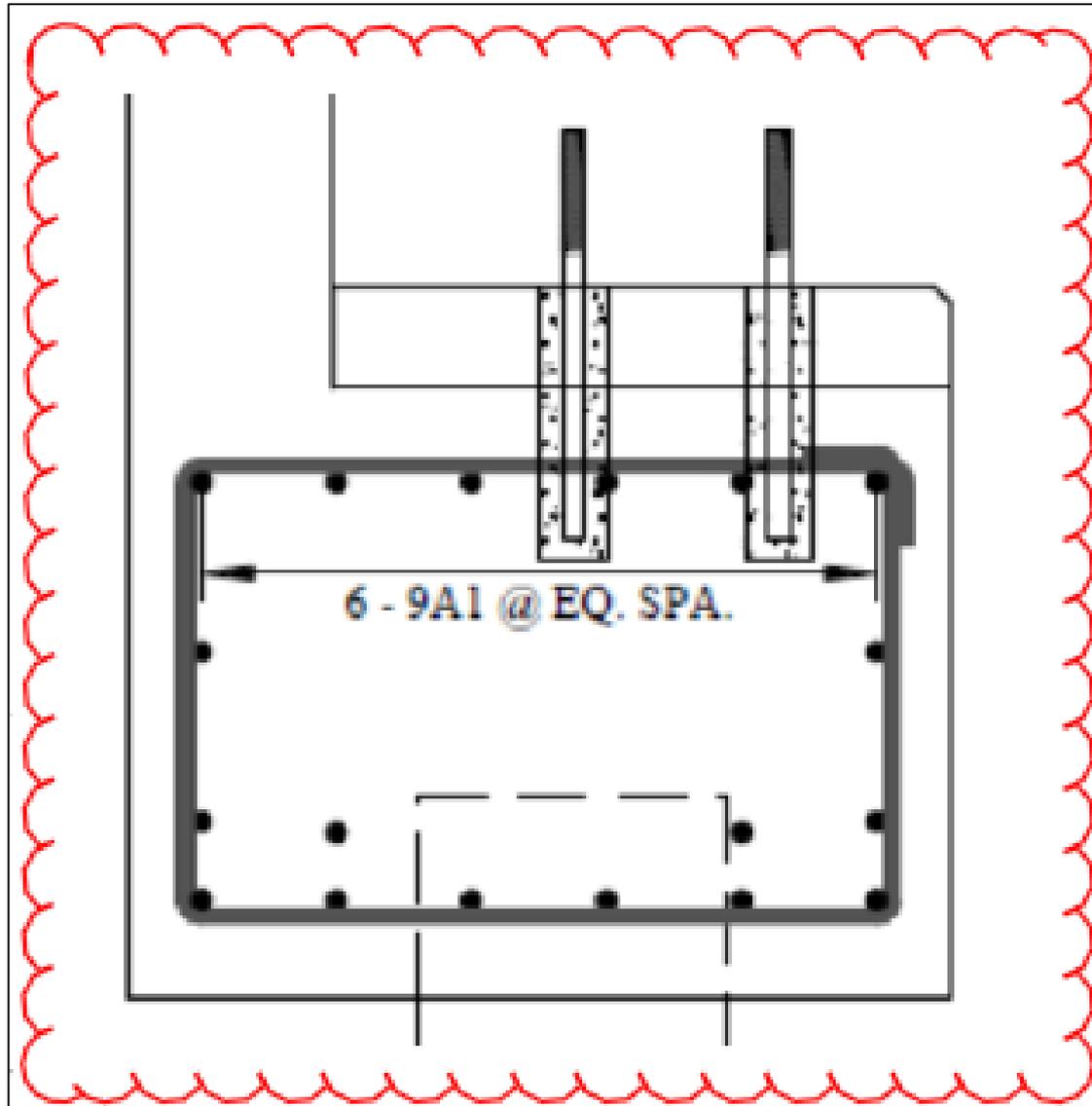
Leware - Issue #3



Leware - Issue #3



Leware - Issue #3



Leware - Issue #3 - Recommendations

- ◆ EOR should locate the anchor bolts & anchor bolt sleeves on the cap detail sheets
- ◆ Reinforcing steel should be spaced accordingly
- ◆ Sleeves should be sized to allow for proper grout cover on anchor bolts

EJM – Issue #3

- ◆ Intersection Reconstruction vs. Overbuild
 - ✓ When intersections elevations are raised
 - ✓ When moderate to heavy traffic
 - ✓ Avoid reconstruction & opt for overbuild
 - ✓ Less expensive in long run due to time savings
 - ✓ Much less impact on traffic

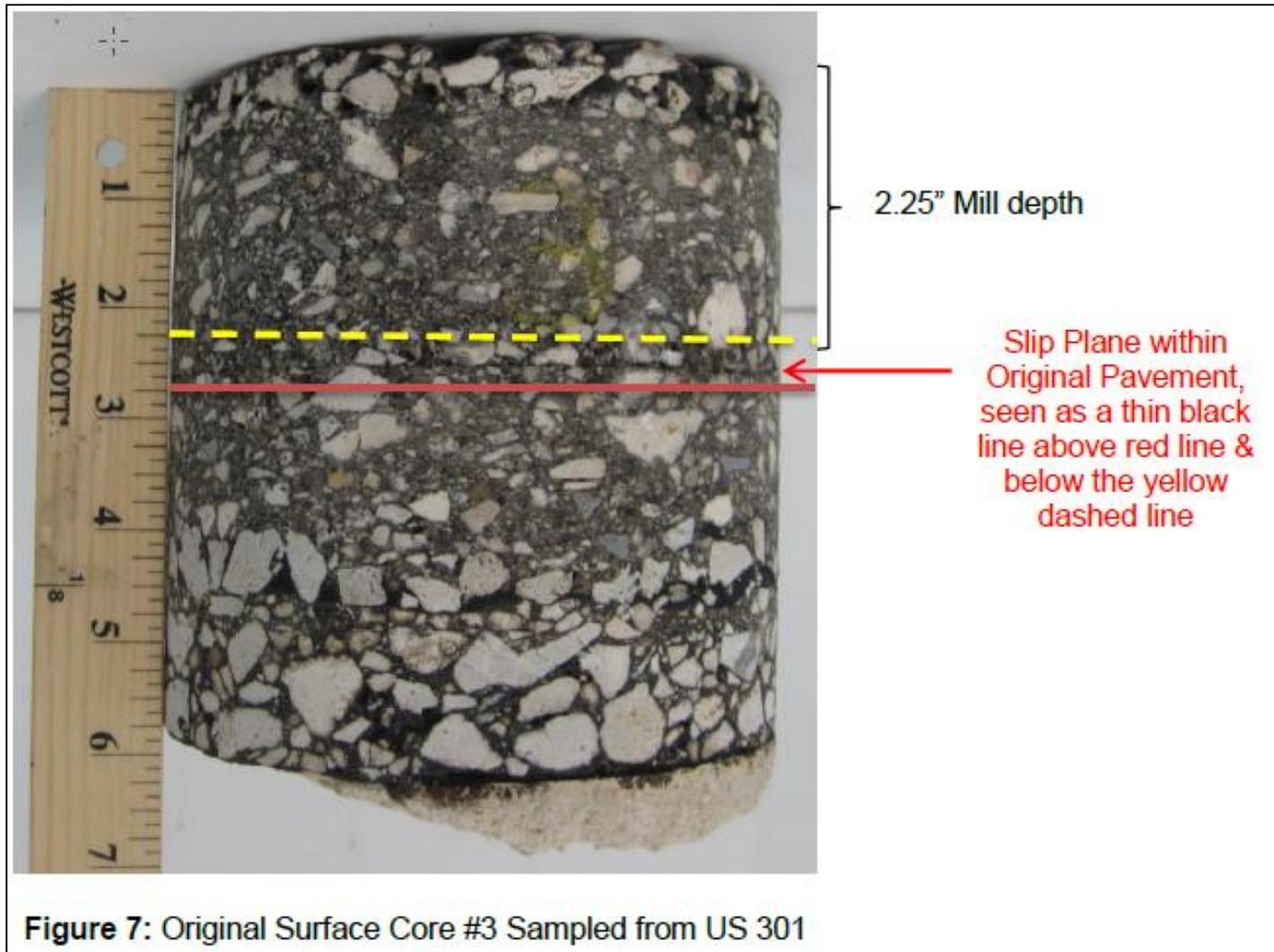
AJAX Paving – Issue #4

- ◆ Thin layer of existing lift remained after milling lead to slippage of pavement after new lifts were placed

AJAX Paving – Issue #4



AJAX Paving – Issue #4



AJAX Paving – Issue #4

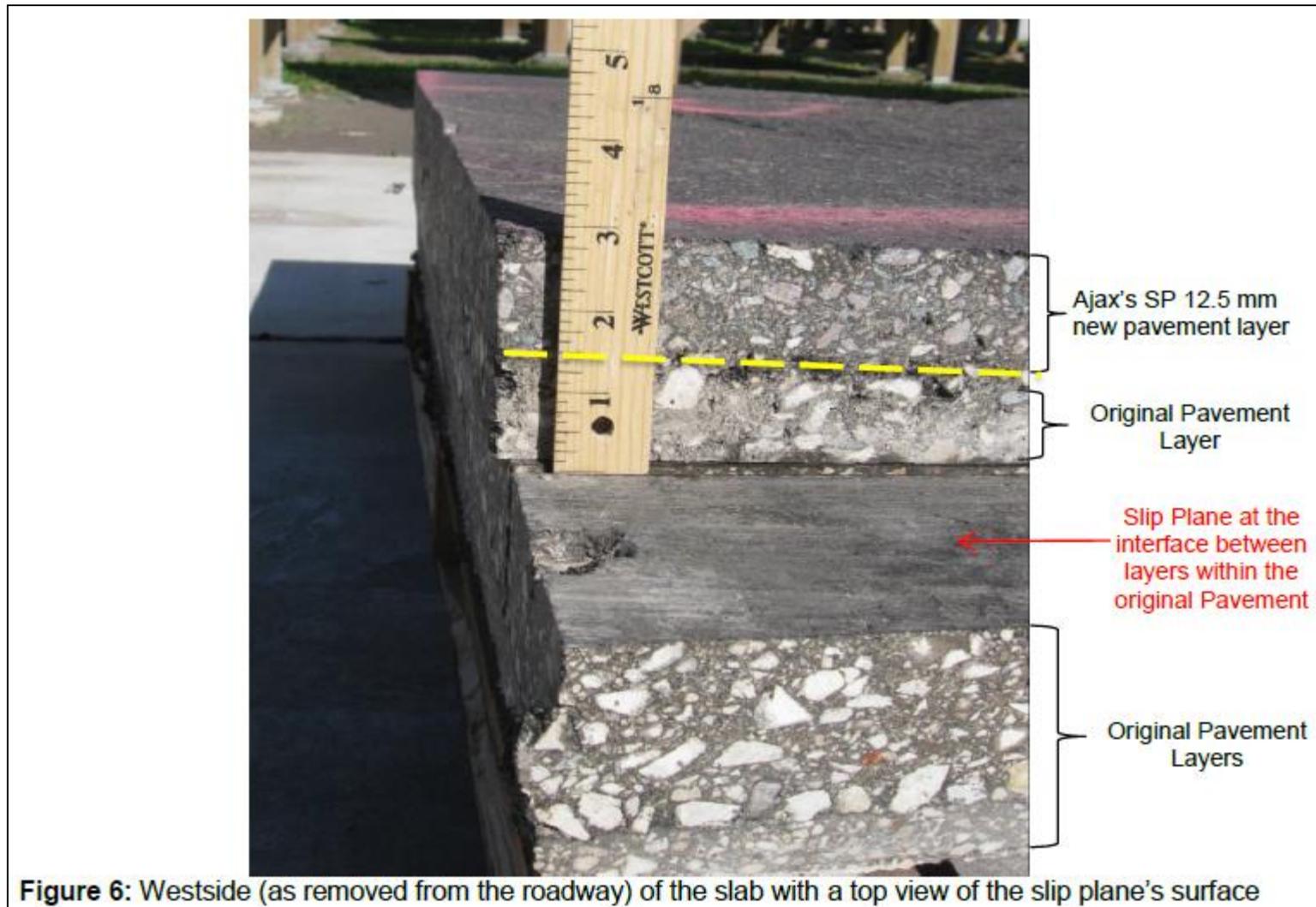


Figure 6: Westside (as removed from the roadway) of the slab with a top view of the slip plane's surface

AJAX Paving – Issue #4 - Recommendations

- ◆ Mill entire layer out

OR

- ◆ Leave enough thickness of an existing layer to remain to prevent slippage

D.A.B. - Issue #4

- ◆ Station equation occurs 67 feet from beginning of project
- ◆ Station equations, while needed in some cases, create confusion on the project and additional paperwork and tracking. They draw attention from more important issues.

D.A.B. - Issue #4

BEGIN PROJECT FPID NO. 424792-1-52-01
STA. 1199+32.45

1 foot station equation 67 feet
into the project limits.
Can this be moved to the end of
the project?

BEGIN GUARDRAIL
STA. 1193+77.58

BEGIN CABLE BARRIER
STA. 1185+50.00, 12' RT.

EQUATION:
1199+98.19 BK =
1199+99.44 AH

HILLSBOROUGH C
PASCO COUNTY

D.A.B. Issue - #4 - Recommendation

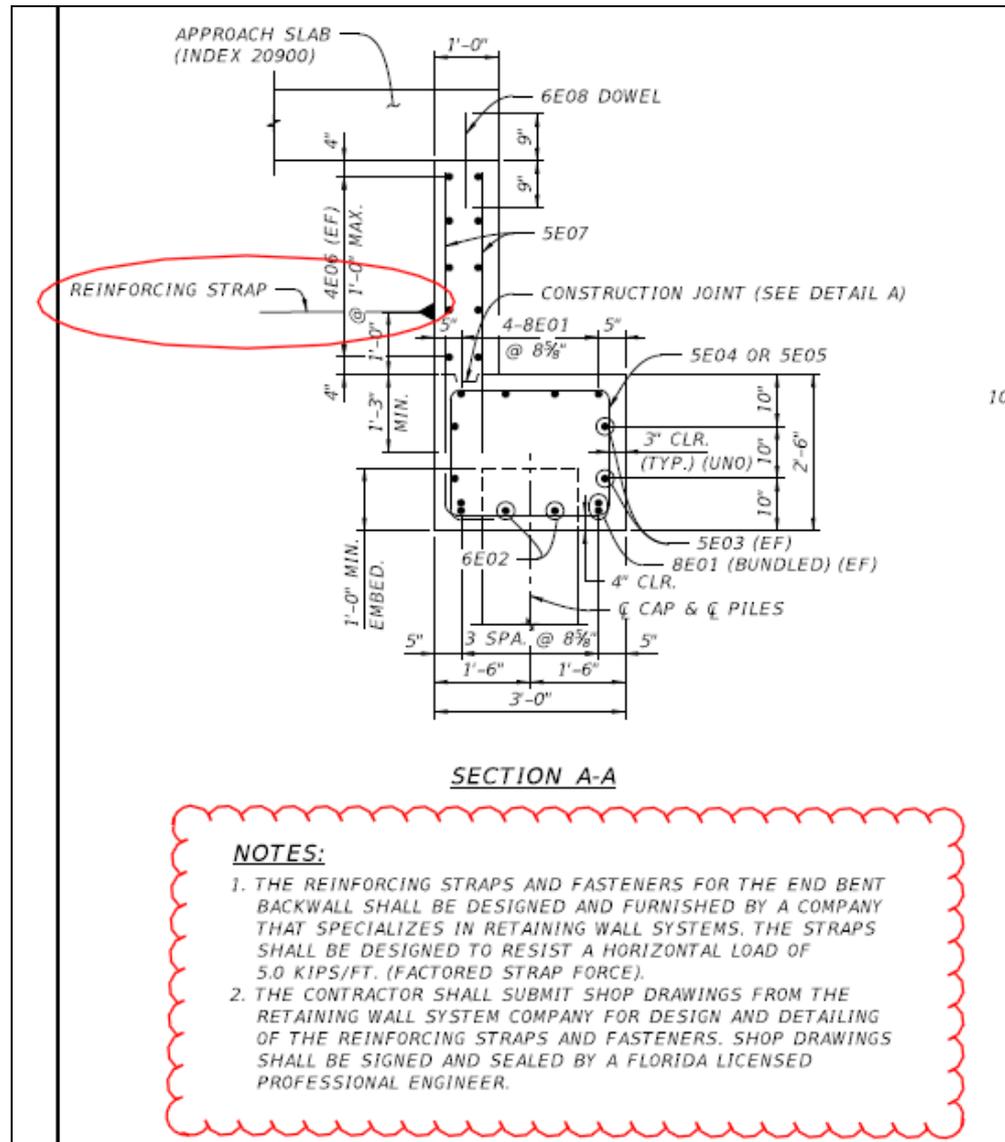
- ◆ Eliminate as many as possible
- ◆ If needed, move to project limits if possible

Leware - Issue #4

◆ Issue:

- ✓ Reinforcing straps to resist horizontal loads shown on widening projects originally constructed with sloped embankments
- ✓ Plan note requires that the material is designed and furnished by a company that specializes in MSE wall systems
- ✓ MSE wall companies decline to design & furnish minimal materials for isolated applications

Leware #4 - Issue #4



NOTES:

1. THE REINFORCING STRAPS AND FASTENERS FOR THE END BENT BACKWALL SHALL BE DESIGNED AND FURNISHED BY A COMPANY THAT SPECIALIZES IN RETAINING WALL SYSTEMS. THE STRAPS SHALL BE DESIGNED TO RESIST A HORIZONTAL LOAD OF 5.0 KIPS/FT. (FACTORED STRAP FORCE).
2. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FROM THE RETAINING WALL SYSTEM COMPANY FOR DESIGN AND DETAILING OF THE REINFORCING STRAPS AND FASTENERS. SHOP DRAWINGS SHALL BE SIGNED AND SEALED BY A FLORIDA LICENSED PROFESSIONAL ENGINEER.

Leware - Issue #4

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Leware #4 - Recommendations

- ◆ EOR should analyze existing end bent to determine amount of horizontal load provided for widening through existing battered piling & through the doweled construction joint
- ◆ EOR could specify batter on new piles or design a dead-man anchor to handle horizontal loads

EJM - Issue #4

- ◆ Earthwork Balancing Across TCP Phases
 - ✓ Overall job may balance, but not within phases, or
 - ✓ Job may have surplus, but not obtained until later phase

EJM - Issue #4



EJM - Issue #4



EJM – Issue #4 - Recommendations

- ◆ Ideally – job balances and each phase balances
 - ✓ highly optimistic & rare
- ◆ Next best – surplus from initial phase
- ◆ Worst – need borrow in initial phase, but have surplus in last phase

EJM – Issue #5 & Recommendation

- ◆ Erosion Control Features & Devices
 - ✓ Although contractor responsible for site specific plan, features & devices limited to what is included in pay items
 - ✓ Contractor only gets paid for what they use
- ◆ Recommendation
 - ✓ Review site specific details & allow several pay item options to be utilized

EJM – Issue #5



04/26/2010

EJM – Issue #5



EJM – Issue #5



Questions & Comments