I-4 Ultimate
Traffic Design Challenges

SIGNING, ITS, SIGNALS & LIGHTING

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System-wide Traffic Lead

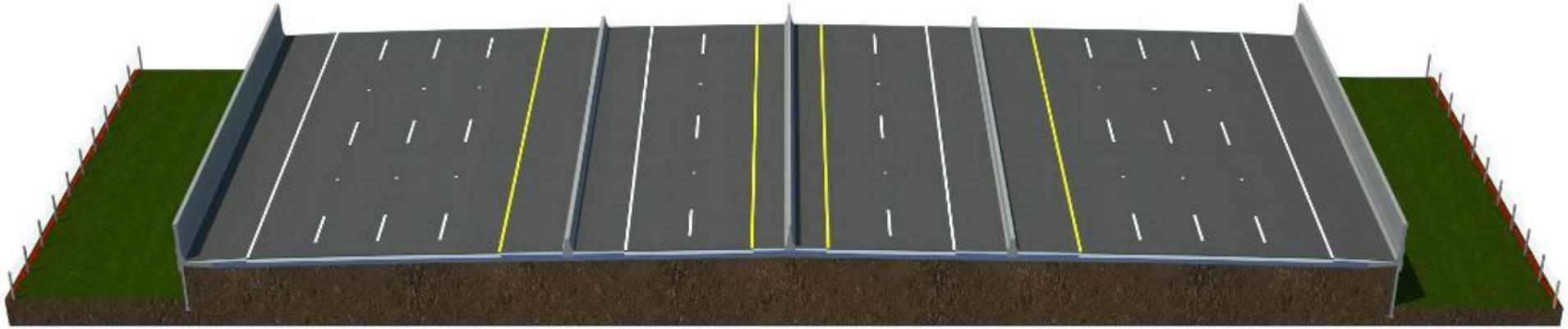
November 2, 2017

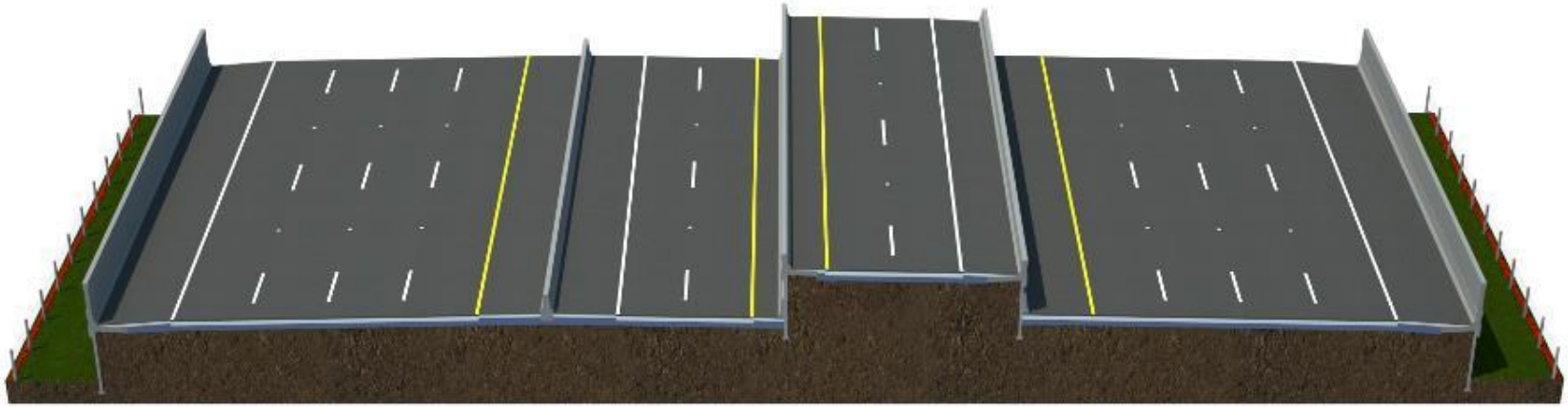
Purpose of Presentation:

- Design Challenges- Tight Urban Interstate
- Interstate & Express Lanes Signing & ITS
- 3 Highway Agencies (L/A facilities)
- Lessons Learned

Layout of I-4 Ultimate

- **70% Elevated**
  - **Viaduct & High Fill Segments Supported by MSEW**
  - **The largest public-private partnership (P3) in the United States to date and the largest transportation project in Florida history.**





I-4 Ultimate Encompasses:

- 3 System Interchanges
- 18 Service Interchanges
  (Includes 5 Split Urban Diamond Interchanges in Downtown)
- Average Interchange Spacing = 1 per mile

Project ÷ 4 Major Areas:

- **Each area comprised of multiple construction packages**
  - **I-4 Design Manager**
  - **4 Area Design Mangers (ADM)**
    - Relied on System-wide Discipline Leads
  - **Most Accelerated Design Periods**
    - Simultaneous components submittal except bridges

I-4 ULTIMATE

4 EXPRESS

FDOT

Moving-4-ward.com

I-4 ULTIMATE

4 EXPRESS

FDOT

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I-4 ULTIMATE

4 EXPRESS

FDOT

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Signing & ITS for Free & Toll Lanes:

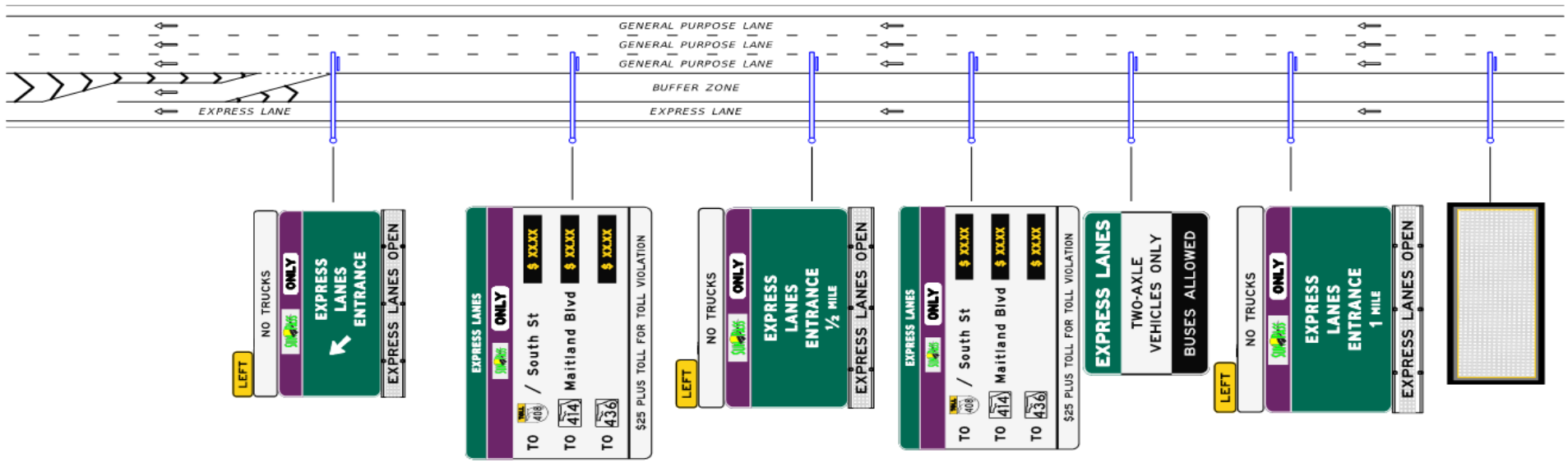
- Major Overhead Guide Sign @ 400’ average
- Limiting Factors:
  - Interchange Density
  - Location of Access Points to & from EL

Guide Signs & Preferential Lanes Signing for Free & Toll Lanes:

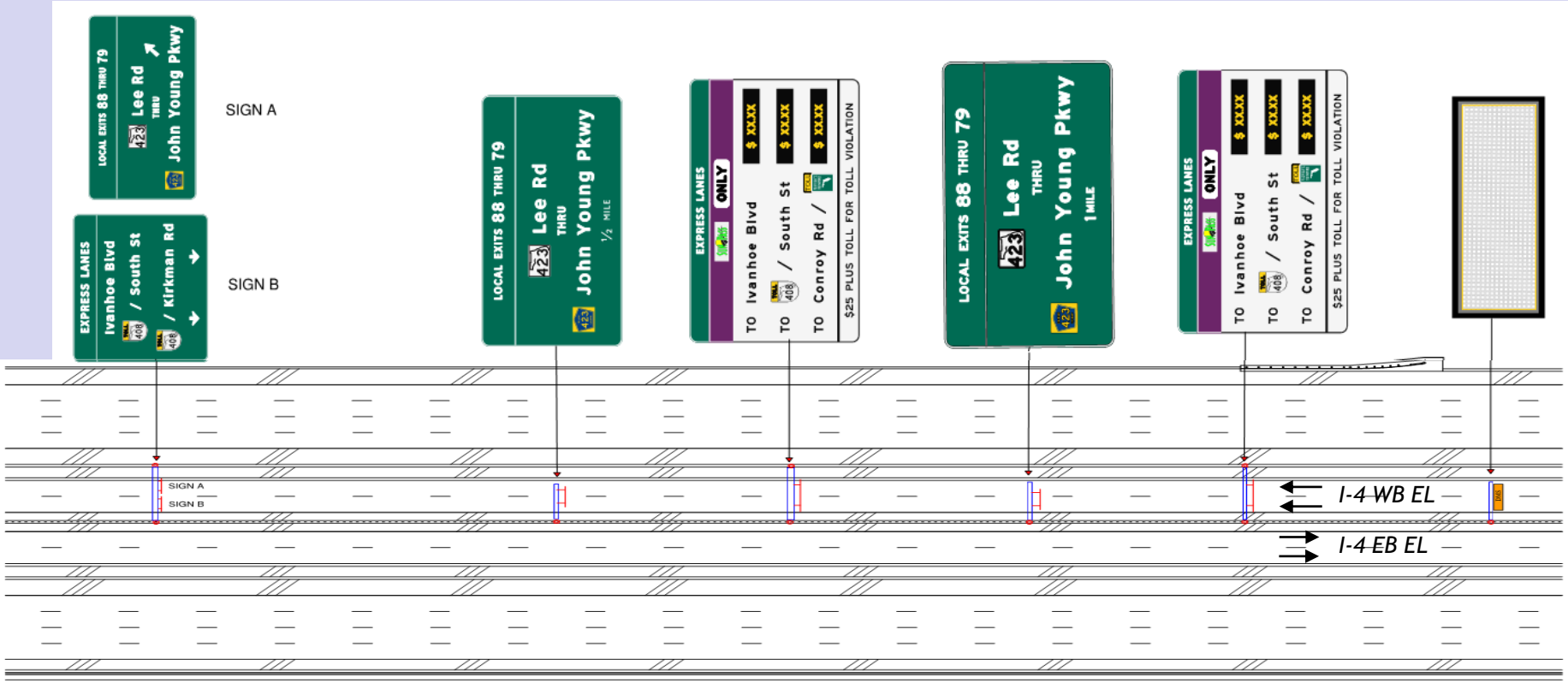
- 15 major guide signs in 1.25 miles = 1 Sign /440’

Signing for Toll Lanes:

- Intermediate Entry



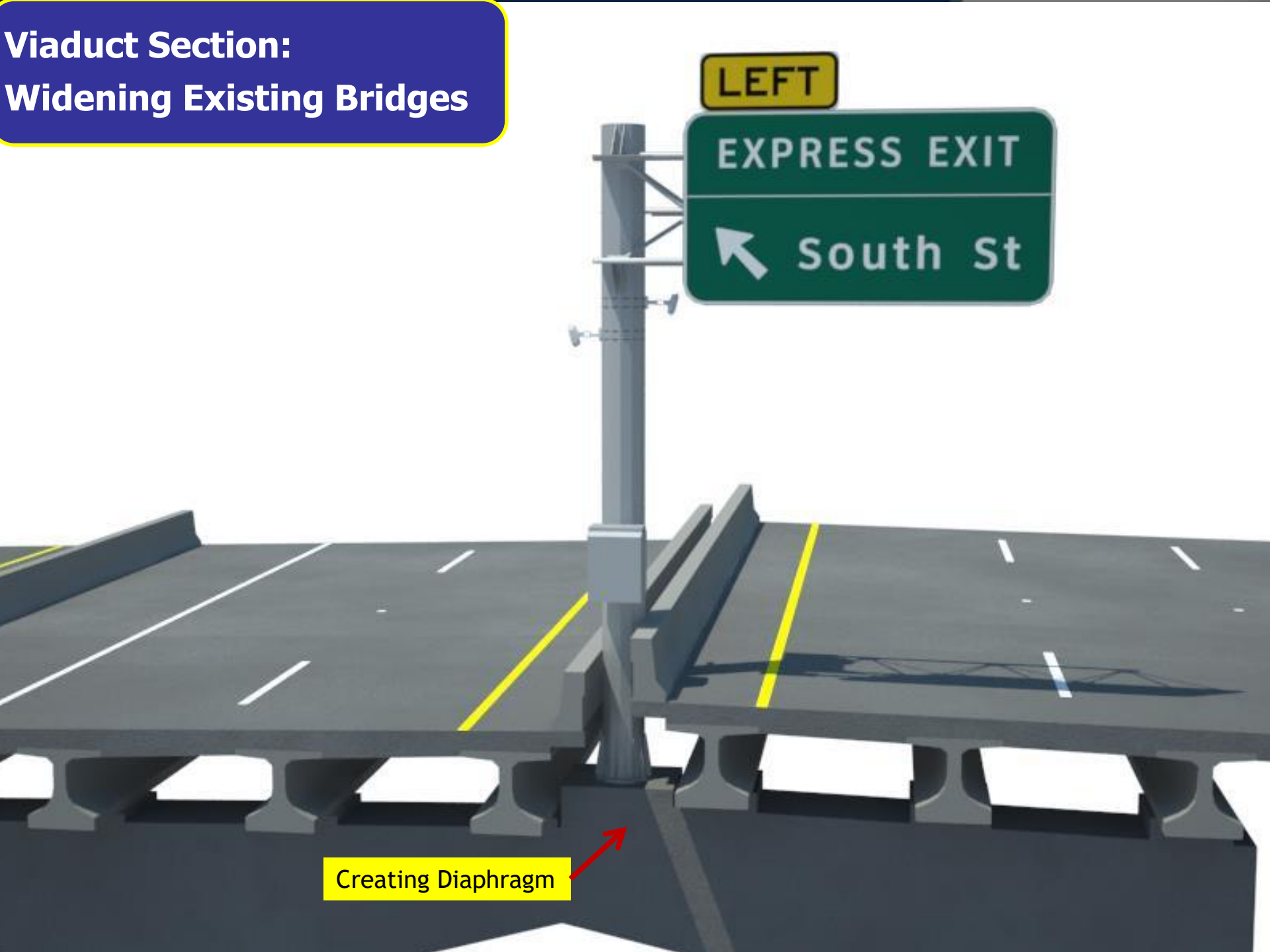
Inside Express Lanes:

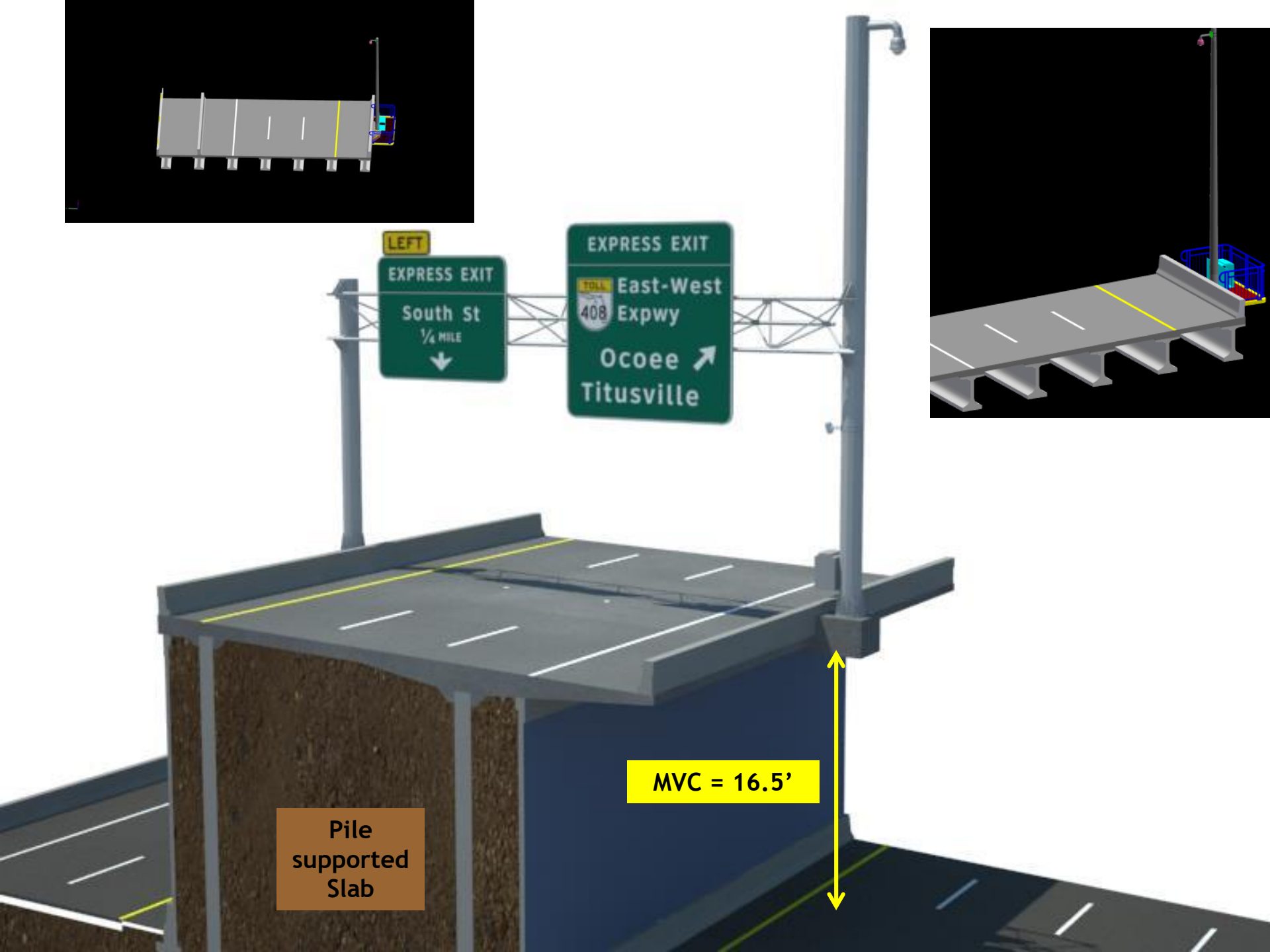


1 Arrow Per Lane Sign @ Decision Point

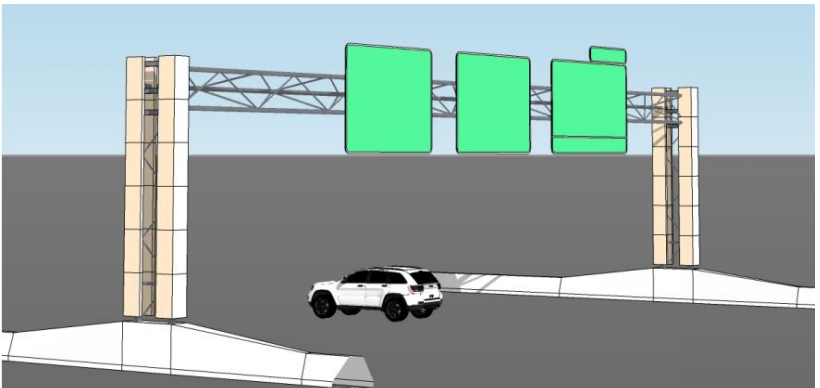
Drilled shaft is inside the fill back of MSEW

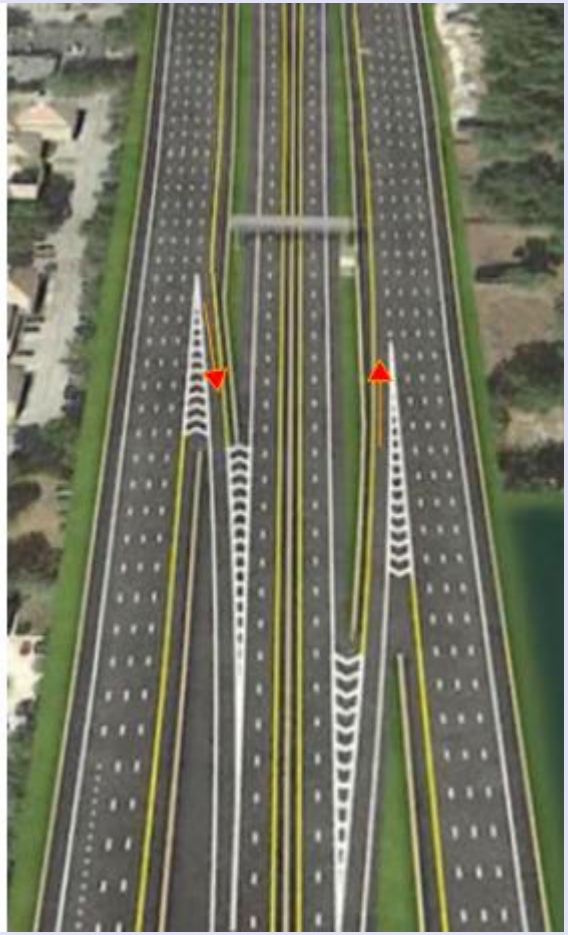
Viaduct Section:
Widening Existing Bridges




LEFT
EXPRESS EXIT
South St
¼ MILE
EXPRESS EXIT
408
East-West
Expwy
Ocoee
Titusville
MVC = 16.5’
Pile
supported
Slab

EXIT 84B
50 WEST
Colonial Dr
½ MILE
EXIT 84A
Amelia St
50 EAST
Colonial Dr
NEXT RIGHT
Creating Diaphragm





Direct Access Points from GPL to EL

Eastbound Direction: 4 Ingress Points
Westbound Direction: 4 Ingress points

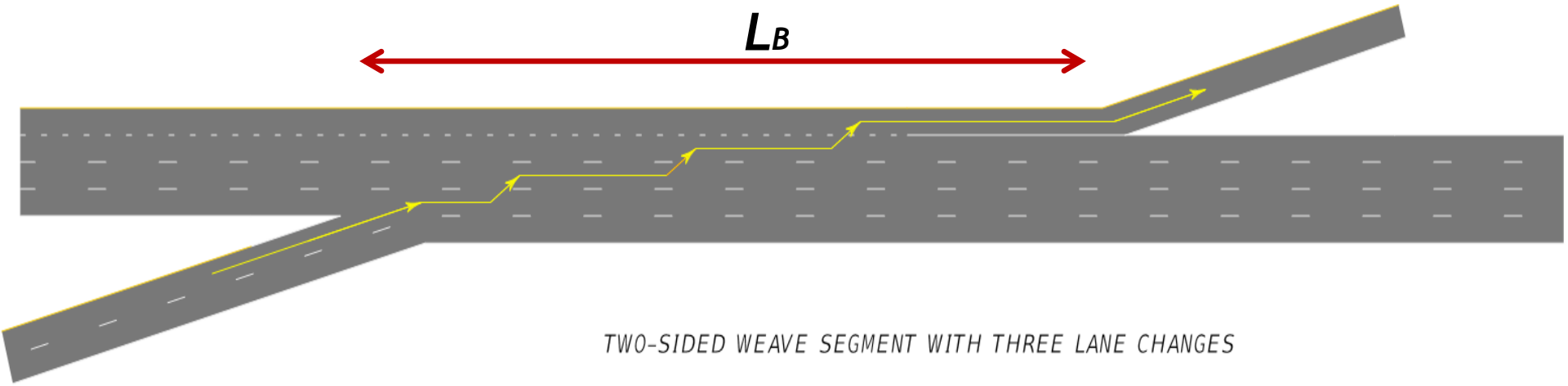
Total Main Entry Points from GPL to EL = 8

Average: 1 Main Entry Point / 5 ¼ Miles

Direct Access Points from Crossroads to EL

Weave Distances-Ingress & Egress Points

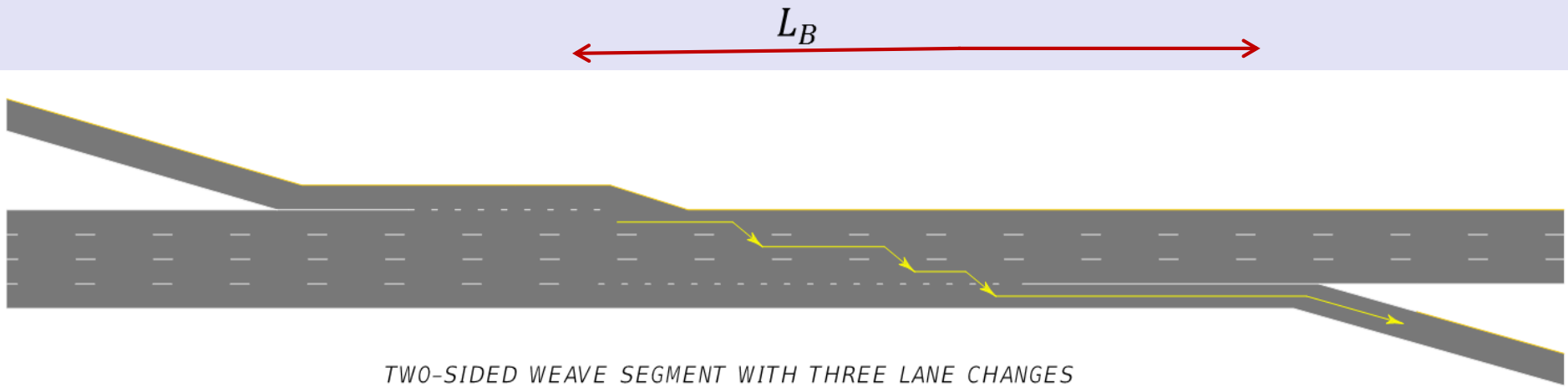
- HCM 6th Edition: 23 Equations to get the results



$N_{WL} = 3$

Weave Distances-Ingress & Egress Points

- HCM 6th Edition: 23 Equations to get the results



$N_{WL} = 3$

Weave Distances-Ingress & Egress Points

- HCM 6th Edition: 23 Equations to get the results

$$L_{MAX} = \left[5728 * (1 + VR)^{1.6}\right] - \left[1566 * N_{WL}\right]$$

$$LCW = LCMIN + 0.39[(LS - 300)^{0.5} N (1 + ID)^{0.8}]$$

$$LC_{NW1} = (0.206 * v_{NW}) + (0.542 * L_S) - (192.6 * N)$$

$$LC_{NW2} = 2{,}135 + 0.223(v_{NW} - 2{,}000)$$

$$I_{NW} = \frac{L_S * ID * v_{NW}}{10{,}000}$$

Then:

$$LC_{NW} = LC_{NW1} \quad \text{if } I_{NW} \le 1{,}300$$

$$LC_{NW} = LC_{NW2} \quad \text{if } I_{NW} \ge 1{,}950$$

$$LC_{NW} = LC_{NW1} + (LC_{NW2} - LC_{NW1}) * \left(\frac{I_{NW} - 1300}{650}\right)$$

$$\text{if } 1{,}300 < I_{NW} < 1{,}950$$

$$LC_{ALL} = LC_W + LC_{NW}$$

$$S_W = 15 + \left(\frac{FFS - 15}{1 + W}\right)$$

$$W = 0.226 * \left(\frac{LC_{ALL}}{L_S}\right)^{0.789}$$

$$S_{NW} = FFS - (0.0072 * LC_{MN}) - (0.0048 * v/N)$$

$$S = \frac{V_W + V_{NW}}{\left(\frac{V_W}{S_W}\right) + \left(\frac{V_{NW}}{S_{NW}}\right)}$$

$$D = \frac{v/N}{S}$$

LOS	Density (pc/mi/ln)	
	Freeway Weaving Sections	Weaving Sections on C-D Roadways or Multilane Highways
A	0 – 10	0 – 12
B	>10 – 20	> 12 – 24
C	> 20 – 28	> 24 – 32
D	> 28 – 35	> 32 – 36
E	> 35	> 36
F	v/c > 1.00	

Weave Distances-Ingress & Egress Points

- **Managed Lanes Modeling - TTI**

Design Year Volume Level	Allow up to 10 mph Mainlane Speed Reduction for Managed Lane Weaving ?	Intermediate Ramp (between freeway entrance/exit and managed lanes entrance/exit) ?	Recommended Minimum Weaving Distance Per Lane (feet)
Medium (LOS C or D)	Yes	No	500
		Yes	600
	No	No	700
		Yes	750
High (LOS E or F)	Yes	No	600
		Yes	650
	No	No	900
		Yes	950

Note: The provided weaving distances are appropriate for freeway vehicle mixes with up to 10 percent heavy vehicles; higher percentages of heavy vehicles will require increasing the per lane weaving distance. The value used should be based on engineering judgment, though a maximum of an additional 250 feet per lane is suggested.

Target LOS → High (LOS E or F) → No → Yes → 950

AASHTO : 1500' / Lane

All I-4 weave distance between ML & Intermediated Interchange EN-EX & EX-EN, EX-EX met the minimum weave distance.

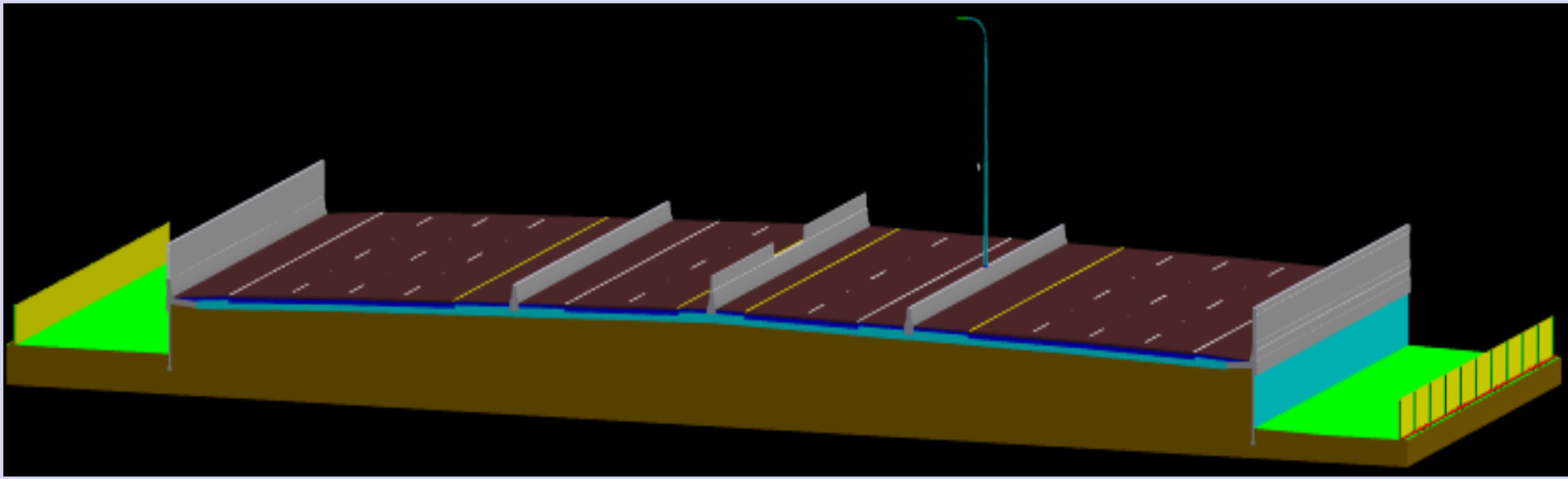
ITS Subsystems

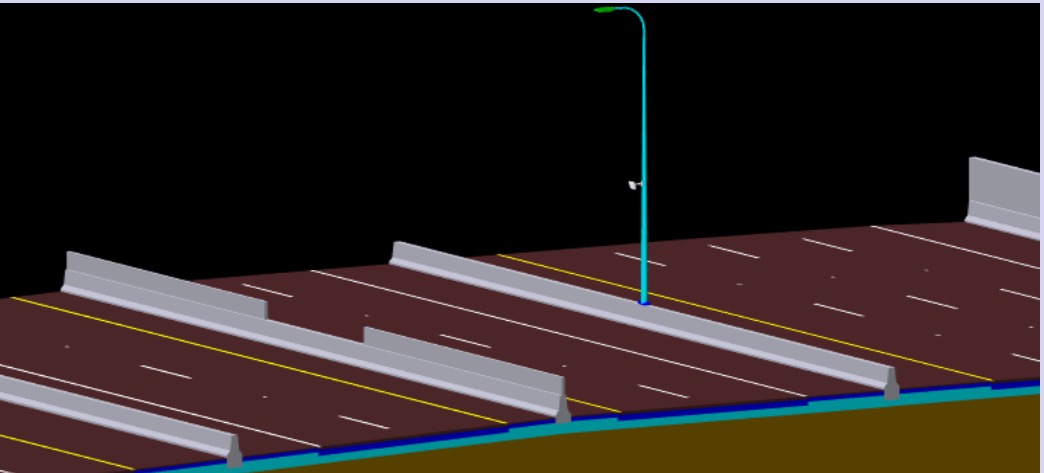
- DMS (Walk-in)
- DMS (Non-Walk-in)
- EL Status DMS
- Toll DMS
- CCTV (Freeway)
- Verification CCTV (Toll and Status Signs)
- Pedestrian tunnel (Security)
- MVDS (GPL and EL separated)
- RSS
- Emergency Access Gates
- Tolling Points
- Communication (Self-healing Ring Topology)
- Power Substations

ITS Device Co-Location

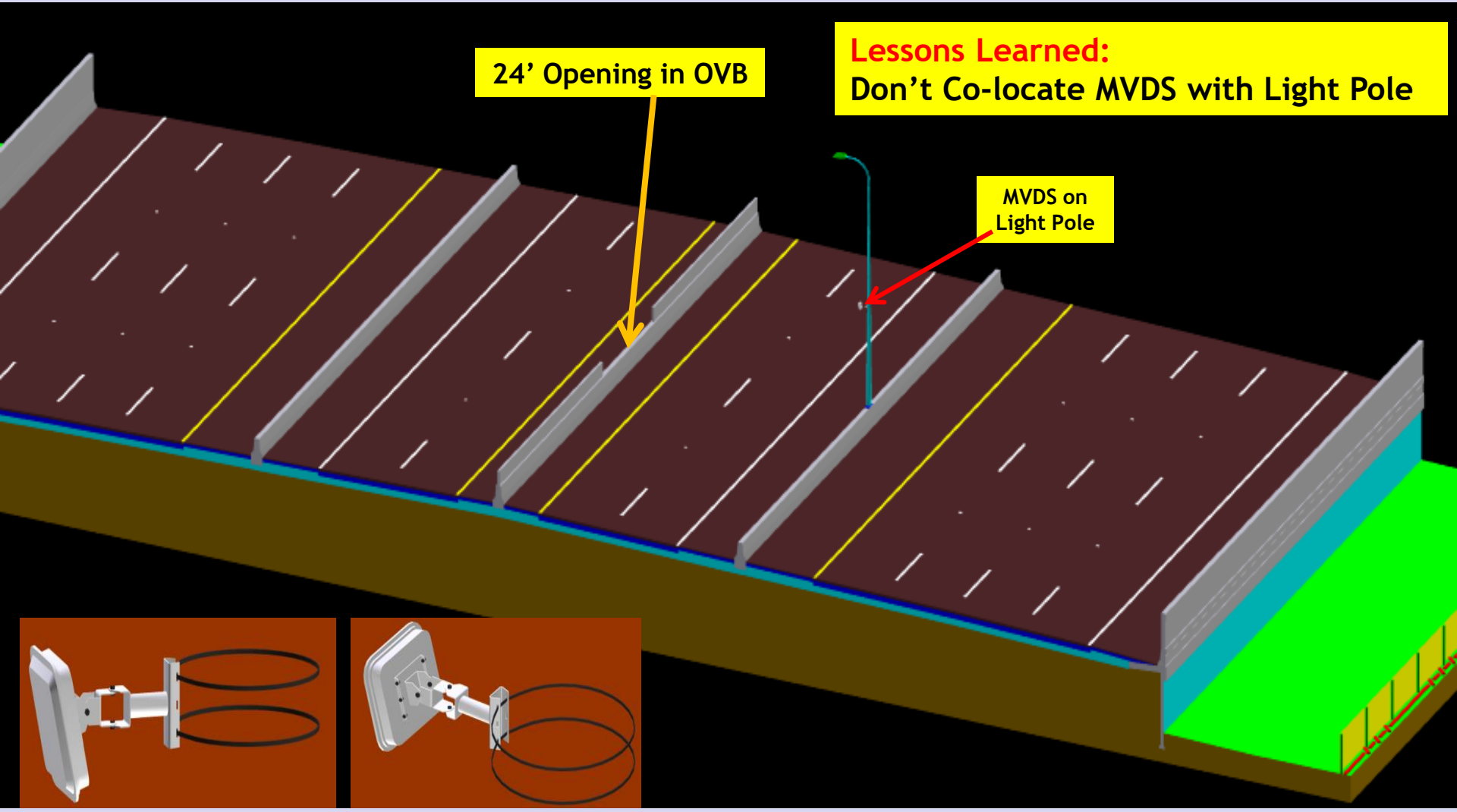
- Challenges in Bifurcated (independent) Segments
- Too many standalone support structures if not co-locating with sign structures capturing full coverage

ITS Device Co-Location





ITS Device Co-Location



Maintenance Of Communication (MOC)

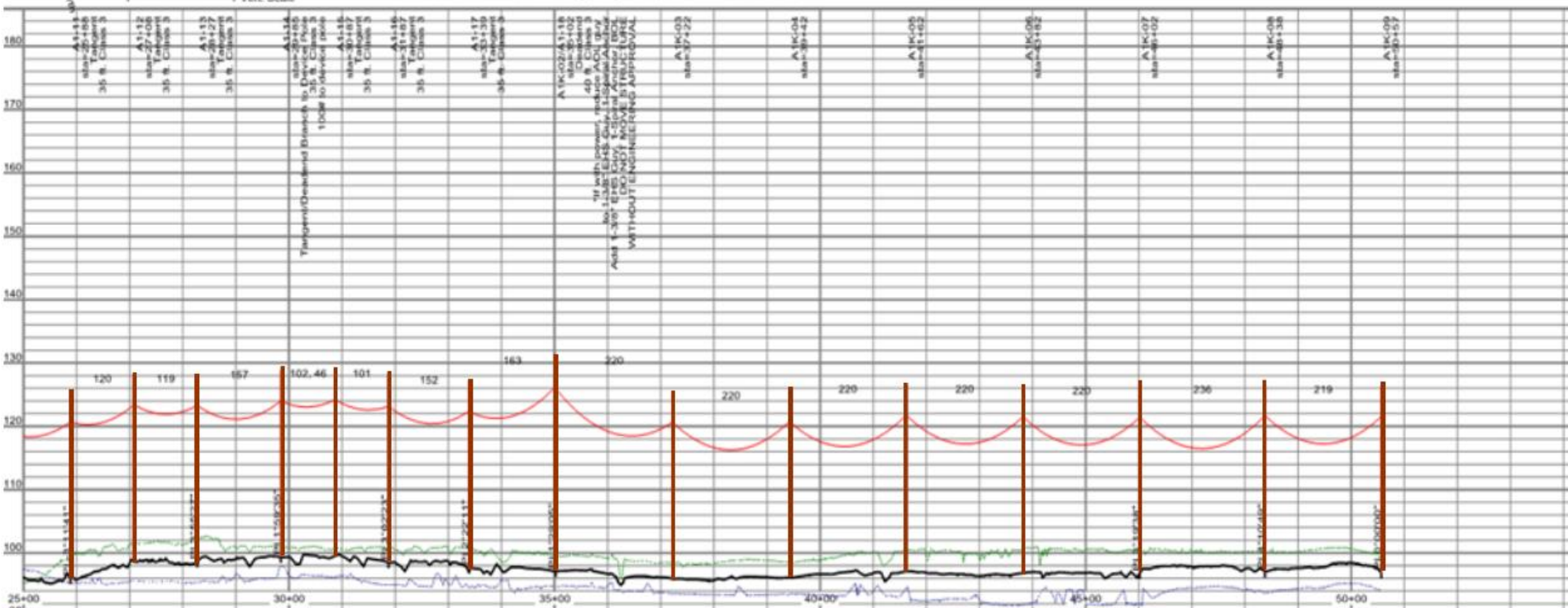
- Technical Requirements: Maintain existing subsystems at all time for all 3 highway owner agencies (D-5, FTE, CFX)
- Abandoned Existing FOC Trunk Line on I-4
- Used temporary wood poles for the length of I-4
- 72 counts of SM FOC overhead
- Used PLS-CADD program to size the support cables and poles
- Developed plans and profiles

All existing aerial cables and other obstructions within ROW should be removed before building these line segme

200.0 ft. Horiz. Scale

20.0 ft. Vert. Scale

DO NOT MOVE ANY STRUCTURE WITHOUT ENGINEERING APPROVAL
*A1K-02 to A1K-09 built during early work, see those P&P's for additional information



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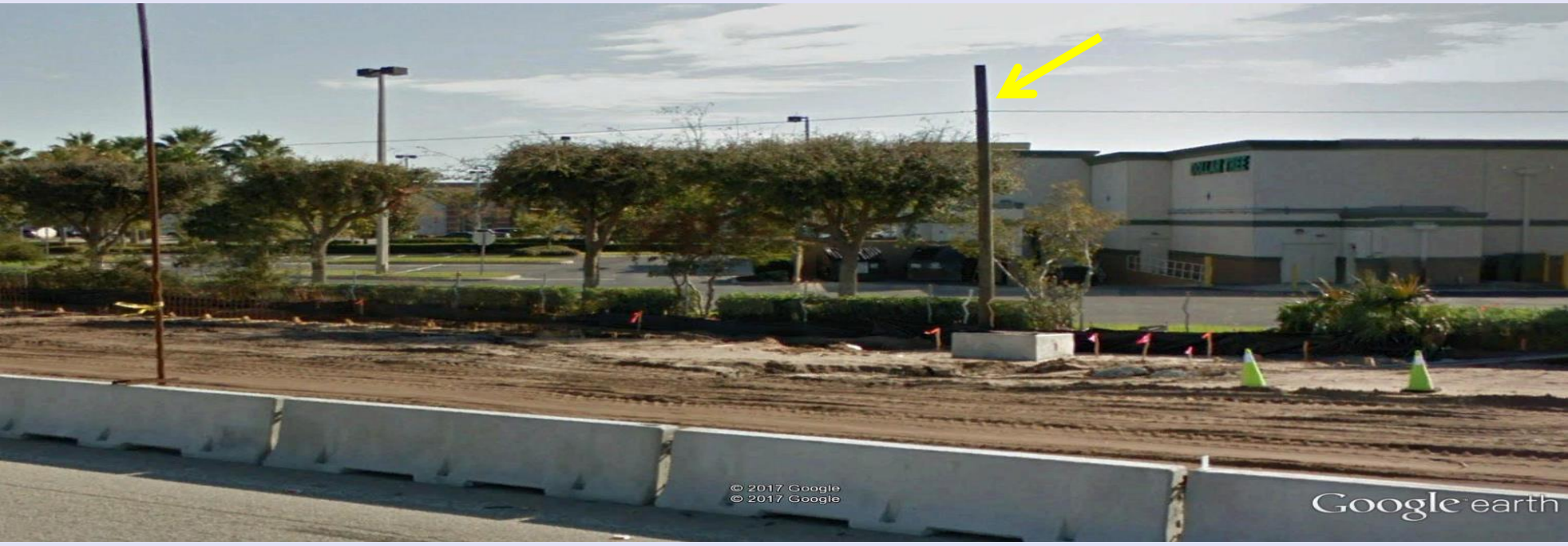
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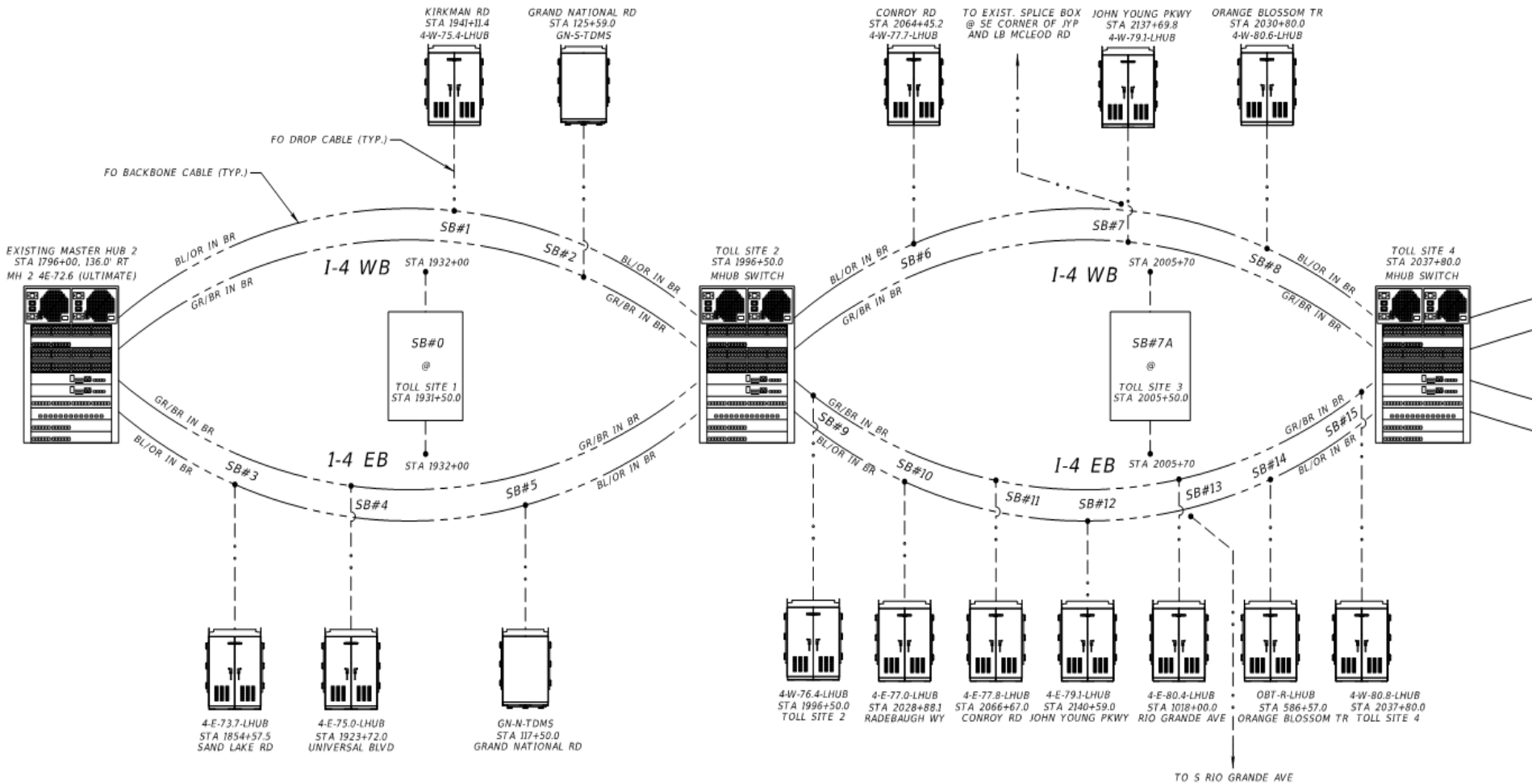
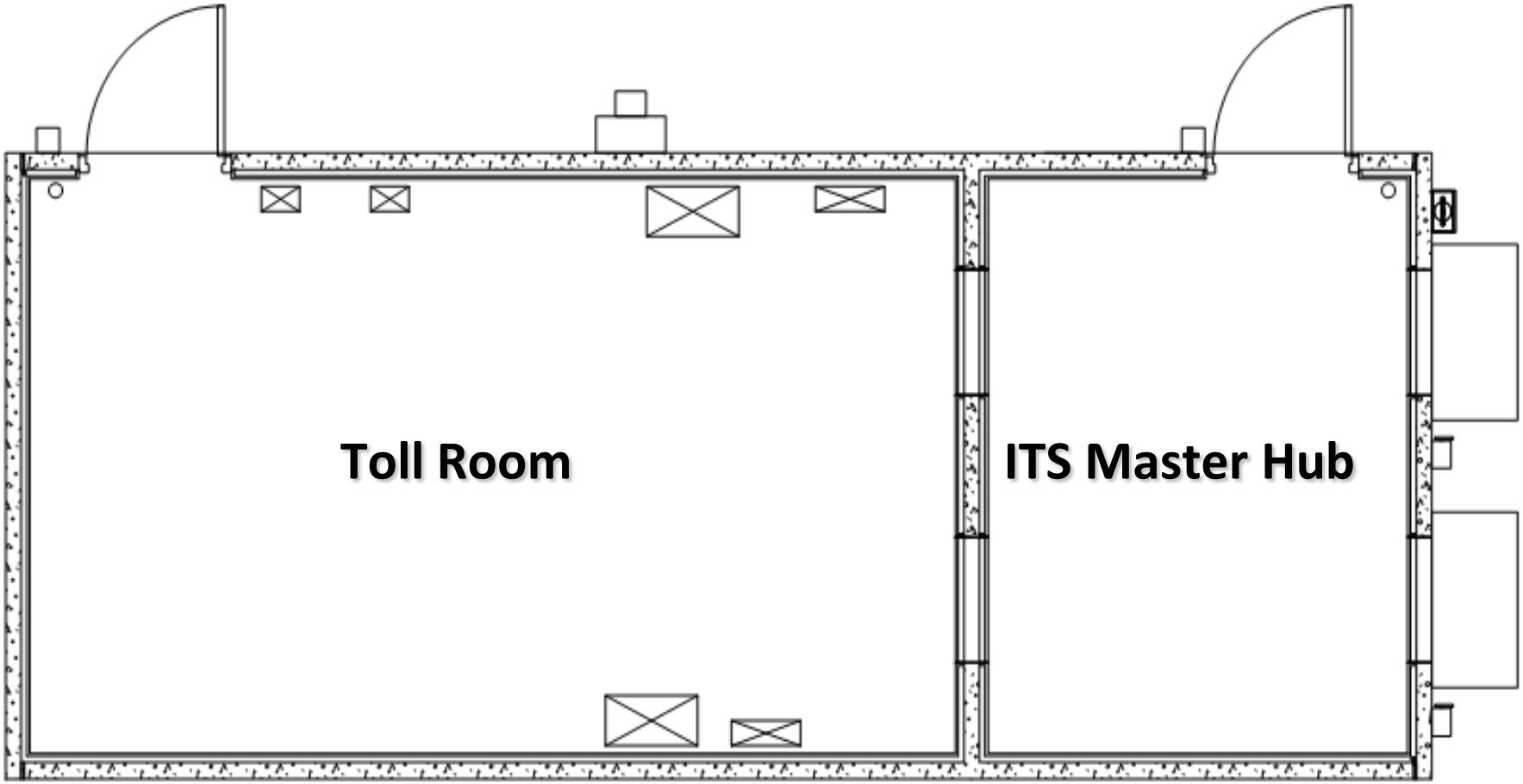
Permanent Communication Topology

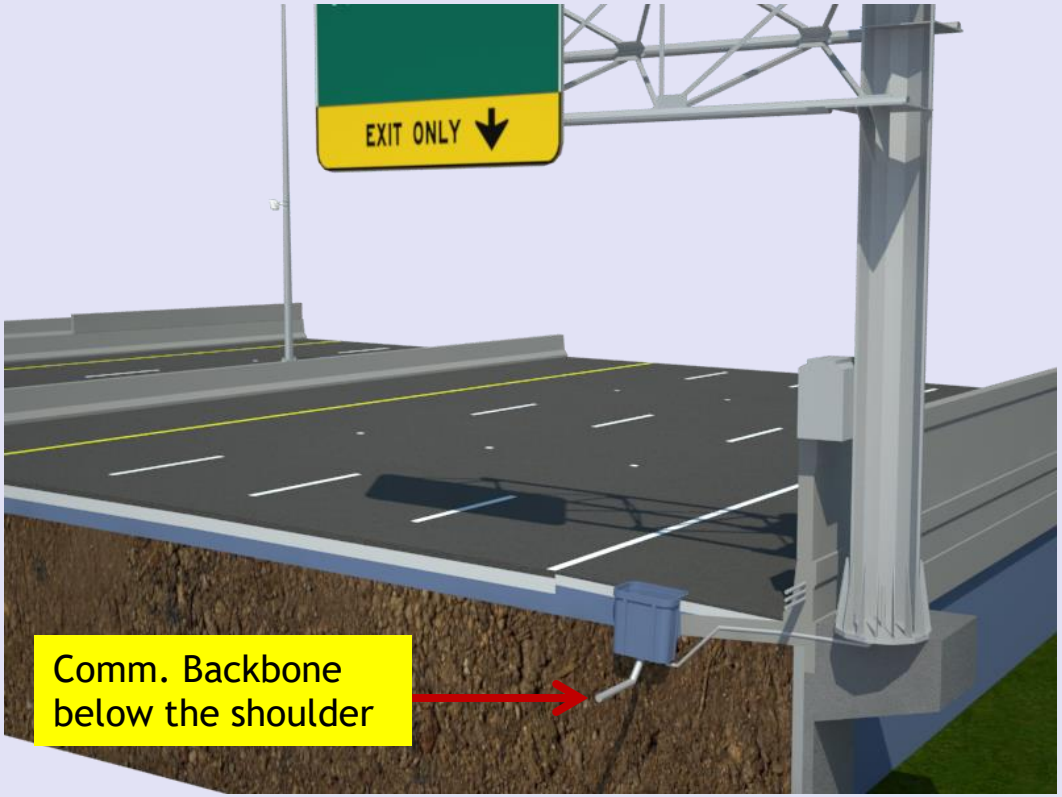


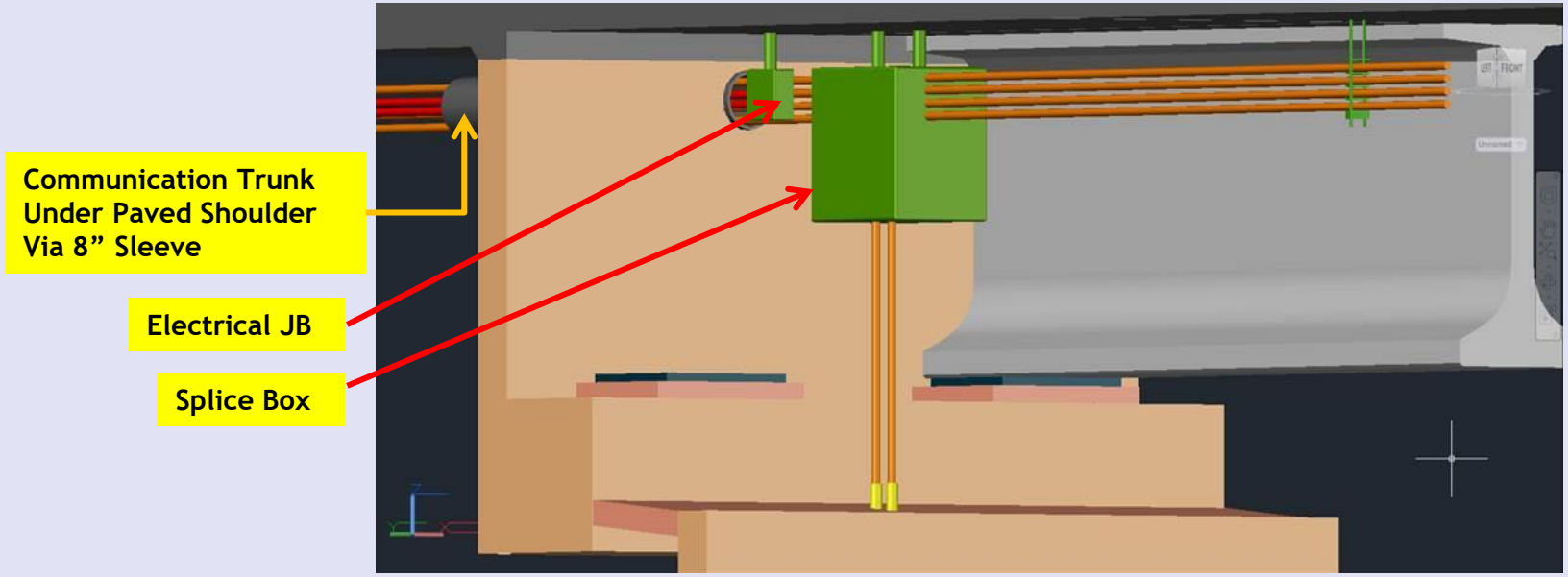
Communication Master Hubs

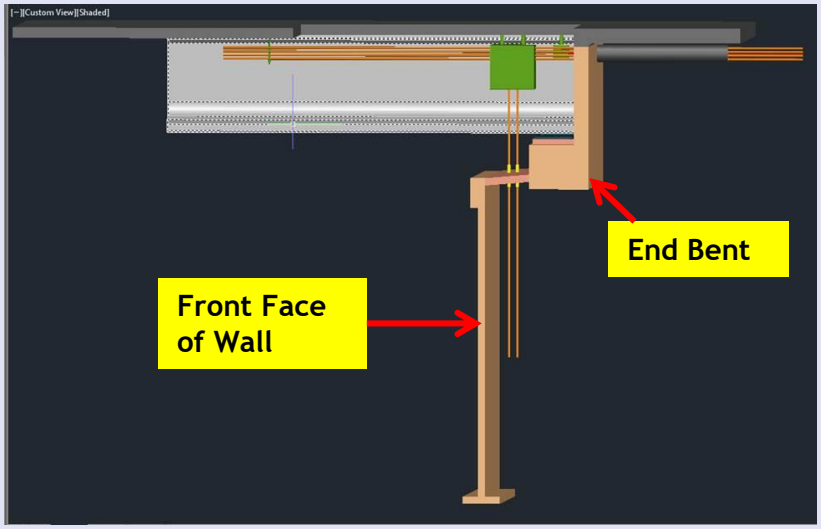
Lessons Learned:
Don't attach the master communication hub to Toll Room



Permanent Communication Locations

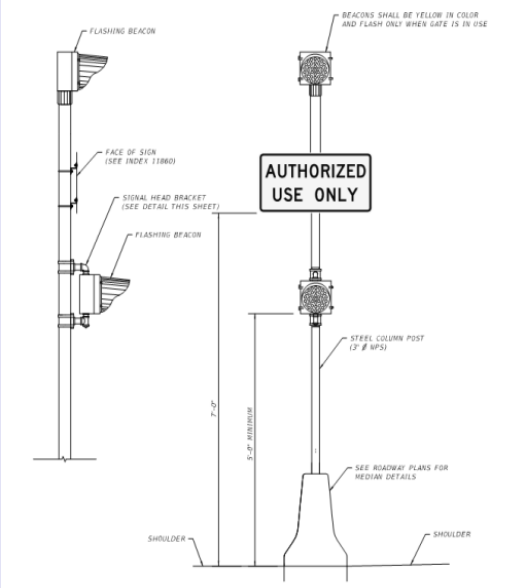


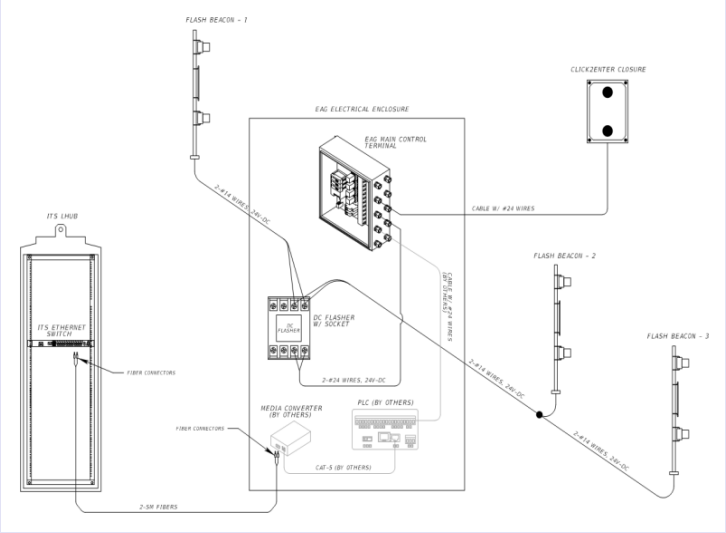

Communication Trunk Under Paved Shoulder Via 8” Sleeve
Electrical JB
Splice Box

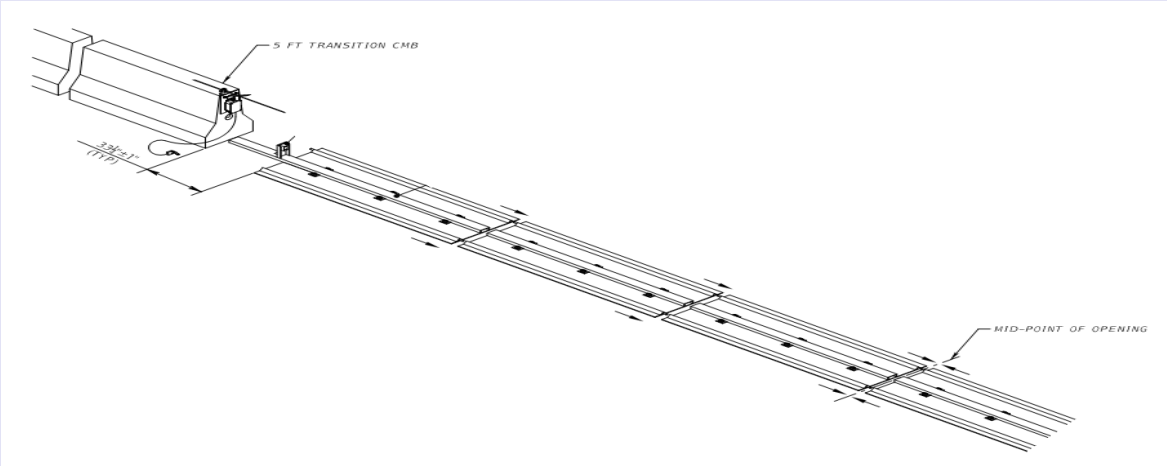

End Bent
Front Face of Wall

Emergency Access Gates

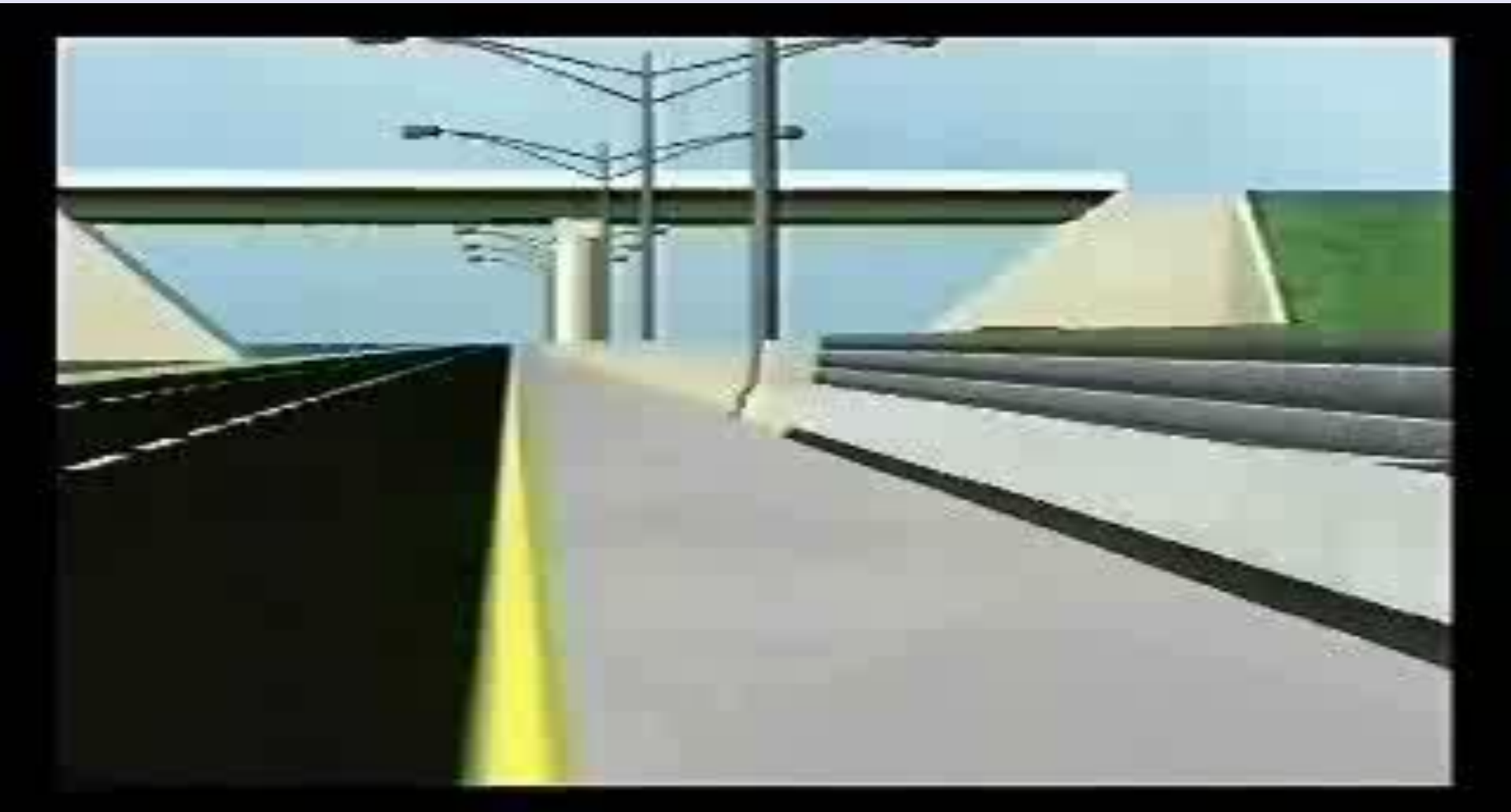
- 10 Locations, Total
- 110 Feet Long Design Envelop
- Controlled Remotely & Manually







EAG



Where Not To Install EAG Envelop

- On Curves
- On tangent-Run-outs & Tangent Run-offs (e_{max})
- Where drainage inlets are proposed
- Approach slabs
- Bridges
- Median barrier wall transitions0

Signal Design & Maintaining Agencies

City Of Orlando

Orange County

Seminole County

City Of Maitland

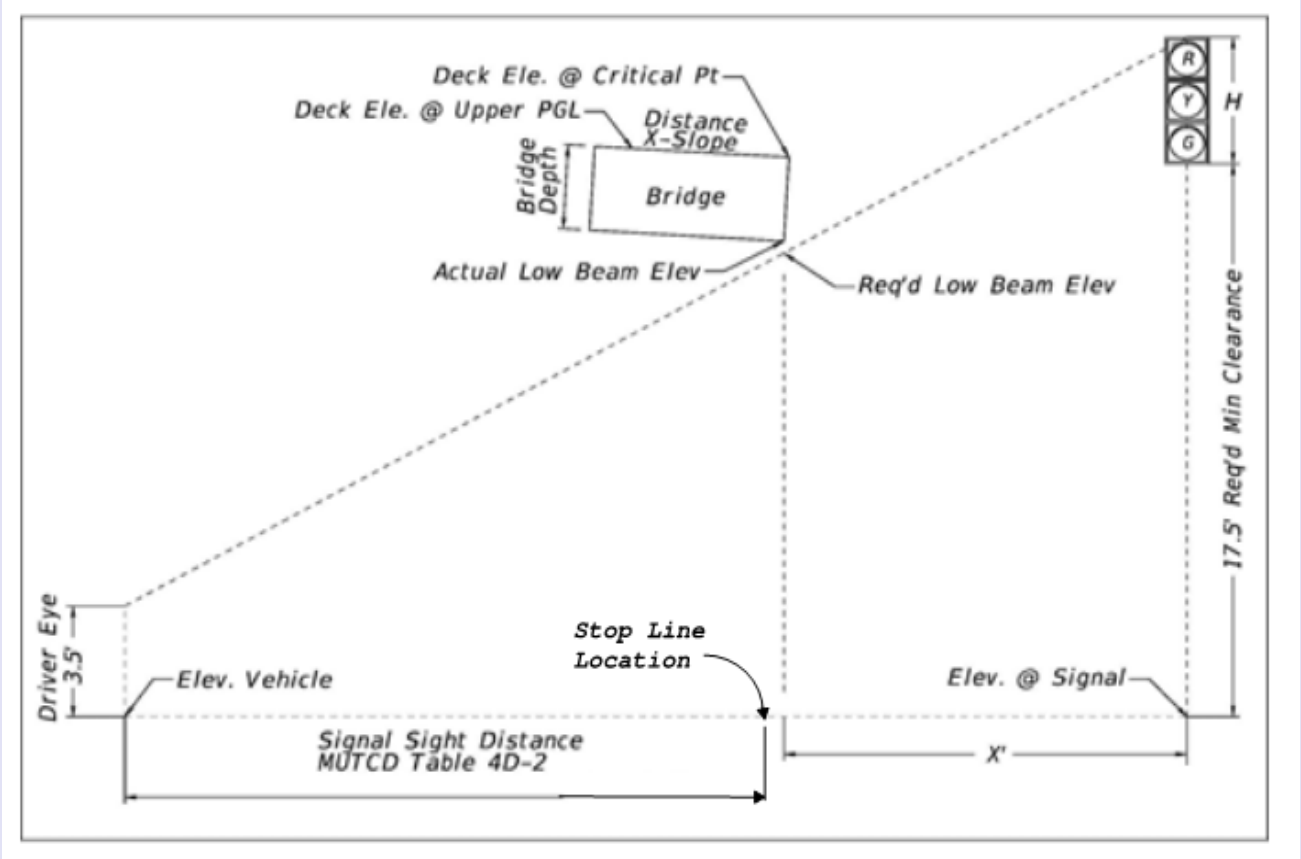
City Of Winter Park

City Of Altamonte Springs

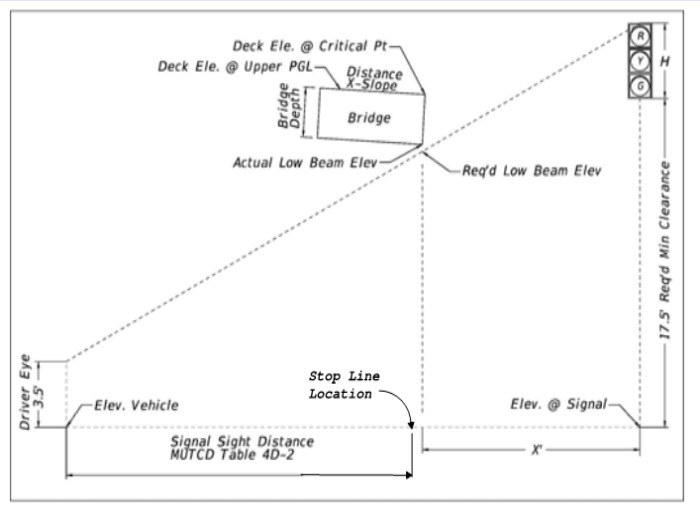
Signal Visibility @ TUDI

1984-1990 ASSHTO Green Book:

d = 100 + 15 (V – 20), Now table 4D-2 of MUTCD



Signal Visibility @ TUDI



Design Speed (mph) =	30	
Signal Sight Distance (ft) =	250.00	
Distance from Stop Line to Signal (ft)	127.50	
X (ft) =	98.00	X = Distance from Signal Head/Sign to Low Bridge Beam
Elev Vehicle =	81.04	Roadway elevation at vehicle
Elev Signal =	81.83	Roadway elevation at minimum signal clearance point
H (ft) =	4.00	H = Height of Signal Head (4'V or 2'H) or Sign (Varies)
Min. Clearance (ft) =	17.50	Standard Min. Vertical Clearance (PPM Tables 2.10.2 and 2.10.3)
Drivers Eye Height (ft) =	3.50	Standard Drivers Eye Height (PPM Tables 2.7.1 and 2.7.2)
Min. Beam Elev =	98.45	Minimum Required Beam Elev at Critical Pt
Upper Rdwy Critical Sta =	2231+13.64	
Upper Rdwy PGL =	107.91	
Cross Slope =	0.030	
Distance (ft) =	59.54	
Deck Elev at Critical Pt =	109.70	
Bridge Depth (ft) =	9.00	Includes Deck Slab Thickness & SIP Forms
Actual Low Beam Elev =	100.70	Actual Beam Elev at Critical Pt
Sufficient Bridge Clearance?	Yes	Excess Bridge Clearance (ft) = 2.24

Aesthetic Lighting

- Ethernet-Based Controller
- Daisy Chain Configuration
- Data Enabler: Integrated data & power to intelligent color and tunable white LED lighting fixtures
- Used I-4 FOC drop to the controller cabinet

Questions?