Attachments

Attachment 1 - Triangle Expressway Gantry and Conduit Drawings

Attachment 2 – 6C TOC AVI Transponder Programming Standard

Attachment 3 – IBTTA NIOP Requirements Document

Attachment 4 – Monroe Gantry and Layout 50 Percent Plans

Attachment 5 – US-74 Conceptual Plans for AET

Attachment 6 – E-ZPass Group Test Scripts for Open Road Toll Facilities

Attachment 7 – E-ZPass Group Test Scripts for Traditional Plaza Toll Facilities

Attachment 8 – NCTA Proposed E-ZPass Group Test Script Execution for Category A – Readers

Attachment 9 – NCTA Proposed E-ZPass Group ORT Test Script Execution for Category B – TDM Transponders

Attachment 10 - NCTA Proposed E-ZPass Group Traditional Plaza Test Script Execution for Category B – TDM Transponders

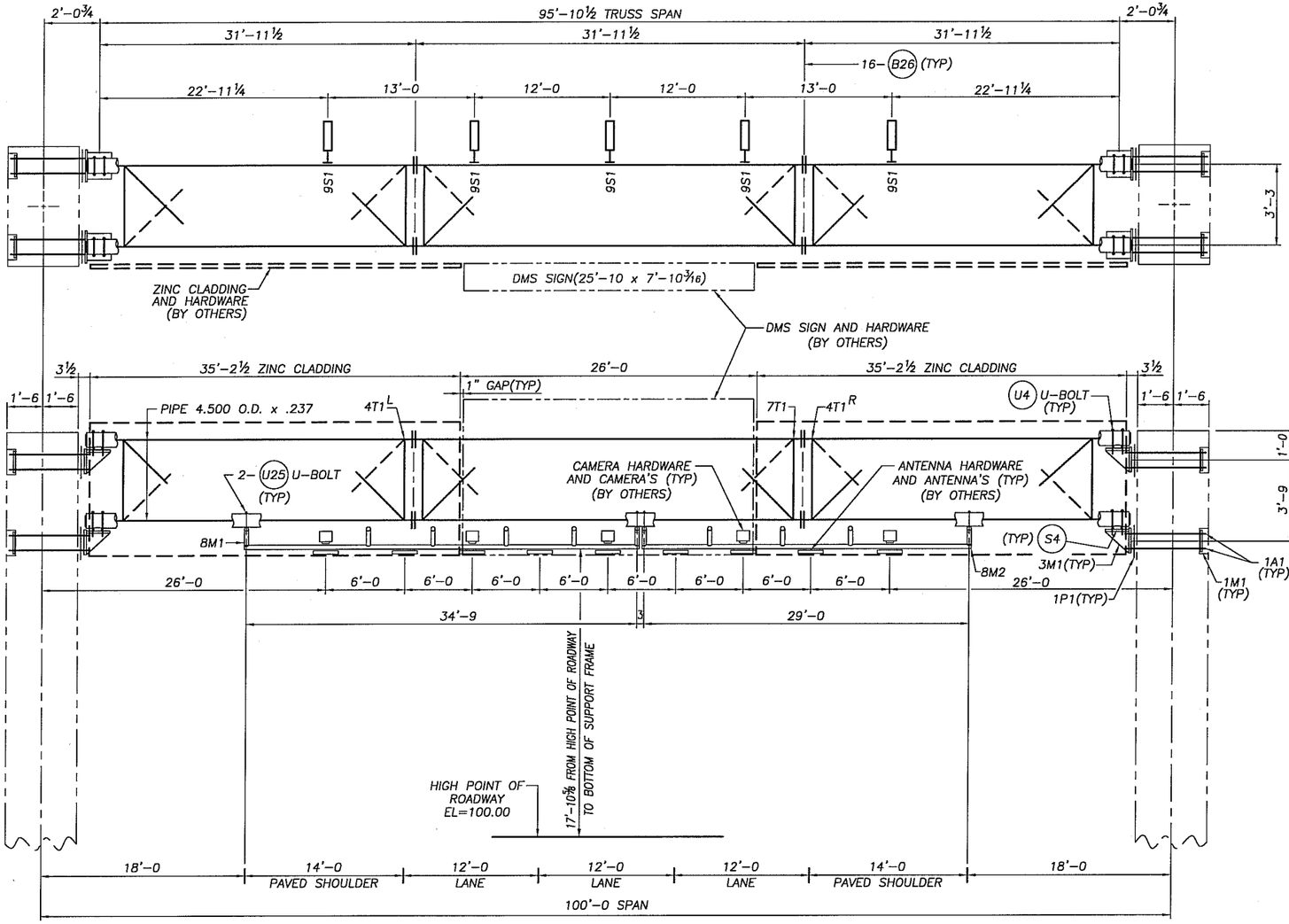
Attachment 11 – Triangle Expressway As-Built RTCS Drawings

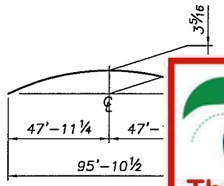
Attachment 12 – Monroe/US-74 Proposed RTCS Implementation Schedule

Attachment 1

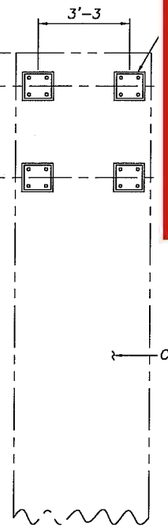
Triangle Expressway Gantry and Conduit Drawings

SHIPPING LIST		C1137–E1
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
2	4T1	TRUSSES 4.1' x 4.6' x 32.3'
		32'
		325 GALV)
		LW/FW(A325) (GALV)
		/(2)FW(A325) (GALV)
		LW/FW(A325) (GALV)
		S
		PLATES





CAMBER DIAGR



NORTH CAROLINA Turnpike Authority

This submittal has been reviewed and found to be:

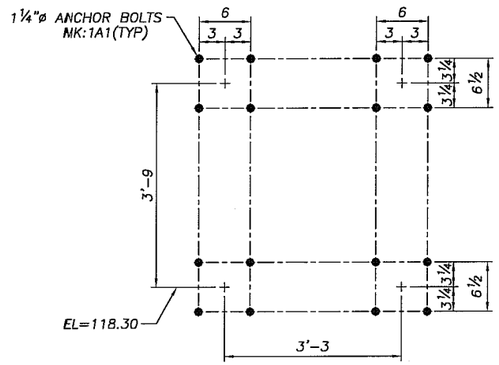
____Accepted

X Accepted as Noted

____Returned for Corrections

DLJ Initials

01/24/12 Date



ANCHOR BOLT LAYOUT

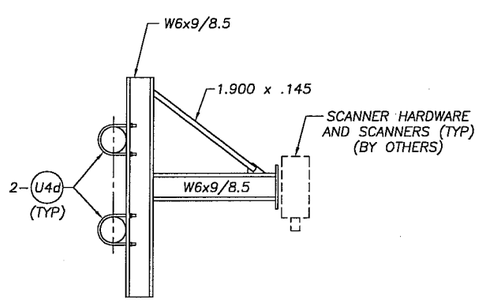
ELEVATION

STR NO: 1–1

STA NO: 66+65(NB) –LA–

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
0	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT– FOR APPROVAL	1/18/12	JLS	RRW

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

AASHTO 4th Edition Spec's

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4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

STATE:	North Carolina
FED PROJ:	-------
ST PROJ:	C201993 (R–2635A, B, C)
COUNTY:	Wake
ROUTE:	Western Wake Freeway
SUBJECT:	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	Raleigh–Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	RRW DATE: 11/2/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137–E1

D

BT–E

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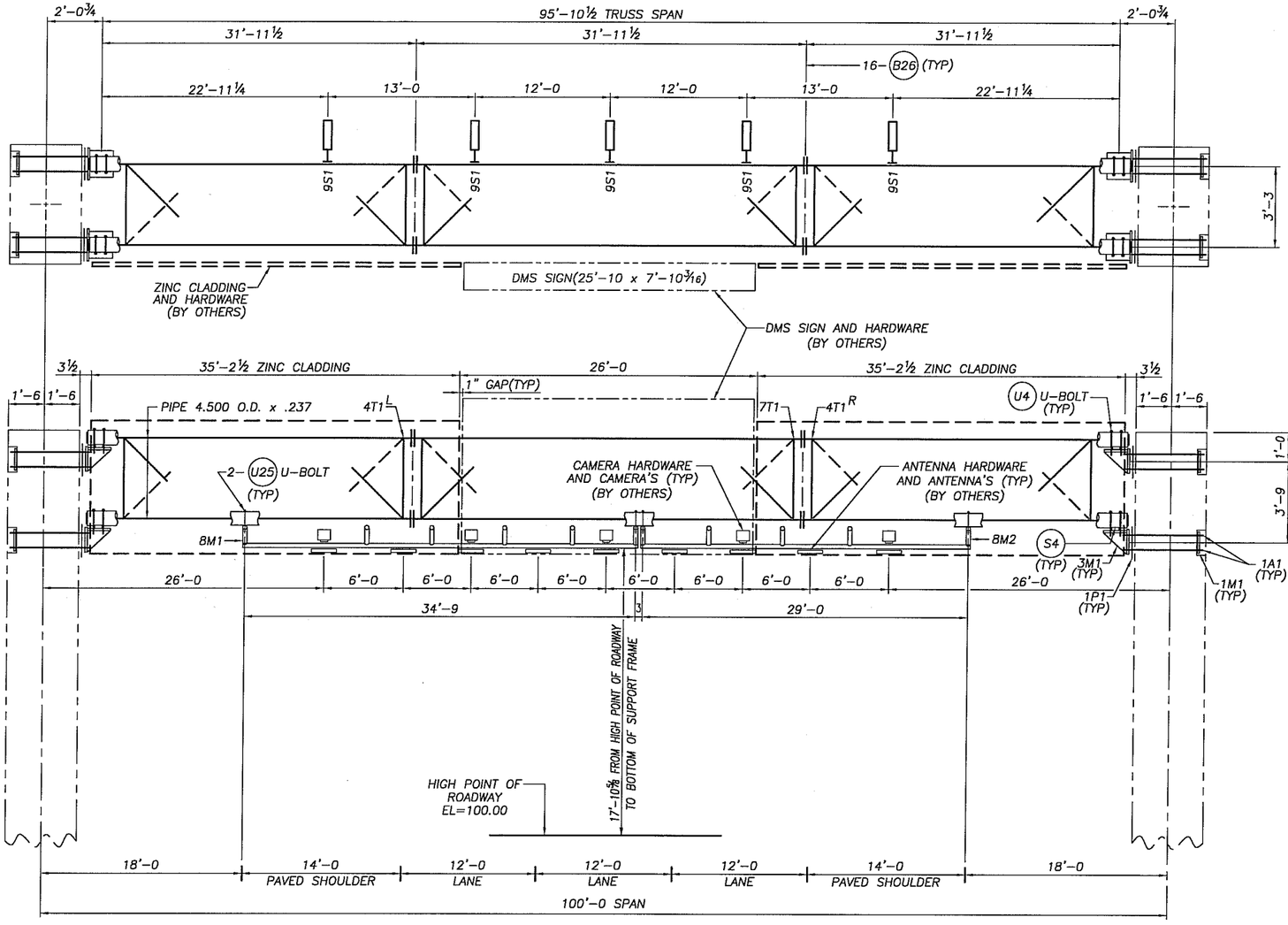
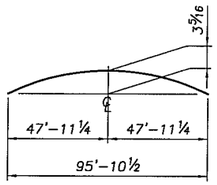
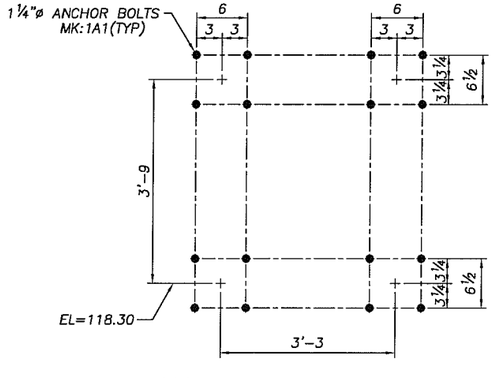




CAMBER DIAGRAM

SHIPPING LIST		C1137-E3
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
2	4T1L/R	TRUSSES 4.1' x 4.6' x 32.3'
1	7T1	TRUSS 4.1' x 4.6' x 32'
8	3M1	TRUSS SEATS
1	8M1	EQUIPMENT SUPPORTS
1	8M2	EQUIPMENT SUPPORTS
5	9S1	SCANNER SUPPORTS
32	B26	7/8" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	S4	SADDLE SHIMS #350
16	U4	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
20	U4d	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
22	U25	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	1P1	ANCHOR BOLT TEMPLATES
8	1M1	ANCHOR BOLT BACKING PLATES



ANCHOR BOLT LAYOUT

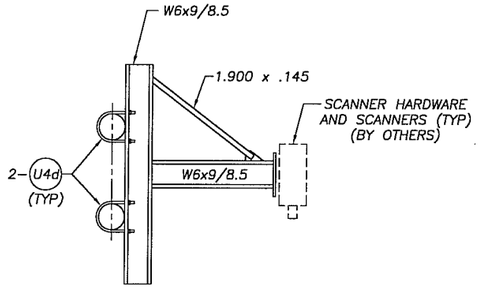
ELEVATION

STR NO: 1-3

STA NO: 67+15(SB) -LA-

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

NAME: E:\pcad\Jobs\Prg\1137\1137-E3.dwg DATE: JAN 18, 2012 TIME: 10:24 AM RobertW

BT-E

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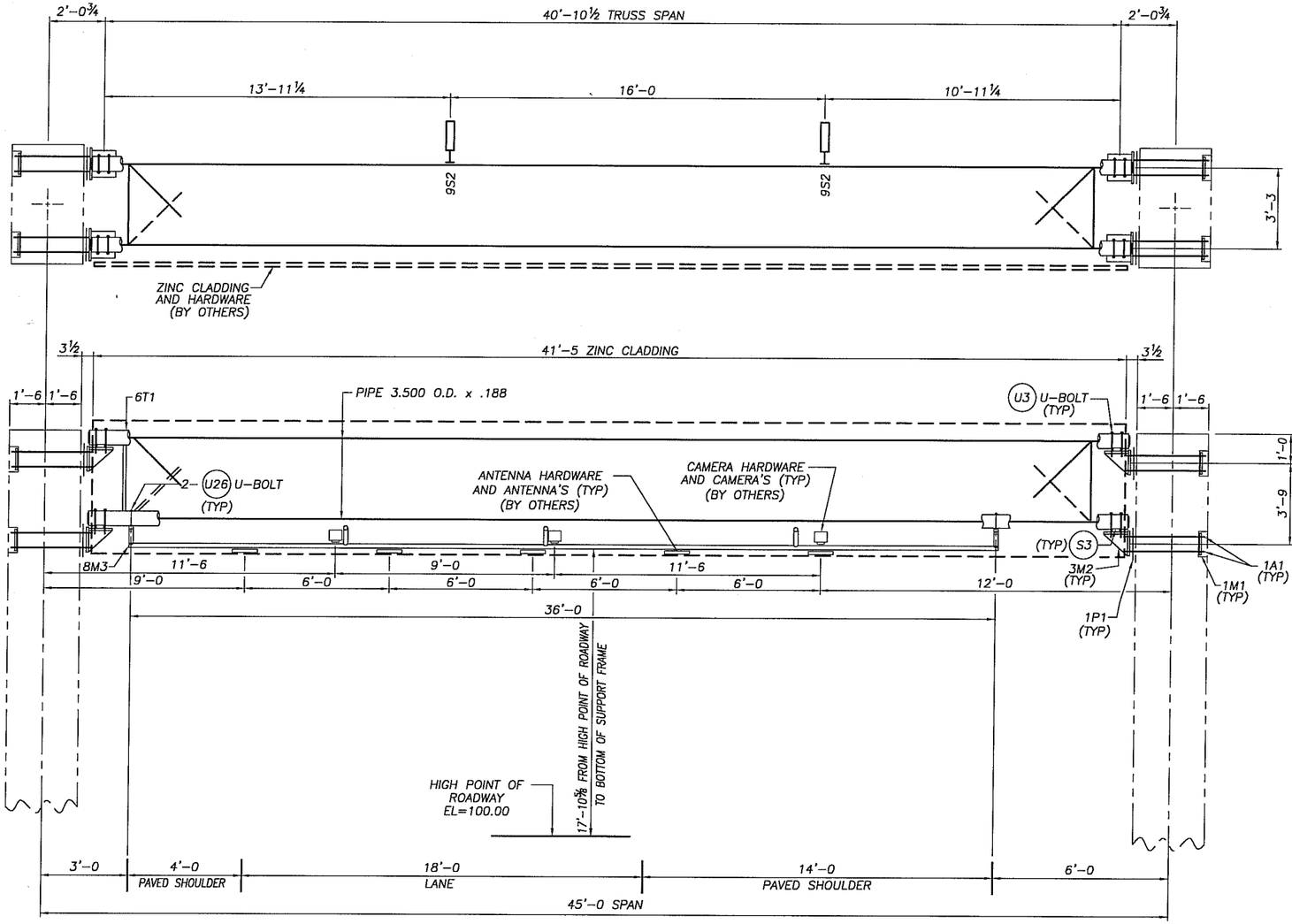
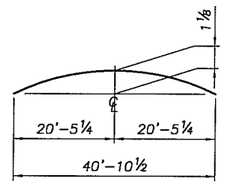
FAX (205) 925-7273

D

STATE:	North Carolina
FED PROJ:	-------
ST PROJ:	C201993 (R-2635A, B, C)
COUNTY:	Wake
ROUTE:	Western Wake Freeway
SUBJECT:	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	Raleigh-Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	RRW DATE: 11/2/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137-E3

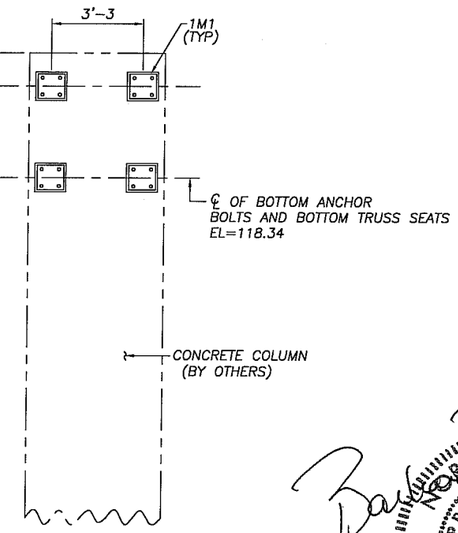
NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

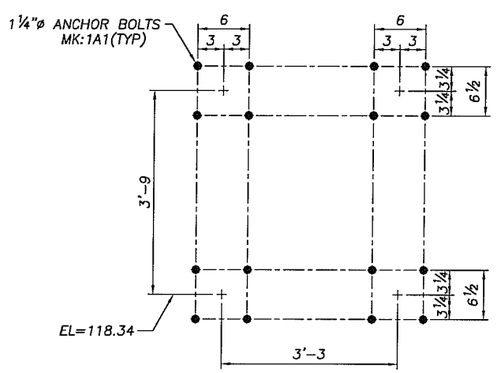




CAMBER DIAGRAM

SHIPPING LIST		C1137–E5
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
1	6T1	TRUSSES 3.5 x 4.0' x 41.5'
8	3M2	TRUSS SEATS
1	8M3	EQUIPMENT SUPPORTS
2	9S2	SCANNER SUPPORTS
8	S3	SADDLE SHIMS #357
16	U3	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
8	U3d	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
10	U26	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	1P1	ANCHOR BOLT TEMPLATES
8	1M1	ANCHOR BOLT BACKING PLATES





ANCHOR BOLT LAYOUT

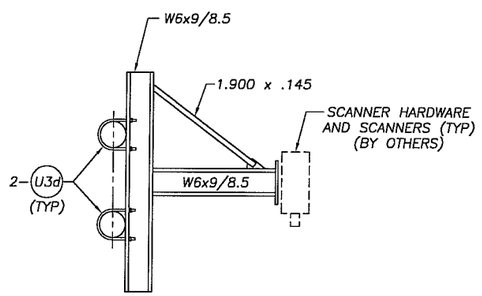
ELEVATION

STR NO: 2–1A

STA NO: 16+00 –Y5LPD–

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT– FOR APPROVAL	1/18/12	JLS	RRW

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

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BIRMINGHAM ALABAMA 35221
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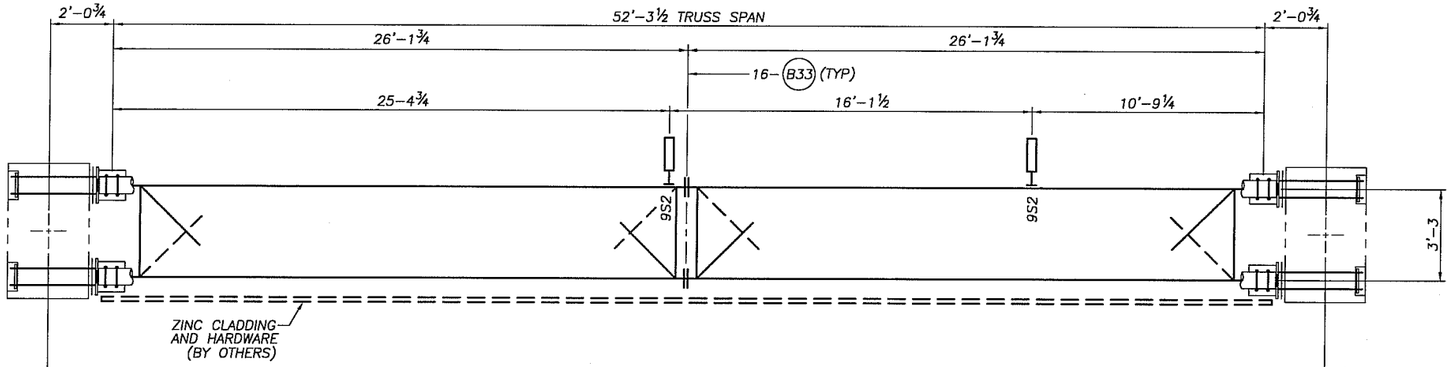
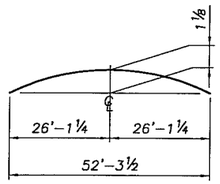
COUNTY:	Wake
ROUTE:	Western Wake Freeway
SUBJECT:	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	Raleigh–Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	RRW DATE: 11/2/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137–E5

D

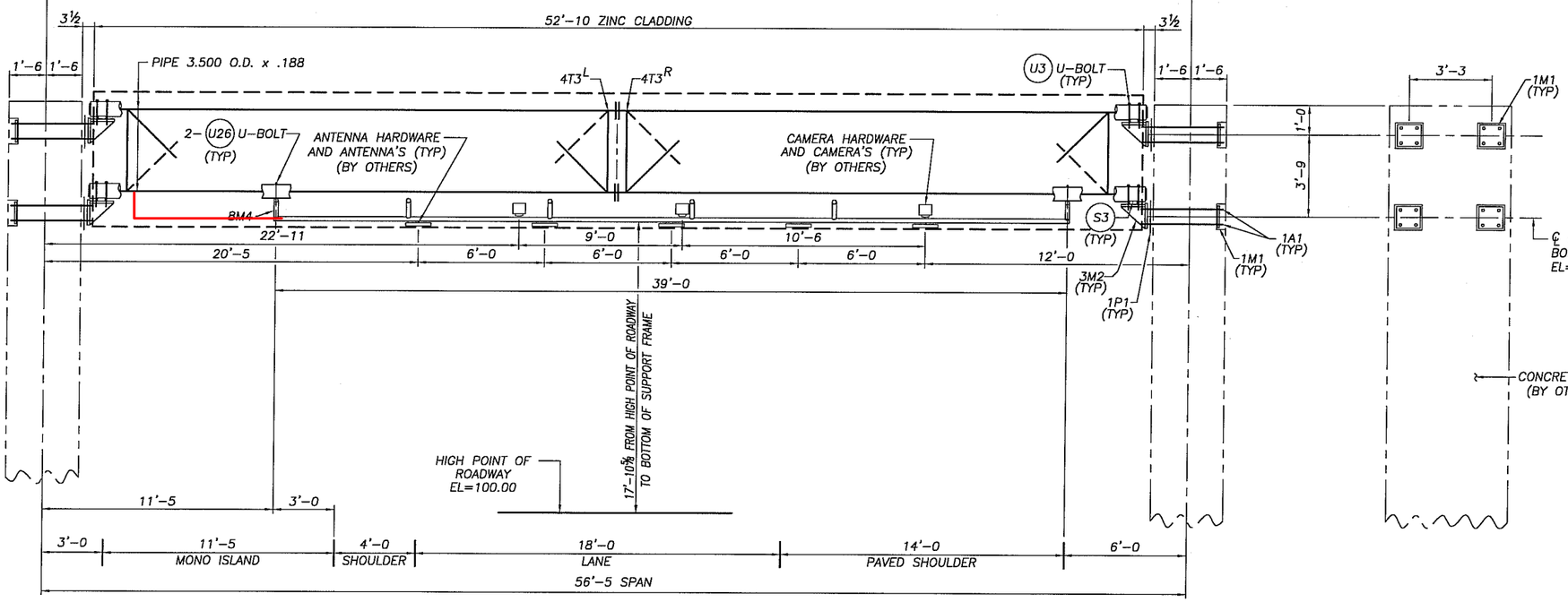
BT–E





CAMBER DIAGRAM

SHIPPING LIST		C1137-E7
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
2	4T3 5/8	TRUSSES 4.0' x 4.5' x 26.5'
8	3M2	TRUSS SEATS
1	8M4	EQUIPMENT SUPPORTS
2	9S2	SCANNER SUPPORTS
16	(B33)	3/4" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	(S3)	SADDLE SHIMS #357
16	(U3)	1/2" U-Bolts(A307) w/(2 eq) HN/LW/FW(A325) (GALV)
8	(U3d)	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
12	(U26)	1/2" U-Bolts(A307) w/(2 eq) HN/LW/FW(A325) (GALV)
–	1P1	ANCHOR BOLT TEMPLATES
8	1M1	ANCHOR BOLT BACKING PLATES



ELEVATION

STR NO: 2-2A

STA NO: 21+85 -Y5LPA-

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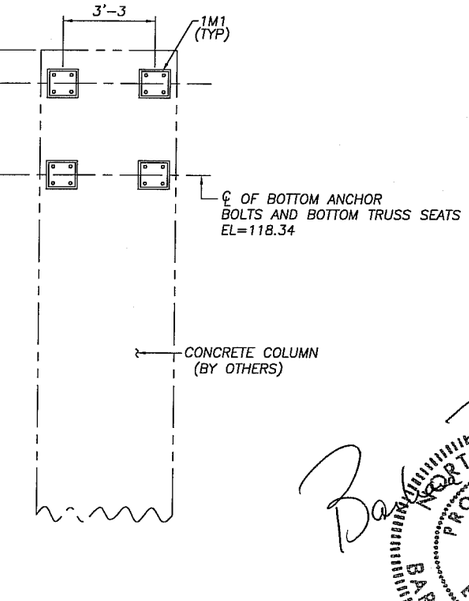
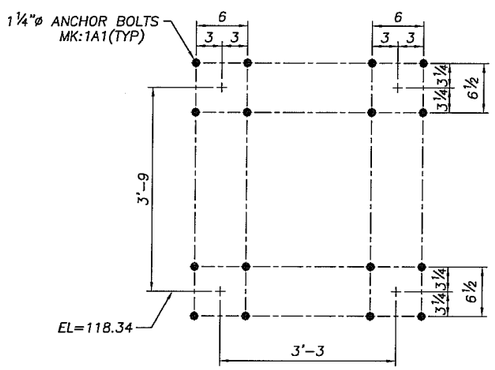
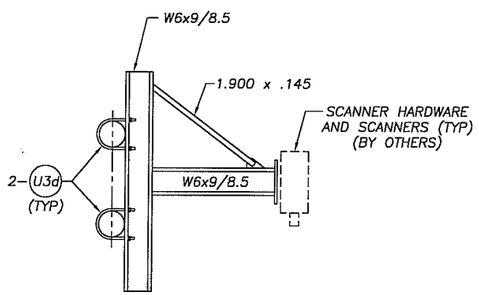
NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00





ANCHOR BOLT LAYOUT



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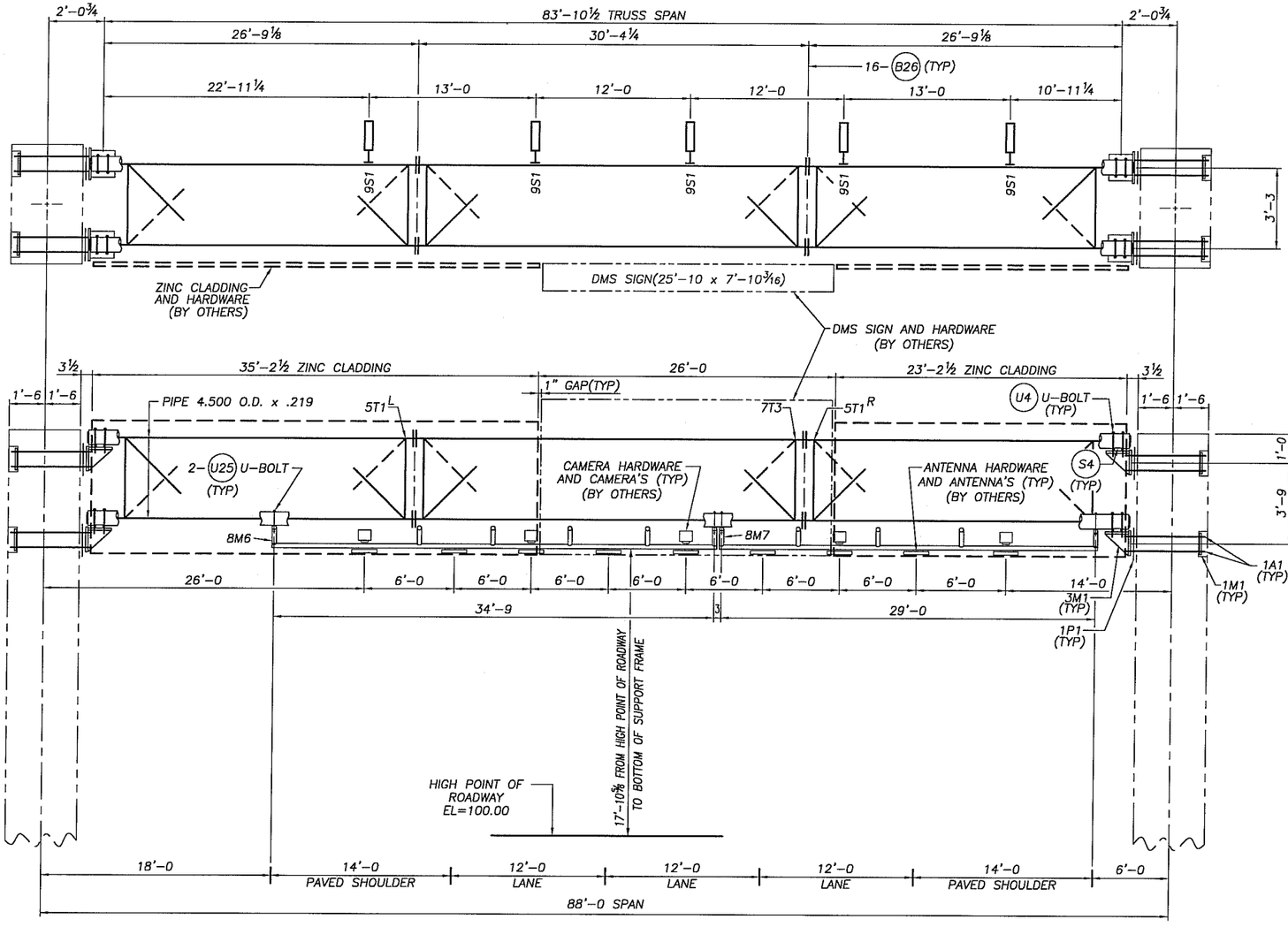
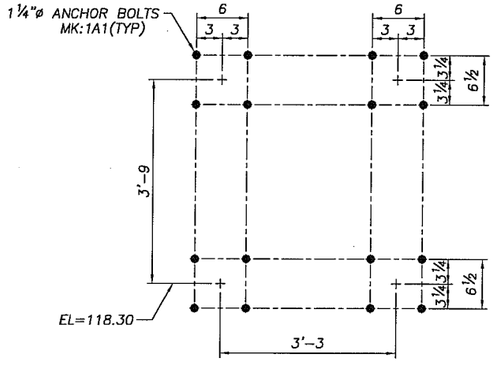
FOR:	Raleigh-Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	RRW DATE: 11/2/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137-E7

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

0

SHIPPING LIST		C1137-E9
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
2	5T1L/R	TRUSSES 4.1' x 4.6' x 27.1'
1	7T3	TRUSS 4.1' x 4.6' x 30.4'
8	3M1	TRUSS SEATS
1	8M6	EQUIPMENT SUPPORTS
1	8M7	EQUIPMENT SUPPORTS
5	9S1	SCANNER SUPPORTS
32	(B26)	7/8" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	(S4)	SADDLE SHIMS #350
16	(U4)	1/2" U-Bolts(A307) w/(2 eq) HN/LW/FW(A325) (GALV)
20	(U4d)	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
22	(U25)	1/2" U-Bolts(A307) w/(2 eq) HN/LW/FW(A325) (GALV)
–	1P1	ANCHOR BOLT TEMPLATES
8	1M1	ANCHOR BOLT BACKING PLATES





ANCHOR BOLT LAYOUT

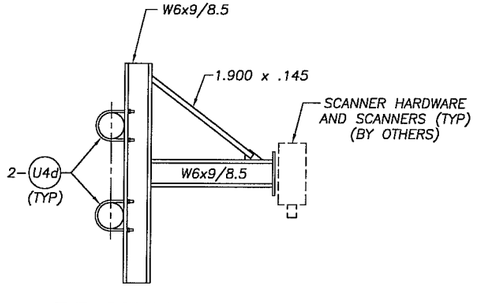
ELEVATION

STR NO: 3-1

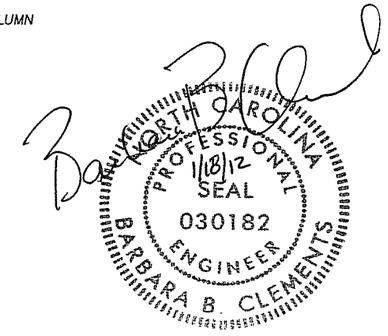
STA NO: 228+59(NB) -LB-

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT



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NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

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BT-E

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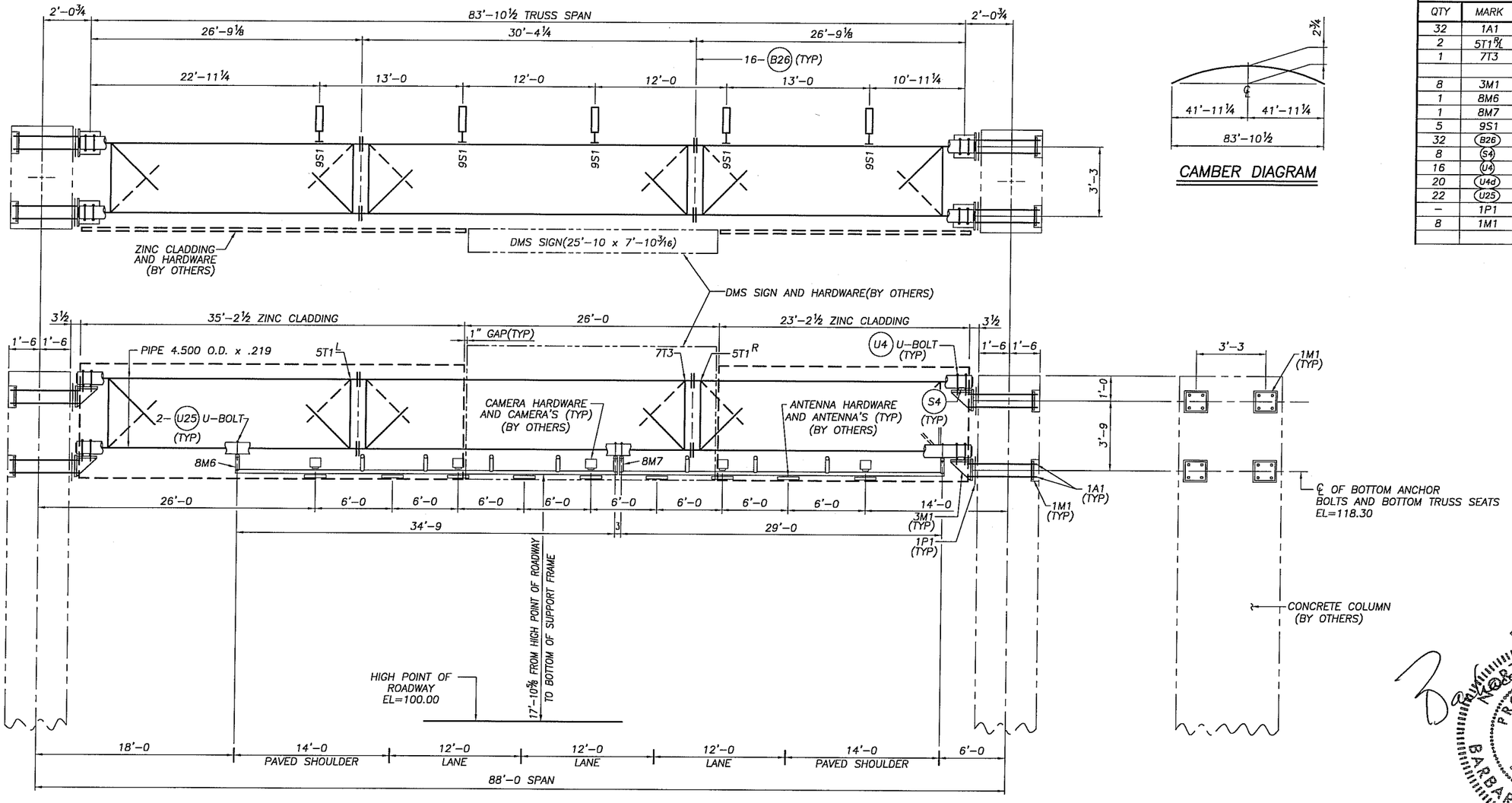
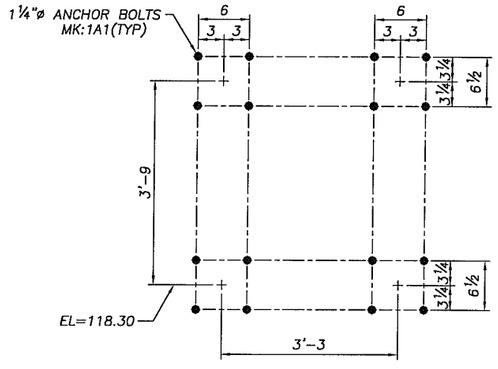


CAMBER DIAGRAM

SHIPPING LIST		C1137-E11
QTY	MARK	DESCRIPTION
32	1A1	ANCHOR BOLTS
2	5T1℄	TRUSSES 4.1' x 4.6' x 27.1'
1	7T3	TRUSS 4.1' x 4.6' x 30.4'
8	3M1	TRUSS SEATS
1	8M6	EQUIPMENT SUPPORTS
1	8M7	EQUIPMENT SUPPORTS
5	9S1	SCANNER SUPPORTS
32	B26	7/8" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	S4	SADDLE SHIMS #350
16	U4	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
20	U4d	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
22	U25	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	1P1	ANCHOR BOLT TEMPLATES
8	1M1	ANCHOR BOLT BACKING PLATES



ANCHOR BOLT LAYOUT

ELEVATION

STR NO: 3-3

STA NO: 229+09(SB) -LB-

(LOOKING IN DIRECTION OF TRAFFIC)

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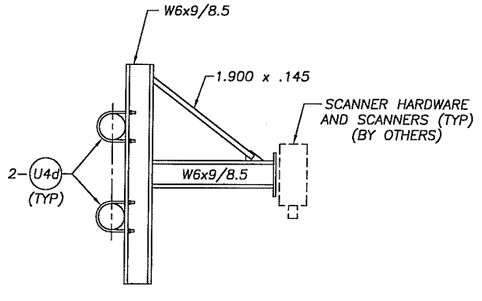


TYP SCANNER SUPPORT

AASHTO 4th Edition Spec's

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

D

STATE: North Carolina
FED PROJ: -------
ST PROJ: C201993 (R-2635A, B, C)
COUNTY: Wake
ROUTE: Western Wake Freeway

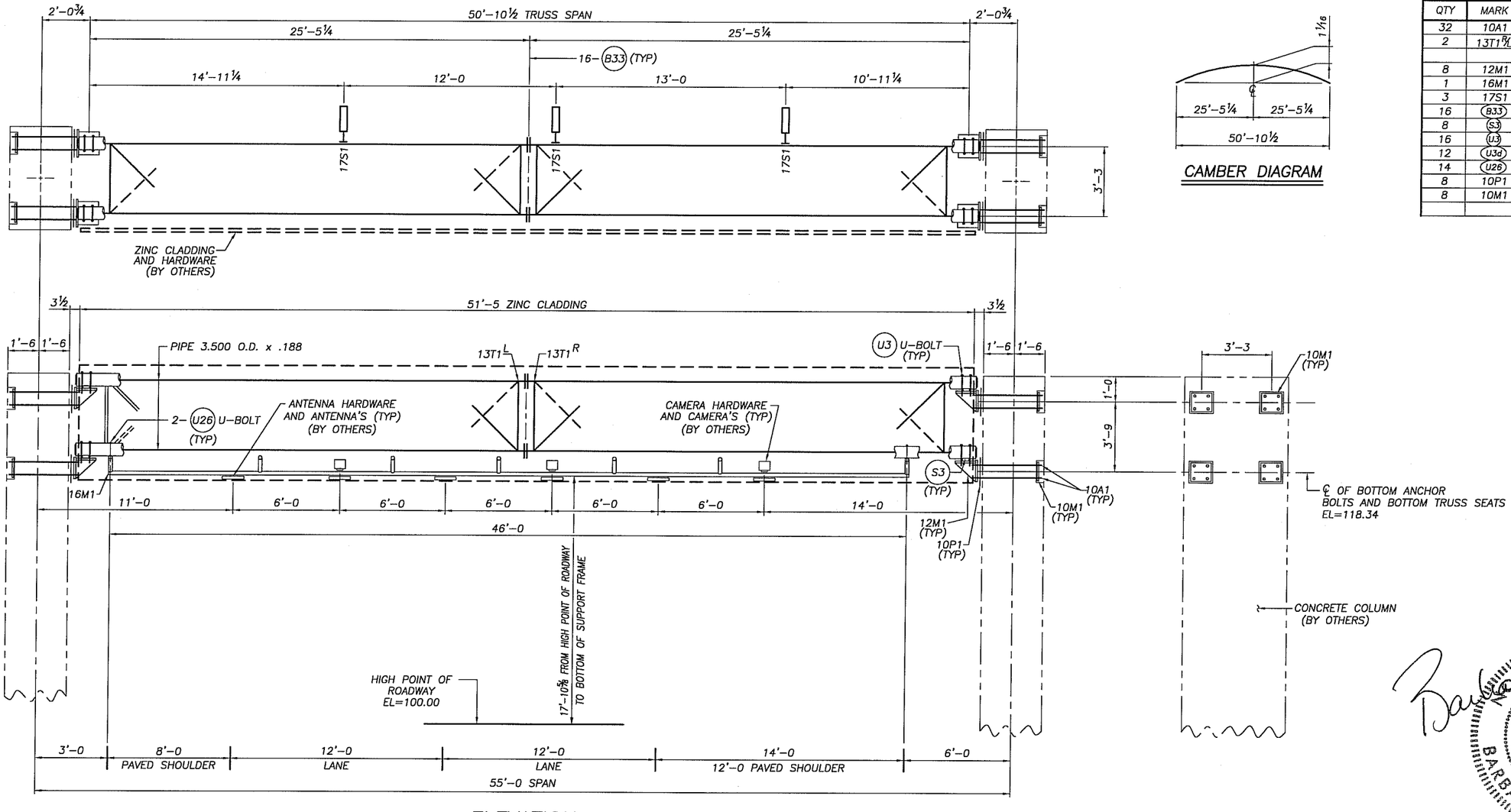
SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: Raleigh-Durham Roadbuilders

DRAWN BY: JLS DATE: 10/26/11
CHECKED BY: RRW DATE: 11/2/11
RELEASE FOR CONSTRUCTION: ☐ DWG NO: C1137-E11

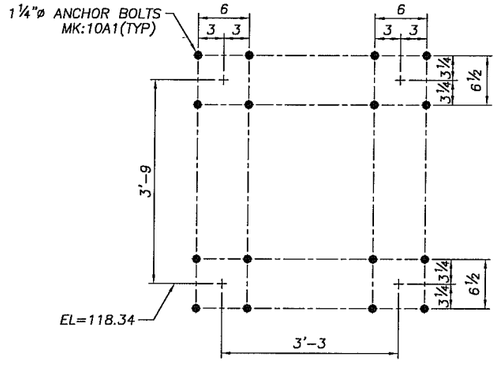
NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

BT-E

SHIPPING LIST		C1137-E13
QTY	MARK	DESCRIPTION
32	10A1	ANCHOR BOLTS
2	13T1 R/L	TRUSSES 4.0' x 4.5' x 25.8'
8	12M1	TRUSS SEATS
1	16M1	EQUIPMENT SUPPORTS
3	17S1	SCANNER SUPPORTS
16	B33	3/4" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	S3	SADDLE SHIMS #357
16	U3	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
12	U3d	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
14	U26	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
8	10P1	ANCHOR BOLT TEMPLATES
8	10M1	ANCHOR BOLT BACKING PLATES



CAMBER DIAGRAM



ANCHOR BOLT LAYOUT

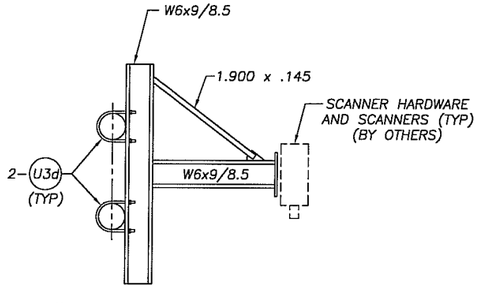
ELEVATION

STR NO: 4-1A

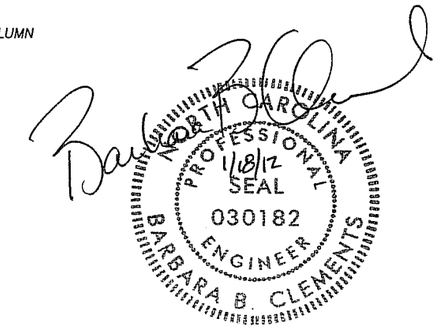
STA NO: 57+70.99 -CD1-

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT



AASHTO 4th Edition Spec's

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

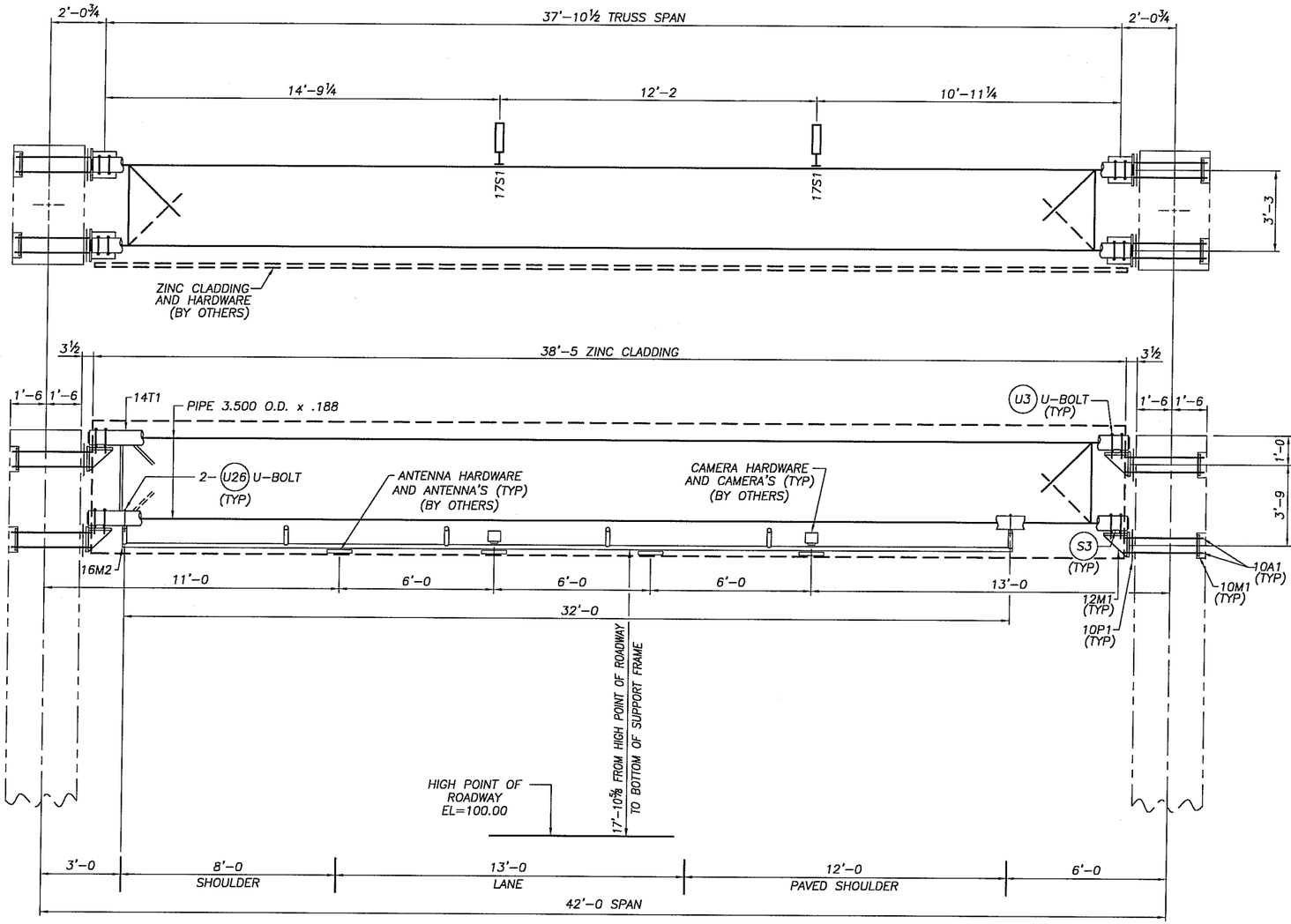
STATE:	North Carolina
FED PROJ:	-------
ST PROJ:	C201993 (R-2635A, B, C)
COUNTY:	Wake
ROUTE:	Western Wake Freeway
SUBJECT:	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	Raleigh-Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	JEFF DATE: 10/31/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137-E13

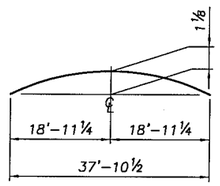
NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

BT-E

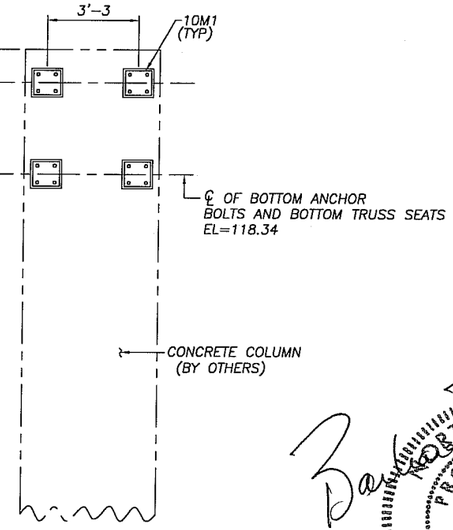
NAME: E:\pcad\JobsNPrg\1137\1137-E13.dwg DATE: JAN 18, 2012 TIME: 11:30 AM RobertW

D

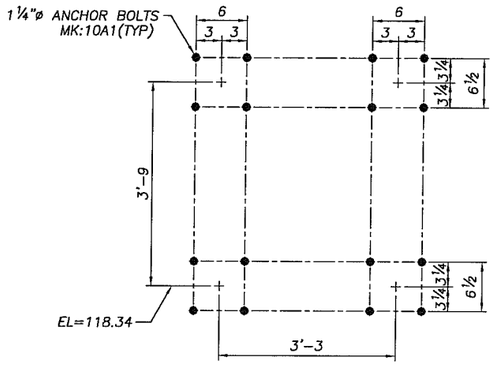




CAMBER DIAGRAM



SHIPPING LIST		C1137-E15
QTY	MARK	DESCRIPTION
32	10A1	ANCHOR BOLTS
1	14T1	TRUSS 3.5 x 4.0' x 38.5'
8	12M1	TRUSS SEATS
1	16M2	EQUIPMENT SUPPORTS
2	17S1	SCANNER SUPPORTS
8	S3	SADDLE SHIMS #357
16	U3	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
8	U3d	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
12	U26	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	10P1	ANCHOR BOLT TEMPLATES
8	10M1	ANCHOR BOLT BACKING PLATES



ANCHOR BOLT LAYOUT

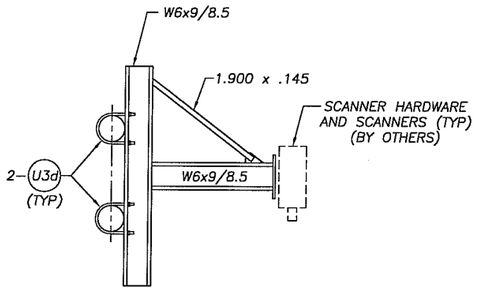
ELEVATION

STR NO: 4-2A

STA NO: 11+33.52 -CD2-

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
1	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

NAME: E:\cocad\JobsNPrg\1137\1137-E15.dwg DATE: JAN 18, 2012 TIME: 11:31 AM RobertW

AASHTO 4th Edition Spec's

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

D

BT-E

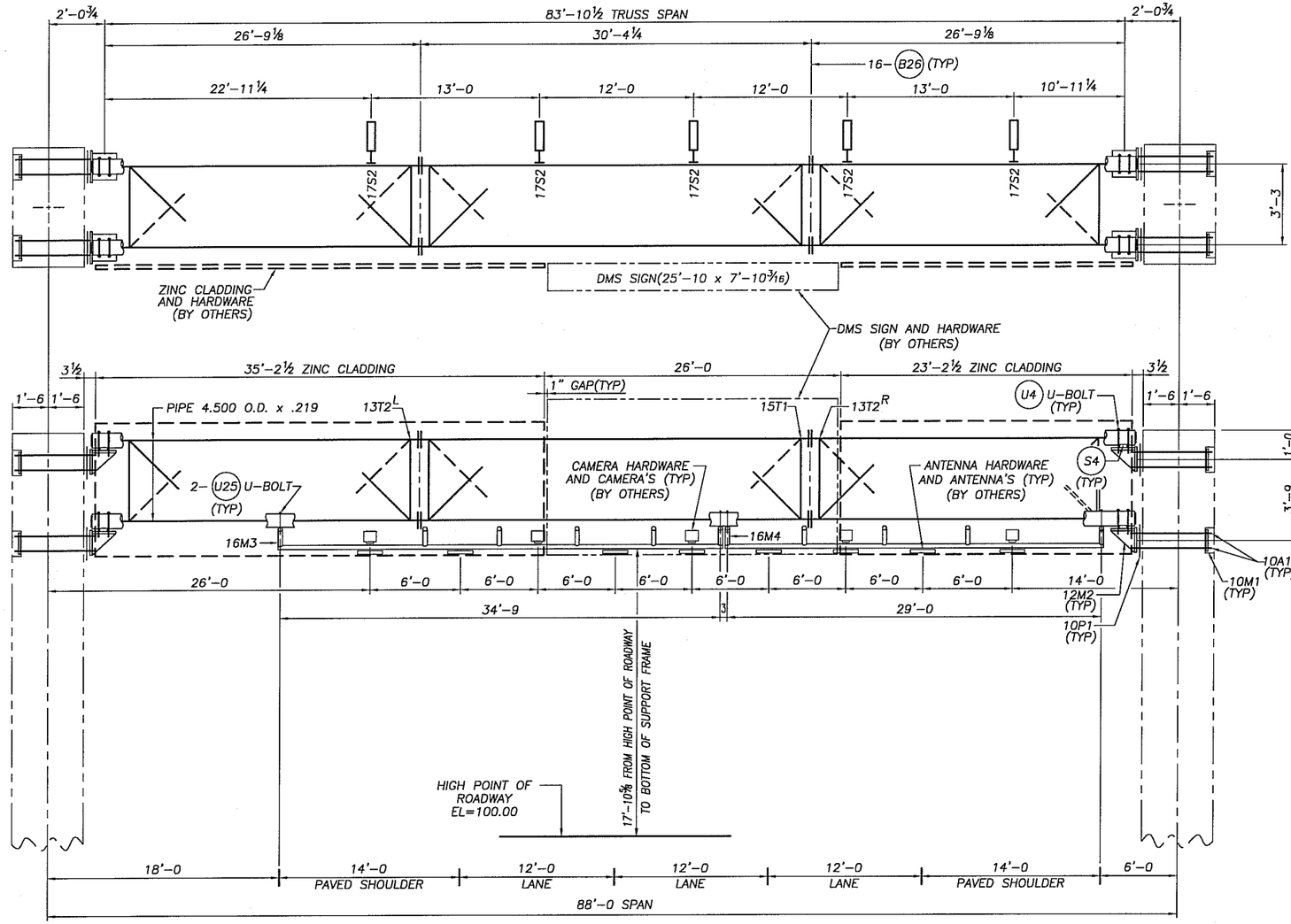
STATE: North Carolina
FED PROJ: -------
ST PROJ: C201993 (R-2635A, B, C)
COUNTY: Wake
ROUTE: Western Wake Freeway

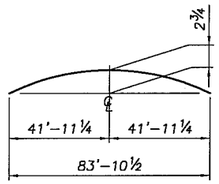
SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: Raleigh-Durham Roadbuilders

DRAWN BY: JLS DATE: 10/26/11
CHECKED BY: JEFF DATE: 11/1/11
RELEASE FOR CONSTRUCTION: ☐ DWG NO: C1137-E15

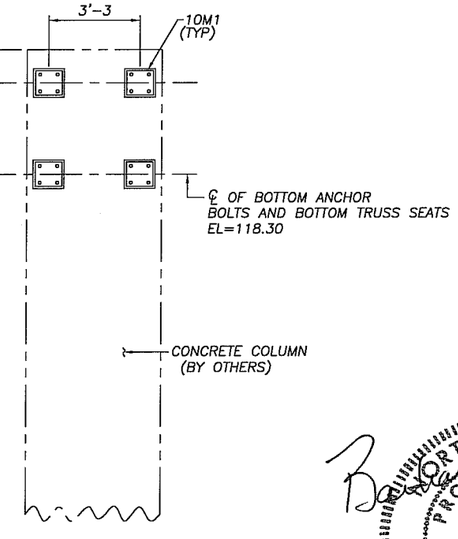
NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

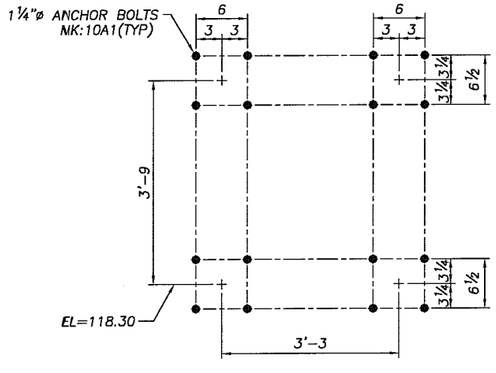
SHIPPING LIST		C1137-E17
QTY	MARK	DESCRIPTION
32	10A1	ANCHOR BOLTS
2	13T2R/L	TRUSSES 4.1' x 4.6' x 27.1'
1	15T1	TRUSS 4.1' x 4.6' x 30.4'
8	12M2	TRUSS SEATS
1	16M3	EQUIPMENT SUPPORTS
1	16M4	EQUIPMENT SUPPORTS
5	17S2	SCANNER SUPPORTS
32	(B26)	7/8" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	(S4)	SADDLE SHIMS #350
16	(U4)	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
20	(U4d)	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
22	(U25)	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	10P1	ANCHOR BOLT TEMPLATES
8	10M1	ANCHOR BOLT BACKING PLATES





CAMBER DIAGRAM





ANCHOR BOLT LAYOUT

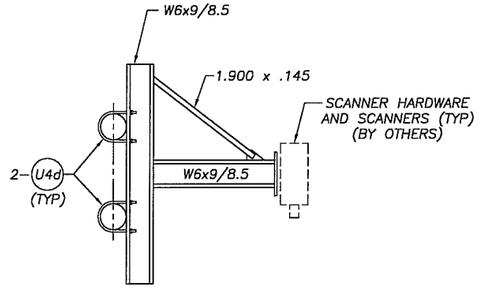
ELEVATION

STR NO: 5-1

STA NO: 509+86.51(NB) -LC2-

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT- FOR APPROVAL	1/18/12	JLS	RRW

NAME: E:\pcad\JobsNrtg\1137\1137-E17.dwg DATE: JAN 18, 2012 TIME: 11:31 AM RobertW

BT-E

AASHTO 4th Edition Spec's

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

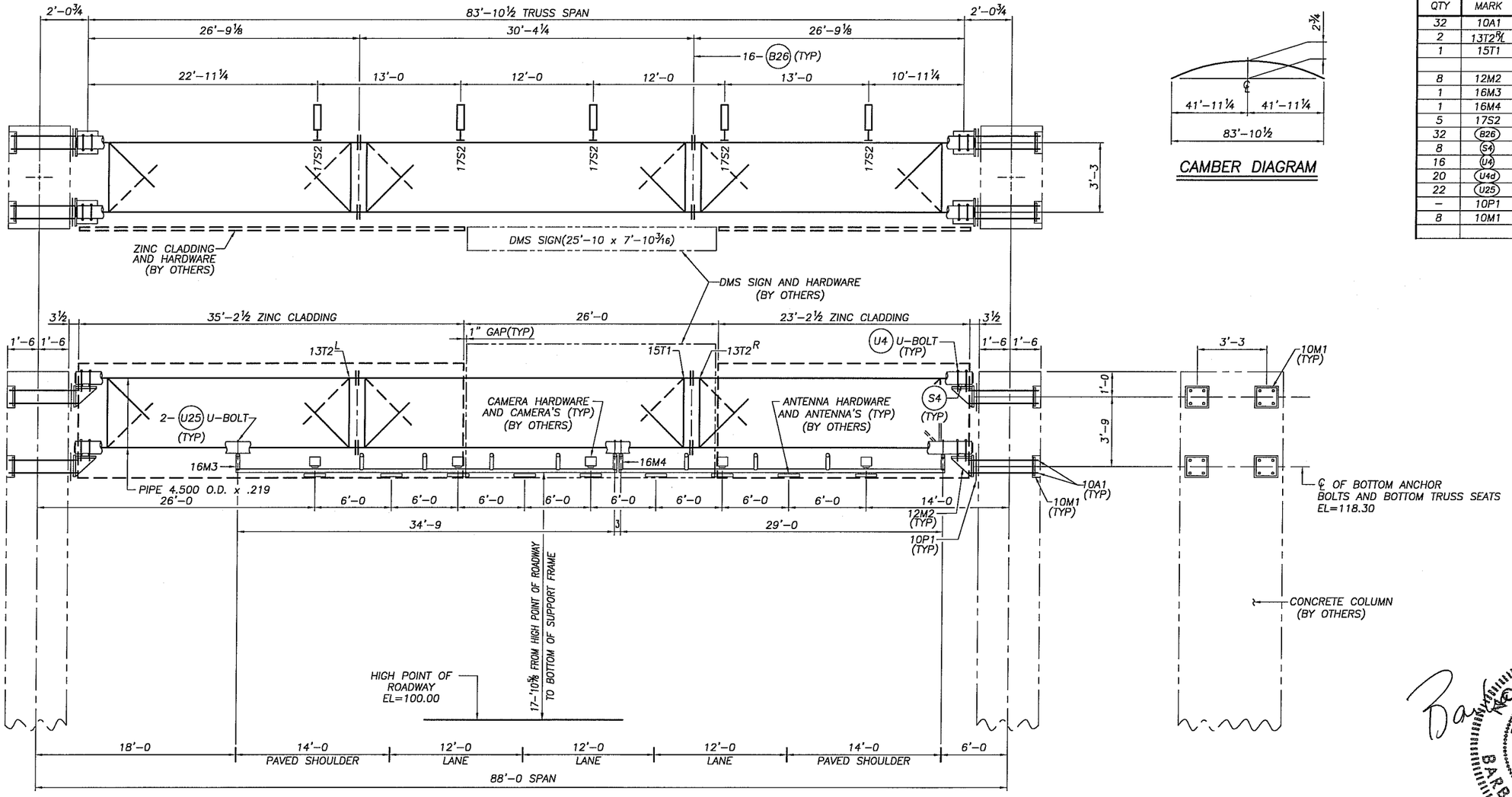
D

STATE:	North Carolina
FED PROJ:	-------
ST PROJ:	C201993 (R-2635A, B, C)
COUNTY:	Wake
ROUTE:	Western Wake Freeway
SUBJECT:	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	Raleigh-Durham Roadbuilders
DRAWN BY:	JLS DATE: 10/26/11
CHECKED BY:	JEFF DATE: 11/1/11
RELEASE FOR CONSTRUCTION: ☐	DWG NO: C1137-E17

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

0

SHIPPING LIST		C1137–E19
QTY	MARK	DESCRIPTION
32	10A1	ANCHOR BOLTS
2	13T2L,R	TRUSSES 4.1' x 4.6' x 27.1'
1	15T1	TRUSS 4.1' x 4.6' x 30.4'
8	12M2	TRUSS SEATS
1	16M3	EQUIPMENT SUPPORTS
1	16M4	EQUIPMENT SUPPORTS
5	17S2	SCANNER SUPPORTS
32	(B26)	7/8" x 3" HHB w/HN/FW/DTI/ (A325 GALV)
8	(S4)	SADDLE SHIMS #350
16	(U4)	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
20	(U4d)	1/2" U-Bolts(A307) w/(4)HN/(2)LW/(2)FW(A325) (GALV)
22	(U25)	1/2" U-Bolts(A307) w/(2 ea) HN/LW/FW(A325) (GALV)
–	10P1	ANCHOR BOLT TEMPLATES
8	10M1	ANCHOR BOLT BACKING PLATES



CAMBER DIAGRAM

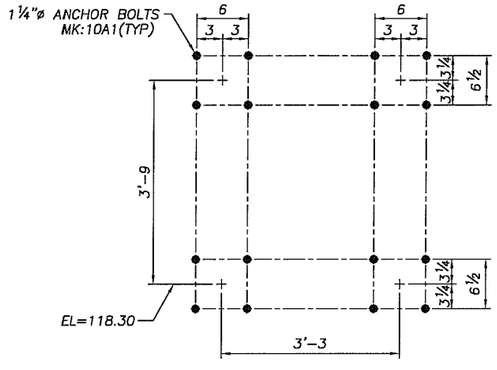
ELEVATION

STR NO: 5–3

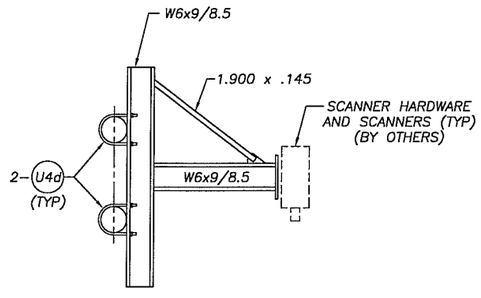
STA NO: 510+36.51(SB) –LC2–

(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER. ALL ELEVATIONS ARE BASED ON A HIGH POINT OF ROADWAY BENCHMARK ELEVATION OF 100.00



ANCHOR BOLT LAYOUT



TYP SCANNER SUPPORT

NO:	REVISIONS	DATE	MADE	CHECKED
D	REVISED DIM FROM HIGH POINT TO BTM OF SUPPORT– FOR APPROVAL	1/18/12	JLS	RRW

NAME: E:\pcad\JobsNPrg\11137\11137–E19.dwg DATE: JAN 18, 2012 TIME: 11:31 AM RobertW

AASHTO 4th Edition Spec's

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

D

STATE: North Carolina
FED PROJ: -------
ST PROJ: C201993 (R–2635A, B, C)
COUNTY: Wake
ROUTE: Western Wake Freeway

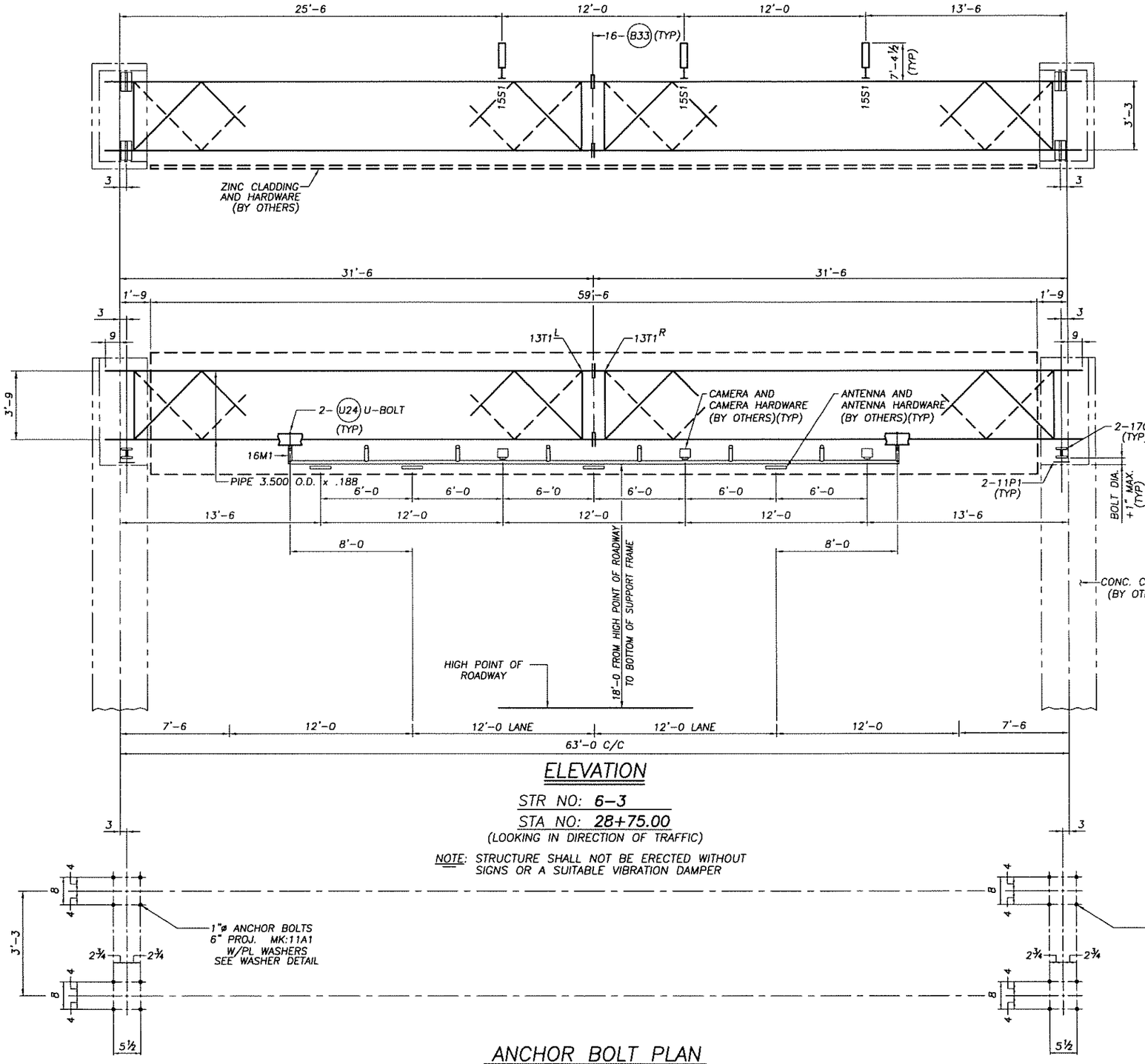
SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: Raleigh–Durham Roadbuilders

DRAWN BY: JLS DATE: 10/26/11
CHECKED BY: JEFF DATE: 11/1/11
RELEASE FOR CONSTRUCTION: ☐ DWG NO: C1137–E19

BT–E

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 1/18/12

SHIPPING LIST		C1040-E13
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
4	11P1	ANCHOR BOLT TEMPLATES
2	13T1L/R	TRUSSES 4' x 4.5' x 32.3'
4	17C1	TRUSS MOUNTING BEAM
3	15S1	SCANNER SUPPORTS
1	16M1	SUPPORT FRAME
16	(B33)	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	(S3)	SADDLE SHIMS #357
20	(U3)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
16	(U24)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

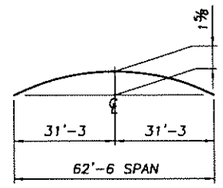
STR NO: 6-3

STA NO: 28+75.00

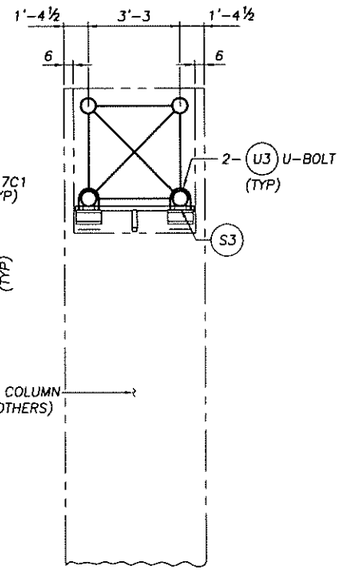
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

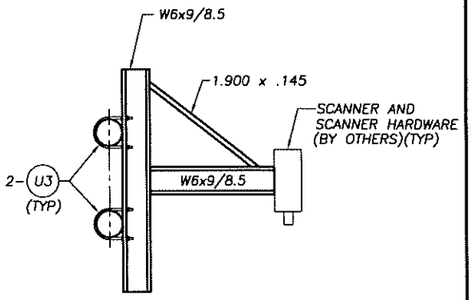
ANCHOR BOLT PLAN



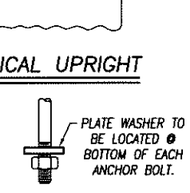
CAMBER DIAGRAM



TYPICAL UPRIGHT



TYP. SCANNER SUPPORT



WASHER DETAIL

(TYPICAL)

NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER BARBARA B. CLEMENTS 8/3/10

NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

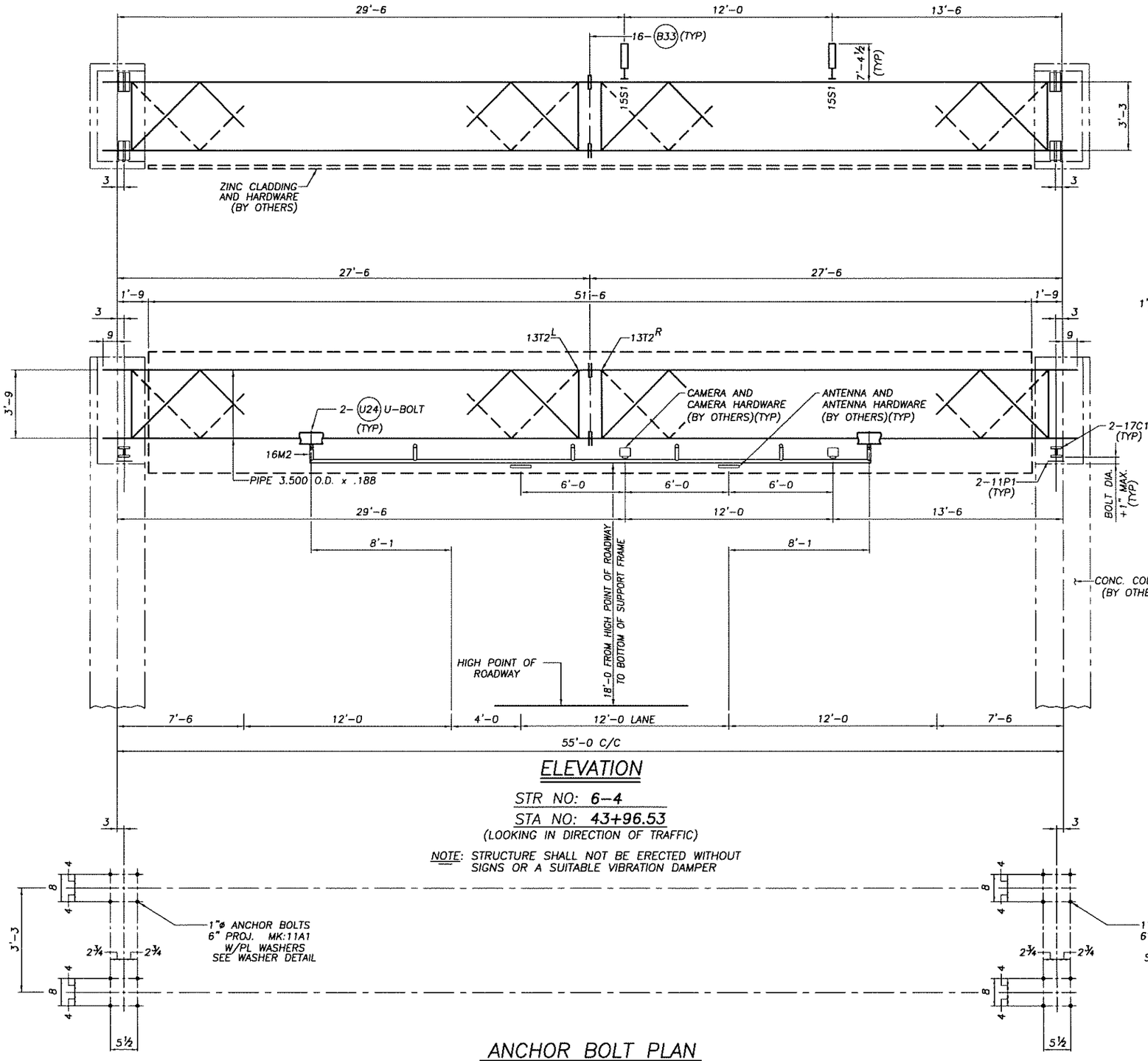
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE: NORTH CAROLINA
FED. PROJ.:
ST. PROJ.: C201994/U-4763B
COUNTY: DURHAM/WAKE
ROUTE: TRIANGLE EXPRESSWAY

SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: T&H ELECTRICAL CORP.

DRAWN BY: JLS DATE: 3/23/10, 6/23/10
CHECKED BY: CC DATE: 5/27/10, 6/23/10
APPROVED: DWG. NO. C1040-E13

SHIPPING LIST		C1040-E15
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	13T2 L/R	TRUSSES 4' x 4.5' x 28.3'
4	17C1	TRUSS MOUNTING BEAM
2	15S1	SCANNER SUPPORTS
1	16M2	SUPPORT FRAME
16	(B33)	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	(S3)	SADDLE SHIMS #357
16	(U3)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
12	(U24)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

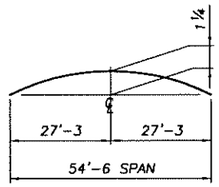
STR NO: 6-4

STA NO: 43+96.53

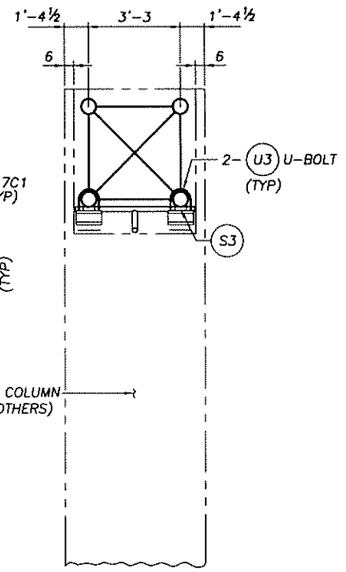
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

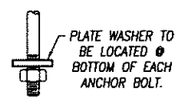
ANCHOR BOLT PLAN



CAMBER DIAGRAM

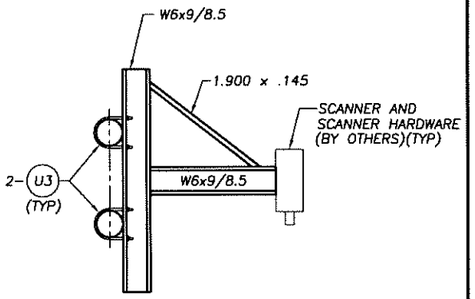


TYPICAL UPRIGHT

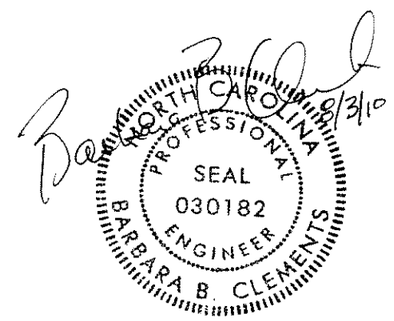


WASHER DETAIL

(TYPICAL)



TYP. SCANNER SUPPORT



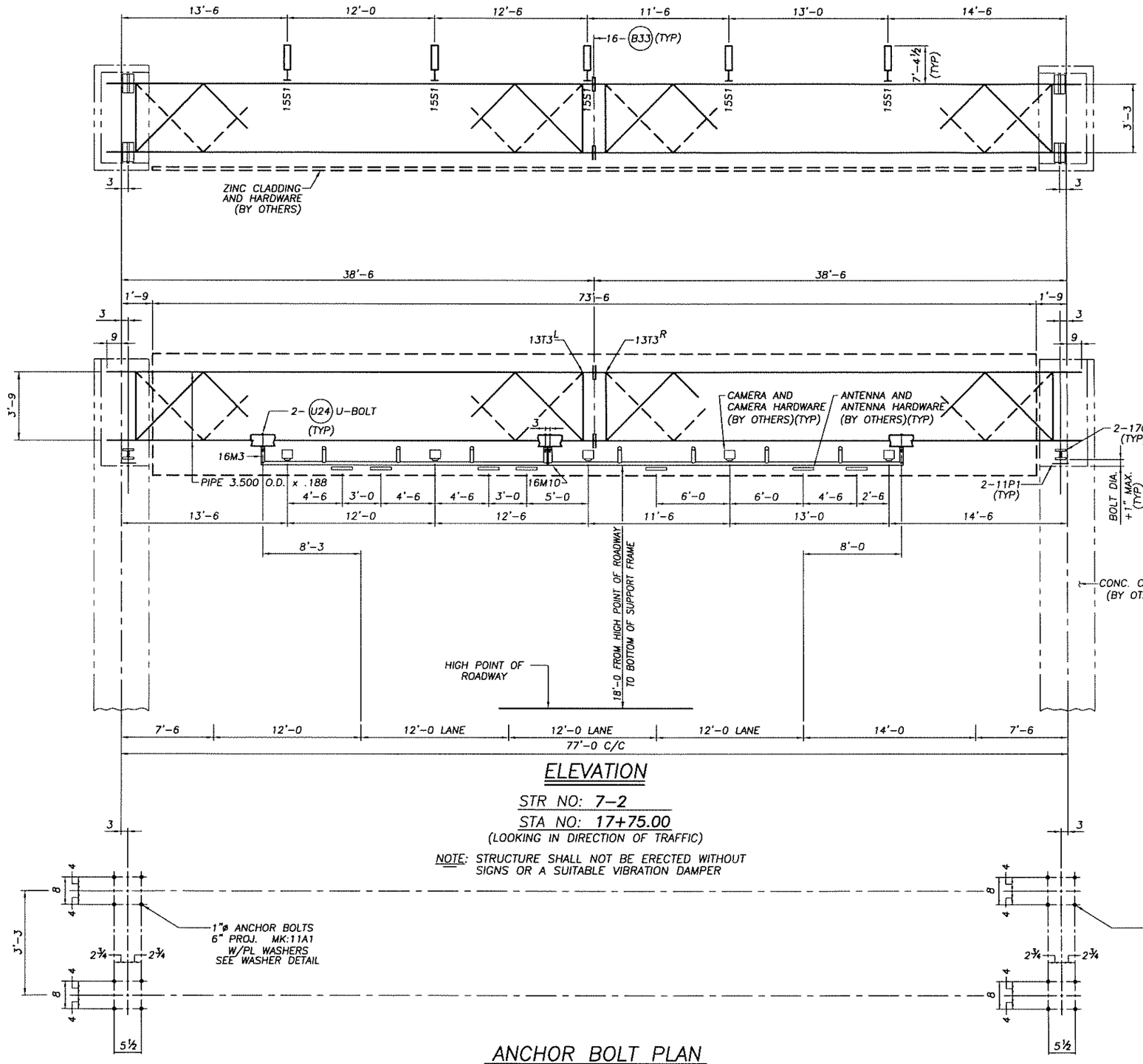
NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE:	NORTH CAROLINA
FED. PROJ.:	
ST. PROJ.:	C201994/U-4763B
COUNTY:	DURHAM/WAKE
ROUTE:	TRIANGLE EXPRESSWAY
SUBJECT	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	T&H ELECTRICAL CORP.
DRAWN BY	JLS DATE 3/23/10,6/23/10
CHECKED BY	CC DATE 5/27/10, 6/23/10
APPROVED	DWG. NO. C1040-E15

SHIPPING LIST		C1040-E17
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	13T3R/L	TRUSSES 4' x 4.5' x 39.3'
4	17C1	TRUSS MOUNTING BEAM
5	15S1	SCANNER SUPPORTS
1	16M3	SUPPORT FRAME
1	16M10	SUPPORT FRAME
16	B33	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	S3	SADDLE SHIMS #357
28	U3	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
22	U24	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

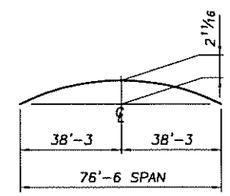
STR NO: 7-2

STA NO: 17+75.00

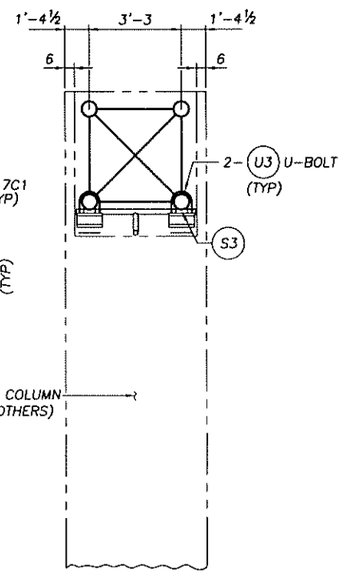
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

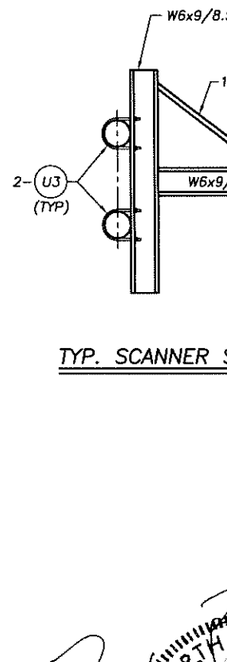
ANCHOR BOLT PLAN



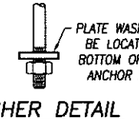
CAMBER DIAGRAM



TYPICAL UPRIGHT

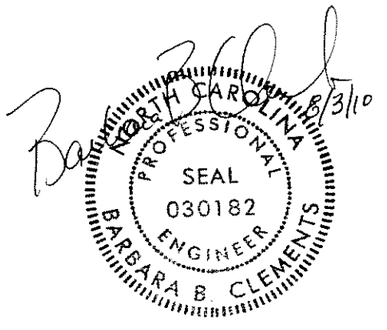


TYP. SCANNER SUPPORT



WASHER DETAIL

(TYPICAL)



NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

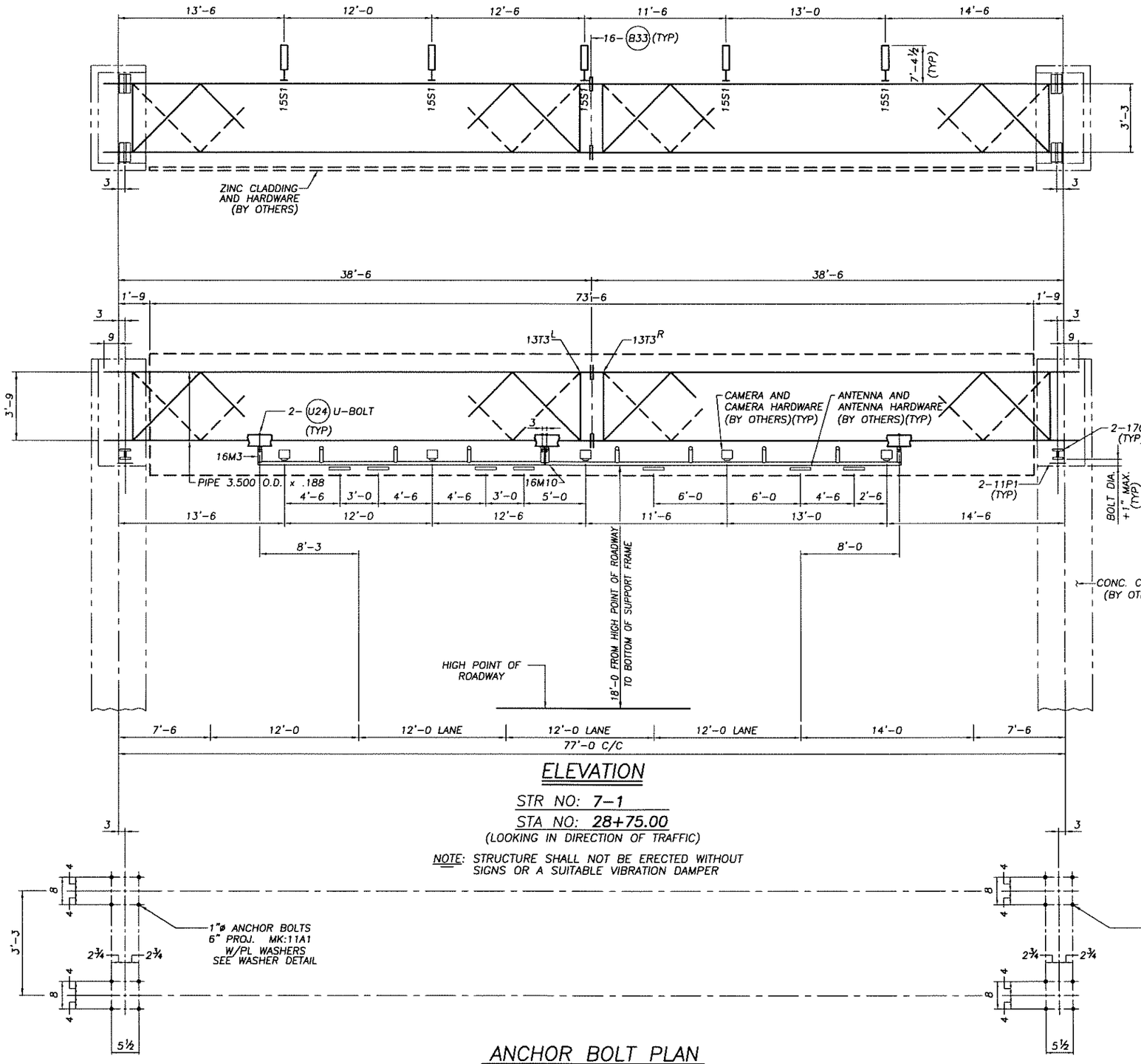
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE: NORTH CAROLINA
FED. PROJ.:
ST. PROJ.: C201994/U-4763B
COUNTY: DURHAM/WAKE
ROUTE: TRIANGLE EXPRESSWAY

SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING

FOR: T&H ELECTRICAL CORP.

DRAWN BY JLS DATE 3/23/10,6/23/10
CHECKED BY CC DATE 6/2/10, 6/23/10
APPROVED DWG. NO. C1040-E17



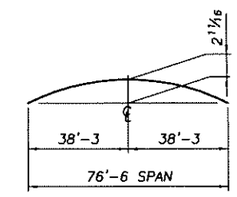
ELEVATION

STR NO: 7-1

STA NO: 28+75.00

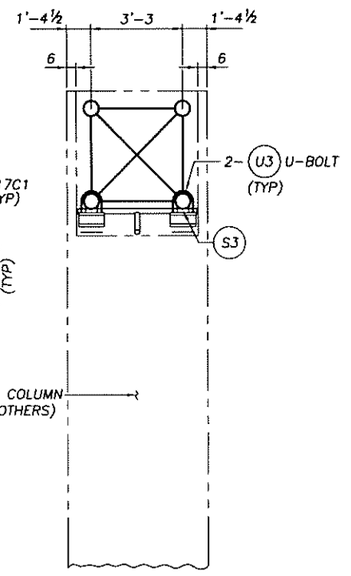
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

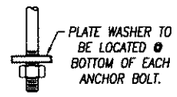


CAMBER DIAGRAM

SHIPPING LIST		C1040-E19
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	13T3 5/8	TRUSSES 4' x 4.5' x 39.3'
4	17C1	TRUSS MOUNTING BEAM
5	15S1	SCANNER SUPPORTS
1	16M3	SUPPORT FRAME
1	16M10	SUPPORT FRAME
16	(B33)	3/4" x 3" HHB /HN/FW/D11 (A325 GALV)
4	(S3)	SADDLE SHIMS #357
28	(U3)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
22	(U24)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)

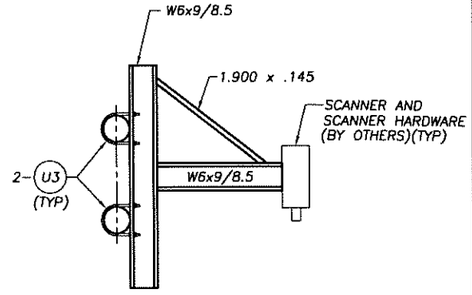


TYPICAL UPRIGHT



WASHER DETAIL

(TYPICAL)



TYP. SCANNER SUPPORT

ANCHOR BOLT PLAN

BARBARA B. CLEMENTS
NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER
8/3/10

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE:	NORTH CAROLINA
FED. PROJ.:	
ST. PROJ.:	C201994/U-4763B
COUNTY:	DURHAM/WAKE
ROUTE:	TRIANGLE EXPRESSWAY

SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING

FOR: T&H ELECTRICAL CORP.

DRAWN BY: JLS DATE: 3/23/10,6/23/10

CHECKED BY: CC DATE: 6/2/10, 6/23/10

APPROVED: DWG. NO. C1040-E19

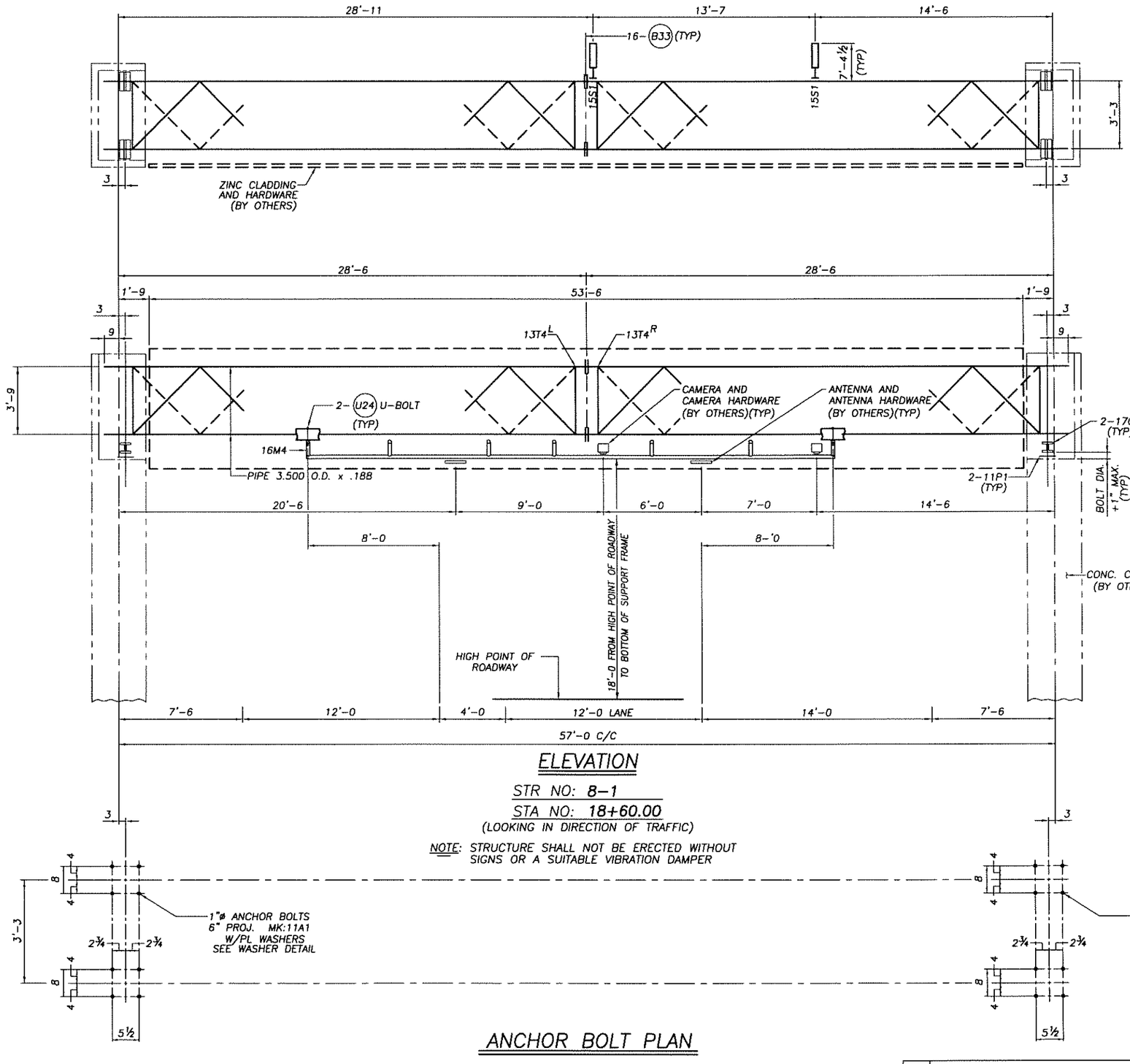
NO.	REVISIONS	DATE	MADE	CHECKED

NAME: E:\saved\JobsMPro\1040\1040-E19.dwg DATE: JUN 23, 2010 TIME: 11:38 AM craigc

BT-E

0

SHIPPING LIST		C1040-E21
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	13T4 5/8	TRUSSES 4' x 4.5' x 29.3'
4	17C1	TRUSS MOUNTING BEAM
2	15S1	SCANNER SUPPORTS
1	16M4	SUPPORT FRAME
16	B33	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	S3	SADDLE SHIMS #357
16	U3	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
14	U24	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

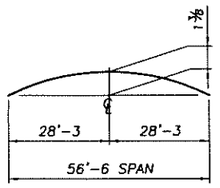
STR NO: 8-1

STA NO: 18+60.00

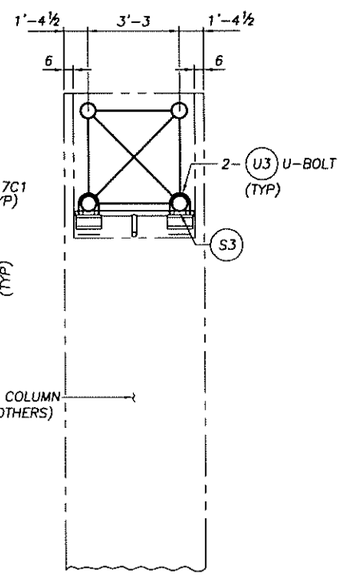
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

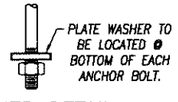
ANCHOR BOLT PLAN



CAMBER DIAGRAM

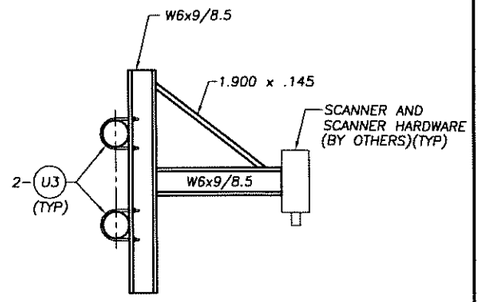


TYPICAL UPRIGHT



WASHER DETAIL

(TYPICAL)



TYP. SCANNER SUPPORT

NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE: NORTH CAROLINA
FED. PROJ.:
ST. PROJ.: C201994/U-4763B
COUNTY: DURHAM/WAKE
ROUTE: TRIANGLE EXPRESSWAY

SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: T&H ELECTRICAL CORP.

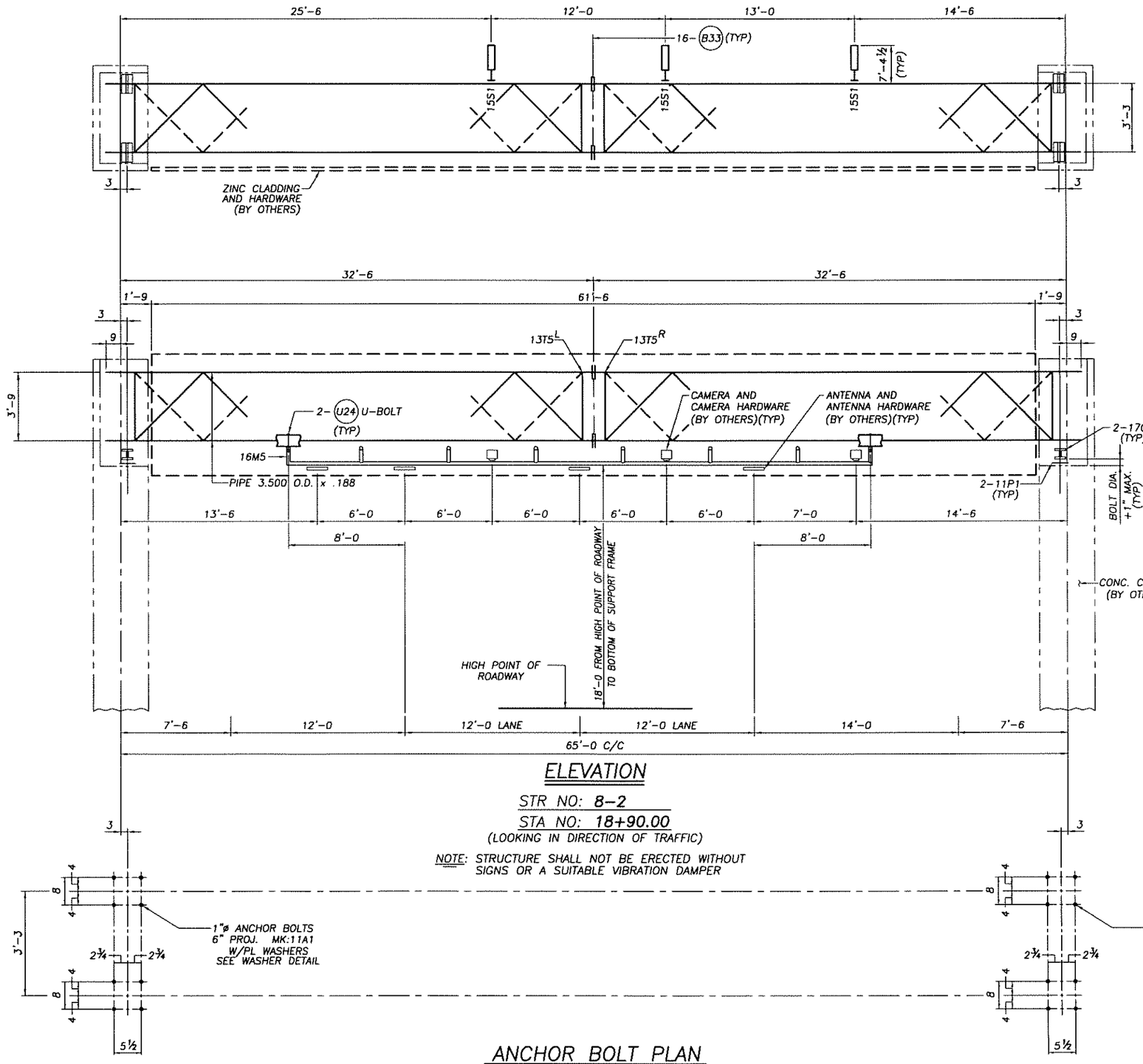
DRAWN BY: JLS DATE: 3/23/10,6/23/10
CHECKED BY: CC DATE: 6/2/10, 6/23/10
APPROVED: DWG. NO. C1040-E21

NAME: E:\pcad\AbbeyProj\1040\1040-E21.dwg DATE: JUN 23, 2010 TIME: 11:38 AM crolpc

BT-E

0

SHIPPING LIST		C1040-E23
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	13T5 R/L	TRUSSES 4' x 4.5' x 33.3'
4	17C1	TRUSS MOUNTING BEAM
3	15S1	SCANNER SUPPORTS
1	16M5	SUPPORT FRAME
16	(B33)	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	(S3)	SADDLE SHIMS #357
20	(U3)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
16	(U24)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

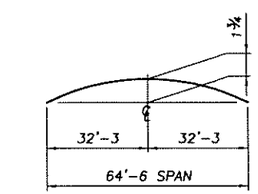
STR NO: 8-2

STA NO: 18+90.00

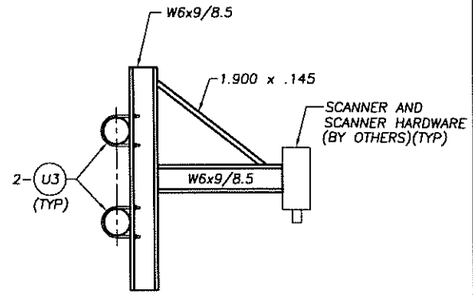
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

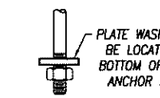
TYPICAL UPRIGHT



CAMBER DIAGRAM



TYP. SCANNER SUPPORT



WASHER DETAIL

(TYPICAL)

ANCHOR BOLT PLAN

BARBARA B. CLEMENTS
NORTH CAROLINA PROFESSIONAL SEAL 030182 ENGINEER
8/3/10

NO.	REVISIONS	DATE	MADE	CHECKED

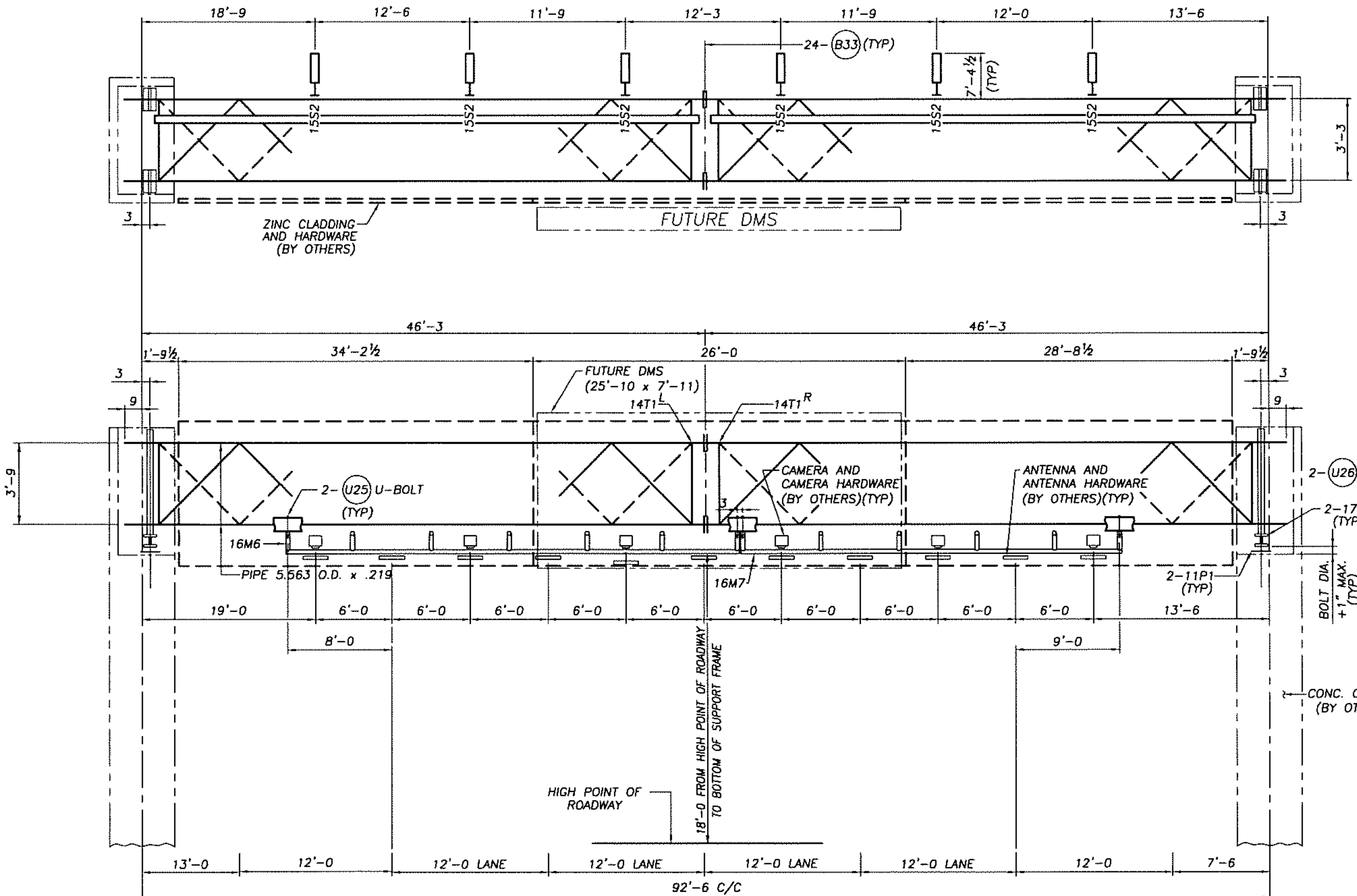
Walpar, LLC
POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE: NORTH CAROLINA
FED. PROJ.:
ST. PROJ.: C201994/U-4763B
COUNTY: DURHAM/WAKE
ROUTE: TRIANGLE EXPRESSWAY

SUBJECT: OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR: T&H ELECTRICAL CORP.

DRAWN BY JLS DATE 3/23/10,6/23/10
CHECKED BY CC DATE 6/2/10, 6/23/10
APPROVED DWG. NO. C1040-E23

SHIPPING LIST		C1040-E25
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	14T1 R/L	TRUSSES 4.2' x 4.7' x 47.0'
4	17C2	TRUSS MOUNTING BEAM
4	14S1	SHIMS
6	15S2	SCANNER SUPPORTS
1	16M6	SUPPORT FRAME
1	16M7	SUPPORT FRAME
24	(B33)	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	(S5)	SADDLE SHIMS #357
24	(U5)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
8	(U10)	5/8" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
26	(U25)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
8	(U26)	5/8" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



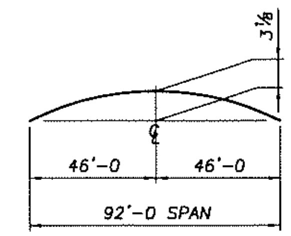
ELEVATION

STR NO: 6-2

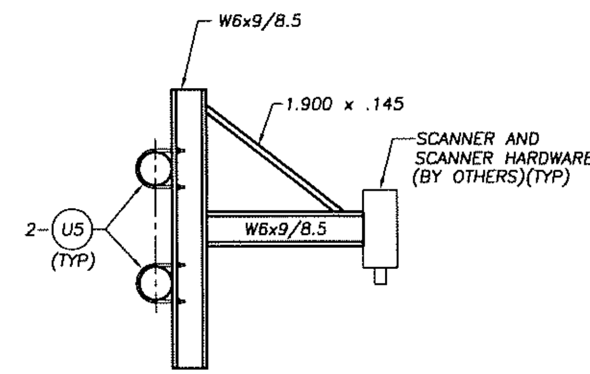
STA NO: 171+03.00

(LOOKING IN DIRECTION OF TRAFFIC)

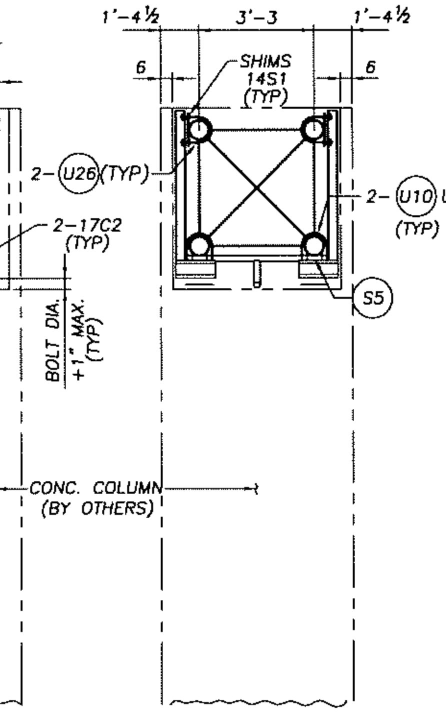
NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER



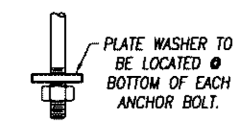
CAMBER DIAGRAM



TYP. SCANNER SUPPORT

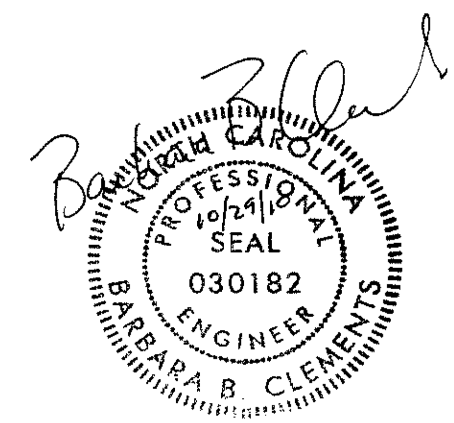


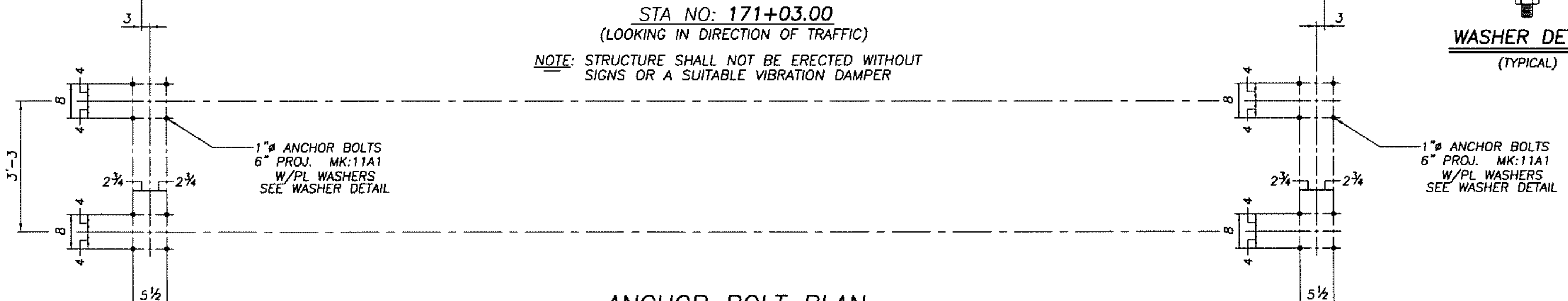
TYPICAL UPRIGHT



WASHER DETAIL

(TYPICAL)





ANCHOR BOLT PLAN

NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)-925-4990
FAX (205) 925-7273

STATE: NORTH CAROLINA
FED. PROJ.:
ST. PROJ.: C201994/U-4763B
COUNTY: DURHAM/WAKE
ROUTE: TRIANGLE EXPRESSWAY

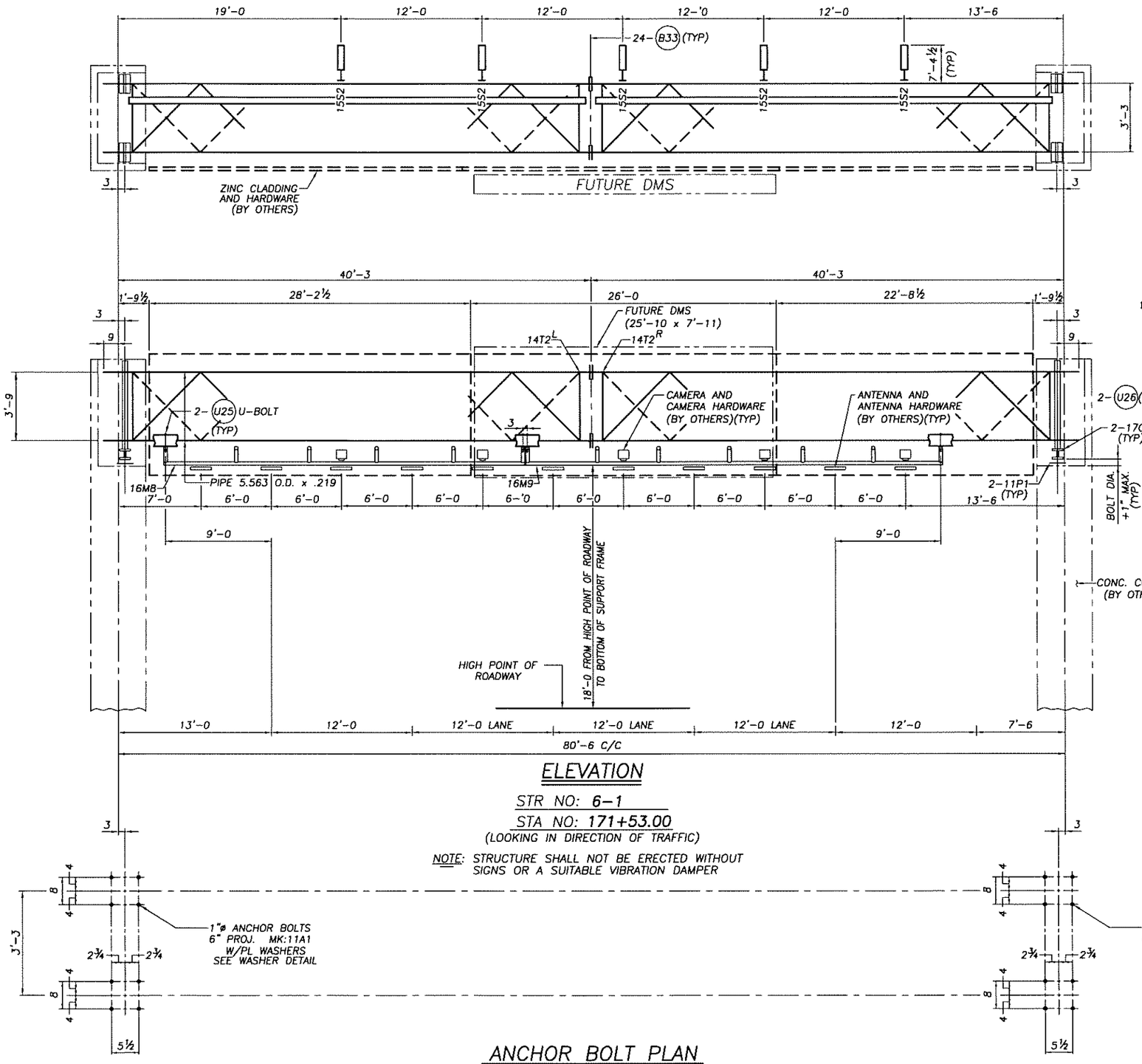
SUBJECT: OVERHEAD BOX TRUSS STRUCTURE
ERECTION DRAWING
FOR: T&H ELECTRICAL CORP.

DRAWN BY JLS DATE 6/23/10, 10/29/10
CHECKED BY CC DATE 6/2/10, 6/23/10, 10/20/10
APPROVED
DWG. NO. C1040-E25

BT-E

NAME: E:\acad\Jobs\Proj\1040\1040-E25.dwg DATE: OCT 29, 2010 TIME: 9:57 AM

SHIPPING LIST		C1040–E27
QTY	MARK	DESCRIPTION
16	11A1	ANCHOR BOLTS
–	11P1	ANCHOR BOLT TEMPLATES
2	14T2 R/L	TRUSSES 4.2' x 4.7' x 41.0
4	17C2	TRUSS MOUNTING BEAM
4	14S1	SHIMS
5	15S2	SCANNER SUPPORTS
1	16M8	SUPPORT FRAME
1	16M9	SUPPORT FRAME
24	(B33)	3/4" x 3" HHB /HN/FW/DTI (A325 GALV)
4	(S5)	SADDLE SHIMS #357
20	(U5)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
8	(U10)	5/8" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
26	(U25)	1/2" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)
8	(U26)	5/8" U-BOLTS /(2 EA) HN/LW/FW (A307 GALV)



ELEVATION

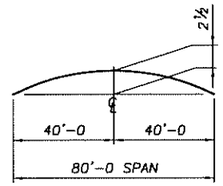
STR NO: 6–1

STA NO: 171+53.00

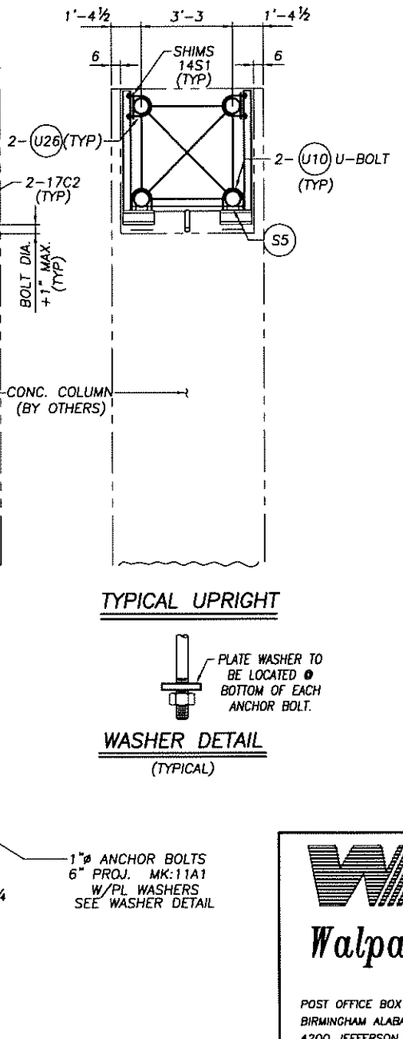
(LOOKING IN DIRECTION OF TRAFFIC)

NOTE: STRUCTURE SHALL NOT BE ERECTED WITHOUT SIGNS OR A SUITABLE VIBRATION DAMPER

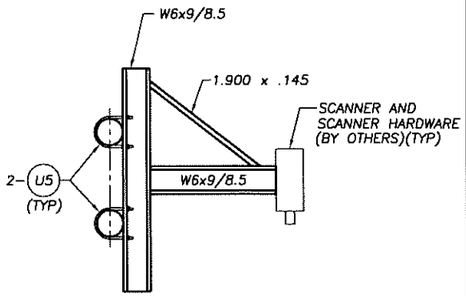
ANCHOR BOLT PLAN



CAMBER DIAGRAM



TYPICAL UPRIGHT



TYP. SCANNER SUPPORT

WASHER DETAIL

(TYPICAL)

NORTH CAROLINA PROFESSIONAL 10/29/10 SEAL 030182 ENGINEER BARBARA B. CLEMENTS

NO.	REVISIONS	DATE	MADE	CHECKED

Walpar, LLC

POST OFFICE BOX 28650
BIRMINGHAM ALABAMA 35228
4200 JEFFERSON AVENUE
BIRMINGHAM ALABAMA 35221
PHONE (205)–925–4990
FAX (205) 925–7273

STATE:	NORTH CAROLINA
FED. PROJ.:	
ST. PROJ.:	C201994/U–4763B
COUNTY:	DURHAM/WAKE
ROUTE:	TRIANGLE EXPRESSWAY
SUBJECT	OVERHEAD BOX TRUSS STRUCTURE ERECTION DRAWING
FOR:	T&H ELECTRICAL CORP.
DRAWN BY	JLS DATE 6/23/10,10/29/10
CHECKED BY	CC DATE 6/2/10, 6/23/10, 10/20/10
APPROVED	DWG. NO. C1040–E27

BT–E

NAME: E:\accad\Jobs#Prg\1040\1040–E27.dwg DATE: OCT 29, 2010 TIME: 8:58 AM arsiga

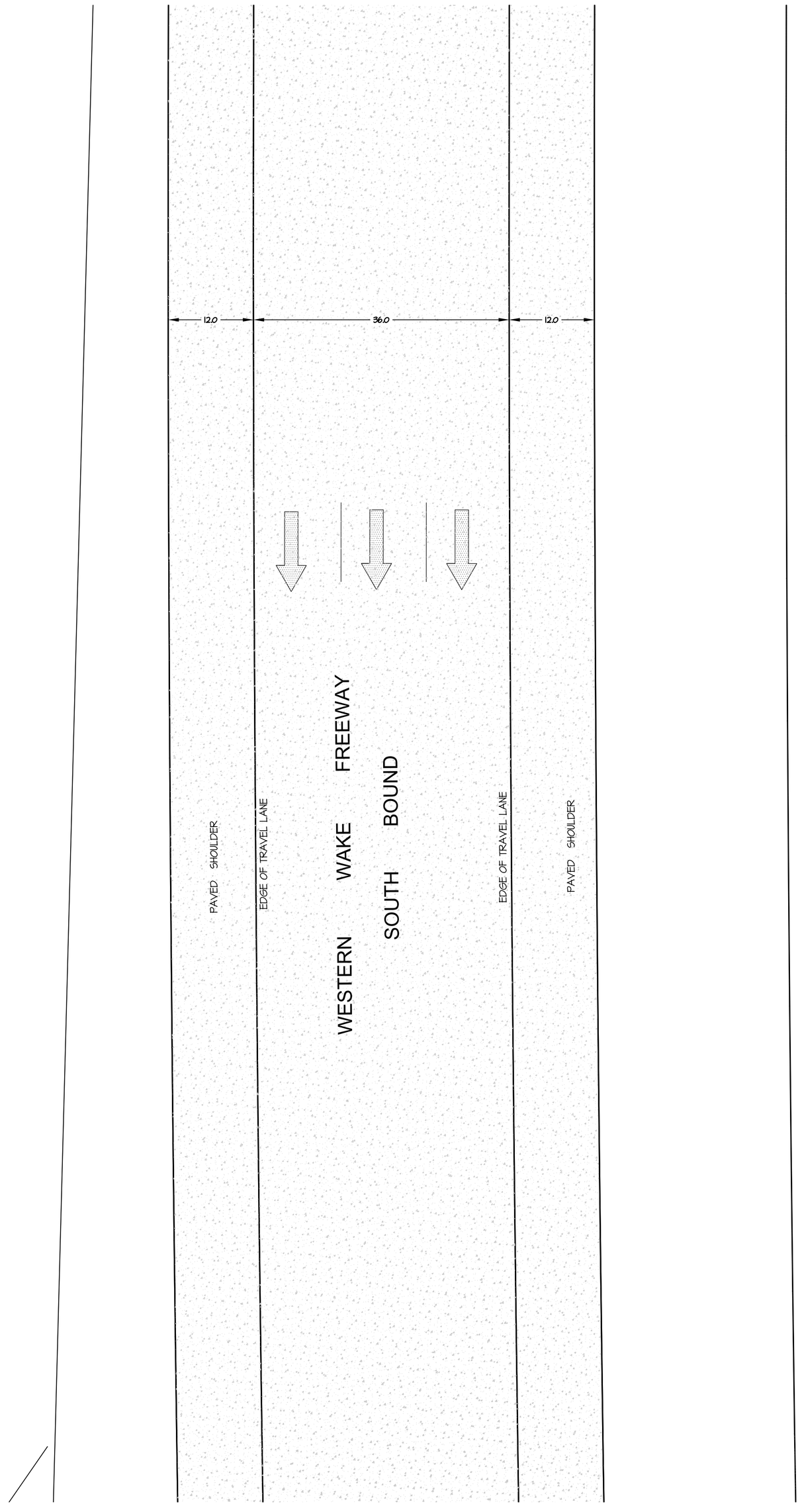
WESTERN WAKE FREEWAY
SOUTH BOUND
WESTERN WAKE FREEWAY
NORTH BOUND
PAVED SHOULDER
EDGE OF TRAVEL LANE
GANTRY
CAT-I
SHOULDER BERM GUTTER
MAIN TRUNK LINE
HEAVY DUTY TOLL SPLICE BOX
HEAVY DUTY ITS JUNCTION BOX
1 EA. @ 4" FOR POWER SERVICE
PROPANE TANK
Show 2 conduit symb. here; Label 2 x 2"
Can POD be identified yet?
need 12' width as per std dwgs
50'
2 x 2"
1 x 3"
4 x 2"
3 x 3"
Plz label this surface.. expressway gutter?
Switch these 2 conduit runs so that the 2x2 is going to P box and 4x2 is going to C box.
1 x 3"
2 x 3"
1 x 2"
3 x 2"
6 x 2"
Including boxes under AVI and ZEC cabinets

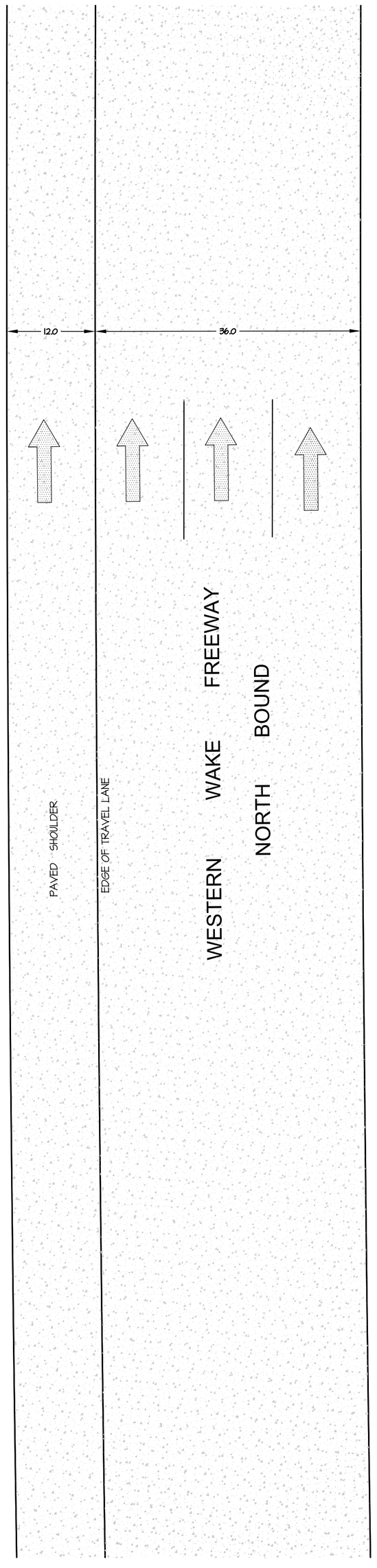
ORT FACILITY #1
ENLARGED SITE PLAN
SCALE: 1" = 10'

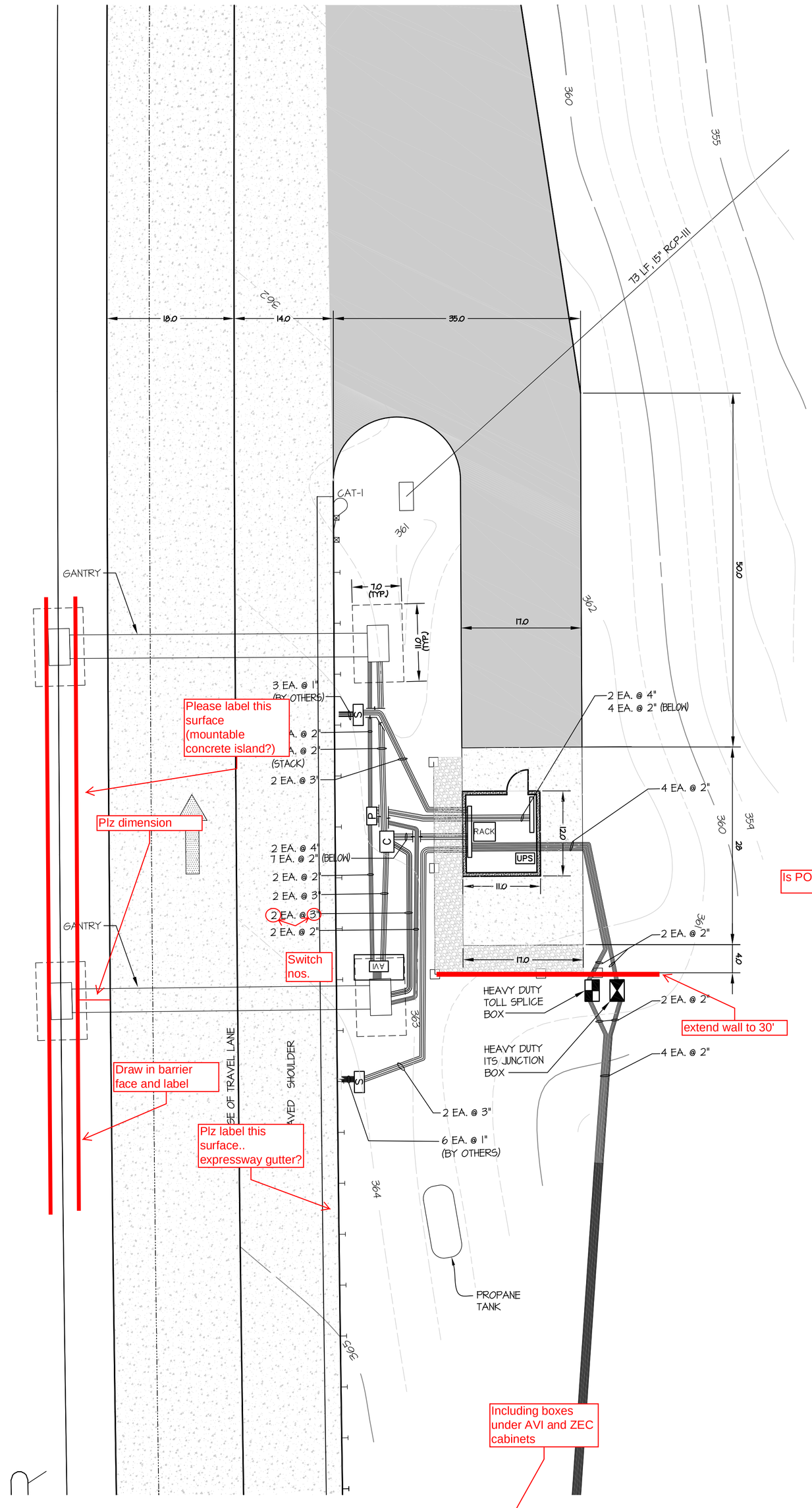
NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

RALEIGH-DURHAM ROADBUILDERS

ORT SITE
1





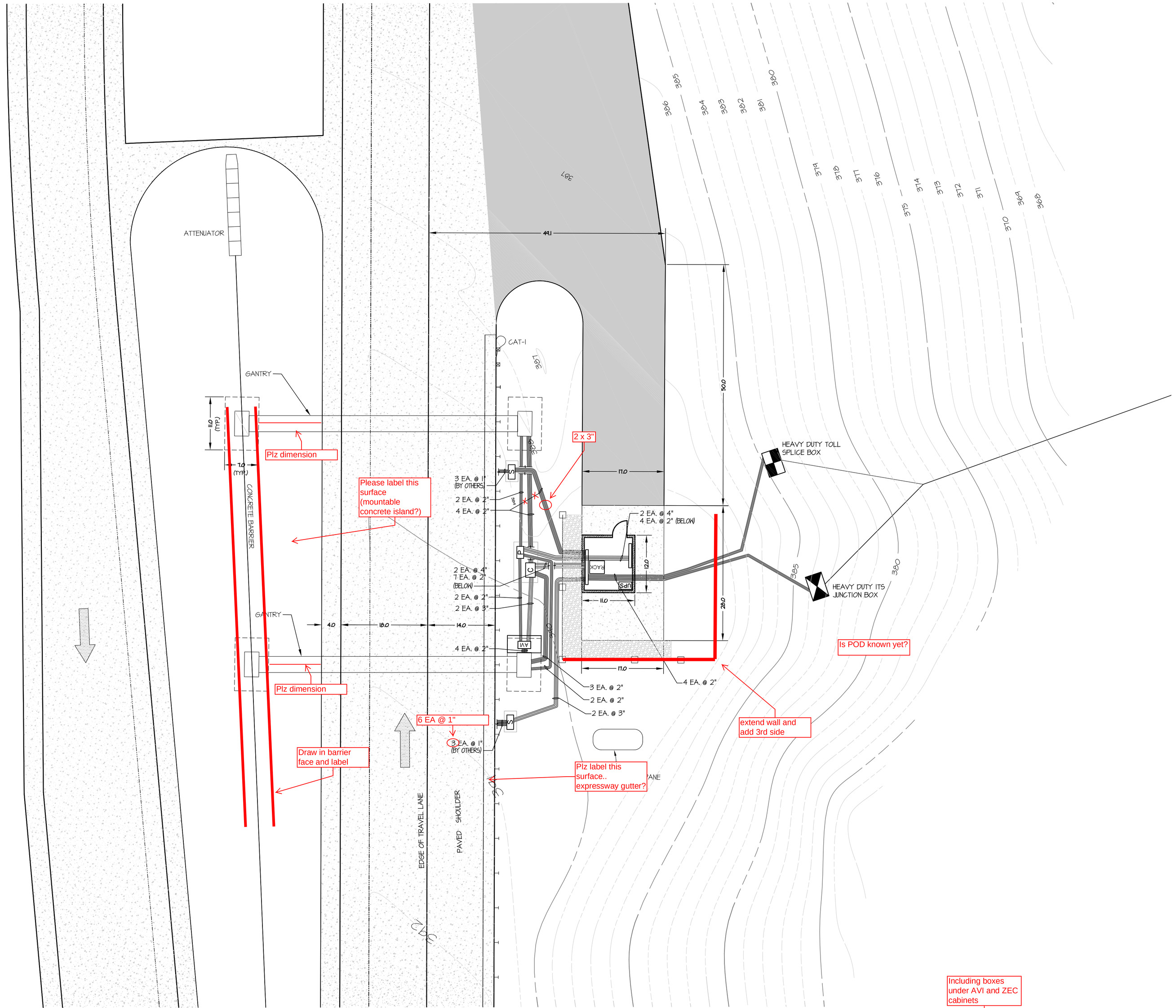


ORT FACILITY #2 AT NB OFF RAMP
ENLARGED SITE PLAN
SCALE: 1" = 10'

NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

RALEIGH-DURHAM ROADBUILDERS

ORT SITE
2-1NB



ORT FACILITY #2 AT ON RAMP
ENLARGED SITE PLAN
SCALE: 1" = 10'

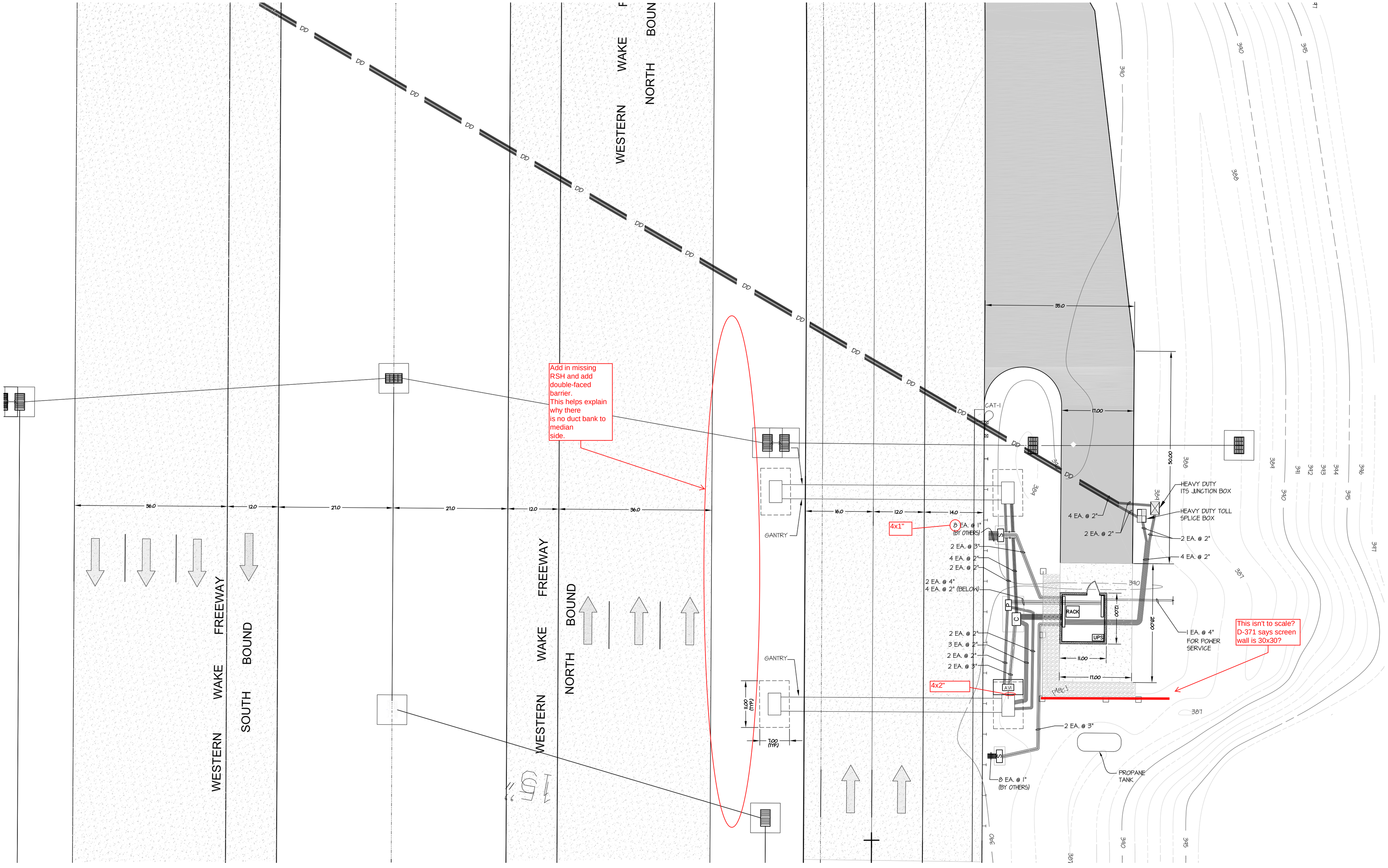
NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

Including boxes under AVI and ZEC cabinets

RALEIGH-DURHAM ROADBUILDERS

ORT SITE
2-2SB

WESTERN WAKE FREEWAY
SOUTH BOUND
WESTERN WAKE FREEWAY
NORTH BOUND
PAVED SHOULDER
EDGE OF TRAVEL LANE
GANTRY
CAT-I
HEAVY DUTY TOLL SPLICE BOX
MAIN TRUNK LINE
PROPANE TANK
SHOULDER BERM GUTTER
48 LF 15" RCP-III
UPS
RACK
GEN.
PWR
SLD
INSTALL CONDUIT IN ROADWAY CROSSING DUCK BANK
"50.2' ???
Can POD be identified yet?
"TTS" not "TOLL"
"11.0011"??
10 x 1" by others
2 x 3"
Plz label this surface.. expressway gutter?
1 x 3"
3 x 2"
6 x 2"
2 x 2"
1 x 2"
4x2"
2x4" 4x2" (BELOW)
6 x 2"
3 x 3"
need 12' width as per std dwgs
No propane tank where there is no building
Including boxes under AVI and ZEC cabinets
NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.
ORT FACILITY #3
ENLARGED SITE PLAN
SCALE: 1" = 10'
RALEIGH-DURHAM ROADBUILDERS
ORT SITE
3

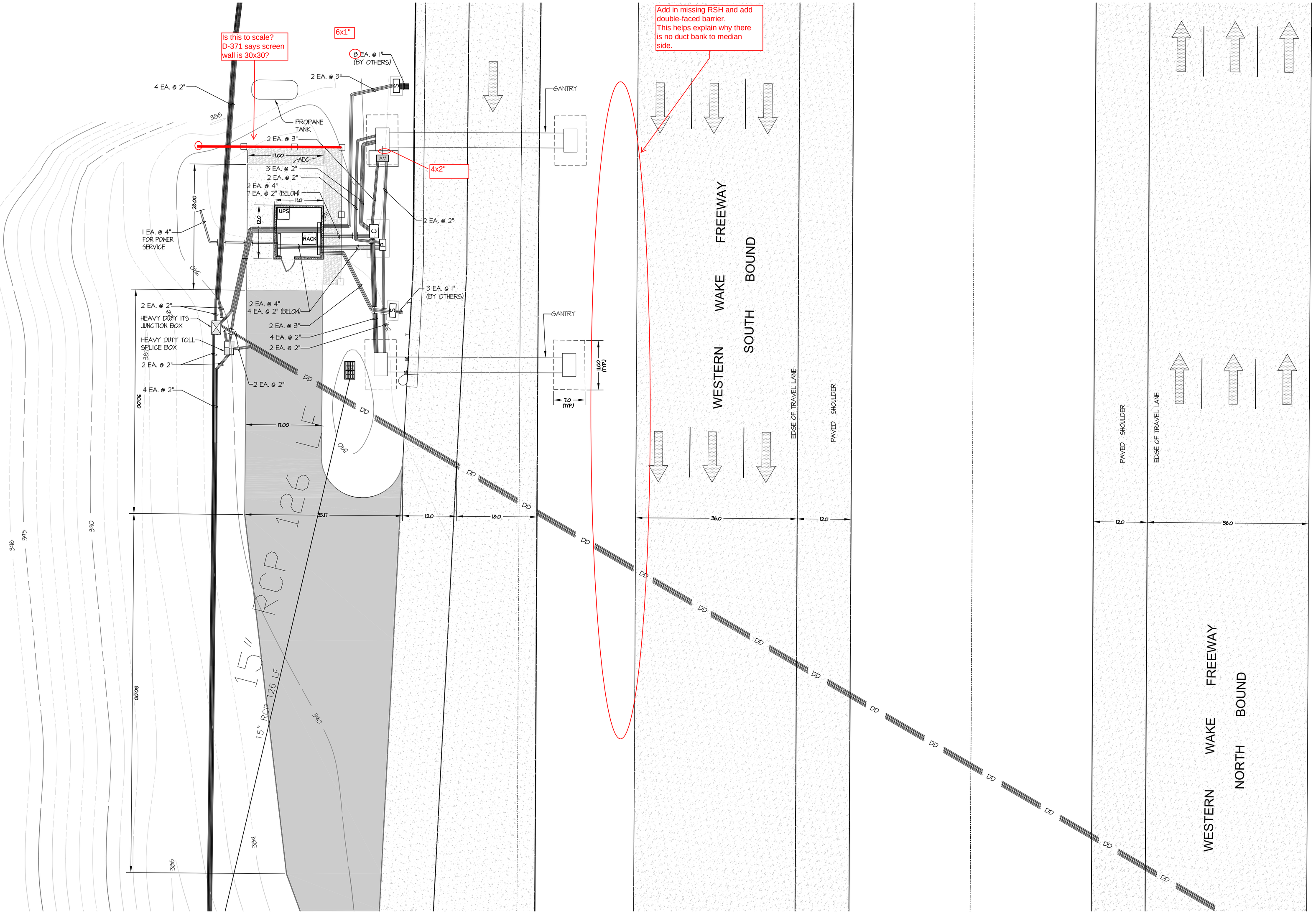


ORT FACILITY #4 NORTH BOUND
ENLARGED SITE PLAN
SCALE: 1" = 10'

NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

RALEIGH-DURHAM ROADBUILDERS

ORT SITE
4-1NB

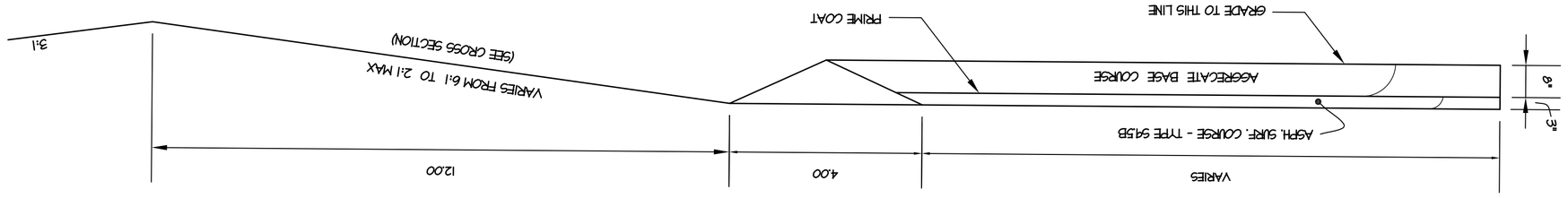


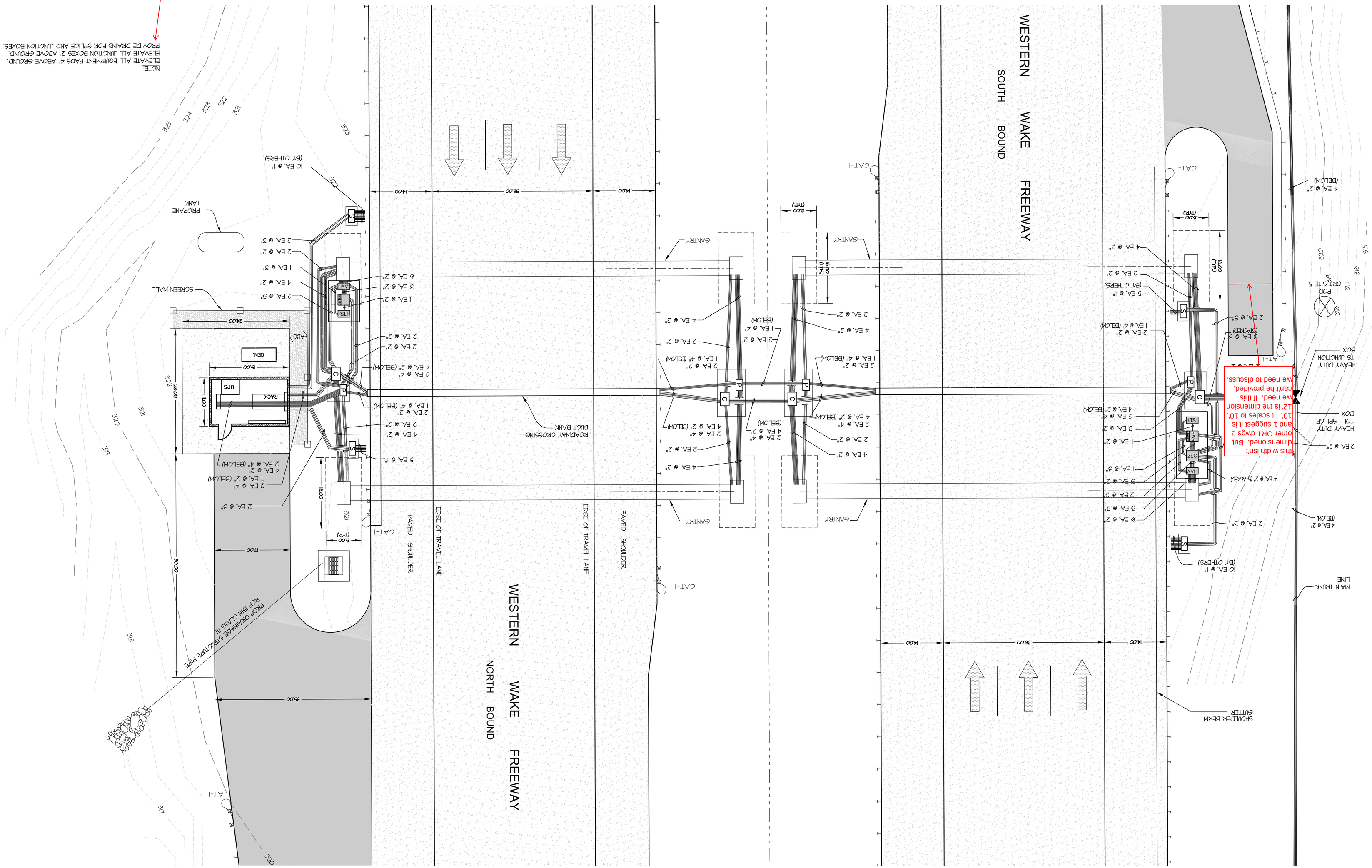
ORT FACILITY #4 SOUTH BOUND
ENLARGED SITE PLAN
SCALE: 1" = 10'

NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

RALEIGH-DURHAM ROADBUILDERS

ORT SITE
4-2SB





this width isn't dimensioned. But other ORT dwgs 3 and 1 suggest it is 10'. It scales to 10'. 12' is the dimension we need. If this can't be provided, we need to discuss.

NOTE:
ELEVATE ALL EQUIPMENT PADS 4" ABOVE GROUND.
ELEVATE ALL JUNCTION BOXES 2" ABOVE GROUND.
PROVIDE DRAINS FOR SPLICE AND JUNCTION BOXES.

Including boxes under AVI and ZEC cabinets; this comment applies to ORT 4 dwgs as well.

ORT FACILITY #5
ENLARGED SITE PLAN

SCALE: 1" = 10'

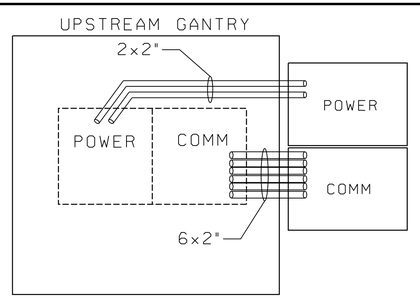
PAVEMENT DETAIL

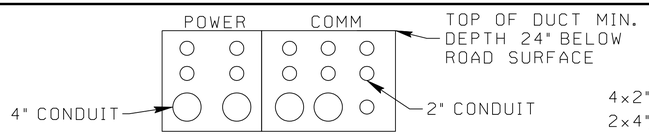
SCALE: 1" = 10'

RALEIGH-DURHAM ROADBUILDERS

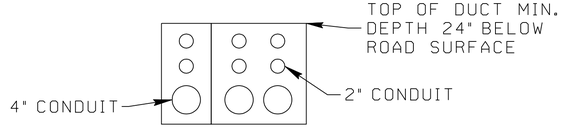
ORT SITE
5

PROJECT REFERENCE NO.	SHEET NO.
U-4763B	ITS-03B

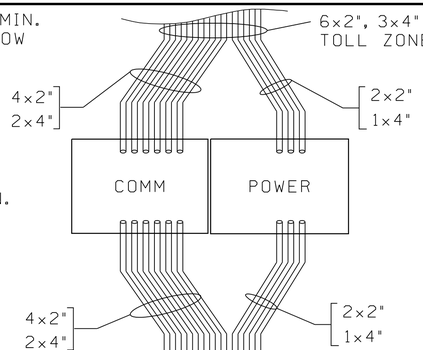


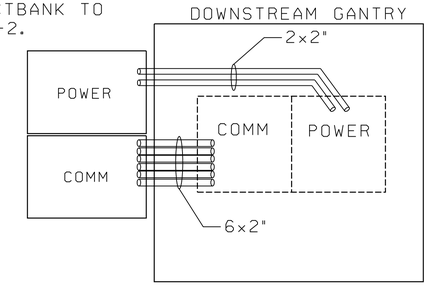


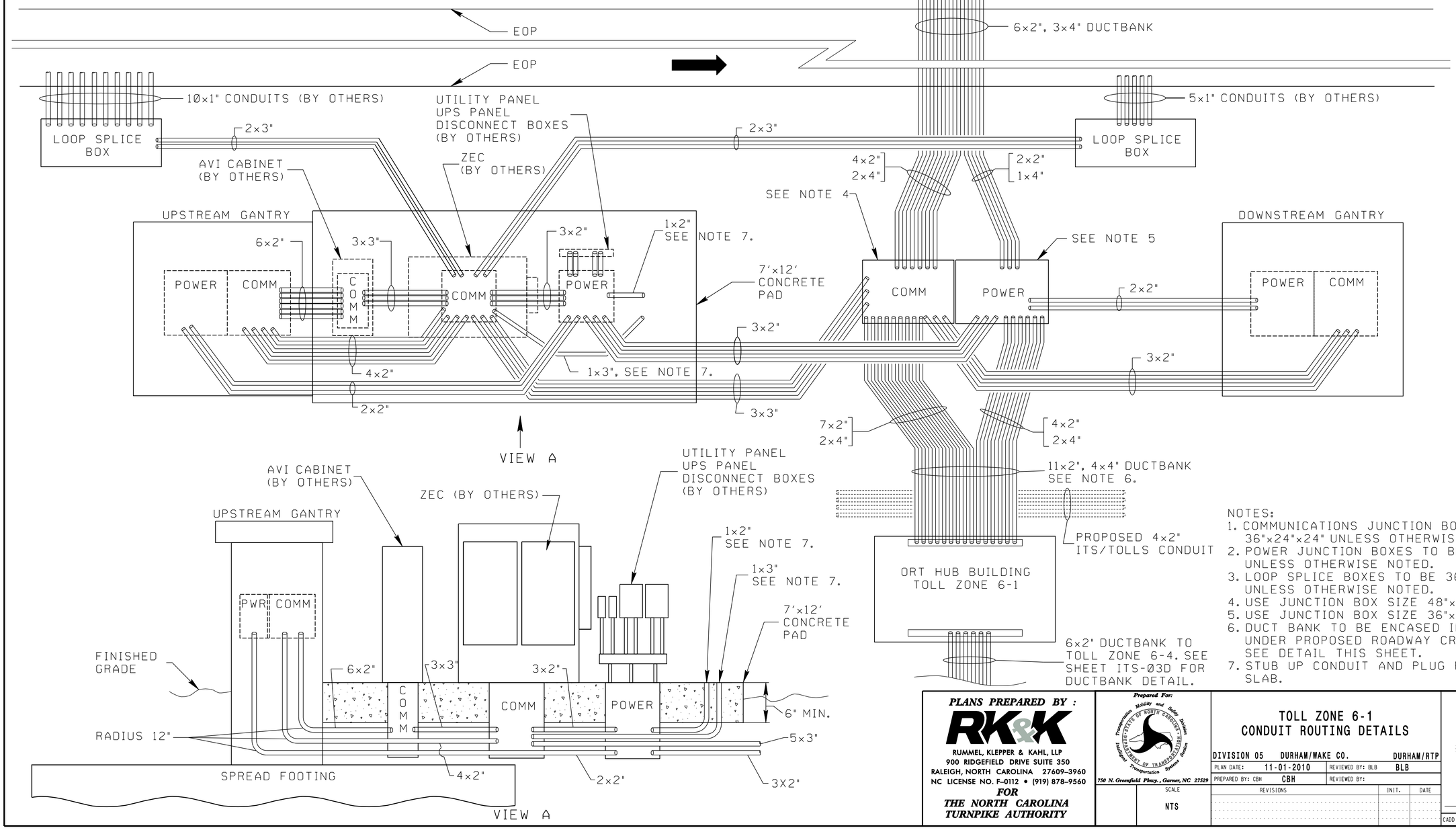
11×2", 4×4" DUCT BANK DETAIL



6×2", 3×4" DUCT BANK DETAIL







NOTES:
1. COMMUNICATIONS JUNCTION BOXES TO BE 36"x24"x24" UNLESS OTHERWISE NOTED.
2. POWER JUNCTION BOXES TO BE 30"x17"x24" UNLESS OTHERWISE NOTED.
3. LOOP SPLICE BOXES TO BE 36"x17"X24" UNLESS OTHERWISE NOTED.
4. USE JUNCTION BOX SIZE 48"x48"x24".
5. USE JUNCTION BOX SIZE 36"x24"x24".
6. DUCT BANK TO BE ENCASED IN CONCRETE UNDER PROPOSED ROADWAY CROSSINGS. SEE DETAIL THIS SHEET.
7. STUB UP CONDUIT AND PLUG FLUSH WITH SLAB.

PLANS PREPARED BY :

RK&K

RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 • (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For:
Integrated Mobility and Safety Division
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
Transportation Systems Section
750 N. Greenfield Pkwy., Garner, NC 27529

SCALE: NTS

TOLL ZONE 6-1
CONDUIT ROUTING DETAILS

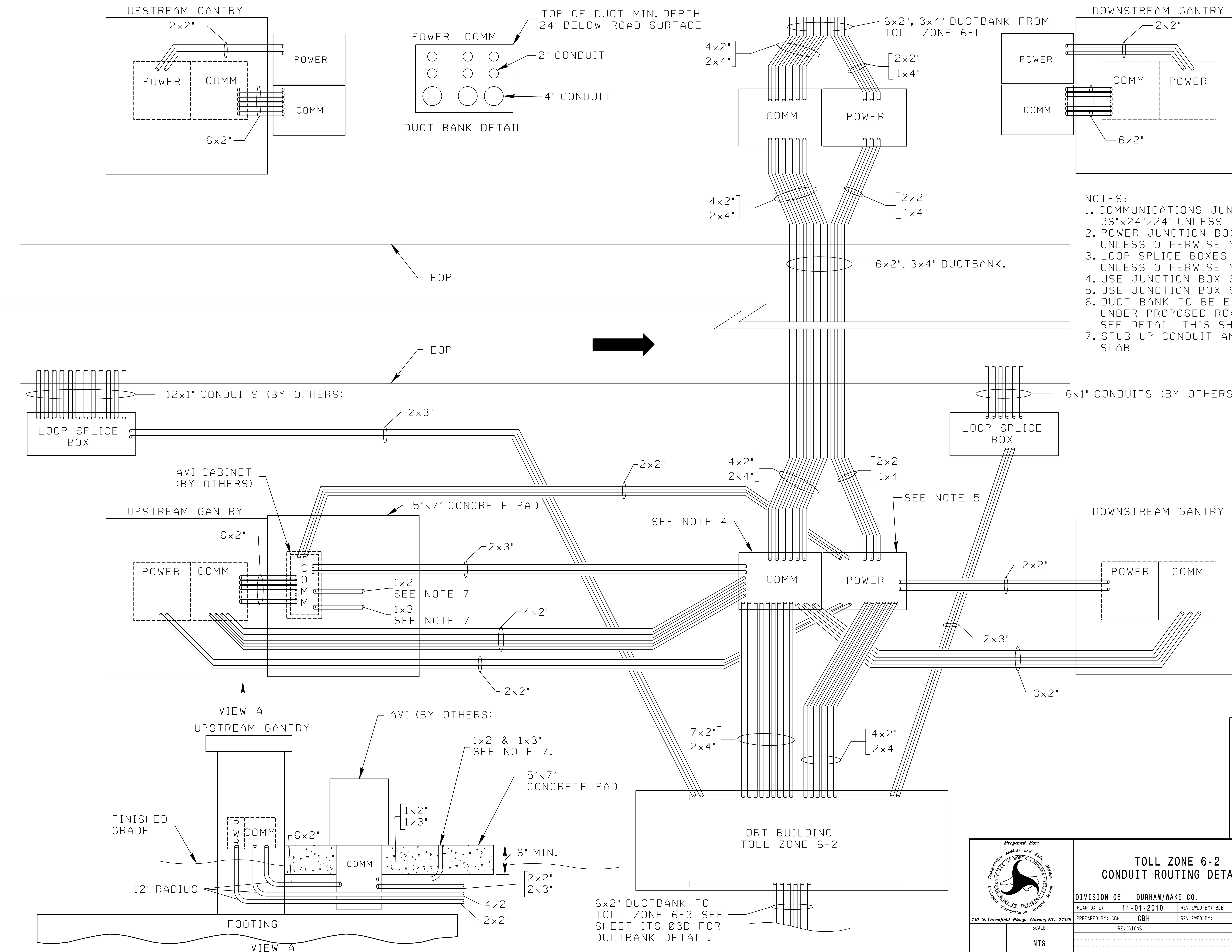
DIVISION 05	DURHAM/WAKE CO.	DURHAM/RTP
PLAN DATE: 11-01-2010	REVIEWED BY: BLB	BLB
PREPARED BY: CBH	CBH	REVIEWED BY:

REVISIONS	INIT.	DATE

SEAL
NORTH CAROLINA
PROFESSIONAL
SEAL
033753
ENGINEER
C. BYRON HOLDEN

SIGNATURE _____ DATE _____

CADD Filename: U4763_ITS_PSH03B.DGN



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7. STUB UP CONDUIT AND PLUG FLUSH WITH SLAB.

PLANS PREPARED BY :
RK&K
RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 • (919) 878-9560
FOR THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For: Transportation Mobility and Safety Division, Intelligent Transportation Systems Section, Department of Transportation, State of North Carolina
750 N. Greenfield Pkwy., Garner, NC 27529

TOLL ZONE 6-2
CONDUIT ROUTING DETAILS

DIVISION 05 DURHAM/WAKE CO. DURHAM/RTP

PLAN DATE:	11-01-2010	REVIEWED BY: BLB	BLB
PREPARED BY: CBH	CBH	REVIEWED BY:	

SCALE: NTS

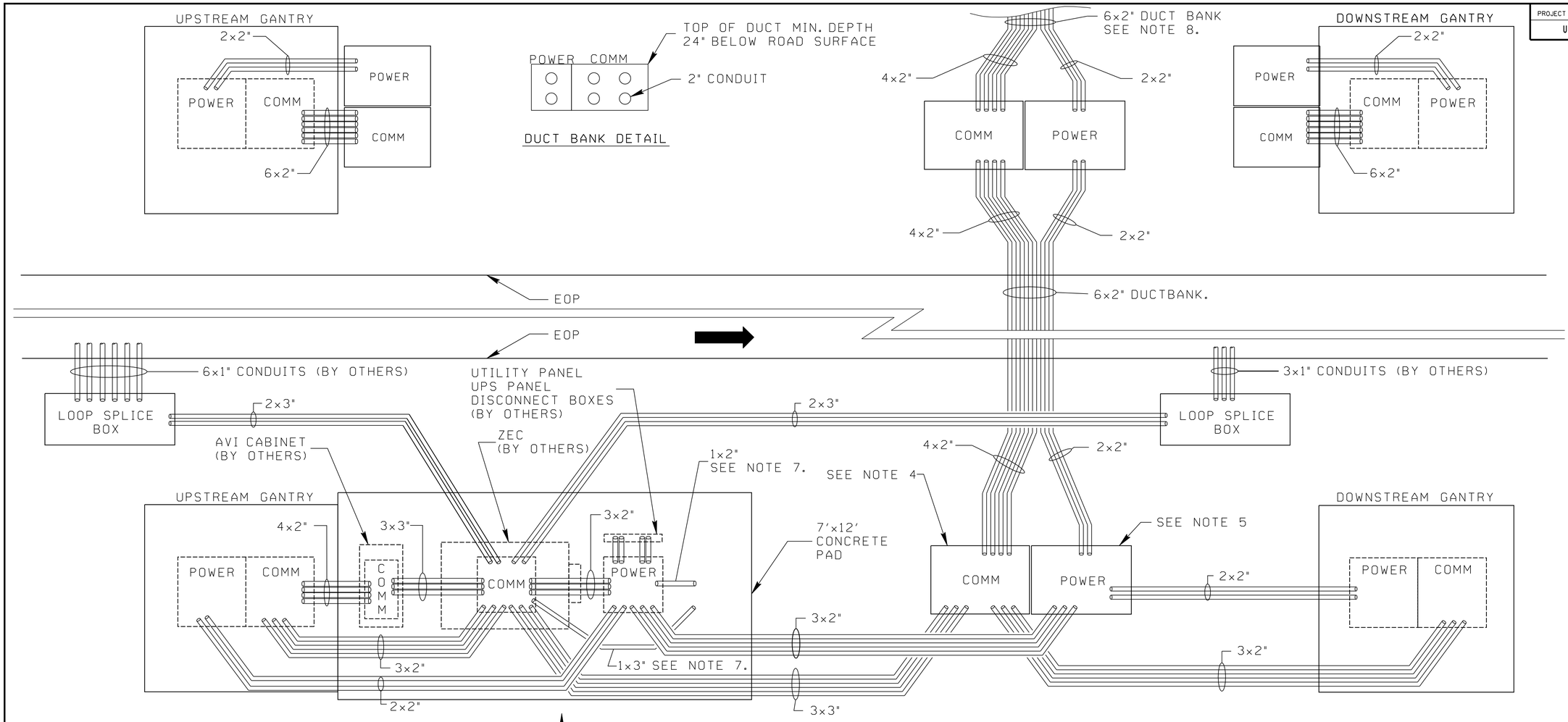
REVISIONS	INIT.	DATE

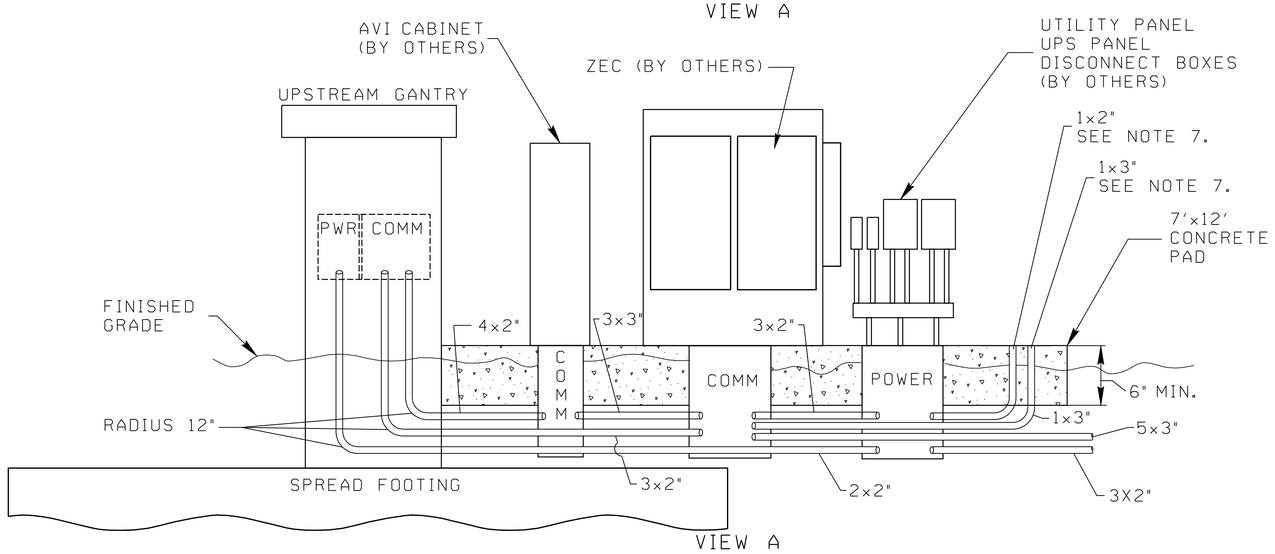
SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 033753 C. BYRON HOLDEN

SIGNATURE DATE

CADD Filename: U4763_ITS_PSH03C.DGN

PROJECT REFERENCE NO.	SHEET NO.
U-4763B	ITS-03D





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6. DUCT BANK TO BE ENCASED IN CONCRETE UNDER PROPOSED ROADWAY CROSSINGS.
7. STUB UP CONDUIT AND PLUG FLUSH WITH SLAB.
8. FOR TOLL ZONE 6-3, DUCT BANK IS FROM ORT BUILDING ZONE 6-2. FOR TOLL ZONE 6-4, DUCT BANK IS FROM ORT HUB BUILDING TOLL ZONE 6-1.

PLANS PREPARED BY :

RK&K

RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 • (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For:
Department of Transportation — Mobility and Safety Division
STATE OF NORTH CAROLINA — DEPARTMENT OF TRANSPORTATION
Transportation Building
750 N. Greenfield Pkwy., Garner, NC 27529

SCALE
NTS

TOLL ZONES 6-3 & 6-4 CONDUIT ROUTING DETAILS

DIVISION 05 DURHAM/WAKE CO. DURHAM/RTP

PLAN DATE: 11-01-2010 REVIEWED BY: BLB BLB

PREPARED BY: CBH CBH REVIEWED BY:

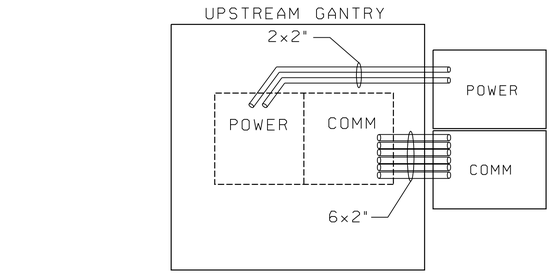
REVISIONS	INIT.	DATE

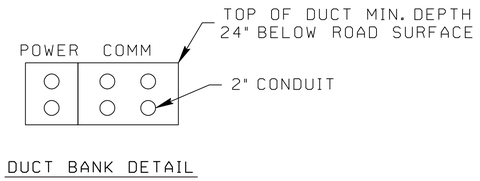
SEAL
NORTH CAROLINA PROFESSIONAL SEAL 033753 ENGINEER CHYRON HOLDEN

SIGNATURE DATE

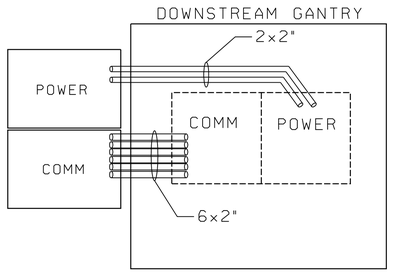
CADD Filename: U4763_ITS_PSH03D.DGN

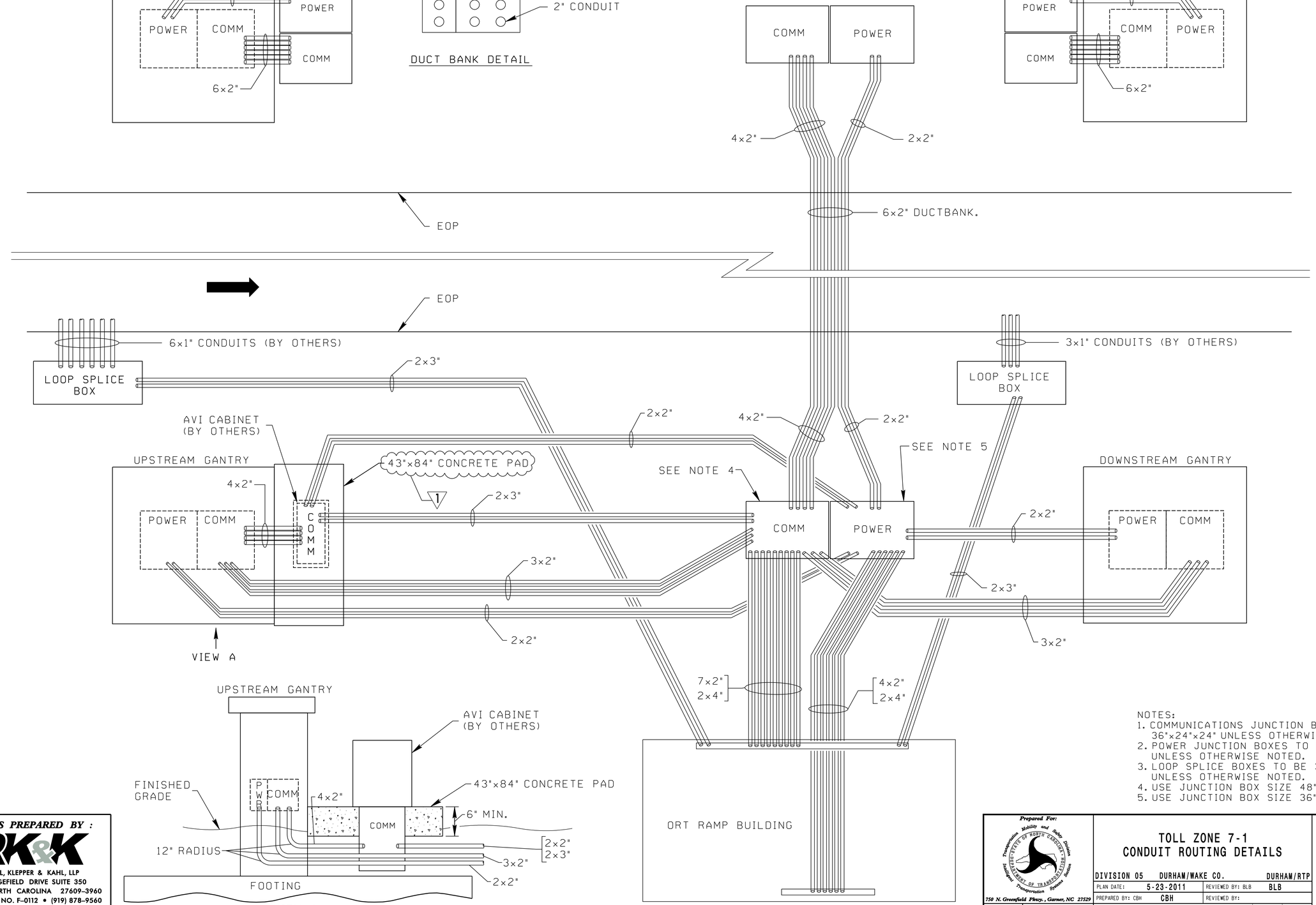
PROJECT REFERENCE NO.	SHEET NO.
U-4763B	ITS-03E





DUCT BANK DETAIL





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PLANS PREPARED BY :

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900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
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FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For:
Transportation Mobility and Safety Division
Intelligent Transportation Systems Section
STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
750 N. Greenfield Pkwy., Garner, NC 27529

TOLL ZONE 7-1
CONDUIT ROUTING DETAILS

DIVISION 05 DURHAM/WAKE CO. DURHAM/RTP

PLAN DATE: 5-23-2011	REVIEWED BY: BLB	BLB
PREPARED BY: CBH	CBH	REVIEWED BY:

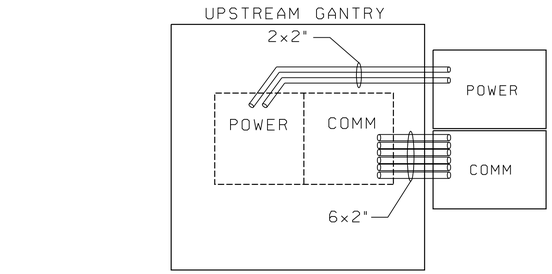
SCALE: NTS

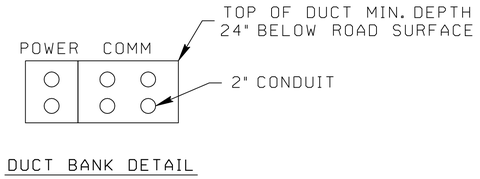
REVISIONS	INIT.	DATE
1 CONSTRUCTION REVISION - REVISED CONCRETE PAD SIZE TO 43"x84"	CBH	5-23-11

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 033753 ENGINEER C. BYRON HOLDEN
SIGNATURE DATE

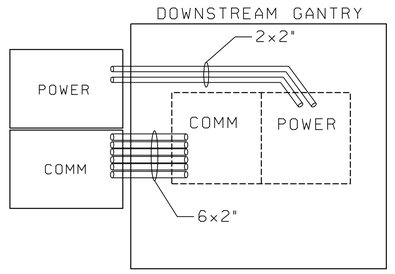
CADD Filename: U4763_ITS_PSH03E.DGN

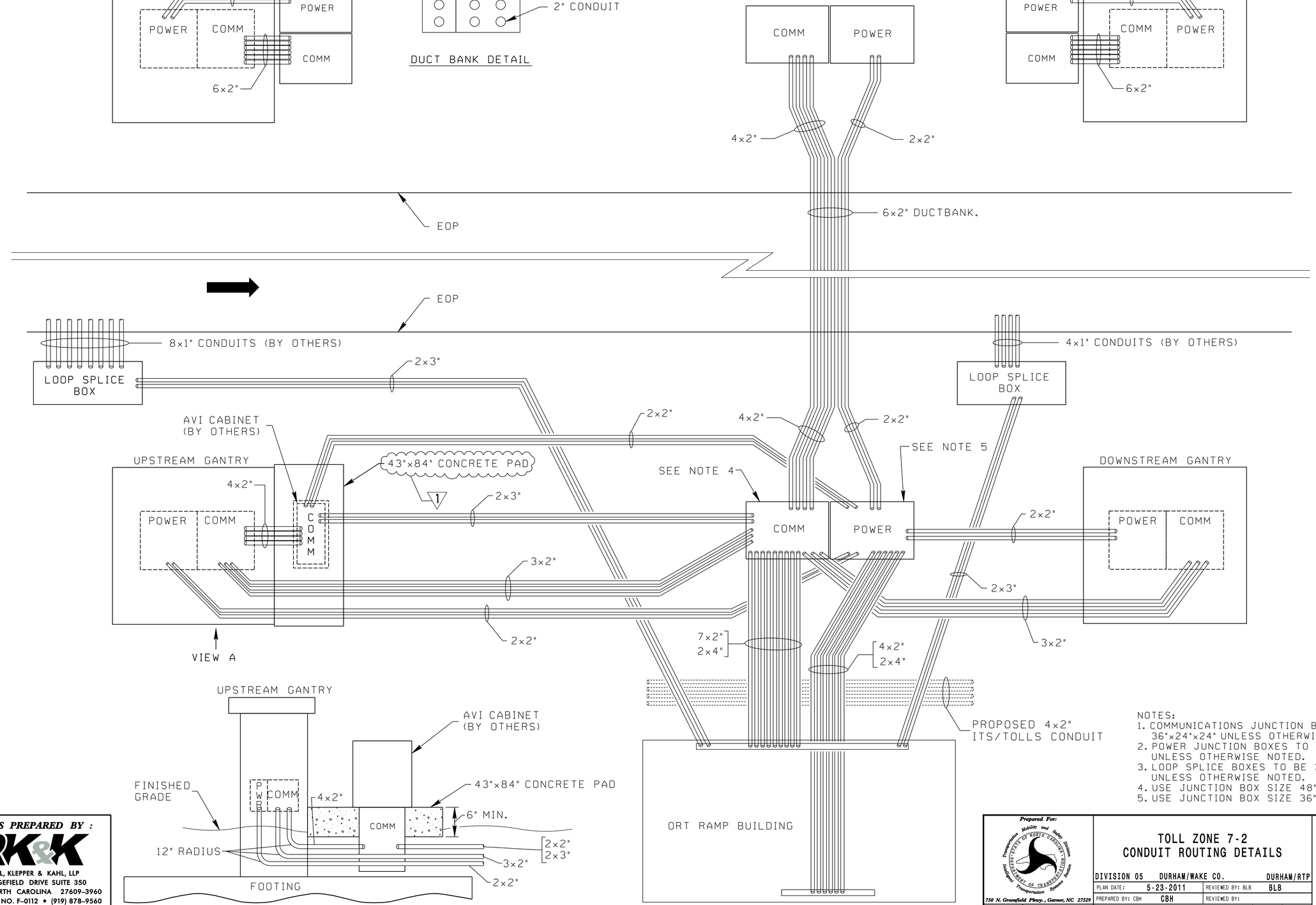
PROJECT REFERENCE NO.	SHEET NO.
U-4763B	ITS-03F





DUCT BANK DETAIL





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PLANS PREPARED BY :

RK&K

RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 • (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For:
Transportation Mobility and Rail Division — State of North Carolina — Department of Transportation — Integrated Mobility Division
750 N. Greenfield Pkwy., Garner, NC 27529

TOLL ZONE 7-2
CONDUIT ROUTING DETAILS

DIVISION 05 DURHAM/WAKE CO. DURHAM/RTP

PLAN DATE: 5-23-2011	REVIEWED BY: BLB	BLB
PREPARED BY: CBH	CBH	REVIEWED BY:

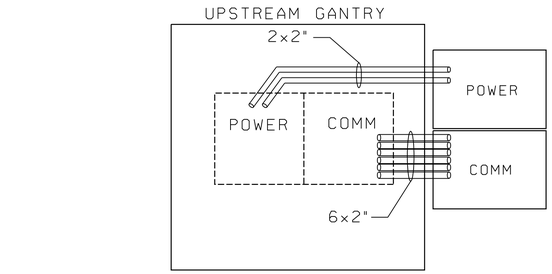
SCALE: NTS

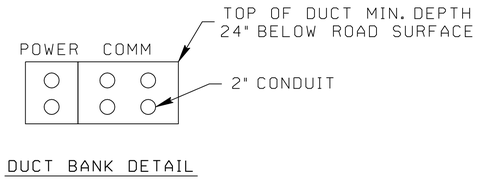
REVISIONS	INIT.	DATE
1 CONSTRUCTION REVISION - REVISED CONCRETE PAD SIZE TO 43"x84"	CBH	5-23-11

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 033753 ENGINEER C. BYRON HOLDEN
SIGNATURE DATE

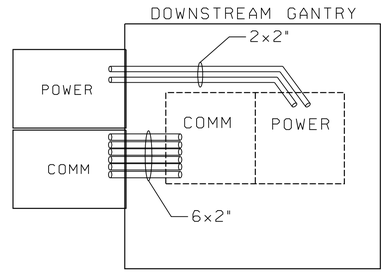
CADD Filename: U4763_ITS_PSH03F.DGN

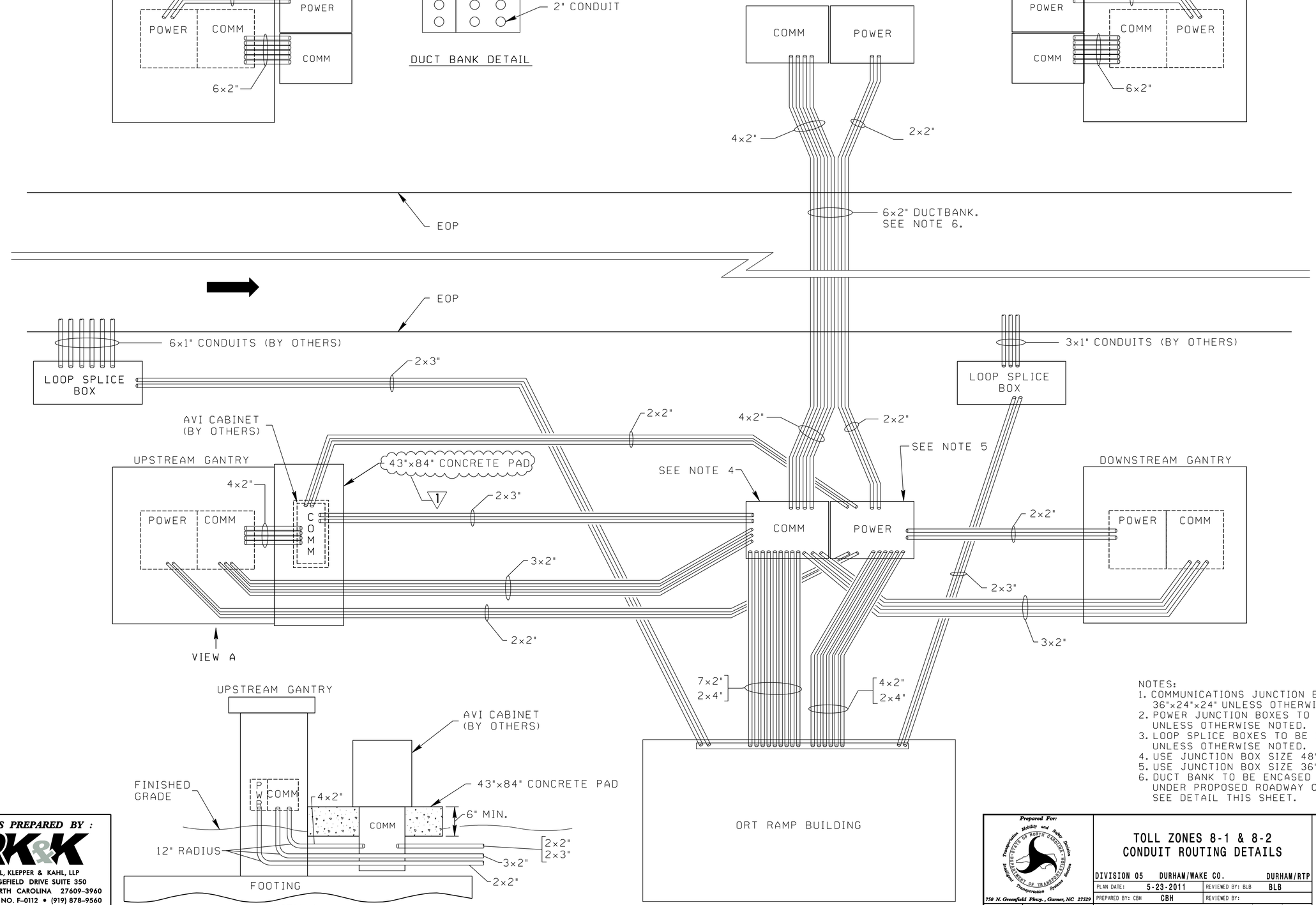
PROJECT REFERENCE NO.	SHEET NO.
U-4763B	ITS-03G





DUCT BANK DETAIL





NOTES:
1. COMMUNICATIONS JUNCTION BOXES TO BE 36"×24"×24" UNLESS OTHERWISE NOTED.
2. POWER JUNCTION BOXES TO BE 30"×17"×24" UNLESS OTHERWISE NOTED.
3. LOOP SPLICE BOXES TO BE 36"×17"X24" UNLESS OTHERWISE NOTED.
4. USE JUNCTION BOX SIZE 48"×48"×24".
5. USE JUNCTION BOX SIZE 36"×24"×24".
6. DUCT BANK TO BE ENCASED IN CONCRETE UNDER PROPOSED ROADWAY CROSSINGS. SEE DETAIL THIS SHEET.

PLANS PREPARED BY :

RK&K

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FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

Prepared For:
Transportation Mobility and Safety Division
Intermodal Transportation Systems Section
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
750 N. Greenfield Pkwy., Garner, NC 27529

TOLL ZONES 8-1 & 8-2
CONDUIT ROUTING DETAILS

DIVISION 05 DURHAM/WAKE CO. DURHAM/RTP

PLAN DATE: 5-23-2011	REVIEWED BY: BLB	BLB
PREPARED BY: CBH	CBH	REVIEWED BY:

SCALE: NTS

REVISIONS	INIT.	DATE
1 CONSTRUCTION REVISION - REVISED CONCRETE PAD SIZE TO 43"x84"	CBH	5-23-11

SEAL
NORTH CAROLINA PROFESSIONAL SEAL 033753 ENGINEER C. BYRON HOLDEN
SIGNATURE DATE

CADD Filename: U4763_ITS_PSH03G.DGN

Attachment 2

6C TOC AVI Transponder Programming Standard

6C TOLL OPERATORS COALITION
AVI TRANSPONDER PROGRAMMING STANDARD

REQUIREMENTS AND GUIDANCE DOCUMENT
VERSION 3.0 REVISION 3
MARCH 15, 2016

DOCUMENT CONTROL

Originator:	6C Toll Operators Coalition
Report Title:	6C Toll Operators coalition avi Transponder Programming Standard
History:	V 0.1 - Initial Draft Release
	V 0.2 – Updates to “State” portion of EPC field Hash Key changed from 16 to 32 bytes Version Code added to Transponder Serial Number Field
	V 0.3 – Existing System Compatibility section added
	V 0.4 – Transponder and Reader Technical Requirements section added
	V 0.5 – Move Technical Requirements Section
	V 0.6 – Update to Barcode format and EPC/Password validation calculation examples
	V 0.7 – Update to User Memory Password validation calculation example and addition of comment regarding HOT declaration in EPC field
	V 1.0 – Updated Agency Codes (E-470 changed from 1 to 2); Made the Barcode format optional; Prohibited Read protection of User Data Memory; Allowed optional Write protection of User Data Memory; Updated references to the TID length to allow use of all fully serialized ISO 18000-6C standard tags
	V 2.0 – Updated the name of the document; redesigned memory map; convert from EPC Global format to ISO format; security update; changes to permit declarable transponders; updated Barcode format
	V 3.0 - Fixed encoding details according to ISO requirements, giving more detail as needed. Combined State and Agency fields to be single Agency field and added Agency ID appendix. Clarified UII validation calculation.
	V 3.0 Revision 2 – Added logo to cover page; clarified barcode format; corrected sample calculation of UII Validation hashing value.
	V 3.0 Revision 3 – Added DSFID (0x3E) to be programmed as initial 2 bytes of UII.

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1. INTRODUCTION

1.1 Purpose

The purpose of this document is to create and maintain a transponder programming standard based on the ISO/IEC 18000-63 (known as 6C) communication protocol for tolling applications that use automatic vehicle identification (AVI). The guidance is intended for tag and reader

manufacturers, toll lane vendors, system integrators, back-office providers, and other members of the RFID industry.

This programming standard meets the interoperability requirements developed by IBTTA's Roadside Interoperability Group.

1.2 Scope

This document addresses the following areas of interest:

- Memory Mapping
- Barcode Format
- Transponder Security and Data Integrity Validation
- Transponder Ordering and Delivery (Manifest Information)
- Compatibility with Existing Systems

1.3 Definitions, Acronyms, and Abbreviations

TID	Transponder Identification Gen2 transponder memory bank 10
UM	User Memory Gen2 transponder memory bank 11
UII	ISO/IEC 18000-63 (formerly '6C'), transponder memory bank 01

2. MEMORY MAPPING

The ISO/IEC 18000-63 transponder memory is separated into four memory banks:

Bank 00	Reserved
Bank 10	TID
Bank 01	CRC, PC, UII
Bank 11	User Memory

2.1 Reserved Memory Specification

The Reserved memory shall be programmed by the tag provider and contents shared with the issuing agency.

2.2 TID Memory Specification

The Transponder Identification (**TID**) memory shall contain a minimum of 64 bits (8 byte) unalterable unique chip ID programmed by the chip manufacturer. This field will not be specified to be any particular value, but it is assumed to be unique for all -63 chips, per the ISO 18000-63 standard.

2.3 Memory Bank 01 Specification

There are three memory areas contained with Memory Bank 01.

- Stored CRC – This 16 bit long area is stored at memory location 00h - 0Fh and is calculated by the transponder.

- Stored PC - This area is 16 bits long and is stored at memory location 10h – 1Fh. The PC word contains the Application Family Identifier (AFI) – an 8 bit identifier (the value being 0xB0) assigned to the 6C Toll Operators Coalition. This number has been assigned for tolling by ISO, along with the Data Storage Format Identifier (DSFID, value of 0x3E) and explicitly describes a tag belonging to the 6C Toll Operators Coalition.

  This number can be used to filter the responses of tags to ensure that only toll tags are being read.

  The PC word is encoded during chip initialization and is dependent on the type of chip being encoded, not on an individual tag's data.

- UII – This area is at least 96 bits long and is stored beginning at memory location 20h. Any memory in excess of 96 bits is undefined and may be used by the issuing agency; however, the additional memory shall not interfere with any of the functionality contained in this document. The UII shall provide read-only access to users. The issuing agency may lock write access permanently or may allow write access by a password maintained by the issuing agency.

2.3.1 MEMORY MAP

Area	#	Memory Address	Section	Description	Values
Stored CRC	1-16	00h-0Fh (16 bits)	Calculated	Area is calculated based on other transponder memory values per ISO 18000-63 specification.	Varies
Stored PC	1-5	10h-14h (5 bits)	Length	Number of 16 bit words in the UII	00110 = 6 words (indicates 96 bit UII) – will vary based on UII length
	6	15h (1 bit)	User Memory	Indicates status of the User Memory	0 = no user memory 1 = user memory available
	7	16h (1 bit)	XPC	Indicates status of extended tag features	0 = no XPC 1 = XPC available
	8	17h (1 bit)	Numbering System Indicator	Indicates if the tag is coded as an EPC or ISO tag.	0 = EPC 1 = ISO (correct value for 6C TOC applications)
	9-16	18h-1Fh (8 bits)	AFI	Application Family Identifier for 6C TOC – B0	1011 0000 = 6C TOC AFI (B0)
UII	1-8	20h-27h (8 bits)	DSFID	Data Storage Format Identifier for 6C TOC – 0x3E	0011 1110 = 6C TOC DSFID (3E)
	9 - 21	28h–34h (13 bits)	Agency Use	Individual agencies may add agency specific information here.	Assigned by agency
	22-33	35h-40h	Classification	Classification is taken directly from 2.2 E-ZPass – IAG, 256 Bit Style #1, Format #1 and includes:	
		(1 bit)	Class	The first bit indicates if the tag has been assigned a classification value. If 0 is selected, the following 11 bits shall be ignored.	0 = no class value assigned (default) 1 = class value assigned
		(5 bits)	Vehicle Type	This field indicates the type of vehicle.	00000 = undefined (default) 00001 = automobile 00010 = motorcycle 00011 = pickup truck 00100 = van (seats 1-9) 00101 = minibus (seats 10-15) 00110 = bus (seats 16+) 00111 = recreational vehicle 01000 = truck 01001 = auto transporter (≤ 65') 01010 = auto transporter (>65') 01011 = tractor & trailer (≤48') 01100 = tractor & trailer (>48') 01101 = tractor & dual trailers each (≤28.5') 01110 = tractor & dual trailers each (>28.5')

Area	#	Memory Address	Section	Description	Values
					01111 = tractor & dual trailers each (one ≤28.5' other >28.5') 10000 = undefined 10001 = tractor/mobile home combination 10010-11111 = undefined
		(4 bits)	Vehicle Axles	This field indicates the number of axles.	0000 = undefined (default) 0001 = undefined 0010 = 2 axles 0011 = 3 axles 0100 = 4 axles 0101 = 5 axles 0110 = 6 axles 0111 = 7 axles 1000 = 8 axles 1001 = 9 axles 1010 = 10 axles 1011 = 11 axles 1100 = 12 axles 1101 = 13 axles 1110 = 14 axles 1111 = 15 axles
		(1bit)	Vehicle Weight	This field indicates the weight of vehicle.	0 = ≤ 7,000 lbs (default) 1 = > 7,000 lbs
		(1 bit)	Vehicle Rear Tires	This field indicates the number of rear tires.	0 = Single rear tires (default) 1 = Dual rear tires
	34-36	41h-43h (3 bits)	HOV Declaration	These three bits indicate the declaration status of the tag. All single mode transponders shall be assigned the default value – 000, unless they are carpool specific tags.	000 = single mode (default) 001 = SOV (non-carpool) 010 = HOV 2+ 011 = HOV 3+ 100 = Carpool (as defined by roadway) 101 = reserved for future use 110 = reserved for future use 111 = reserved for future use
	37-40	44h-47h (4 bits)	Version	There are 16 possible values to indicate the version of programming standard used on the tag.	0000 = unassigned 0001 = Ver. 1.0 0010 = Ver. 2.0 0011 = Ver. 3.0
	41-52	48h-53h (12 bits)	Agency	The Agency Code allows for up to 4,096 agencies. The known agencies are included in the values column. See Appendix A for details.	See Appendix A – Table of Agencies
	53-80	54h-6Fh (28 bits)	Transponder Serial Number	This identifies the particular tag within the agency. There are 268,435,456 values accommodated in this space. The values in this field will be assigned by each agency.	Assigned by agency

Area	#	Memory Address	Section	Description	Values
	81-96	70h-7Fh (16 bits)	UII Validation (Hash Value)	This is calculated using the first 80 UII bits and 32 byte key. Example is provided in Section 4.	Assigned at the time of transponder manufacturer. Calculated as per Section 4.

Table 1: UII Memory Mapping

2.4 User Memory Specification

As of the publication date of this Version 3.0, none of the current members of the 6C Toll Operators Coalition write to their tags, nor do any of them read the User memory. It is anticipated that this memory bank may be required to accommodate future group members or affiliates. The following general specifications shall apply.

The User memory shall have at least 512 bits (64 bytes) and shall NOT be read or write protected.

The User memory bank shall be designated as a temporary data field, where facilities may read and write whatever information is necessary, recognizing that the data may be overwritten at any time. For example, an agency operating a closed ticket type of system may choose to use this bank and write trip start date, time, location, and price as the trip begins and read this information at the conclusion of the trip. This could be used to compute the correct toll.

Any agency-specific use of User memory outside the specifications in this document should be closely coordinated to reduce the risk of future conflicts.

DSFID – Data Storage Format Identifier

The DSFID declares the data format for the data in User Memory. It is a value set by ISO as part of the AFI process. ISO has assigned the value 0x3E, which means the data is defined by the 6C Toll Operators Coalition. The User Memory portion of the tag shall have the following format:

#	Memory Address	Section	Description	Values
1-8	00h-07h (8 bits)	DSFID	• Data Storage Format Identifier	0011 1110 = 6C TOC DSFID (3E)
9-20	08h-23h (12 bits)	Agency	• 12 bit **Agency Code**. As assigned in the previous section.	Section 2.3.1
21-27	24h-1Ah (7 bits)	Plaza ID	• 7 bit **Plaza ID**. Each operator may choose.	To be defined by agencies using this field.
28-32	1Bh-1Fh (5 bits)	Lane ID	• 5 bit **Lane ID**. Each operator may choose.	To be defined by agencies using this field.
33-57	20h-38h (25 bits)	Day/Time	• 25 bit **Day**. Each operator may choose. (seconds since Jan 01 00:00:00)	To be defined by agencies using this field.
58—60	39h-3Bh (3 bits)	Occupancy Setting	• 3 bit **Occupancy**. Each operator may choose.	To be defined by agencies using this field.
61+	3Ch -	Undefined	• The remaining bits may be defined as individual agency needs arise.	

Table 2: User Memory Mapping

3. BARCODE FORMAT

3.1 Barcode Format

The transponder barcode includes only the Agency Code and the Transponder Serial Number along with a check digit. The barcode shall be printed using EPC Code 128 and the code data digits shall be in decimal format AAAATTTTTTTTTTL where AAAA is the Agency Code as a 4-digit number with leading zeros, TTTTTTTTTT is the Transponder Serial Number (TSN) as a 10-digit number with leading zeros and L is the Luhn check digit computed using only the last 2 digits of the Agency Code and all 10 digits of the TSN.

Below the barcode the Agency Code, the TSN and the check digit shall be displayed in the following decimal format <AA>AA TTTTTTTTTT L. The printed Agency Code shall NOT contain leading zeros and shall be separated from the TSN by a double space., where <AA>AA is the Agency code excluding leading zeros. The TSN shall include the leading zeros (to fill all 10 digits) and shall be separated from the check digit number L by a double space.

<AA>AA TTTTTTTTTT L

Where:

<AA>AA = 4 digit Agency Code (leading zeroes not printed)

TTTTTTTTTT = 10 digit Transponder Serial Number (leading zeroes printed)

L = Check digit Luhn (mod10) coded – calculated based upon **<AA>AA** (third and fourth digits only) and **TTTTTTTTTT** (all ten digits)

For example, a transponder with serial number 12 for agency 77 would return 007700000000123 as the barcode content and the printed information below the barcode would be **77 0000000012 3**.

Similarly for agency 449 a transponder with serial number 12 would return 044900000000122 as the barcode content and the printed information below the barcode would be **449 0000000012 2**.

4. SECURITY AND DATA INTEGRITY VALIDATION

4.1 Overview

Transponder security is critical to the toll industry. It is anticipated that as more security features become available they will be evaluated and deployed, as appropriate. The following security measures are currently employed.

4.1.1 TID MEMORY BANK

The transponder identification number shall be uniquely assigned by the manufacturer. It shall be readable without a password, cannot be altered and must be unique.

4.1.2 UII MEMORY BANK

1. Read Password – The UII memory shall be readable without a password and mapped according to the requirement table in Section 2.3.1.

2. Write Password – The UII memory shall be writable with a password. The issuing agency shall be the only entity authorized to change the encoded bits on the transponder. The password shall be known only to the issuing agency.

3. UII Authentication/Validation – The UII memory data shall be authenticated with two hashed validation bytes. The UII Validation bytes can be used for transponder data verification and can also provide some level of transponder authentication. Further details are contained in Section 4.2

4. Encryption – Under development.

4.1.3 USER MEMORY BANK

1. Read Password – The User memory shall be readable without a password.

2. Write Password – The User memory shall be writable without a password.

3. Authentication/Validation – Authentication and validation shall not be used.

4. Encryption – Under development.

4.2 UII Validation

Below is example of how the UII validation bytes shall be calculated using:

1. The first 10 bytes of the UII (starting with the “Agency Use” field)

2. The 32 byte key (determined by the tag issuing agency)

3. The bytes of the transponder TID[1] (length varies - see footnote)

For ensuring interagency interoperability and consistency between transponders manufactured by different vendors the open standard SHA1 hashing algorithm shall be used. The hashing sequence shall be:

a. Concatenate the 10 UII memory bytes, the 32 byte key and the TID bytes to form a single byte sequence

b. Determine the SHA1 hash of this byte sequence above

c. For UII Validation the first 2 bytes from the 40 byte hash result shall be used.

UII Validation Reference Calculation is provided below:

UII 10 byte: 0x**FFFFFFFFFFFFFFFFFFFF**

Key 32 byte:
0x**ABABABABABABABABABABABABABABABABABABABABABABABABABABABAB**
ABABABABAB

TID (12 byte example): 0x**000000000000000000000000**

Result 20 byte hash value: 0x**167F9C5B3933148B68AAD51EE3C4B5F858166451**

UII Validation bytes: 0x**167F**

The 12 UII bytes shall be encoded as: 0x**FFFFFFFFFFFFFFFFFFFF167F**

Tags which are not fully serialized (that is, have at least a 48 bit unique serial number) will not conform to this standards document and should not be used for interoperable 6C tolling deployments.

[1] The TID length can vary per the ISO 18000-63 specification. For fully serialized tags, the complete header and serialized portion of the TID (which can be anywhere from 96 - 192 bits, given the allowable serial number length of 48 - 144 bits) will be used for the indicated calculations. Per the standard, the length of a transponder’s TID serial number is indicated on each transponder, in bits 20h - 22h of the TID.

5. TRANSPONDER ORDERING AND DELIVERY (MANIFEST INFORMATION)

To facilitate loading of data in back office transponder inventory on transponder delivery, manufacturers should provide a file with comma separated UII memory and TID. Each transponder entry should be on a new line:

12_Byte_UII_Memory,TID (length varies)

0101CE00010000000101CE8C,E2003412012EC0FFEE041392[2]

[2] Note: Values shown are for illustrative purposes only and are not actual/valid EPC or TID values. A 12 byte TID is used for example purposes.

6. COMPATABILITY WITH EXISTING DEPLOYMENTS

6.1 6C Toll Operators Coalition, Version 1.0

ISO 18000-6C Tolling AVI Transponder Programing Standard Version 1.0 was finalized in June 2012. Colorado's and British Columbia's TI Corp follow the standard. This standard is administered by the 6C Toll Operators Coalition. This standard is forward compatible with Version 2.0 and 3.0.

6.1.1 E-470 TOLL AUTHORITY, USA

Colorado's E-470 follows this interoperable standard (1.0).

6.1.2 TI CORP, CA

British Columbia's TI Corp follows this interoperable standard (1.0).

6.2 6C Toll Operators Coalition, Version 2.0

ISO 18000-63 Tolling AVI Transponder Programing Standard Version 2.0 was published in draft form in October 2014. This standard is administered by the 6C Toll Operators Coalition. This standard is compatible with Version 1.0 and 3.0.

6.2.1 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, USA

Washington State Department of Transportation follows this interoperable version (2.0).

6.3 Legacy Systems

6.3.1 STATE ROAD AND TOLLWAY AUTHORITY (SRTA), USA

Georgia's State Road and Tollway Authority (SRTA) had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system.

6.3.2 UTAH DEPARTMENT OF TRANSPORTATION, USA

Utah Department of Transportation had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system.

6.3.3 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, USA

Washington State Department of Transportation had already deployed transponder programming requirements before Version 1.0 was developed and continue to operate their current legacy system. This legacy standard is being phased out.

7. APPENDICES

7.1 Appendix A – Table of Agencies

Agency	Acronym	State	Status	Decimal	Hex	Binary
Reserved	N/A	N/A	Reserved	0	0	0000 0000 0000
Washington State Department of Transportation	WSDOT	WA	Assigned	77	4D	0000 0100 1101
Bay Area Toll Authority	BATA	CA	Assigned	101	65	0000 0110 0101
California Department of Transportation	CalTrans	CA	Assigned	102	66	0000 0110 0110
Foothill/Eastern Transportation Corridor Agency	FETCA	CA	Assigned	103	67	0000 0110 0111
San Joaquin Hills Transportation Corridor Agency	SJHTCA	CA	Assigned	104	68	0000 0110 1000
Golden Gate Bridge, Highway and Tunnel District	GGBHTD	CA	Assigned	105	69	0000 0110 1001
Los Angeles County Metropolitan Transportation Authority	LACMTA	CA	Assigned	106	6A	0000 0110 1010
Orange County Transportation Authority	OCTA	CA	Assigned	107	6B	0000 0110 1011
Riverside County Transportation Commission	RCTC	CA	Assigned	108	6C	0000 0110 1100
San Diego Association of Governments	SANDAG	CA	Assigned	109	6D	0000 0110 1101
Santa Clara Valley Transportation Authority	VTA	CA	Assigned	110	6E	0000 0110 1110
South Bay Expressway, LLC	SBX	CA	Assigned	111	6F	0000 0110 1111
Sunol SMART Carpool Lanes Joint Powers Authority	Sunol JPA	CA	Assigned	112	70	0000 0111 0000
San Francisco County Transportation Authority	SFCTA	CA	Assigned	113	71	0000 0111 0001
San Bernardino Associated Governments	SANBAG	CA	Assigned	114	72	0000 0111 0010
E-470	E-470	CO	Assigned	194	C2	0000 1100 0010
State Road & Toll Way Authority	SRTA	GA	Assigned	321	141	0001 0100 0001
Puerto Rico Highway and Transportation Authority	PRHTA	PR	Assigned	448	1C0	0001 1100 0000
Louisville-Southern Indiana Ohio River Bridges	LSIORB	KY	Assigned	449	1C1	0001 1100 0001
Louisiana Department of Transportation and Development	LADOTD	LA	Assigned	450	1C2	0001 1100 0010
Utah Department of Transportation	UDOT	UT	Reserved	1409	581	0101 1000 0001
Washington State Department of Transportation	WSDOT	WA	Reserved	1505	5E1	0101 1110 0001
Transportation Investment Corporation	TI Corp	BC	Assigned	2305	901	1001 0000 0001
Blue Water Bridge Authority	BWBA	ON	Assigned	2529	9E1	1001 1110 0001

Table A-1: Agency IDs

Attachment 3
IBTTA NIOP Requirements Document

International Bridge, Tunnel, and Turnpike Association

North American Toll Interoperability Program

Electronic Toll Collection Protocol

Requirements Document

Final

Version 2.2014.09

September 2014

Table of Contents

1 Introduction

During the summer of 2012 the International Bridge, Tunnel, and Turnpike Association's Interoperability Committee formed a "Technical Subgroup" in order to begin discussions of requirements for tolling interoperability in North America. The goal was to establish a set of requirements for protocol(s) to be used by in-lane equipment and tags/transponders that would provide interoperability for participating members of the traveling public and also meet the technical and business needs of the toll operators.

The IBTTA requirements initiative is meant to serve as a basis upon which further planning and design work can move the industry toward compliance with MAP-21, a federal law signed into law in 2012, which calls for a nationally interoperable system by July of 2016.

There are roughly six separate radio frequency-based "protocols" used in North America to collect toll from participating travelers. These protocols, while all based on radio communication in the same band of spectrum (902-928 MHz), are not compatible with each other.

The aggressive schedule for MAP-21 eliminates the possibility of moving away from RF-based identification systems. In addition, the industry has a large investment in the installed base of equipment. For these reasons, the Technical Subgroup (TSG) has focused its efforts on requirements for RF-based systems, since it is very likely that only protocols currently in use are feasible candidates for use across all of North America within the MAP-21 schedule.

This document is intended to be the formal statement of the requirements for any protocol selected to be a candidate for serving as a "National Protocol". The goal is to get agreement on these requirements so that a decision can be made about which protocol(s) will be tested and eventually selected for the final interoperable system.

2 Nature/Scope of this Document

The intention of the IBTTA is to specify the requirements for Radio Frequency Identification (RFID) protocols that could be used to meet the needs for an interoperable toll network of North American toll operators. This effort focuses on those needs by determining the requirements rather than on specific existing or proposed technologies or products. The requirements for the ETC Protocols are described in terms of on-board units ("OBUs") and roadside equipment ("RSEs"). These are used as generic terms and are not intended to indicate the use of a specific technology.

IBTTA recognizes that many hardware components, software modules, and operational issues are involved in an overall program to implement an Electronic Toll Collection (ETC) system. The technical requirements herein, however, deal specifically with the system component that provides the ability to automatically and in real-time communicate a unique identifier and other data stored in an OBU traveling with a vehicle passing through a toll lane/zone. Other equipment in the toll lane and/or back office then determines the toll assigned to that vehicle.

The Technical Subgroup (TSG) focused on technical requirements without regard to possible costs to implement compliant equipment and/or changes that might be required to other aspects of the overall toll collection process.

The primary purpose is to define requirements for Protocols, not Products. To the extent possible, this document is limited to protocol requirements that are intended to serve as the NTP. However, since the selected protocol(s) must be able to operate in tolling environments (which are the result of significant investment) some requirements that go beyond just protocol needs are included. These additional requirements are intended to ensure the selected protocols are properly defined and to guide the testing program that will follow agreement on requirements.

2.1 Abbreviations, Definitions and Terminology

For the purposes of this requirements document, the term "ETC Protocol" shall be used to refer to an RF-based identification methodology which uses roadside and vehicle based equipment to communicate certain data elements between those two locations.

The term Onboard Unit (OBU) shall be used to refer to the vehicle-based device.

The term Roadside Equipment (RSE) shall be used to refer to all of the equipment necessary at the roadside in order to carry out the functions defined herein

Following is a list of other abbreviations used in this document:

AVC - Automatic Vehicle Classification
DMV - Department of Motor Vehicles: Not intended to refer to any particular state's DMV but the corresponding agency in all relevant states or provinces.
ETC - Electronic Toll Collection
FCC - Federal Communications Commission

GPS - Global Positioning System
ID – Identification
IBTTA -International Bridge Tunnel and Turnpike Association
I/O - Input/output
MHz - Megahertz
NEMA - National Electrical Manufacturers Association
NTP – National Toll Protocol (interoperable protocol as specified by IBTTA)
OBU - On-board Unit
ORT - Open Road Tolling
Protocol – A method of communication based on sending and receiving messages
RF - Radio Frequency
ETC Protocol – Radio Frequency Identification Protocol
RSE - Roadside Equipment
TCP/IP – Transmission Control Protocol/Internet Protocol
VES - Violation Enforcement System

3 ETC Protocol Requirements

3.1 Single and Multi-Protocol Requirements

The requirements herein apply to NTP RSE and OBU devices intended to operate in single and multi-protocol environments. Single protocol NTP environments are considered to only operate with the use of the NTP specified protocol, where as multi-protocol environments are intended operate with both the NTP protocol and the existing protocol(s) of a toll operator.

The requirements herein apply only to the performance of the RSE and OBU devices operating in the NTP mode in a dual-protocol environment. It is recognized that toll operators may have existing protocol(s), functionality, and performance requirements different from those specified in this NTP document. It is not the intent of this document to make changes to the requirements of any toll operator, but rather to define the performance capability of the NTP devices that may be used by a toll operator to support interoperability. It is the expectation that the NTP devices will meet the requirements of this document, while simultaneously meeting local toll operator requirements for one of the following other protocols in use. The local toll operator protocols are commonly known as one or more of the following:

- Allegro
- ASTM v6
- ATA
- ISO 18000 6C (63)
- SeGo (eGo Plus)
- TDM (IAG)
- Title 21

For a dual-protocol environment, the performance of the local (non-NTP) protocol cannot be degraded by the addition of the NTP protocol by more than 60%, based on the average number of 'handshakes' obtained by the existing protocol.

3.2 Organization of the Requirements

The requirements have been organized into the following categories:

- Legal and Safety Requirements (Section 3.3)
- "Open Protocol" Requirement (Section 3.4)
- Functional Requirements (Section 3.5)
- Operational Requirements (Section 3.6)
- Performance Requirements (Section 3.7)
- OBU Data Requirements (Section 3.8)
- Environmental Requirements (Section 3.9)

3.3 Legal and Safety Requirements

3.3.1 Regulatory Compliance and Licensing

The ETC Protocol, when incorporated into tolling equipment, shall comply with applicable federal, province, state and local licensing and regulations for the technology in question.

3.3.2 Spectrum Usage

The OBUs and RSEs utilizing the protocol shall operate in such FCC allocated radio frequencies as appropriate for this application.

3.3.3 FCC Licensing

All ETC equipment using the protocol shall comply with all FCC requirements. OBUs shall not require an operating license. RSE's shall operate and require a license to provide protection from interference. If there are different levels of license available (primary, secondary, other), the ETC Protocol shall be eligible for no less than a secondary license.

3.3.4 Resistance to Interference

Equipment utilizing the ETC Protocol shall be able to be made resistant to electromagnetic interference or noise, electrical interference, and mechanical interference that may typically be found in a toll plaza environment from sources such as, but not limited to, wireless data and voice services, satellite radio signals, GPS devices, vehicle electronics, ignition systems, electrical appliances, lightning (except for direct hits), other toll registration equipment in and/or near toll booths, power tools, power lines, power transformers, mobile and portable communications radios, cellular telephones, walkie talkies, VES equipment, security systems, lighting, speed radar sources and detectors, refrigeration units, windshield wipers, detuned engines, defrosters, and any moving parts. Resistance to direct, in-band signals of significant signal strength is not included in these requirements.

3.3.5 Safety

Equipment utilizing the ETC Protocol shall be able to meet or exceed all applicable safety and environmental requirements related to the technology and its applications in addition to any requirements listed herein. The equipment shall not pose either a short-term safety risk or a long-term health risk to drivers, toll collector, technicians, and other people who may frequently be in the vicinity of the equipment in operation. All RSE components shall be able to operate continuously and still meet all pertinent specifications stated herein. RSE components must be installed per the manufacturers' installation guidelines.

All transactions shall be automatic without any involvement of the driver, except with a possible exception of moving an external switch on a "switchable tag". The OBU devices shall allow for the placement of safety labels as required by prevailing laws, regulations, and standards of the State in which they are issued.

3.4 "Open Protocol" Requirements

3.4.1 Definition of "Open Protocol"

Any protocol chosen for North American interoperability of electronic toll collection (ETC) equipment which includes, but is not limited to, the readers and transponders necessary to identify the ETC account associated with a vehicle passing through a tolling point must satisfy the following criteria:

- The protocol shall include specifications and operational information that:
  - are documented, published for all to use, and readily available on a royalty-free or a fair and reasonable basis;
  - describe the parameters necessary to allow anyone to manufacture readers, transponders and other ETC equipment that can be independently certified as meeting the published specifications. Adequacy of this documentation will be subject to a peer review process;
  - do not withhold any detail necessary for interoperable implementation; and
  - contain no unreasonable constraints on re-use or modification.
- A continuing obligation from the owner and/or licensor of the protocol to offer all persons the unrestricted right to implement, use, and exercise other rights with respect to all technology and intellectual property necessary to implement the protocol (including the right to use, make, have made, market, import, offer to sell, and sell, and to otherwise directly or indirectly distribute ETC equipment that implements the protocol's specifications) under:
  - a royalty-free and otherwise reasonable and non-discriminatory license; or
  - a license that contains Fair, Reasonable and Non-Discriminatory (FRAND) terms and conditions that do not unduly restrict competition.

3.4.2 Compliance with Published Specifications

Equipment utilizing a candidate ETC Protocol shall fully comply with the published specifications referenced in Section 3.4.1.

3.5 Functional Requirements

3.5.1 Basic Functions

Devices using the ETC Protocol shall be able to establish a communication link between the roadside and vehicle in order to determine the unique identifier and other associated data stored in an OBU contained in or attached to the vehicle and communicate these data to the lane/zone controller. Other communication functions are described below.

3.5.2 Roadside Equipment (RSE) Requirements

The RSE is defined as encompassing all toll plaza equipment (e.g., antennas, similar devices, cables, readers and any electronics modules) utilized to communicate with the OBU and to process data for communication to the existing lane or zone controllers.

Equipment utilizing the ETC Protocol may use different RSE configurations for different purposes (single lane, multi-lane, open road tolling, etc.) but they all shall meet the requirements stated herein except if explicitly stated otherwise.

3.5.2.1 Operational Environment

The ETC Protocol shall support the ability of equipment to operate in both traditional plaza environments and open road tolling environments. Current environments include traditional plazas with at least 28 lane and open road environments with at least 6 lanes of live traffic and 2 shoulder lanes. Protocols should support as many lanes as needed, without any logical maximum limit.

In a multi-lane environment the Protocol shall support methods to avoid adjacent lane interference (if desired).

3.5.2.2 Equipment Location

The in-lane equipment shall typically be located outdoors attached to pipes, posts, toll booths, canopy support columns or other suitable means of support. RSE electronic components shall typically be located outdoors in suitable weatherproof enclosures but may be located indoors (e.g., inside toll booths, the toll plaza tunnel, or the toll plaza building) at the discretion of the Operator.

3.5.2.3 Overhead Equipment

IBTTA Members have a variety of canopy layouts and clearances. Equipment using the ETC Protocol shall meet the accuracy requirements herein for all antenna mounted heights between 13.5 feet and 20 feet.

3.5.2.4 Security

Security requirements shall include features typically deployed with the protocol by toll operators in North America.

3.6 Operational Requirements

3.6.1 Operational Modes and Environments

Equipment utilizing the ETC Protocol shall be required to operate in numerous operational modes and environments. These operational modes include various combinations of the following attributes:

- Payment models
    - Entry or Exit payment only
    - Closed (entry and exit) payment;
    - HOV/HOT facilities
- Toll collection sites
    - Toll plazas
    - Open road tolling sites;
- Lane toll collection configurations
    - *ETC*-only
    - *ETC* with automatic coin machine
    - *ETC* with automatic coin/cash/credit card machine
    - *ETC* with staffed booth
    - *ETC* with automatic coin machine and staffed booth
    - *ETC* with tandem booth (the lane supports two vehicles paying at the
    - same time);
- Lane speeds
    - High-speed
    - Low-speed
    - Stopped, no gate
    - Stopped and gated
    - High-speed gated
    - Low-speed, no gate; and
- Traffic flow characteristics
    - Free flow
    - Bumper to bumper
    - Tailgating
    - Stop and go
    - Backing up
    - Lane Straddling

3.6.2 Definitions

3.6.2.1 Lane Types

The ETC Protocol shall support both conventional toll plaza lanes as well as high-speed open road tolling lanes. These lane types may be stand-alone configurations or adjacent to other lane types. Lanes in traditional plazas may vary from 10 to 15 feet in width and up to 20 feet in height. Open Road Tolling Lanes may vary from 11 to 12 feet in width and up to 20 feet in height.

- Open Road Tolling Lanes

  An open road tolling lane is a lane where a toll is collected but there are no toll booths or other toll collection equipment beyond that needed for electronic toll collection, allowing the vehicle to continue at highway speeds at any lateral position across the provided lanes or shoulder. An entry open road tolling lane in a closed system is a lane where the entry into the system is identified but there are no toll booths or other toll collection equipment beyond that needed for electronic toll collection, allowing the vehicle to continue at highway speeds at any lateral position across the provided lanes or shoulder.

- Traditional Toll Plaza Lanes

  A traditional toll lane is part of a toll plaza where tolls may be collected by toll collectors in booths, automatic coin machines, and/or electronically. Lanes dedicated to electronic toll collection in a toll plaza environment are considered toll lanes even if they do not require the vehicle to slow down. An entry lane in a closed system is part of a toll plaza where the entry into the system is identified.

- Reversible Lanes

  A reversible lane is a lane where tolls may be collected from vehicles traveling in either direction during different periods of the day.

- Express Lanes

  Express lanes are dedicated ETC lanes which permit higher speeds than toll lanes and may have some lane delineation and equipment installed around the lane.

- High Speed Lanes

  High speed lanes are lanes where the vehicle may pass through the toll collection site at or near highway speeds. These may be present in open road tolling and toll plaza sites.

- Low Speed Lanes

Low speed lanes are lanes where the vehicle must slow down well below highway speeds while passing through the toll collection site. These are typically found in toll plazas to enhance safety.

- Gated Lanes

  Gated lanes are lanes in a toll plaza where a gate is used to prevent passage of vehicles until the lane/zone controller provides confirmation that a valid ETC, cash or credit transaction has occurred.

- Dedicated Lanes

  A dedicated lane is a lane where only one form of payment is accepted such as a lane where only OBU-equipped vehicles can pass without triggering a violation enforcement system. A dedicated lane may be gated to control violations.

- Mixed Mode Lanes

  A mixed mode lane is a lane where multiple forms of payment are accepted. For example, it could consist of any combination of manual toll collection, Automatic Coin machines as well as ETC.

- Tandem Lanes

  A tandem lane is a lane configured such that two tollbooths are situated one in front of the other, allowing two vehicles in the same lane to make payments at the same time.

- High Occupancy Toll (HOT) Lanes

  HOT lanes are limited-access, normally barrier-separated, highway lanes that provide free or reduced cost access to qualifying High Occupancy Vehicles (HOVs), and also provide access to other paying vehicles not meeting passenger occupancy requirements.

3.6.2.2 Lane/Zone Controller

The term “lane controller” or “zone controller” refers to all hardware and software necessary to interface with the RSE to receive the OBU-stored data.

3.6.2.3 Properly Mounted/Presented OBU

A properly mounted/presented OBU is an OBU that has been mounted/presented in accordance with the Manufacturer’s specifications and tolerances. When an OBU is properly mounted or presented in accordance with the specifications the OBU data shall be communicated to or captured by the RSE.

3.6.2.4 Read

A read is defined as the transfer of data stored in an OBU contained in or attached to a vehicle as specified herein to the RSE for subsequent transmission to the lane/zone controller as the result of the passage of the equipped vehicle through the Capture Zone.

3.6.2.5 Write

A write is the ability of the RSE to transmit and store new or modified data to/on an OBU for later access or further modification.

3.6.2.6 Capture Zone

The Capture Zone is defined as a volumetric space within which the system performs any vehicle identification, communications, and transactions.

The ETC Protocol shall support the ability of RSE's to utilize Capture Zones that ensure that the required capture rate, at a minimum, is achievable under all traffic conditions, speeds, conditions of congestion (e.g., bumper-to-bumper, stop and go, free flowing), environmental conditions and mixes of vehicle types which occur at the reading location.

3.6.2.7 Capture Compatibility

Capture Compatible OBUs are any OBUs which have the same "over the air" characteristics and some commonly recognizable data fields, such that the RSE can conduct transactions (reads and/or writes) with the OBU in a manner similar to those conducted for OBUs which are actually issued by the Operator. OBUs issued by the Operator are, by default, Capture-Compatible OBUs.

3.6.2.8 OBU Capture

OBU Capture is defined as the RSE's successful completion of a transaction with an OBU where a transaction is a successful "read" and "write" (where applicable). A successful 'read' is achieved when the ETC Protocol is able to correctly determine the fixed identification data (e.g. read only fields) as well as the variable data associated with a vehicle that may have been set by a prior lane/zone controller and RSE (write fields). A successful 'read' and 'write' are achieved when the variable data fields are demonstrated to have been correctly updated so that they are available to RSEs at other tolling points.

3.6.2.9 Reporting Zone

The Reporting Zone is defined as a linear portion of the lane within which a vehicle will be present when the RSE reports the result of an interaction with an OBU to the lane/zone controller. The Reporting Zone is important in that current lane/zone controller algorithms make assumptions about the location of OBUs for association with vehicles that are detected using other roadside equipment. In keeping with the preference to maintain existing lane/zone

controllers and algorithms, the ETC Protocol should support reporting zones similar to what is in current practice.

Reporting Zones shall be designed to ensure that the required capture rate, at a minimum, is achievable under all traffic conditions, speeds, conditions of congestion (e.g., bumper-to-bumper, stop and go, free flowing), and mixes of vehicle types which occur at the reading location.

3.6.2.9.1 Toll Lanes

The ETC Protocol timing shall support the ability to limit the Toll Lane Reporting Zone length for each lane type so as to permit no more than the properly mounted/presented OBU of one vehicle to be present in this space at a given time. The Reporting Zone shall be shaped such that it enables an upstream system (i.e. lane controller) to perform unambiguous correlation between each vehicle with a properly mounted/presented OBU. This includes the requirement that transactions reported by the RSE shall be done so in the same order as the vehicles passing through the toll lane.

3.6.2.9.2 Open Road Tolling

The ETC Protocol timing shall support the ability to limit the Reporting Zone such that it enables an upstream system (i.e. lane controller) to perform unambiguous correlation of each vehicle with a properly mounted/presented OBU and the OBU in/on that vehicle. This includes the requirement that transactions reported by the RSE shall be done so in the same order as the vehicles passing through the Reporting Zone. This also includes the requirement to be able to report the lateral location of the vehicle to the extent necessary for upstream systems (i.e. lane controller) to perform unambiguous correlation between an identified OBU and the vehicles detected in the zone.

3.6.2.10 On-Board Unit Requirements

Any OBU or other vehicle-based Equipment included in the ETC Protocol shall conform to the requirements of this Section.

3.6.2.10.1 OBU Types

OBU Models will fall into two general OBU types. Those OBU types are ones that are suitable for mounting/presentation on/from the “interior” of the vehicle and those that are suitable for mounting on the “exterior” of the vehicle. An interior OBU type is defined as an OBU whose mounting/presentation location is within the passenger compartment of the vehicle. An exterior OBU is defined as an OBU whose mounting location is outside the vehicle’s passenger compartment.

These two types of OBUs can further be categorized as to the mounting/presentation requirement, battery and non-battery powered, feedback, and switchability. The following is a list of definitions for these items.

"Permanent mount" is a method of attachment for the OBU that if the OBU is removed from its mounting will result in it becoming permanently unusable.

"Transferable OBU" is an OBU that can be easily moved from one vehicle and mounted/presented from another vehicle.

"Battery powered" is defined to mean an OBU that operates using the power provided by a battery.

"Switchable" is defined as an OBU that is equipped with a user-operable switch that can be used by vehicle operator to indicate occupancy of the vehicle. The position of the switch is communicated to the RSE for use in determining occupancy-based tolling benefits.

"Feedback" OBU's are OBU's that perform a function that indicates to the vehicle operator/occupants the result of a trip past a tolling point. This feedback can be visual or audible.

3.6.2.10.2 Required OBU and Optional OBU Types

The ETC Protocol shall be required to support, at a minimum, the following OBU Types:

- Interior Transferable
- Interior Permanent Mount
- Interior "Switchable"
- Interior "Feedback"
- Exterior Mount

3.6.2.10.3 General OBU Requirements

All OBUs shall meet the following general requirements.

3.6.2.10.3.1 Consumer Product Safety

All components used in the OBU should be approved for use in consumer products in terms of safety. The OBU shall not give off dangerous substances at any time including when damaged.

3.6.2.10.4 Interior OBU Requirements

The following requirements regarding interior-mounted/presented OBUs shall be applicable to all types of interior-mounted/presented OBUs in all vehicles.

3.6.2.10.4.1 Location

The preferred mounting location for interior-mounted OBUs is within the passenger compartment of the vehicle on the windshield either at the base of or behind the rear view mirror.

Mounting/presentation locations are acceptable where interior OBUs will operate per these specifications and alternate mounting locations required due to performance reasons.

Alternate mounting/presentation locations shall not violate any state or province DMV (or Operator state or province equivalent) and Vehicle Code regulations.

Any alternate or additional mounting/presentation locations shall not conflict with existing vehicle registration stickers or vehicle inspection stickers and decals which are typically located in the lower left or lower right corner of the windshield.

The OBU location shall not obstruct with the driver's view of the road.

OBU mounting locations shall accommodate all vehicle types.

3.6.2.10.4.2 Size

Interior OBUs shall be small enough that it can be mounted so that it shall not obstruct the driver's field of vision.

3.6.2.10.4.3 Exterior OBU Requirements

Interior OBUs may not provide adequate performance for some situations. In these situations the exterior OBUs shall be utilized. Exterior OBUs shall be mounted anywhere except inside the passenger compartment and under the vehicle. All exterior OBUs shall meet the following specifications.

3.6.2.10.4.4 Location

Exterior OBUs shall be designed for installation on surfaces outside of the passenger compartment of motor vehicles. The preferred location for exterior OBUs on passenger vehicles is the front bumper combined with the license plate mounting. Exterior mounting locations shall not violate any state or province DMV and Vehicle Code regulations. Commercial vehicles may have OBUs mounted in a greater variety of locations such as on the roof. OBUs shall be located where a motorist could perform the OBU installation, using common tools. Mounting/presentation locations shall not impact read/write accuracy.

Any alternate or additional mounting/presentation locations shall not conflict with existing vehicle registration stickers or vehicle inspection stickers and decals which are typically located in the lower left or lower right corner of the windshield.

3.6.2.10.4.5 Attachment

When mounted, OBUs shall not obscure the license plate numbering (numbers and letters) information. OBUs shall be readily moved using common tools when the owner replaces his or her vehicle. The mounting method for OBU's developed to be removable and re-usable shall

allow removal without risk of damage to the OBU or vehicle. The attachment methods shall be sufficient to prevent inadvertent displacement or projectile motion in case of rough road surfaces or accident.

3.7 Performance Requirements

3.7.1 OBU Capture, Read Accuracy and Write Accuracy

3.7.1.1 Applicability of Accuracy Requirements

The accuracy requirements which follow are for all vehicles equipped with an OBU at the specified mounting/presentation location. The requirements shall be valid for all motor vehicle types and for all properly mounted/presented Capture Compatible OBUs. The requirements apply to all lane types defined herein.

The accuracy requirements apply to every individual lane installation and not to the aggregate system.

3.7.1.2 Read Rate Performance

For properly equipped vehicles passing completely through the Capture Zone, the RFID subsystem shall successfully perform a 'read' transaction (see 'read' definition in 3.6.2.4) at least 99.90 percent of the time.

3.7.1.3 Write Rate Performance

For properly equipped vehicles passing completely through the Capture Zone, the RFID subsystem shall successfully perform a 'read' and 'write' transaction (see 'read' and 'write' definition in 3.6.2.5) at least 99.80 percent of the time.

3.8 Protocol Data Requirements

3.8.1 Protocol Data Storage Requirements

3.8.1.1 Data Field Programmability

OBUs utilizing the protocol shall have fixed and variable data fields. Fixed data fields transmitted to the lane/zone controller by the RSE shall include two types of data fields: those which are factory programmed and those which are Participating Operator programmable, as specified herein. The factory programmable data fields shall be set at the factory and shall not be able to be changed by programming Equipment supplied to any Participating Operator.

Participating Operator programmable data fields shall be such that they can be changed multiple times via programmer Equipment. Typically, these fields are used to associate a vehicle class with each vehicle OBU.

The tables below present a "first cut" of the memory mapping for each storage area within the OBUs. Note that the number of bits for each field is labeled "Proposed". The intent is to identify the minimum data elements that are required. The mapping may be somewhat protocol-dependent and will be finalized later in the NIOP process.

3.8.1.2 Fixed Data Storage – Minimum Requirements

Read

ID	Name	Proposed # bits	# Possible values	Description	Comments
R1	VersionID	4	16	NTP version	Used to track to which version the memory map conforms
R2	Agency ID	12	4,096	Operator or Agency code for the tag issuer, which provides a unique identifier for each tag issuer	This new field combines the previously separate StateID and AgencyID fields
R3	Serial Number	26	67,108,864	A unique value for the tag, to differentiate it from all other tags issued by the tag issuer	
	R1 +R2+R3 SUBTOTAL	**42**	**274,877,906,944**		
R5	Vehicle Class/Profile	11	2,048	For toll systems that cannot determine class at the lane Vehicle Type: 5 bits (TBD: 32 possible values) Vehicle Axles: 4 bits (0-15) Vehicle Weight: 1 bit (<7k lbs / >=7k lbs) Vehicle rear tires: 1 bit (single/dual)	
	Read TOTAL	**53**			

READ OR WRITE*

WR1	Vehicle Occupancy	3	8	For HOV declaration, for use in HOT/managed lanes Config: TBD	000: Not a switchable tag 001: SOV 010: HOV2 011: HOV3 100: Reserved for future use 101: Reserved for future use 110: Reserved for future use 111: Reserved for future use
	Read or Write TOTAL	**3**			

*Depending on switching method, this could be a read or write solution

Write

ID	Name	Proposed # bits	# Possible values	Description	
W1	Agency ID	12	4,096	This provides a unique identifier for each toll operator	The Agency ID of whoever is writing to the tag
W2	Scratch pad	40	1,099,511,627,776	This section is free for agencies to use as they wish. Possible usage would be Plaza ID: 7 bits Lane ID: 5 bits Date/Time: 25 bits (seconds since Jan 01 00:00:00) Occupancy: 3 bits	This can be increased if there is no performance impact. The displayed value represents the minimum requirement
	Write TOTAL	**52**			

TOTAL BITS RQD	**108**

3.9 Environmental Requirements

The ETC Protocol shall support operation in varying climatic and electromagnetic conditions found in and around toll plazas and roadways in North America. The toll facilities require continuous operation, 24 hours a day, 7 days a week.

The ETC Protocol shall meet the accuracy requirements herein under worst case conditions including the following:

- Vehicles traveling up to 100 mph;
- "Stop and go traffic" with continuous intermittent acceleration and deceleration between 0 and 15 miles per hour;
- Vehicles tailgating;
- Different mixes of all vehicle types encountered on North American roads including but not limited to cars, trucks, tractor-trailers, recreation vehicles, motorcycles, buses, and delivery vans;
- Vehicles arriving simultaneously at every toll lane in a plaza or open road tolling site;
- Vehicles changing and/or straddling lanes (where applicable);
- Environmental conditions that may be encountered in North America including but not limited to:
  - Rain : ¼ inch of rain per minute
  - Fog : 10 feet visibility
  - Ice : ¼ inch thickness between the OBU and the RSE
  - Heavy or Blowing Snow : 2 inches of snow per hour
  - All forms of driving precipitation (sleet, hail, blizzard, etc.)
  - Mud, Dust, Sand, and any other debris or contaminant as might be found in toll lanes or open road tolling sites; and

3.9.1 OBU Environmental Requirements

The ETC Protocol shall support OBUs able to operate as specified without degradation in performance and accuracy under the following environmental conditions, radio frequency emissions, mechanical or electrical interference, and lightning (except for direct hits). The environmental extremes are derived in part from SAE J1211, "Recommended Environmental Practices for Electronic Equipment Design" or other recognized test bodies, and verification programs relevant to the device.

All interior OBUs shall be able to be subjected to and operated in 95 percent humidity, non-condensing environments. All exterior OBUs shall operate in 100% humidity, condensing environments. All OBUs shall be designed to be resistant to penetration of fluids, dust, etc., including automotive fluids, salt spray, and fuels, whether through the design of the OBU case or the mounting of the OBU.

All OBUs shall withstand thermal shocks and gradients associated with dashboard or window mounting and temperature gradients of up to 20º F per minute and continue to meet the environmental requirements herein.

3.9.1.1 Internal OBU Environmental

Interior OBUs shall be designed for operation from -40º F to +185º F.

The OBUs shall operate as specified while undergoing the recommended shock and vibration of SAE J1211 for the proposed mounting/presentation location.

All OBUs shall comply with any and all current U.S. and international safety standards to permit unrestricted shipment by mail and commercial carriers with appropriate documentation and in the recommended packaging.

3.9.1.2 External OBU Environmental

Exterior OBUs shall be designed for operation from -40º F to +150º F. Exterior OBUs shall withstand ice, snow, steam, dirt, mud, any solutions used in the lanes, as well as stones and other projectiles such as sand particles and gravel. Exterior OBUs shall operate as specified under all environmental conditions that will be experienced in this environment including radio frequency emissions, mechanical or electrical interference, and lightning (except for direct hits).

3.9.1.3 Interference Susceptibility

OBU Models mounted/presented in accordance with manufacturers' specifications and within the specified tolerances shall not have their performance affected by the nearby presence of common objects such as beverage cans, cell phones, sunglasses, cigarette packs, etc.

----- END OF DOCUMENT ----

Attachment 4

Monroe Gantry and Layout 50 Percent Plans

09/08/09

TIP PROJECT: R-3329 /R-2559

CONTRACT: C202587

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\r3329_r2559_rdy_AET_tsh SHEET 01.dgn
MLH

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

MECKLENBURG & UNION COUNTY

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.
N.C.	R-3329 /R-2559	GAN-1

STATE PROJ. NO.	F. A. PROJ. NO.	DESCRIPTION
34533.5.TA1		

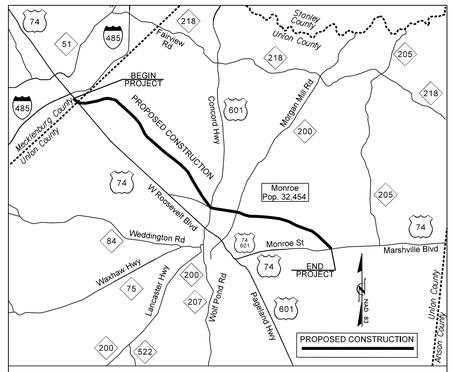
GANTRY 50% PLANS
SUBMITTAL NO. S-380
DATE: 11/19/2015

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

LOCATION: *US 74 BYPASS FROM US 74 JUST EAST OF I-485 NEAR MATTHEWS AND STALLINGS TO US 74 JUST EAST OF WINGATE AND WEST OF MARSHVILLE*

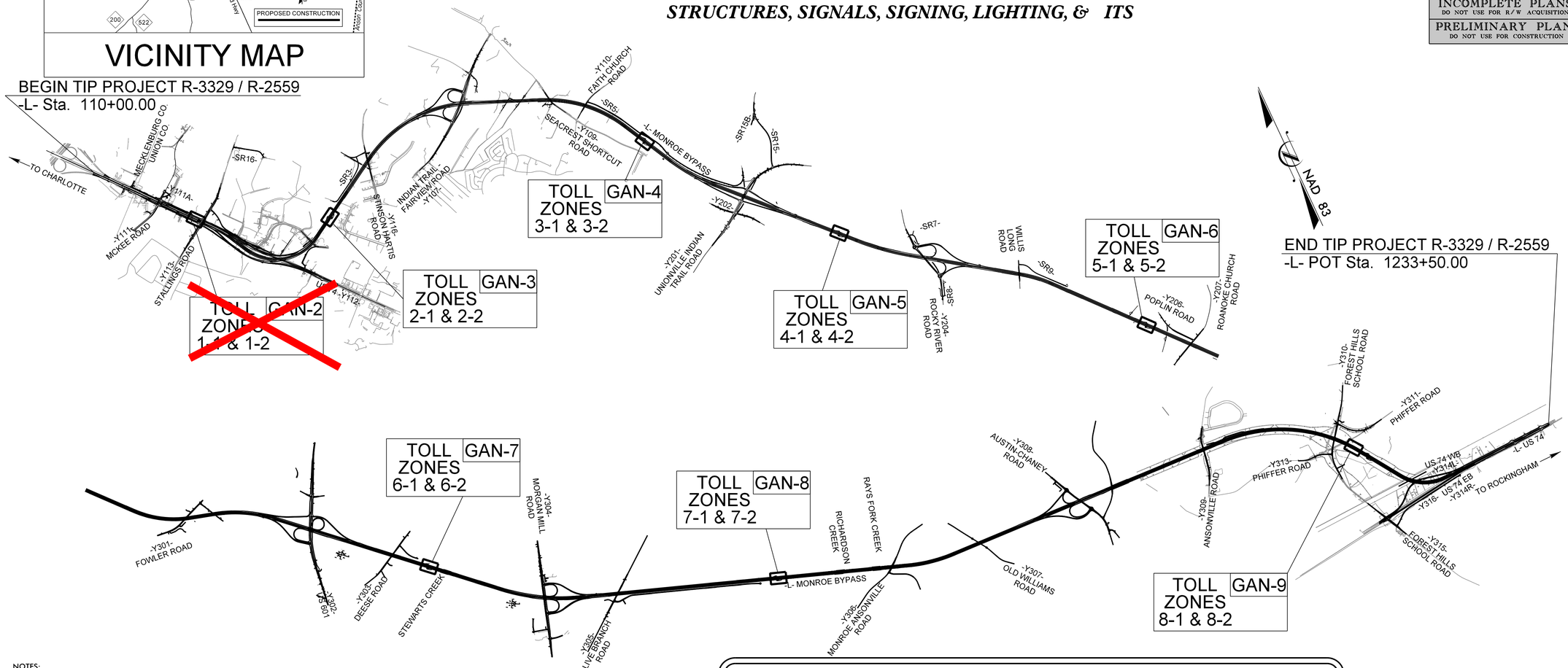
TYPE OF WORK: *GRADING, DRAINAGE, PAVING, WIDENING, RESURFACING, STRUCTURES, SIGNALS, SIGNING, LIGHTING, & ITS*



VICINITY MAP

BEGIN TIP PROJECT R-3329 / R-2559
-L- Sta. 110+00.00

END TIP PROJECT R-3329 / R-2559
-L- POT Sta. 1233+50.00



TOLL ZONES 1-1 & 1-2 GAN-2 — ~~CLOSED~~

TOLL ZONES 2-1 & 2-2 GAN-3

TOLL ZONES 3-1 & 3-2 GAN-4

TOLL ZONES 4-1 & 4-2 GAN-5

TOLL ZONES 5-1 & 5-2 GAN-6

TOLL ZONES 6-1 & 6-2 GAN-7

TOLL ZONES 7-1 & 7-2 GAN-8

TOLL ZONES 8-1 & 8-2 GAN-9

NOTES:
1. THIS IS A CONTROLLED-ACCESS PROJECT WITH ACCESS BEING LIMITED TO INTERCHANGES.

DESIGN – BUILD TEAM

GRAPHIC SCALES

CROSS-SECTION LINE DRAWINGS
0 0 0 0 0

PLANS
20 10 0 20 40

DESIGN DATA

ADT 2013 = 64,100
ADT 2035 = 95,600
DHV = 8%
D = 55%
T = 18%*
V = 70 mph

(*TTST 11% + DUAL 7%)
FUNCTIONAL CLASS.: FREEWAY

PROJECT LENGTH

LENGTH ROADWAY TIP PROJECT R-3329 /R-2559..... 18.1 mi
LENGTH STRUCTURE TIP PROJECT R-3329 /R-2559..... *1.6 mi
TOTAL LENGTH TIP PROJECT R-3329 /R-2559..... 19.7 mi

* LENGTH OF STRUCTURES BASED ON WB LANES

NCDOT CONTACT: *K. ZAK HAMIDI, P.E.*
DESIGN BUILD UNIT

PLANS PREPARED BY :

RK&K
RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE, SUITE 350
RALEIGH, NORTH CAROLINA 27609
NC LICENSE NO. F-0112
FOR THE NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

2006 STANDARD SPECIFICATIONS

LETTING DATE:
OCTOBER 28, 2010

J.T. Peacock, Jr., P.E.
PROJECT ENGINEER

Stephen E. Roberts, P.E.
PROJECT DESIGN ENGINEER

CONTRACTOR :

MONROE BYPASS CONSTRUCTORS

TRANSPORTATION ENGINEER

P.E.
SIGNATURE:

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-3

APPROVED:

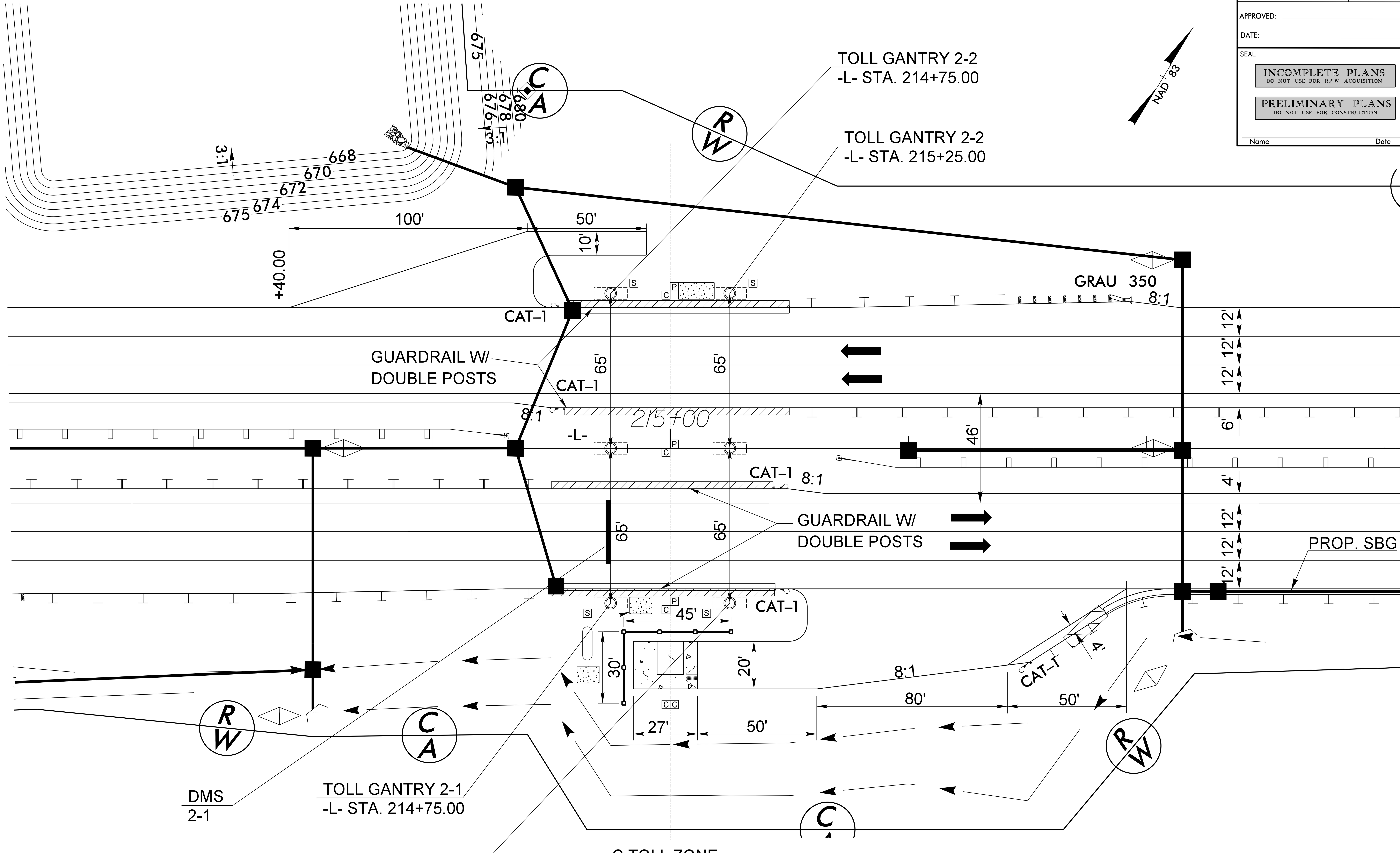
DATE:

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



PLANS PREPARED BY :
RK&K
RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

TOLL ZONE AND GANTRY 2-1 AND 2-2 DMS 2-1

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_RDY_PSH_AET02 SHEET 03.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-4

APPROVED: _____

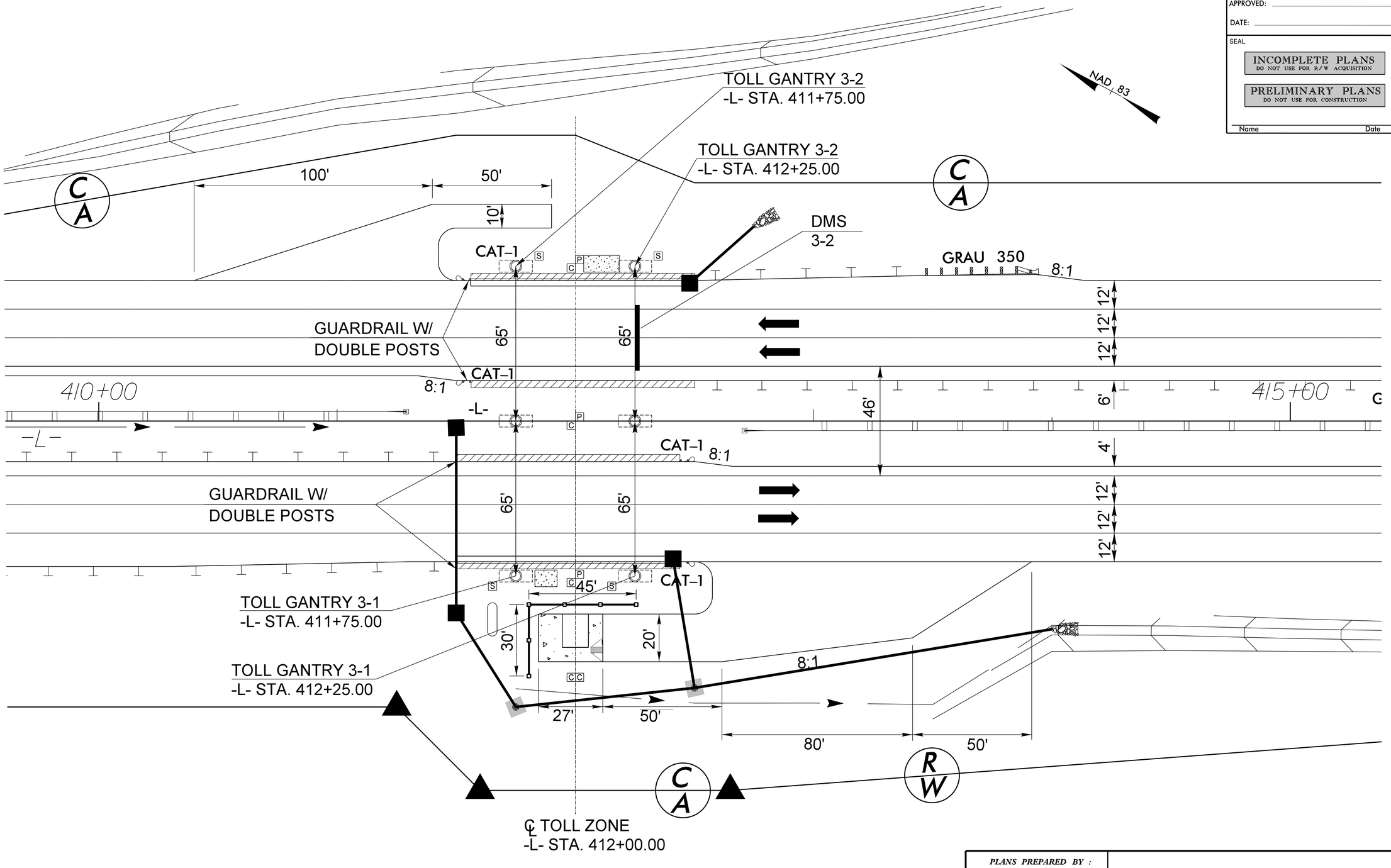
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



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NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

TOLL ZONE AND GANTRY 3.1 AND 3.2 DMS 3-2

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_RDY_PSH_AET03 SHEET 04.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-5

APPROVED: _____

DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NAD 83

TOLL GANTRY 4-2
-L- STA. 494+75.00

TOLL GANTRY 4-2
-L- STA. 495+25.00

100'

50'

10'

CAT–1

GRAU

350

12'

12'

12'

GUARDRAIL W / DOUBLE POSTS

65'

65'

495+00

CAT–1

6'

43° 41' 48.0" E

46'

4'

CAT–1

GUARDRAIL W / DOUBLE POSTS

65'

65'

12'

12'

12'

45'

CAT–1

30'

20'

8:1

TOLL GANTRY 4-1
-L- STA. 494+75.00

27'

50'

50'

TOLL GANTRY 4-1
-L- STA. 495+25.00

℄ TOLL ZONE
-L- STA. 495+00.00

20 0 20 40

PLANS PREPARED BY :

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FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

TOLL ZONE AND GANTRY 4-1 AND 4-2

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_RDY_PSH_AET104 SHEET 05.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-6

APPROVED: _____

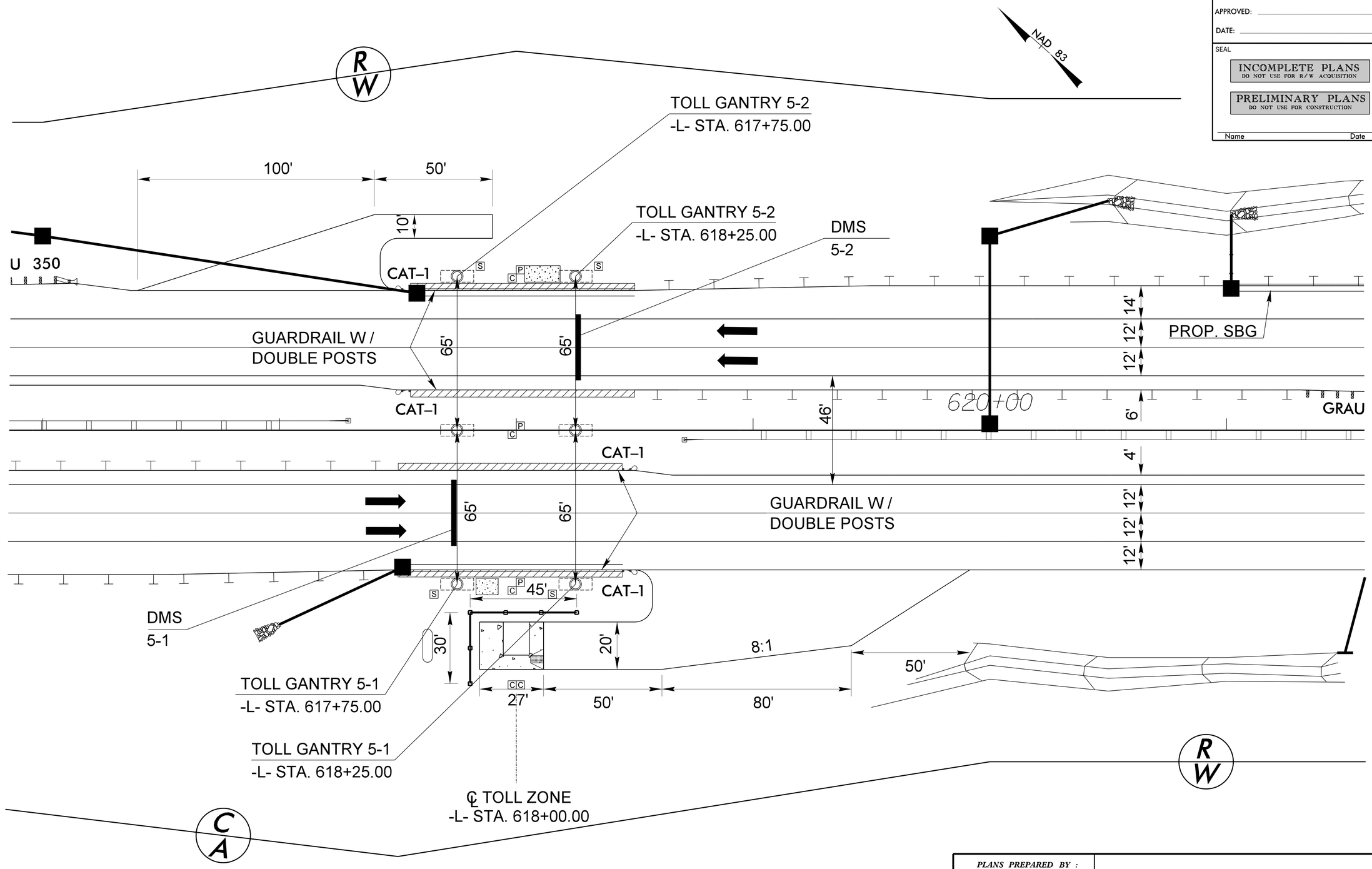
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



20 0 20 40

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NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

TOLL ZONE AND GANTRY 5.1 AND 5.2 DMS 5-1 AND DMS 5-2

11/17/2015
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MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-7

APPROVED: _____

DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

PROP 48'' WW FENCE

℄ TOLL ZONE
-L- Sta. 784+00.00

TOLL GANTRY 6-2
-L- Sta. 783+75.00

TOLL GANTRY 6-2
-L- Sta. 784+25.00

NAD 83

DMS
6-2

100′ 50′ 10′

CAT–1 S P C S

GRAU 350

50:1

12′ 12′ 12′

GUARDRAIL W/
DOUBLE POSTS

65′ 65′

8:1
2GI

CAT–1

785+00

4′ 6′ P.S. 46′

12′ 14′

6′ 46′

GUARDRAIL W/
DOUBLE POSTS

14′ 12′ 12′

CAT–1

50:1

45′

30′ 20′

8:1

GRAU 350

TOLL GANTRY 6-1
-L- Sta. 783+75.00

TOLL GANTRY 6-1
-L- Sta. 784+25.00

27′ 50′ 80′ 50′

20 0 20 40

PLANS PREPARED BY :

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NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

TOLL ZONE AND GANTRY 6-1 AND 6-2 DMS 6-2

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_ROY_PSH_AET06 SHEET 07.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-8

APPROVED: _____

DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

PROP. 48" WW FENCE

℄ TOLL ZONE
-L- STA. 919+25.00

NAD 83

TOLL GANTRY 7-2
-L- STA. 919+00.00

TOLL GANTRY 7-2
-L- STA. 919+50.00

100'

50'

10'

CAT-1

15" RCP-III

50:1

GRAU 3

GUARDRAIL W/DOUBLE POSTS

65'

65'

920+00

14'

12'

12'

6'

S 70° 33' 38.8" E

CAT-1

4'

46'

GUARDRAIL W/DOUBLE POSTS

PROP. SBG

50:1

12'

12'

12'

65'

65'

CAT-1

8:1

45'

DMS
7-1

30'

20'

8:1

TOLL GANTRY 7-1
-L- STA. 919+00.00

27'

50'

80'

50'

TOLL GANTRY 7-1
-L- STA. 919+50.00

20 0 20 40

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TOLL ZONE AND GANTRY 7-1 AND 7-2 DMS 7-1

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\planSheets\R3329_R2559_RDY_PSH_AET07 SHEET 08.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-9

APPROVED: _____

DATE: _____

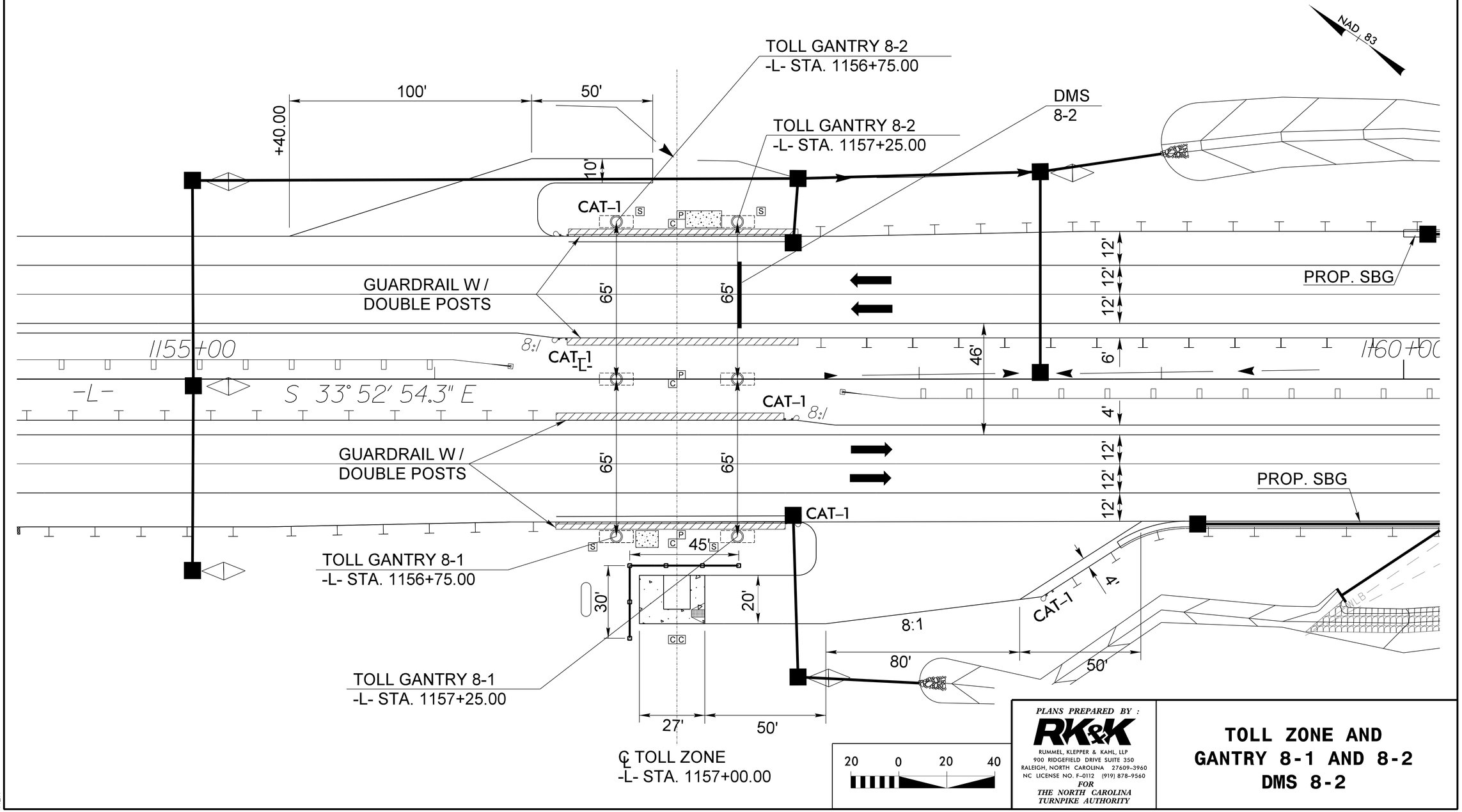
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

PROP 48" WW FENCE



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TOLL ZONE AND GANTRY 8-1 AND 8-2 DMS 8-2

11/17/2015
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MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-11

APPROVED: _____

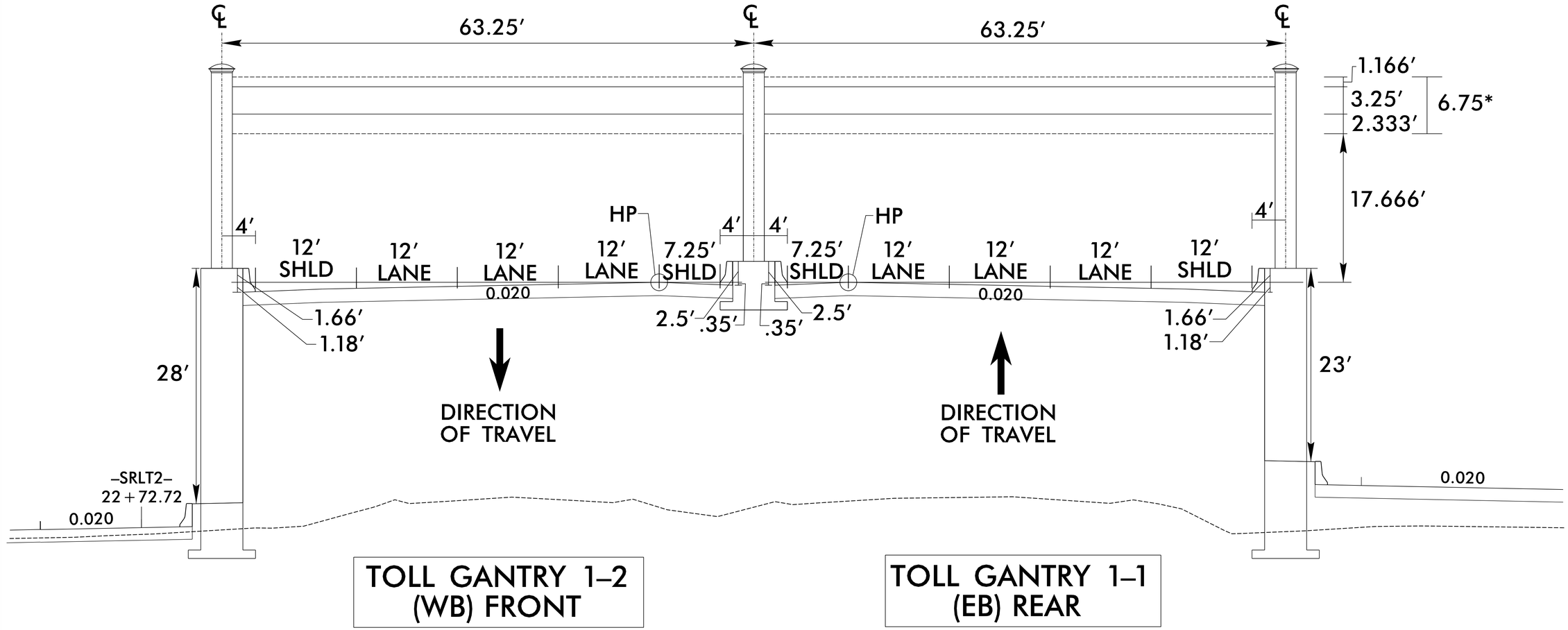
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 1–2
(WB) FRONT

TOLL GANTRY 1–1
(EB) REAR

* AESTHETIC CLADDING

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FOR
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-L-151+40
TOLL ZONE AND
GANTRY 1-1 AND 1-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_LL1_AET-1 SHEET 10 AND 11.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-12

APPROVED: _____

DATE: _____

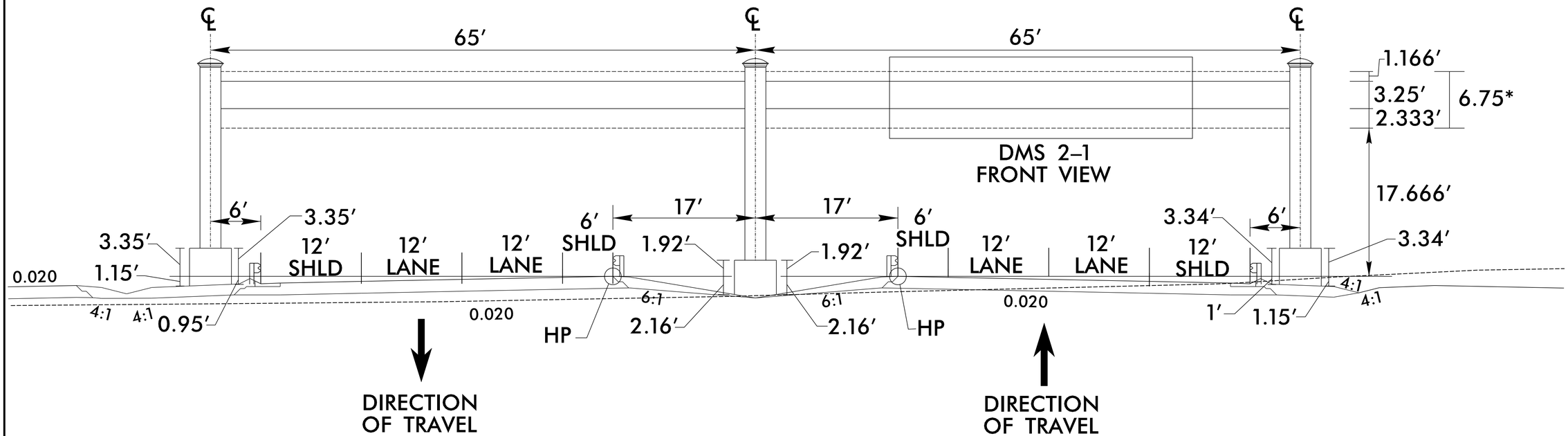
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 2–1 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 2–2
(WB) REAR

TOLL GANTRY 2–1
(EB) FRONT

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FOR
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TURNPIKE AUTHORITY

-L-214+75
TOLL ZONE AND GANTRY
2-1 AND 2-2 AND DMS 2-1
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L1_AET-2 SHEET 12 AND 13.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-14

APPROVED: _____

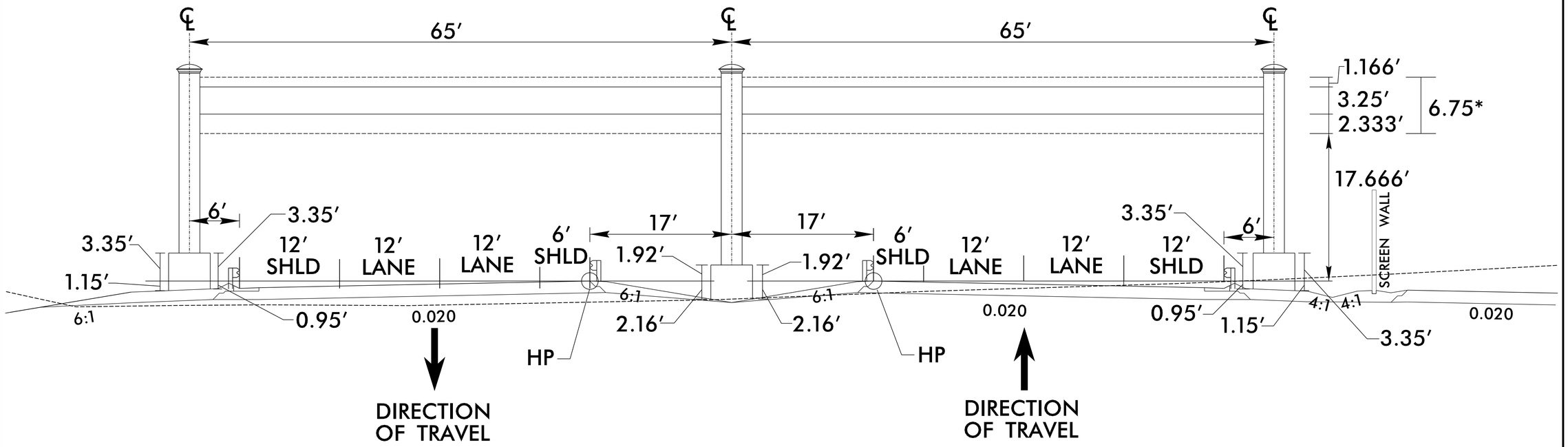
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 2–2
(WB) FRONT

TOLL GANTRY 2–1
(EB) REAR

* AESTHETIC CLADDING

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NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-215+25
TOLL ZONE AND GANTRY
2-1 AND 2-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\planSheets\R3329_R2559_rdy_xsc_L1_AET-2 SHEET 12 AND 13.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-14

APPROVED: _____

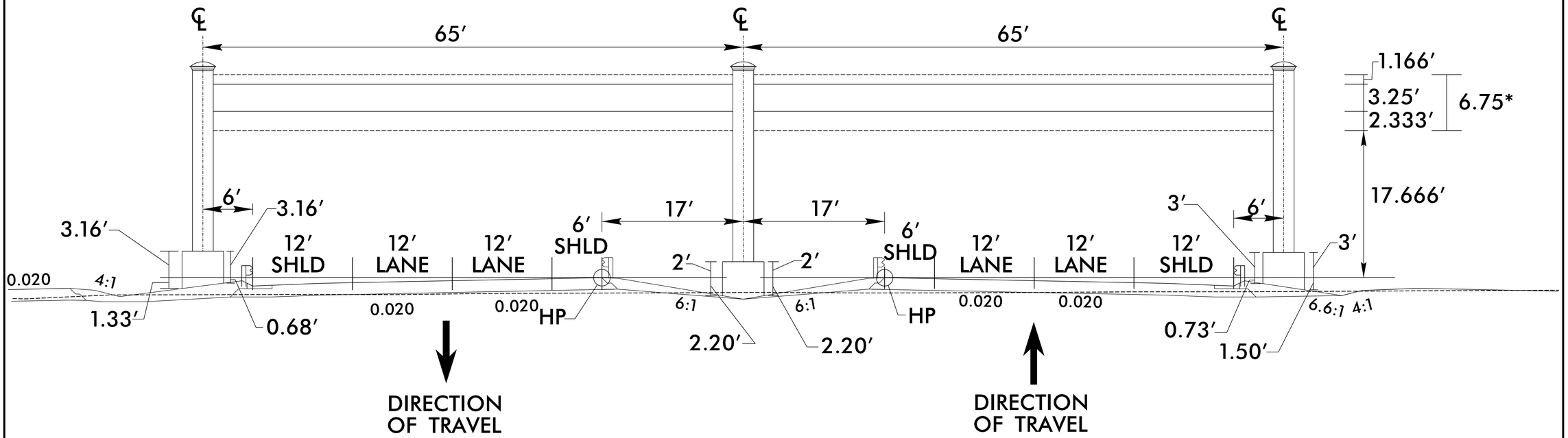
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 3–2 (WB) REAR

TOLL GANTRY 3–1 (EB) FRONT

* AESTHETIC CLADDING

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RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

-L-411+75
TOLL ZONE AND GANTRY 3-1 AND 3-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L2A_AET-3 SHEET 14 AND 15.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-15

APPROVED: _____

DATE: _____

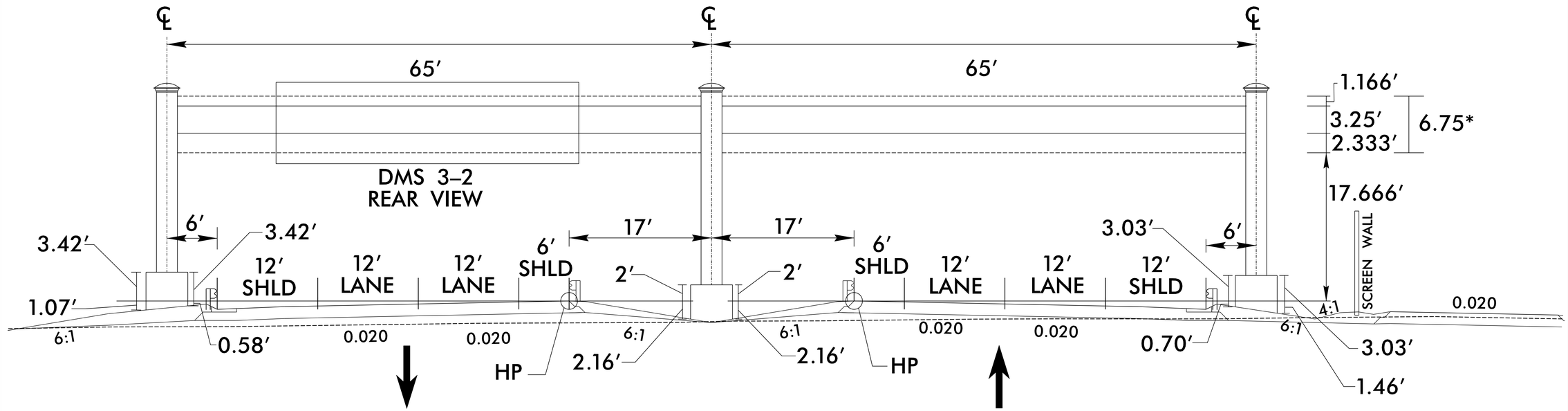
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 3–2 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 3–2
(WB) FRONT

TOLL GANTRY 3–1
(EB) REAR

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FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-412+25
TOLL ZONE AND GANTRY
3-1 AND 3-2 AND DMS 3-2
BY-PASS US 74

11/17/2015
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MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-16

APPROVED: _____

DATE: _____

SEAL

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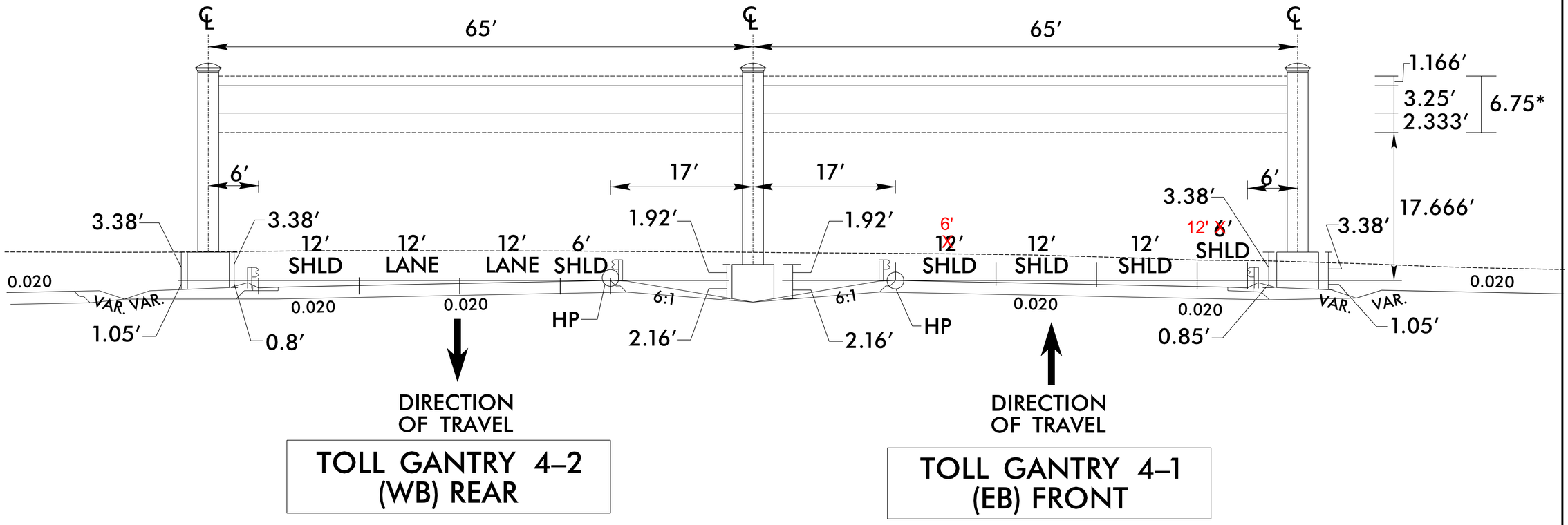
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



DIRECTION OF TRAVEL

TOLL GANTRY 4–2 (WB) REAR

DIRECTION OF TRAVEL

TOLL GANTRY 4–1 (EB) FRONT

* AESTHETIC CLADDING

PLANS PREPARED BY :

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RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-494+75
TOLL ZONE AND
GANTRY 4-1 AND 4-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L2B_AET-4 SHEET 16 AND 17.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-17

APPROVED: _____

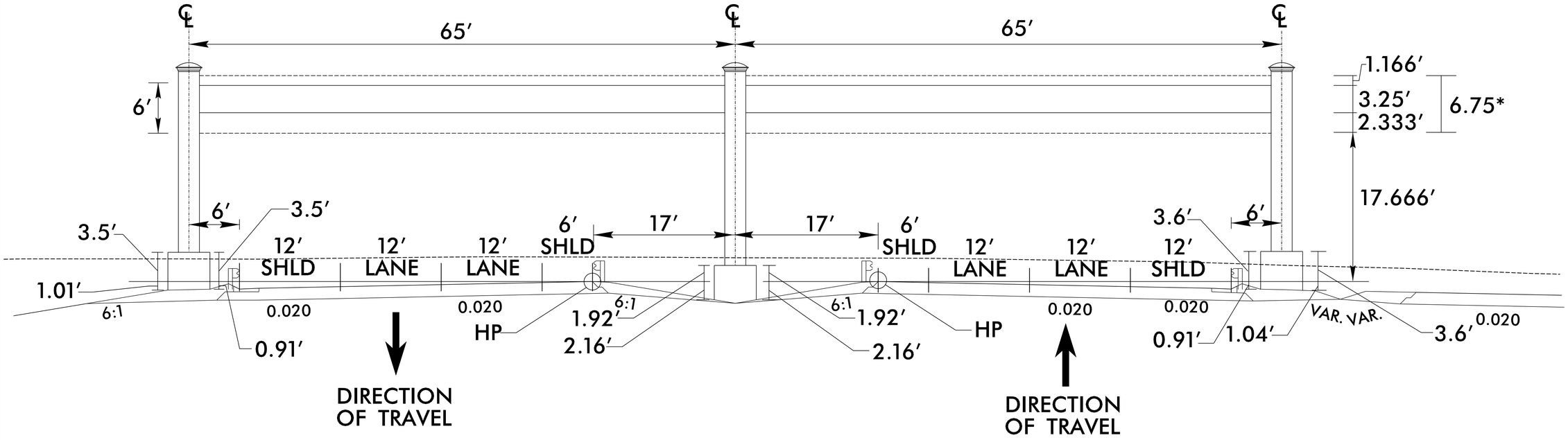
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 4–2 (WB) FRONT

TOLL GANTRY 4–1 (EB) REAR

* AESTHETIC CLADDING

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NC LICENSE NO. F-0112 (919) 878-9560
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THE NORTH CAROLINA TURNPIKE AUTHORITY

-L-495+25
TOLL ZONE AND GANTRY 4-1 AND 4-2 BY-PASS US 74

11/17/2015
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MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-18

APPROVED: _____

DATE: _____

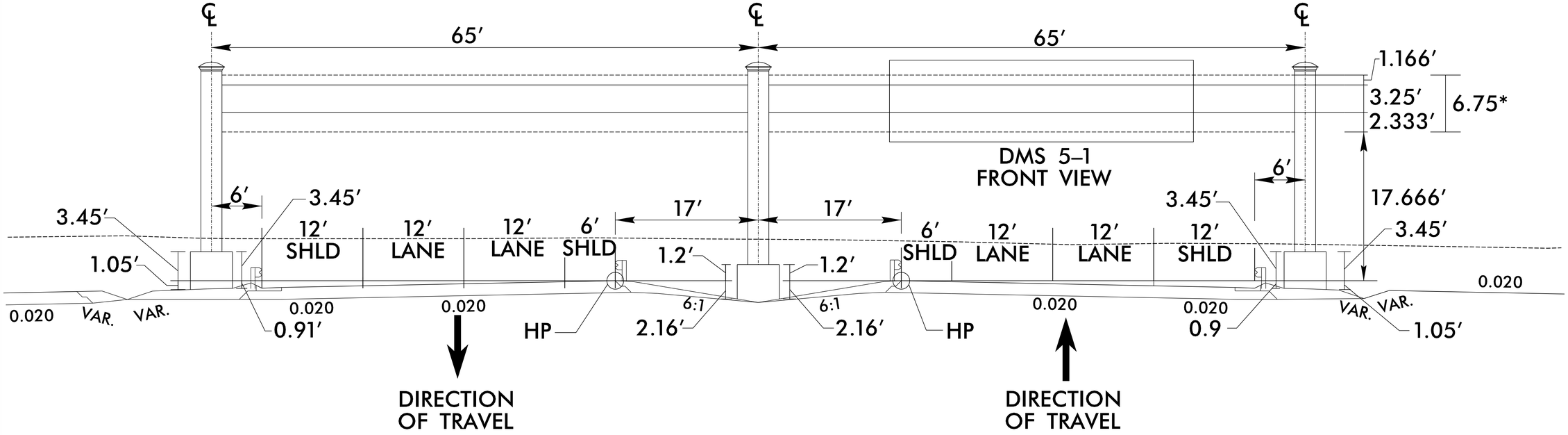
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 5–1 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 5–2
(WB) REAR

TOLL GANTRY 5–1
(EB) FRONT

* AESTHETIC CLADDING

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RK&K

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RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

-L-617+75
TOLL ZONE AND GANTRY 5-1 AND 5-2 AND DMS 5-1
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L2B_AET-5 SHEET 18 AND 19.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-19

APPROVED: _____

DATE: _____

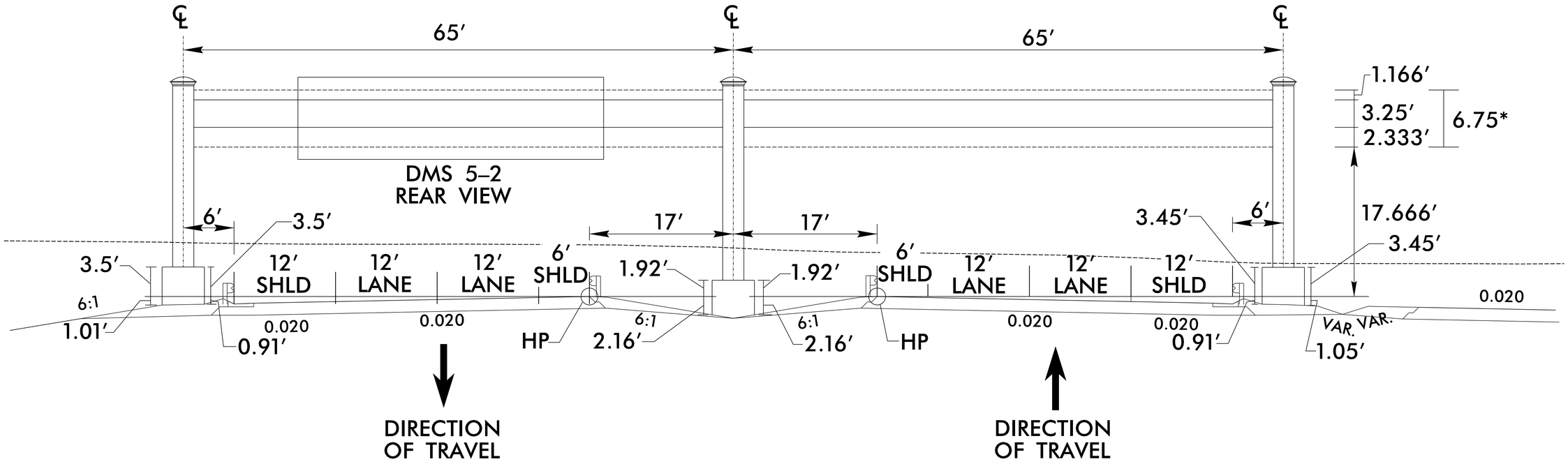
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 5–2 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 5–2
(WB) FRONT

TOLL GANTRY 5–1
(EB) REAR

* AESTHETIC CLADDING

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L28_AET-5 SHEET 18 AND 19.dgn
MLH

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RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA TURNPIKE AUTHORITY

-L-618+25
TOLL ZONE AND GANTRY 5-1 AND 5-2 AND DMS 5-2
BY-PASS US 74

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-20

APPROVED: _____

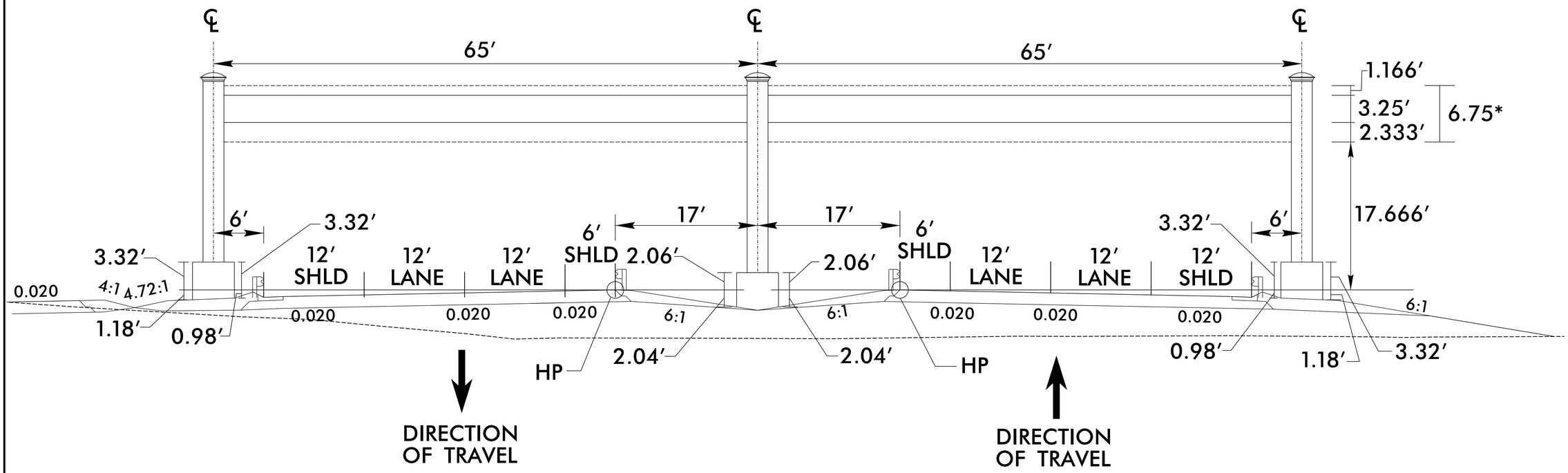
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 6–2
(WB) REAR

TOLL GANTRY 6–1
(EB) FRONT

* AESTHETIC CLADDING

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NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-783+75
TOLL ZONE AND
GANTRY 6-1 AND 6-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_RDY.xsc_L2C_AET-6 SHEET 20 AND 21.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-21

APPROVED: _____

DATE: _____

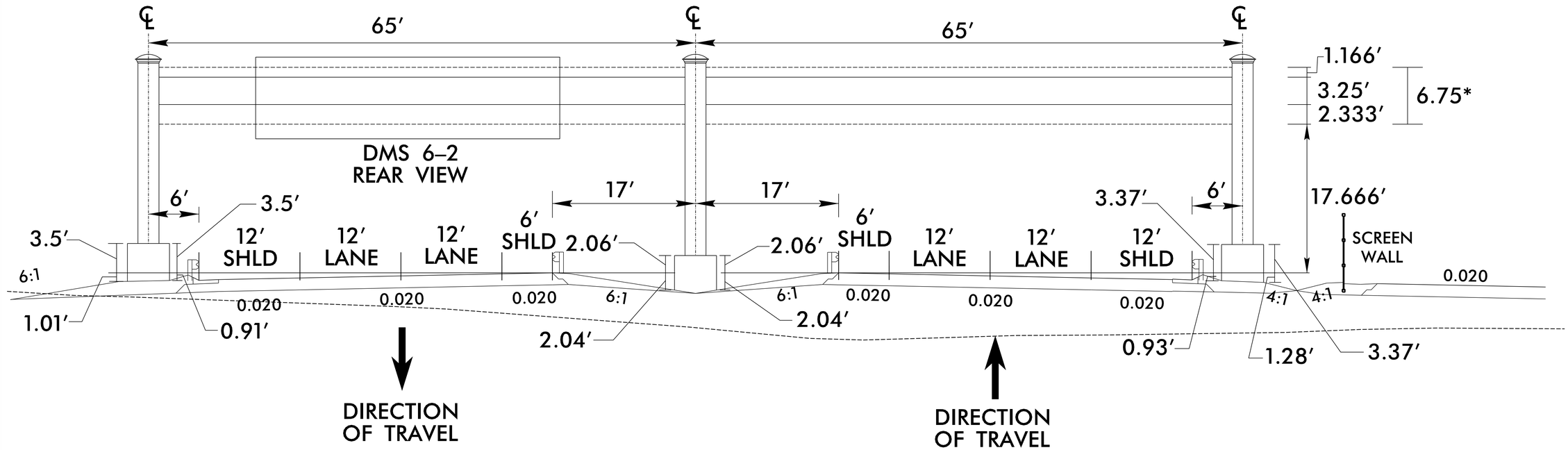
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 6–2 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 6–2
(WB) FRONT

TOLL GANTRY 6–1
(EB) REAR

* AESTHETIC CLADDING

PLANS PREPARED BY :

RK&K

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900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560

FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-784+25
TOLL ZONE AND GANTRY
6-1 AND 6-2 AND DMS 6-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_RDY_xsc_L2C_AET-6 SHEET 20 AND 21.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-22

APPROVED: _____

DATE: _____

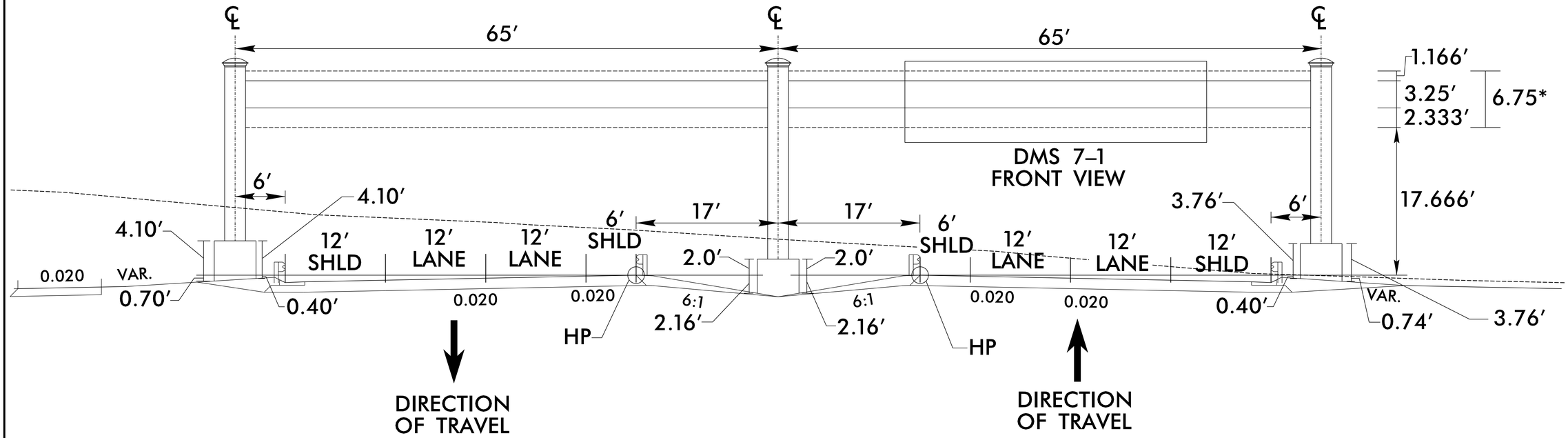
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 7–1 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 7–2 (WB) REAR

TOLL GANTRY 7–1 (EB) FRONT

* AESTHETIC CLADDING

PLANS PREPARED BY :

RK&K

RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560

FOR THE NORTH CAROLINA TURNPIKE AUTHORITY

-L-919+00
TOLL ZONE AND GANTRY 7-1 AND 7-2 AND DMS 7-1
BY-PASS US 74

11/17/2015
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MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-23

APPROVED: _____

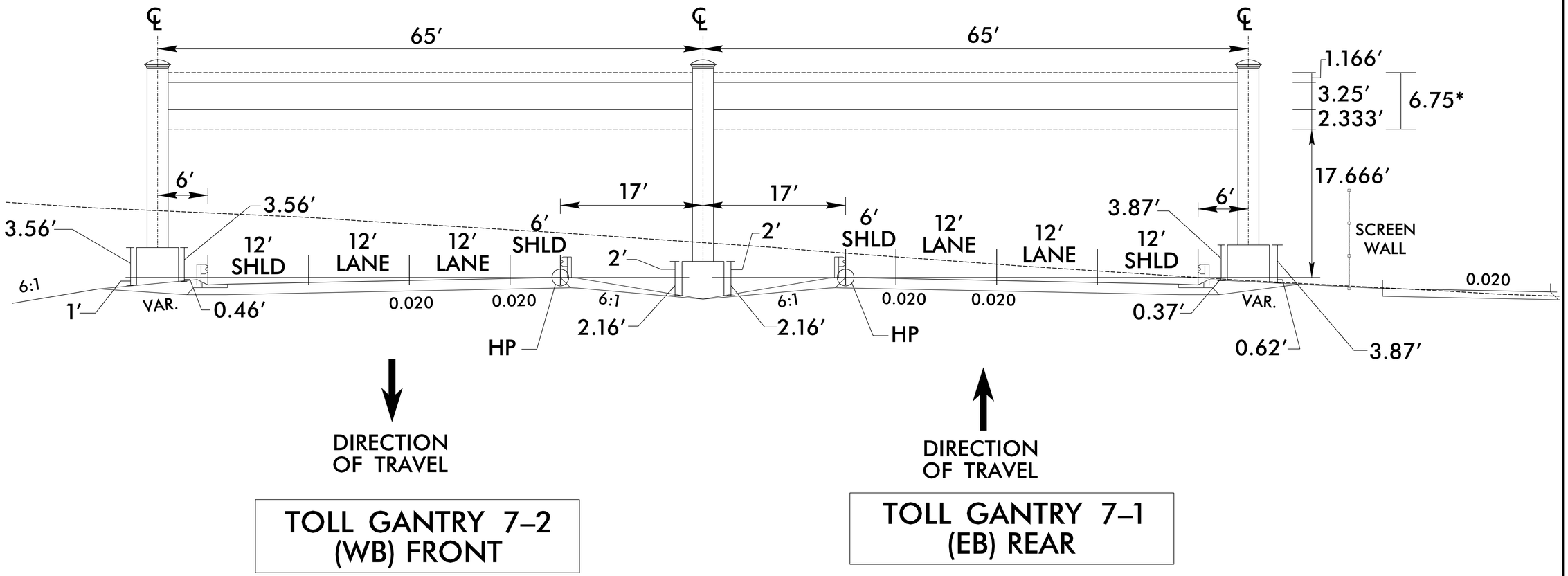
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



TOLL GANTRY 7–2
(WB) FRONT

TOLL GANTRY 7–1
(EB) REAR

* AESTHETIC CLADDING

PLANS PREPARED BY :
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FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-919+50
TOLL ZONE AND
GANTRY 7-1 AND 7-2
BY-PASS US 74

11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L3A_AET-7 SHEET 22 AND 23.dgn
MLH

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-24

APPROVED: _____

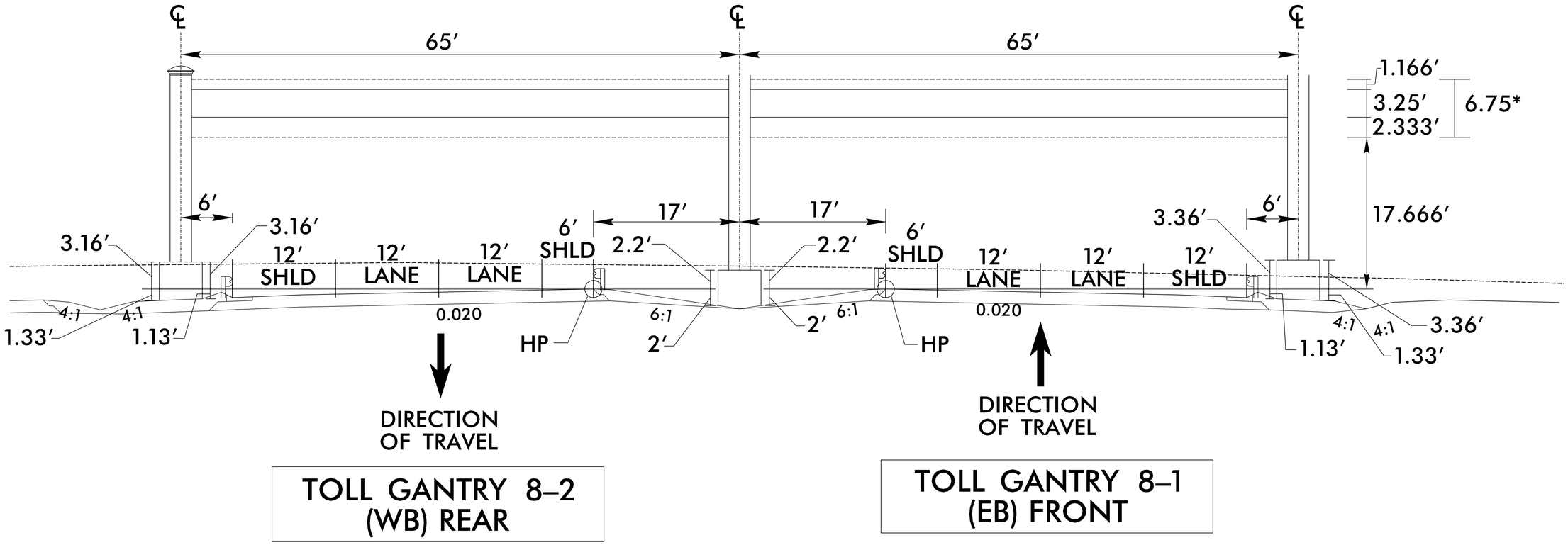
DATE: _____

SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date



DIRECTION OF TRAVEL

TOLL GANTRY 8–2
(WB) REAR

DIRECTION OF TRAVEL

TOLL GANTRY 8–1
(EB) FRONT

* AESTHETIC CLADDING

PLANS PREPARED BY :
RK&K
RUMMEL, KLEPPER & KAHL, LLP
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RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-1156+00
TOLL ZONE AND
GANTRY 8-1 AND 8-2
BY-PASS US 74

TIP NO.	SHEET NO.
R-3329/R-2559	GAN-25

APPROVED: _____

DATE: _____

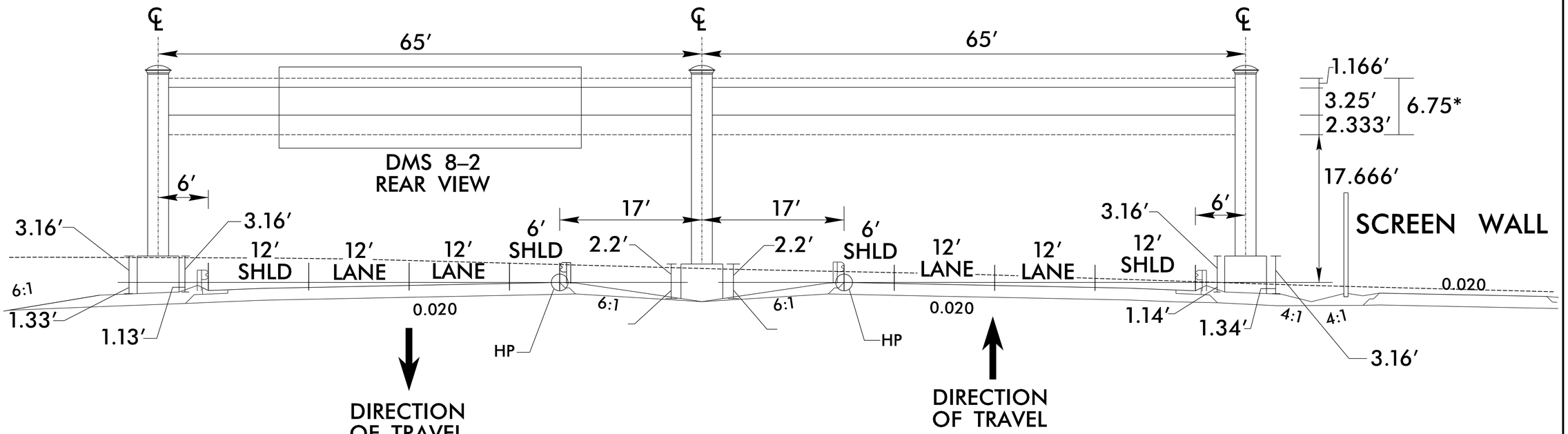
SEAL

INCOMPLETE PLANS
DO NOT USE FOR R/W ACQUISITION

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

Name Date

NOTE: DMS 8–2 DIMENSIONS TO BE DETERMINED AT A LATER DATE.



TOLL GANTRY 8–2
(WB) FRONT

TOLL GANTRY 8–1
(EB) REAR

* AESTHETIC CLADDING

PLANS PREPARED BY :
RK&K
RUMMEL, KLEPPER & KAHL, LLP
900 RIDGEFIELD DRIVE SUITE 350
RALEIGH, NORTH CAROLINA 27609-3960
NC LICENSE NO. F-0112 (919) 878-9560
FOR
THE NORTH CAROLINA
TURNPIKE AUTHORITY

-L-1157+00
TOLL ZONE AND GANTRY
8-1 AND 8-2 AND DMS 8-2
BY-PASS US 74

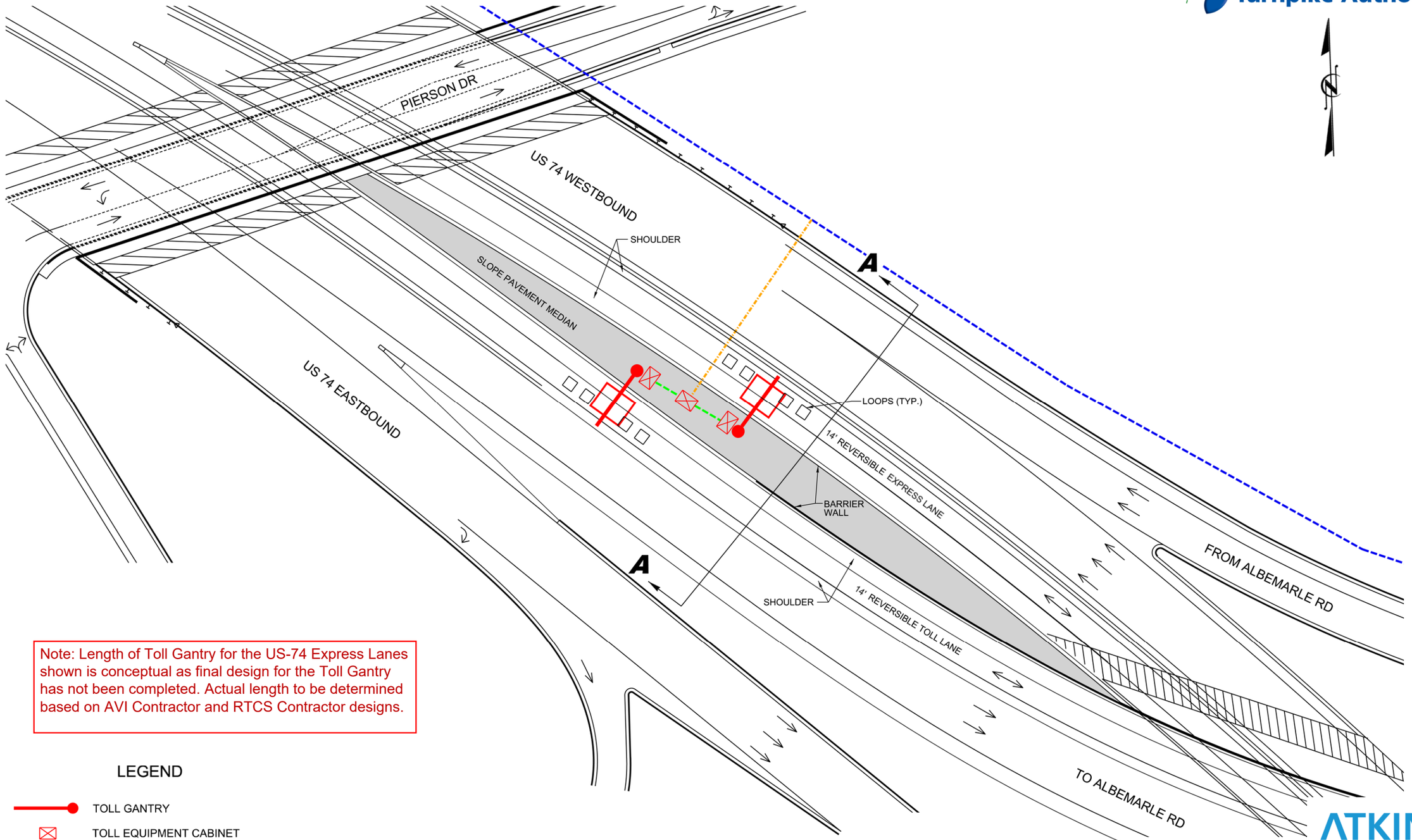
11/17/2015
R:\Traffic\Signing\CADD\GANTRY PLANS\plansheets\R3329_R2559_rdy_xsc_L3B_AET-8 SHEET 24 AND 25.dgn
MLH

Attachment 5

US 74 Express Lanes Conceptual Plans for AET

TOLL SITE CONCEPT PLAN

NORTH CAROLINA Turnpike Authority



Note: Length of Toll Gantry for the US-74 Express Lanes shown is conceptual as final design for the Toll Gantry has not been completed. Actual length to be determined based on AVI Contractor and RTCS Contractor designs.

LEGEND

- TOLL GANTRY
- TOLL EQUIPMENT CABINET
- EXISTING FIBER-OPTIC COMMUNICATIONS CABLES AND CONDUIT
- PROPOSED FIBER-OPTIC COMMUNICATIONS CABLES AND CONDUIT
- PROPOSED TOLL COMMUNICATIONS CABLE

GRAPHIC SCALE

0 100'

ATKINS

US 74 Express Lanes
U-5526 – I-277 to Wallace Lane
Signing, ITS and Tolling
Conceptual Plans

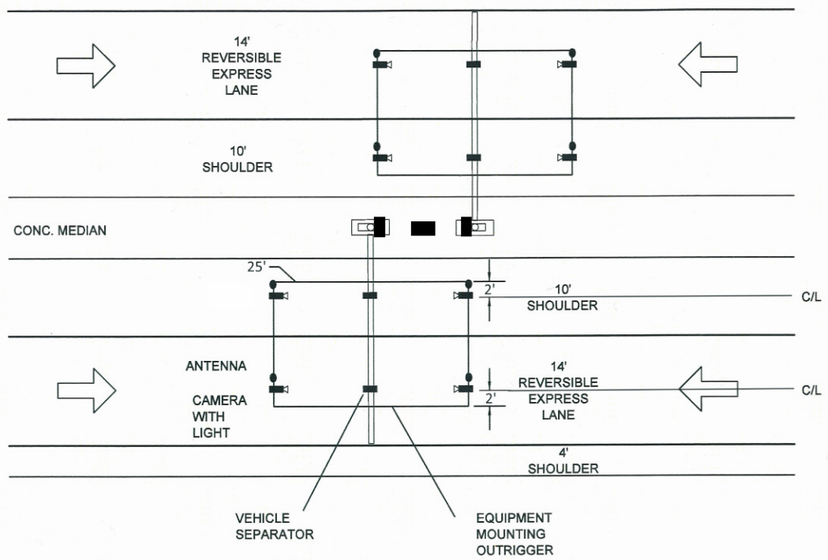
DATE: 4/06/16

NORTH CAROLINA TURNPIKE AUTHORITY

SHEET NO. 7

TOLL SITE DETAILS

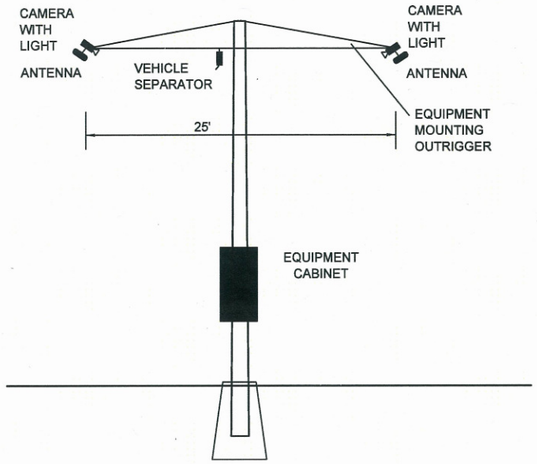
NORTH CAROLINA Turnpike Authority



TOP VIEW

NOTE:
MAST ARMS MAY BE CO-LOCATED ON A SINGLE UPRIGHT

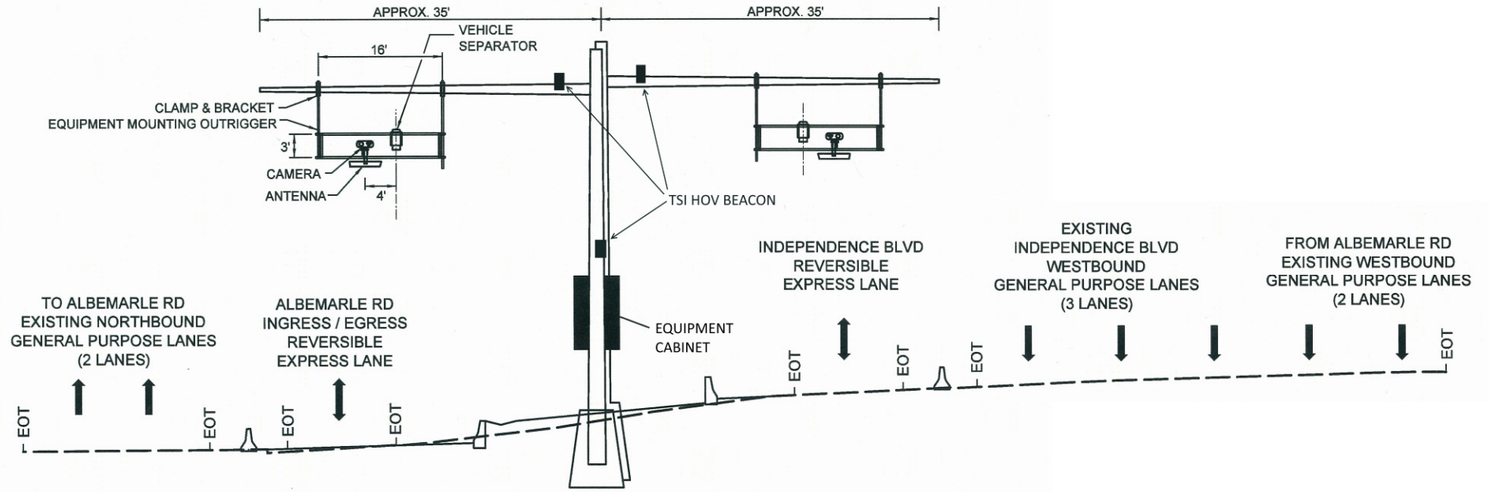
SAMPLE OUTRIGGER



SIDE VIEW

TYPICAL MANAGED LANES TOLL GANTRIES

Note: Length of Toll Gantry for the US-74 Express Lanes shown is conceptual as final design for the Toll Gantry has not been completed. Actual length to be determined based on AVI Contractor and RTCS Contractor designs.



X-SECTION VIEW A-A

NOT TO SCALE

ATKINS

US 74 Express Lanes U-5526 – I-277 to Wallace Lane Signing, ITS and Tolling Conceptual Plans		
DATE: 4/06/16	NORTH CAROLINA TURNPIKE AUTHORITY	SHEET NO. 8

Attachment 6

E-ZPass Group Test Scripts for Open Road Toll Facilities

Electronic Toll Collection Equipment Test Scripts

for Open Road Toll Facilities

E-ZPass Group and North Carolina Turnpike Authority

1 INTRODUCTION

1.1 General

This test script document provides the test scripts to be used for **Open Road Toll (ORT) Facility** testing by the North Carolina Turnpike Authority (NCTA) of its proposed elements of Electronic Toll Collection Equipment to satisfy the E-ZPass Group's (EZG) National Affiliate (NA) requirements.

The script will be used to demonstrate that the proposed National Affiliate (NA) transponders (aka On-Board Unit or OBU), meet the performance requirements stipulated in Attachment 1 of Amendment 8 to the EZG Operating Agreement for NA transponders on EZG readers (aka Roadside Equipment or RSE) and that EZG transponders meet the NA performance requirements on NCTA readers (RSE).

The test script consists of a number of test cases (see Attachment 1) that are designed to replicate real-world conditions that may exist in ORT lanes from time-to-time. The test cases are then grouped into a test Scenario. Each Scenario is outlined as a table that lists the test cases that will be used to exercise both sets of transponders and readers (EZG and NCTA) for the Scenario.

The Scenarios to be tested are listed below:

Table 1 – Volume Scenario List

Scenario	Category	Site Type	RSE	NCTA OBU Transactions	EZG Interior OBU Transactions	EZG Exterior OBU Transactions	Minimum Planned Transactions
1	B	ORT	EZG	6,935 (Note 1)	645	0	7,580
2	A	ORT	NCTA	1,935 (Note 2)	5,000	645	7,580

Note 1: NCTA OBU Transactions are comprised of 5,645 Interior TDM transponders, 645 Switchable TDM transponders and 645 Exterior TDM Transponders.

Note 2: NCTA OBU Transactions are comprised of 645 TDM/SeGo transponders, 645 SeGo Sticker transponders and 645 6C transponders.

1.2 Technology to be Tested

The following equipment will be tested in an ORT setting, coupling native and foreign technologies, e.g. Category B Transponders with EZG Readers and EZG Transponders with Category A Readers.

- NCTA
  - Category A – Tri-Protocol Reader
  - Category B – Hardcase Interior Transponder
  - Category B – Bumper-Mounted Exterior Transponder
  - Category B – Hardcase Interior Switchable Transponder

- EZG
  - Kapsch Reader
  - Kapsch Hardcase Interior Transponders (both G3B and G4 models)
  - Kapsch Front Mount Exterior (FME) Transponder

References in this document to Exterior Transponders are always meant to refer to bumper/front mounted exterior transponders.

1.3 Minimum Performance Requirements

1.3.1 Category B Transponder (Interior/Exterior) on EZG Reader

The tests must meet the minimum test performance requirements as stipulated by EZG of:

Site Type	Read Performance	Write Performance	Lane Assignment
ORT	99.90%	98.00%	99.90% (Note 1)

Note 1: Lane Assignment is considered correct if it is within +/- one antenna/channel from actual position in lane.

1.3.2 EZG Transponders (Interior/Exterior) on Category A Reader

The tests must meet the minimum test performance requirements as stipulated by NCTA of:

Site Type	Read Performance	Write Performance	Lane Assignment
ORT	99.90%	98.00%	99.90%

2 TEST PARAMETERS

2.1 General ORT Test Standards

Each OBU transaction is expected to meet the standards outlined below for ORT. If these standards appear not met, an investigation will be conducted. Refer to the Test Plan for details on how the verifications will be accomplished.

The following standards apply to ORT testing for both the native and foreign transponders:

- OBU must be reported only once and only to a single lane. Straddle lane assignment is allowed.
- OBU must be reported in the correct lane, which may be a straddle lane.
- All read-only fields must be read and reported with their programmed values.
- All variable fields must be read and the reported values must match what the RSE last wrote.
- All OBUs traveling in a particular lane must be reported in the same order that they went through the lane.
- No OBUs are reported that have not traveled through a lane.

2.2 Test Details

2.2.1 Equipment

The equipment will meet the following conditions in order to run the test:

Item	Condition
RSE	Sending data to RECORDING SYSTEM. No failed modules or other reported anomalies.
RECORDING SYSTEM (RS)	The RECORDING SYSTEM is comprised of two main components: A laptop logging all data generated by the RSE and camcorders logging video footage of all test runs. Laptop is functional and logging data. All cameras operational.
OBUs	OBU Tester indicates that OBU is working properly.
Vehicles	Operable in a safe manner – varying types of road-legal vehicles (Lights functional, no flat tires and no significant body damage).

2.2.2 Test Track

Test track will be provided by the Contractor and will be configured as further described below.

The test track will be configured to support three (3) AVI equipped undelineated travel lanes that will be numbered 1, 2 and 3 from left to right (see Figure 1). The straddle areas between the travel lanes will be designated as 12 and 23 throughout this document. The shoulder areas will not be equipped or utilized during the testing.

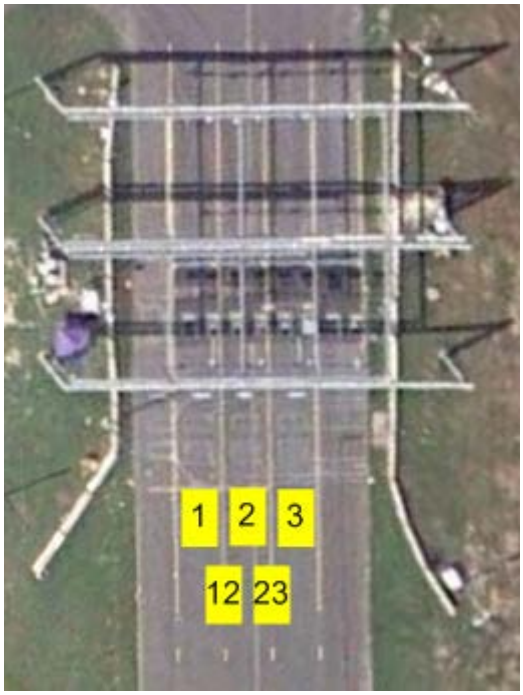


Figure 1 - Test Track Lane Designations

The track will be kept clear of obstructions except for traffic cones, signage or other devices needed to direct traffic or maintain safe operating conditions.

The Site Director will direct the monitoring of the track for the level of mud, snow, ice or other slickness that may affect vehicle safety and select test cases or adjust operations to maintain an acceptable safety level.

2.2.3 Weather Conditions

Weather will be monitored and documented prior to each test. Any significant changes that occur during the test such as precipitation or temperature will also be documented. The weather must meet the following conditions in order to run test cases.

Temperature Range: -20°F to +120°F

Visibility: Sufficient to operate safely for the test cases in the judgment of the Site Director. If visibility is reduced, test cases that use lower speeds will be performed.

Precipitation: Low enough to operate safely for the test cases in the judgment of the Site Director. If precipitation affects visibility or track quality, test cases that use lower speeds will be performed.

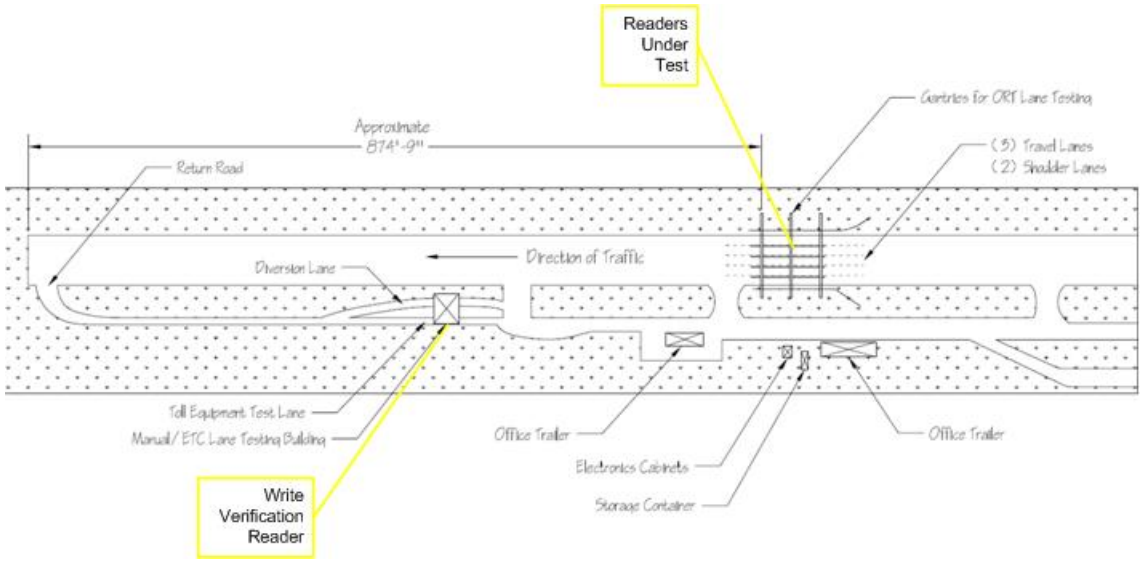
The Site Director will also monitor for weather alerts related any potentially hazardous conditions (NOAA weather radio service or local reporting service).

2.2.4 RF Emissions

RF emissions will be monitored using a spectrum analyzer which will be provided by each respective vendor. The spectrum analyzer will be connected to a PC that will sound an alarm when emissions exceed the thresholds in the monitored frequency bands.

Testing will be halted until emissions remain under the threshold for at least five minutes.

Proposed reader locations at the ORT test site are shown below:



2.2.5 Lane and Entrance/Exit Usage

Two entrances and exits will be used throughout testing. Entrance 1 is the entrance nearest the gantry and may be used for tests at 30 MPH and under. Entrance 2 is the entrance farthest from the gantry and will be used for any test above 30 MPH or where the space is needed for acceleration.

Technically, Exit 1 refers to the second exit from the track after the gantry; the first is too close in proximity to the gantry for safe operation. Use of Exit 1 will bypass the return road RSE and may be used when the test case speeds are 30 MPH or less. Exit 2 refers to the exit at the end of the track that

will go through the return road RSE and will be used for any test case above 30 MPH as well as selected cases at or under 30 MPH.

See Figure 2 for the entrance and exit locations.

Figure 2 - Test Track Entrance/Exit Locations

The Site Director or Test Coordinator may adjust the usage of the entrances or exits during the course of testing if deemed necessary for safely accelerating, decelerating, accessing the return road or accessing the track.

2.2.6 Special Vehicle Cases

Special vehicles testing at the ORT site are expected to include a dump truck and a tractor (no trailer). For case selection, it is assumed that the special vehicles have safety limitations that will limit their use to test cases whose speeds do not exceed 30 MPH.

The test cases listed below will include vehicle patterns with the special vehicles included as well as regular vehicles. The test cases are also listed in the recommended order for executing the test cases. Since the special vehicle drivers may be unfamiliar with site procedures, it is recommended to start with the basic tests and move to more difficult ones as drivers and tester become more comfortable with adapting to vehicle and site constraints.

1. 2015S - 30 MPH Two Vehicle - Special
2. 2051S – Mixed Lane 30 MPH - Special

3 TEST SCRIPT STANDARDS

3.1 References

Each test script describes the order, lane assignment and type of vehicles for the test case. Vehicle types are abbreviated using the following codes:

- CC – Compact car
- MC – Midsize car
- FC – Fullsize car
- SS – Small SUV
- LS – Large SUV
- MV – Minivan
- BX – Box Truck
- DU – Dump Truck
- TR – Tractor (no trailer)

3.2 Grid Notation

Each test case will display the vehicles to be used in the test in a grid format to indicate position relative to other vehicles.

The grid will show the vehicle type, vehicle lane, order within the lane (row) and approximate lateral position with other cars (column within the row).

For each row, the relationship between the vehicles in the row will depend on if the test case is a 'Simultaneous' case or not. If it is, all drivers for the vehicles in the row will attempt to travel through the capture zone at the same time. If the test case is not simultaneous, drivers do not have to focus on traveling through the capture zone at the same time.

Specific vehicles are selected just prior to the test case execution based on usage and availability and are not defined as part of the test case.

Lanes are designated from left to the right but may be modified due to the testing environment. As an ORT site, vehicles may appear in straddle lanes. This will be part of the testing and is part of the vehicle grid shown in Table 2.

Table 2 – ORT Vehicle Grid Example

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	BX		MV
Row 2	LS	FC	
Row 3		LS	SS

3.3 Test Case Format

Each test case is presented with eight (8) subsections as follows:

1) Purpose – a brief description as to the purpose of the particular test case

2) Description – a brief description of the vehicle behavior that will be used in the test case.

3) Special Conditions – a list of any special conditions applicable to the test case.

4) Special Standards – a list of any special standards that must be adhered to in the test case.

5) Iterations – the number of iterations/passes that will be executed for the test case.

6) Equipment – an inventory of the Vehicle and OBU equipment necessary for the test case.

7) Script – a detailed script of the test case

8) Driver Instructions – an overview of the instructions that will be given to each driver to ensure that the proper vehicle behavior is adhered to while maintain a safe driving environment at all times.

3.4 Test Scenarios

The set of test cases documented in Attachment 1 (collectively called the test Scenario) will be completed twice as follows:

1) NCTA Category B Transponders on EZG Readers

2) EZG Transponders on NCTA Category A Readers

Refer to Attachments 8 and 9 for a summary of the various Scenarios that will be executed. For each Scenario, the attachments list the test cases to be tested at the ORT testing site, the number of EZG transponders (by type), the number of NCTA transponders, the number of passes for each test case, the total number of transactions with the associated transponder type and finally the total number of transactions executed for the test case.

Figure 3 presents a summary of the vehicles that will be required by test case.

Seq	Test Case #	Description	Compact Car (CC)	Midsize Car (MC)	Fullsize Car (FC)	Small SUV (SS)	Large SUV (LS)	Minivan (MV)	Box Truck (BX)	Tractor (TR)	Dump Truck (DU)	Total Vehicles
1	2004	10 MPH Single Vehicle	2	2	1	2	2	2	1	0	0	12
3	2020	60 MPH Single Vehicle	2	2	1	2	2	2	1	0	0	12
4	2038	10 MPH Lane 1 Only	2	2	1	2	2	2	1	0	0	12
6	2042	60 MPH Lane 3 Only	2	2	1	2	2	2	1	0	0	12
7	2037	Stop and Go Lane 3 Only	2	2	1	2	2	2	1	0	0	12
9	2046	45 MPH Lane 23 Only	2	2	1	2	2	2	1	0	0	12
10	2010	20 MPH Two Vehicle	2	2	2	2	2	1	1	0	0	12
12	2021	60 MPH Two Vehicle – Order A	2	2	2	2	2	1	1	0	0	12
19	2060	10 MPH Two Vehicle Simultaneous	2	2	2	2	2	1	1	0	0	12
20	2067	60 MPH Two Vehicle Simultaneous	2	2	2	2	2	1	1	0	0	12
22	2069	Two Vehicle Medium Speed Acceleration	2	2	2	2	2	1	1	0	0	12
24	2071	Two Vehicle Passing	2	2	2	2	2	1	1	0	0	12
28	2048	Mixed Lane Stop and Go	2	2	2	2	1	2	1	0	0	12
31	2053	Mixed Lane 60 MPH	2	2	2	2	1	2	1	0	0	12
33	2076	Changing Lanes Two Vehicles 30 MPH	1	2	1	1	2	1	0	0	0	8
35	2015S	30 MPH Two Vehicle - Special	2	1	1	2	1	1	1	1	1	11
37	2048S	Mixed Lane Stop and Go - Special	2	1	1	1	1	1	1	1	1	10
38	2051S	Mixed Lane 30 MPH - Special	2	0	1	1	1	1	1	1	1	9
13	2023	Straddle Lane Two Vehicle Stop and Go	2	2	2	2	2	1	1	0	0	12
16	2054	Stop and Go Side-by-Side	2	2	2	2	2	1	1	0	0	12

Figure 3 - ORT Vehicle Summary

ORT Test Script Details

1. TEST CASE 2004 – 10 MPH SINGLE VEHICLE

1.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and low speeds in the striped lanes.

1.2 Description

Vehicles will approach and proceed through the toll zone one at a time at a constant speed of 10 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

1.3 Special Conditions

None

1.4 Special Standards

None

1.5 Iterations

<__>

1.6 Equipment

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

1.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 1.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 1 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 1 – Test Case 2004 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1		CC	
Row 2	MV		
Row 3			SS
Row 4		FC	
Row 5	LS		
Row 6	MC		
Row 7		MC	
Row 8			MV
Row 9			CC
Row 10		SS	
Row 11			LS
Row 12	BX		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 10 MPH.

12. Vehicles will use Exit 1 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 1 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

1.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number> in Lane <Assignment>.
3. Go when directed to.
4. Approach and proceed through the gantry at 10 MPH.
5. Do not pass the vehicles in front of you.
6. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

2. TEST CASE 2020 – 60 MPH SINGLE VEHICLE

2.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the striped lanes.

2.2 Description

Vehicles will approach and proceed through the toll zone one at a time at a constant speed of 60 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

2.3 Special Conditions

None

2.4 Special Standards

None

2.5 Iterations

<__>

2.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

2.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 2.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 2 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 2 – Test Case 2020 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	CC		
Row 2			MV
Row 3		SS	
Row 4	FC		
Row 5			LS
Row 6			MC
Row 7	MC		
Row 8		MV	
Row 9		CC	
Row 10	SS		
Row 11		LS	
Row 12			BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 60 MPH.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 2 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

2.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number> in Lane <Assignment>.
3. Go when directed to.
4. Approach and proceed through the gantry at 60 MPH.
5. Do not pass the vehicles in front of you.
6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.
7. You will drive <__> laps.

3. TEST CASE 2038 – 10 MPH LANE 1 ONLY

3.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles use a single lane at low speeds.

3.2 Description

Vehicles will approach and proceed through the toll zone in a single column in Lane 1 at a constant speed of 10 MPH.

Each vehicle will be in lane 1 for each iteration of the test case.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

3.3 Special Conditions

None

3.4 Special Standards

None

3.5 Iterations

<__>

3.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

3.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 3.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 3 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 3 – Test Case 2038 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	CC		
Row 2	MV		
Row 3	SS		
Row 4	FC		
Row 5	LS		
Row 6	MC		
Row 7	MC		
Row 8	MV		
Row 9	CC		
Row 10	SS		
Row 11	LS		
Row 12	BX		

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area with several feet between each vehicle.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the vehicles will all begin at once and proceed towards and through the capture zone at 10 MPH.

10. The vehicles should maintain several feet of following distance while driving to and through the capture zone.

11. Vehicles will use Exit 1 to get to the return road.

12. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 3 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

3.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane1. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach and proceed through the gantry at 10 MPH.

5. Stay at least a few feet back from the vehicle in front of you and maintain an appropriate following distance.

6. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.

7. You will drive <__> laps.

4. TEST CASE 2042 – 60 MPH LANE 3 ONLY

4.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles can only use a single lane at high speeds.

4.2 Description

Vehicles will approach and proceed through the toll zone in a single column in Lane 3 at a constant speed of 60 MPH.

Each vehicle will be in lane 3 for each iteration of the test case.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

4.3 Special Conditions

None

4.4 Special Standards

None

4.5 Iterations

<__>

4.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

4.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 4.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 4 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 4 – Test Case 2042 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1			CC
Row 2			MV
Row 3			SS
Row 4			FC
Row 5			LS
Row 6			MC
Row 7			MC
Row 8			MV
Row 9			CC
Row 10			SS
Row 11			LS
Row 12			BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area with several feet between each vehicle.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the vehicles will all begin at once and proceed towards and through the capture zone at 60 MPH.

10. The vehicles should maintain several feet of following distance while driving to and through the capture zone.

11. Vehicles will use Exit 2 to get to the return road.

12. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 4 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

4.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane 3. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Stay at least several feet back from the vehicle in front of you and maintain an appropriate following distance.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

5. TEST CASE 2037 – STOP AND GO LANE 3 ONLY

5.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles stop in the capture zones in only one lane, simulating stop and go traffic on a road.

5.2 Description

Vehicles will approach the toll zone in a single column in Lane 3 at a slow speed of less than 15 MPH. Each vehicle will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, each vehicle will proceed through the rest of the toll zone.

Each vehicle will be in Lane 3 for each iteration of the test case.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

5.3 Special Conditions

None

5.4 Special Standards

None

5.5 Iterations

<__>

5.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

5.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 5.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 5 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 5 – Test Case 2037 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1			CC
Row 2			MV
Row 3			SS
Row 4			FC
Row 5			LS
Row 6			MC
Row 7			MC
Row 8			MV
Row 9			CC
Row 10			SS
Row 11			LS
Row 12			BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area with several feet between each vehicle.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the vehicles will all begin at once and proceed towards the capture zone at no more than 15 MPH.

10. Vehicles will approach the gantry at no more than 15 MPH and will stop as necessary based on previous vehicles stopping in the capture zone.

11. When a vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry.

12. Vehicles will use Exit 1 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 5 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

5.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane 3. Stay in the center of your lane.

2. The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.

9. You will drive <__> laps.

6. TEST CASE 2046 – 45 MPH LANE 23 ONLY

6.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles can only use a straddle lane at moderate speeds.

6.2 Description

Vehicles will approach and proceed through the toll zone in a single column in Lane 23 at a constant speed of 45 MPH.

Each vehicle will be in straddle lane 23 for each iteration of the test case.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

6.3 Special Conditions

None

6.4 Special Standards

None

6.5 Iterations

<__>

6.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

6.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 6.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 6 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 6 – Test Case 2046 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1			CC
Row 2			MV
Row 3			SS
Row 4			FC
Row 5			LS
Row 6			MC
Row 7			MC
Row 8			MV
Row 9			CC
Row 10			SS
Row 11			LS
Row 12			BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area with several feet between each vehicle.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the vehicles will all begin at once and proceed towards and through the capture zone at 45 MPH.

10. The vehicles should maintain several feet of following distance while driving to and through the capture zone.

11. Vehicles will use Exit 2 to get to the return road.

12. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 6 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

6.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Straddle Lane 23. Try to center yourself on the lane stripe.

2. The vehicle in front of you is <Vehicle Number>.

3. Go when directed to.

4. Approach and proceed through the gantry at 45 MPH.

5. Stay at least a few feet back from the vehicle in front of you and maintain an appropriate following distance.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

7. TEST CASE 2010 – 20 MPH TWO VEHICLE

7.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and low speeds in the striped lanes.

7.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 20 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

7.3 Special Conditions

None

7.4 Special Standards

None

7.5 Iterations

<__>

7.6 Equipment

This test case will require a new vehicle configuration and a new set of transponders.

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

7.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 7.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. New OBU tags are to be used: mount the new OBU and note the new OBU number on the test sheet.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 7 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 7 – Test Case 2010 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1		FC	SS
Row 2		MV	MC
Row 3	FC	MC	
Row 4	CC		LS
Row 5	SS		CC
Row 6	LS	BX	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 20 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 20 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 7 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

7.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 20 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 1. You can speed up but don't exceed 30 MPH.

7. You will drive <__> laps.

8. TEST CASE 2021 – 60 MPH TWO VEHICLE ORDER A

8.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the striped lanes.

8.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 60 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

8.3 Special Conditions

None

8.4 Special Standards

None

8.5 Iterations

<__>

8.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

8.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 8.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 8 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 8 – Test Case 2021 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	FC	SS	
Row 2	MV	MC	
Row 3	MC		FC
Row 4		LS	CC
Row 5		CC	SS
Row 6	BX		LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 8 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

8.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

9. TEST CASE 2036 – STRADDLE LANE TWO VEHICLE 60 MPH

9.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and high speeds in the straddle lanes.

9.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 60 MPH in the straddle lanes.

Each vehicle will have a designated travel lane which will be a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

9.3 Special Conditions

None

9.4 Special Standards

None

9.5 Iterations

<__>

9.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

9.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 9.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 9 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 9 – Test Case 2036 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	FC		SS
Row 2	MV		MC
Row 3	FC		MC
Row 4	CC		LS
Row 5	SS		CC
Row 6	LS		BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 60 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 45 MPH and reassemble in the original order of Table 9 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

9.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Try to center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.
4. Approach and proceed through the gantry at 60 MPH.
5. Do not pass the vehicles in front of you.
6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.
7. You will drive <__> laps.

10. TEST CASE 2054 – STOP AND GO SIDE-BY-SIDE

10.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving in a stop and go manner.

10.2 Description

Vehicles will approach the toll zone in six rows of two vehicles at a slow speed of less than 15 MPH with reduced lateral separation. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, they will proceed through the rest of the toll zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

10.3 Special Conditions

None

10.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left. For example, if a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the EZG.

10.5 Iterations

<__>

10.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

10.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 10.

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 10 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 10 – Test Case 2054 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1		FC	SS
Row 2	MC		MV
Row 3	MC		FC
Row 4		CC	LS
Row 5	CC		SS
Row 6		LS	BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards the capture zone at no more than 15 MPH and come to a complete stop between the capture zone markers for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. The following rows will approach the gantry at no more than 15 MPH and will stop as necessary based on previous row stopping in the capture zone.

12. When the vehicle reaches the capture zone, it will come to a complete stop for about one second before proceeding through the gantry. Vehicles in a row may stop and proceed through the gantry without being synchronized with other vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not aligned with the vehicle on the left.

13. Vehicles will use Exit 1 to get to the return road.

14. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 10 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

15. The vehicles will repeat Steps 8 to 14 until <__> iterations are complete.

    a. If an incorrect lane is reported by the RECORDING SYSTEM, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will mark the iteration for later review and immediately proceed to the next iteration without further data review.

10.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don't adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach the gantry at less than 15 MPH.

5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.

6. Be aware that the vehicles in front of you will be stopping briefly.

    a. Right vehicle – The left vehicle may get a little ahead or behind your vehicle. Do not worry much about this but try and keep the side-to-side spacing low.

7. Stop between the capture zone markers for about one second before returning to 15 MPH like you are in stop and go traffic.

8. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.

9. You will drive <__> laps.

11. TEST CASE 2059 – 60 MPH SIDE-BY-SIDE

11.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles have limited lateral separation while driving at high speeds.

11.2 Description

Vehicles will approach and proceed through the toll zone in six rows of two vehicles at a constant speed of 60 MPH with reduced lateral separation.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle. Both vehicles in a row will either be both in striped lanes or both in straddle lanes.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

The vehicle on the left will maintain a straight course while the vehicle on the right will control lateral separation.

11.3 Special Conditions

None

11.4 Special Standards

As the vehicle on the right will be controlling the lateral separation, they could be reported in either their planned travel lane or the half lane to their left. For example, if a vehicle is in a striped lane but towards the left of the lane to minimize distance, it may be acceptable if the subsystem reports the vehicle in the straddle lane between the two.

If the transaction is reported in an unexpected lane, it will still be considered an anomaly requiring further review of the video and data with further submittal to the EZG.

11.5 Iterations

<__>

11.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

11.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 11.

2. OBU/Vehicle Organizers will assign a driver to each vehicle. NOTE – ASK DRIVERS WHO IS COMFORTABLE DRIVING ON THE RIGHT AND SETTING THE LATERAL SPACING.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 11 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 11 – Test Case 2059 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	FC	SS	
Row 2	MC	MV	
Row 3	FC		MC
Row 4	CC	LS	
Row 5		SS	CC
Row 6	LS	BX	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH. Vehicles in a row may proceed through the gantry without being synchronized with other vehicles in the row.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. The following rows will approach and proceed through the gantry at 60 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row but the vehicle on the right should remain cognizant of proper spacing if they are not synchronized with the vehicle on the left.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 11 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

    a. If an incorrect lane is reported by the RECORDING SYSTEM, the Toll Zone Observer will check which lane was reported incorrectly. If the vehicle on the right is reported in the travel lane a half lane to the left of the planned travel lane, the Toll Zone Observer will

mark the iteration for later review and immediately proceed to the next iteration without further data review.

11.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

    a. Left vehicle - If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

    b. Right vehicle – Try to drive with less space between your vehicle and the vehicle on your left than normal while staying in the proper lane. If in striped lane, you should be close to the left stripe. If straddle lane, lane stripe should be under right side of vehicle towards the wheels.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

    a. Left vehicle – The vehicle to your right will be driving with less space than normal between you two so don't adjust your spacing unless absolutely necessary for safety.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

12. TEST CASE 2067 – 60 MPH TWO VEHICLE SIMULTANEOUS

12.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when vehicles are arriving simultaneously in the capture zones at high speeds.

12.2 Description

Vehicles will approach and proceed through the toll zone in six rows of two vehicles at a constant speed of 60 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

12.3 Special Conditions

None

12.4 Special Standards

'Simultaneous' is a qualitative standard and an iteration shall not be rerun if there is a lag between the two vehicles in a row going through the capture zone.

12.5 Iterations

<__>

12.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

12.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 12.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 13 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 12 – Test Case 2067 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	SS		FC
Row 2	MV		MC
Row 3	MC		FC
Row 4		CC	LS
Row 5		CC	SS
Row 6		LS	BX

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH and synchronize their movements so they pass through the capture zone at the same time.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. The following rows will approach and proceed through the gantry at 60 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 12 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

12.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Stay aligned with the other vehicle in your row through the plaza.

    a. If the left vehicle, set the pace.

    b. If the right vehicle, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.

    a. Left vehicle - Remain behind all vehicles in the previous row no matter what lanes the vehicles are in.

    b. Right vehicle - Be aware that you may have to slow down as the left vehicle maintains this distance.

7. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

8. You will drive <__> laps.

13. TEST CASE 2071 – TWO VEHICLE PASSING

13.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when two vehicles are passing through the capture zone at different speeds.

13.2 Description

Vehicles will approach the toll zone two at a time. One vehicle will go first and drive around 30 MPH through the capture zone. A second vehicle will follow in a different lane at around 60 MPH and should pass through the capture zone at about the same time as the other vehicle.

Each vehicle will have a designated travel lane which may be a striped lane or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

13.3 Special Conditions

None

13.4 Special Standards

None

13.5 Iterations

<__>

13.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

13.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 13.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track assemble their vehicles in the order shown in Table 13 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 13 - Test Case 2071 Vehicle Grid and Speed

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	SS 60 MPH		FC 30 MPH
Row 2	MC 60 MPH	MV 30 MPH	
Row 3	FC 60 MPH	MC 30 MPH	
Row 4	LS 60 MPH		CC 30 MPH
Row 5	SS 60 MPH	CC 30 MPH	
Row 6	BX 60 MPH		LS 30 MPH

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the slow vehicle in the first row will approach and proceed through the capture zone at 30 MPH.

10. The OBU/Vehicle Organizer will wave a flag to indicate that the fast vehicle should proceed approximately 6 seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the first vehicle. This vehicle will approach and proceed through the capture zone at 60 MPH.

11. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. They will follow the same process as Steps 9 and 10 with the slow vehicle in the row being sent and then the fast vehicle so that they should arrive in the capture zone at about the same time. There will be a six second gap between vehicles in the row and four second gaps between the last vehicle in one row and the first vehicle in the next. The gaps may be adjusted as deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test case.

12. After clearing the gantry and unless it is the last iteration, the vehicles will use Exit 2 and follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 13 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

13.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.

2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach Instructions:

    a. Slow Driver – Approach and go through the gantry at about 30 MPH. The other vehicle should catch up to you about the time you are passing under the gantry.

    b. Fast Driver – Approach and go through the gantry at about 60 MPH. You should catch up to the other vehicle about the time you are passing under the gantry.

5. Stay behind the vehicles in the rows before you by at least 5 feet no matter what lane that vehicle is in.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

14. TEST CASE 2019 – 45 MPH THREE VEHICLE

14.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and moderate speeds in the striped lanes.

14.2 Description

Vehicles will approach and proceed through the toll zone three at a time at a constant speed of 45 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

14.3 Special Conditions

None

14.4 Special Standards

None

14.5 Iterations

<__>

14.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

14.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 14.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 2 and assemble their vehicles in the order shown in Table 14 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 14 – Test Case 2019 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	CC	MV	BX
Row 2	FC	SS	LS
Row 3	LS	SS	MC
Row 4	MC	MV	CC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 45 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 45 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 14 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

14.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 45 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

15. TEST CASE 2049 – MIXED LANE 10 MPH

15.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and low speeds when vehicles are using both striped and straddle lanes.

15.2 Description

Vehicles will approach and proceed through the toll zone two or three at a time at a constant speed of 10 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

15.3 Special Conditions

None

15.4 Special Standards

None

15.5 Iterations

<__>

15.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

15.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 15.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 15 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 15 – Test Case 2049 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	MC	CC	
Row 2	FC	SS	LS
Row 3	MV	FC	
Row 4	SS	MC	BX
Row 5	CC	MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 10 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 10 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 1 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 15 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

15.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 10 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.

7. You will drive <__> laps.

16. TEST CASE 2053 – MIXED LANE 60 MPH

16.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and high speeds when vehicles are using both striped and straddle lanes.

16.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 60 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

16.3 Special Conditions

None

16.4 Special Standards

None

16.5 Iterations

<__>

16.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

16.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 16.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 16 as appropriate in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 16 – Test Case 2053 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12		Lane 23
Row 1	CC		MC
Row 2	SS		FC
Row 3	MV		LS
Row 4		FC	SS
Row 5		MC	BX
Row 6		CC	MV

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 60 MPH or slower if deemed necessary for safety by the Test Coordinator during special vehicles testing. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 2 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 16 as appropriate following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

16.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 60 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

7. You will drive <__> laps.

17. TEST CASE 2076 – CHANGING LANES TWO VEHICLES 30 MPH

17.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment with two vehicles changing in or near the capture zone while traveling at moderate speed.

17.2 Description

Vehicles will approach the gantry two at a time at a speed of 30 MPH. As they near or enter the capture zone, they will change lanes.

Each vehicle will have a designated travel lane at the beginning and a designated travel lane to switch into. These lanes may be either a striped lane or a straddle lane. The beginning and end lanes may also be different types. For example, start in a straddle lane and end in a striped lane. These lanes will be the same for each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

17.3 Special Conditions

None

17.4 Special Standards

OBUs must be reported once but acceptable lanes to report from include:

- The travel lane the OBU-equipped vehicle started in;
- The travel lane the vehicle ended in; and
- Any striped or straddle lanes between the start and end lanes.

17.5 Iterations

<__>

17.6 Equipment

This test case will require a new vehicle configuration and a new set of transponders.

Vehicle Type	Quantity
Compact Car	1
Midsize car	2
Fullsize car	1
Small SUV	1
Large SUV	2
Minivan	1
Box Truck	0

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	4
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	5	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

17.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 17.

2. OBU/Vehicle Organizers will assign a driver to each vehicle and each driver will move their vehicle from the parking area to the staging area.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. New OBU tags are to be used: mount the new OBU and note the new OBU number on the test sheet.

5. Drivers will enter the track and assemble their vehicles in the order shown in Table 17 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 17 - Test Case 2076 Starting Vehicle Grid Positions

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1		MC	SS
Row 2	MV	CC	
Row 3	LS		MC
Row 4	LS		FC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed to the capture zone at 30 MPH.

10. Upon reaching the capture zone, the vehicles will perform the lane changes shown in Table 18 while maintaining a speed of 30 MPH.

Table 18 - Test Case 2076 Lane Changes

	Left Vehicle	Right Vehicle
Row 1	Lane 2 to Lane 1	Lane 3 to Lane 2
Row 2	Lane 1 to Lane 2	Lane 23 to Lane 3
Row 3	Lane 1 to Lane 12	Lane 3 to Lane 23
Row 4	Lane 12 to Lane 1	Lane 3 to Lane 2

11. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

12. The vehicles will approach the capture zone at 30 MPH and remain behind the vehicle in the previous row no matter what lane the previous row is in. Vehicles will not have to be synchronized with the other vehicles in the row.

13. The vehicles will be arranged in the pattern shown in Table 19 after they go through the gantry:

Table 19 - Test Case 2076 Final Vehicle Grid Positions

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	MC	SS	
Row 2		MV	CC
Row 3	LS		MC
Row 4	LS	FC	

14. Vehicles will use Exit 2 to get to the return road.

15. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 2 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 17 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the parking area.

16. The vehicles will repeat Steps 8 to 15 until <__> iterations are complete.

17.8 Driver Instructions

1. You will drive in a <Insert Vehicle Type> in Lane <Insert Assignment>.

2. Vehicle <Insert Number> will be in Lane <Insert Lane>. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>.

3. Go when directed to.

4. Approach the gantry at 30 MPH.

5. Remain behind the vehicles in the previous row no matter what lanes the previous row is in. If in the same lane as you, stay back at least 10 feet.

6. You do not have to be synchronized with the other vehicle in the row.

7. As you reach the capture zone markers, change into Lane <Insert New Lane>. The other vehicle in your row will be shifting into Lane <Insert New Lane>.

8. Once you get past the gantry, return to the assembly area using Exit 2 and Entrance 2. Do not exceed 30 MPH.

9. When you get back around to the assembly area, return to your starting position and lane.

10. You will drive <__> laps.

18. TEST CASE 2083 – STOPPED VEHICLE IN LANE

18.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment when one vehicle is stopped in the capture zone for several seconds while other vehicles briefly stop in the capture zones, simulating stop and go traffic on a road.

18.2 Description

Vehicles will approach the toll zone in at a slow speed of less than 15 MPH. They will stop while in the capture zone which will be marked. After coming to a complete stop for about 1 second, most vehicles will proceed through the rest of the toll zone. Three vehicles will be designated to sit in the capture zone for a longer period of time before proceeding.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will maintain a spacing of a few feet to simulate stop and go traffic until they have left the capture zone.

18.3 Special Conditions

None

18.4 Special Standards

If a vehicle is stopped in the capture zone for a period longer than the timeout, multiple reads from that vehicle from that lane are acceptable.

18.5 Iterations

<__>

18.6 Equipment

This test case will require a new vehicle configuration and a new set of transponders.

Vehicle Type	Quantity
Compact Car	2
Midsize car	2
Fullsize car	2
Small SUV	2
Large SUV	1
Minivan	2
Box Truck	1

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	8
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	9	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

18.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 20.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. New OBU tags are to be used: mount the new OBU and note the new OBU number on the test sheet.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 20 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 20 – Test Case 2083 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	MV	BX Hold	
Row 2	SS		CC
Row 3	LS	CC Hold	FC
Row 4	FC	MC	MC Hold
Row 5	SS	MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first vehicle will proceed through the approach area at no more than 15 MPH and come to a complete stop in the capture zone for 10 seconds or as appropriate for the RSE configuration before proceeding through the rest of the gantry where appropriate is at least a few seconds less than the configured timeout parameter.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach the gantry at no more than 15 MPH. The driver must ensure that they remain behind the vehicle in the previous row no matter what lane the previous vehicle is in with the exception of the Hold vehicles.

12. When each vehicle reaches the capture zone, it will come to a complete stop for a period depending on its status before proceeding through the rest of the gantry.

    a. Vehicles with 'Hold' in Table 20 will stay stopped at the gantry for 10 seconds or as appropriate for the RSE configuration before proceeding.

    b. All other vehicles will stop in the capture zone for about a second before proceeding.

13. Vehicles will use Exit 1 to get to the return road.

14. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 20 following the instructions of the OBU/Vehicle Organizer.

    a. When reassembling, vehicles will need to provide some space for the Hold vehicles to get back into the proper start position.

    b. If it is the last iteration, the vehicles will return to the staging area

15. The vehicles will repeat Steps 8 to 14 until <__> iterations are complete.

18.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.
2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignment>. Vehicle <Vehicle Number> will be in Lanes <Assignment>.
3. Go when directed to.
4. Approach the gantry at less than 15 MPH.
5. Stay at least 5 feet behind the vehicle in front of you but at similar distance to what you would encounter in stop and go traffic.
6. Be aware that the vehicles in front of you will be stopping briefly.
7. Stop between the capture zone markers for at least:
    a. If a Hold vehicle – 10 seconds (or as appropriate for the RSE configuration). Vehicles will pass you while you are sitting here.
    b. All other vehicles – 1 second. You may pass a vehicle stopped in a lane.
8. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. You can speed up but don't exceed 30 MPH.
    a. If a Hold vehicle, use shoulder lanes to get back to your correct spot.
    b. All other vehicles, provide room for the Hold vehicles to pass by you.
    c. If the vehicle before you is a Hold vehicle, make sure there is enough room when you come back around for that vehicle to get back in front of you.
9. You will drive <__> laps.

19. TEST CASE 2015S – 30 MPH TWO VEHICLE - SPECIAL

19.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for low volumes and moderate speeds in the striped lanes.

19.2 Description

Vehicles will approach and proceed through the toll zone two at a time at a constant speed of 30 MPH.

Each vehicle will have a designated travel lane which will be a striped lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

19.3 Special Conditions

None

19.4 Special Standards

None

19.5 Iterations

<__>

19.6 Equipment

This test case will require a new vehicle configuration and a new set of transponders.

Vehicle Type	Quantity
Compact Car	2
Midsize Car	1
Fullsize Car	1
Small SUV	1
Large SUV	1
Minivan	1
Box Truck	1
Tractor	1
Dump Truck	1

OBU Type	Quantity	
	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	6
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	7	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

19.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 21.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. New OBU tags are to be used: mount the new OBU and note the new OBU number on the test sheet.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 21 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 21 – Test Case 2015 Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	CC		DU
Row 2		LS	MC
Row 3		TR	SS
Row 4	FC		BX
Row 5	MV	CC	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 1 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 21 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

19.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. Stay in the center of your lane.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.

3. Go when directed to.

4. Approach and proceed through the gantry at 30 MPH.

5. Do not pass the vehicles in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. Do not exceed 30 MPH.

7. You will drive <__> laps.

20. TEST CASE 2051S – MIXED LANE 30 MPH - SPECIAL

20.1 Purpose

Test that the system can capture and report toll transactions in an ORT environment for moderate volumes and moderate speeds when vehicles are using both striped and straddle lanes.

20.2 Description

Vehicles will approach and proceed through the toll zone two or three at a time at a constant speed of 30 MPH.

Each vehicle will have a designated travel lane which may be either a striped or a straddle lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

20.3 Special Conditions

None

20.4 Special Standards

None

20.5 Iterations

<__>

20.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	0
Fullsize Car	1
Small SUV	1
Large SUV	1
Minivan	1
Box Truck	1
Tractor	1
Dump Truck	1

	Quantity	
OBU Type	Scenario 1 NCTA OBU on EZG Reader	Scenario 2 EZG Interior OBU on NCTA Reader
EZG Interior	1	5
EZG Exterior	0	1
NCTA TDM/SeGo Interior	0	1
NCTA SeGo Sticker	0	1
NCTA 6C Sticker	0	1
NCTA Interior TDM	6	0
NCTA Exterior TDM	1	0
NCTA Interior TDM Switchable	1	0

20.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 22.

2. OBU/Vehicle Organizers will assign a driver to each vehicle.

3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.

4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:

    a. If a new OBU is to be used, they will mount the OBU and note the OBU number on the test sheet.

b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.

5. Drivers will enter the track at Entrance 1 and assemble their vehicles in the order shown in Table 22 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 22 - Test Case 2051S Vehicle Grid

	Lane 1	Lane 2	Lane 3
	Lane 12	Lane 23	
Row 1	CC	DU	
Row 2	SS	CC	MV
Row 3	FC	LS	
Row 4	TR		MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.

7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.

8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will proceed towards and through the capture zone at 30 MPH. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

10. Each following row will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.

11. Vehicles will approach and proceed through the gantry at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Each vehicle in a row does not have to be synchronized with other vehicles in the row.

12. Vehicles will use Exit 1 to get to the return road.

13. After clearing the gantry and unless it is the last iteration, the vehicles will follow the return road back to Entrance 1 and the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 22 following the instructions of the OBU/Vehicle Organizer.

    a. If it is the last iteration, the vehicles will return to the staging area.

14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

20.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>. If in a normal striped lane, stay in the center of your lane. If in a straddle lane, center yourself on the lane stripe.

2. The vehicles in front of you are <Vehicle Numbers> in Lanes <Assignments>. Vehicles <Vehicle Numbers> will be in your row in Lanes <Assignments>.

3. Go when directed to.

4. Approach and proceed through the gantry at 30 MPH.

5. Do not pass the vehicles in front of you. You should be at least a few feet behind any vehicles in the row in front of you.

6. Once you get past the gantry, return to the assembly area using Exit 1 and Entrance 1. Do not exceed 30 MPH.

7. You will drive <__> laps.

Attachment 7

E-ZPass Group Test Scripts for Traditional Plaza Toll Facilities

Electronic Toll Collection Equipment Test Scripts

for Traditional Plaza Toll Facilities

E-ZPass Group and North Carolina Turnpike Authority

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1 Introduction

1.1 General

This test script document provides the test scripts to be used for **traditional plaza facility** testing by the North Carolina Turnpike Authority (NCTA) of its proposed elements of Electronic Toll Collection Equipment to satisfy the E-ZPass Group's (EZG) National Affiliate (NA) requirements.

The script will be used to demonstrate that the proposed National Affiliate (NA) transponders (aka On-Board Unit or OBU) meets the performance requirements stipulated in Attachment 1 of Amendment 8 to the EZG Operating Agreement for NA transponders on EZG readers (aka Roadside Equipment or RSE).

The test script consists of a number of test cases (see Attachment 1) that are designed to replicate real-world conditions that may exist in plaza lanes from time-to-time. The test cases are then grouped into a test Scenario. Each Scenario is outlined as a table that lists the test cases that will be used to exercise both sets of transponders and readers (EZG and NCTA) for the Scenario.

The Scenario to be tested is listed below:

Table 1 – Volume Scenario List

Scenario #	Category	Site Type	RSE	NCTA Interior OBU Transactions	NCTA Switchable OBU Transactions	NCTA Exterior OBU Transactions	EZG OBU Transactions	Minimum Planned Transactions
1	B	Plaza	EZG	5,260	590	590	640	7,080

1.2 Technology to be Tested

The following equipment will be tested in a plaza setting, coupling native and foreign technologies, e.g. Category B Transponders with EZG Readers.

- NCTA
  - Category B – Hardcase Interior Transponder
  - Category B – Bumper-Mounted Exterior Transponder
  - Category B – Hardcase Interior Switchable Transponder
- EZG
  - Kapsch Reader
  - Kapsch Hardcase Interior Transponders (both G3B and G4 models)

References in this document to Exterior Transponders are always meant to refer to bumper/front mounted exterior transponders.

1.3 Minimum Performance Requirements

1.3.1 Category B Transponder (Interior/Exterior) on EZG Reader

The tests must meet the minimum test performance requirements as stipulated by EZG of:

Site Type	Read Performance	Write Performance	Lane Assignment
Plaza	99.90%	98.00%	99.98%

2 Test Parameters

2.1 General Plaza Test Standards

Each OBU transaction is expected to meet the standards outlined below for a plaza setting. If these standards appear not met, an investigation will be conducted. Refer to the Test Plan for details on how the verifications will be accomplished.

The following standards apply to plaza testing for both the native and foreign transponders:

- OBU must be reported only once and only to a single lane.
- OBU must be reported in the correct lane.
- All read-only fields must be read and reported with their programmed values.
- All variable fields must be read and the reported values must match what the RSE last wrote.
- All OBUs traveling in a particular lane must be reported in the same order that they went through the lane.
- No OBUs are reported that have not traveled through a lane.

2.2 Test Details

2.2.1 Equipment

The equipment will meet the following conditions in order to run the test:

Item	Condition
RSE	Sending data to RECORDING SYSTEM. No failed modules or other reported anomalies.
RECORDING SYSTEM (RS)	The RECORDING SYSTEM is comprised of two main components: A laptop logging all data generated by the RSE and camcorders logging video footage of all test runs. Laptop is functional and logging data. All cameras operational.
OBUs	OBU Tester indicates that OBU is working properly.
Vehicles	Operable in a safe manner – varying types of road-legal vehicles (Lights functional, no flat tires and no significant body damage).

2.2.2 Test Track

Test track will be provided by the Contractor and will be configured as further described below.

The test track will be configured to support three (3) AVI equipped traditional toll plaza lanes with an overhead canopy that will be numbered 1, 2 and 3 from right to left (see Figure 1).

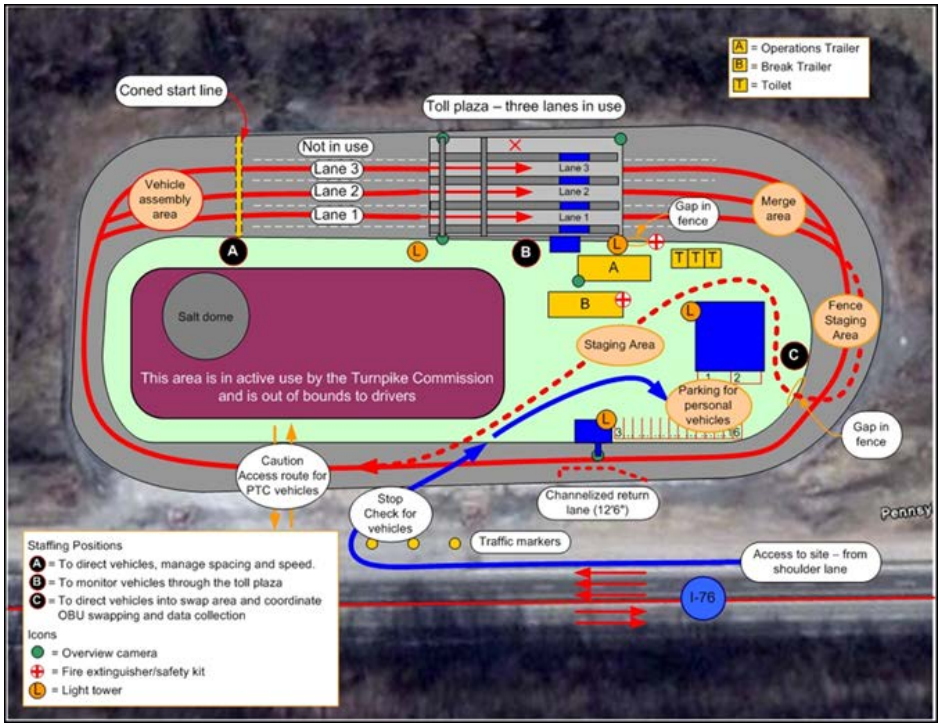


Figure 1 - Test Track Lane Designations

The track will be kept clear of obstructions except for traffic cones, signage or other devices needed to direct traffic or maintain safe operating conditions.

The Site Director will direct the monitoring of the track for the level of mud, snow, ice or other slickness that may affect vehicle safety and select test cases or adjust operations to maintain an acceptable safety level.

The Site Director and/or the OBU/Vehicle Organizers may adjust vehicle speeds and/or spacing subject to local conditions and to maintain site safety.

2.2.3 Weather Conditions

Weather will be monitored and documented prior to each test. Any significant changes that occur during the test such as precipitation or temperature will also be documented. The weather must meet the following conditions in order to run test cases.

Temperature Range: -20°F to +120°F

Visibility: Sufficient to operate safely for the test cases in the judgment of the Site Director. If visibility is reduced, test cases that use lower speeds will be performed.

Precipitation: Low enough to operate safely for the test cases in the judgment of the Site Director. If precipitation affects visibility or track quality, test cases that use lower speeds will be performed.

The Site Director will also monitor for weather alerts related any potentially hazardous conditions (NOAA weather radio service or local reporting service).

2.2.4 RF Emissions

RF emissions will be monitored using a spectrum analyzer which will be provided by each respective vendor. The spectrum analyzer will be connected to a PC that will sound an alarm when emissions exceed the thresholds in the monitored frequency bands.

Testing will be halted until emissions remain under the threshold for at least five minutes.

Proposed reader locations at the plaza test site are shown in the figure above.

2.2.5 Special Vehicle Cases

Special vehicles testing at the plaza site are expected to include a dump truck and a tractor (no trailer). For case selection, it is assumed that the special vehicles have safety limitations that will limit their use to test cases whose speeds do not exceed 30 MPH.

The test cases listed below will include vehicle patterns with the special vehicles included as well as regular vehicles. Since the special vehicle drivers may be unfamiliar with site procedures, it is recommended to start with the basic tests and move to more difficult ones as drivers and tester become more comfortable with adapting to vehicle and site constraints.

1. 1018S – Gated Three Vehicle Simultaneous – Order B - Special

3 Test Script Standards

3.1 References

Each test script describes the order, lane assignment and type of vehicles for the test case. Vehicle types are abbreviated using the following codes:

- CC – Compact car
- MC – Midsize car
- FC – Fullsize car
- SS – Small SUV
- LS – Large SUV
- MV – Minivan
- BX – Box Truck
- DU – Dump Truck
- TR – Tractor (no trailer)

3.2 Grid Notation

Each test case will display the vehicles to be used in the test in a grid format to indicate position relative to other vehicles.

The grid will show the vehicle type, vehicle lane, order within the lane (row) and approximate lateral position with other cars (column within the row).

For each row, the relationship between the vehicles in the row will depend on if the test case is a 'Simultaneous' case or not. If it is, all drivers for the vehicles in the row will attempt to travel through the capture zone at the same time. If the test case is not simultaneous, drivers do not have to focus on traveling through the capture zone at the same time.

While specific vehicles types are listed in the grid for each test case, final vehicle selection will be based on vehicle usage and availability and may vary from the types shown.

Lanes are designated from right to the left but may be modified due to the testing environment.

Table 2 – Plaza Vehicle Grid Example

	Lane 3	Lane 2	Lane 1
Row 1	BX		MV
Row 2	LS	FC	
Row 3		LS	SS

3.3 Test Case Format

Each test case is presented with eight (8) subsections as follows:

1) Purpose – a brief description as to the purpose of the particular test case

2) Description – a brief description of the vehicle behavior that will be used in the test case.

3) Special Conditions – a list of any special conditions applicable to the test case.

4) Special Standards – a list of any special standards that must be adhered to in the test case.

5) Iterations – the number of iterations/passes that will be executed for the test case.

6) Equipment – an inventory of the Vehicle and OBU equipment necessary for the test case.

7) Script – a detailed script of the test case

8) Driver Instructions – an overview of the instructions that will be given to each driver to ensure that the proper vehicle behavior is adhered to while maintain a safe driving environment at all times.

3.4 Test Scenarios

The set of test cases documented in Attachment 1 (collectively called the test Scenario) will be completed two times as follows:

1) NCTA Category B Transponders on EZG Reader

Refer to Attachment 10 for a summary of the various Scenarios that will be executed. For each Scenario, the figure lists the test cases to be tested at the plaza testing site, the number of EZG transponders (by type), the number of National Affiliate (NA) transponders by type, the number of passes for each test case, the total number of transactions with the associated transponder type and finally the total number of transactions executed for the test case.

Figure 2 presents a summary of the vehicles that will be required by test case.

Seq. Order	Test Case	Compact Car (CC)	Midsize Car (MC)	Fullsize Car (FC)	Small SUV (SS)	Large SUV (LS)	Minivan (MV)	Box Truck (BX)	Tractor (TR)	Dump Truck (DU)	Total Vehicles
4	1028 – Gated Lane 2 Only	2	2	2	2	2	1	1	0	0	12
6	1034 – 20 MPH Lane 2 Only	2	2	2	2	2	1	1	0	0	12
11	1004 – 5 MPH Single Vehicle	2	2	2	2	2	1	1	0	0	12
17	1005 – 5 MPH Two Vehicle	2	2	1	2	2	2	1	0	0	12
18	1011 – 20 MPH Two Vehicle	2	2	1	2	2	2	1	0	0	12
24	1040 – Two Vehicle Low Speed Acceleration	2	2	1	2	2	2	1	0	0	12
26	1003 – Gated Three Vehicle	2	2	2	1	2	2	1	0	0	12
27	1006 – 5 MPH Three Vehicle	2	2	2	1	2	2	1	0	0	12
29	1015 – 30 MPH Three Vehicle	2	2	2	1	2	2	1	0	0	12
30	1017 – Gated Three Vehicle Simultaneous – Order A	2	2	2	1	2	2	1	0	0	12
31	1022 – 10 MPH Three Vehicle Simultaneous	2	2	2	1	2	2	1	0	0	12
33	1026 – 30 MPH Three Vehicle Simultaneous	2	2	2	1	2	2	1	0	0	12
39	1005S – 5 MPH Two Vehicle	2	2	1	1	1	2	1	1	1	12
	Totals	2	2	2	2	2	2	1	1	1	15

Figure 2 - Plaza Vehicle Summary

Attachment 1

Plaza Test Script Details

4 Test Case 1028 – Gated Lane 2 Only

4.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment with high volume in a single lane.

4.2 Description

Vehicles will approach the toll plaza in a single column at a slow speed of less than 15 MPH. They will stop prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

All vehicles will use Lane 2 for all laps.

Vehicles will maintain a few feet of spacing from the vehicle in front of them as they proceed through the plaza.

4.3 Special Conditions

Traffic cones will be placed in a line with the gate installed in Lane 3 to indicate the position where a gate would be.

4.4 Special Standards

None

4.5 Iterations

<__>

4.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

4.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 1.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 1 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 1 – Test Case 1028 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1		FC	
Row 2		LS	
Row 3		MC	
Row 4		MC	
Row 5		BX	
Row 6		SS	
Row 7		LS	
Row 8		SS	
Row 9		CC	
Row 10		FC	
Row 11		CC	
Row 12		MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first vehicle will proceed through the approach area and capture zone at no more than 15 MPH and come to a complete stop at the traffic cones that simulate a gate for at least one second before proceeding through the rest of the plaza.
10. The following vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding vehicle has begun.
11. Vehicles will approach the plaza at no more than 15 MPH.
12. When the vehicle reaches the gate, it will come to a complete stop for at least one second before proceeding through the rest of the plaza.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of **Error! Reference source not found.** following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

4.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane 2.
2. The vehicle in front of you is <Vehicle Number>.
3. Go when directed to.
4. Approach the toll plaza at less than 15 MPH.
5. Stay at least 5 feet behind the preceding vehicle.
6. Stop before the traffic cones for at least one second as if it were a toll gate.
7. Once you get past the plaza, return to the assembly area. You can speed up but don't exceed 30 MPH.
8. You will drive <__> laps.

5 Test Case 1034 – 20 MPH Single Vehicle Lane 2 Only

5.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at moderate speeds and high volume in a single lane.

5.2 Description

Vehicles will approach the toll plaza in a single column and proceed through the plaza at 20 MPH.

All vehicles will use Lane 2 for every lap.

Vehicles will maintain a few feet of spacing through the plaza and capture zone.

5.3 Special Conditions

None

5.4 Special Standards

None

5.5 Iterations

<__>

5.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

5.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 2.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 2 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 2 – Test Case 1034 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1		FC	
Row 2		LS	
Row 3		MC	
Row 4		MC	
Row 5		BX	
Row 6		SS	
Row 7		LS	
Row 8		SS	
Row 9		CC	
Row 10		FC	
Row 11		CC	
Row 12		MV	

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first vehicle will approach and continue through the plaza at 20 MPH.
10. The following vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about two seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding vehicle has begun.
11. Vehicles will approach and continue through the plaza at 20 MPH.
12. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 2 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

5.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane 2.
2. The vehicle in front of you is <Vehicle Number>.
3. Go when directed to.
4. Approach and go through the plaza at 20 MPH
5. Stay at least 5 feet behind the preceding vehicle.
6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

6 Test Case 1004 – 5 MPH Single Vehicle

6.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at low volumes and low speeds.

6.2 Description

Vehicles will approach the toll plaza one at a time and proceed through the plaza at 5 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

6.3 Special Conditions

None

6.4 Special Standards

None

6.5 Iterations

<__>

6.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	2
Large SUV	2
Minivan	1
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

6.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 3.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 3 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 3 – Test Case 1004 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1		FC	
Row 2		LS	
Row 3			MC
Row 4	MC		
Row 5		BX	
Row 6	SS		
Row 7	LS		
Row 8			SS
Row 9		CC	
Row 10			FC
Row 11	CC		
Row 12			MV

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 5 MPH.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 5 MPH as they reach the plaza islands. The driver must ensure that they remain behind the vehicle in the previous row no matter what lane the previous vehicle is in.
12. All vehicles will proceed through the plaza at 5 MPH.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 3 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

6.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in the preceding row is <Vehicle Number> who will be in Lane <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH and then reduce speed to 5 MPH as you reach the front edge of the plaza islands.
5. Remain behind the vehicle in the previous row no matter what lane the vehicle is in. If it is in the same lane as you, stay at least 5 feet behind that vehicle.
6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

7 Test Case 1005 – 5 MPH Two Vehicle

7.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at moderate volumes and low speeds.

7.2 Description

Vehicles will approach the toll plaza two at a time and proceed through the plaza at 5 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

7.3 Special Conditions

None

7.4 Special Standards

None

7.5 Iterations

<__>

7.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

7.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 4.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown Table 4 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 4 – Test Case 1005 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MV		MC
Row 2		CC	SS
Row 3	FC		CC
Row 4	SS	LS	
Row 5	MV	BX	
Row 6		MC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 5 MPH. Vehicles do not have to be synchronized with other vehicles in their row.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 5 MPH as they reach the plaza islands. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.
12. All vehicles will proceed through the plaza at 5 MPH.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 4 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

7.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicles in the preceding row are <Vehicle Numbers> who will be in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH and then reduce speed to 5 MPH as you reach the front edge of the plaza islands.
5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.
6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

8 Test Case 1011 – 20 MPH Two Vehicle

8.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at moderate volumes and moderate speeds.

8.2 Description

Vehicles will approach the toll plaza two at a time and proceed through the plaza at 20 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

8.3 Special Conditions

None

8.4 Special Standards

None

8.5 Iterations

<__>

8.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

8.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 5.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 5 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 5 – Test Case 1011 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	
Row 2	SS		CC
Row 3	CC	FC	
Row 4		SS	LS
Row 5		MV	BX
Row 6	LS		MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will approach and proceed through the plaza at 20 MPH or less if the Test Coordinator deems 20 MPH unsafe for the special vehicles. Vehicles do not have to be synchronized with other vehicles in their row.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach and proceed through the plaza at 20 MPH or less if the Test Coordinator deems 20 MPH unsafe for the special vehicles. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.
12. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 5 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

8.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicles in the preceding row are <Vehicle Numbers> who will be in Lanes <Assignments>. Vehicle <Vehicle Number> will be in your row in Lane <Assignment>.
3. Go when directed to.
4. Approach the plaza at 20 MPH and stay at that speed through the plaza.
5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.
6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

9 Test Case 1040 – Two Vehicle Low Speed Acceleration

9.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment when two vehicles at a time accelerate through the capture zone.

9.2 Description

Vehicles will approach the toll plaza two at a time at about 10 MPH and then accelerate to no more than 30 MPH as they pass through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Each vehicle will perform the same action on each iteration.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

9.3 Special Conditions

None

9.4 Special Standards

None

9.5 Iterations

<__>

9.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	1
Small SUV	2
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

9.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 6.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 6 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 6 – Test Case 1040 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MC	MV	
Row 2	SS		CC
Row 3	CC	FC	
Row 4		SS	LS
Row 5		MV	BX
Row 6	LS		MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row of vehicles will approach the toll plaza at 10 MPH and as they near the capture zone markers, begin accelerating up to 30 MPH.
10. The following rows of vehicles will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the toll plaza at 10 MPH and as they near the capture zone markers, begin accelerating up to 30 MPH. Vehicles shall not pass any vehicles in any other lanes and shall maintain a few feet of spacing with any vehicle directly in front of them. Vehicles do not have to be synchronized with other vehicles in their row.
12. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 6 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

9.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number> who will be in Lane <Assignment>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 10 MPH and then begin speeding up as you reach the point indicated by the OBU/Vehicle Organizer.
5. Do not go faster than 30 MPH.
6. Stay behind the vehicles before you by at least 5 feet no matter what lane they are in.
7. Once you get past the plaza islands, return to the assembly area. Do not exceed 30 MPH.
8. You will drive <__> laps.

10 Test Case 1003 – Gated Three Vehicle

10.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes.

10.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

10.3 Special Conditions

Traffic cones will be placed in a line with the gate installed in Lane 3 to indicate the position where a gate would be.

10.4 Special Standards

None

10.5 Iterations

<__>

10.6 Equipment

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

10.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 7.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 7 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 7 – Test Case 1003 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	MV	CC
Row 3	FC	MC	SS
Row 4	CC	LS	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH and come to a complete stop at the traffic cones that

simulate a gate for at least one second before proceeding through the rest of the plaza. Vehicles do not have to be synchronized with other vehicles in their row.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH. The drivers will pull up to the gate if no one is in front of the vehicle or hold a few feet behind any preceding vehicles. Vehicles do not have to be synchronized with other vehicles in their row.
12. When each vehicle reaches the gate, it will come to a complete stop for at least one second before proceeding through the rest of the plaza.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 7 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

10.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH.
5. Stay at least 5 feet behind any vehicle in front of you. If no one is in front of you, pull up to the gate.
6. Stop before the traffic cones for at least one second as if it were a toll gate.
7. Once you get past the plaza, return to the assembly area. You can speed up but don't exceed 30 MPH.
8. You will drive <__> laps.

11 Test Case 1006 – 5 MPH Three Vehicle

11.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and low speeds.

11.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 5 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

11.3 Special Conditions

None

11.4 Special Standards

None

11.5 Iterations

<__>

11.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

11.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 8.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 8 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 8 – Test Case 1006 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	BX	MV	LS
Row 2	CC	FC	MV
Row 3	SS	FC	MC
Row 4	MC	CC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 5 MPH. Vehicles do not have to be synchronized with other vehicles in their row.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 5 MPH as they reach the plaza islands. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.
12. All vehicles will proceed through the plaza at 5 MPH.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 8 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

11.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH and then reduce speed to 5 MPH as you reach the front edge of the plaza islands.
5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.
6. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
7. You will drive <__> laps.

12 Test Case 1015 – 30 MPH Three Vehicle

12.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and high speeds.

12.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 30 MPH.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

12.3 Special Conditions

None

12.4 Special Standards

None

12.5 Iterations

<__>

12.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

12.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 9.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 9 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 9 – Test Case 1015 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	MV	LS	BX
Row 2	FC	MV	CC
Row 3	FC	MC	SS
Row 4	CC	LS	MC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first row will approach and proceed through the plaza at 30 MPH. Vehicles do not have to be synchronized with other vehicles in their row.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach and proceed through the plaza at 30 MPH. The driver must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in. Vehicles do not have to be synchronized with other vehicles in their row.
12. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 9 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
13. The vehicles will repeat Steps 8 to 12 until <__> iterations are complete.

12.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at 30 MPH and stay at that speed through the plaza.
5. Remain behind the vehicles in the previous row no matter what lanes the vehicles are in. If one is in the same lane as you, stay at least 5 feet behind that vehicle.
6. Once you get past the plaza islands, return to the assembly area. Do not exceed 30 MPH.
7. You will drive <__> laps.

13 Test Case 1017 – Gated Three Vehicle Simultaneous – Order A

13.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes when vehicles are arriving at about the same time.

13.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop at approximately the same time prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

13.3 Special Conditions

Traffic cones will be placed in a line with the gate installed in Lane 3 to indicate the position where a gate would be.

13.4 Special Standards

None

13.5 Iterations

<__>

13.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

13.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 10.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 10 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 10 – Test Case 1017 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	BX	MV	LS
Row 2	CC	FC	MV
Row 3	SS	FC	MC
Row 4	MC	CC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH, synchronizing their movements so they come to a

complete stop at the traffic cones that simulate a gate at the same time. They will hold for at least one second before proceeding through the rest of the plaza.

10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements.
12. When the vehicles reach their gates, they will come to a complete stop for at least one second before proceeding through the rest of the plaza. They should leave the plaza at the same time.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 10 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

13.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH.
5. Stay aligned with the other vehicles in your row.
    a. If the leftmost vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.
6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles, be aware that you may have to slow down or stop prior to the gate as the leftmost vehicle maintains this distance.
7. Stop before the traffic cones for at least one second as if it were a toll gate and leave when the leftmost vehicle leaves.
8. You will drive <__> laps.

14 Test Case 1022 – 10 MPH Three Vehicle Simultaneous

14.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and low speeds when vehicles are arriving at about the same time.

14.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 10 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

14.3 Special Conditions

None

14.4 Special Standards

None

14.5 Iterations

<__>

14.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

14.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 11.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 11 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 11 – Test Case 1022 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	LS	BX	MV
Row 2	MV	CC	FC
Row 3	MC	SS	FC
Row 4	LS	MC	CC

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will approach the plaza at no more than 15 MPH and as they reach the plaza islands, reduce speed to 10 MPH and synchronize their movements so they pass through the capture zone at the same time.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH and reduce speed to 10 MPH as they reach the plaza islands. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.
12. All vehicles will proceed through the plaza at 10 MPH.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 11 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

14.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH and then reduce speed to 10 MPH as you reach the front edge of the plaza islands.
5. Stay aligned with the other vehicles in your row through the plaza.
    a. If the leftmost vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.
6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles, be aware that you may have to slow down as the leftmost vehicle maintains this distance.
7. Once you get past the plaza islands, return to the assembly area. You can speed up but don't exceed 30 MPH.
8. You will drive <__> laps.

15 Test Case 1026 – 30 MPH Three Vehicle Simultaneous

15.1 Purpose

Test that the system can capture and report toll transactions in a toll plaza environment with vehicles at high volumes and high speeds when vehicles are arriving at about the same time.

15.2 Description

Vehicles will approach the toll plaza three at a time and proceed through the plaza at 30 MPH while trying to arrive and stay aligned with each other through the capture zone.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone and should maintain constant spacing with any vehicles in front of them.

15.3 Special Conditions

None

15.4 Special Standards

None

15.5 Iterations

<__>

15.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	2
Midsize Car	2
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1

OBU Type	Quantity Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

15.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 12.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 12 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 12 – Test Case 1026 Vehicle Grid

	Lane 3	Lane 2	Lane 1
Row 1	BX	MV	LS
Row 2	CC	FC	MV
Row 3	SS	FC	MC
Row 4	MC	CC	LS

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.

9. Upon command from the Test Coordinator, the first row will approach and pass through the plaza at 30 MPH, synchronizing their movements so they pass through the capture zone at the same time.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach and pass through the plaza at 30 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements with their own row.
12. All vehicles will proceed through the plaza at 30 MPH.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 12 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

15.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza and drive through the plaza at 30 MPH.
5. Stay aligned with the other vehicles in your row through the plaza.
    a. If the leftmost vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.
6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles, be aware that you may have to slow down as the leftmost vehicle maintains this distance.
7. Once you get past the plaza islands, return to the assembly area. Don't exceed 30 MPH.
8. You will drive <__> laps.

16 Test Case 1018S – Gated Three Vehicle - Special Simultaneous – Order B

16.1 Purpose

Test that the system can capture and report toll transactions in a gated toll plaza environment at high volumes when vehicles are arriving at about the same time.

16.2 Description

Vehicles will approach the toll plaza three at a time at a slow speed of less than 15 MPH. They will stop at approximately the same time prior to passing a simulated gate to be marked by traffic cones. After coming to a complete stop for at least 1 second, they will proceed through the plaza.

Each vehicle will have a designated travel lane. This lane will be the same for each iteration of the test case for that vehicle.

Vehicles will not tailgate through the capture zone although they may reduce their spacing as they reach the simulated gate if a previous vehicle has not cleared the plaza yet.

16.3 Special Conditions

Traffic cones will be placed in a line with the gate installed in Lane 3 to indicate the position where a gate would be.

16.4 Special Standards

None

16.5 Iterations

<__>

16.6 Equipment

The equipment listed below will be the same as used in the prior test case unless a substitution was required due to equipment failure (vehicle and/or transponder).

Vehicle Type	Quantity
Compact Car	1
Midsize Car	1
Fullsize Car	2
Small SUV	1
Large SUV	2
Minivan	2
Box Truck	1
Dump Truck	1
Tractor	1

	Quantity
OBU Type	Scenario 1 NCTA OBU on EZG Reader
EZG Interior	1
NCTA TDM Interior	9
NCTA TDM Switchable	1
NCTA TDM Exterior	1

16.7 Script

1. OBU/Vehicle Organizers will select vehicles from the inventory to meet required quantities and assign it to a slot in the vehicle grid shown in Table 13.
2. OBU/Vehicle Organizers will assign a driver to each vehicle.
3. OBU/Vehicle Organizers will brief the drivers on their actions based on the vehicle they are assigned to.
4. OBU/Vehicle Organizers will perform actions as needed for OBU handling:
    a. If a new OBU is to be used, they will mount the OBU, scan barcodes for the vehicle and OBU, take a picture and transmit the data to the RECORDING SYSTEM.
    b. If the previously mounted OBU is to be used, OBU/Vehicle Organizers will verify that the mounting still meets requirements.
5. Drivers will assemble their vehicles in the order shown in Table 13 in the vehicle assembly area following the instructions of the OBU/Vehicle Organizer.

Table 13 - Test Case 1018S Vehicle Grid - Special

	Lane 3	Lane 2	Lane 1
Row 1	LS	BX	MV
Row 2	MV	CC	FC
Row 3	DU	SS	FC
Row 4	LS	MC	TR

6. The OBU/Vehicle Organizers will verify that the vehicles are correctly positioned in the vehicle assembly area.
7. The OBU/Vehicle Organizers will provide the vehicle assignments to the positions to the Toll Zone Observer who will configure the test in the RECORDING SYSTEM.
8. The Toll Zone Observer will notify the Test Coordinator when the RECORDING SYSTEM is ready.
9. Upon command from the Test Coordinator, the first row will proceed through the approach area and capture zone at no more than 15 MPH, synchronizing their movements so they come to a complete stop at the traffic cones that simulate a gate at the same time. They will hold for at least one second before proceeding through the rest of the plaza.
10. The following rows will begin their approach when the OBU/Vehicle Organizer waves a flag to indicate that they should proceed. This should be about three seconds or at an interval deemed appropriate by the Test Coordinator for safety and to meet the purpose of the test after the preceding row has begun.
11. Vehicles will approach the plaza at no more than 15 MPH. The drivers must ensure that they remain behind the vehicles in the previous row no matter what lanes the previous vehicles are in while also synchronizing their own movements.
12. When the vehicles reach their gates, they will come to a complete stop for at least one second before proceeding through the rest of the plaza. They should leave the plaza at the same time.
13. After clearing the plaza and unless it is the last iteration, the vehicles will follow the track around to the vehicle assembly area at no more than 30 MPH and reassemble in the original order of Table 13 following the instructions of the OBU/Vehicle Organizer.
    a. If it is the last iteration, the vehicles will return to the staging area.
14. The vehicles will repeat Steps 8 to 13 until <__> iterations are complete.

16.8 Driver Instructions

1. You will drive in a <Vehicle Type> in Lane <Assignment>.
2. The vehicle in front of you is <Vehicle Number>. Vehicles <Vehicle Number> will be in your row in Lanes <Assignment>.
3. Go when directed to.
4. Approach the plaza at less than 15 MPH.
5. Stay aligned with the other vehicles in your row.
    a. If the leftmost vehicle, set the pace.
    b. All other vehicles, keep pace as best you can with the vehicle immediately to your left.

6. Stay behind all vehicles in the previous row by at least 5 feet.
    a. Leftmost vehicle, remain behind all vehicles in the previous row no matter what lanes the vehicles are in.
    b. All other vehicles, be aware that you may have to slow down or stop prior to the gate as the leftmost vehicle maintains this distance.
7. Stop before the traffic cones for at least one second as if it were a toll gate and leave when the leftmost vehicle leaves.
8. You will drive <__> laps.

Attachment 8

NCTA Proposed E-ZPass Group Test Script Execution for Category A - Readers

			Proposed NCTA Tri-Protocol Reader Testing for EZG Approval																	
Seq	Test Case	Description	Iterations	# Vehicles	Vehicles w/EZG Interior Tag	Vehicles w/NCTA TDM/SeGo Tag	Vehicles w/NCTA SeGo Sticker	Vehicles w/6C Sticker Tag	Vehicles w/EZG Plate Tag	Total Transactions	EZG Interior Tag Transactions		NCTA TDM/SeGo Tag Transactions		NCTA SeGo Sticker Tag Transactions		6C Sticker Tag Transactions		EZG Plate Tag Transactions	
1	2004	10 MPH Single Vehicle	40	12	8	1	1	1	1	480	320	67%	40	8%	40	8%	40	8%	40	8%
3	2020	60 MPH Single Vehicle	40	12	8	1	1	1	1	480	320	67%	40	8%	40	8%	40	8%	40	8%
4	2038	10 MPH Lane 1 Only	40	12	8	1	1	1	1	480	320	67%	40	8%	40	8%	40	8%	40	8%
6	2042	60 MPH Lane 3 Only	40	12	8	1	1	1	1	480	320	67%	40	8%	40	8%	40	8%	40	8%
7	2037	Stop and Go Lane 3 Only	20	12	8	1	1	1	1	240	160	67%	20	8%	20	8%	20	8%	20	8%
9	2046	45 MPH Lane 23 Only	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
10	2010	20 MPH Two Vehicle	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
12	2021	60 MPH Two Vehicle – Order A	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
19	2036	Straddle Lane Two Vehicle 60 MPH	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
20	2054	Stop and Go Side-by-Side	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
22	2059	60 MPH Side-by-Side	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
24	2067	60 MPH Two Vehicle Simultaneous	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
28	2071	Two Vehicle Passing	30	12	8	1	1	1	1	360	240	67%	30	8%	30	8%	30	8%	30	8%
31	2019	45 MPH Three Vehicle	50	12	8	1	1	1	1	600	400	67%	50	8%	50	8%	50	8%	50	8%
33	2049	Mixed Lane 10 MPH	50	12	8	1	1	1	1	600	400	67%	50	8%	50	8%	50	8%	50	8%
35	2053	Mixed Lane 60 MPH	55	12	8	1	1	1	1	660	440	67%	55	8%	55	8%	55	8%	55	8%
37	2076	Changing Lanes Two Vehicles 30 MPH	15	8	4	1	1	1	1	120	60	50%	15	13%	15	13%	15	13%	15	13%
38	2083	Stopped Vehicle in Lane	15	12	8	1	1	1	1	180	120	67%	15	8%	15	8%	15	8%	15	8%
13	2015S	30 MPH Two Vehicle - Special	20	10	6	1	1	1	1	200	120	60%	20	10%	20	10%	20	10%	20	10%
16	2051S	Mixed Lane 30 MPH - Special	20	9	5	1	1	1	1	180	100	56%	20	11%	20	11%	20	11%	20	11%
		Totals								**7580**	**5000**	**66%**	**645**	**9%**	**645**	**9%**	**645**	**9%**	**645**	**9%**

Attachment 9

NCTA Proposed E-ZPass Group ORT Test Script Execution for Category B – TDM Transponders

			Proposed NCTA Tag Testing in ORT Setting for EZG Approval															
Seq	Test Case	Description	Iterations	# Vehicles	Vehicles w/NCTA Interior TDM Tag	Vehicles w/EZG Interior Tag	Vehicles w/NCTA TDM Switchable Tag	Vehicles w/NCTA TDM Plate Tag	Total Transactions	NCTA Interior TDM Tag Transactions		EZG Interior Tag Transactions		NCTA TDM Switchable Tag Transactions		NCTA TDM Plate Tag Transactions	
1	2004	10 MPH Single Vehicle	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
3	2020	60 MPH Single Vehicle	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
4	2038	10 MPH Lane 1 Only	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
6	2042	60 MPH Lane 3 Only	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
7	2037	Stop and Go Lane 3 Only	20	12	9	1	1	1	240	180	75%	20	8%	20	8%	20	8%
9	2046	45 MPH Lane 23 Only	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
10	2010	20 MPH Two Vehicle	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
12	2021	60 MPH Two Vehicle – Order A	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
19	2036	Straddle Lane Two Vehicle 60 MPH	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
20	2054	Stop and Go Side-by-Side	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
22	2059	60 MPH Side-by-Side	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
24	2067	60 MPH Two Vehicle Simultaneous	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
28	2071	Two Vehicle Passing	30	12	9	1	1	1	360	270	75%	30	8%	30	8%	30	8%
31	2019	45 MPH Three Vehicle	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
33	2049	Mixed Lane 10 MPH	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
35	2053	Mixed Lane 60 MPH	55	12	9	1	1	1	660	495	75%	55	8%	55	8%	55	8%
37	2076	Changing Lanes Two Vehicles 30 MPH	15	8	5	1	1	1	120	75	63%	15	13%	15	13%	15	13%
38	2083	Stopped Vehicle in Lane	15	12	9	1	1	1	180	135	75%	15	8%	15	8%	15	8%
13	2015S	30 MPH Two Vehicle - Special	20	10	7	1	1	1	200	140	70%	20	10%	20	10%	20	10%
16	2051S	Mixed Lane 30 MPH - Special	20	9	6	1	1	1	180	120	67%	20	11%	20	11%	20	11%
		Totals							**7580**	**5645**	**74%**	**645**	**9%**	**645**	**9%**	**645**	**9%**

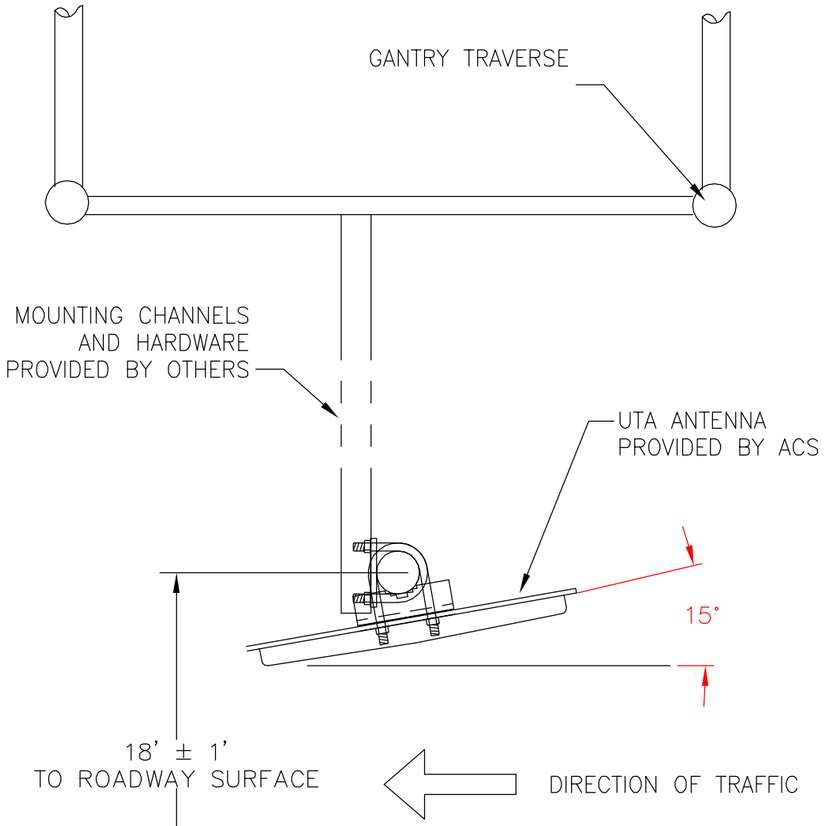
Attachment 10

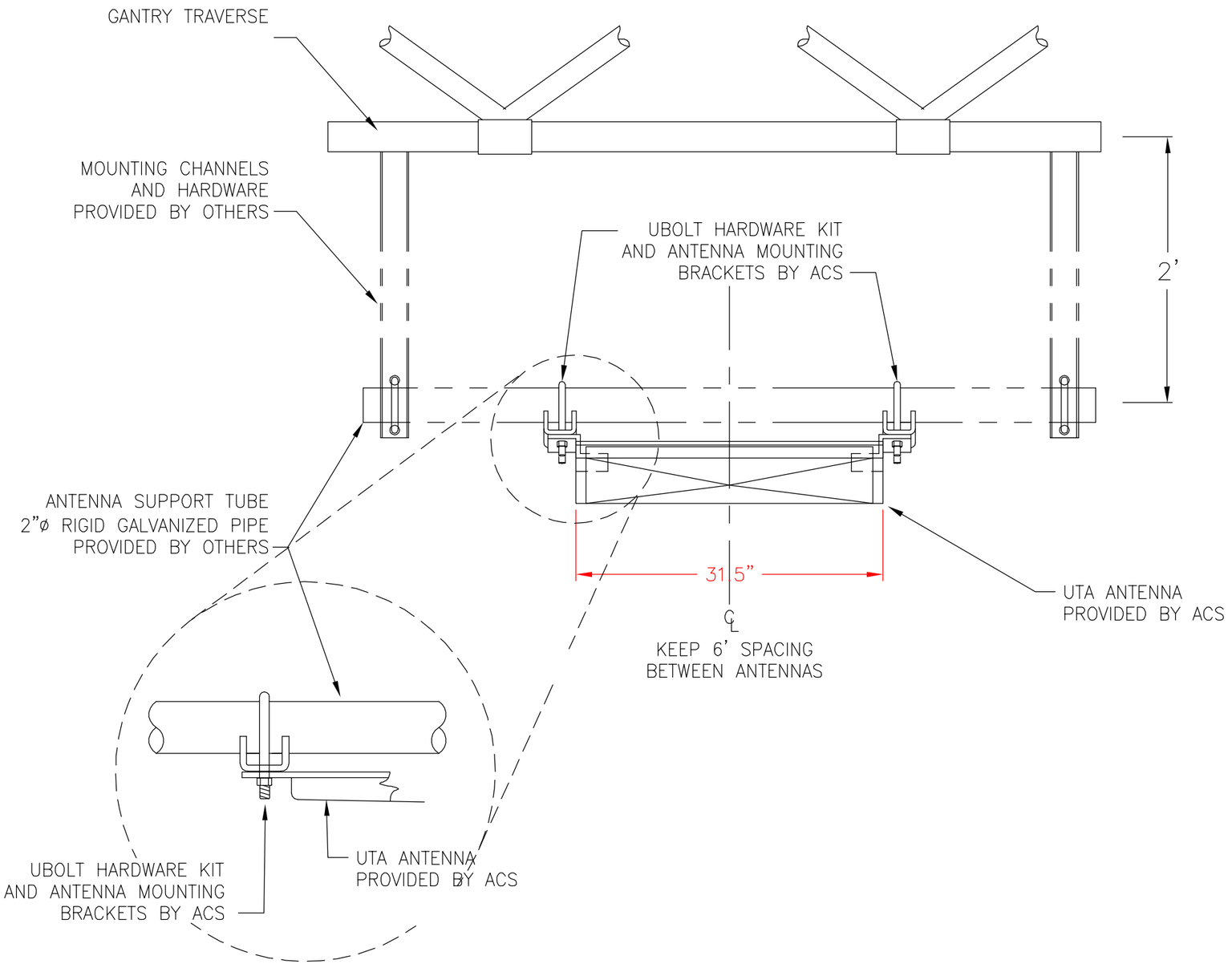
NCTA Proposed E-ZPass Group Traditional Plaza Test Script Execution for Category B – TDM Transponders

			Proposed NCTA Tag Testing in Plaza Setting for EZG Approval															
Seq	Test Case	Description	Iterations	# Vehicles	Vehicles w/NCTA Interior TDM Tag	Vehicles w/EZG Interior Tag	Vehicles w/NCTA TDM Switchable Tag	w/NCTA TDM Plate Tag	Total Transactions	NCTA Interior TDM Tag Transactions		EZG Interior Tag Transactions		NCTA TDM Switchable Tag Transactions		NCTA TDM Plate Tag Transactions	
4	1028	Gated Lane 2 Only	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
6	1034	20 MPH Lane 2 Only	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
11	1004	5 MPH Single Vehicle	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
17	1005	5 MPH Two Vehicle	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
18	1011	20 MPH Two Vehicle	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
24	1040	Two Vehicle Low Speed Acceleration	40	12	9	1	1	1	480	360	75%	40	8%	40	8%	40	8%
26	1003	Gated Three Vehicle	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
27	1006	5 MPH Three Vehicle	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
29	1015	30 MPH Three Vehicle	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
30	1017	Gated Three Vehicle Simultaneous - Order A	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
31	1022	10 MPH Three Vehicle Simultaneous	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
33	1026	30 MPH Three Vehicle Simultaneous	50	12	9	1	1	1	600	450	75%	50	8%	50	8%	50	8%
39	1018S	Gated Three Vehicle Simultaneous - Order B	50	12	8	2	1	1	600	400	67%	100	17%	50	8%	50	8%
		Totals							**7080**	**5260**	**74%**	**640**	**9%**	**590**	**8%**	**590**	**8%**

Attachment 11

Triangle Expressway As-Built RTCS Drawings





REVISION			
LTR	DESCRIPTION	DATE	APPROVED

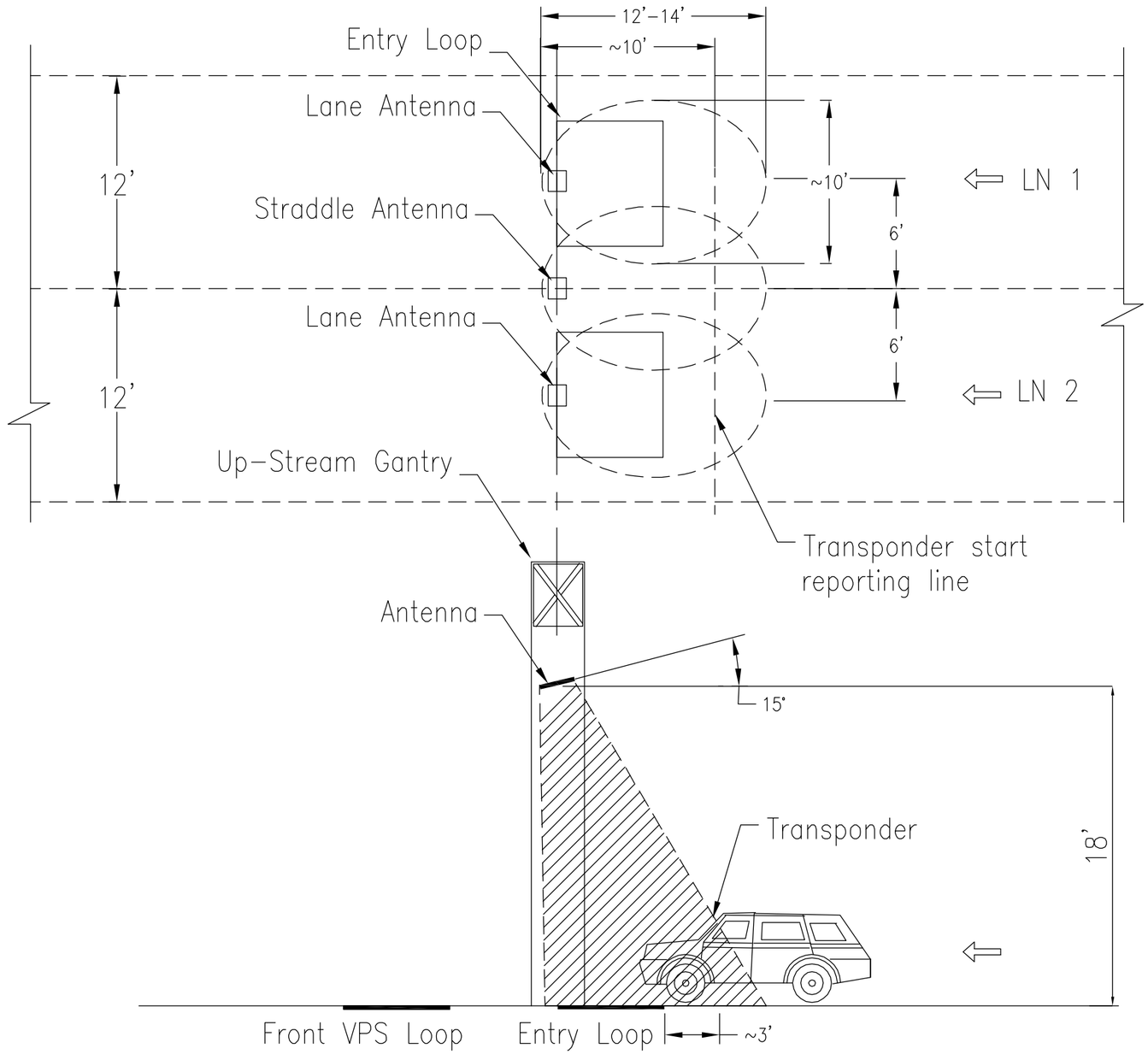
A C S
Germantown, MD

12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

CONTRACT NO.
—
ENGINEER
DATE
08/04/10
DRAWN
LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
OPEN ROAD TOLLING
TRANSCORE ANTENNA
TYPICAL INSTALLATION DETAILS

SIZE: B
DRAWING NO.: E12a
REV: A
SCALE: N/S
SHEET OF



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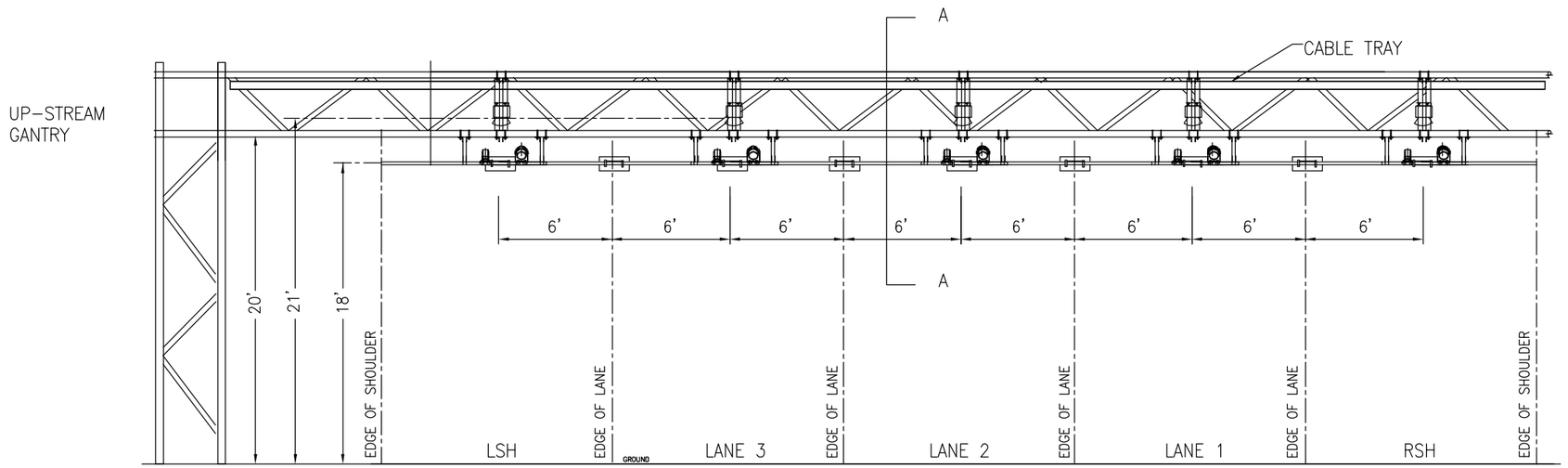
A C S
Germantown, MD

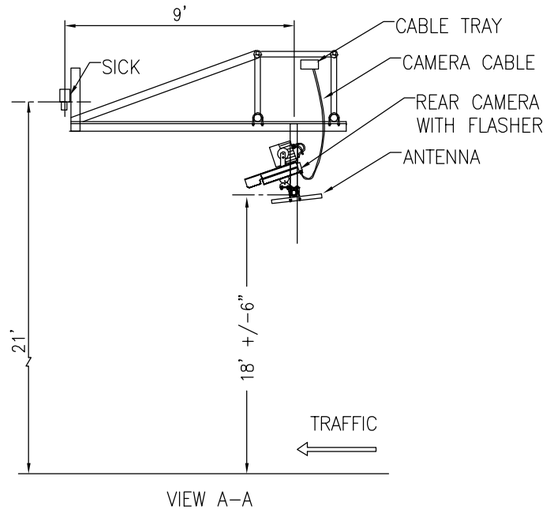
12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

CONTRACT NO. —
ENGINEER
DATE 01/11/13
DRAWN LFUKSON
APPROVAL
APPROVAL

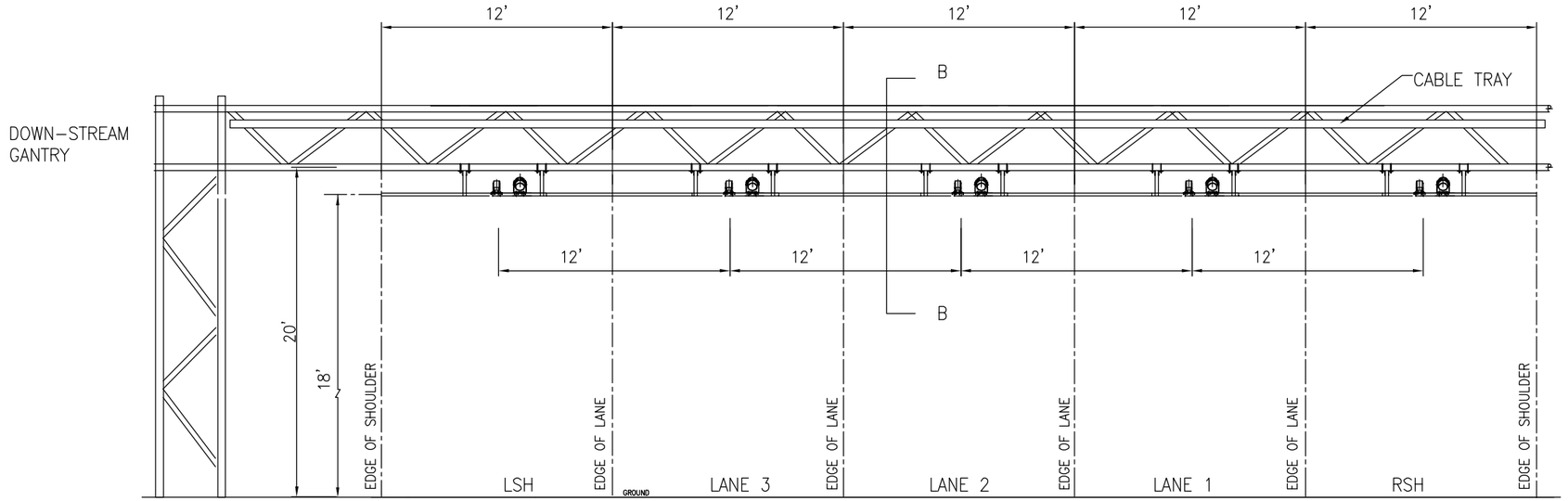
NCTA RTCS
OPEN ROAD TOLLING
TYPICAL ANTENNA READING ZONE

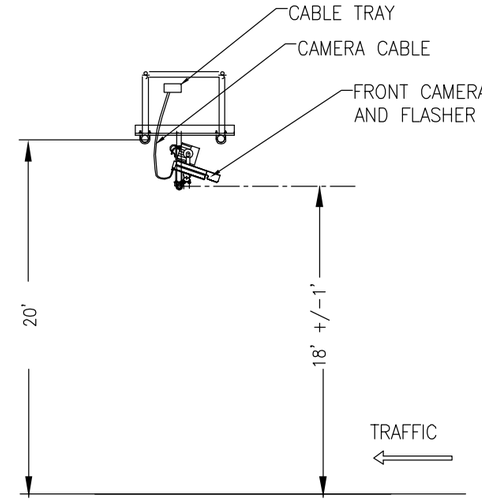
SIZE *B* | DRAWING NO. *E12b* | REV *A*
SCALE: N/S | SHEET | OF





VIEW A–A





VIEW B–B

NOTE:
1. GANTRY AND ATTACHED METAL STRUCTURE SUPPORTING ANTENNAS, CAMERAS AND SCANNER BY OTHERS.
2. ANTENNAS, CAMERAS AND SCANNER ARE CENTERED OVER STANDARD 12' LANE. SOME EQUIPMENT MAY NOT BE IN THE CENTER OF 16' AND 18' LANES.
3. FOR EXACT DIMENSIONS OF EQUIPMENT PLACEMENT SEE LAYOUT DRAWINGS 03–03f.
4. IF ANTENNA MOUNTING PIPE IS HIGHER THAN 18'+/–6", ACS PROVIDES DROP DOWN BRACKETS TO MEET THIS REQUIREMENT.
5. PROVIDE RIGID/FLEX CONDUIT FROM GANTRY CABLE TRAY TO SICK UNIT.

REVISION			
LTR	DESCRIPTION	DATE	APPROVED

A C S
Germantown, MD

12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

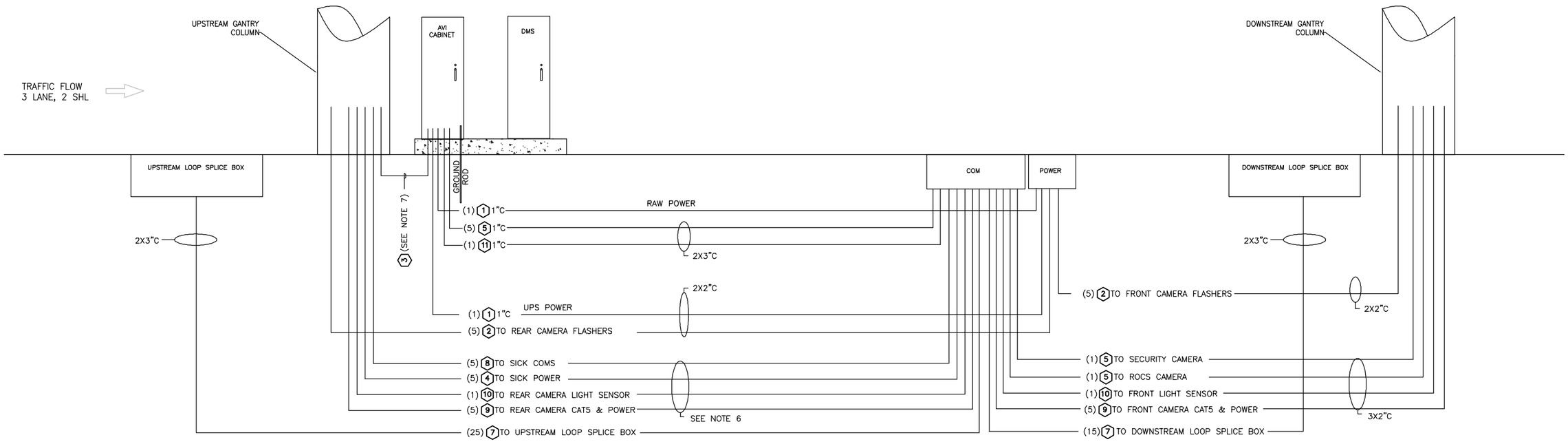
CONTRACT NO. —
ENGINEER LFUKSON
DATE 01/15/13
DRAWN LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
OPEN ROAD TOLLING
TYPICAL GANTRY EQUIPMENT LAYOUT

SIZE *B* | DRAWING NO. *E21* | REV *A*
SCALE: N/S | SHEET | OF

NOTES:
1. APPLICABLE FOR TOLL ZONES WITH BUILDING.
2. ESTIMATED RF CABLE LENGTH IS 100' TO LAST ANTENNA. LMR-600 SHOULD NOT EXCEED 3DB ATTENUATION AS PER TRANSCORE RECOMMENDATIONS.
3. CONDUITS TO/FROM TRANSCORE READER CABINET IS SUBJECT FOR TRANSCORE APPROVAL
4. ONLY ORT SYSTEM CONDUITS ARE SHOWN ON THE DRAWING.
5. ASSUMPTION: THE FOLLOWING EQUIPMENT: ETHERNET SWITCH, DEVICE MASTER, REMOTE POWER MANAGER AND POWER SUPPLIES ARE INSTALLED IN TRANSCORE READER CABINET.
6. 4X2"C FOR TOLL ZONES: 6.2, 3.2, 1.1, 5.1, 3X2"C FOR 7.1, 7.2, 8.1, 8.2, 2.2, 2.1, 4.1, 4.2.
7. 6X2"C FOR TOLL ZONES: 6.2, 3.2, 1.1, 5.1, 4X2"C FOR 7.1, 7.2, 8.1, 8.2, 2.2, 2.1, 4.1, 4.2.

LETTER	USE	PART NO.	CABLE DETAILS
0	UPS POWER INPUT	THH	#4 AWG, BLK, RED, WHT, #8 AWG GRN TO CONCRETE PAD #6 AWG, BLK, RED, WHT, #10 AWG GRN TO ML POWER PANEL #8 AWG, BLK, RED, WHT, #10 AWG GRN TO RAMP CONCRETE PAD
1	POWER DISTRIBUTION	THH	THH, #12 AWG, BLK, WHT, GRN 20A
2	UPS POWER	THH	THH, #14 AWG, BLK, WHT, GRN
3	AVI ANTENNA RF CABLE	LMR-600 LMR-900 (OPTIONAL)	MIN BEND RADIUS-5", OD-.59" MIN BEND RADIUS-9", OD-.87"
4	SICK POWER CABLE	BELDEN 5202U1	16AWG, 4-CONDUCTOR, STRANDED (7x24) TINNED CONDUCTOR, PVC INSULATION, .291" OD, 54LBS/1000FT
5	CAT 5 SHIELDED	BELDEN 7229	4 TWISTED PAIR, 24AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .224 OD
6	LOOP WIRES	ANIXTER 6M-1401-03-1000	1 CONDUCTOR, 14AWG, 19 STRANDED BARE COPPER, CROSS-LINKED POLYETHELENE JACKET
7	LOOP LEAD-IN CABLE	BELDEN 8720	1 TWISTED PAIR, 14AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .355 OD
8	COMS CABLE	BELDEN 8303	3 TWISTED PAIR, 22 AWG STRANDED TINNED COPPER CONDUCTORS INDIVIDUALLY SHIELDED, .328" OD
9	JAI CAMERA COMPOSITE CABLE	JAI 10010171	COMPOSITE MULTICONDUCTOR CABLE .521"OD, 157.1LBS/1000FT
10	JAI LIGHT SENSOR COMPOSITE CABLE	JAI 60-1327-01	COMPOSITE MULTICONDUCTOR CABLE .521"OD, 157.1LBS/1000FT
11	MM 6-FIBER OPTIC CABLE	OCC BX006DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE
12	ROCS CAMERA	PAIGE ELECTRIC 740160M	RG59/U COAX CABLE 6MM OD, 40LBS/1000FT
13	CAT 5 PATCH CABLE	PAIGE ELECTRIC 326US4P24N	4 TWISTED PAIR, 24AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .224 OD
14	MM 18-FIBER OPTIC CABLE	OCC BX018DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE
15	MM 12-FIBER OPTIC CABLE	OCC BX012DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE



REVISION			
LTR	DESCRIPTION	DATE	APPROVED

A C S
Germantown, MD

12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

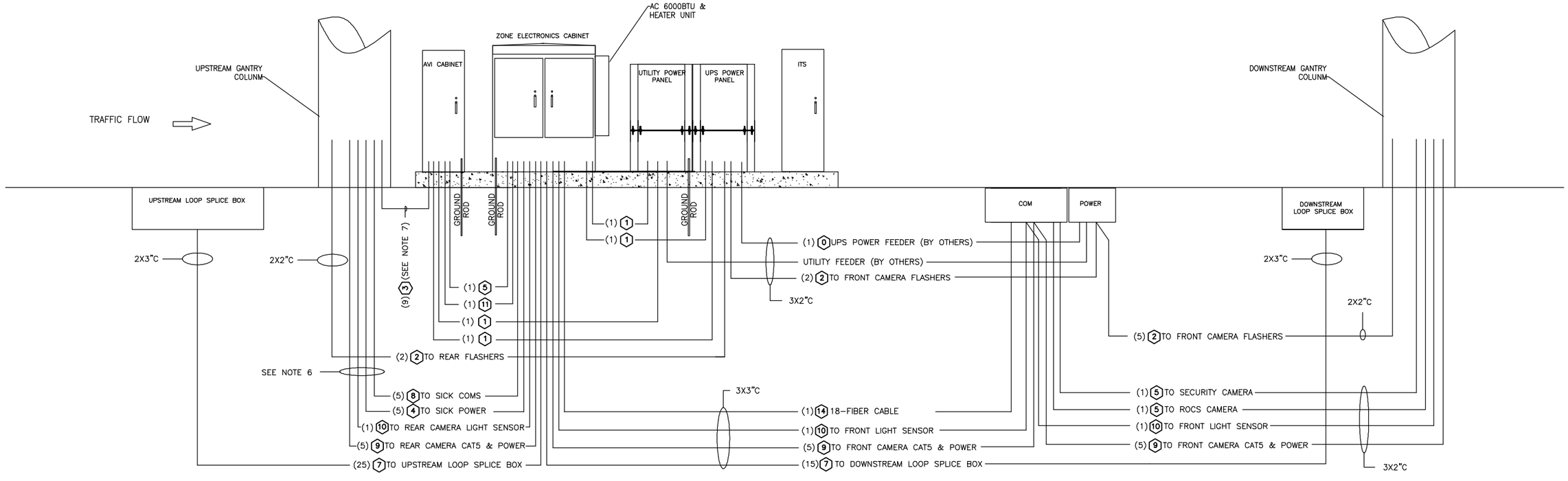
CONTRACT NO. —
ENGINEER LFUKSON
DATE 01/15/13
DRAWN LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
AVI CONCRETE PAD CABLING LAYOUT

SIZE B | DRAWING NO. E21a | REV A
SCALE: N/S | SHEET | OF

NOTES:
1. APPLICABLE FOR 1.2, 3.1, 5.2, 6.1, 6.3, 6.4.
2. ESTIMATED RF CABLE LENGTH IS 100' TO LAST ANTENNA. LMR-600 SHOULD NOT EXCEED 3DB ATTENUATION AS PER TRANSCORE REQUEREMENT.
3. CONDUITS TO/FROM TRANSCORE READER CABINET IS SUBJECT FOR TRANSCORE APPROVAL
4. ONLY ORT SYSTEM CABLES ARE SHOWN ON THE DRAWING.
5. ASSUMPTION: THE FOLOWING EQUIPMENT: ETHERNET SWITCH, DEVICE MASTER, REMOTE POWER MANAGER AND READER'S POWER SUPPLIES ARE INSTALLED IN AVI READER CABINET.
6. 4X2"C FOR TOLL ZONES 6.1, 1.2, 3.1, 5.2, 3X2"C FOR 6.3 AND 6.4.
7. 6X2"C FOR TOLL ZONES 6.1, 1.2, 3.1, 5.2, 4X2"C FOR 6.3 AND 6.4

LETTER	USE	PART NO.	CABLE DETAILS
0	UPS POWER INPUT	THH	#4 AWG, BLK, RED, WHT, #8 AWG GRN TO CONCRETE PAD #6 AWG, BLK, RED, WHT, #10 AWG GRN TO ML POWER PANEL #8 AWG, BLK, RED, WHT, #10 AWG GRN TO RAMP CONCRETE PAD
1	POWER DISTRIBUTION	THH	THH, #12 AWG, BLK, WHT, GRN 20A
2	UPS POWER	THH	THH, #14 AWG, BLK, WHT, GRN
3	AVI ANTENNA RF CABLE	LMR-600 LMR-900 (OPTIONAL)	MIN BEND RADIUS-5", OD-.59" MIN BEND RADIUS-9", OD-.87"
4	SICK POWER CABLE	BELDEN 5202U1	16AWG, 4-CONDUCTOR, STRANDED (7x24) TINNED CONDUCTOR, PVC INSULATION, .291" OD, 54LBS/1000FT
5	CAT 5 SHIELDED	BELDEN 7229	4 TWISTED PAIR, 24AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .224 OD
6	LOOP WIRES	ANIXTER 6M-1401-03-1000	1 CONDUCTOR, 14AWG, 19 STRANDED BARE COPPER, CROSS-LINKED POLYETHELENE JACKET
7	LOOP LEAD-IN CABLE	BELDEN 8720	1 TWISTED PAIR, 14AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .355 OD
8	COMS CABLE	BELDEN 8303	3 TWISTED PAIR, 22 AWG STRANDED TINNED COPPER CONDUCTORS INDIVIDUALLY SHIELDED, .328" OD
9	JAI CAMERA COMPOSITE CABLE	JAI 10010171	COMPOSITE MULTICONDUCTOR CABLE .521"OD, 157.1LBS/1000FT
10	JAI LIGHT SENSOR COMPOSITE CABLE	JAI 60-1327-01	COMPOSITE MULTICONDUCTOR CABLE .521"OD, 157.1LBS/1000FT
11	MM 6-FIBER OPTIC CABLE	OCC BX006DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE
12	ROCS CAMERA	PAIGE ELECTRIC 740160M	RG59/U COAX CABLE 6MM OD, 40LBS/1000FT
13	CAT 5 PATCH CABLE	PAIGE ELECTRIC 326US4P24N	4 TWISTED PAIR, 24AWG, STRANDED TINNED COPPER, OVERALL SHIELDED, PVC JACKET, .224 OD
14	MM 18-FIBER OPTIC CABLE	OCC BX018DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE
15	MM 12-FIBER OPTIC CABLE	OCC BX012DALS9KR	MULTIMODE OUTDOOR, 50/125, OM2, 2.9MM SUB-JACKET CABLE



REVISION			
LTR	DESCRIPTION	DATE	APPROVED

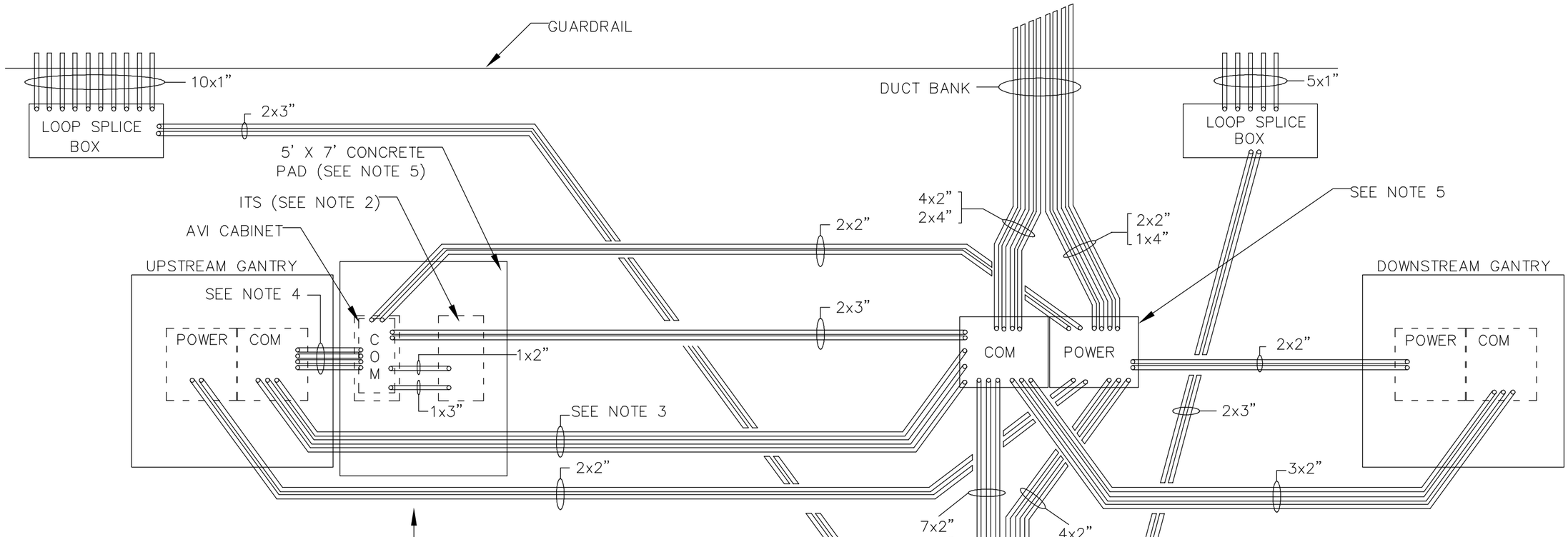
A C S
Germantown, MD

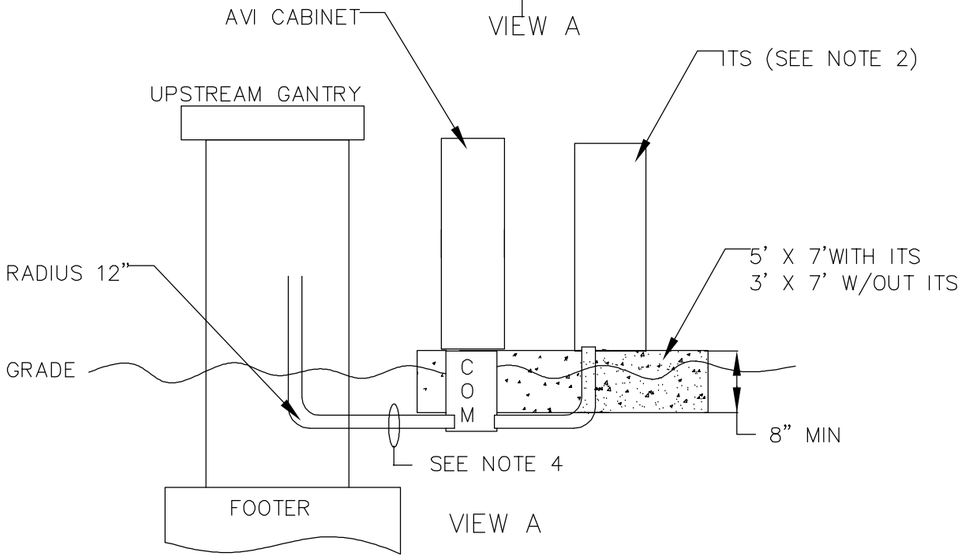
12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

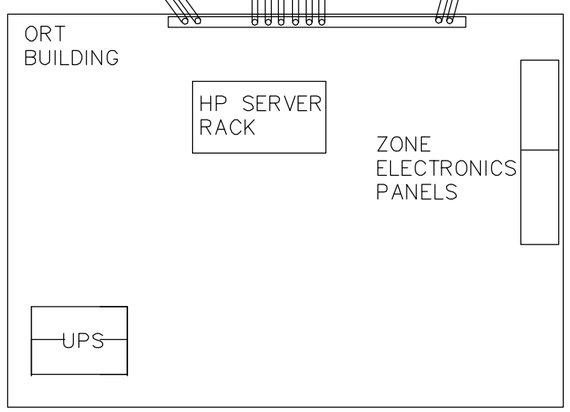
CONTRACT NO. —
ENGINEER LFUKSON
DATE 01/15/13
DRAWN LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
ORT DESIGN
FREESTANDING CABINET
CONCRETE PAD CABLING LAYOUT

SIZE B | DRAWING NO. E21b | REV A
SCALE: N/S
SHEET OF







NOTES:
1. APPLICABLE TOLL ZONES: WITH ITS CABINET: 6–2, 1–1, 3–2, 5–1 WITHOUT ITS CABINET: 7–1, 7–2, 8–1, 8–2, 2–2, 2–1, 4–1, 4–2.
2. FOR PAD WITHOUT ITS CABINET IGNORE CONDUITS TO ITS CABINET
3. 4X2" FOR TOLL ZONES: 6–2, 1–1, 3–2, 5–1: 3X2" FOR: 7–1, 7–2, 8–1, 8–2, 2–2, 2–1, 4–1, 4–2.
4. 6X2" FOR TOLL ZONES: 6–2, 1–1, 3–2, 5–1: 4X2" FOR: 7–1, 7–2, 8–1, 8–2, 2–2, 2–1, 4–1, 4–2.
5. USE COM BOX SIZE 4'X4'X2'AND POWER BOX 3'X2'X2'.

REVISION			
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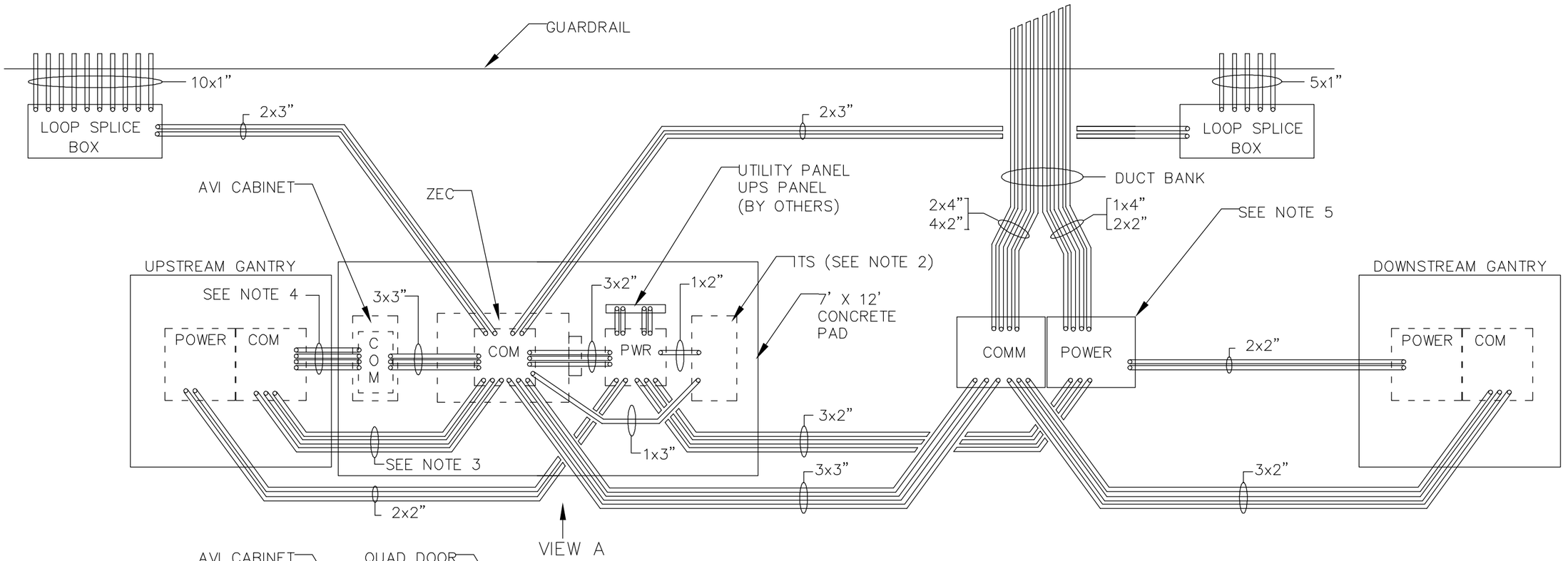
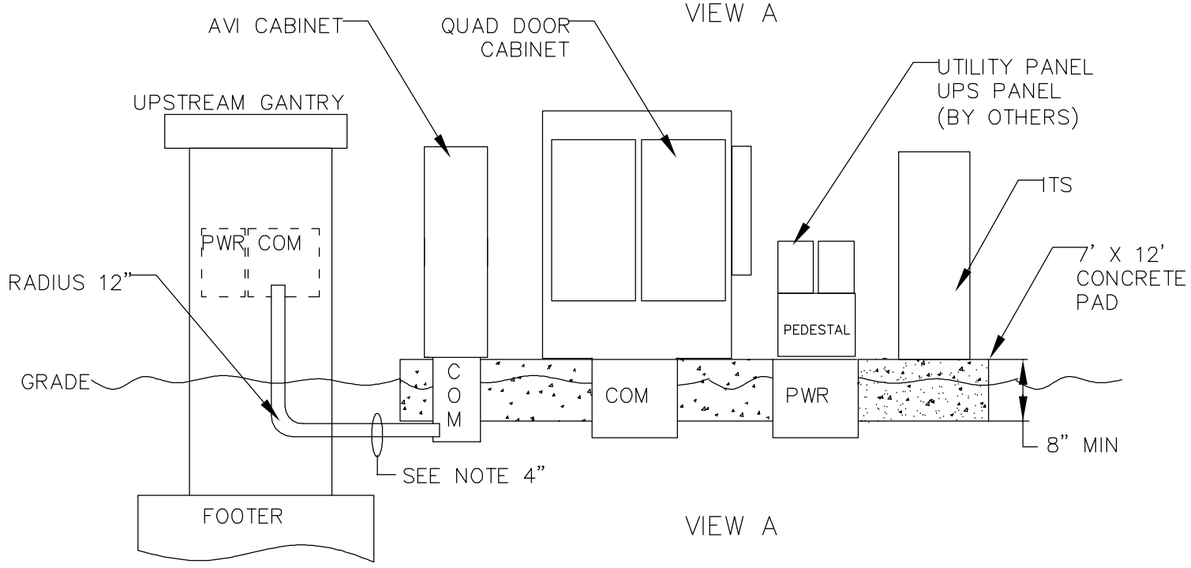
12410 MILESTONE CENTER DRIVE
4TH FLOOR
GERMANTOWN, MD 20876

CONTRACT NO. —
ENGINEER
DATE 01/15/13
DRAWN LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
TOLL ZONE BUILDING SIDE
CONCRETE PAD
CONDUITS LAYOUT

SIZE B | DRAWING NO. *E21c* | REV *A*
SCALE: N/S | SHEET OF





NOTES:
1 APPLICABLE TOLL ZONES: 6–1, 1–2, 3–1,5–2
WITHOUT ITS CABINET: 6–3, 6–4
2. FOR PAD WITHOUT ITS CABINET STUB UP CONDUITS AND PLUG FLUSH WITH SLAB
3. 4X2" FOR TOLL ZONES: 6–1, 1–2, 3–1, 5–2:
3X2" FOR: 6–3, 6–4
4. 6X2" FOR TOLL ZONES: 6–1, 1–2, 3–1, 5–2:
4X2" FOR: 6–3, 6–4.
5. USE COM BOX SIZE 4'X4'X2', POWER BOXES SIZE 3'X2'X2'.

REVISION			
LTR	DESCRIPTION	DATE	APPROVED

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4TH FLOOR
GERMANTOWN, MD 20876

CONTRACT NO. —
ENGINEER
DATE 08/20/10
DRAWN LFUKSON
APPROVAL
APPROVAL

NCTA RTCS
FREESTANDING CABINET
CONCRETE PAD
CONDUITS LAYOUT

SIZE *B* | DRAWING NO. *E21d* | REV *A*
SCALE: N/S
SHEET OF

Attachment 12

Monroe/US-74 Proposed RTCS Implementation Schedule

Monroe/US-74 Project Implementation Schedule		
Major Milestone Description	**Projected Start**	**Projected End**
Notice to Proceed	***11/1/2016***	--
Project Kickoff Meeting	***11/1/2016***	--
Project Planning Documentation (Project Schedule, Project Management Plan, Master Test Plan)	Nov. 2016	Jan. 2017
System Design (US-74 Express Lanes and Monroe Expressway)		
Requirements Review / Business Rules Workshops	Nov. 2016	Dec. 2016
Reports Design Workshops	Dec. 2016	Jan. 2017
System Detailed Design Review		Jan. 2017
Bill of Materials		Jan. 2017
Third Party Hardware and Software Documentation Submitted		Jan. 2017
Draft System Detailed Design Document (SDDD) Approved		Feb. 2017
Final System Detailed Design Document (SDDD) Submitted		Mar. 2017
RTCS Installation Design and Documentation Package Approved		Apr. 2017
System Development, Installation and Test (US-74 Express Lanes)		
Software Development	Apr. 2017	Jul. 2017
System Formal Demonstration		May 2017
System HW & SW Procurement	Apr. 2017	Jul. 2017
Factory Acceptance Test (FAT)	Jun. 2017	Jul. 2017
Final Installation Plan Approved		Jul. 2017
Installation and Testing of US-74 Tolling Location	Aug. 2017	Sep. 2017
Onsite Installation Test (OIT)	Oct. 2017	Nov. 2017
NCTA CSC Back Office Interface Test		Dec. 2017
Installation and Commissioning Test	Dec. 2017	Feb. 2018
Maintenance Plan		Jan. 2018
Training Complete		Feb. 2018
US-74 Express Lanes Go-Live (Time of Day Pricing)		***3/1/2018***
Dynamic Pricing Calibration and Testing	Mar. 2018	Jun. 2018
US-74 Express Lanes Go-Live (Dynamic Pricing)		Jun. 2018
Final Testing and Phase Closeout (US-74 Express Lanes)		
Formal Operational and Acceptance Testing	***3/1/2018***	5/15/2018
As-Built System Detailed Design Document (SDDD) Approved		May 2018
As-Built Drawing Package Approved		May 2018
System Operations / Acceptance (Start of Maintenance Phase for US-74)		***6/1/2018***
System Development, Installation and Test (Monroe Expressway)		
Software Development	Jul. 2017	Jan. 2018
System Formal Demonstration		Jan. 2018
System HW & SW Procurement	Dec. 2017	Mar. 2018
Factory Acceptance Test (FAT)	Mar. 2018	Apr. 2018
Final Installation Plan Approved		Apr. 2018
Installation of Monroe Expressway - Zone 7	May 1, 2018	Jun. 2018
Onsite Installation Test (OIT)	Jun. 2018	Jun. 2018
NCTA Back Office Interface Test		Jun. 2018
Installation and Commissioning Test	Jun. 2018	Jun. 2018

Monroe/US-74 Project Implementation Schedule		
Major Milestone Description	**Projected Start**	**Projected End**
Remaining Installations on Monroe Expressway:	Jun. 2018	Nov. 2018
Monroe Expressway - Zone 6	Jun. 2018	Jul. 2018
→ Installation and Commissioning Test		Jul. 2018
Monroe Expressway - Zone 5	Jul. 2018	Aug. 2018
→ Installation and Commissioning Test		Aug. 2018
Monroe Expressway - Zone 4	Aug. 2018	Sep. 2018
→ Installation and Commissioning Test		Sep. 2018
Monroe Expressway - Zone 3	Aug. 2018	Sep. 2018
→ Installation and Commissioning Test		Sep. 2018
Monroe Expressway - Zone 2	Sep. 2018	Oct. 2018
→ Installation and Commissioning Test		Oct. 2018
Monroe Expressway - Zone 1	Oct. 2018	Nov. 2018
→ Installation and Commissioning Test		Nov. 2018
Maintenance Plan		Nov. 2018
Training Complete		Nov. 2018
Monroe Expressway Go-Live		***11/26/2018***
Final Testing and Phase Closeout (Monroe Expressway)		
Formal Operational and Acceptance Testing	***11/26/2018***	1/15/2019
As-Built System Detailed Design Document (SDDD) Approved		Jan. 2019
As-Built Drawing Package Approved		Jan. 2019
System Operations / Acceptance (Start of Maintenance Phase for Monroe)		***2/1/2019***

NOTE: RTCS Proposers may be identifying and proposing changes to the interim milestones on the Project Schedule; however, it is critical that the milestone dates in ***italicized & bold font*** are achieved on the dates shown in the schedule.