2015 Design Training Expo

Diamonds In The Rough

Lessons Learned Implementing DDIs

June 10, 2015

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Engineers ■ Architects ■ Planners

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B&N's Experience with DDIs

- **Designed first DDI in Ohio**
  - **Opened to traffic in 2013**
- **Designed first DDI in Indiana; two overall**
  - **Opened to traffic in 2015**
- **Design reviewer of first DDI in Michigan**
  - **DB - Expected to be opened to traffic in 2015**
- **Developed many as PE Alternatives**

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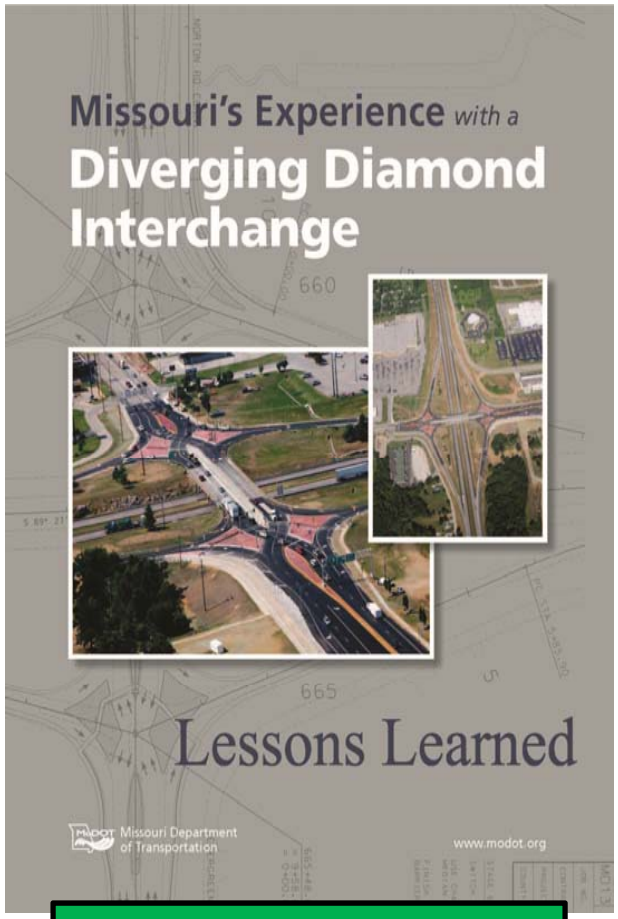
DDI Challenges / Myths

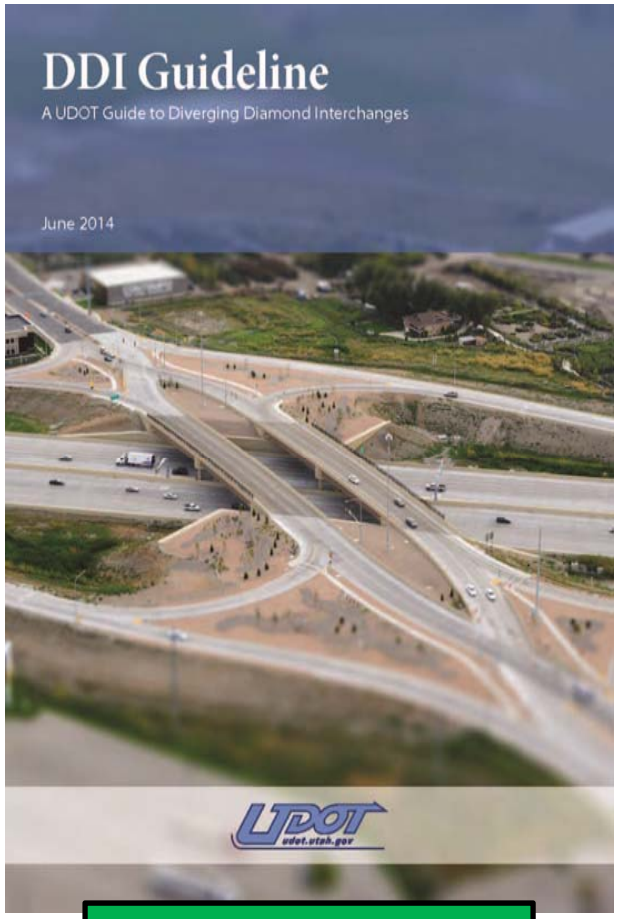
- **Challenges**
  - **Users can't travel from off-ramp to on-ramp in a DDI**
  - **DDIs don't always accommodate heavy opposing thru volumes along arterial well**
  - **DDIs violate driver expectations by placing traffic left of center**
  - **DDIs must be evaluated within the corridor rather than as an isolated solution**

- **Myths**
  - **DDIs are not suitable for high-speed arterials**
  - **DDIs are confusing to navigate**
  - **DDIs are not pedestrian or bike friendly**

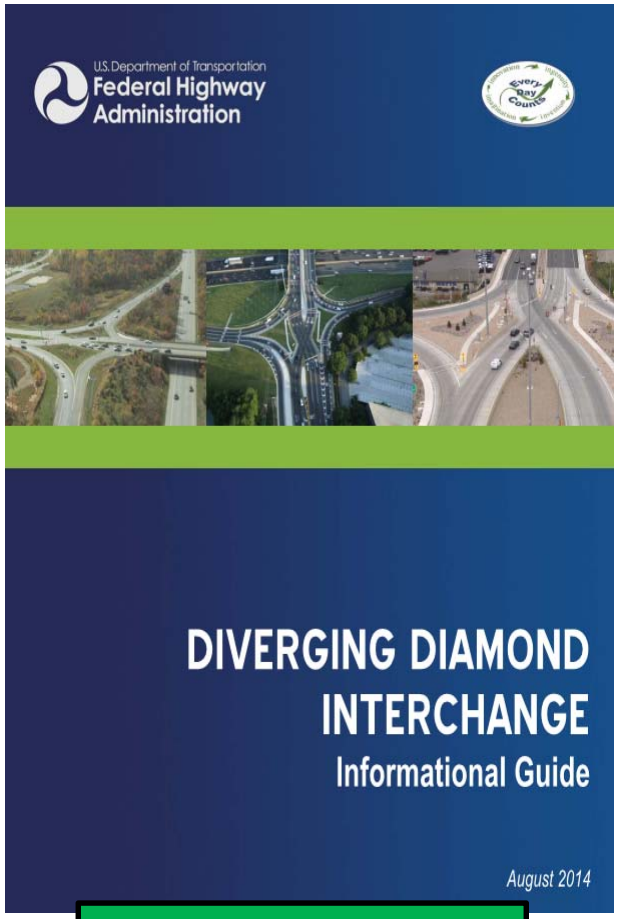
Lessons Learned



Missouri DOT - 2010



Utah DOT - 2014



FHWA - 2014

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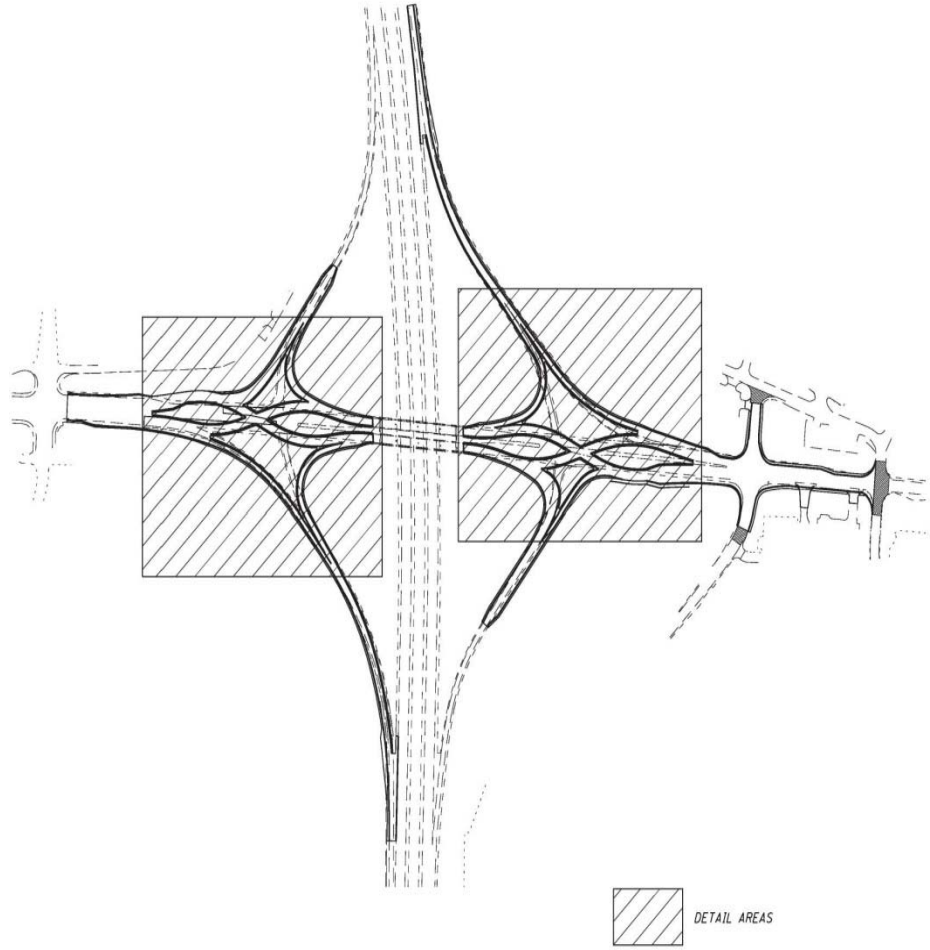
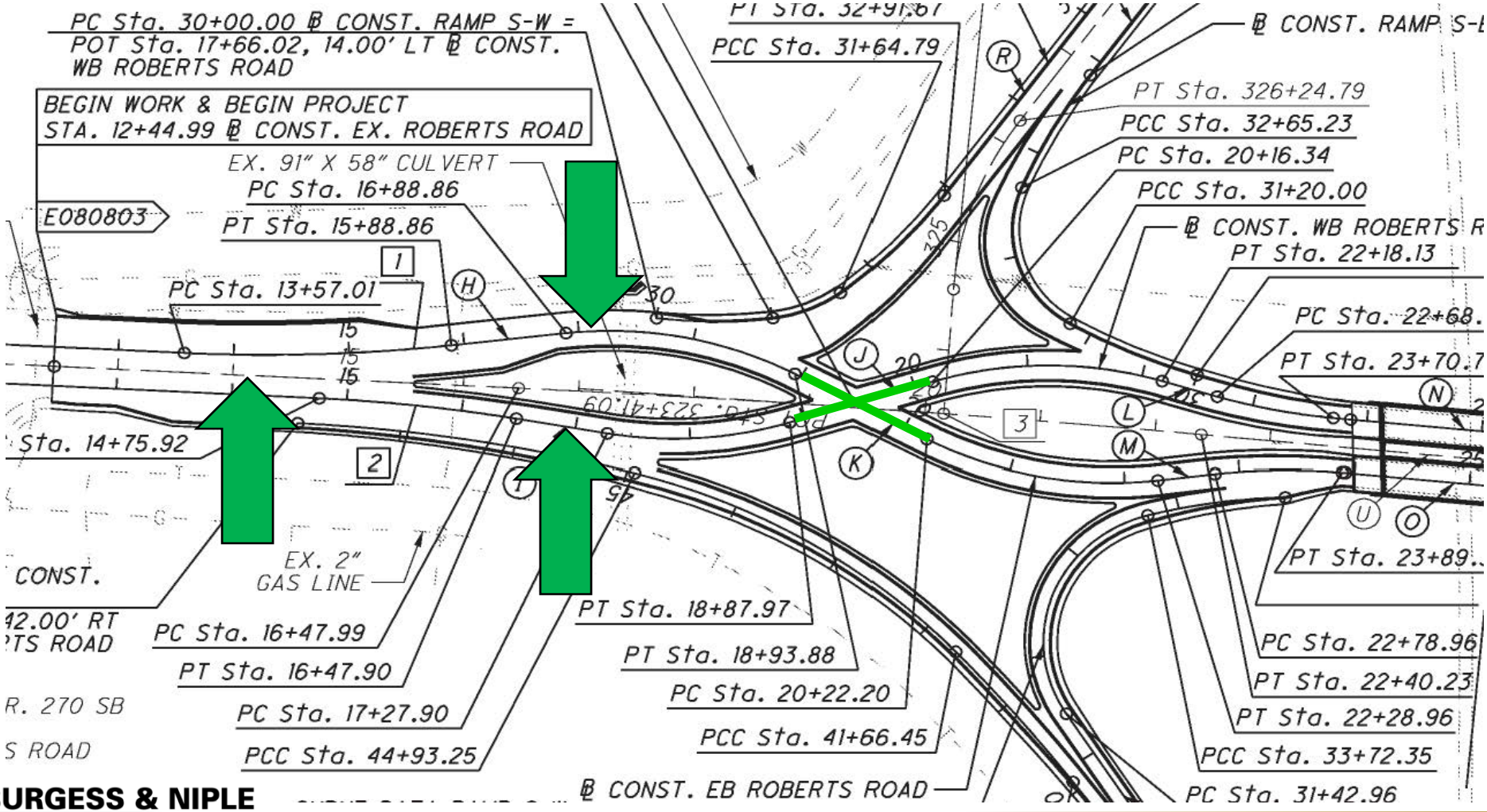
Plan Development – Duplication

THE INFORMATION BELOW IS LISTED IN THE SHEETS AS MARKED IN THIS CHART. SEE THE DETAIL ON THIS SHEET FOR THE LOCATIONS THIS INFORMATION IS INTENDED TO DETAIL.	SCHEMATIC PLAN (3 - 4)	TYPICAL SECTIONS (6 - 20)	PLAN SHEETS (126 - 171)	RAMP SCHEMATIC DETAILS (263 - 264)	SUPERELEVATION TABLES (254 - 262)	INTERSECTION DETAIL (265 - 266)	MEDIAN DETAILS (277 - 278)	GORE DETAILS (269 - 274)	TRAFFIC CONTROL (323 - 337)
BASELINE CURVE DATA	X		X	X					
PAVEMENT TAPERS		X	X						
PAVEMENT WIDTHS		X	X	X		X		X	
STRIPING TAPERS									X
STRIPING WIDTHS									X
CURVE DATA / ℄ OF CONST. AND REFERENCE ℄ STATIONING FOR EDGE OF PAVEMENTS				X					
CURVE DATA / ℄ OF CONST. STATIONING FOR STRIPING									X
ELEVATIONS (EDGE OF PAVEMENT, SHOULDER, FACE OF CURB)					X	X		X	
MEDIAN DETAILS							X		



Plan Development - Baselines



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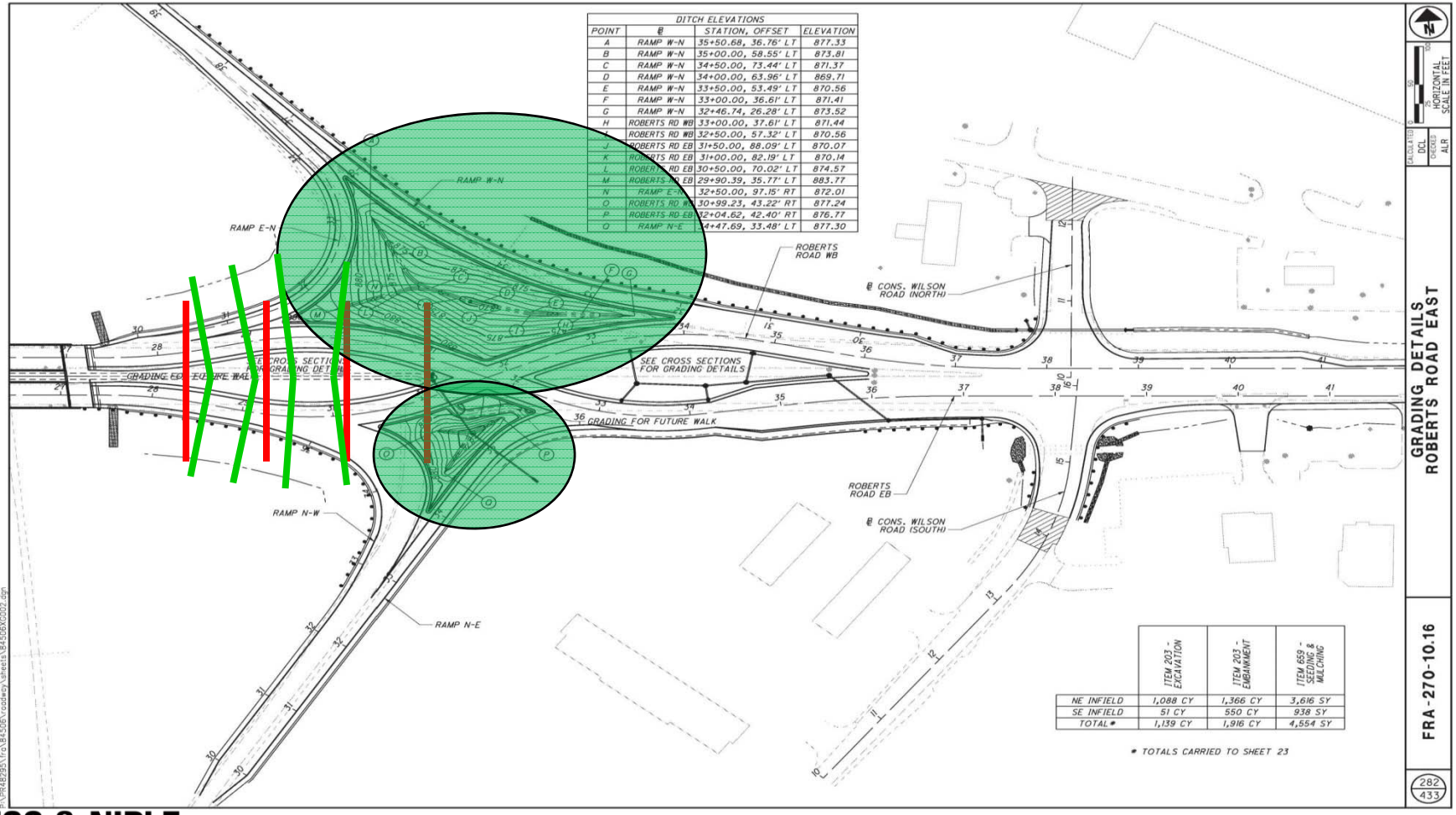
Plan Development – Cross Sections

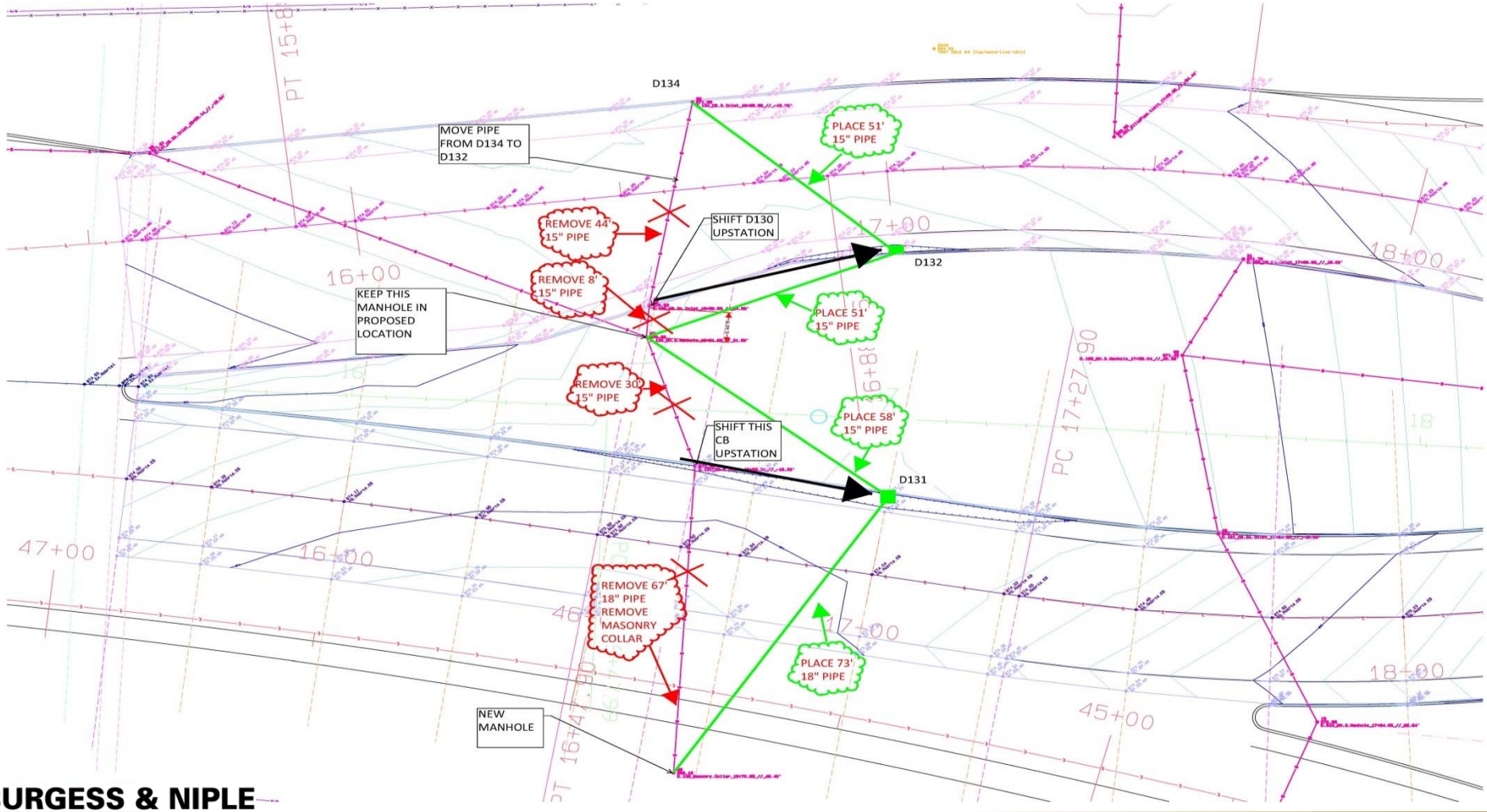


DITCH ELEVATIONS			
POINT	@	STATION, OFFSET	ELEVATION
A	RAMP W-N	35+50.68, 36.76' LT	877.33
B	RAMP W-N	35+00.00, 58.55' LT	873.81
C	RAMP W-N	34+50.00, 73.44' LT	871.37
D	RAMP W-N	34+00.00, 63.96' LT	869.71
E	RAMP W-N	33+50.00, 53.49' LT	870.56
F	RAMP W-N	33+00.00, 36.61' LT	871.41
G	RAMP W-N	32+46.74, 26.28' LT	873.52
H	ROBERTS RD WB	33+00.00, 37.61' LT	871.44
I	ROBERTS RD WB	32+50.00, 57.32' LT	870.56
J	ROBERTS RD EB	31+50.00, 88.09' LT	870.07
K	ROBERTS RD EB	31+00.00, 82.19' LT	870.14
L	ROBERTS RD EB	30+50.00, 70.02' LT	874.57
M	ROBERTS RD EB	29+90.39, 35.77' LT	883.77
N	RAMP E-N	32+50.00, 97.15' RT	872.01
O	ROBERTS RD WB	30+99.23, 43.22' RT	877.24
P	ROBERTS RD EB	32+04.62, 42.40' RT	876.77
Q	RAMP N-E	34+47.69, 33.48' LT	877.30

	ITEM 203 - EXCAVATION	ITEM 203 - EMBANKMENT	ITEM 659 - SEEDING & MULCHING
NE INFIELD	1,088 CY	1,366 CY	3,616 SY
SE INFIELD	51 CY	550 CY	938 SY
TOTAL*	1,139 CY	1,916 CY	4,554 SY

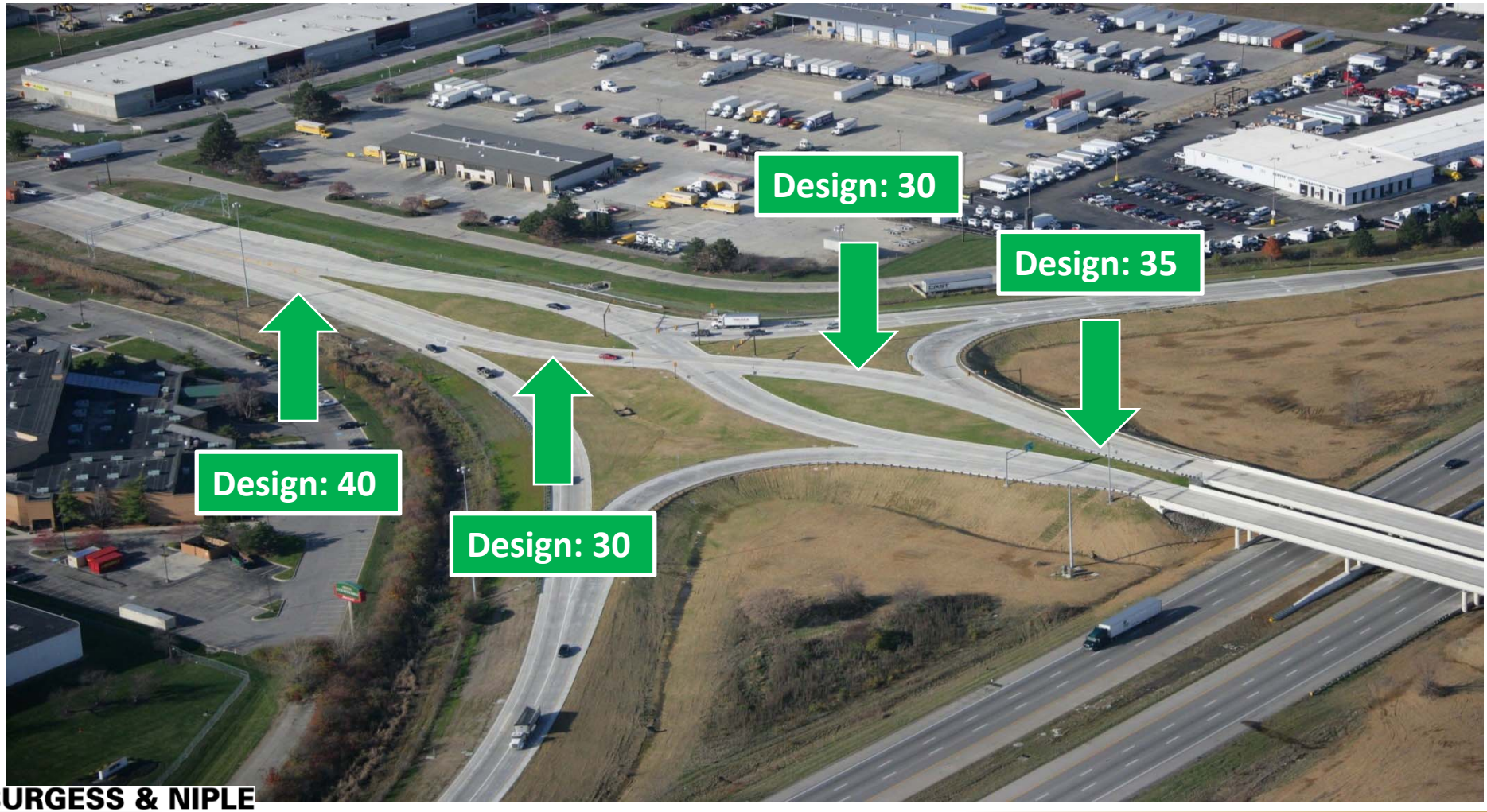
* TOTALS CARRIED TO SHEET 23

Plan Development – Surfaces



Design – Design Speed

Design – Design Speed



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Design – Design Speed

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Design – Crossover Design

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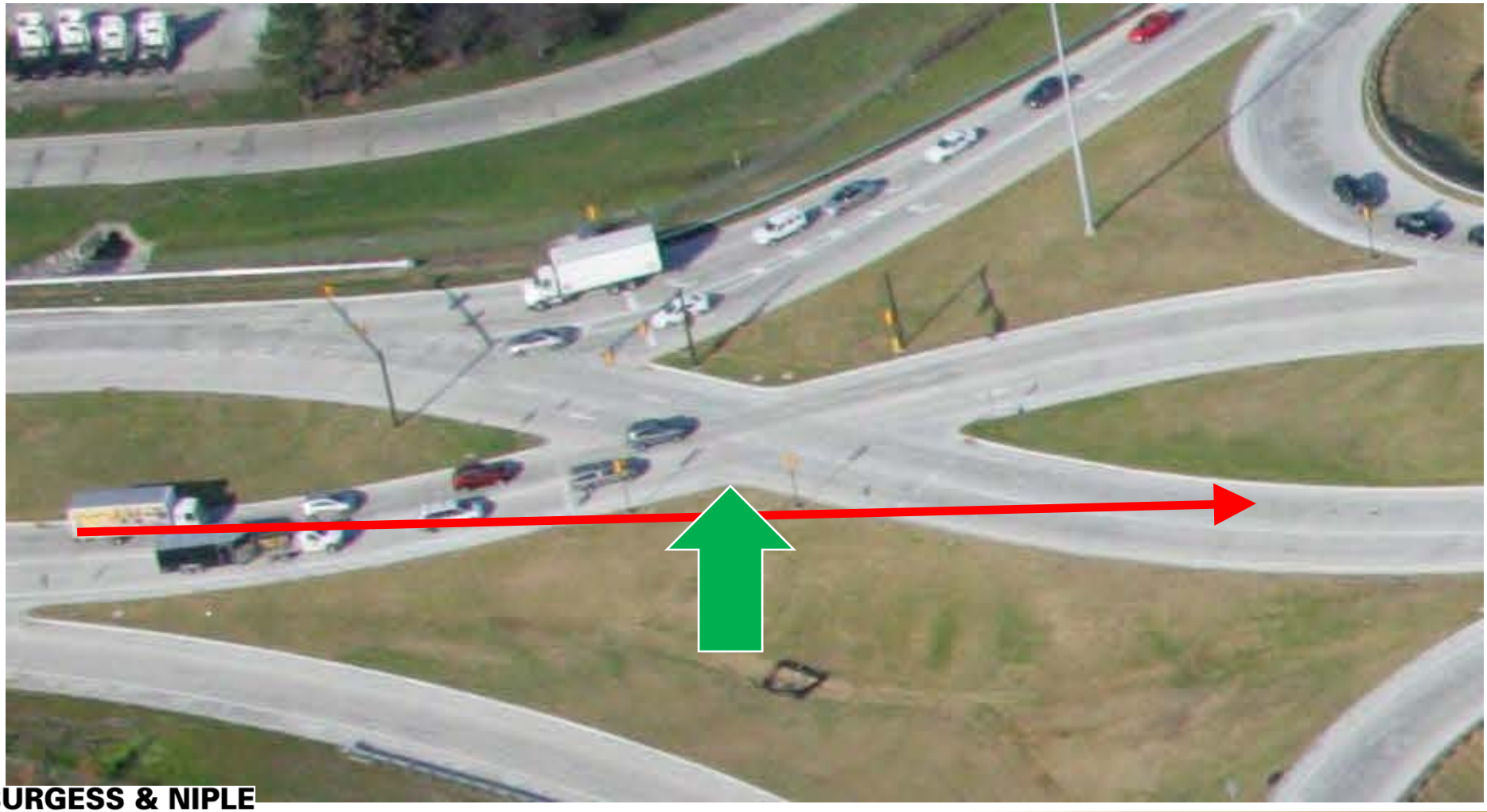
Design – Crossover Design



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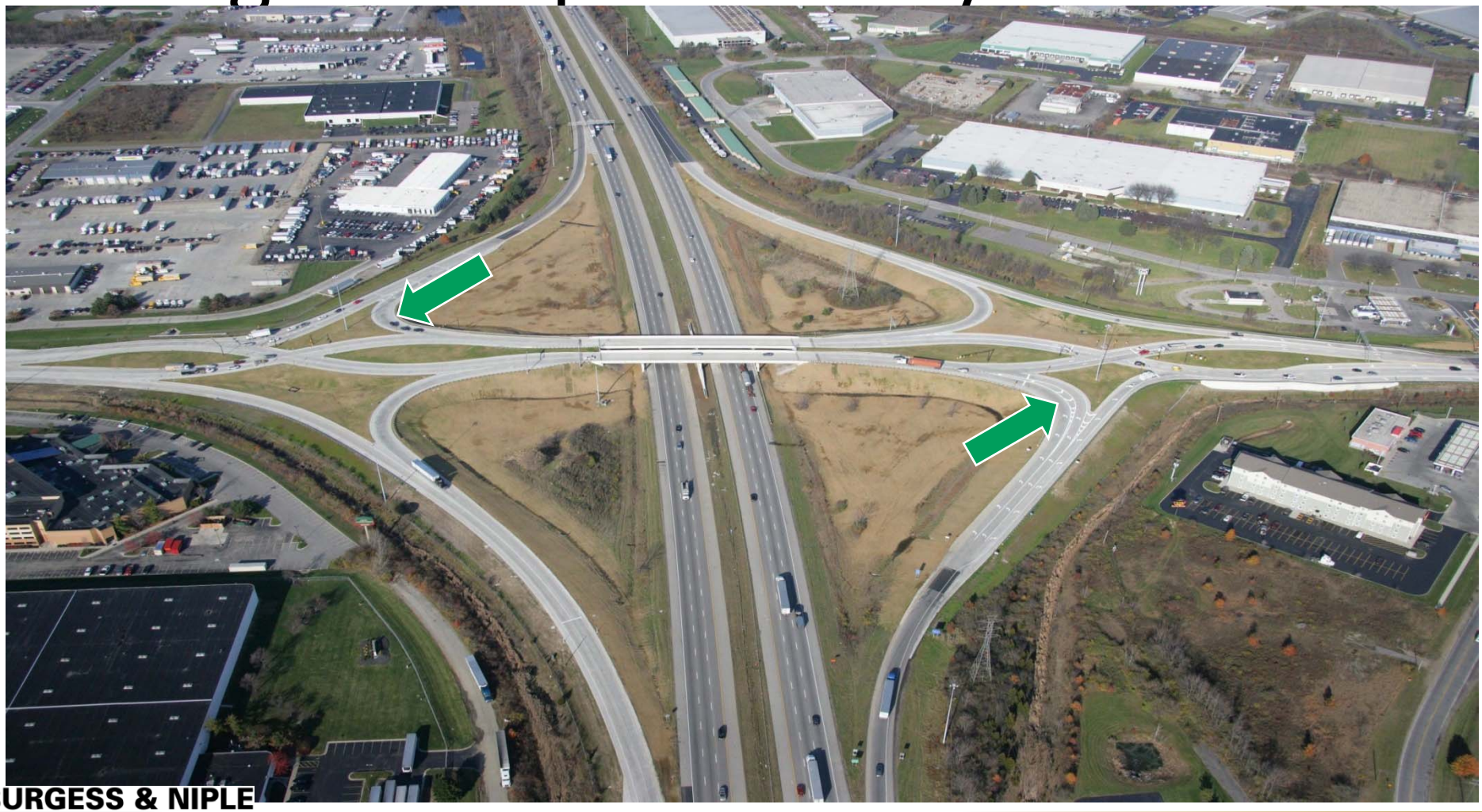
Design - Ramp Geometry



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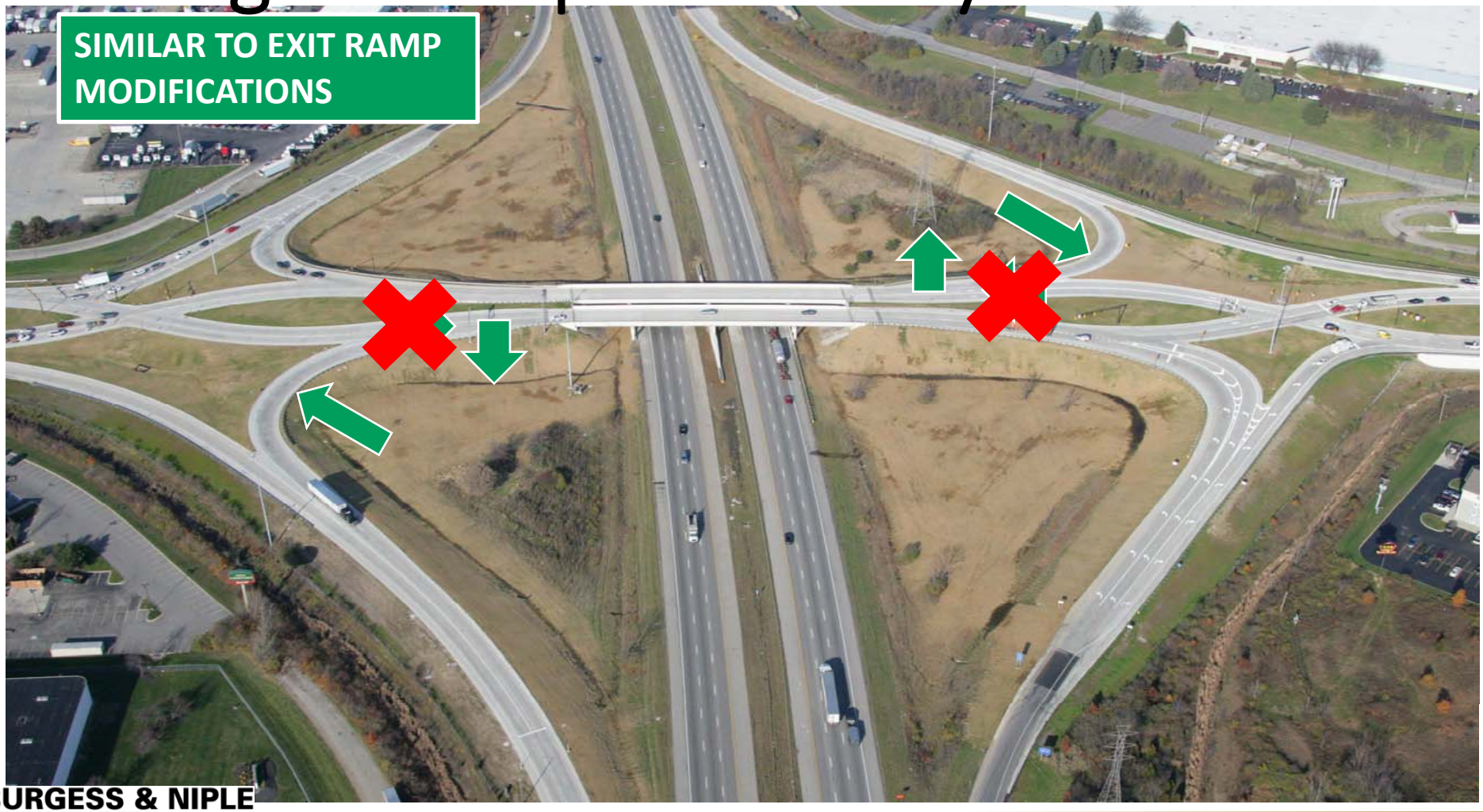

Design - Ramp Geometry

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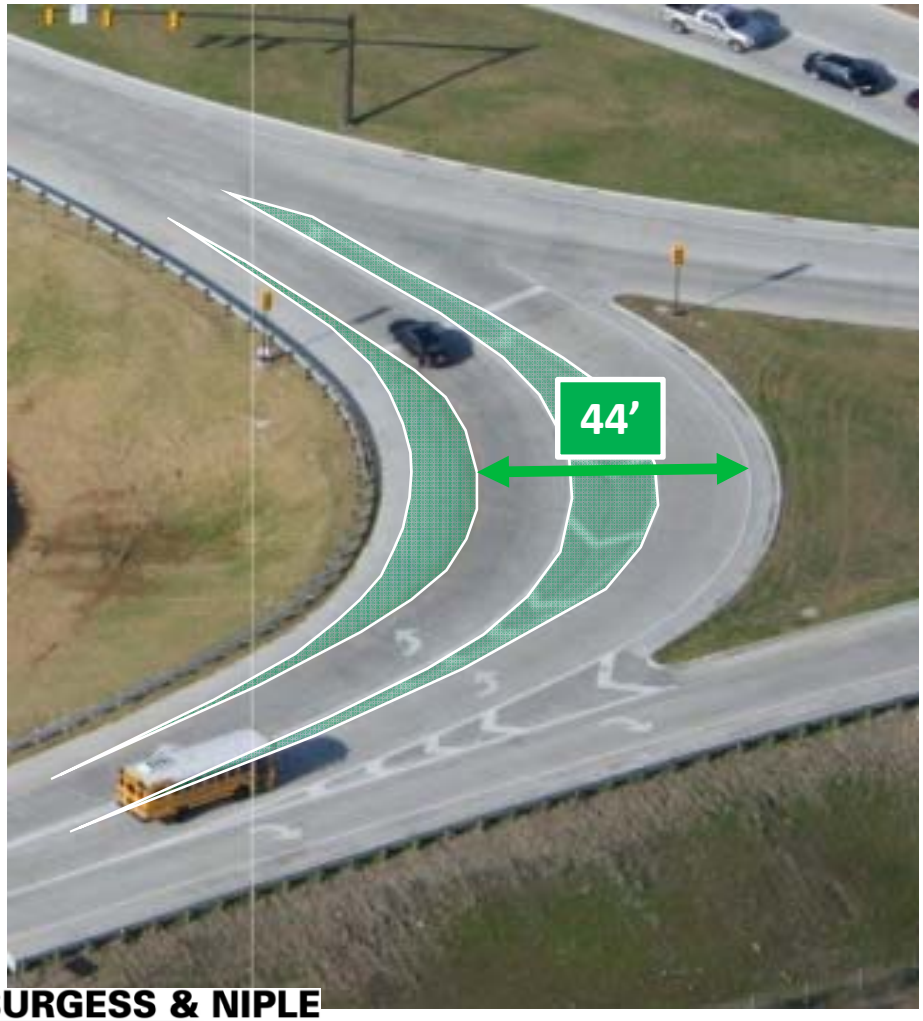
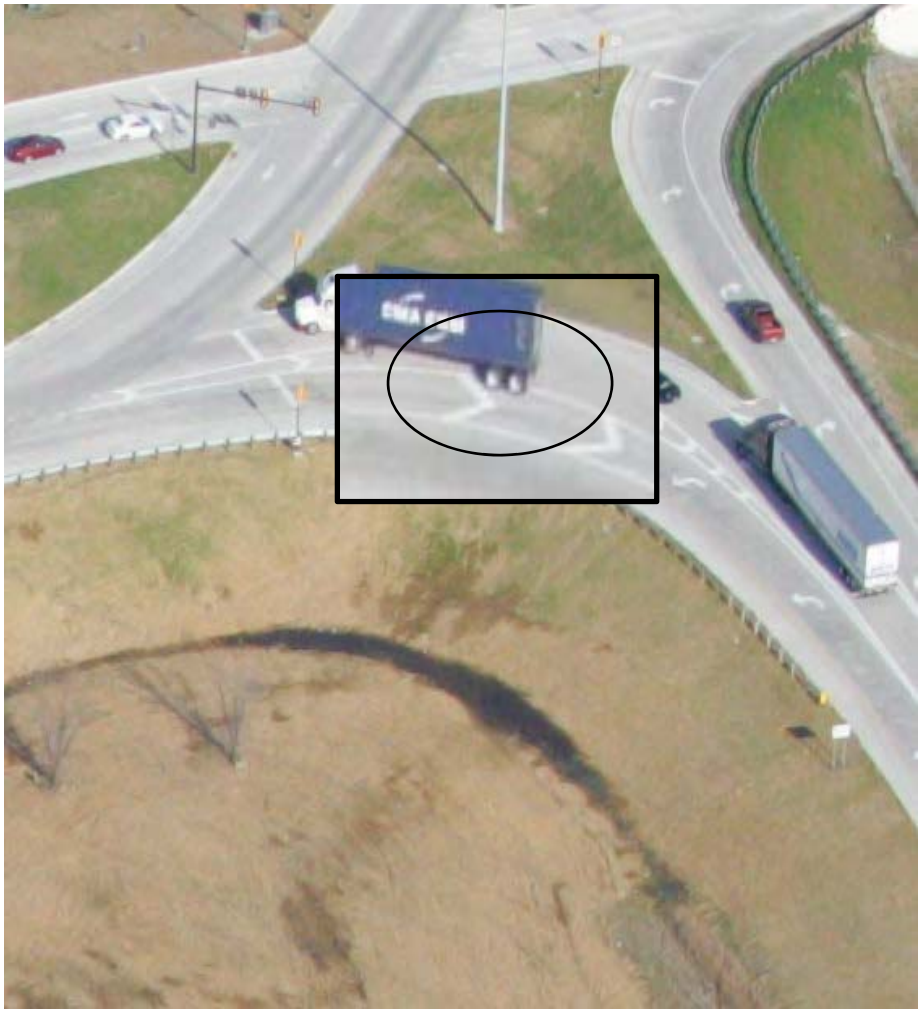
Design - Ramp Geometry

Design – Design Vehicles





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Design – Design Vehicles

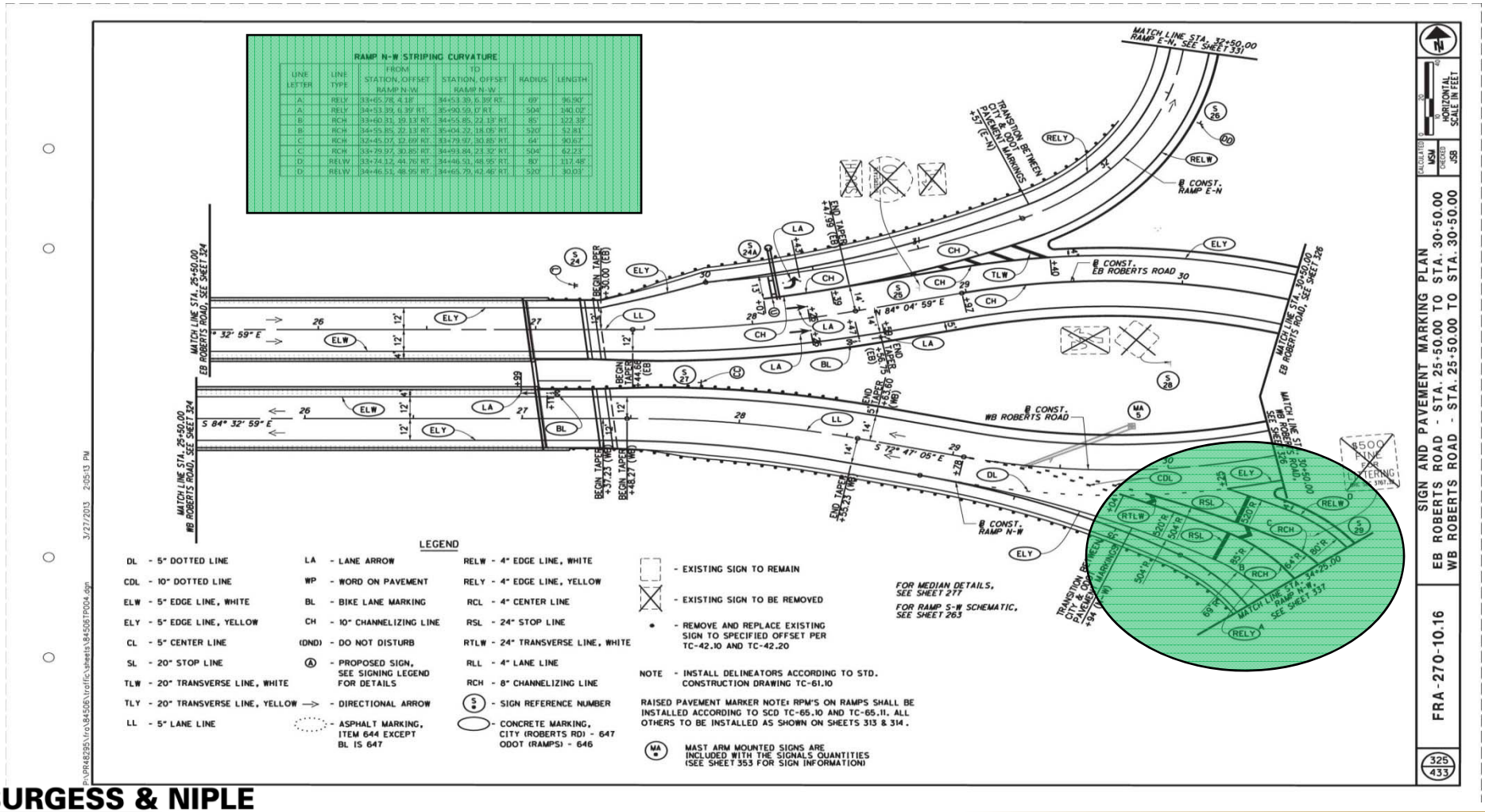
Design – Design Vehicles

Roundabouts

Good design

Poor design

Design – Design Vehicles



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Design – Design Vehicles

RAMP N-W STRIPING CURVATURE

LINE LETTER	LINE TYPE	FROM STATION, OFFSET RAMP N-W	TO STATION, OFFSET RAMP N-W	RADIUS	LENGTH
A	RELY	32+23.19, 0' RT.	33+65.78, 4.18'	504'	143.54'
A	RELY	33+65.78, 4.18'	34+53.39, 6.39' RT.	69'	96.90'
B	RCH	32+37.32, 12.39' RT.	33+60.31, 19.13' RT.	520'	130'
B	RCH	33+60.31, 19.13' RT.	34+55.85, 22.13' RT.	85'	122.33'
C	RCH	32+45.07, 12.69' RT.	33+79.97, 30.85' RT.	504'	149.98'
C	RCH	33+79.97, 30.85' RT.	34+42.36, 34.09' RT.	64'	90.67'
D	RELW	33+74.12, 44.76' RT.	34+46.51, 48.95' RT.	80'	117.48'
E	RCH	32+65.92, 26.37' RT.	33+74.12, 44.76' RT.	520'	128.60'

Design – Signalized Right Turns

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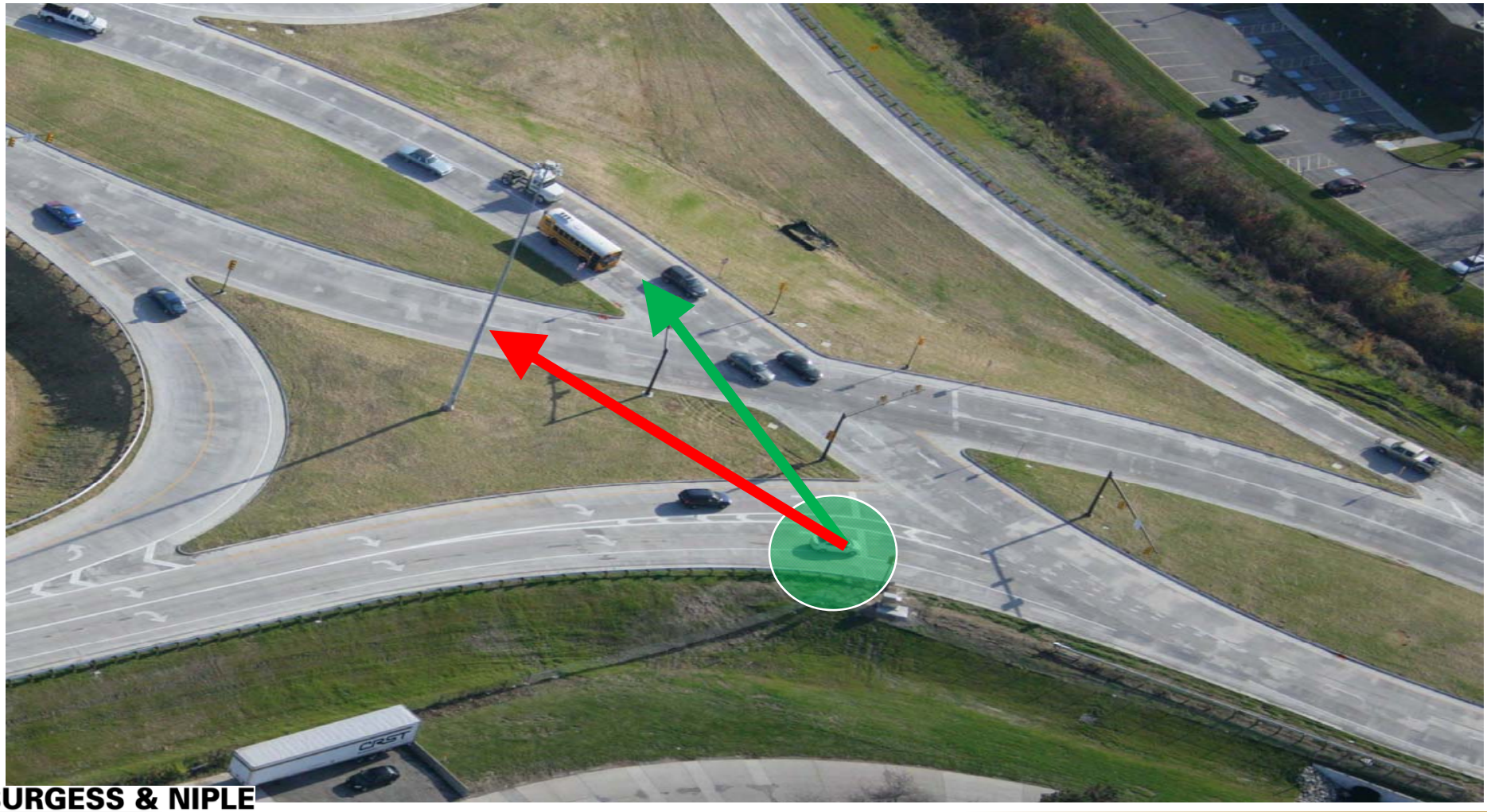
Design – Signalized Right Turns



Design – Signalized Right Turns

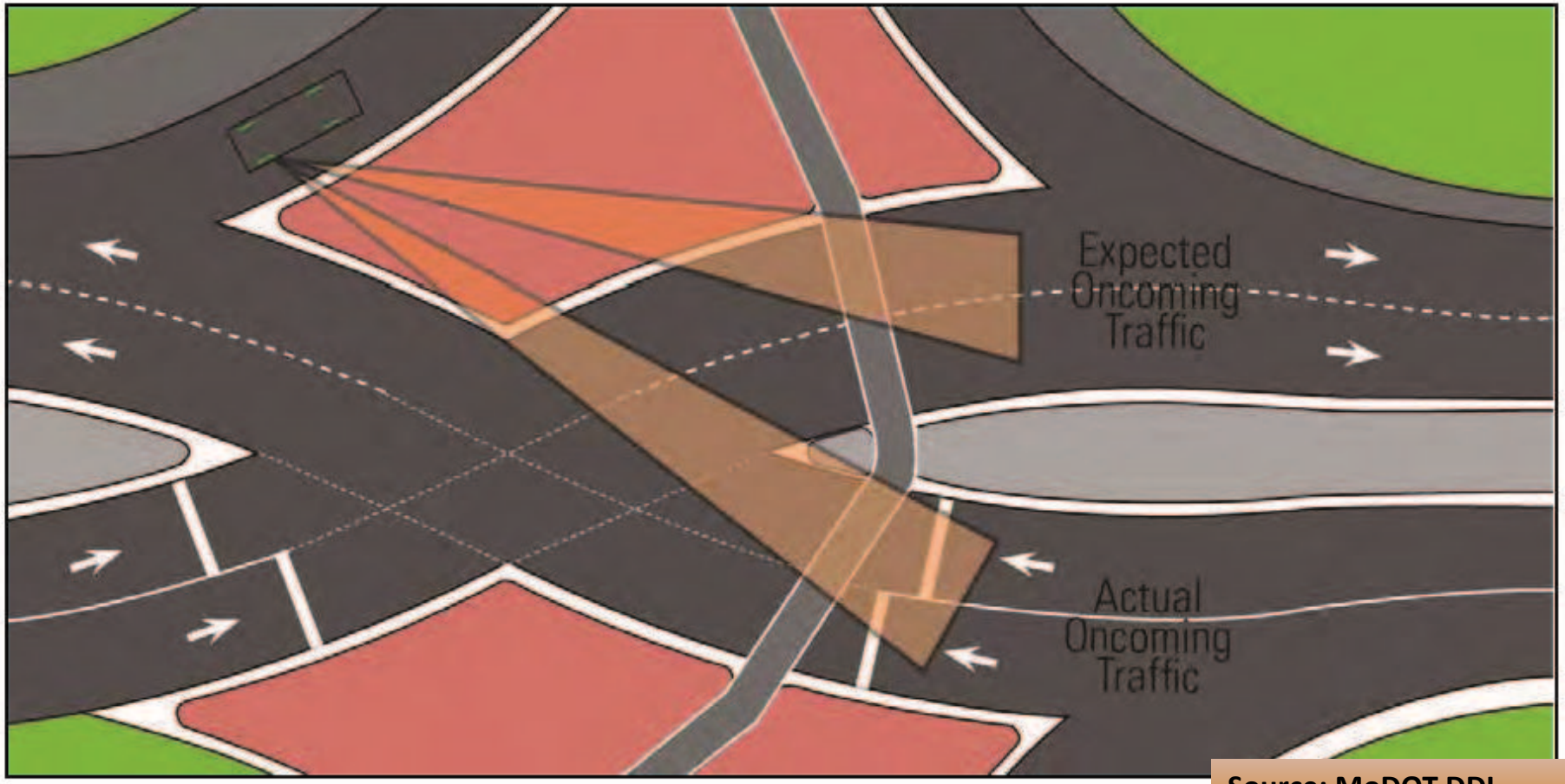


Figure 2.8 Diagram of expected oncoming traffic versus actual oncoming traffic

Source: MoDOT DDI Lessons Learned –2010

Design – Pedestrian Facilities

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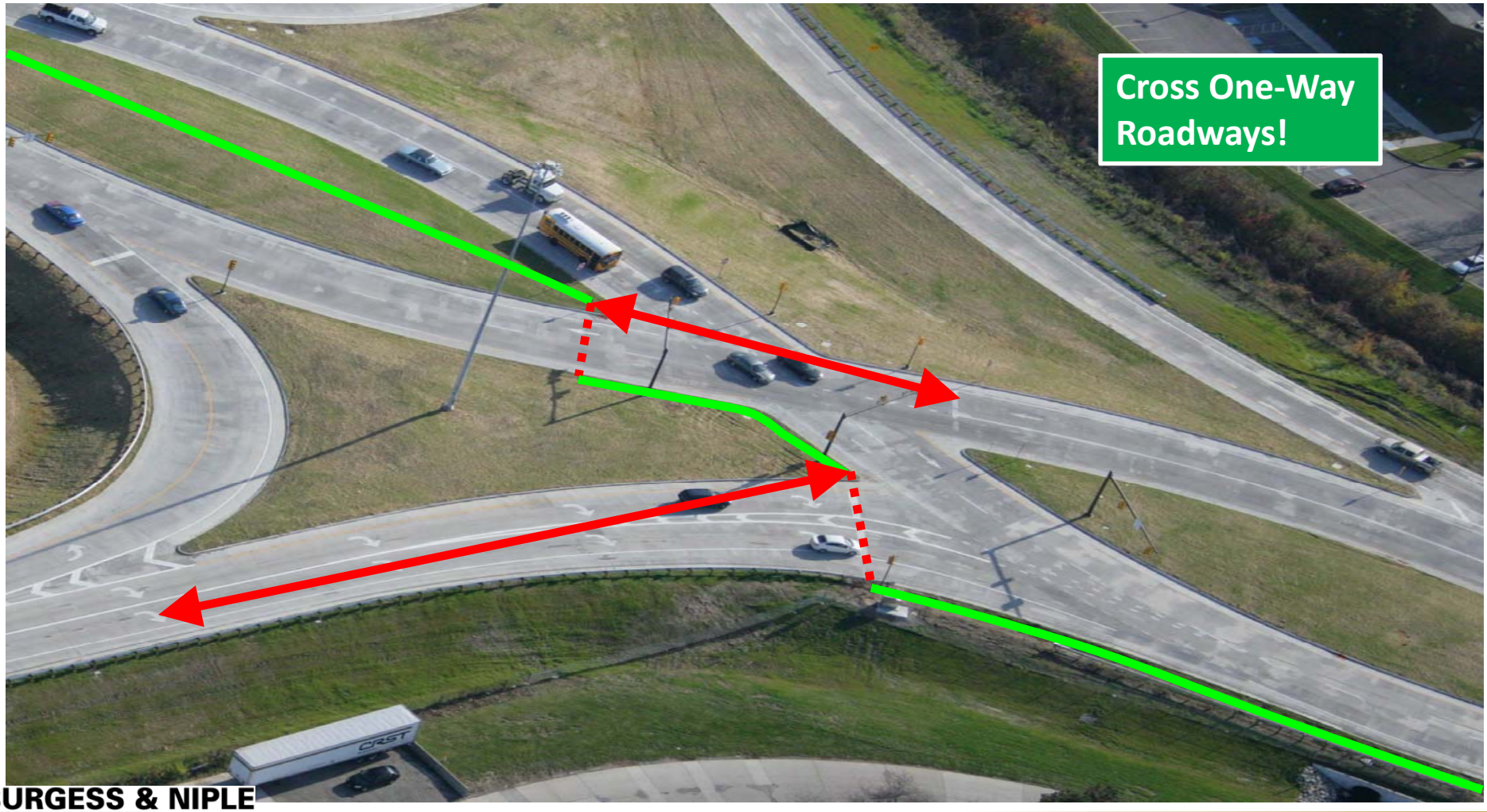
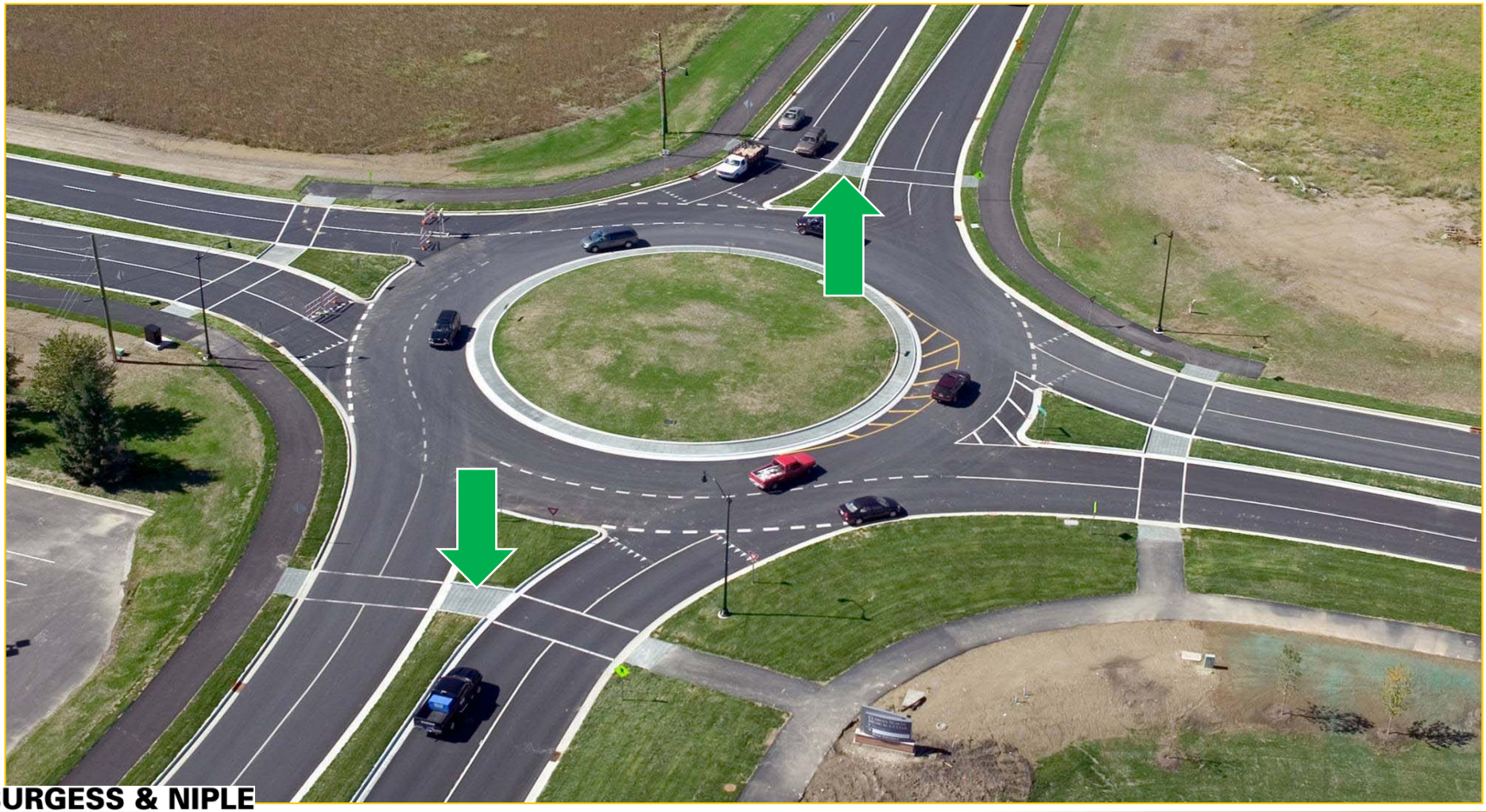
Design – Pedestrian Facilities



Design – Pedestrian Facilities



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Design – Pedestrian Facilities

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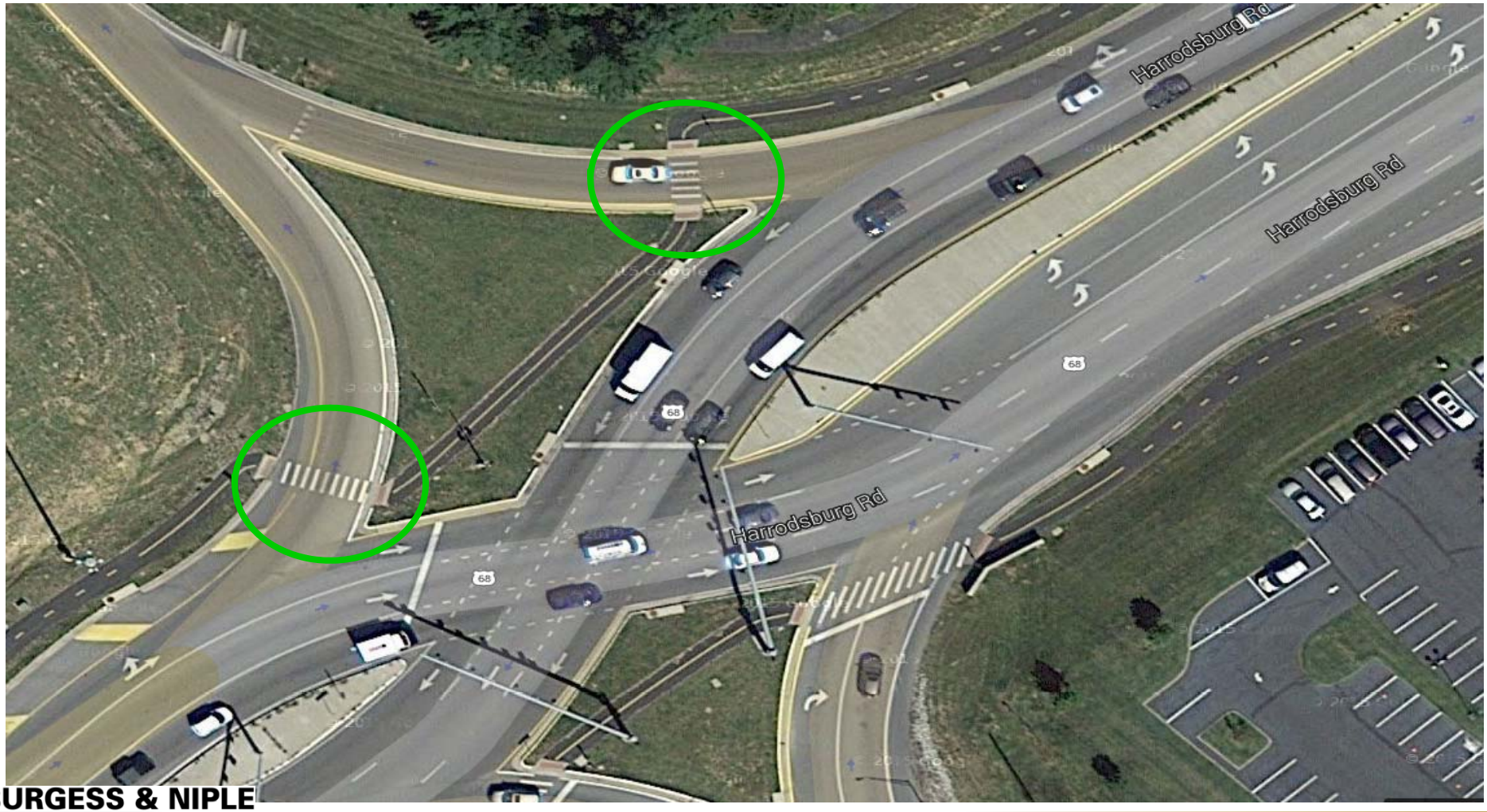

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Design – Pedestrian Facilities

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Design – Bicycle Facilities

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Design – Bicycle Facilities

Design – Bicycle Facilities

Design - Signal Head Placement

Design - Signal Head Placement

Design - Signal Head Placement

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Design - Signal Head Placement

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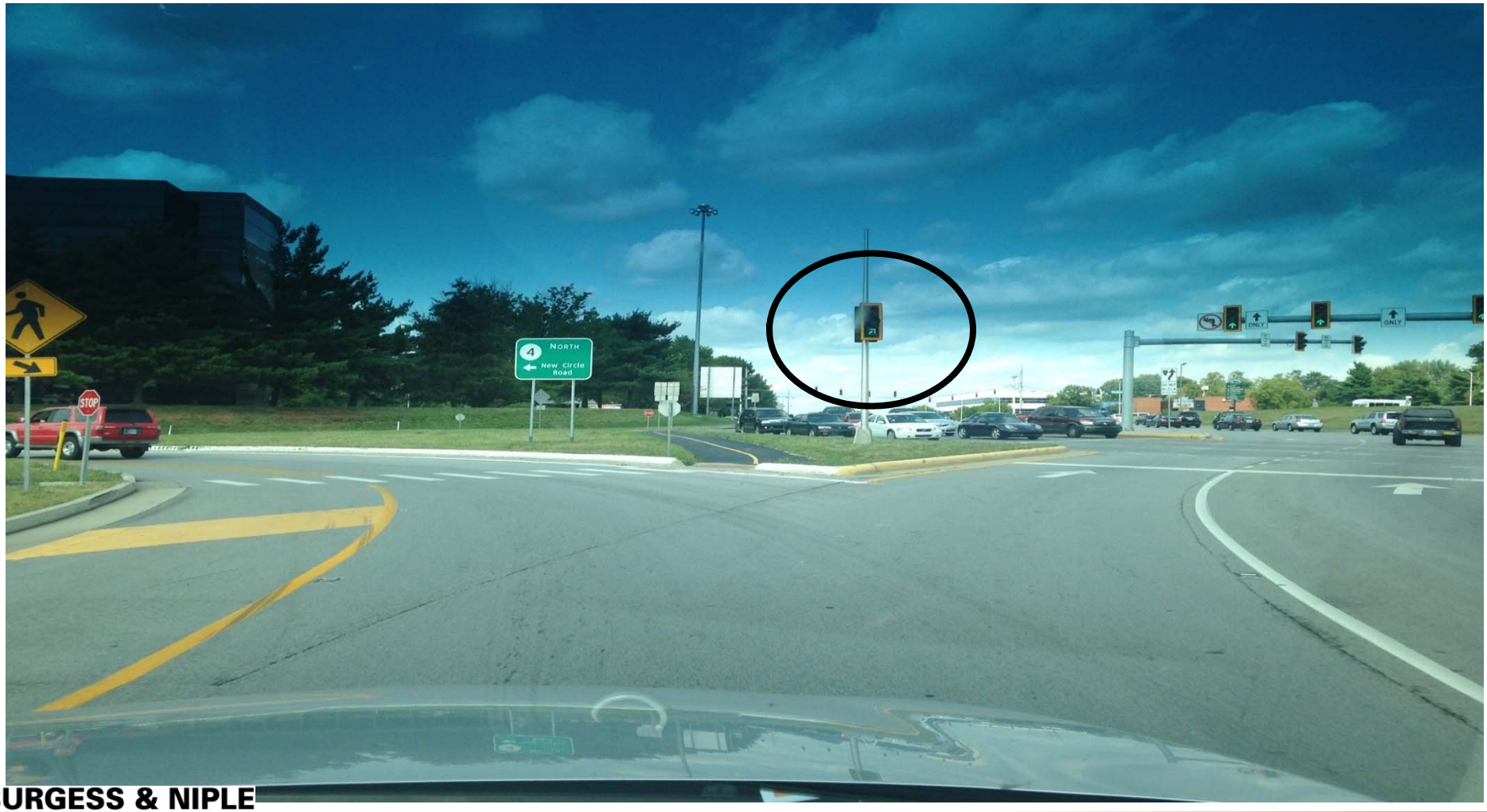
Design - Signal Head Placement



Design - Signal Head Placement

Design - Lane Usage Outside of DDI

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Design - Adjacent Streets

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Design - Adjacent Streets

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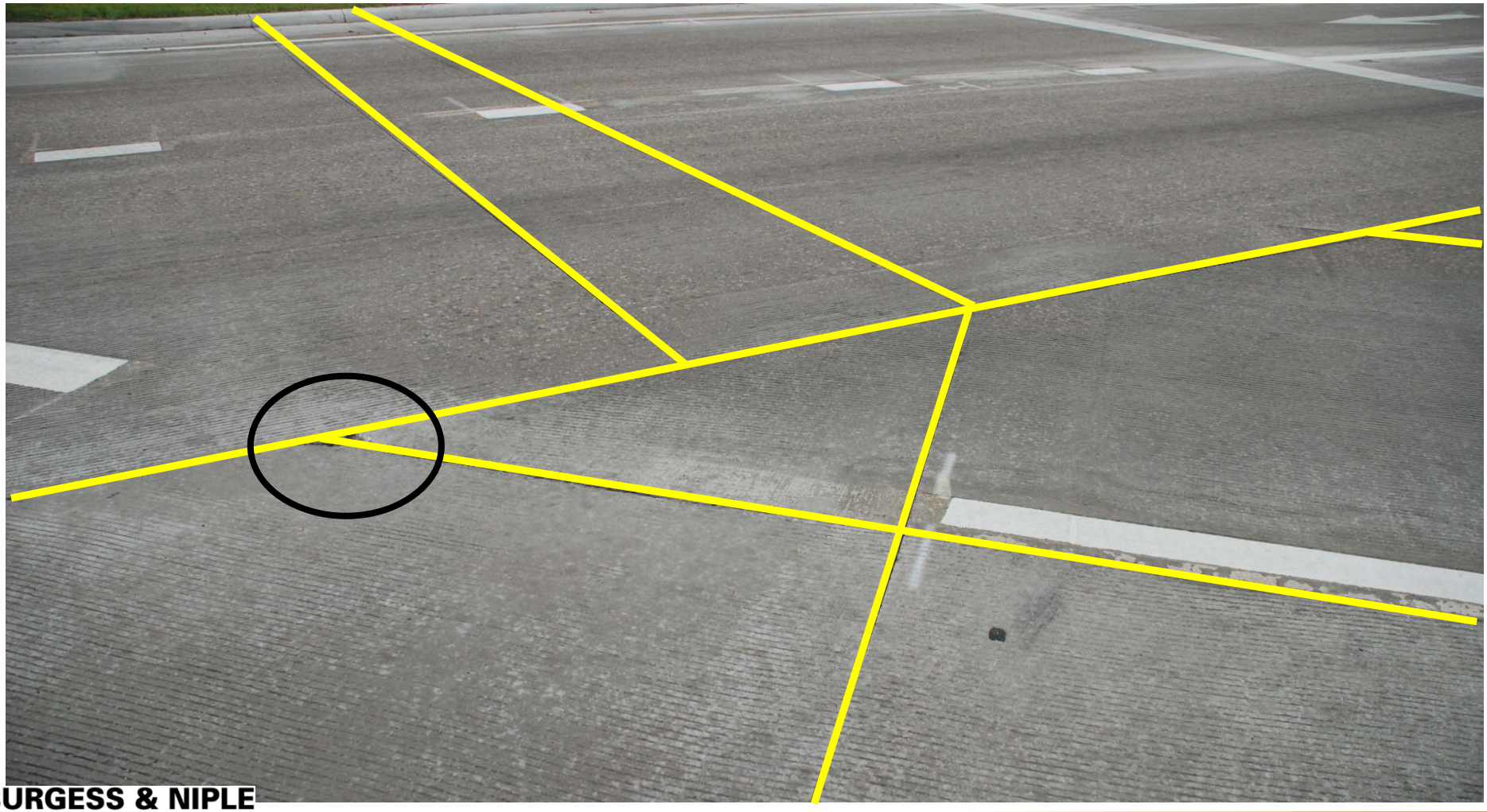
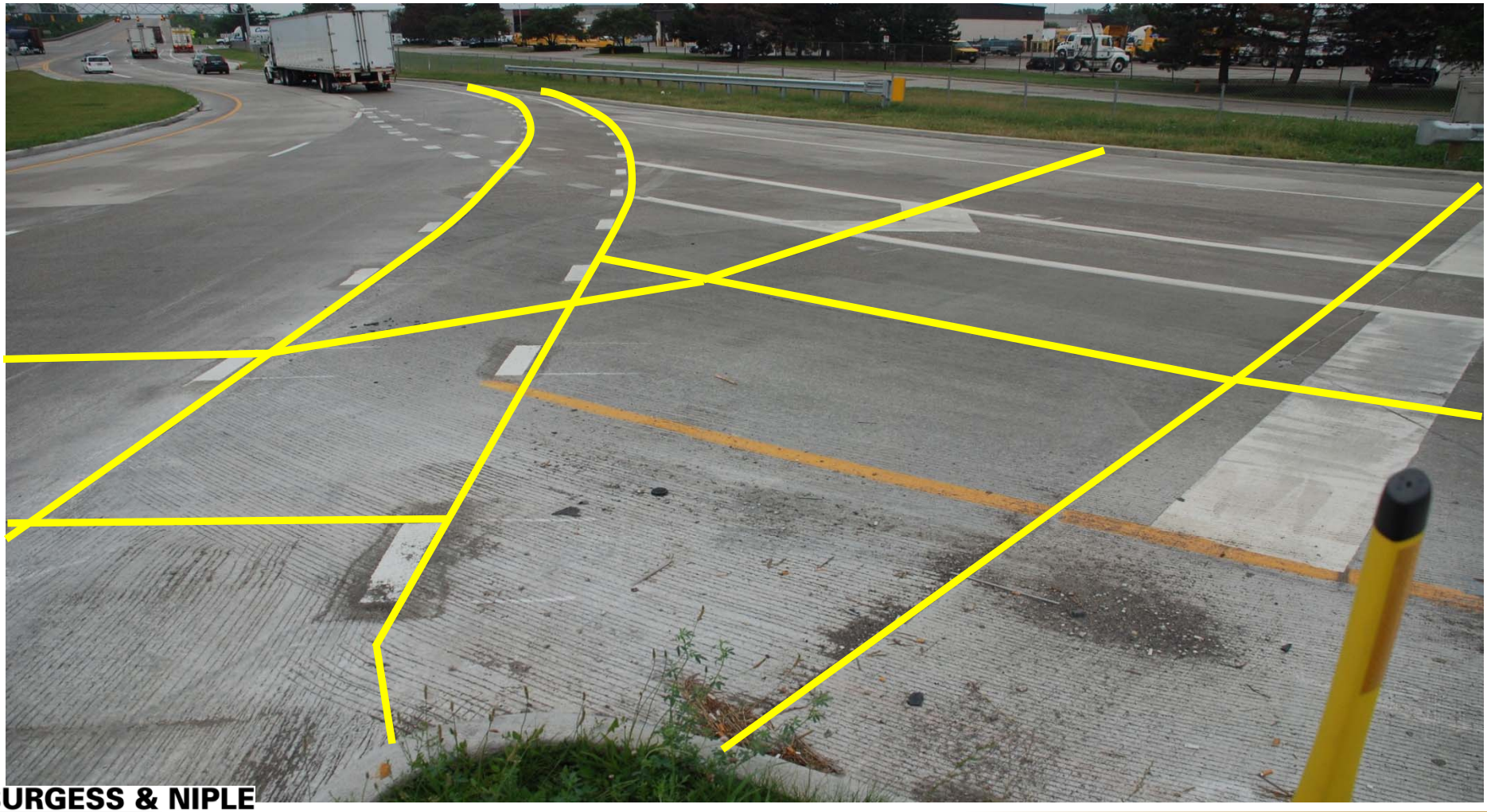
Construction - Pavement Joints

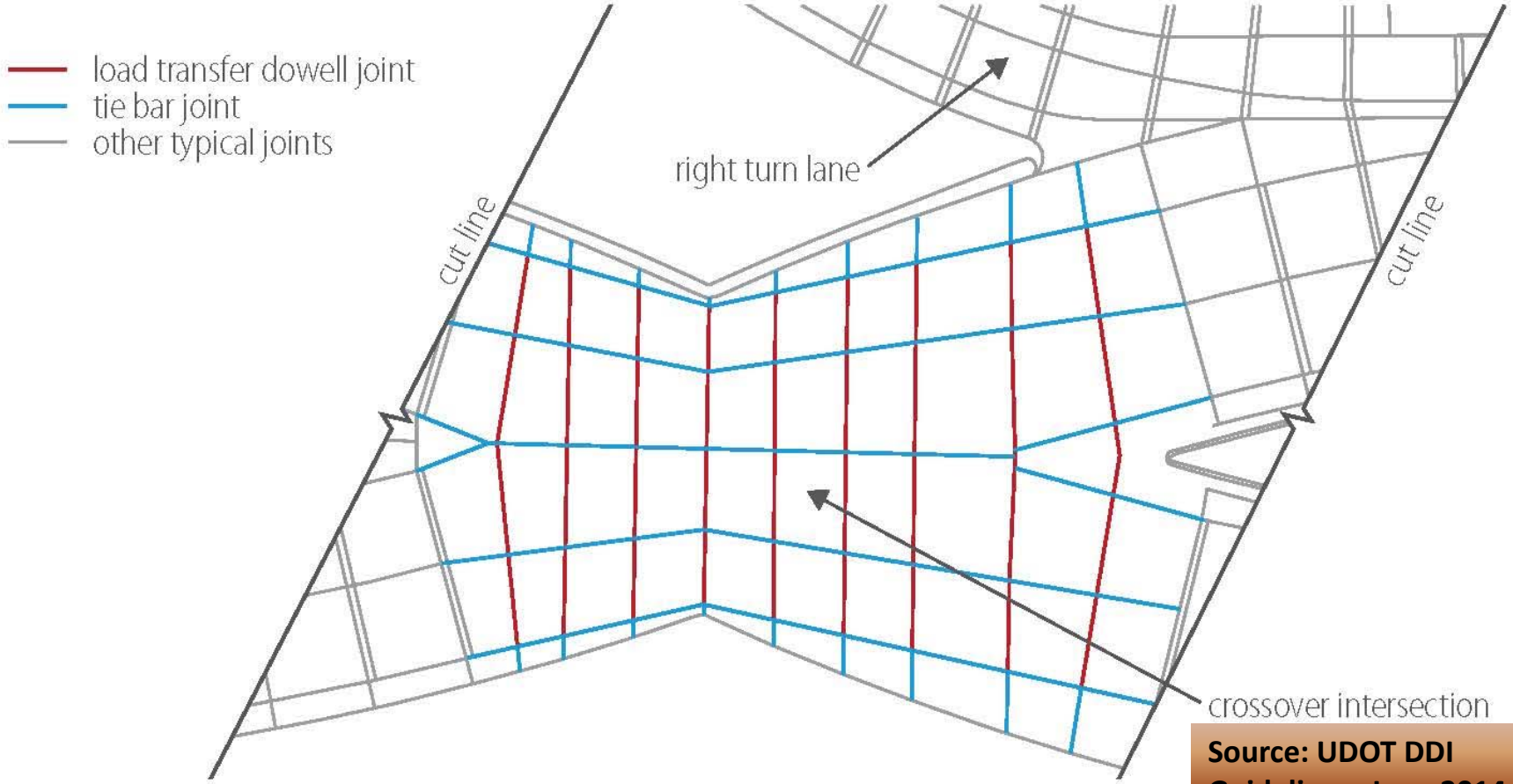


Construction - Pavement Joints



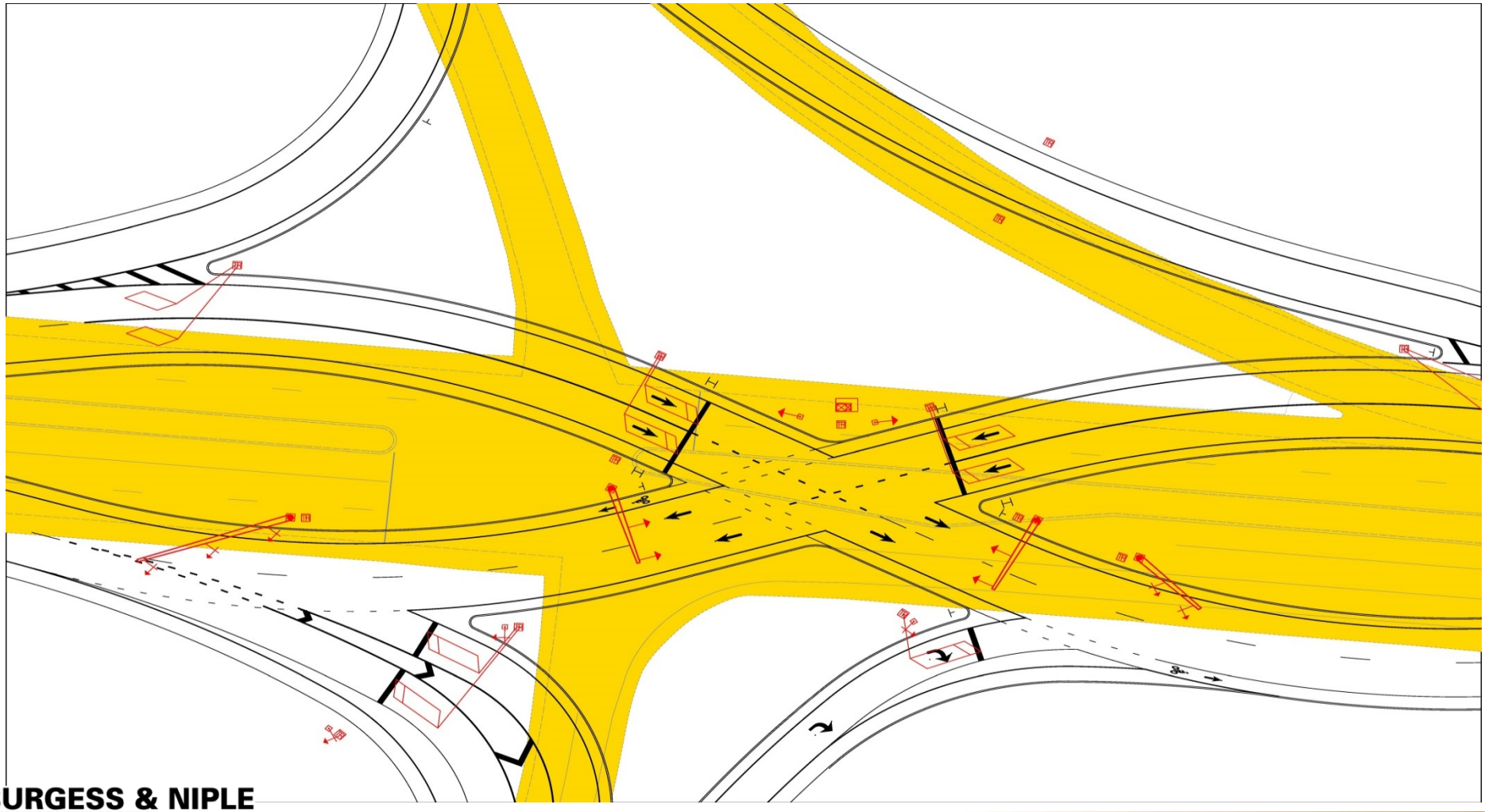
Construction - Pavement Joints

exhibit 5-2: pccp sample joint layout



Source: UDOT DDI Guideline – June 2014

Construction – MOT



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Construction - Lighting

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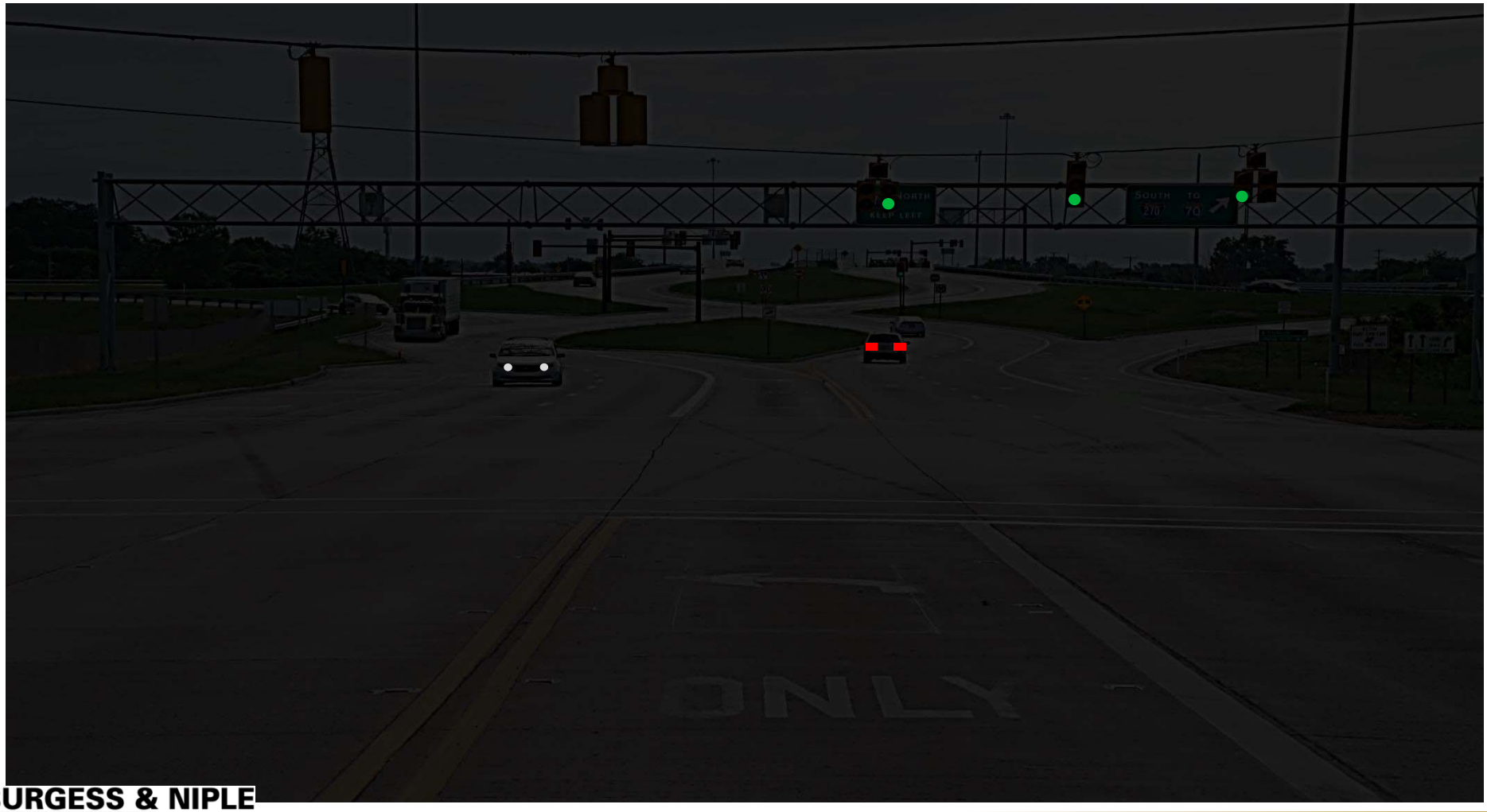

Other DDI Lessons Learned

- **Project Management**
- **Communication with Public**
- **DDI Selection at a Location**
- **Operational Analysis; VISSIM vs. Synchro**
- **Number of Signal Controllers**
- **ITS**
- **Signals - Loops vs. Video Detections**
- **Superelevation Design Thru Crossovers**
- **Signing at Crossover Intersections**
- **Ramp Metering**

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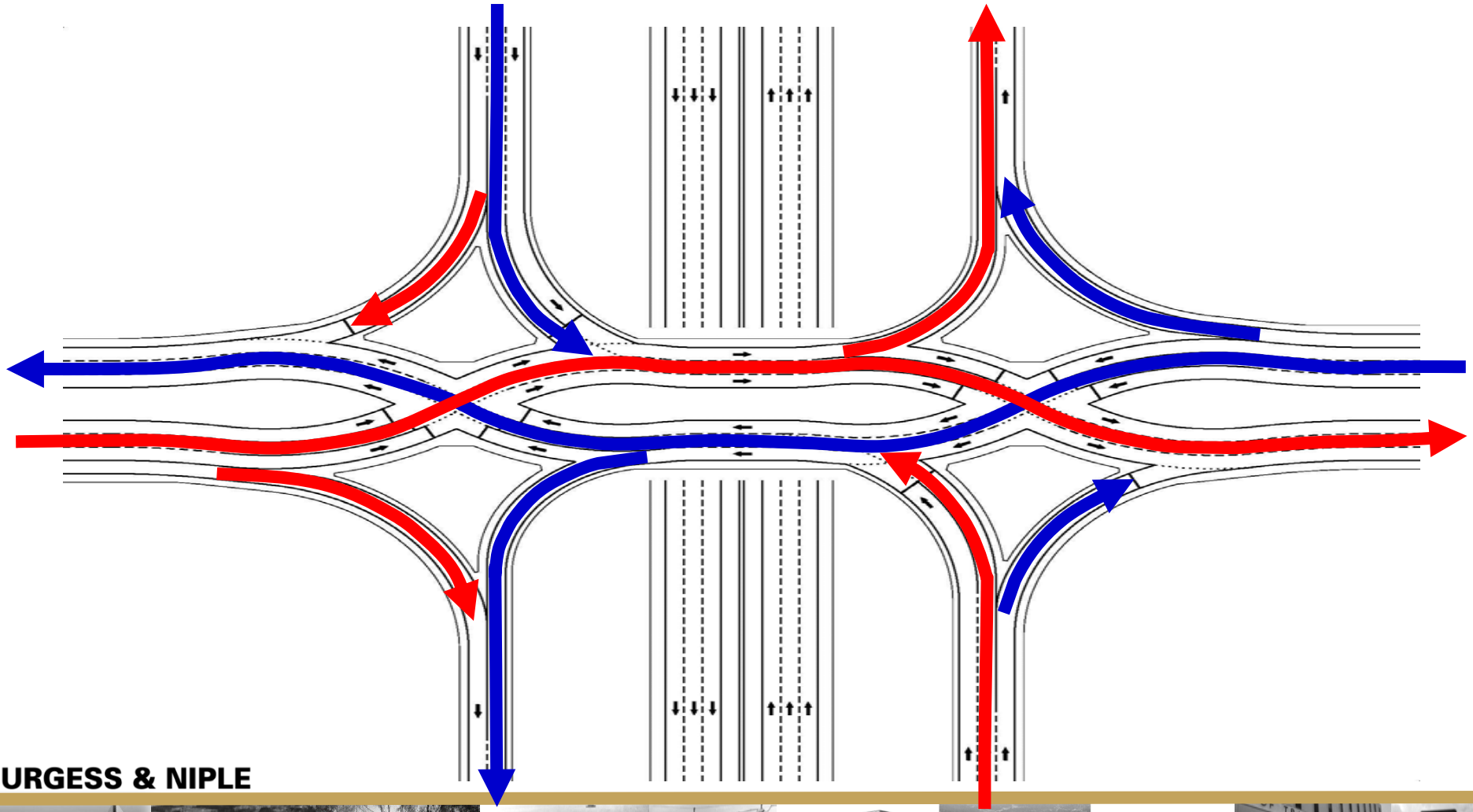
How a DDI works



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DDI Advantages - Operational

- Research shows that compared to a normal diamond interchange, the DDI:
  - Reduces intersection delay 15% - 60%
  - Increases intersection through traffic 10% - 30%
  - Increases intersection capacity 15% - 25%
- Simple two phase signal operation
- Increased capacity for the left-turning movements to/from the ramps.
- Left-turn vehicles only go through one signal
- Traffic is better spread out entering a freeway
- Oversized loads can make left turns to freeway easier
- U-turns from/to freeway are easier

DDI Advantages – Cost and Safety

- The increased capacity and unique configuration of the DDI provides the potential to reduce the number of lanes on the crossroad; **smaller bridge footprint**!

- Small footprint of the DDI often **reduces the right-of-way** needed for the interchange compared to other traditional interchange types.
  - Within interchange area
  - On arterial approaches

- **Reduces Number of Conflict Points**

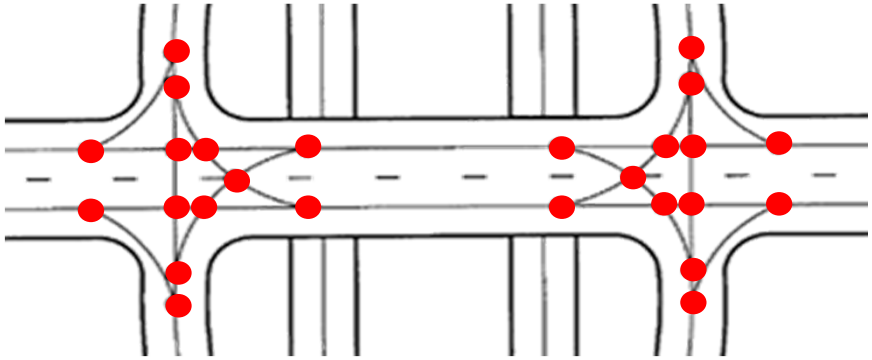
DDI in Columbus, Ohio

31% REDUCTION IN TOTAL CRASHES!

56% REDUCTION IN INJURY CRASHES!

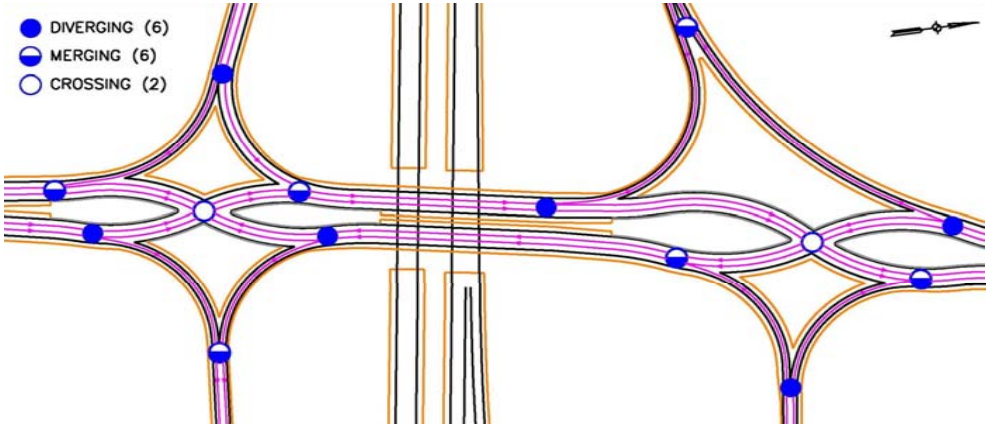
DDI Advantages – Reduced Conflict

- Reduced Number and **Severity** of Conflict Points – fewer conflict points generally results in fewer crashes.

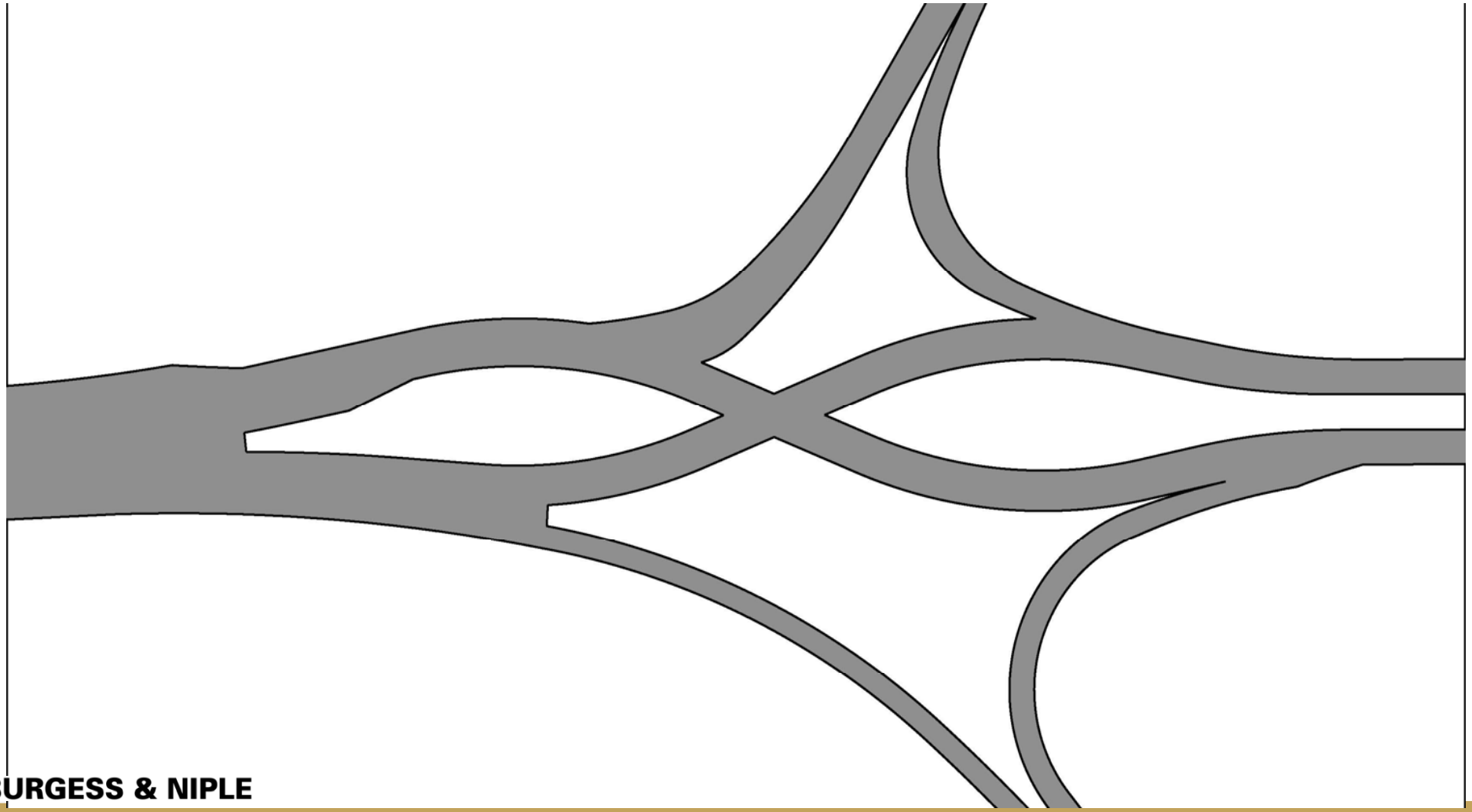


Normal Diamond has 24 Conflict Points; 10 are crossings

DDI has 14 Conflict Points; only 2 are crossings



Can DDIs Expand?



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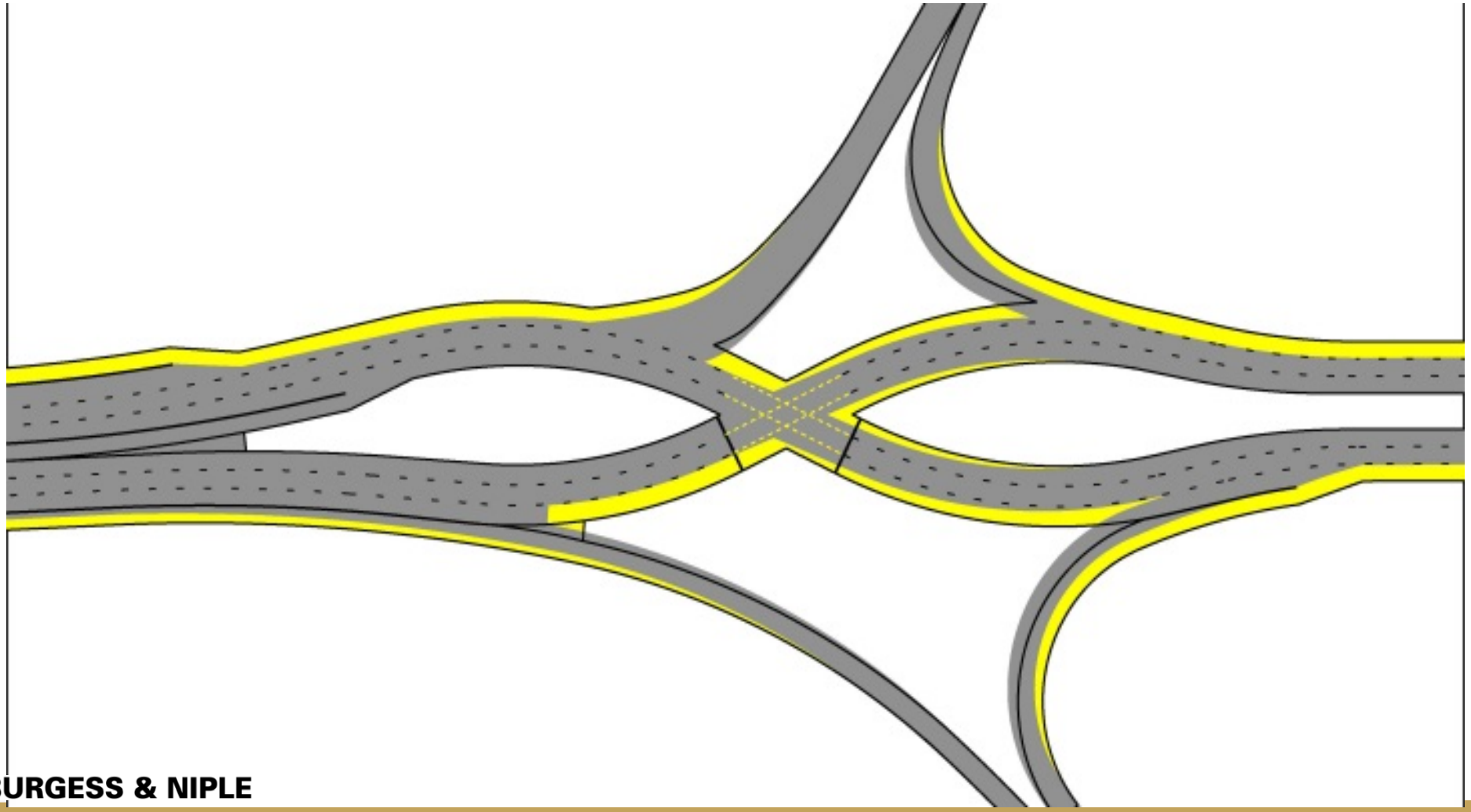

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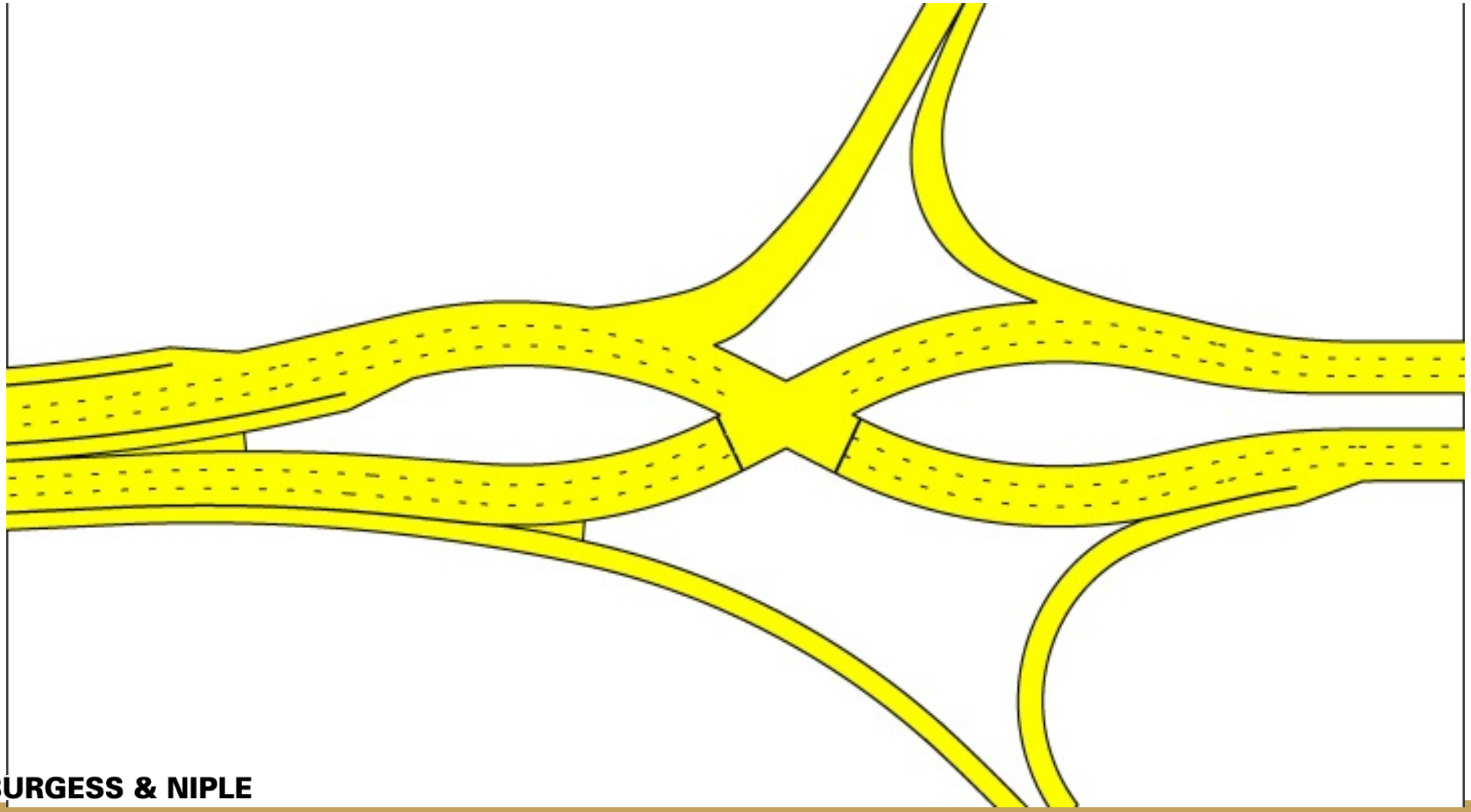
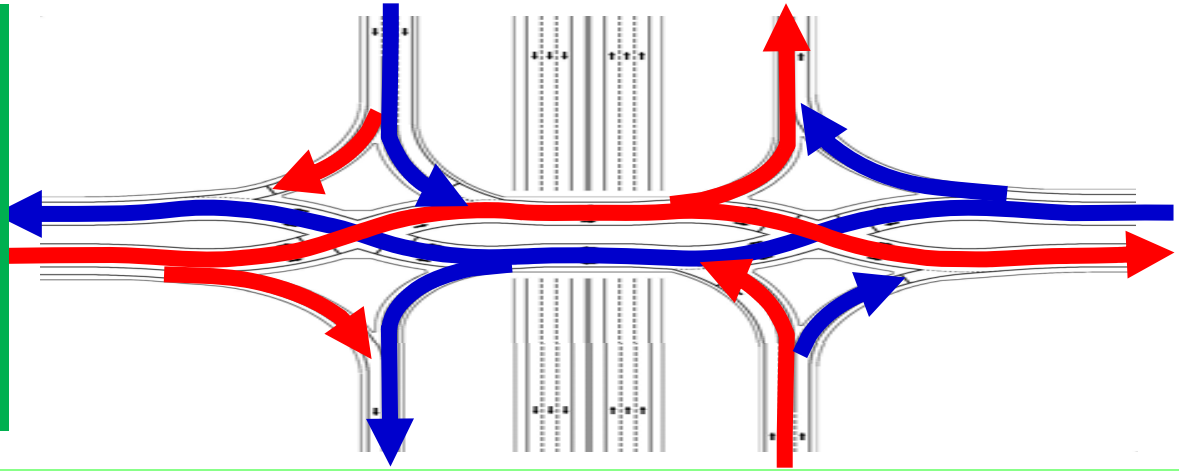


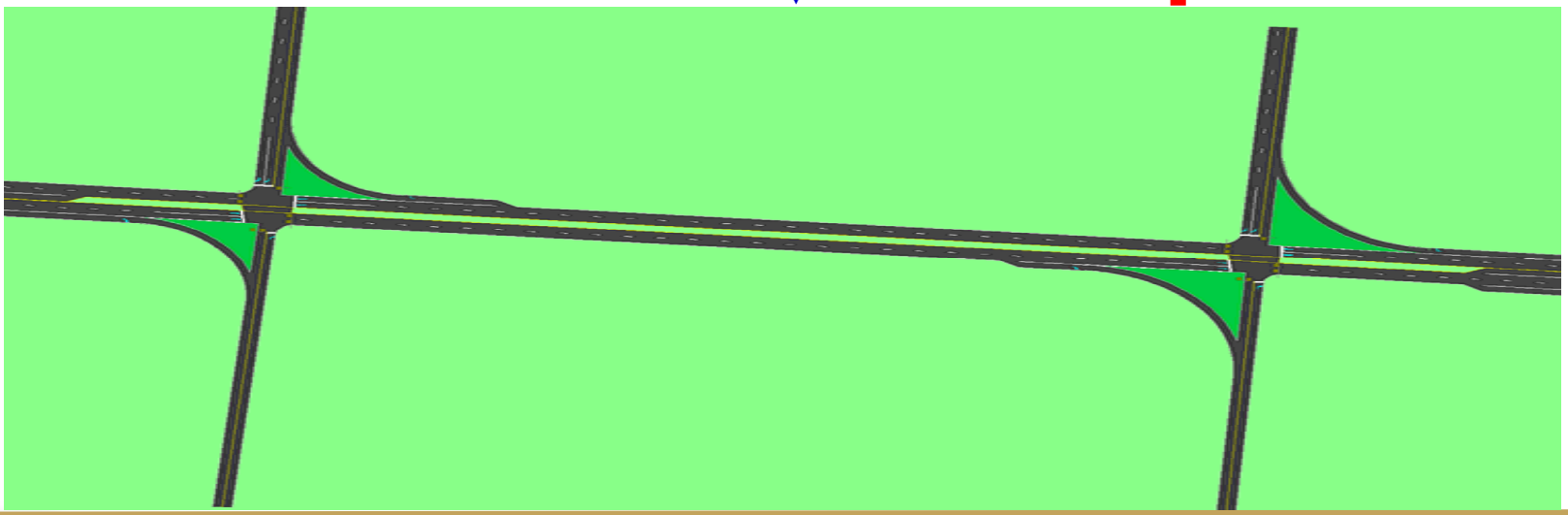
Capacity Analysis – Synchro

- ➕ Easy to use
- ➕ Works well for corridor analysis
- ➕ Use this when evaluating several alternatives
- ➕ Quick analysis; starting point for signal timings
- ➖ Difficult to use with non-traditional intersection geometry and signal phasing
- ➖ Workaround needed for DDI; doesn't like free flow left turns

Capacity Analysis – Synchro

- **Change Lefts to Unopposed Rights**
- **Make the signals split phase to not allow opposing directions of arterial to go simultaneously**

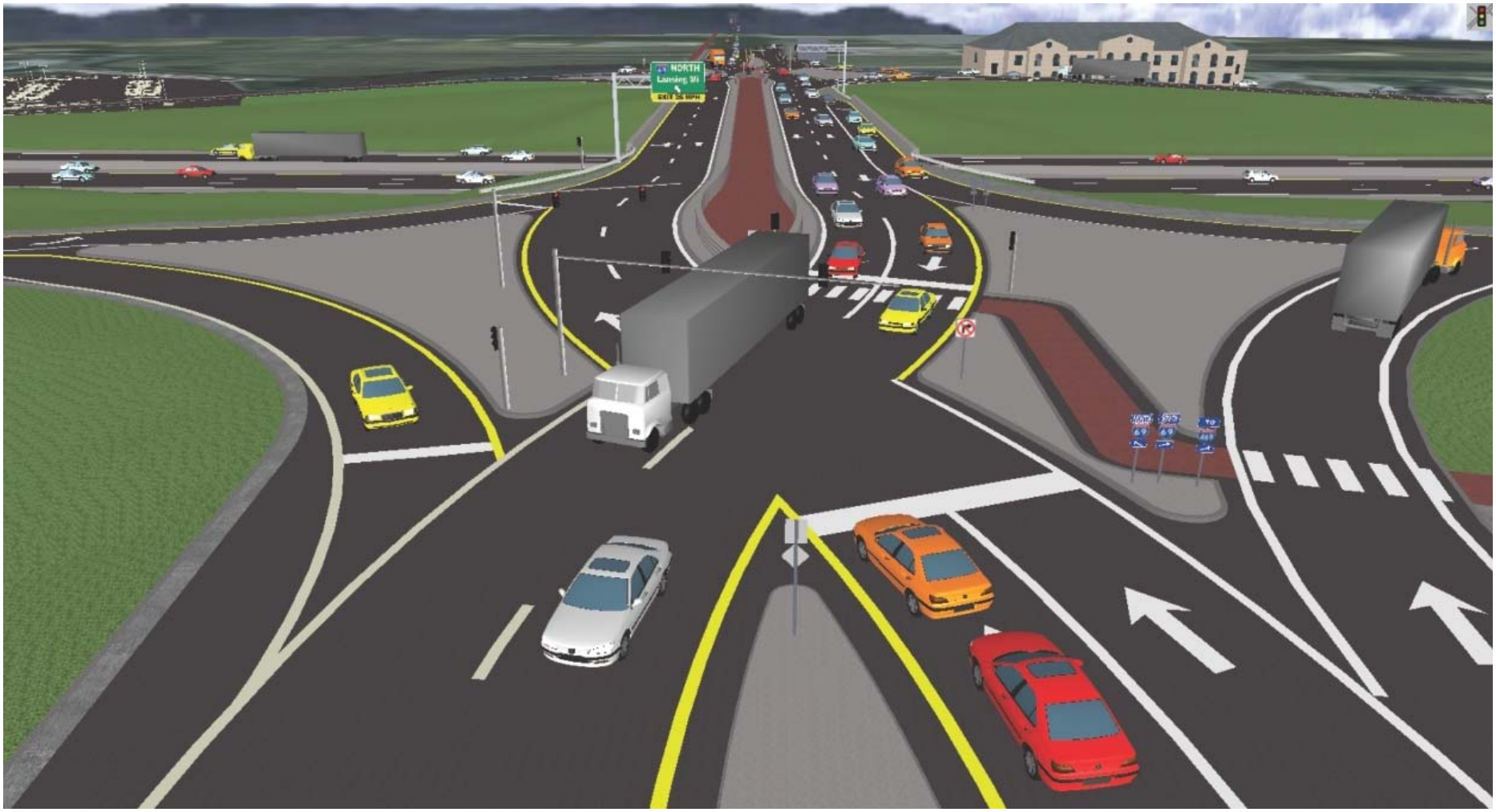




Capacity Analysis – VISSIM

- Can analyze nearly any geometric configuration and signal phasing
- Great visual display
- Helps the public understand how non-traditional geometry works
- Verify Synchro results
- Can get very labor intensive; best to do when down to a single alternative

Capacity Analysis – VISSIM



Signal Controllers

Two Controllers

- Requires Interconnect cable to connect
- Lose Interconnect, signals independently running

One Controller

- More Options for overlaps/timings
- Can't lose coordination
- Requires conduit to connect the signals

Most DDIs are moving to using *One Signal Controller* now.

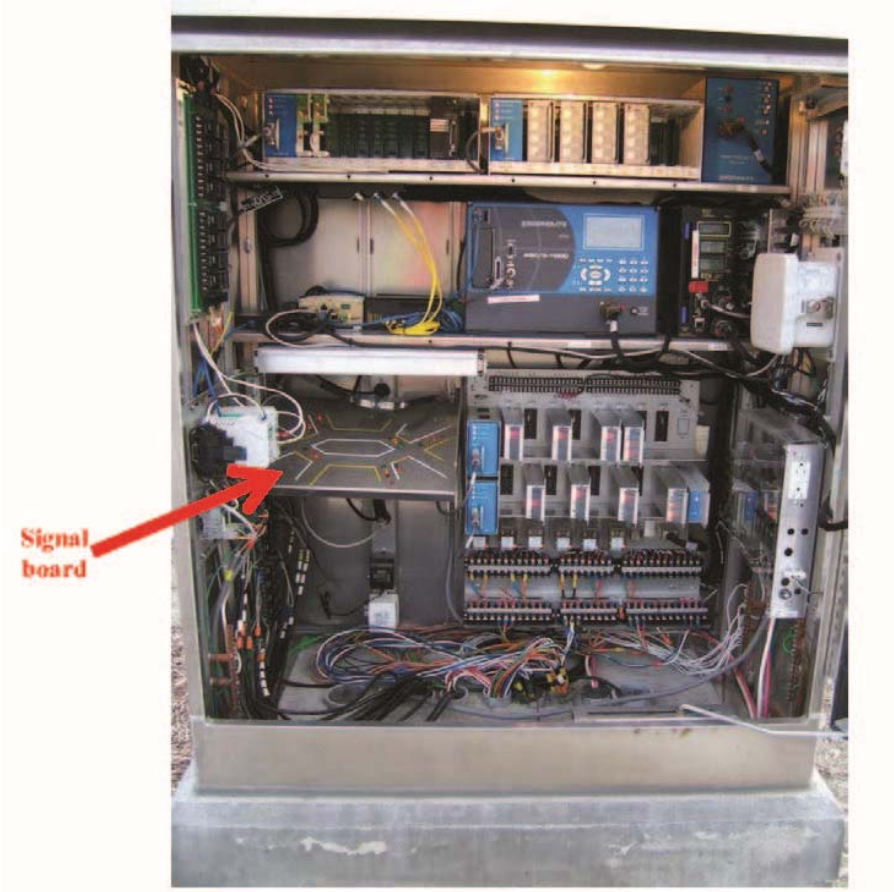


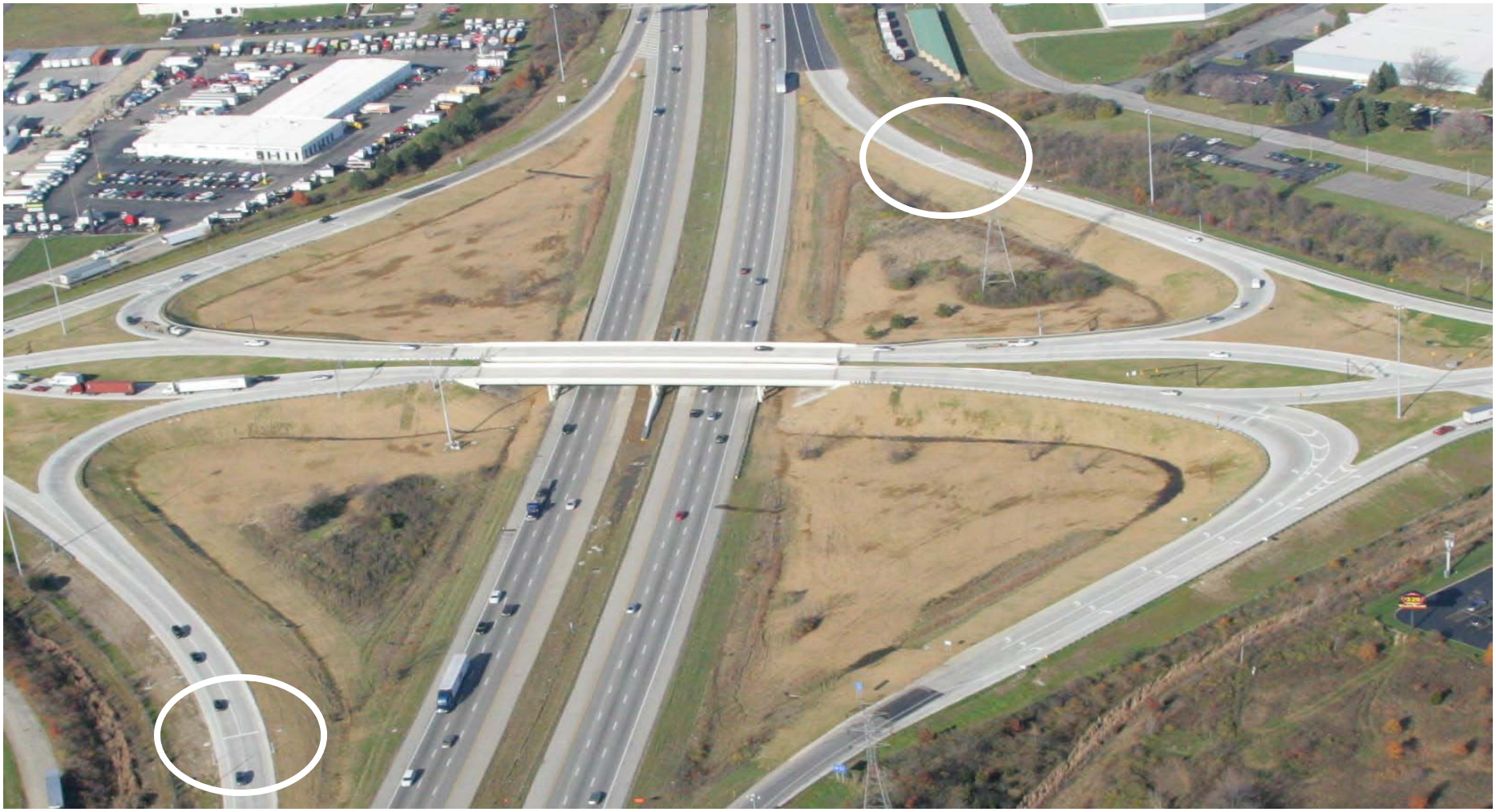
Figure 3-1. Signal Cabinet Pioneer Crossing DDI.

Detection at Signals

Stop Bar

- Video vs. Loops
- No significant difference in detection between Video and Loops as long as tangents run thru the intersections

Dilemma Zone

- Radar vs. Loops
- Loops allowed on bridge?
- Curvature not an issue; may just need multiple units or change locations

Design - Ramp Metering